APPENDIX 6-4

AQUATIC BASELINE REPORT

Aquatic baseline report for Knockshanvo wind farm, Co. Clare

Prepared by Triturus Environmental Ltd. for MKO

November 2023

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1. Introduction

Triturus Environmental Ltd. was commissioned by MKO to conduct baseline aquatic surveys for the proposed Knockshanvo wind farm project (the 'Proposed Development') located approximately 5km north-east of Sixmilebridge, Co. Clare.

The proposed Knockshanvo wind farm is located in an upland area within the townlands of Cloontra, Cloontra East, Ballyvorgal South, Belvoir, Crag, Snaty (Wilson), Snaty (Massy), Ballykelly, Cloontra West, Knockshanvo, Kyle, Drumsillagh (Parke), Drumsillagh (Merritt) and Muingboy, approximately 5km north-west of Sixmilebridge, Co. Clare (**Figure 2.1**). The proposed wind farm site is within the Shannon River Basin District and within hydrometric area 27 (Shannon Estuary North). The aquatic survey sites were located within the Owenogarney_SC_010, Owenogarney_SC_012 and Shannon[Lower]_SC_100 river sub-catchments. The proposed wind farm site is drained by the Clashduff Stream (27C44), Gortadroma Stream (27G12), Ballyvorgal North Stream (27B47), Snaty Stream (25S34) and an unnamed tributary, O'Neill's Stream (25O02), Knockshanvo Stream (25K82) and the Mountrice River (25M03) (**Table 2.1**).

1.1 Project description

The Proposed Development will comprise of 9 No. turbines with a limited tip height range of 179.5 metres to 185 metres and all associated foundations and hardstanding areas, access roads and entrance(s) including upgrade of existing site roads and provision of new roads, 110kV electrical substation and wind farm control building(s), underground cabling, borrow pit(s), electrical cabling for 110kV grid connection, amenity works, biodiversity enhancement areas, temporary construction compounds, a permanent meteorological mast, temporary transition compound and upgrades to roads along the turbine delivery route. A full description of the Proposed Development is available in Chapter 4 of this EIAR.

1.2 Purpose of this report

This 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 vicinity of the proposed project, located approx. 5km north-east of Sixmilebridge, Co. Clare.

1.3 Project team

Ross Macklin (Ph.D. (candidate), B.Sc. (Hons) MCIEEM, MIFM, HDip GIS, PDip IPM) is an aquatic, fisheries and mammalian ecologist with over 18 years' professional experience in Ireland. He is Director of Triturus Environmental Ltd. Ross has a B.Sc. in Applied Ecology and diplomas in integrated Pest Management and GIS. He is currently completing his PhD in fisheries ecology. He has considerable experience in a wide range of ecological and environmental projects including EIAR, EcIA, CEMP and AA/NIS reporting, as well as biodiversity, water quality monitoring, invasive species, mammalian surveys and fisheries management. He also has expert identification skills in fisheries, macrophytes, freshwater invertebrates and protected species. His diverse project experience includes work on renewable energy developments, flood relief schemes, road schemes, waste management, blueways/greenways, biodiversity projects, non-volant mammal monitoring, fisheries management

projects and catchment wide water quality management. He has worked extensively within Dublin City and Cork City on mammal monitoring projects for Dublin City Council, Waterways Ireland, Pfizer, Irving Oil, Transport Infrastructure Ireland, OPW and for numerous consulting engineers. He recently completed and was lead author of the Dublin City Otter survey which was the largest urban otter survey completed in the history of the state.

Bill Brazier (Ph.D. (candidate), B.Sc. (Hons.), MIFM) is an aquatic, fisheries and mammalian ecologist with over 11 years' professional experience in Ireland. He is Associate Director and senior ecologist at Triturus Environmental Ltd. Bill studied Applied Freshwater & Marine Biology at Galway-Mayo IT and is currently completing a Ph.D. in fish ecology and genetics. He has considerable experience in a wide range of ecological and environmental projects including EIAR, EcIA and AA/NIS reporting, as well as the areas of fisheries assessments, fisheries management plans, fish health screening, renewable energy developments, flood relief schemes, road schemes, invasive species management, blueways/greenways, biodiversity projects and non-volant mammal monitoring. Bill has extensive experience in identifying and assessing fish, macrophytes, aquatic bryophytes and macro-invertebrates from a variety of aquatic habitats, as well as specialising in otter surveys and management in more recent years. He has worked extensively with state bodies, local authorities, and a range of consulting engineer firms.

2. Methods

2.1 Study area

The proposed wind farm and associated infrastructure are not located within a European site although there is downstream hydrological connectivity (via several watercourses) with Danes Hole, Poulanecka SAC (000003) and Glenomra Wood SAC (001013). Neither of these sites have aquatic qualifying interests (NPWS, 2018a, 2018b).

All freshwater watercourses that could be affected directly or indirectly by the proposed wind farm project were considered as part of the current baseline. A range of survey sites were selected based on their proximity to proposed infrastructure and connectivity with catchments downstream of the proposed development. A total of 26 sites on 18 watercourses were selected for detailed aquatic assessment (see **Table 2.1, Figure 2.1** below).

