Aquatic baseline report for Glenora wind farm, Co. Mayo

Prepared by Triturus Environmental Ltd. for McCarthy Keville O'Sullivan Ltd.

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by McCarthy Keville O'Sullivan Ltd. to conduct baseline aquatic surveys to inform EIAR preparation for the Proposed Development. The full description of the Proposed Development is provided in Chapter 4 of this EIAR. The following report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected aquatic species and habitats in the catchment of the proposed Glenora Wind Farm EIAR Site Boundary, located near Ballycastle, Co. Mayo.

Undertaken on a catchment-wide scale, the baseline surveys focused on aquatic habitats in relation to fisheries potential (including both salmonid and lamprey habitat), freshwater pearl mussel (*Margaritifera margaritifera*) (eDNA only), macro-invertebrates (biological water quality), macrophytes and aquatic bryophytes, aquatic invasive species, and fish of conservation value which may use the watercourses in the vicinity of the proposed project (**Figure 2.1**). Aquatic surveys were undertaken in September 2021.

The *n*=17 aquatic survey sites were located within the Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 sub-catchments. Whilst not located within a European site, the proposed Glenora Wind Farm EIAR site Boundary shared downstream hydrological connectivity (via several watercourses) with the Bellacorick Bog Complex SAC (001922).

1.2 Project description

A full description of the Proposed Development is provided in the accompanying EIAR.

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed wind farm project were considered as part of the current assessment. A total of *n*=14 riverine sites and *n*=3 lakes were selected for detailed aquatic assessment (see **Table 2.1, Figure 2.1** below). The nomenclature for the watercourses surveyed is as per the Environmental Protection Agency (EPA). Aquatic survey sites were present on the Owenmore River (EPA code: 33O04), Keerglen River (33K01), Ballykinlettragh Stream (33B32) and a number of unnamed tributaries, in addition to Altderg Lough and two other unnamed lakes (**Table 2.1**). The *n*=17 aquatic survey sites were located within the Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 sub-catchments.

Please note this aquatic report should be read in conjunction with the final Environmental Impact Assessment Report (EIAR) prepared for the proposed project. More specific aquatic methodology is outlined below and in the appendices of this report.

2.2 Aquatic site surveys

Surveys of the watercourses within the catchment of the proposed EIAR Site Boundary were conducted in September 2021. Surveys at each of these sites included a fisheries assessment (electro-fishing, habitat appraisal), macrophyte & aquatic bryophyte surveys and (where suitable) biological water quality sampling (Q-sampling at riverine sites) (**Figure 2.1**). Suitability for freshwater pearl mussel was assessed at each survey site with environmental DNA (eDNA) sampling undertaken for the species at *n*=2 strategically chosen riverine locations within the vicinity of the project. Water samples were also analysed for brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and smooth newt (*Lissotriton vulgaris*) eDNA at the three lake sites. This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed wind farm project.

A broad aquatic habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth etc.)
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type, listing percentage of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

Table 2.1 Location of *n*=17 proposed aquatic survey sites in the vicinity of the proposed Glenora wind farm Development near Ballycastle, Co. Mayo

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Unnamed stream	n/a	Lugnalettin	502865	835088
A2	Unnamed stream	n/a	Lugnalettin	502504	835021
A3	Unnamed stream	n/a	Lugnalettin	502868	834593
A4	Unnamed stream	n/a	Lugnalettin	504596	833956
A5	Unnamed stream	n/a	Lugnalettin	502715	833295
A6	Unnamed stream	n/a	Altderg	502970	832564
A7	Unnamed stream	n/a	Local road crossing, Altderg	501760	831993
A8	Owenmore River	33O04	Bridge at Muinganieran	501496	832109
A9	Owenmore River	33O04	Ford at Srahmeen	501498	829729
B1	Keerglen River	33K01	Keerlglen	505500	832589
B2	Ballykinlettragh Stream	33B32	Keerlglen	505902	832783
B3	Unnamed stream	n/a	Keerlglen	506297	832647
B4	Unnamed stream	n/a	Keerlglen	506607	832656
B5	Keerglen River	33K01	Keerlglen	509072	833090
L1	Unnamed lake	n/a	Altderg	502072	832669
L2	Unnamed lake	n/a	Altderg	502206	832721
L3	Altderg Lough	n/a	Altderg	502304	832510

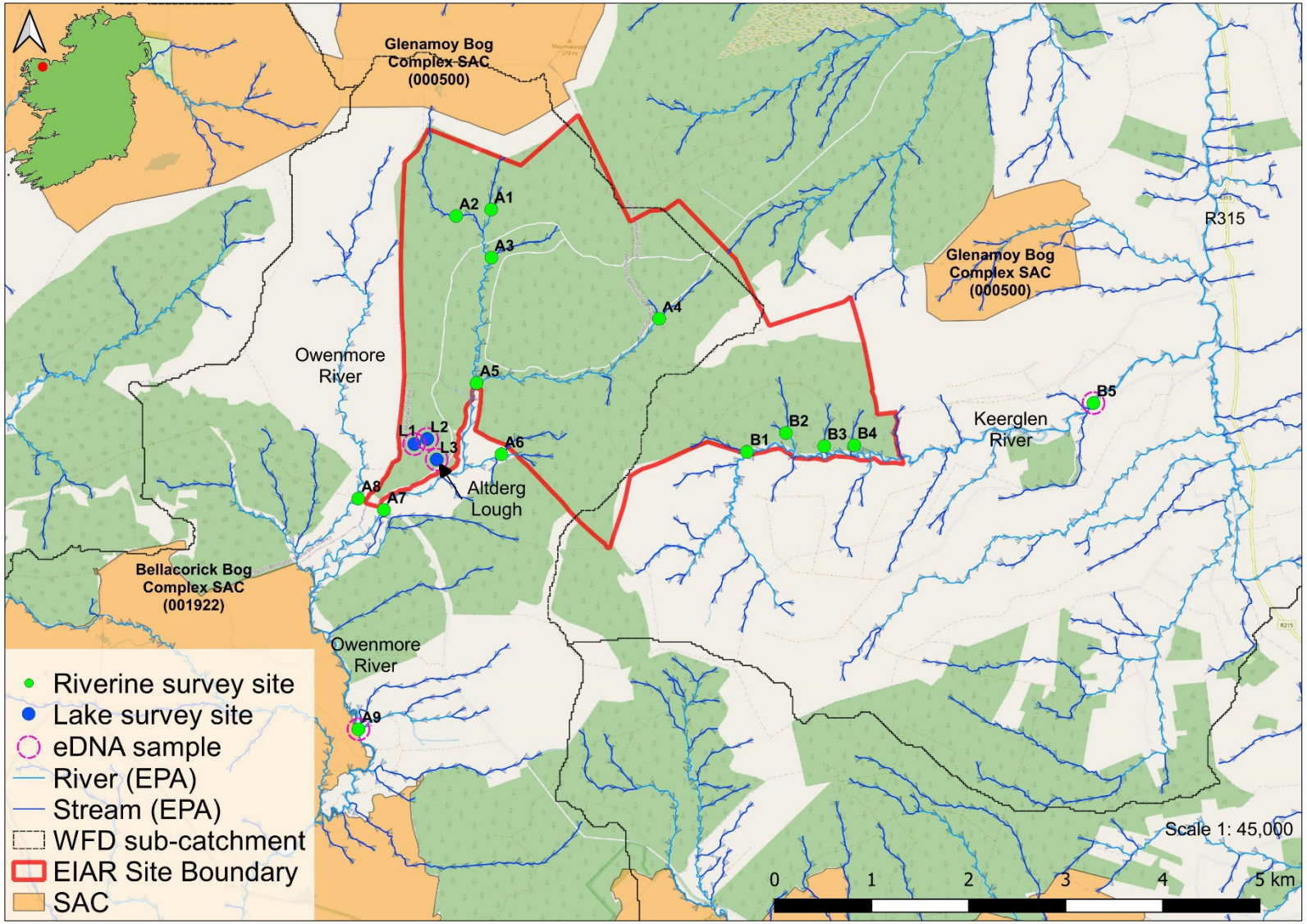

Figure 2.1 Overview of the *n*=17 aquatic survey site and biological water quality sampling locations for the proposed Glenora wind farm Development

2.3 Catchment-wide electro-fishing

A catchment-wide electro-fishing (CWEF) survey of the watercourses within the vicinity of the proposed wind farm (*n*=14 riverine sites, **Figure 2.1**) was conducted in September 2021, under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) licence. The survey was undertaken in accordance with best practice and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the watercourses in the vicinity of the proposed wind farm project (**Figure 2.1**) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within the vicinity of the survey sites.

For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A.**

2.4 Freshwater pearl mussel survey

There are no known freshwater pearl mussel (*Margaritifera margaritifera*) records in the Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 sub-catchments. This was based on an extensive literature review and also examination of the NPWS sensitive species data requests. However, following to the precautionary principle and to account for any lacunae in data for the species, environmental DNA (eDNA) samples were collected from the Owenmore River and Keerglen River and analysed for freshwater pearl mussel eDNA to confirm the species' absence within vicinity of the proposed wind farm site. Please refer to section 2.5 (eDNA analysis) below for further detail.

2.5 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of freshwater pearl mussel within the study area, *n*=2 composite water samples were collected from the Owenmore River (site A9) and Keerglen River (site B5) and analysed for freshwater pearl mussel environmental DNA (eDNA) (**Figure 2.1**). Water samples were also collected from the *n*=3 survey lakes (sites L1, L2 & L3) and analysed for brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and smooth newt (*Lissotriton vulgaris*). The water samples were collected on 26th September 2021, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection).

In accordance with best practice, a composite (500ml) water sample was collected from the sampling point, maximising the geographic spread at the site (20 x 25ml samples at each site), thus increasing the chance of detecting the target species' DNA. The composite sample was filtered on site using a sterile proprietary eDNA sampling kit. The fixed sample was stored at room temperature and sent to the laboratory for analysis with 48 hours of collection. A total of *n*=12 qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at and or upstream of the sampling point. Please refer to **Appendix D** for full eDNA laboratory analysis methodology.

2.6 Biological water quality (Q-sampling)

The *n*=14 riverine survey sites were assessed for biological water quality through Q-sampling in September 2021 (**Figure 2.1**). Macro-invertebrate samples were converted to Q-ratings as per Toner et al. (2005). All riverine samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a three-minute sample. Large cobble was also washed at each site where present and samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

Table 2.2 Reference categories for EPA Q-ratings (Q1 to Q5) (Toner et al., 2005)

Q Value	WFD Status	Pollution status	Condition
Q5 or Q4-5	High status	Unpolluted	Satisfactory
Q4	Good status	Unpolluted	Satisfactory
Q3-4	Moderate status	Slightly polluted	Unsatisfactory
Q3 or Q2-3	Poor status	Moderately polluted	Unsatisfactory
Q2, Q1-2 or Q1	Bad status	Seriously polluted	Unsatisfactory

2.7 Lake macro-invertebrate communities

The *n*=3 lake survey sites (L1, L2 & L3) were sampled for macro-invertebrates via sweep netting. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the lake bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats.

2.8 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading and visual examinations at each of the *n*=14 riverine sites. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species or habitats corresponding to the Annex I habitat, 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses [3260]' (more commonly referred to as 'floating river vegetation'). Grapnel sampling was undertaken at the *n*=3 lake survey sites, with specimens collected by grapnel for on-site identification. Additionally, the site surveys considered the likelihood for rare macrophyte species such as Annex II and IV slender naiad (*Najas flexilis*) to occur. The presence of rare macrophytes was validated by site surveys.

2.9 Otter signs

The presence of otter (*Lutra lutra*) at each aquatic survey site was determined through the recording of otter signs, if encountered during aquatic surveys. Notes on the age and location (ITM coordinates) were made for each otter sign recorded, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, molluscs etc.).

2.10 Aquatic ecological evaluation

The evaluation of aquatic ecological receptors contained within this report uses the geographic scale and criteria defined in the 'Guidelines for Assessment of Ecological Impacts of National Road Schemes' (NRA, 2009).

2.11 Biosecurity

A strict biosecurity protocol including 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. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. 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.

3. Desktop review

3.1 Glenora wind farm catchment and survey area description

The Proposed Development is located in an upland area within the townlands of Glenora, Lugnalettin, Ballykinlettragh and Altderg in north-west County Mayo, approximately 7km south-west of Ballycastle (**Figure 2.1**). The Proposed Development is within the Western River Basin District and within hydrometric area 33 (Blacksod - Broadhaven). The aquatic survey sites were located within Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 sub-catchments (**Figure 2.1**). The proposed wind farm site was drained by the Owenmore River (EPA code: 33O04) to the south and the Keerglen River (33K01) to the east, in addition to a number of associated unnamed tributaries (**Table 2.1**).

The watercourses and aquatic surveys sites in the vicinity of the Proposed Development were typically small, upland eroding channels (FW1; Fossitt, 2000) (see **section 4** for more details). Land use practices in the wider survey area were primarily Forest and semi-natural areas (CORINE 324) and coniferous forestry (CORINE 312) bordered by peat bogs (412). In the wider survey area, the watercourses flowed over areas of Visean sandstone and mudstone (Geological Survey of Ireland data).

3.2 Fisheries asset of the survey area

The Keerglen River (EPA code: 33K01; also known locally as Ballinglen River in its lower reaches) is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2010, 2015). In this river, brown trout growth is noted as being very slow (Kelly et al., 2015). The river also supports sea trout in its lower reaches. This catchment is under environmental pressure with fish stocks below their conservation limit. As a result, the fishery is closed to angling. This closure was introduced as a conservation measure to allow stocks recover (A. Donegan, IFI pers. comm., April 2021).

Within the proposed wind farm site Boundary, the Glennafrankagh River, Glenora River, Fiddaunfrankagh River and Fiddaundoo River (all unnamed on EPA mapping) flow into the Altderg River and on into the Oweninny River (Owenmore River). The Owenmore River is a noted recreational salmon and sea trout fishery (O'Reilly, 2009). After several years of failure to meet its conservation limit for Atlantic salmon the system did achieve its targets in 2020 (Gargan et al., 2021). The proposed wind farm site drains a number of tributary streams of the Oweninny River (Owenmore River) which provides valuable salmon, sea trout and brown trout spawning and nursery habitat for the wider Owenmore River catchment (A. Donegan, IFI pers. comm., April 2021).

Fisheries data for the other (more minor) watercourses within the survey area, as well as Altderg Lough and two other small lakes within the proposed wind farm Boundary, was not available at the time of survey.

3.3 Protected aquatic species data

A sensitive species data request was submitted to the National Parks and Wildlife Service for the 10km grid squares containing and adjoining the Proposed Development (i.e. G02, G03 and G13) and was received on the 20th January 2022. A low number of records for a low number of rare or protected aquatic species were available, although none overlapped directly with the survey area (**Figure 3.1**).

A low number of contemporary otter (*lutra lutra*) records were available for the relevant grid squares, with records from the Keerglen River, Oweninny River and Owenmore River, as well as the Bellanaminnaun River draining to the north of the proposed wind farm (**Figure 3.1**). These records ranged from the 2005-2015 period (NPWS & NBDC data). Additional records were available for the Keerglen River and Altderg River but these were historical only (i.e. 1980).

There was a single record available for common frog (*Rana temporaria*) in the vicinity of the proposed wind farm, with a record from 2003 along the northern extent of the proposed wind farm site Boundary (Glenora townland).

There are no known records for freshwater pearl mussel (*Margaritifera margaritifera*) in the G02, G03 or G13 10km grid squares or the Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 river sub-catchments.

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed wind farm project. Only recent water quality (i.e. since 2015) is summarised below. With the exception of the Keerglen River, there were no existing EPA biological monitoring data available for the watercourses surveyed in the vicinity of the proposed wind farm.

Please note that biological water quality analysis was undertaken as part of this study, with the results presented in the **section 4** and **Appendix B** of this report.

3.4.1 Keerglen River

The Keerglen River (EPA code: 33K01; also known as the Ballinglen River in its lower reaches) drains the eastern portion of the proposed wind farm site Boundary before flowing north to Bunatrahir Bay north of Ballycastle, approx. 10.5km downstream of the wind farm Boundary. There were several EPA biological monitoring stations that had been recently monitored on the river (since 2015). The Keerglen River achieved Q4-5 (high status) at station RS33K010200 in 2020, approx. 3km downstream of the proposed wind farm Boundary. Further downstream, at Ballinglen Bridge (station RS33B010100), the river also achieved Q4-5 (high status) in 2020. In the lower reaches, at New Bridge in Ballycastle (RS33B010200), the river achieved Q3-4 (moderate status) in 2020.

The Keerglen River (Keerglen_010 river-waterbody) was of high WFD status in the 2013-2018 period with a River Waterbodies Risk score of 'not at risk' of achieving good ecological status (EPA data). However, moving downstream the Ballinglen_010 river waterbody was of moderate WFD status in the same period with a River Waterbodies Risk score of 'at risk'. This improved moving downstream, with the Ballinglen_020 river waterbody achieving good WFD status in the 2013-2018 period but with a River Waterbodies score of 'at risk'. The primary risks to water quality in the Glencullin [NorthMayo]_SC_010 sub-catchment are related to hydromorphology and agriculture (EPA, 2019).

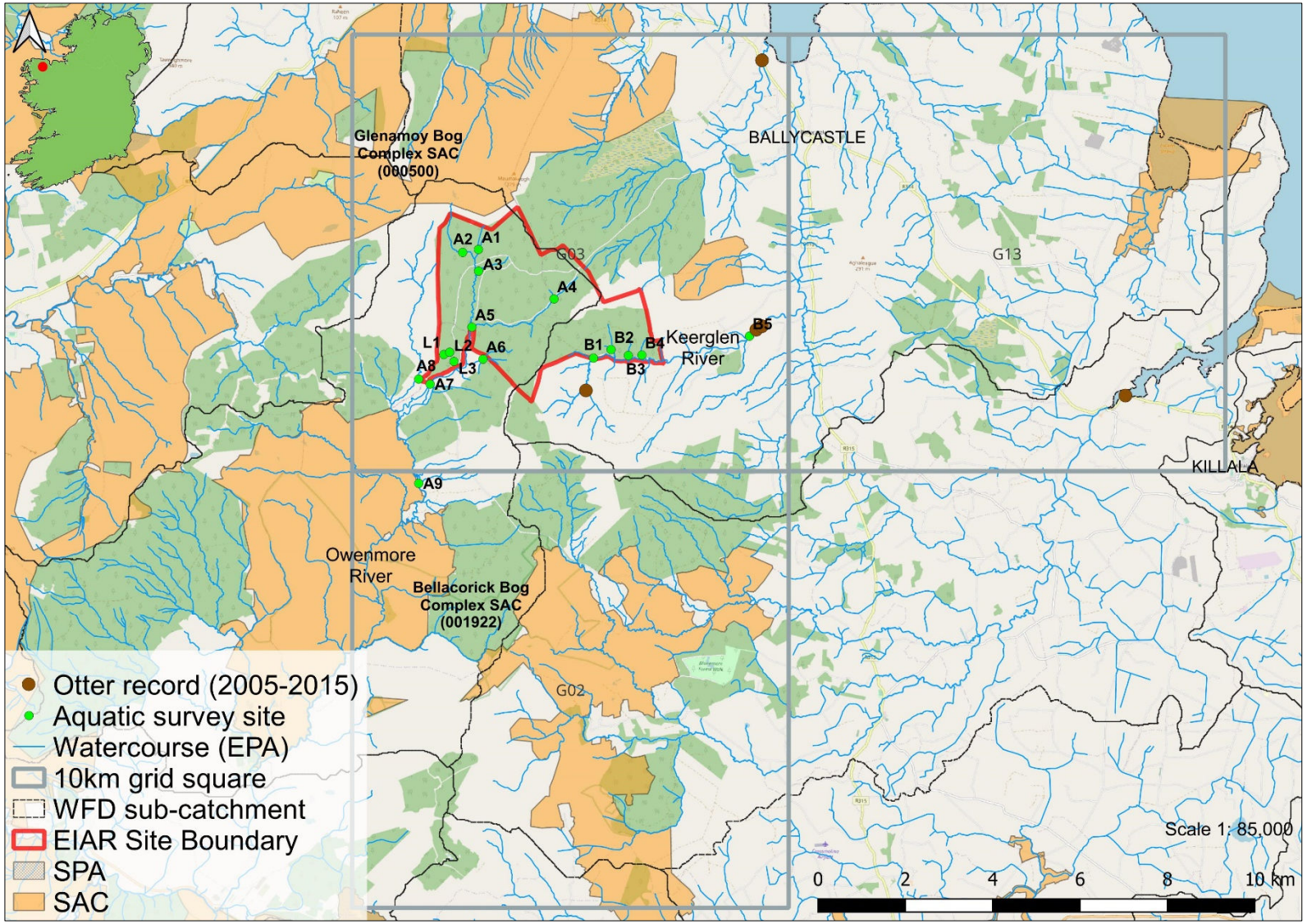

Figure 3.1 Distribution of otter records in the vicinity of the proposed Glenora wind farm Development (source: NPWS & NBDC data, 1996-2015 period)

4. Results of aquatic surveys

The following section summarises each of the *n*=17 survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, macro-invertebrates and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each riverine sampling site (*n*=14) and in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in September 2021. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.2**.

4.1 Aquatic survey site results

4.1.1 Site A1 – unnamed stream, Lugnalettin

Site A1 was located on the upper reaches of a small, unnamed upland eroding watercourse (FW1; no EPA code), within the proposed wind farm site Boundary. The small stream averaged 0.5m wide and 0.1-0.2m deep and flowed through a deeply-incised valley with bankfull heights of 1m. The narrow, first order spate channel had a sinuous profile meandering through the adjoining steep V-shaped valley. The profile was of cascading riffle, glide and pool being dominated by broken water over a very steep gradient. The substrata were mainly small boulder and cobble bedded in peat. The substrata were relatively compacted, given high flow rates. Macrophytes were absent although the site supported very small patches of the moss *Brachythecium rivulare* on larger boulder. The riparian areas were densely vegetated with bracken (*Pteridium aquilinum*) and willow (*Salix* sp.) with mosaics of upland blanket bog (PB2) and wet heath (HH3). The channel was adjoined by semi-mature conifer plantations (WD4) of lodgepole pine (*Pinus contorta*).

No fish were recorded via electro-fishing at site A1 (**Appendix A**). The stream at this location was a poor-quality salmonid nursery given its diminutive size and very steep gradient. It was also a poor-quality salmonid spawning habitat given the high gradient, peat base and absence of suitable spawning gravels. Holding habitat quality was also poor. European eel habitat was poor overall, given the steep gradient, small size and bedded larger substrata. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given siltation pressures and the location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of **Q4** (good status) water quality, the aquatic ecological evaluation of site A1 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.1 Representative image of site A1, September 2021

4.1.2 Site A2 – unnamed stream, Lugnalettin

Site A2 was located on the upper reaches of a small, unnamed upland eroding watercourse (FW1; no EPA code), within the proposed wind farm site Boundary. The stream is known locally as the Glennafrankagh Stream. The upland eroding watercourse (FW1) averaged 2m wide and 0.2-0.4m deep, with 0.5m high banks grading into a very steep V-shaped valley. The high-energy spate channel was dominated by very fast boulder cascade habitat with localised, lower-gradient glide in steps below natural cascade falls. The substrata comprised abundant angular boulder and cobble with small patches of interstitial mixed gravels in pools. The coarse substrata of the bed were loose with only very light siltation. The did not support macrophytes due to its very high energy. However, the bryophyte species *Brachythecium rivulare* and *Platyhypnidium riparoides* were present locally on the tops of boulders. The site was bordered by siliceous upland heath (HH1) with heather (*Calluna vulgaris*), grey willow (*Salix cinerea*), rowan (*Sorbus aucuparia*) and ferns.

Brown trout was the only fish species recorded via electro-fishing at site A2 (**Appendix A**). A moderate density of juveniles were present in addition to a low number of adults. The site was a good-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor given high flows and gradients (none recorded). The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the very high energy of the channel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site A2 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.2 Representative image of site A2, September 2021

4.1.3 Site A3 – unnamed stream, Lugnalettin

Site A3 was located on an unnamed stream (no EPA code) approx. 0.7km downstream of site A2. The stream is known locally as the Fiddaunfrankagh Stream. At this location, the upland eroding watercourse (FW1) averaged 1m wide and varied from 0.2m to 0.5m in depth. The sinuous channel flowed in a U-shaped channel with 1.2m high banks cut into peat. The first order spate channel had boulder cascade sequences with lower-gradient areas of glide and pool. The substrata were dominated by boulder and cobble with small patches of interstitial mixed gravels in pools. The coarse substrata were bedded with moderate siltation (peat). The did not support macrophytes due to its very high energy. However, the bryophyte species *Scapania undulata* was present on boulder tops with the moss *Platyhypnidium riparoides* present along the waterline. The site was bordered by upland blanket bog (PB3), heath (HH1) and immature conifer plantations (WD4).

Brown trout was the only fish species recorded via electro-fishing at site A3 (**Appendix A**). A moderate density of juveniles were present in addition to a low number of small adults. The site was a moderate-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was moderate given the presence of ample boulder and cobble refugia, although none were recorded. given high

flows and gradients (none recorded). The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site A3 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.3 Representative image of site A3, September 2021

4.1.4 Site A4 – unnamed stream, Lugnalettin

Site A4 was located on an unnamed stream (no EPA code) within the wind farm site Boundary. The stream is known locally as the Glenora Stream. At this location, the upland eroding watercourse (FW1) averaged 0.5-1m wide and 0.2-0.4m deep. The narrow, sinuous channel flowed in a U-shaped channel with 1m high banks. The profile was dominated by shallow glide and riffle with occasional deeper pool. The substrata comprised mainly small angular boulder and cobble with interstitial patches of mixed gravels. The coarse substrata of the bed were moderately compacted with moderate siltation. The site did not support macrophytes due to the high-energy nature, peat staining and riparian shading. However, it did support common upland aquatic bryophyte species on instream boulders, including *Scapania undulata* with *Platyhypnidium riparoides* and *Chiloscyphus polyanthos*. The site was bordered by upland blanket bog.

Brown trout was the only fish species recorded via electro-fishing at site A4 (**Appendix A**). The site supported a moderate density of juveniles with a low number of small adults. The site was a moderate-

quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor overall given the small size of the channel and location at the headwaters of the stream. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site A4 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.4 Representative image of site A4, September 2021

4.1.5 Site A5 – unnamed stream, Lugnalettin

Site A5 was located on the upper reaches of an unnamed stream (no EPA code) on the southern Boundary of the proposed wind farm site, approx. 1.7km downstream of site A3. The stream is known locally as the Fiddaunfrankagh Stream. The upland eroding watercourse (FW1) averaged 1.5-2m wide and 0.2-0.4m deep, with localised deeper pool to 0.6m. The channel was situated in a U-shaped channel with 1-1.3m high banks cut into peat and followed a sinuous course through a moderate-gradient, V-shaped valley. The low order spate channel featured frequent boulder-cascade sequences with low-gradient areas of glide and pool. The substrata comprised mainly boulder and cobble with small interstitial patches of mixed gravels in pools. The coarse substrata of the bed were moderately compacted with moderate siltation (peat). The site did not support macrophytes due to the high-energy nature and peat staining. However, it did support occasional *Chiloscyphus polyanthos* with

frequent *Platyhypnidium riparoides* on boulder edges. The site was bordered by siliceous heath (HH1), upland blanket bog (PB2) and immature conifer plantations.

A total of three fish species were recorded via electro-fishing at site A5 (**Appendix A**). The site was dominated by Atlantic salmon (*Salmo salar*), with two size classes present. Low numbers of mixed cohort brown trout were also captured, in addition to a single European eel. The site was a very good quality salmonid nursery given a natural profile and increased size (relative to other low order streams in the vicinity). The site also featured moderate-quality spawning habitat locally at the tailings of deeper pools and glide, where pockets of well-sorted gravels and cobble were present (in lower gradient runs). Holding habitat was limited to more isolated pools and deeper glide. Despite high gradient and flows, the site was of moderate value for European eel given ample instream refugia. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and **Q4** (good status) water quality, the aquatic ecological evaluation of site A5 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.5 Representative image of site A5, September 2021

4.1.6 Site A6 – unnamed stream, Altderg

Site A6 was located on the upper reaches of an unnamed stream (no EPA code) near the southern Boundary of the proposed wind farm site. The stream is known locally as the Fiddaundoo Stream. The upland eroding watercourse (FW1) averaged <1m wide and 0.2-0.3m deep, with localised deeper pool to 0.4m. The small spate channel was situated in a U-shaped channel with low-lying banks and followed a sinuous course through a steep-gradient, V-shaped valley. The profile was cascading riffle, glide and pool, being dominated by broken water over a steep gradient. The substrata comprised boulder and cobble with small interstitial patches of mixed gravels in pools. The coarse substrata of the bed were moderately compacted with moderate siltation (peat). The site did not support macrophytes due to the high-energy nature, riparian shading and peat staining. However, it did support occasional *Platyhypnidium riparoides* on instream boulders. The site was bordered by upland blanket bog (PB2) and conifer plantations (WD4).

Brown trout was the only fish species recorded via electro-fishing at site A6 (**Appendix A**). The site supported a moderate density of juveniles with a low number of adults. The site was a moderate-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor overall given the small size of the channel and location at the headwaters of the stream. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the size of the channel and location in the uppermost reaches of the catchment.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site A6 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.6 Representative image of site A6 on an unnamed stream, September 2021

4.1.7 Site A7 – unnamed river, Altderg

Site A7 was located on an unnamed stream (no EPA code) at a local road crossing, approx. 2km downstream of site A5 and 1.3km upstream of the Owenmore (Oweninny) River confluence and Bellacorick Bog Complex SAC (001922). Known locally as the Altderg River, the river at this location was an upland eroding spate channel (FW1) that averaged 4-5m wide and 0.2-0.6m deep. The channel was shallow U-shaped in profile with 1-1.5m high banks. The profile was dominated by riffle and glide with more localised deeper pool. Peat-staining was high at the time of survey. The substrata were dominated by compacted boulder and large cobble with small patches of coarse gravels. The high-energy site did not support macrophytes. However, submerged boulders supported the upland aquatic moss *Fontinalis squamosa* while wetted emergent boulders supported *Platyhypnidium riparoides*. The muddy banks supported the liverwort *Conocephalum conicum*. The site was bordered by largely open banks with scattered sitka spruce (*Picea sitchensis*), grey willow and ash (*Fraxinus excelsior*). The adjoining land use was wetter improved grassland (GA1) that graded into blanket bog on higher ground. Conifer plantations (WD4) were present upstream.

A total of four fish species were recorded via electro-fishing at site A7 (**Appendix A**). The site was dominated by relatively high densities of Atlantic salmon parr, with two size classes present. Low numbers of three-spined stickleback (*Gasterosteus aculeatus*) and mixed cohort brown trout were also present, in addition to a single juvenile European eel. The site was a very good-quality salmonid nursery given the presence of shallow glide and riffle areas with boulder and cobble refugia. However, the site was only of moderate value as a salmonid spawning habitat, given more limited gravels and a dominance of coarser substrata. Salmonid holding habitat was locally good given the presence of deeper pool and glide. The site was of moderate value for European eel given the presence of large boulder and cobble refugia but reduced somewhat because of a more compacted bed. The upland

eroding site was unsuitable for lamprey (none recorded). There was low suitability for freshwater pearl mussel given the compaction of substrata.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site A6 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.7 Representative image of site A7, September 2021

4.1.8 Site A8 – Owenmore River, bridge at Muinganieran

Site A8 was located on the upper reaches of the Owenmore River (33O04) at a local road crossing, approx. 1km upstream of the Bellacorick Bog Complex SAC (001922). The river at this location is also known locally as the Inagh River. At this location, the upland eroding spate channel (FW1) was 2-3m wide and 0.2-0.5m deep. The river flowed in a shallow U-shaped channel (1m-high banks) and followed a sinuous course. The profile was dominated by riffle and shallow glide with only very localised deeper pool. The water was peat stained at the time of survey (as with the majority of the survey sites in the catchment). The substrata were dominated by boulder and large cobble with small patches of coarse gravels. The high-energy site did not support macrophytes. However, submerged boulders supported the aquatic mosses *Fontinalis antipyretica* and *Brachythecium rivulare*. The site was bordered by semi-improved grassland (GA1) with open riparian areas devoid of trees.