Selection of watercourses for assessment

The aquatic survey sites were chosen both within the windfarm boundary in the low order upper reaches of riverine survey areas and also downstream where channel size increased to improve coverage. This helped detect changes in fisheries composition, biological water quality and also the presence of Annex I aquatic habitats and protected species such as crayfish longitudinally in the respective sub-catchments. The nomenclature for the watercourses surveyed follows that of the Environmental Protection Agency (EPA). The aquatic survey sites were located within the Owenogarney_SC_010, Owenogarney_SC_012 and Shannon[Lower]_SC_100 river sub-catchments. Aquatic survey sites were selected on the Ballyvorgal North Stream (EPA code: 27B47), Belvoir Stream (27B45), Snaty Stream (27S13), Clashduff Stream (27C44), East Cloontra Stream (25E29), Glenomra Wood Stream (25G12), Gortadroma Stream (27G12), Knockshanvo Stream (25K82), Kyleglass Stream (25K83), Mountrice River (25M03), Oatfield Stream (25O07), O'Neill's Stream (25O02), Owenogarney River (27O01), River (Clare) Blackwater (25B06), Rocks Stream (27R07), Snaty River (25S34), Springmount Stream (27S93), West Cloontra Stream (25W36) and an unnamed stream (**Table 2.1**).

2.2 Aquatic surveys

Aquatic surveys of the watercourses within the vicinity of the proposed wind farm project were conducted on Monday 25th to Thursday 28th July 2022. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (**Figure 2.1**). Surveys at each of these sites included a fisheries assessment (electro-fishing and or fisheries habitat appraisal), white-clawed crayfish survey, macrophyte and aquatic bryophyte survey and (where suitable) biological water quality sampling (Q-sampling) (**Figure 2.1**).

The riparian and aquatic habitats were surveyed following the methods set out in the Environment Agency's *'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003*' (EA, 2003) The habitats were classified using *'A Guide to Habitats in Ireland'* (Fossitt, 2000). The sampling locations were all evaluated and described in terms of:

- Physical watercourse/waterbody characteristics (i.e. bank height, river width, depth etc.) including associated evidence of historical drainage
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)

- Flow type by proportion 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*=26 aquatic survey sites at Knockshanvo wind farm, Co. Clare (* denotes eDNA sampling)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Clashduff Stream	27C44	Snaty	553836	670219
A2	Clashduff Stream	27C44	Druminakella Bridge	552881	671880
A3	Gortadroma Stream	27G12	Crag	552195	669943
A4	Gortadroma Stream	27G12	Crag Bridge	551863	670582
A5	Belvoir Stream	27B45	Belvoir Bridge	550819	669926
A6	Ballyvorgal North Stream	27B47	Glenwood Bridge	550133	669294
A7*	Owenogarney River	27O01	Annagore Bridge	547643	667656
B1	Snaty River	25S34	Ballykelly	555008	670164
B2	Snaty River	25S34	Cloontra	554575	669398
B3	Oatfield Stream	25O07	R471 crossing, Oatfield	554155	667344
B4	Unnamed stream	n/a	Cloontra West	555089	669210
B5	Snaty River	25S34	Aughnagourney Bridge	555064	667195
B6	West Cloontra Stream	25W36	Callaghan's Bridge	556667	666673
B7	O'Neill's Stream	25O02	Cloontra East	556288	668282
B8	Knockshanvo Stream	25K82	Mountrice	556637	668529
B9	O'Neill's Stream	25O02	Knockshanvo Stream confluence	557852	666079
B10	Mountrice River	25M03	Sallybank	557156	670025
B11	East Cloontra Stream	25E29	Sallybank	558419	668388
B12	Mountrice River	25M03	Cloghera Bridge	558168	666159
B13*	River (Clare) Blackwater	25B06	Killally's Bridge	558950	665665
B14	Kyleglass Stream	25K83	R465 road crossing	559692	669016
C1	Rocks Stream	27R07	Crean Stream confluence	558219	671385
N1	Snaty Stream	27S13	Snaty	554067	671130
N2	Glenomra Wood Stream	25G12	Kilmore	560350	668820
N3	Springmount Stream	27S93	Springmount	560962	668876
N4*	Glenomra Wood Stream	25G12	R471 road crossing	559988	665891

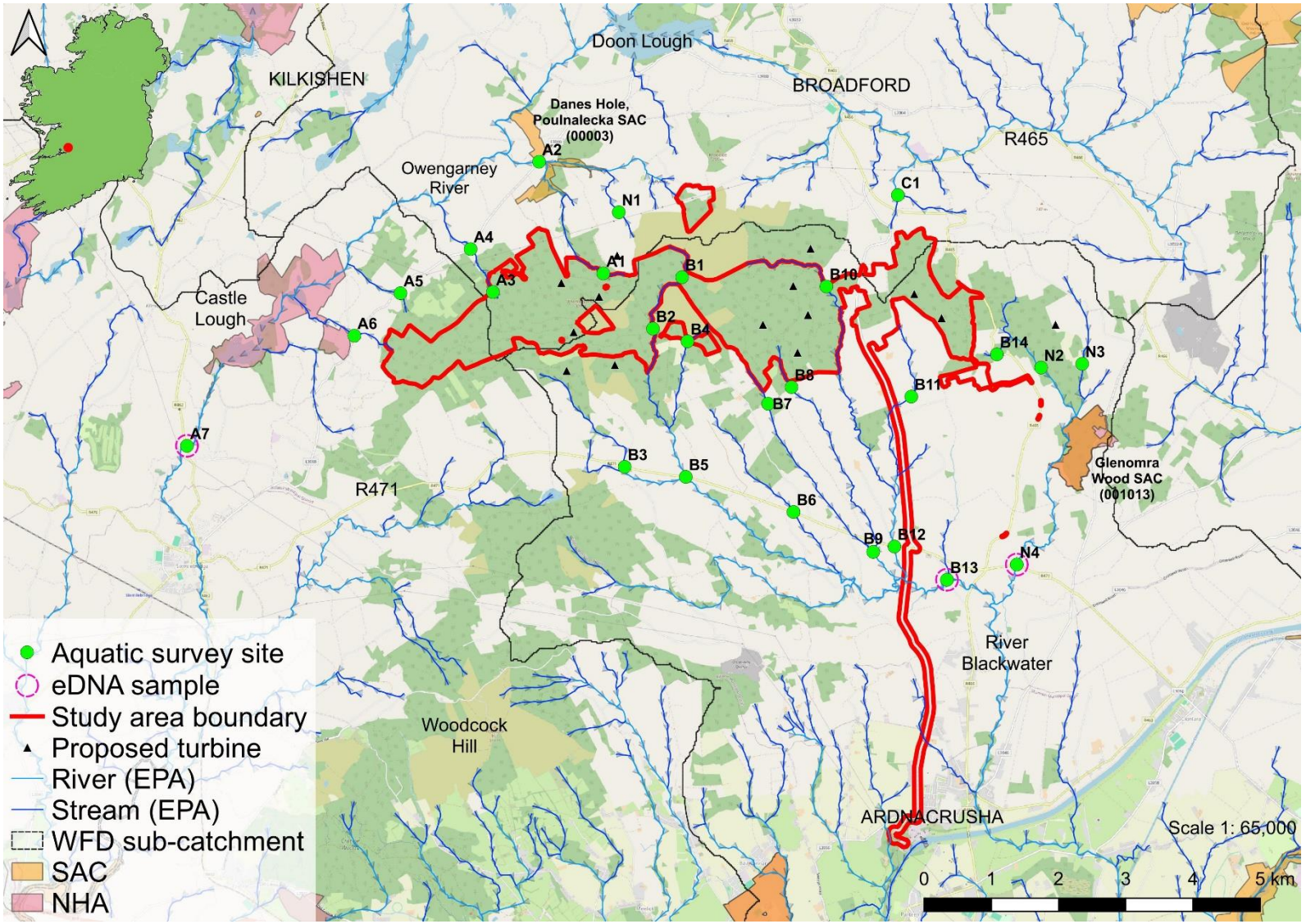

Figure 2.1 Overview of the 26 no. aquatic survey site locations for the proposed Knockshanvo wind farm, Co. Clare, July 2022

Fisheries assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the survey area in July 2022 (**Table 2.1, Figure 2.1; Appendix A**), following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The survey was undertaken in accordance with best practice (CFB, 2008; CEN, 2003) and Section 14 licencing requirements. For detailed electro-fishing survey methodology, please refer to accompanying fisheries assessment report in **Appendix A.** The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within at the survey sites.

White-clawed crayfish survey

White-clawed crayfish surveys were undertaken at all of the aquatic survey sites in July 2022 under a National Parks and Wildlife (NPWS) national licence (no. C31/2022), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2023), to capture and release crayfish back to their site of capture, under condition no. 6 of the licence. Hand-searching of instream refugia and sweep netting was undertaken following the approach described in Reynolds *et al*. (2010). The suitability of the habitat for white-clawed crayfish was evaluated at each survey site.

As per Inland Fisheries Ireland aquatic biosecurity recommendations, the crayfish sampling started at the uppermost site(s) of the wind farm catchment/sub-catchments in the survey area to minimise the risk of transferring invasive propagules (including crayfish plague) in an upstream direction.

eDNA analysis

To validate site surveys and to detect potentially cryptically low populations of freshwater pearl mussel and white-clawed crayfish within the study area, three composite water samples were collected on 28th July 2022 from the Owengarney River (site A7), River Blackwater (B13) and Glenomra Wood Stream (N4) and analysed for freshwater pearl mussel, white-clawed crayfish and crayfish plague eDNA (**Figure 2.1**). The water sample locations were strategically chosen to maximise longitudinal (instream) coverage within the catchment, thus facilitating a greater likelihood of species detection.

In accordance with laboratory guidance, a composite (500ml) water sample was collected from each of the three sampling points, 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 and fixed on-site using a sterile eDNA sampling kit. The fixed sample was stored at room temperature and sent to the SureScreen Scientifics laboratory and ISO9001 accredited laboratory for analysis within 48 hours of collection. A total of 12 qPCR[1] 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 C** for full eDNA laboratory analysis methodology.