A total of three fish species were recorded via electro-fishing at site A8 (**Appendix A**). The site was dominated by relatively high densities of Atlantic salmon parr, with two size classes present. Low

numbers of mixed cohort brown trout were also present, in addition to a single juvenile European eel. The site was a very good-quality salmonid nursery given the presence of shallow glide and riffle areas with boulder and cobble refugia. However, the site was only of moderate value as a salmonid spawning habitat, given more limited gravels and a dominance of coarser substrata. Salmonid holding habitat was moderate only due to a paucity of deeper glide and pool. The site was of moderate value for European eel given the presence of large boulder and cobble refugia but reduced somewhat given the high-energy nature of the site. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given mobile nature of the bed due to the high energy of the channel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and **Q4** (good status) water quality, the aquatic ecological evaluation of site A8 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.8 Representative image of site A8 on the upper Owenmore River, September 2021

4.1.9 Site A9 – Owenmore River, Srahmeen Ford

Site A9 was located on the Owenmore River (33O04) at a local ford crossing, approx. 3.5km downstream of site A8 and 1km upstream of the Bellacorick Bog Complex SAC (001922). The river at this location is also known locally as the Oweninny River. The upland eroding watercourse (FW1) averaged 5-8m wide and varied from 0.3 to 1.2m deep. The sinuous channel flowed over a lower gradient compared with upstream site A8. The sandy-loam banks were 3-4m high on average. The profile was of slow-moving glide and deeper pool with heavily peat-stained water. The substrata were dominated by medium and finer gravels with a high sand fraction. The gravels were partially

compacted and had moderate to high siltation. The site supported occasional beds of bog pondweed (*Potamogeton polygonifolious*) and alternate-leaved milfoil (*Myriophyllum alterniflorum*). The site was bordered by wet improved grassland (GA1) that graded into blanket big on higher ground. The banks were open with only scattered rowan, hawthorn (*Crataegus monoygna*) and bracken. Coniferous plantations (WD4) were present upstream.

A total of five fish species were recorded (vial electro-fishing) at site A9 (**Appendix A**). The site supported low numbers of mixed cohort Atlantic salmon parr and brown trout, in addition to three-spined stickleback and minnow (*Phoxinus phoxinus*). *Lampetra* sp. ammocoetes were also recorded at a density of 11 per m^2. The site was a good quality salmonid nursery although spawning habitat was of moderate quality only given siltation of gravels. Good-quality holding habitat was present in deeper glide and pool areas. European eel habitat as moderate overall, being reduced due to a paucity of suitable refugia. Areas of soft sediment provided good-quality lamprey nursery habitat, locally, with spawning habitat (finer gravels) of moderate quality due to siltation. There was some suitability for freshwater pearl mussel but none were recorded.

Biological water quality, based on Q-sampling, was calculated as **Q4-5 (high status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Site A9 is located within the Bellacorick Bog Complex SAC (001922) (no aquatic species listed as qualifying interests; NPWS, 2017) and is thus of **international importance**. The presence of a salmonid population (including Atlantic salmon), *Lampetra* sp. and **Q4-5** (high status) water quality are also noteworthy ecological attributes.

Plate 4.9 Representative image of site A9 on the Owenmore River, September 2021

4.1.10 Site B1 – Keerglen River, Keerglen

Site B1 was located on the upper reaches of the Keerglen River (33K01), along the southern Boundary of the proposed wind farm site. The upland eroding watercourse (FW1) averaged 2.5m wide and 0.2-0.5m deep. The river followed a natural meandering course in a U-shaped channel with bankfull heights of 1m. The profile of the high-energy site comprised lower-gradient boulder-cascade sequences with equal proportions of riffle, glide and pool. Peat-staining was high at the time of survey. The substrata were dominated by large boulder and cobble with localised areas of interstitial mixed gravels. The substrata had low siltation as a consequence of the high energy of the site. The site did not support macrophytes but aquatic bryophytes were abundant, including *Platyhypnidium riparoides*, *Racomitrium aciculare* and *Fontinalis antipyretica* on large boulders. The liverwort *Chiloscyphus polyanthos* was recorded on submerged boulders. The site was bordered by upland blanket bog (PB2) with adjoining coniferous plantations (WD4).

Brown trout and European eel were the only two fish species recorded via electro-fishing at site B1 (**Appendix A**). The site supported a healthy mixed cohort trout population, with a single adult eel also recorded. The site was a very good-quality nursery for brown trout given a well-defined thalweg, increased size (relative to other low order channels in the vicinity) and a natural profile. Some moderate-quality spawning habitat was present but this was highly localised at the tailings of deeper pools and glide, due to the high energy. Holding habitat was of good-quality overall, with ample cover in pools below boulder cascade areas. The site was of moderate value for European eel, given the presence of ample boulder and cobble refugia for the species. The upland eroding site was unsuitable for lamprey (none recorded). There was limited suitability for freshwater pearl mussel given the high energy of the river at the survey site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population and **Q4** (good status) water quality, the aquatic ecological evaluation of site B1 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.10 Representative image of site B1 on the upper Keerglen River, September 2021

4.1.11 Site B2 – Ballykinlettragh Stream, Keerglen

Site B2 was located on an Ballykinlettragh Stream (33B32) approx. 0.25km upstream of the Keerglen River confluence. The high-energy upland eroding watercourse (FW1) averaged 0.5m wide and 0.1-0.2m deep. The very narrow stream was situated in a U-shaped channel grading into a V-shaped river valley. The profile was of very slow flowing glide and pool, with low flows at the time of survey (channel may dry up during drier periods). However, the flows increased with increasing gradient towards the Keerglen River. The substrata comprised large boulder and cobble which were bedded in peat. The site did not support macrophytes due to its very high energy and riparian shading. However, instream boulders supported occasional *Scapania undulata*. The site was bordered by pre-thicket lodgepole pine conifer plantations (WD4) on upland blanket bog (PB2).

No fish were recorded (via electro-fishing) at site B2 (**Appendix A**). The site provided poor salmonid nursery and holding habitat given the small size and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. There was no suitability for lamprey or freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative Q-rating given the lack of flow and suitable riffle areas for sampling. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of high conservation value, in addition to **Q3** (poor status) water quality, the aquatic ecological evaluation of site B2 was of **local importance (lower value)** (**Table 4.2**).

Plate 4.11 Representative image of site B2 on the Ballykinlettragh Stream, September 2021

4.1.12 Site B3 – Unnamed stream, Keerglen

Site B2 was located on an unnamed Keerglen River tributary (no EPA code) approx. 0.1km upstream of the Keerglen River confluence. The high-energy upland eroding watercourse (FW1) averaged 1.5m wide and 0.1-0.2m deep. The small spate stream was situated in a V-shaped channel with steep banks grading into a V-shaped river valley. The profile of the first order channel was of steep boulder-cascade sequences. The substrata were dominated by large boulder and cobble with gravels being largely absent. The coarse substrata were bedded with moderate to high siltation. The site did not support macrophytes due to its very high energy and riparian shading. However, instream boulders supported *Jungermannia atrovirens* near the waterline with *Platyhypnidium riparoides* on boulder tops. The site was situated in an immature lodgepole pine plantation (WS2) with patches of grey willow scrub adjoining the channel.

No fish were recorded (via electro-fishing) at site B3 (**Appendix A**). The site provided poor salmonid nursery and holding habitat given the small size and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. There was no suitability for lamprey or freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of high conservation value, in addition to **Q3-4** (moderate status) water quality, the aquatic ecological evaluation of site B3 was of **local importance (lower value)** (**Table 4.2**).

Plate 4.12 Representative image of site B3 on an unnamed Keerglen River tributary, September 2021

4.1.13 Site B4 – Unnamed stream, Keerglen

Site B4 was located on an unnamed Keerglen River tributary (no EPA code) approx. 0.1km upstream of the Keerglen River confluence. The high-energy upland eroding watercourse (FW1) averaged 1m wide and 0.1-0.2m deep. The small spate stream was situated in a V-shaped channel with steep banks grading into a V-shaped river valley. The profile of the first order channel was of steep boulder-cascade sequences. The substrata were dominated by large boulder and cobble with gravels being largely absent. The coarse substrata were bedded with moderate to high siltation. The site did not support macrophytes due to its very high energy and riparian shading. However, instream boulders supported *Jungermannia atrovirens* near the waterline with *Brachythecium rivulare* on boulder tops. The site was situated in an immature lodgepole pine plantation (WS2).

No fish were recorded (via electro-fishing) at site B3 (**Appendix A**). The site provided poor salmonid nursery and holding habitat given the small size and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. There was no suitability for lamprey or freshwater pearl mussel.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of **Q4** (good status) water quality, the aquatic ecological evaluation of site B4 was of **local importance (higher value)** (**Table 4.2**).

Plate 4.13 Representative image of site B4 on an unnamed Keerglen River tributary, September 2021

4.1.14 Site B5 – Keerglen River, Keerglen

Site B5 was located on the Keerglen River (33K01), approx. 4.5km downstream of site B1 and 2.5km downstream of the proposed wind farm site Boundary. At this location, the upland eroding watercourse (FW1) averaged 8-10m wide and 0.3-0.6m deep. The river flowed along a natural meandering course in a V-shaped valley. The upland spate river featured boulder-cascade sequences with lower-gradient areas of glide and pool. The substrata comprised large boulder and large cobble with only very localised areas of interstitial mixed gravels (in pools). The substrata were non-mobile and had low siltation (as a consequence of the high energy of the site). The site did not support macrophytes given the high-energy nature, riparian shading and peat-staining. However, *Platyhypnidium riparoides* and *Racomitrium aquaticum* were present on large boulders. The liverwort *Jungermannia atrovirens* was locally frequent on submerged boulders. The riparian areas supported mature hazel (*Corylus avellana*), ash, rowan and hawthorn and adjoined wet improved grassland (GA1).

A total of three fish species were recorded via electro-fishing at site B5 (**Appendix A**). The site supported moderate densities of Atlantic salmon parr (two size classes) and mixed-cohort brown trout. A single European eel was also recorded. The site was a very good-quality salmonid nursery given good flows, an increased size (relative to other low order channels in the vicinity) and a natural

profile. Some moderate-quality spawning habitat was present but this was highly localised at the tailings of deeper pools and glide, due to the high energy. Holding habitat was of good-quality overall, with ample cover in pools below boulder cascade areas. The site was of moderate value for European eel, given the presence of ample boulder and cobble refugia for the species. The upland eroding site was unsuitable for lamprey (none recorded). There was no suitability for freshwater pearl mussel given the compaction of substrata.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a salmonid population (including Atlantic salmon) and **Q4** (good status) water quality, the aquatic ecological evaluation of site B5 was of **local importance (higher value)** (**Table 4.2**).

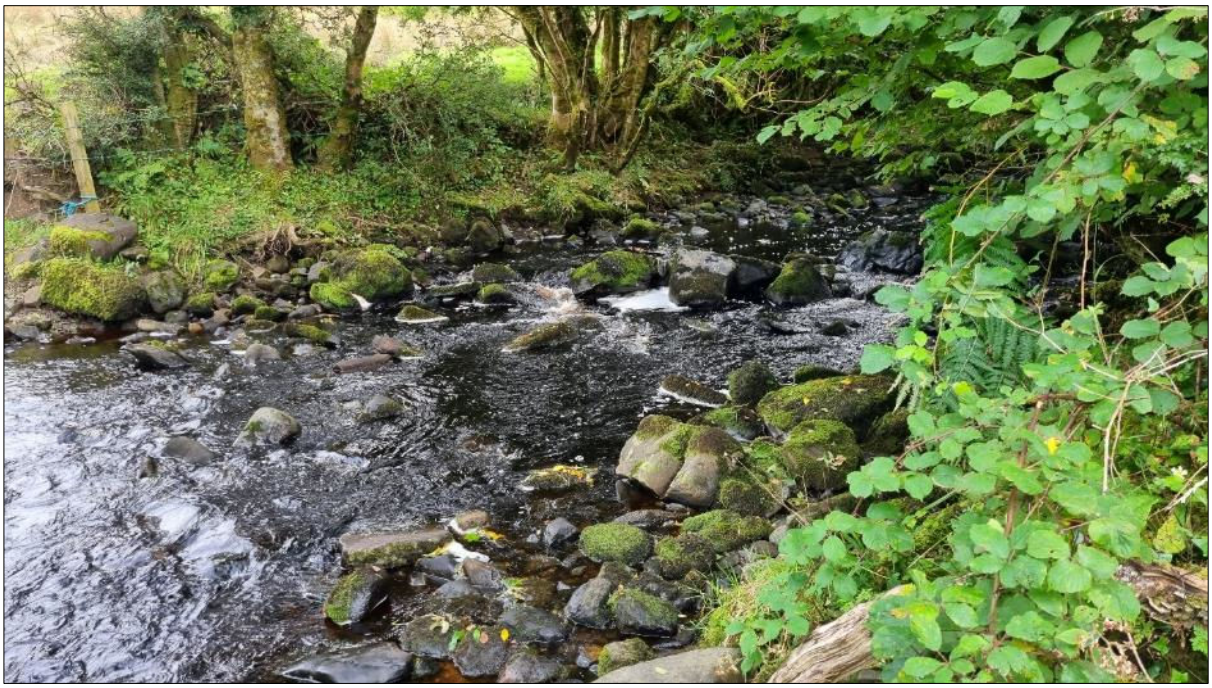

Plate 4.14 Representative image of site B5 on the Keerglen River, September 2021

4.1.15 Site L1 – Unnamed lake, Altderg

Site L1 was located to the south-western extent of the proposed wind farm site Boundary. The small dystrophic lake (pH of 4.53; FL1 habitat) covered an area of approx. 0.02ha and averaged 0.5m deep with a bed comprised entirely of deep, soft silt (peat). The small shallow basin supported abundant floating mats of *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. mosses which covered c.90% of the lake's surface. The basin also supported occasional bog bean (*Menyanthes trifoliata*). The lake's quaking margins supported the aforementioned *Sphagnum* species in addition to *Sphagnum magellanicum* on hummocks. These margins graded into adjoining blanket bog habitat. The *Sphagnum*-dominated lake corresponds to the Annex I habitat 'Blanket bogs [7130]'. Adjoining the dystrophic lake basin, semi-mature lodgepole pine plantations (WD4) were present within 5m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. Whilst no brown trout eDNA was detected, low levels of European eel eDNA were detected (**Table 4.1; Appendix D**). This result was considered as evidence of the presence of eel at this site. Additionally, smooth newt eDNA was not detected in the water sample and this result was considered as evidence of the species' absence at this site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Given the lake corresponds to the Annex I habitat 'Blanket bogs (*if active) [7130]', the aquatic ecological evaluation of site L2 was of **county importance**[1] (**Table 4.2**). The presence of European eel (confirmed by eDNA analysis) was also noteworthy.

Plate 4.15 Representative image of site L1, September 2021

4.1.16 Site L2 – Unnamed lake, Altderg

Site L2 was located to the south-western extent of the proposed wind farm site Boundary, adjacent to site L1. The small dystrophic lake (pH of 4.39; FL1 habitat) covered an area of approx. 0.25ha and ranged from 0.5 to 2m in depth. The bed was comprised entirely of deep, soft silt (peat). As per site L1, the small shallow basin supported abundant floating mats of *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. mosses, which covered c.90% of the lake's surface. The basin also supported occasional bog bean. The lake's quaking margins supported the aforementioned *Sphagnum* species in addition to *Sphagnum magellanicum,* purple moor grass (*Molinia carulea*) and heather on hummocks. These margins graded into adjoining blanket bog habitat. The *Sphagnum*-dominated lake

[1] sites containing areas of habitat listed in Annex I of the Habitats Directive "that do not fulfil the criteria for valuation of international and or national importance" (NRA, 2009).

corresponds to the Annex I habitat 'Blanket bogs [7130]'. Adjoining the dystrophic lake basin, semi-mature lodgepole pine plantations (WD4) were present within 5m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. Despite some good suitability, no brown trout or European eel eDNA was detected, (**Table 4.1; Appendix D**). This result was considered as evidence of species' absence at this site. Additionally, smooth newt eDNA was not detected in the water sample and this result was considered as evidence of the species' absence at this site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Given the lake corresponds to the Annex I habitat 'Blanket bogs (*if active) [7130]', the aquatic ecological evaluation of site L2 was of **county importance** (**Table 4.2**).