[1] qPCR stands for quantitative polymerase chain reaction and is a technology used for measuring DNA using PCR

Evaluation of biological water quality (via Q-sampling)

The 26 no. riverine aquatic survey sites were assessed for biological water quality through Q-sampling in July 2022 (**Figure 2.1).** All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, following the Environmental Protection Authority (EPA) methodology (Feeley *et al.*, 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley *et al.*, 2020). Samples were elutriated[2] and fixed in 70% ethanol for subsequent laboratory species-level identification. Samples were converted to Q-ratings as per Toner *et al.* (2005) and assigned Water Framework Directive (WFD) status (see **Table 2.2** below). The occurrence of any rare invertebrate species 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) were noted.

Table 2.2 Reference categories for EPA Q-ratings, WFD status, pollution status and condition (Toner *et al.*, 2005)

Q value	WFD status	Pollution status[3]	Condition
Q5 or Q4-5	High status	Unpolluted (pristine)	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

Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the 26 aquatic survey sites, with specimens collected (by hand, sweep nets or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species (listed under the Flora Protection Order and or the national red list for vascular plants (Wyse-Jackson *et al.*, 2016)). The aquatic vegetation community was also examined to determine if it corresponded to Annex I habitats, such as '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').

Otter

The presence of otter (*Lutra lutra*) was determined through the recording of otter signs within 150m radius of each survey site. Notes on the age and location of signs (in ITM coordinates) were made, in

[2] A method used to separate organic material from non-organic materials to improve the detection rate of macro-invertebrates within a sample

[3] Appendix I of Toner *et al.* (2005)

addition to the quantity and visible constituents of spraint (i.e. remains of fish, crustaceans, molluscs etc.).

Biosecurity

Cognisance was given towards preventing the spread or introduction of crayfish plague given the known historical distribution of white-clawed crayfish in the wider survey area. A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in *'Good fieldwork practice: slowing the spread of invasive non-native species*' by the University of Leeds.

2.3 Limitations

Surveys were undertaken during base summer flows, dry and bright conditions and at the appropriate time of year for aquatic and fisheries surveys (i.e. open season for fisheries assessments, white-clawed crayfish & macrophyte surveys). All selected surveys sites were accessible which facilitated catchment-wide data collection.

3. Baseline ecological conditions

3.1 Desk study

The desk study for the Proposed Development returned records from the National Parks and Wildlife Service, National Biodiversity Data Centre, Inland Fisheries Ireland, Botanical Society of Britain and Ireland and the Environmental Protection Agency for rare and or protected aquatic species within the 10km grid squares containing and adjoining the Proposed Development (i.e. R46, R56, R57, R66 & R67).

White-clawed crayfish

A low number of records for Annex II and V white-clawed crayfish (*Austropotamobius pallipes*) were available for the River (Clare) Blackwater (1996 & 2002) and the Glenomra Wood Stream at survey site N4 (1996 & 1999) (**Figure 3.1**).

Otter

A number of Annex II otter (*Lutra lutra*) records were available in the vicinity of the proposed project although most were historical only (i.e. 1980). More contemporary records were available for the Mountrice River at Cloghera Bridge (survey site B12), Owenogarney River and the River Blackwater (NPWS & NBDC data; **Figure 3.1**).

Fish species

Four historical records for Annex II brook lamprey (*Lampetra planeri*) were available for the River Blackwater (Clare) (grid square R56).

A single historical record (unspecified date) for Annex II and V allis shad (*Alosa alosa*) was available for the River Shannon upstream of Killaloe.

Records for Annex II and V river lamprey (*Lampetra fluviatilis*) exist for the River Shannon at Castleconnell from 1994 and 1995, respectively (R66). Historical records for Annex II and V sea lamprey (*Petromyzon marinus*) are also available for the lower River Shannon, with a single record for the lower reaches of the River Blackwater (period 1972-1995).

Aquatic plant species

Records for two plant species listed under the Flora (Protection) Order 2022 (S.I. No. 235/2022) were available for the wider study area. Two records were available for opposite-leaved pondweed (*Groenlandia densa*) in the River Shannon at Killaloe (R66) but these were historical only (1970). Triangular clubrush (*Schoenoplectus triqueter*), a rare and highly threatened vascular plant species in Britain and Ireland, restricted to tidal stretches of rivers (Preston, 2003), is known from the lower reaches of the Owenogarney/Ratty River. Both species are listed as 'near threatened' in Ireland (Wyse-Jackson *et al.*, 2016).

Fisheries asset of the survey area

The Owenogarney River is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*)

and European eel (*Anguilla anguilla*) (pers. obs.). Nationally the Owenogarney is ranked 45th in terms of the amount of fluvial habitat accessible to Atlantic salmon (0.41% of national; McGinnity *et al.*, 2003). The Owenogarney system is also known locally to contain stocks of coarse fish species including bream (*Abramis brama*), rudd (*Scardinius erythropthalmus*), tench (*Tinca tinca*), perch (*Perca fluviatilis*), pike (*Esox lucius*), gudgeon (*Gobio gobio)* and minnow (*Phoxinus phoxinus*) (pers. obs.). The non-native, invasive cyprinid species dace (*Leuciscus leuciscus*) has been recorded in the Owenogarney River system since 1980 (Caffrey *et al.*, 2007), with invasive roach (*Rutilus rutilus*) present since the early 1980s (Brazier, 2018). Additionally, the lower reaches are known historically to support both river (*Lampetra fluviatilis*) and sea lamprey (Ross, 2017; Igoe et al, 2004) and a spawning site for European smelt (*Osmerus eperlanus*) has been recorded downstream of Sixmilebridge (Quigley *et al.*, 2004).