Plate 4.16 Representative image of site L2, September 2021

4.1.17 Site L3 – Altderg Lough, Altderg

Site L3 (Altderg Lough) was located to the south-western extent of the proposed wind farm Boundary, immediately south of sites L1 and L2. The small dystrophic lake (pH of 4.94; FL1 habitat) covered an area of approx. 1.1ha and averaged 2-4m deep with a deep silt (peat) base. The lake featured steep marginal shelves, particularly along the southern shore. The margins supported quaking margins adjoining blanket bog habitat on the northern bank with *Sphagnum cuspidatum* and *Sphagnum subsecundum* agg. The main basin supported localised stands of bogbean and white-water lily (*Nymphaea alba*) with small patches of bottle sedge (*Carex rostrata*), marginally. The littoral areas were predominantly deep and supported abundant quillwort (*Isoetes lacustris*) and submerged bulbosus rush (*Juncus bulbosus*). Lesser bladderwort (*Utricularia minor*) was present but rare. Very

localised stands of floating bur-reed (*Sparganium angustifolium*) were present along the northern shoreline. The lake corresponds with the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'. These lakes are known to be species-poor, are *Sphagnum*-dominated at the margins and form an ecotone with blanket bog (O'Connor, 2015). Adjoining the dystrophic lake basin, semi-mature lodgepole pine plantations (WD4) were present within 5m of the shoreline.

Whilst a targeted fisheries survey was not undertaken at this site, a composite water sample was analysed for brown trout and European eel eDNA. Whilst no brown trout eDNA was detected, low levels of European eel eDNA were detected (**Table 4.1; Appendix D**). This result was considered as evidence of the presence of eel at this site. Additionally, smooth newt eDNA was not detected in the water sample and this result was considered as evidence of the species' absence at this site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting of macrophytes and lake substrata (**Appendix C**).

Given the lake corresponds to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]', the aquatic ecological evaluation of site L3 was of **county importance** (**Table 4.2**). The presence of European eel (confirmed by eDNA analysis) was also noteworthy.

Plate 4.17 Representative image of site L3, September 2021 (facing towards northern shoreline)

4.2 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=14 riverine sites in September 2021 (**Figure 4.1, Appendix B**).

Site A9 (Owenmore River) achieved **Q4-5 (high status)** water quality, based on Q-sampling, and thus met the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). This site was elevated above Q4 (good status) based on the presence of presence of five Group A (pollution sensitive) species. These included the clean water indicator mayflies *Ecdyonurus dispar*, *Rhithrogena semicolorata* and *Heptagenia sulphurea*, in addition to the stonefly species *Chloroperla tripunctata* and *Nemoura cinerea* (**Appendix B**).

A total of 12 no. survey sites (i.e. sites A1, A2, A3, A4, A5, A6, A7, A8, B1, B3, B4 & B5) achieved **Q4 (good status)** water quality, based on Q-sampling, and thus met the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). These sites achieved good status based on the presence of ≥1 group A species in 'fair numbers', such as *Ecdyonurus dispar* and *Protonemura meyeri* (**Appendix B**).

Site B2 on the Ballykinlettragh Stream achieved **Q3 (poor status)** water quality given the absence of group A species, a paucity of group B (less sensitive) species and a dominance of group C (pollution tolerant) species such as the caseless caddis *Plectrocnemia conspersa*, freshwater shrimp (*Gammarus duebeni*) and Chironomid larvae (excl. *Chironomus* sp.) (**Appendix B**). Thus, site B2 was the only riverine survey site that failed to meet the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC).

4.3 Lake macro-invertebrates

No rare or protected macro-invertebrate species were recorded in the sweep samples taken from *n*=3 lake sites (**Appendix C**).

The three lakes (sites L1, L2 & L3) supported a moderate diversity of low-abundance species typical of dystrophic lake habitats. The lakes supported Odonata species such as the common hawker (*Aeshna juncea*), four-spotted chaser (*Libellula quadrimaculata*) and *Coenagrion* sp. damselfly, in addition to Dipteran larvae such as Chironomid and Chaoboridae. Gerridae (pond skater) and Corixidae (water boatmen) species were also present in low numbers. Lakes L2 and L3 also supported low abundance of an unidentified *Cloeon* sp. mayfly (**Appendix C**).

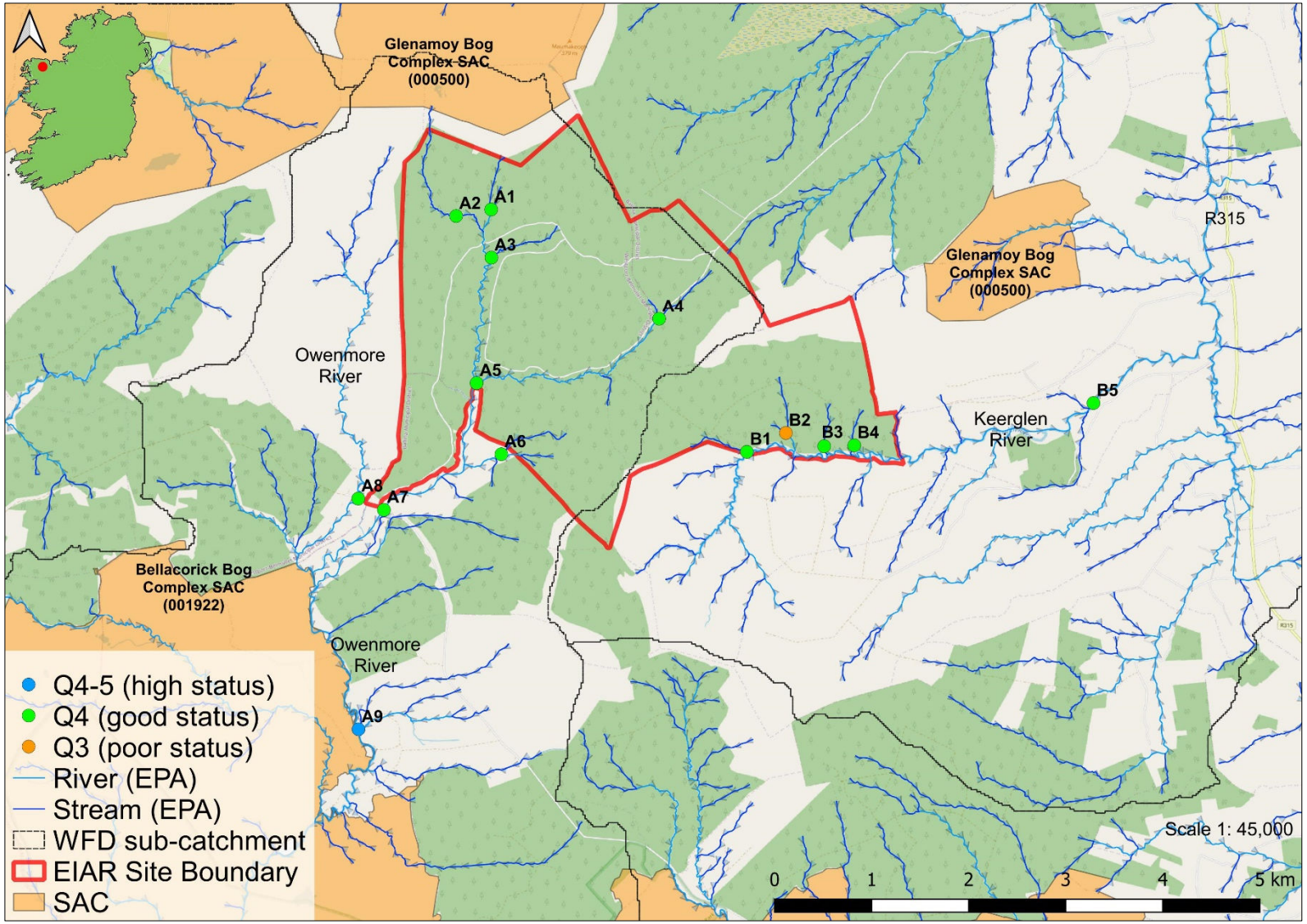

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Glenora wind farm Development, Co. Mayo

4.4 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the *n*=23 survey sites. Similarly, no examples of the Annex I habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]' (aka floating river vegetation) was recorded during the surveys.

4.5 eDNA analysis

Composite water samples collected from the Keerglen River (FK48) and Owenmore River (FK198) returned a negative result for freshwater pearl mussel eDNA, i.e. freshwater pearl mussel eDNA not present or was present below the limit of detection in a series of 12 qPCR replicates (0 positive replicates out of 12, respectively) (**Table 4.1**; **Appendix D**).

All three lake water samples (FK91, FK92 & FK94) tested negative for brown trout eDNA (0 of 12 qPCR replicates, respectively) (**Table 4.1**). However, European eel eDNA was detected in lakes L1 and L3 (1 of 12 qPCR replicates, respectively) (**Table 4.1**). No smooth newt eDNA was detected in the three lake samples. This result was considered as evidence of the species' absence at these sites.

Table 4.1 eDNA results in the vicinity of the proposed Glenora wind farm, Co. Mayo (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	Freshwater pearl mussel	Brown trout	European eel	Smooth newt
FK48	Keerglen River (site B5)	Negative (0/12)	n/a	n/a	n/a
FK198	Owenmore River (site A9)	Negative (0/12)	n/a	n/a	n/a
FK92	Unnamed lake (L1)	n/a	Negative (0/12)	**Positive (1/12)**	Negative (0/12)
FK94	Unnamed lake (L2)	n/a	Negative (0/12)	Negative (0/12)	Negative (0/12)
FK91	Unnamed lake (L3)	n/a	Negative (0/12)	**Positive (1/12)**	Negative (0/12)

4.6 Invasive aquatic species

No aquatic invasive species were recorded during the survey of a total of *n*=14 riverine sites or three unnamed lakes in September 2021.

4.7 Otter signs

No otter signs (i.e. spraint, latrine, slide, prints, couch or holt) were recorded at the *n*=17 aquatic survey sites during September 2021 while conducting aquatic surveys. However, otter are known in the downstream connecting Keerglen River and Owenmore River (Owenmore River) (see section 3.1; **Figure 3.1**).

4.8 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of electro-fishing, macrophyte, aquatic invertebrate, eDNA analysis and biological water quality surveys (**Table 4.2**).

Site A9 on the Owenmore River is located within the Bellacorick Bog Complex SAC (001922) and is thus of **international importance**. Additionally, the site also supported Annex II Atlantic salmon, Annex II *Lampetra* sp. and **Q4-5** (high status) water quality.

Sites L1 and L2 were evaluated as being of **county importance** given that they supported good examples of the Annex I habitat 'Blanket bogs (*if active) [7130]'. Site L3 was also evaluated as as being of **county importance** given the site supported a good example of the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'.

With the exception of site B2 (see below), all other aquatic survey sites were evaluated as **local importance (higher value)**. Primarily, this evaluation was due to the presence of salmonids and ≥**Q4** (good status) water quality.

Site B2 on the Ballykinlettragh Stream was evaluated as being of **local importance (lower value)**, given the absence of aquatic species or habitats of high conservation value, in addition to having **Q3** (poor status) water quality.

Table 4.2 Aquatic ecological evaluation summary of the survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Unnamed stream	n/a	**Local importance (higher value)**	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
A2	Unnamed stream	n/a	**Local importance (higher value)**	Good-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A3	Unnamed stream	n/a	**Local importance (higher value)**	Moderate-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A4	Unnamed stream	n/a	**Local importance (higher value)**	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A5	Unnamed stream	n/a	**Local importance (higher value)**	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon, brown trout & European eel recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A6	Unnamed stream	n/a	**Local importance (higher value)**	Moderate-quality salmonid & poor-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A7	Unnamed stream	n/a	**Local importance (higher value)**	Very good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon, brown trout, three-spined stickleback & European eel recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A8	Owenmore River	33O04	**Local importance (higher value)**	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon, brown trout & European eel recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
A9	Owenmore River	33O04	**International importance**	Located within the Bellacorick Bog Complex SAC (001922); good-quality salmonid habitat, moderate-quality European eel habitat and good-quality lamprey habitat, no value for freshwater pearl mussel; Atlantic salmon, brown trout, three-spined stickleback, European eel and *Lampetra* sp. recorded via electro-fishing; Q4-5 (high status) water quality; no other aquatic species or habitats of high conservation value
B1	Keerglen River	33K01	**Local importance (higher value)**	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; brown trout & European eel recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value
B2	Ballykinlettragh Stream	33B32	Local importance (lower value)	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q3 (poor status) water quality (tentative value due to low flows); no aquatic species or habitats of high conservation value
B3	Unnamed stream	n/a	**Local importance (higher value)**	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
B4	Unnamed stream	n/a	**Local importance (higher value)**	Poor-quality salmonid & European eel habitat, no value for lamprey or freshwater pearl mussel; no fish recorded via electro-fishing; Q4 (good status) water quality; no aquatic species or habitats of high conservation value
B5	Keerglen River	33K01	**Local importance (higher value)**	Good-quality salmonid & moderate-quality European eel habitat, no value for lamprey or freshwater pearl mussel; Atlantic salmon, brown trout & European eel recorded via electro-fishing; Q4 (good status)

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
				water quality; no other aquatic species or habitats of high conservation value
L1	Unnamed lake	n/a	**County importance**	Small, shallow dystrophic lake; no brown trout or smooth newt[1] detected by eDNA but European eel eDNA was detected (i.e. species present); the *Sphagnum*-dominated lake corresponds to the Annex I habitat 'Blanket bogs [7130]; no aquatic species or other habitats of high conservation value
L2	Unnamed lake	n/a	**County importance**	Small, shallow dystrophic lake; no brown trout, European eel or smooth newt eDNA recorded via eDNA analysis (i.e. species absent); the *Sphagnum*-dominated lake corresponds to the Annex I habitat 'Blanket bogs [7130]; no aquatic species or other habitats of high conservation value
L3	Altderg Lough	n/a	**County importance**	Small, shallow dystrophic lake; no brown trout or smooth newt eDNA recorded via eDNA analysis but European eel eDNA detected (i.e. species present); lake corresponds to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]'; no aquatic species or other habitats of high conservation value

[1] Smooth newt (*Lissotriton vulgaris*), as well as common frog (*Rana temporaria*), are protected under the Wildlife Act (1976-2021). Furthermore, common frogs are protected under Annex V of the Habitats Directive [92/42/EEC]

Conservation value: Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (L*ampetra planeri*), river lamprey (*Lampetra fluviatilis*), freshwater pearl mussel (*Margaritifera margaritifera*) and otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon, river lamprey, freshwater pearl mussel and otter are also listed under Annex V of the Habitats Directive [92/42/EEC]. Freshwater pearl mussel and otters (along with their breeding and resting places) are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. 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). With the exception of the Fisheries Acts 1959 to 2019, brown trout have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

Site A9 on the Owenmore River is located within the Bellacorick Bog Complex SAC (001922) and is thus of **international importance**. Additionally, the site also supported Annex II Atlantic salmon, Annex II *Lampetra* sp. and **Q4-5** (high status) water quality. The *Sphagnum*-dominated lakes surveyed at sites L1 and L2 corresponded to the Annex I habitat 'Blanket bog [7130]' and were considered of **county importance** given they supported good examples of this habitat. These small, shallow lakes featured >90% surface cover of *Sphagnum* spp. mosses, with occasional stands of bog bean (*Menyanthes trifoliata*). The much larger lake L3 (1.1ha surface area), corresponded to the Annex I habitat 'Natural dystrophic lakes and ponds [3160]' and was also evaluated as **county importance**. The lake supported typical species of such habitats (O'Connor, 2015; EC, 2013) including bog bean, white water lily (*Nymphaea alba*) bottle sedge (*Carex rostrata*), bulbosus rush (*Juncus bulbosus*), lesser bladderwort (*Utricularia minor*), floating bur-reed (*Sparganium angustifolium*) and abundant quillwort (*Isoetes lacustris*). None of the lakes supported brown trout or smooth newt (confirmed by eDNA analysis) although European eel eDNA was detected in lakes L1 and L3. With the exception of site B2 on the Ballykinlettragh Stream, which was evaluated as **local importance (lower value)**, all other aquatic survey sites were evaluated as **local importance (higher value)**. Primarily, this was due to the presence of salmonid populations and ≤**Q4** (good status) water quality.

Atlantic salmon were recorded (via electro-fishing) from a total of 5 no. sites. These were located on the Owenmore River (sites A8 & A9) and two unnamed tributaries (sites A5 & A7) as well as a site on the Keerglen River (site B5). Brown trout were also recorded from these sites, in addition to sites A2, A3, A4, A6 and B1 (10 no. sites in total). Most of the watercourses surveyed only supported brown trout given their narrow, shallow and high-gradient, upland nature. The sites on the Owenmore River (A8 & A9), unnamed river (site A7, aka. Altderg River) and Keerglen River (B5) provided the best overall salmonid habitat, with good-quality nursery habitat present at all three sites. Whilst suitability was largely absent throughout the survey sites given the upland, eroding nature of the watercourses, *Lampetra* sp. ammocoetes were recorded from a single site on the Owenmore River (site A9). A moderate density of ammocoetes (11 per m^2) was recorded from marginal sand/silt accumulations. This site also provided the only suitable lamprey spawning habitat within the survey area. European eel habitat was typically poor to moderate, at best, across the riverine survey sites due to high flows, gradients and naturally compacted substrata. Eel were only recorded (via electro-fishing) from sites A5 (unnamed stream), A7 (unnamed stream), A8 (Owenmore River) and B1 & B5 (Keerglen River) (**Appendix A**). Environmental DNA analysis also detected eel in lake sites L1 and L3 (**Table 4.1**).

No otter signs (i.e. spraint, latrine, slide, prints, couch or holt) were recorded at the *n*=17 aquatic survey sites during September 2021. Suitability was typically poor given the small and or high-energy, upland nature of most watercourses surveyed. However, otter are known in the downstream connecting Keerglen River and Owenmore River (see section 3.1; **Figure 3.1**).

The riverine survey sites were typically unsuitable for freshwater pearl mussel given that many were located in the upper extent of river catchments, in addition to sub-optimal substrata and siltation

pressures (primarily from peat escapement). Analysis of water samples collected from the Owenmore River and Keerglen River did not detect pearl mussel eDNA (see section 4.6) and there are no known records of the species in the vicinity of the proposed wind farm or in the downstream hydrologically connected catchments.

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=14 riverine sites (**Appendix B**). With the exception of sites B2 (Q3, poor status, tentative rating), all survey sites achieved **≥Q4 (good status)** water quality and, thus, met the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). Site A9 (Owenmore River) achieved **Q4-5 (high status)** water quality.

In summary, the majority of the aquatic survey areas in the study area were of **local importance (higher value)** in terms of their aquatic ecology. However, enrichment pressures (primarily from upland afforestation) and peat escapement (siltation) are considerable threats to water quality in the watercourses draining the proposed wind farm site Boundary. Typically, larger watercourses with higher flow rates, such as the Owenmore River and Keerglen River, are better able to buffer against such impacts and these watercourses generally supported the best quality aquatic habitat within the vicinity of the proposed wind farm for aquatic receptors of conservation value, such as salmonids. The three lake survey sites corresponded to Annex I habitats (7130 or 3160) and are, therefore, considered of considerable aquatic ecological value.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

Fisheries assessment of Glenora wind farm, Co. Mayo

Prepared by Triturus Environmental Ltd. for McCarthy Keville O' Sullivan Ltd.

October 2023

Please cite as:

Triturus (2022). Aquatic baseline report for Glenora wind farm, Co. Mayo. Report prepared by Triturus Environmental Ltd. for McCarthy Keville O' Sullivan Ltd. February 2022.

Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by McCarthy Keville O' Sullivan Ltd. to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Glenora wind farm, located near 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 Development. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the catchment of the proposed Glenora wind farm EIAR site boundary, a catchment-wide electro-fishing survey across *n*=14 riverine 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 and European eel (*Anguilla anguilla*), as well as other species, and helped to further inform impact assessment and any subsequent mitigation for the project. Environmental DNA and fisheries appraisal surveys at a total of *n*=3 lake sites were also undertaken (please refer to accompanying aquatic baseline report).

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 Glenora wind farm. Permission was granted on 6th August 2021 and the survey was undertaken in late September 2021.

1.2 Fisheries asset of the survey area

The survey sites were located in the Owenmore [Mayo]_SC_010 and Glencullin [North Mayo]_SC_010 sub-catchments. Whilst not located within a European site, the proposed wind farm site boundary shared downstream hydrological connectivity (via several watercourses) with the Bellacorick Bog Complex SAC (001922).

Fisheries survey sites were present on the Owenmore River (EPA code: 33O04), Keerglen River (33K01), Ballykinlettragh Stream (33B32) and a number of unnamed tributaries (**Table 2.1**; **Figure 2.1**).

The Keerglen River (EPA code: 33K01; also known locally as Ballinglen River in its lower reaches) is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2010, 2015). In this river, brown trout growth is noted as being very slow (Kelly et al., 2015). The river also supports sea trout in its lower reaches. This catchment is under environmental pressure with fish stocks below their conservation limit. As a result, the fishery is closed to angling. This closure was introduced as a conservation measure to allow stocks recover (A. Donegan, IFI pers. comm., April 2021).

Within the proposed wind farm site boundary, the Glennafrankagh River, Glenora River, Fiddaunfrankagh River and Fiddaundoo River (all unnamed on EPA mapping) flow into the Altderg River and on into the Oweninny River (Owenmore River). The Owenmore River is a noted recreational salmon and sea trout fishery (O'Reilly, 2009) and, after several years of failure, was meeting its

conservation limit for Atlantic salmon in 2020 (Gargan et al., 2021). The proposed wind farm site drains a number of tributary streams of the Oweninny River (Owenmore River) which provides valuable salmon, sea trout and brown trout spawning and nursery habitat for the wider Owenmore River catchment (A. Donegan, IFI pers. comm., April 2021).

Fisheries data for the other (more minor) watercourses within the survey area, as well as Altderg Lough and two other small lakes within the proposed wind farm EIAR Site Boundary, was not available at the time of survey. However, eDNA was collected at two of these small lakes with European eel detected in lakes L1 and L3 (see accompanying aquatic report).

2. Methodology

2.1 Fish stock 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 Glenora wind farm in September 2021, following notification to Inland Fisheries Ireland (IFI) and the National Parks and Wildlife Service (NPWS), under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) 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). The catchment-wide electro-fishing (CWEF) survey was undertaken across *n*=14 riverine sites (see **Table 2.1, Figure 2.1**).

Table 2.1 Location of *n*=14 electro-fishing survey sites in the vicinity of Glenora wind farm, Co. Mayo

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Unnamed stream	n/a	Lugnalettin	502865	835088
A2	Unnamed stream	n/a	Lugnalettin	502504	835021
A3	Unnamed stream	n/a	Lugnalettin	502868	834593
A4	Unnamed stream	n/a	Lugnalettin	504596	833956
A5	Unnamed stream	n/a	Lugnalettin	502715	833295
A6	Unnamed stream	n/a	Altderg	502970	832564
A7	Unnamed stream	n/a	Local road crossing, Altderg	501760	831993
A8	Owenmore River	33O04	Bridge at Muinganieran	501496	832109
A9	Owenmore River	33O04	Ford at Srahmeen	501498	829729
B1	Keerglen River	33K01	Keerlglen	505500	832589
B2	Ballykinlettragh Stream	33B32	Keerlglen	505902	832783
B3	Unnamed stream	n/a	Keerlglen	506297	832647
B4	Unnamed stream	n/a	Keerlglen	506607	832656
B5	Keerglen River	33K01	Keerlglen	509072	833090

2.1.1 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. 50-100m 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 (**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 low conductivity waters of the sites, a voltage of 350-400v, frequency of 30-35Hz and pulse duration of 3-3.5ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 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, approx. 10-15 cm 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

2.2.1 General fisheries habitat

A broad appraisal of the upstream and downstream habitat at each site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. 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 including 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. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. 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.

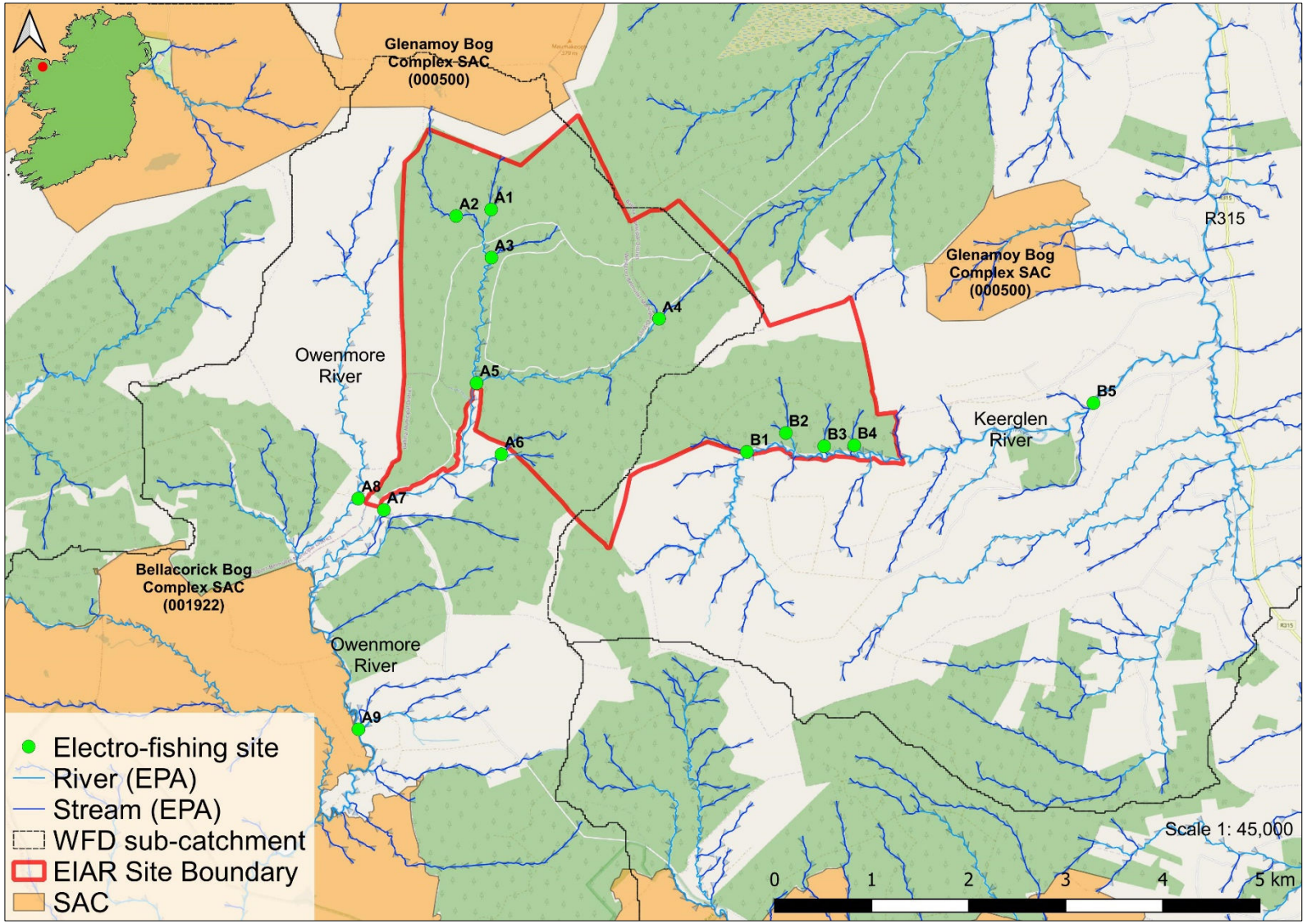

Figure 2.1 Location overview of the *n*=14 electro-fishing sites in vicinity of the proposed Glenora wind farm, Co. Mayo

3. Results

A catchment-wide electro-fishing survey of *n*=14 sites in the vicinity of the proposed Glenora wind farm development (**Figure 2.1**) was conducted in September 2021, following notification to Inland Fisheries Ireland (IFI) and the National Parks and Wildlife Service (NPWS). 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 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – unnamed stream, Lugnalettin

No fish were recorded at site A1. The stream at this location was a poor-quality salmonid nursery given its diminutive size and very steep gradient. It was also a poor-quality salmonid spawning habitat given the high gradient, peat base and absence of suitable spawning gravels. Holding habitat quality was also poor. European eel habitat was poor overall, given the steep gradient, small size and bedded larger substrata. The upland eroding site was unsuitable for lamprey (none recorded).

Plate 3.1 Representative image of site A1, September 2021

3.1.2 Site A2 – unnamed stream, Lugnalettin

Brown trout (*Salmo trutta*) was the only fish species recorded at site A2 (**Figure 3.1**). A moderate density of juveniles were present in addition to a low number of adults (*n*=32 total).

The site was a good-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated

pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor given high flows and gradients (none recorded). The upland eroding site was unsuitable for lamprey (none recorded).

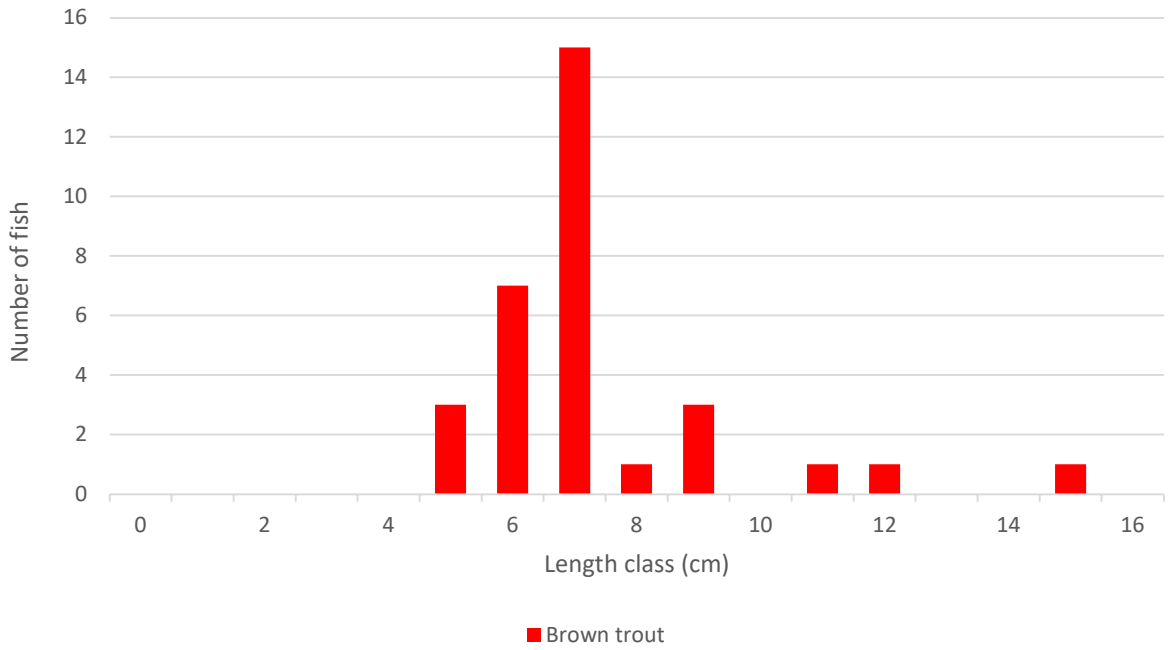

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1, September 2021

Plate 3.2 Representative image of site A2, September 2021

3.1.3 Site A3 – unnamed stream, Lugnalettin

Brown trout was the only fish species recorded at site A3 (**Figure 3.2**). A moderate density of juveniles were present in addition to a low number of small adults (*n*=21 total).