The River (Clare) Blackwater is known to support Atlantic salmon and brown trout and European eel, with a wide range of coarse fish species, including non-native dace, in the lower reaches. Brook lamprey have previously been recorded throughout the river by Ross (2017).

In July 2017, Atlantic salmon were recorded from sites on the Snaty Stream, Mountrice River (Cloghera Bridge), River Blackwater and Clashduff Stream, with brown trout and, to a lesser extent, European eel widespread throughout the catchment. Lamprey (*Lampetra* sp.) were recorded from sites on the Cloontra West Stream (Callaghan's Bridge) and the River Blackwater (Triturus, 2017).

Please note that biological water quality analysis (Q-sampling) was undertaken as part of this survey, with the results presented in the **section 4** and **Appendix B** of this report.

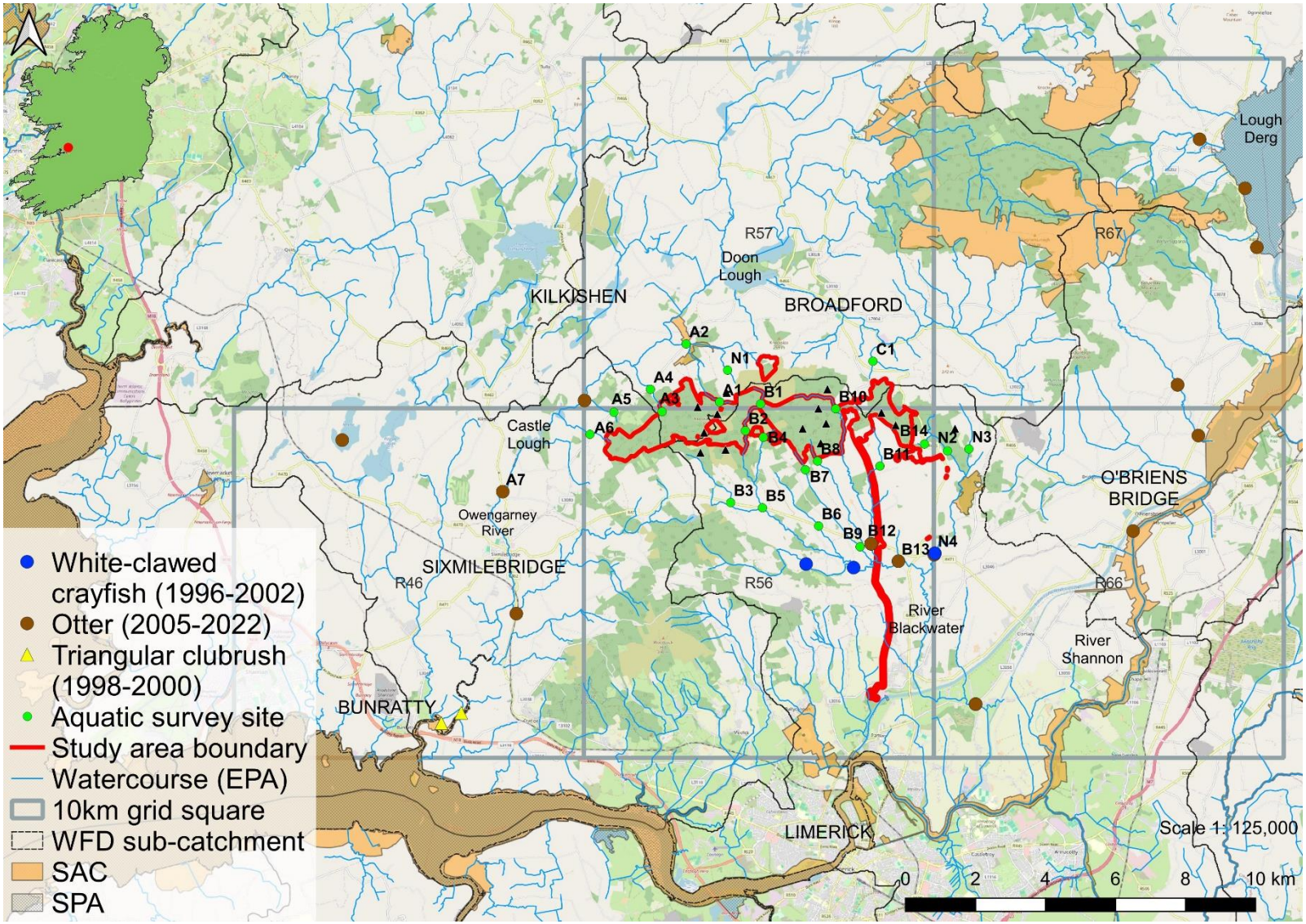

Figure 3.1 Selected protected aquatic species records in the vicinity of the proposed Knockshanvo wind farm (source: Triturus, NPWS & NBDC data)