The site was a moderate-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was moderate given the presence of ample boulder and cobble refugia, although none were recorded. given high flows and gradients (none recorded). The upland eroding site was unsuitable for lamprey (none recorded).

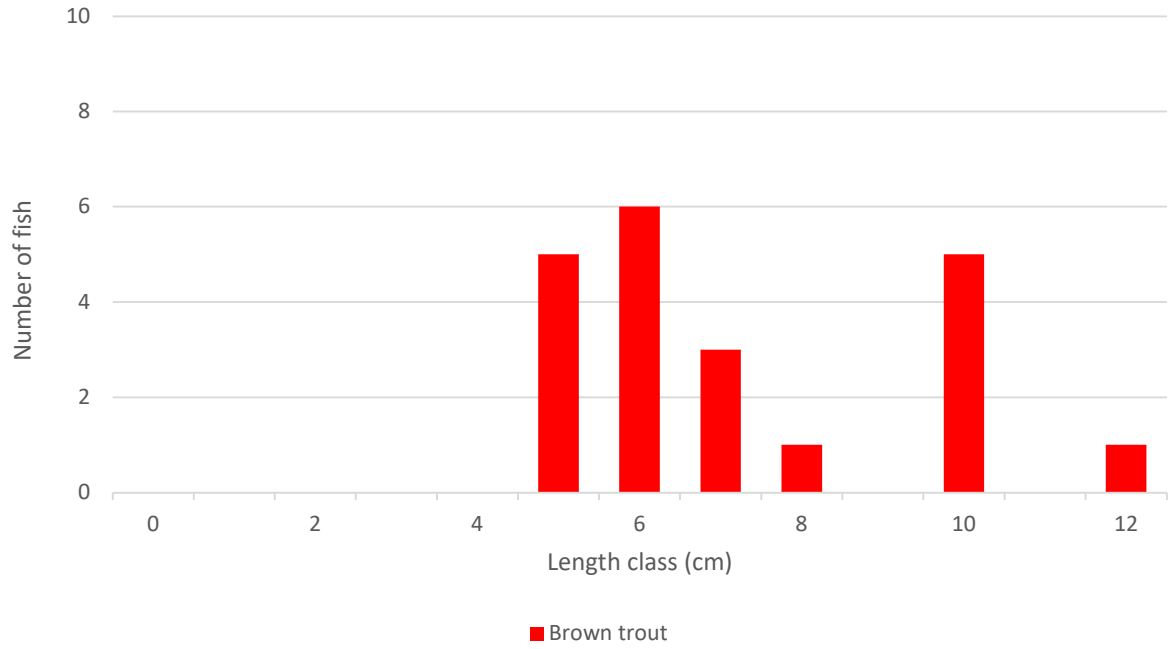

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A3, September 2021

Plate 3.3 Brown trout recorded from site A3, September 2021

3.1.4 Site A4 – unnamed stream, Lugnalettin

Brown trout was the only fish species recorded at site A4 (**Figure 3.3**). The site supported a moderate density of juveniles with a low number of small adults (*n*=26 total).

The site was a moderate-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor overall given the small size of the channel and location at the headwaters of the stream. The upland eroding site was unsuitable for lamprey (none recorded).

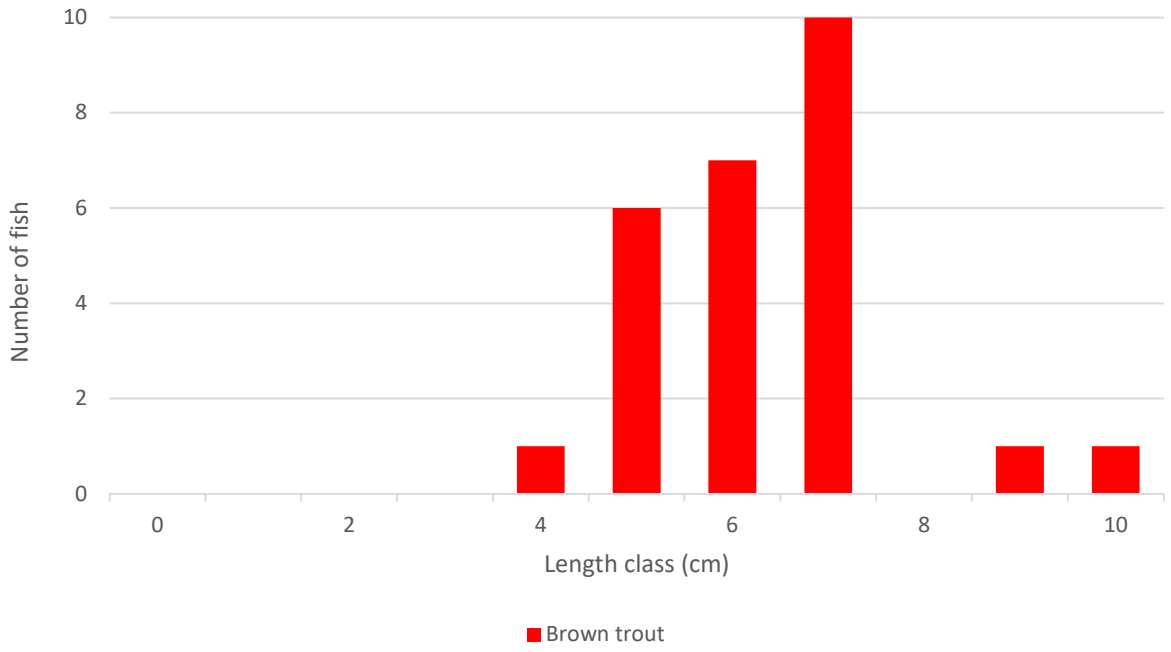

Figure 3.3 Length frequency distribution recorded via electro-fishing at site A4, September 2021

Plate 3.4 Mixed-cohort brown trout recorded at site A4, September 2021

3.1.5 Site A5 – unnamed stream, Lugnalettin

A total of three fish species were recorded at site A5 (**Figure 3.4**). The site was dominated by Atlantic salmon (*Salmo salar*), with two size classes present (*n*=30 total). Low numbers of mixed cohort brown trout were also captured (*n*=12), in addition to a single adult European eel (*Anguilla anguilla*).

The site was a very good quality salmonid nursery given a natural profile and increased size (relative to other low order streams in the vicinity). The site also featured moderate-quality spawning habitat locally at the tailings of deeper pools and glide, where pockets of well-sorted gravels and cobble were present (in lower gradient runs). Holding habitat was limited to more isolated pools and deeper glide. Despite high gradient and flows, the site was of moderate value for European eel given ample instream refugia. The upland eroding site was unsuitable for lamprey (none recorded).

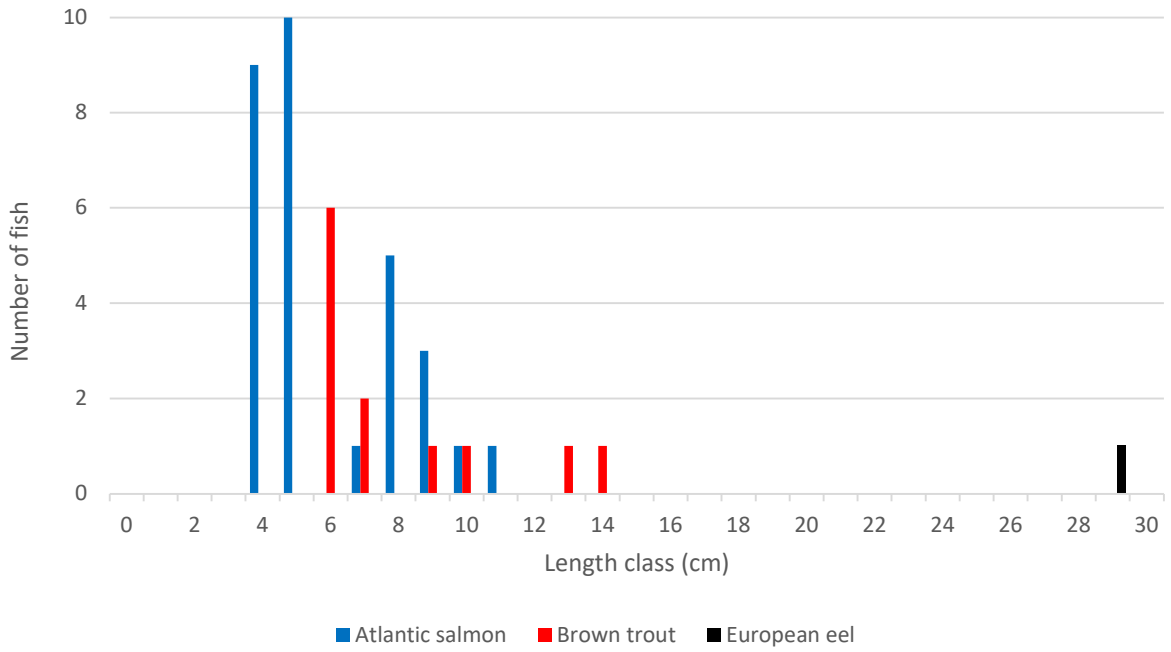

Figure 3.4 Length frequency distribution recorded via electro-fishing at site A5, September 2021

Plate 4.5 Representative image of site A5, September 2021

3.1.6 Site A6 – unnamed stream, Altderg

Brown trout was the only fish species recorded at site A6 (**Figure 3.5**). The site supported a moderate density of juveniles with a low number of adults (*n*=22 total).

The site was a moderate-quality salmonid nursery, with the tailings of pools (featuring more gravels) providing some moderate-quality spawning habitat. Holding habitat was limited to more isolated pools adjoining longer stretches of riffle and glide but was considered good locally for brown trout. European eel habitat was poor overall given the small size of the channel and location at the headwaters of the stream. The upland eroding site was unsuitable for lamprey (none recorded).

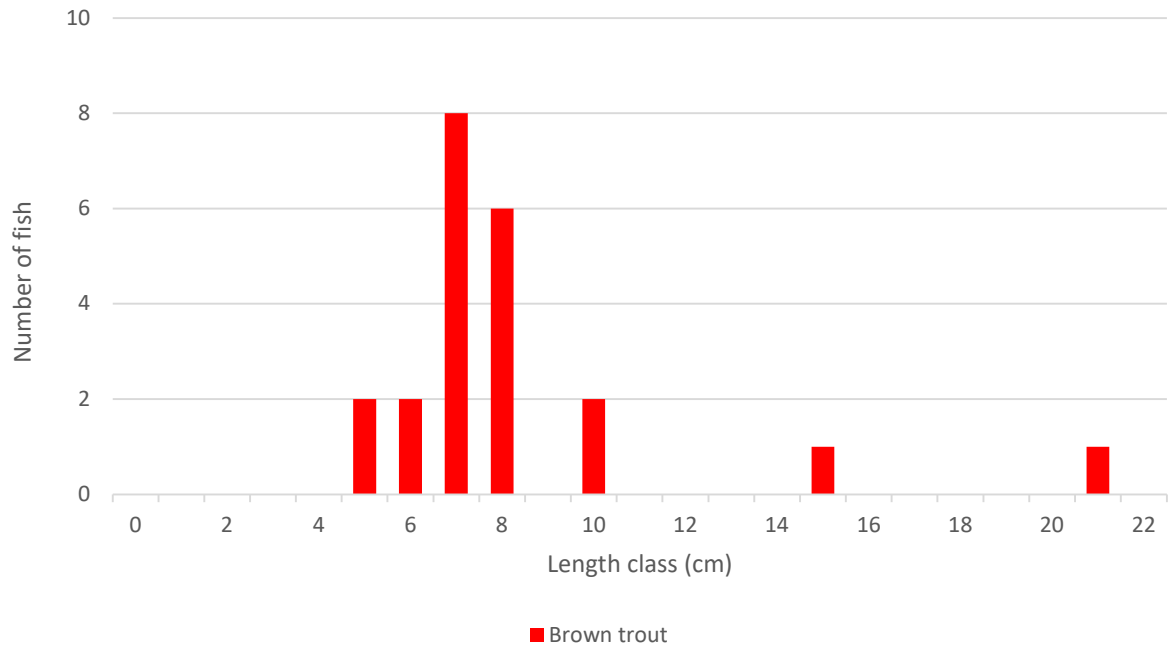

Figure 3.5 Length frequency distribution recorded via electro-fishing at site A6, September 2021

Plate 3.6 Representative image of site A6 on an unnamed stream, September 2021

3.1.7 Site A7 – unnamed river, Altderg

A total of four fish species were recorded at site A7 (**Figure 3.6**). The site was dominated by relatively high densities of Atlantic salmon parr, with two size classes present (*n*=54 total, most 0+). Low numbers of three-spined stickleback (*Gasterosteus aculeatus*) (*n*=2) and mixed cohort brown trout (*n*=13) were also present, in addition to a single juvenile European eel.

The site was a very good-quality salmonid nursery given the presence of shallow glide and riffle areas with boulder and cobble refugia. However, the site was only of moderate value as a salmonid spawning habitat, given more limited gravels and a dominance of coarser substrata. Salmonid holding habitat was locally good given the presence of deeper pool and glide. The site was of moderate value for European eel given the presence of large boulder and cobble refugia but reduced somewhat because of a more compacted bed. The upland eroding site was unsuitable for lamprey (none recorded).

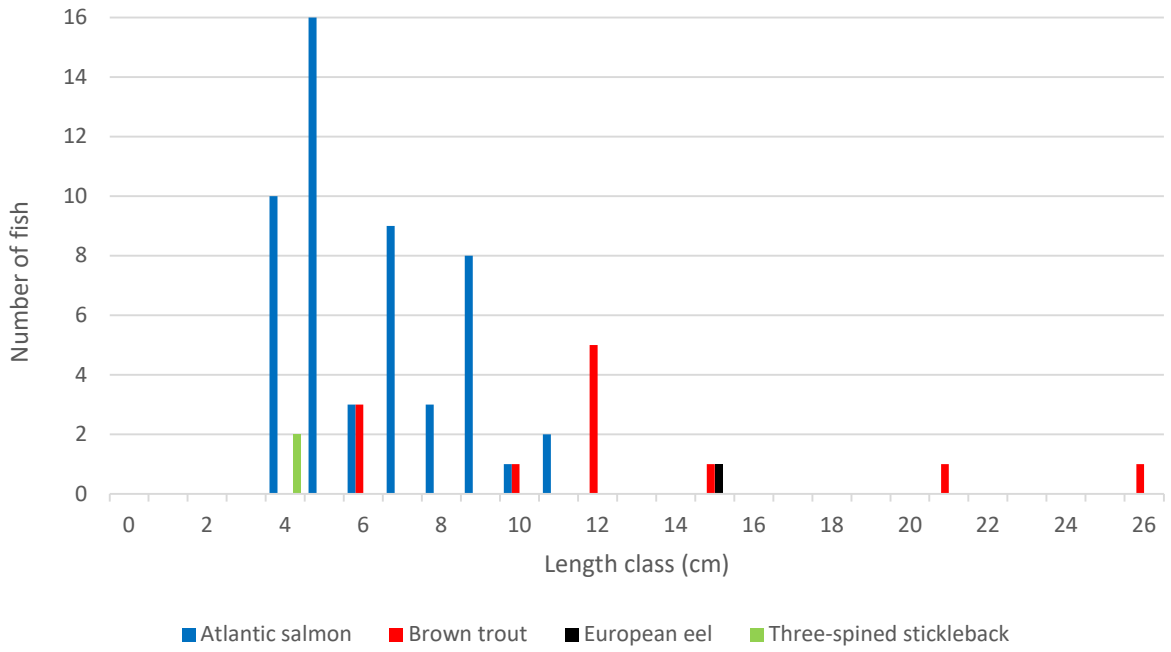

Figure 3.6 Length frequency distribution recorded via electro-fishing at site A7, September 2021

Plate 3.7 Representative image of site A7, September 2021

3.1.8 Site A8 – Owenmore River, bridge at Muinganieran

A total of three fish species were recorded at site A8 (**Figure 3.7**). The site was dominated by relatively high densities of Atlantic salmon parr, with two size classes present (*n*=42 total, mostly 0+). Low numbers of mixed cohort brown trout were also present (*n*=11), in addition to a single juvenile European eel.

The site was a very good-quality salmonid nursery given the presence of shallow glide and riffle areas with boulder and cobble refugia. However, the site was only of moderate value as a salmonid spawning habitat, given more limited gravels and a dominance of coarser substrata. Salmonid holding habitat was moderate only due to a paucity of deeper glide and pool. The site was of moderate value for European eel given the presence of large boulder and cobble refugia but reduced somewhat given the high-energy nature of the site. The upland eroding site was unsuitable for lamprey (none recorded).

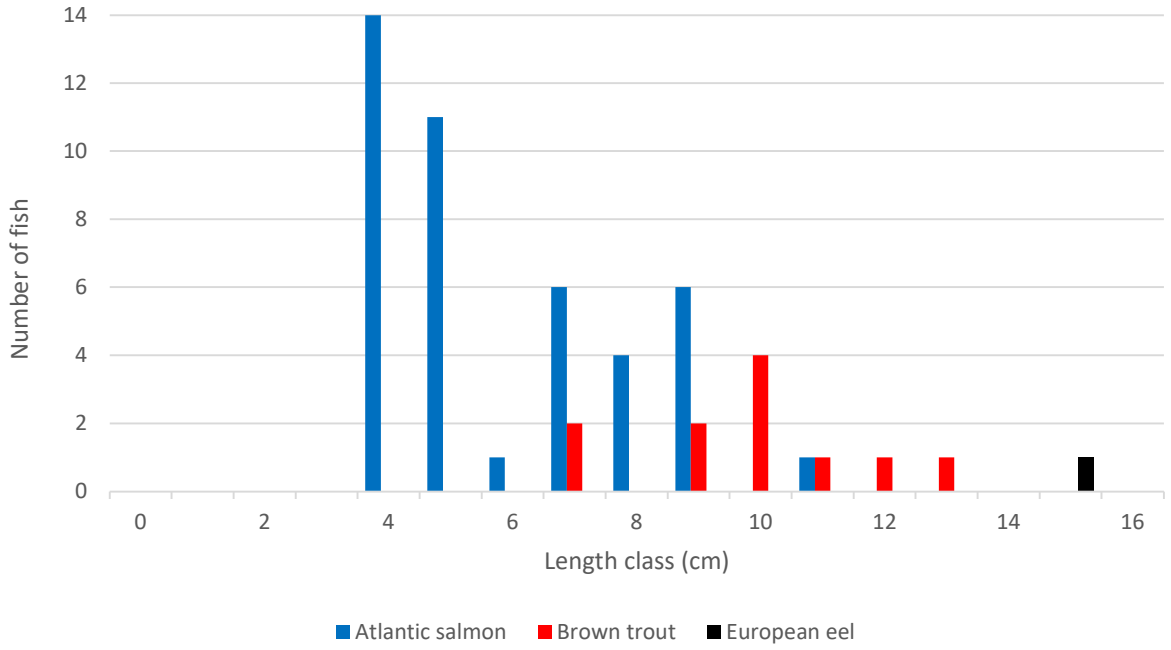

Figure 3.7 Length frequency distribution recorded via electro-fishing at site A8, September 2021

Plate 3.8 Representative image of site A8 on the upper Owenmore River, September 2021

3.1.9 Site A9 – Owenmore River, Srahmeen Ford

A total of five fish species were recorded at site A9 (**Figure 3.8**), the highest species density species recorded during the survey. The site supported low numbers of mixed cohort Atlantic salmon parr (*n*=16) and brown trout (*n*=11), in addition to three-spined stickleback (*n*=1) and minnow (*Phoxinus phoxinus*) (*n*=15). *Lampetra* sp. ammocoetes were also recorded at a density of 11 per m^2 (*n*=22 total).

The site was a good quality salmonid nursery although spawning habitat was of moderate quality only given siltation of gravels. Good quality holding habitat was present in deeper glide and pool areas. European eel habitat as moderate overall, being reduced due to a paucity of suitable refugia. Areas of soft sediment provided good-quality lamprey nursery habitat, locally, with spawning habitat (finer gravels) of moderate quality due to siltation.

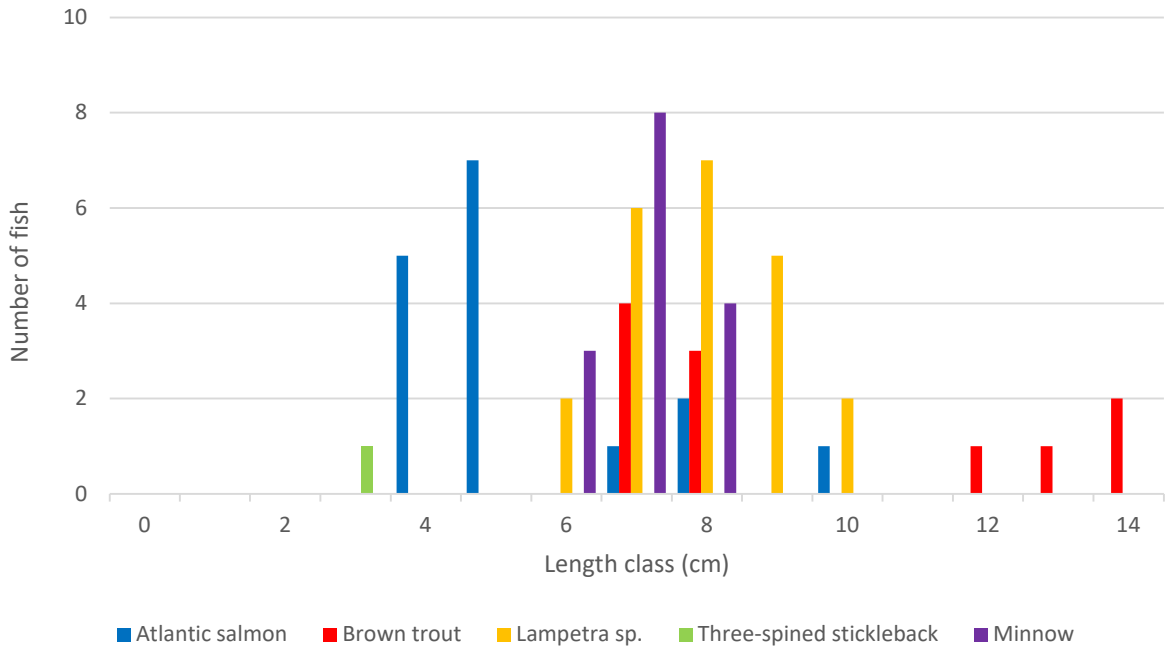

Figure 3.8 Length frequency distribution recorded via electro-fishing at site A9, September 2021

Plate 3.9 *Lampetra* sp. ammocoetes recorded at site A9 on the Owenmore River, September 2021

3.1.10 Site B1 – Keerglen River, Keerglen

Brown trout and European eel were the only two fish species recorded at site B1 (**Figure 3.9**). The site supported a healthy mixed cohort trout population (*n*=36 total), with a single adult eel also recorded.

The site was a very good-quality nursery for brown trout given a well-defined thalweg, increased size (relative to other low order channels in the vicinity) and a natural profile. Some moderate-quality

spawning habitat was present, but this was highly localised at the tailings of deeper pools and glide, due to the high energy. Holding habitat was of good quality overall, with ample cover in pools below boulder cascade areas. The site was of moderate value for European eel, given the presence of ample boulder and cobble refugia for the species. The upland eroding site was unsuitable for lamprey (none recorded).

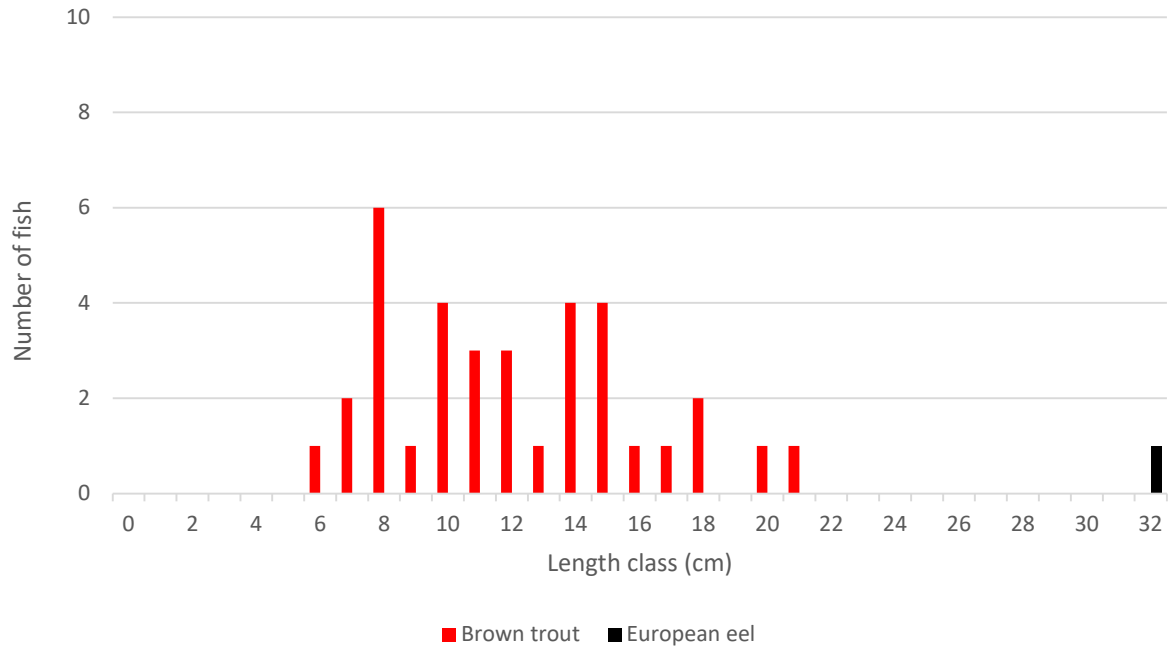

Figure 3.9 Length frequency distribution recorded via electro-fishing at site B1, September 2021

Plate 3.10 Representative image of site B1 on the upper Keerglen River, September 2021

3.1.11 Site B2 – Ballykinlettragh Stream, Keerglen

No fish were recorded at site B2. The site provided poor salmonid nursery and holding habitat given the small size of the channel (likely dries up, seasonally) and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. The upland eroding site was unsuitable for lamprey (none recorded).

Plate 3.11 Representative image of site B2 on the Ballykinlettragh Stream, September 2021

3.1.12 Site B3 – Unnamed stream, Keerglen

No fish were recorded at site B3. The site provided poor salmonid nursery and holding habitat given the small size and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. The upland eroding site was unsuitable for lamprey (none recorded).

Plate 3.12 Representative image of site B3 on an unnamed Keerglen River tributary, September 2021

3.1.13 Site B4 – Unnamed stream, Keerglen

No fish were recorded at site B4. The site provided poor salmonid nursery and holding habitat given the small size and limited deeper pool areas in addition to poor accessibility from the Keerglen River (high gradients). Spawning habitat was also of poor quality due to the absence of gravels. The channel was of low value for European eel given the high gradient and limited pool habitat. The upland eroding site was unsuitable for lamprey (none recorded).

Plate 3.13 Representative image of site B4 on an unnamed Keerglen River tributary, September 2021

3.1.14 Site B5 – Keerglen River, Keerglen

A total of three fish species were recorded at site B5 (**Appendix A**). The site supported moderate densities of Atlantic salmon parr (two size classes) (*n*=13 total) and mixed-cohort brown trout (*n*=17). A single European eel was also recorded.

The site was a very good quality salmonid nursery given good flows, an increased size (relative to other low order channels in the vicinity) and a natural profile. Some moderate quality spawning habitat was present but this was highly localised at the tailings of deeper pools and glide, due to the high energy. Holding habitat was of good quality overall, with ample cover in pools below boulder cascade areas. The site was of moderate value for European eel, given the presence of ample boulder and cobble refugia for the species. The upland eroding site was unsuitable for lamprey (none recorded).

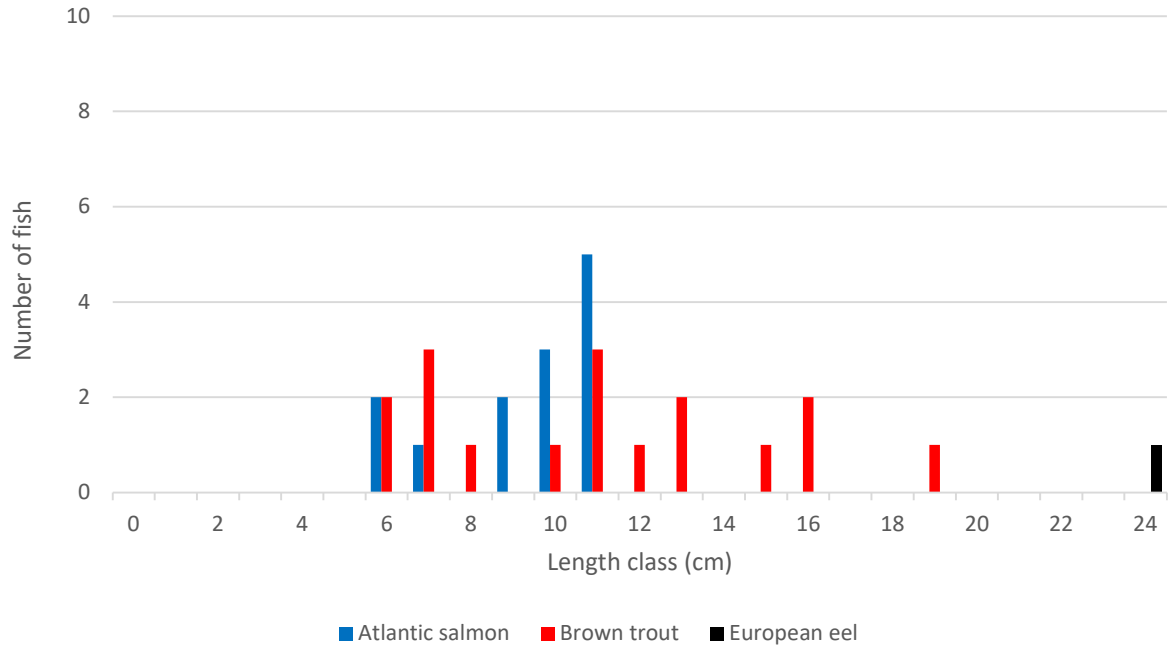

Figure 3.10 Length frequency distribution recorded via electro-fishing at site B5, September 2021

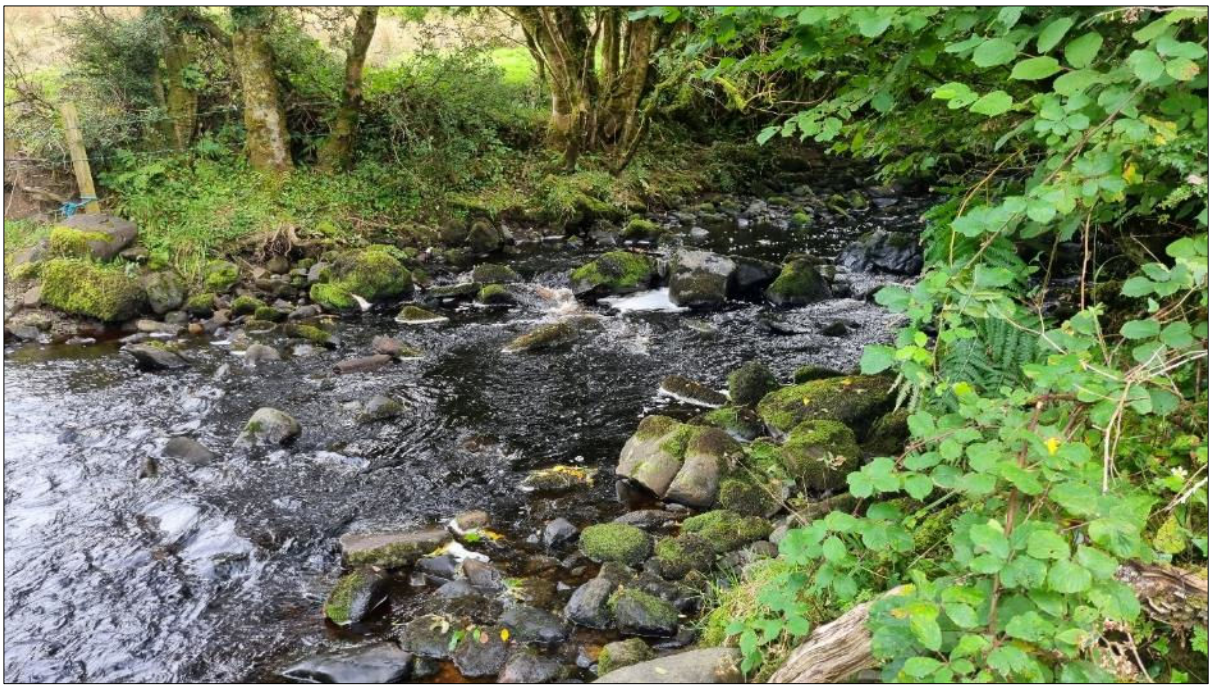

Plate 3.14 Representative image of site B5 on the Keerglen River, September 2021

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of Glenora wind farm development via electro-fishing in September 2021. Values in bold represent the highest densities recorded for each species, respectively. * = no. ammocoetes per m^2 of targeted habitat fished. Greyed out values indicate no fish recorded during the survey.