3.2 Aquatic survey site results

4.1.1 Site A1 – Clashduff Stream, Snaty

Site A1 was located on the uppermost reaches of the Clashduff Stream (EPA code: 27C44) adjoining the proposed site boundary. The small upland eroding watercourse (FW1) averaged 0.5-1m wide with shallow water depths between 0.05m and 0.1m deep. The channel flowed over a moderate gradient with 0.5m high V-shaped banks grading into the adjoining valley. The profile comprised boulder-cascade and pool sequences with shallow riffle and pools. The substrata comprised bedrock at natural falls with mixed gravels and silt in lower gradient areas. The bed was covered with iron-oxidising bacterial deposits (40%) and floc[4], indicating lower pH conditions. Macrophytes were not present although the bryophyte *Scapania undulata* was occasional on bedrock. Riparian shading was high with abundant grey willow (*Salix cinerea*) and a mature sitka spruce (*Picea sitchensis*) plantation (WD4) on the south bank. The site was bordered by species-poor wet grassland (GS4) on the north bank.

No fish were recorded via electro-fishing at site A1 (**Appendix A**). The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which precluded upstream fish passage. Spawning habitat for salmonids was also absent given the predominance of bedrock substrata and smothering of the bed by iron-oxidising bacteria. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

Plate 4.1 Representative image of site A1 on the Clashduff Stream, July 2022

[4] floc is defined as an aggregation of (mostly dead) organic material, mainly from algae and diatoms, but also with potential origins from decaying macrophytes and associated decomposers (bacteria and fungi). The floc can form a layer at the surface of the substrate, or infiltrate the substrate, generally where there is insufficient flow to keep the material in suspension (Moorkens & Killeen, 2020)

4.1.2 Site A2 – Clashduff Stream, Druminakella Bridge

Site A2 was located on the Clashduff Stream (27C44) at Druminakella Bridge (L3080 road crossing), approx. 2.2km downstream of site A1 and immediately downstream of Danes Hole, Poulnalecka SAC (000030). The natural upland eroding watercourse (FW1) averaged 2m wide and 0.1-0.3m deep. The stream meandered over a slight gradient in a low-lying valley with bank of 0.5-1.2m in height. The profile comprised equal proportions of pool, riffle and shallow glide. The substrata were dominated by small boulder and cobble with mixed gravels at the tailings of pools and also in shallow glide areas. The bed was moderately compacted with moderate siltation (silt plumes underfoot and partial movement in the sediment when disturbed). Whilst macrophytes were not recorded, the liverwort *Jungermannia* sp. and moss species *Hygroamblystegium* sp. were recorded locally on wet boulder tops. The riparian areas supported mature oak (*Quercus robur*), ash (*Fraxinus excelsior*), hazel (*Corylus avellana*), sycamore (*Acer pseudoplatanus*) and holly (*Ilex aquifolium*) (WD1) with dry grassy meadows (GS2) bordering the riparian areas.

Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) were the only two fish species recorded via electro-fishing at site A2 (**Appendix A**). The stream at this location was considered a good salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Spawning habitat was of moderate quality locally, being reduced due to a paucity of smaller substrata and also evident siltation. Good quality holding areas were associated with pool areas on meanders. The site was considered a good quality European eel nursery with good riparian shading and abundant cobble and boulder refugia (none recorded). The high energy upland eroding site was unsuitable for lamprey or white-clawed crayfish. There was no suitability for freshwater pearl mussel. Despite some foraging suitability, no otter signs were recorded in the vicinity of the 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.

Plate 4.2 Representative image of site A2 on the Clashduff Stream downstream of Druminakella Bridge, July 2022

4.1.3 Site A3 - Gortadroma Stream, Crag

Site A3 was located on the uppermost reaches of the Gortadroma Stream (27G12) at a forestry track crossing adjoining the site boundary. The upland eroding stream channel (FW1) averaged 1-2m wide and 0.1-0.3m deep with bank heights of 0.5m which graded into the adjoining V-shaped valley. The profile comprised boulder-cascade and pool formations over exposed bedrock. The substrata were dominated by exposed siliceous bedrock with some mixed localised mixed gravels, sand and silt in pools. The bed featured a high coverage (70%) of iron-oxidising bacterial deposits and floc indicating lower pH conditions. Given high shading and high energy conditions, macrophytes were not recorded. However, the aquatic bryophytes J*ungermannia* sp. and *Pellia epiphylla* were present locally on boulder tops. The riparian areas supported mature conifer plantations (WD4) upstream of the bridge with grey willow, downy birch (*Betula pubescens*), rowan (*Sorbus aucuparia*) and bracken (*Pteridium aquilinum*) scrub downstream of the site.

No fish were recorded via electro-fishing at site A3 (**Appendix A**). The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which precluded upstream fish passage. Spawning habitat for salmonids was also absent given the predominance of bedrock substrata and smothering of the bed by iron-oxidising bacteria. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

Plate 4.3 Representative image of site A3 on the Gortadroma Stream, July 2022

4.1.4 Site A4 - Gortadroma Stream, Crag Bridge

Site A4 was located on the Gortadroma Stream (27G12) at Crag Bridge (L3080), approx. 0.7km downstream of site A3. The small upland eroding stream (FW1) averaged 1-2m wide (channel up to 3m) and 0.1-0.3m deep and flowed in a steep incised valley with 8-10m high banks. The profile

comprised bolder-cascade and pool formations over exposed bedrock. The substrata were dominated by exposed bedrock and small boulder. Mixed cobble, gravels and sand accumulations were present at the tailings of pools and also in shallow glide areas. The bed was moderately compacted with moderate siltation (silt plumes underfoot and partial movement in the sediment when disturbed). Given high shading and high energy conditions, macrophytes were not recorded. However, the aquatic bryophytes J*ungermannia* sp., *Scapania undulata* and *Hygroamblystegium* sp. were present locally on boulder tops. The riparian areas mature treelines (WL2) of ash, oak, holly and dense bramble (*Rubus fruticosus* agg.). Dense cherry laurel (*Prunus laurocerasus*) was recorded upstream of the bridge. The site was bordered by low-intensity semi-improved grassland (GA1) with areas of species-poor wet grassland (GS4).

Brown trout was the only fish species recorded via electro-fishing at site A4 (**Appendix A**). The site was considered a moderate salmonid nursery, given more limited oxygenated riffle and glide habitat and a dominance of heavily shaded, high energy boulder cascade pool areas – no juveniles were recorded. Spawning habitat was moderate quality at best given limited gravels and dominance of coarse substrata. The paucity of deeper pool areas reduced the value for adult salmonids, which were present in low densities only. Suitability for European eel was relatively poor given the high energy, steep gradient of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey or white-clawed crayfish. There was no suitability for freshwater pearl mussel. Despite some foraging suitability, no otter signs were recorded in the vicinity of the site.
Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.4 Representative image of site A4 on the Gortadroma Stream, July 2022

4.1.5 Site A5 – Belvoir Stream, Belvoir Bridge

Site A5 was located on the Belvoir Stream (27B45) at Belvoir Bridge (L3080). The small upland eroding spate channel (FW1) suffered from low summer flows at the time of survey and averaged 0.5-2m wide (2-3m channel) and 0.05m deep. The profile comprised mainly shallow glide with very localised pool in a semi-natural, sinuous channel. The substrata were dominated by exposed small boulder and cobble with localised coarse gravels. Given high shading and high energy conditions, macrophytes were not present. The aquatic moss *Brachythecium rivulare* was infrequent on exposed boulder. The site was bordered by mixed broadleaved woodland (WD1) that supported beech (*Fagus sylvatica*), holly, alder (*Alnus glutinosa*), ash, wych elm (*Ulmus glabra*) and horse chestnut (*Aesculus hippocastanum*). Improved pasture (GA1) was located adjacent to the site.

No fish were recorded via electro-fishing at site A5 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows and shallow depths although given some physical suitability and proximity to the Owenogarney River (0.9km downstream), there may be some low salmonid and European value during higher water levels. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.5 Representative image of site A5 on the Belvoir Stream, July 2022 (downstream of bridge)

4.1.6 Site A6 – Ballyvorgal North Stream, Glenwood Bridge

Site A6 was located on the Ballyvorgal North Stream (27B47) at Glenwood Bridge (L3080) approx. 0.5km downstream of the proposed site boundary. The small upland eroding spate channel (FW1) had been historically realigned and straightened and suffered from low summer flows at the time of survey. The stream averaged 0.5-1m wide (2m channel) and <0.05m deep with imperceptible flows in a semi-dry channel. Ponding areas were present locally. The bed comprised exposed littoral boulder,

cobble and mixed gravels. Siltation was moderate to high (exacerbated by low flows). Macrophytes were limited to occasional brooklime (*Veronica beccabunga*) with water figwort (*Scrophularia auriculata*) also present instream. No aquatic bryophytes were recorded. The riparian areas supported narrow treelines of scattered alder, ash and grey willow with scrub dominated by bramble, meadowsweet (*Filipendula ulmaria*), gorse (*Ulex europaeus*) and foxglove (*Digitalis purpurea*) on the open banks. The site was bordered by semi-improved pasture (GA1).

No fish were recorded via electro-fishing at site A6 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows and shallow depths. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.6 Representative image of site A6 on the Ballyvorgal North Stream, July 2022

4.1.7 Site A7 – Owenogarney River, Annagore Bridge

Site A7 was located on the Owenogarney River (27O01) at Annagore Bridge (R462) approx. 1.3km downstream of the Castle Lough outflow. The large upland eroding watercourse (FW1) averaged 15-18m wide and 0.2-0.5m deep in a natural sinuous channel. Bank heights were 1-1.2m. The profile was of shallow glide and riffle with only occasional pool. The substrata were dominated by small boulder and cobble with mixed gravels between coarser substrata. The bed was moderately compacted with light to moderate siltation (silt plumes underfoot and partial movement in the sediment when disturbed). Given high energy and riparian shading, macrophytes were limited to occasional beds of water crowfoot (*Ranunculus* sp.) instream with frequent hemlock water dropwort (*Oenanthe crocata*) and water mint (*Mentha aquatica*) along channel margins. Filamentous algae (*Cladophora* sp.) were present (10% cover), indicating enrichment. The small boulder and cobble substrata supported frequent *Rhynchostegium riparoides* and *Fontinalis antipyretica* with occasional *Leptodictyum riparium* (the latter being a further indicator of enrichment; Weekes *et al.*, 2021). The riparian areas

supported treelines of mature ash, wych elm, blackthorn (*Prunus spinosa*), honeysuckle (*Lonicera periclymenum*) and osier (*Salix viminalis*). The site was bordered by improved grassland (GA1).