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)					
				Atlantic salmon	Brown trout	European eel	*Lampetra* sp.	Minnow	Three-spined stickleback
A1	Unnamed stream	5	50	0.000	0.000	0.000	0.000	0.000	0.000
A2	Unnamed stream	10	240	0.000	0.133	0.000	0.000	0.000	0.000
A3	Unnamed stream	10	150	0.000	0.140	0.000	0.000	0.000	0.000
A4	Unnamed stream	10	130	0.000	0.200	0.000	0.000	0.000	0.000
A5	Unnamed stream	10	240	0.125	0.050	0.004	0.000	0.000	0.000
A6	Unnamed stream	10	120	0.000	0.183	0.000	0.000	0.000	0.000
A7	Unnamed stream	10	240	**0.217**	0.054	0.004	0.000	0.000	**0.008**
A8	Owenmore River	10	245	0.171	0.045	0.004	0.000	0.000	0.000
A9	Owenmore River	10	360	0.044	0.031	0.000	***11**	**0.039**	0.003
B1	Keerglen River	10	162.5	0.000	**0.222**	**0.006**	0.000	0.000	0.000
B2	Ballykinlettragh Stream	5	22.5	0.000	0.000	0.000	0.000	0.000	0.000
B3	Unnamed stream	5	105	0.000	0.000	0.000	0.000	0.000	0.000
B4	Unnamed stream	5	85	0.000	0.000	0.000	0.000	0.000	0.000
B5	Keerglen River	10	280	0.046	0.061	0.004	0.000	0.000	0.000

4. Discussion

4.1 Most valuable sites

4.1.1 Salmonids

Atlantic salmon were recorded from a total of 5 no. sites. These were located on the larger watercourses surveyed, namely the Owenmore River (sites A8 & A9) and two unnamed tributaries (sites A5 & A7) as well as a site on the Keerglen River (site B5). The highest densities of salmon were present at sites A7 (unnamed river, aka. Altderg River) and A8 (Owenmore River) (**Table 3.2**). All sites containing Atlantic salmon supported two size classes (i.e. 0+ and 1+).

Brown trout were also recorded from these aforementioned sites, in addition to sites A2, A3, A4, A6 and B1 (10 no. sites in total). All sites containing trout supported mixed cohort populations (i.e. juveniles and adults), with site B1 on the Keerglen River supporting a particularly healthy, balanced population of several size/year classes (**Figure 3.9**). Site B1 also supported the highest density of brown trout recorded during the survey (**Table 3.2**).

The sites on the larger watercourses such as the Owenmore River (A8 & A9), unnamed river (site A7, aka. Altderg River) and Keerglen River (B5) provided the best overall salmonid habitat, with good-quality nursery habitat present at all three sites. Most of the watercourses surveyed only supported small (but healthy) brown trout populations given their narrow, shallow and high-gradient, upland nature. Furthermore, most survey watercourses flow over and or drain extensive areas of blanket bog. Peat-based catchments are less productive than other those flowing over other geologies (O'Grady, 2006), with reduced primary productivity, reduced macro-invertebrate communities, and, generally speaking, lower fish biomass (Richardson, 1993). Siltation (from peat) was evidently reducing the spawning capacity of many sites, particularly on more minor watercourses where spawning habitat quality was invariably poor to moderate, at best. Diffuse siltation is one of the greatest threats to salmonid populations. Sediment not only blocks interstitial spaces in substrata and limits oxygen supply to salmonid eggs (required for healthy embryonic development and successful hatching) but can also smother substrata, thus reducing available spawning habitat and impact macro-invertebrate communities on which salmonids feed (Soulsby et al., 2001; Walling et al., 2003; Heywood & Walling, 2007; Louhi et al., 2008, 2011; Cocchiglia et al., 2012; Conroy et al., 2016; Davis et al., 2018; Kelly-Quinn et al., 2020). Furthermore, it has been shown that eggs laid in clean gravels which have subsequently been silted over by peat have failed to hatch (Crisp 1993, 2000).

In general, the Glenora survey sites were small, upland eroding spate channels located in the upper reaches of the respective catchments. Many were located in high-gradient areas. Stream gradient is known to be one of the principal determinants of juvenile salmonid production, with medium gradients most optimal in terms of successful recruitment and population persistence (Wood & Budy, 2009; O'Grady, 2006; Amiro, 1993). Moreover, as would be expected in catchments exposed to pressures including coniferous afforestation and peat escapement (such as those in the vicinity of Glenora), survey sites on larger watercourses typically offered better quality salmonid habitat and supported higher densities of salmonids. This pattern of improved fish densities in lower gradient areas and locations in higher order riverine sites moving down the catchments was evident.

4.1.2 Lamprey

Suitability for juvenile lamprey settlement was absent throughout the survey sites given the upland, eroding nature of the watercourses, with the exception of site A9 on the Owenmore River. Here, lower natural gradients facilitated some depositional habitat to form along river margins and in association with pools, and the subsequent sand/silt accumulations supported a moderate density of ammocoetes (11 per m^2 recorded from $2m^2$ total habitat). This site also featured the only suitable lamprey spawning habitat within the survey area, although the finer gravels present were impacted by siltation.

Most watercourses did not support soft sediment areas suitable for ammocoete burial given very high flow rates (i.e. spate channels) and a lack of depositional areas required for larval settlement (Goodwin et al., 2008). The paucity of finer substrata not exposed to siltation (peat) pressures precluded lamprey from most of the watercourses surveyed, in addition to high natural gradients. Owing to their relatively small morphologies, *Lampetra* species such as brook lamprey require clean, un-silted fine gravels in which to dig their redds (Lasne et al., 2010; Rooney et al., 2013; Aronsuu & Virkkala, 2014; Dawson et al., 2015) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010).

4.1.3 European eel

On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011). Eel were recorded from a total of 5 no. sites, namely site A5 (unnamed stream), A7 (unnamed stream), A8 (Owenmore River) and B1 & B5 (Keerglen River) (**Table 3.1**), i.e. larger, deeper watercourses. Here, the presence of larger, deeper pools and a greater complexity of less-compacted refugia (e.g. boulder, cobble etc.) provided superior eel habitat compared to the smaller, higher-gradient, upland stream sites where there was a paucity of suitable refugia or deeper pool areas favoured by the species (Laffaille et al., 2003). Nonetheless, even smaller channels with poor or little overall fisheries value offer value as potential European eel migratory pathways, provided they maintain downstream connectivity to larger channels. (e.g. adult migration seawards, usually from September/October onwards). The species was also detected via eDNA at two of three small lake sites (see accompanying aquatic report) indicating the importance of migratory routes to contiguous nursery habitats.

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8. Appendix B – Q-sample results (biological water quality)

Table 8.1 Macro-invertebrate Q-sampling results for the aquatic survey sites A1-A9, September 2021

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	EPA group
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*		2				3	25	11	7	A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*		1						1	2	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*									1	A
Plecoptera	Chloroperlidae	*Chloroperla tripunctata*							3		3	A
Plecoptera	Nemouridae	*Protonemura meyeri*	6	2	10	14	15	43	13	1		A
Plecoptera	Nemouridae	*Nemoura cinerea*								2	2	A
Plecoptera	Perlidae	*Dinocras cephalotes*		3				3				B
Ephemeroptera	Baetidae	*Alainites (Baetis) muticus*					6	5	3			B
Ephemeroptera	Baetidae	Unidentified species										B
Plecoptera	Leuctridae	*Leuctra hippopus*	1	2	4	1	1	20	7	2	4	B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*	7	1								B
Ephemeroptera	Baetidae	*Baetis rhodani*	2	95	3	5	46	30	18	6	1	B
Ephemeroptera	Ephemerellidae	*Serratella ignita*		5							1	C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*					1		2	1		C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*							6	5	5	C
Trichoptera	Polycentropodidae	*Polycentropus flavomaculatus*			7		3	2	4	2		C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*						2				C
Trichoptera	Polycentropodidae	*Plectrocnemia geniculata*						2				C
Trichoptera	Rhyacophilidae	*Rhyacophila munda*		1								C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*		1	1					1		C
Mollusca	Tateidae	*Potamopyrgus antipodarum*								34		C
Coleoptera	Dytiscidae	*Stictotarusus duodecimpustulatus*									1	C
Coleoptera	Elmidae	*Elmis aenea*		1	1	2	4	3	3			C
Coleoptera	Elmidae	*Limnius volckmari*							4	2	17	C

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	EPA group
Coleoptera	Elmidae	*Esolus parallelepipedus*									5	C
Coleoptera	Gyrinidae	Gyrinidae larva							2		1	C
Coleoptera	Hydraenidae	*Hydraena* sp.					1					C
Coleoptera	Scirtidae	Scirtidae larva	1	1								C
Diptera	Chaoboridae	Chaoboridae larva										C
Diptera	Chironomidae	Chironomidae larva	2	2	3	1	3	5	8	1	2	C
Diptera	Culicidae	Culicidae larva					1					C
Diptera	Pediciidae	*Dicranota* sp.		1	3				1		4	C
Diptera	Pediciidae	*Pedicia* sp.				1						C
Diptera	Simuliidae	Simuliidae	4	6	3	1			1			C
Hemiptera	Gerridae	Gerridae nymph	1									C
Crustacea	Gammaridae	*Gammarus duebeni*	9		3	76	85	20	3	1	3	C
Oligochaeta	Lumbricidae	Unidentified species				2	1			1		C
Arachnida	Hydrachnidiae	Unidentified species				1	1	1			1	D
Mollusca	Lymnaeidae	*Ampullacaena (Radix) balthica*									1	E
Diptera	Chironomidae	*Chironomus* sp.									7	n/a
Abundance			33	124	38	104	168	139	103	71	68	
Q-rating			**Q4**	**Q4**	**Q4**	**Q4**	**Q4**	**Q4**	**Q4**	**Q4**	**Q4-5**	
WFD status			Good	Good	Good	Good	Good	Good	Good	Good	High	

Table 8.2 Macro-invertebrate Q-sampling results for the aquatic survey sites B1-B5, September 2021

Group	Family	Species	B1	B2	B3	B4	B5	EPA group
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*	8				7	A
Plecoptera	Chloroperlidae	*Chloroperla tripunctata*				1		A
Plecoptera	Nemouridae	*Protonemura meyeri*	5		1	4	4	A
Plecoptera	Perlidae	*Dinocras cephalotes*	1				7	B
Ephemeroptera	Baetidae	*Alainites (Baetis) muticus*	1					B
Plecoptera	Leuctridae	*Leuctra hippopus*	3	4	4	13	2	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*					2	B
Trichoptera	Trichoptera	*Trichoptera pupa*	1					B
Ephemeroptera	Baetidae	*Baetis rhodani*	51		3	8	90	B
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*	4				4	C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*	2				2	C
Trichoptera	Philopotamidae	*Chimarra marginata*					7	C
Trichoptera	Polycentropodidae	*Polycentropus flavomaculatus*	2				1	C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*		9	3	2		C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*	1					C
Coleoptera	Elmidae	*Elmis aenea*					6	C
Coleoptera	Elmidae	*Limnius volckmari*					1	C
Coleoptera	Gyrinidae	Gyrinidae larva	2					C
Coleoptera	Hydraenidae	*Hydraena* sp.					1	C
Coleoptera	Scirtidae	Scirtidae larva			2	10	1	C
Diptera	Chironomidae	Chironomidae larva		7	3	3	1	C
Diptera	Culicidae	Culicidae larva		2				C
Diptera	Simuliidae	Simuliidae	6		2	4	4	C
Diptera	Thaumaleidea	Thaumaleidea larva				1		C
Hemiptera	Gerridae	Gerridae nymph		1				C

Group	Family	Species	B1	B2	B3	B4	B5	EPA group
Crustacea	Gammaridae	*Gammarus duebeni*	6	6			8	C
Diptera	Chironomidae	*Chironomus* sp.			1			n/a
Abundance			**93**	**29**	**19**	**46**	**148**	
Q-rating			**Q4**	***Q3**	**Q4**	**Q4**	**Q4**	
WFD status			Good	Poor	Good	Good	Good	

* tentative rating due to poor flows and or lack of suitable riffle areas for sampling (as per Toner et al., 2005)

9. Appendix C – lake macro-invertebrate communities

Table 9.1 Macro-invertebrate communities recorded from lakes L1, L2 & L3, September 2021

Group	Family	Species	L1	L2	L3	EPA group
Ephemeroptera	Baetidae	*Cloeon* species		1	1	B
Odonata	Aeshnidae	*Aeshna juncea*	10	1		B
Odonata	Coenagrionidae	*Coenagrion* sp.	3	3	3	B
Odonata	Libellulidae	*Libellula quadrimaculata*	1	3		B
Trichoptera	Polycentropodidae	*Holocentropus dubius*			4	C
Coleoptera	Dytiscidae	*Dytiscidae larva*	1			C
Coleoptera	Dytiscidae	*Hydroporus obscurus*	5			C
Coleoptera	Dytiscidae	*Ilybius ater*		1		C
Coleoptera	Dytiscidae	*Acilius sulcatus*			3	C
Diptera	Chaoboridae	Chaoboridae larva			7	C
Diptera	Chironomidae	Chironomidae larva	2	6	3	C
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*		4	1	C
Hemiptera	Gerridae	*Gerris lacustris*	3	1		C
Hemiptera	Notonectidae	*Notonecta obliqua*			1	C
Arachnida	Hydrachnidiae	Unidentified species	2			C
Abundance			**27**	**20**	**23**	

10. Appendix D – eDNA analysis lab report

SureScreen Scientifics

Folio No: E12283
Report No: 2 - Glenora Wind Farm
Client: Triturus Environmental Ltd
Contact: Ross Macklin

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: 01/11/2021
Date results reported: 11/11/2021
Matters affecting result: None

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

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK48	Keerglen River (site B5)	-	Pass	Pass	Pass	Negative	0/12
FK198	Owenmore River (site A9)	-	Pass	Pass	Pass	Negative	0/12

TARGET SPECIES: Brown (Sea) Trout *(Salmo trutta)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK91	Lake L3	-	Pass	Pass	Pass	Negative	0/12
FK92	Lake L1	-	Pass	Pass	Pass	Negative	0/12
FK94	Lake L2	-	Pass	Pass	Pass	Negative	0/12

TARGET SPECIES: European eel *(Anguilla anguilla)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK91	Lake L3	-	Pass	Pass	Pass	Positive	1/12
FK92	Lake L1	-	Pass	Pass	Pass	Positive	1/12
FK94	Lake L2	-	Pass	Pass	Pass	Negative	0/12

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TARGET SPECIES: Smooth Newt *(Lissotriton vulgaris)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK91	Lake L3	-	Pass	Pass	Pass	Negative	0/12
FK92	Lake L1	-	Pass	Pass	Pass	Negative	0/12
FK94	Lake L2	-	Pass	Pass	Pass	Negative	0/12

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

Reported by: **MSc Gabriela Danickova** Approved by: **Jennifer Higginbottom**

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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.

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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.

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