A total of six fish species were recorded via electro-fishing at site A7, namely Atlantic salmon, European eel (*Anguilla anguilla*), gudgeon (*Gobio gobio*), stone loach (*Barbatula barbatula*), roach (*Rutilus rutilus*) and dace (*Leuciscus leuciscus*) (**Appendix A**). This was the highest fish diversity recorded during the survey. The latter two species, roach and dace are considered invasive of rivers. The Owenogarney River at site A7 was considered an excellent salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Atlantic salmon parr were abundant. Good quality spawning habitat was present in the tailings of pool habitat but was reduced in glide areas due to compaction and siltation. Holding habitat was of good quality in the more localised deeper glide and pool. The site was also a good quality European eel habitat due to ample boulder and cobble refugia, with a low density recorded via electro-fishing. The high energy site was unsuitable for lamprey. Despite some low suitability, no white-clawed crayfish were recorded via hand-searching or environmental DNA sampling. No freshwater pearl mussel eDNA was detected at the site. A regular otter spraint site (containing fish remains only) was recorded under the northernmost arch of the bridge (ITM 547642, 667659).

Biological water quality, based on Q-sampling, was calculated as **Q4 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling. The invasive bivalve mollusc zebra mussel (Dreissena polymorpha) was recorded in the sample.

Plate 4.7 Representative image of site A7 on the Owenogarney River at Annagore Bridge, July 2022

4.1.8 Site B1 – Snaty River, Ballykelly

Site B1 was located on the uppermost reaches of the Snaty River (27S34) within the proposed site boundary. The diminutive upland eroding stream (FW1) suffered from very low summer water levels at the time of survey and averaged 0.5m wide and 0.05-0.1m deep. The steep-sided, U-shaped channel had been historically modified and featured imperceptible flows and localised standing water in pools. The bed was dominated by peat and sand. The substrata were heavily bedded with a very high cover

of floc. Macrophytes were not present given high riparian shading. Aquatic bryophytes were not recorded although some localised *Pellia* sp. was present on muddy banks. The site was bordered by degraded blanket bog (PB4) and wet grassland (GS4).

No fish were recorded via electro-fishing at site B1 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows, shallow depths and heavy siltation. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.8 Representative image of site B1 on the upper reaches of the Snaty River, July 2022

4.1.9 Site B2 – Snaty River, Cloontra

Site B2 was located on the upper reaches of the Snaty River (27S34) at a forestry track crossing within the proposed site boundary, approx. 1km downstream of site B1. The small upland eroding watercourse (FW1) averaged 1-2m wide and 0.05-0.2m deep in a sinuous channel flowing in a shallow sloping V-shaped valley. The profile comprised boulder-cascade and pool. The substrata were dominated by small boulder and cobble with patches of coarse gravel, sand and peat. The substrata were moderately bedded with very high cover (75%) of iron-oxidising bacterial deposits and floc. Given the high energy characteristics, the site did not support macrophytes although aquatic bryophytes were present on emergent boulders. These included *Fissidens* sp. moss with liverwort species including *Jungermannia* sp., *Scapania undulata* and *Pellia epiphylla*. The riparian areas supported abundant grey willow, meadowsweet and bracken scrub, with the site bordered by conifer plantations (WD4) and upland blanket bog (PB4).

No fish were recorded via electro-fishing at site B2 (**Appendix A**). The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which

precluded upstream fish passage. Spawning habitat for salmonids was also absent given siltation (peat) and smothering of the bed by iron-oxidising bacteria. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

Plate 4.9 Representative image of site B2 on the Snaty River, July 2022

4.1.10 Site B3 – Oatfield Stream, Oatfield

Site B3 was located on the Oatfield Stream (27O07) at the R471 road crossing. The small upland eroding watercourse (FW1) suffered from very low summer water levels at the time of survey with imperceptible flows. The stream had been historically deepened and averaged 0.5-1m wide and 0.05-0.1m deep with a U-shaped channel. The profile comprised boulder-cascade and pool sequence. The substrata were dominated by small boulder and cobble with coarse gravels. The substrata were heavily bedded and siltation was high. The stream was lined by mature treelines of sycamore, beech, hawthorn (*Crataegus monogyna*) and ivy (*Hedera* sp.) with bramble, wild angelica (*Angelica sylvestris*) and bracken in the understories. The site was bordered by a residential property and improved pasture (GA1).

Three-spined stickleback (*Gasterosteus aculeatus*) was the only fish species recorded via electro-fishing at site B3 (**Appendix A**). Apart from low densities of this species in localised pools, the site was not of fisheries value given its diminutive nature, low summer flows and heavy siltation. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.10 Representative image of site B3 on the Oatfield Stream, July 2022

4.1.11 Site B4 – unnamed Stream, Cloontra West

Site B4 was located on the upper reaches of an unnamed Snaty Stream tributary adjoining the proposed site boundary. The very small upland eroding stream (FW1) suffered from very low summer water levels at the time of survey with imperceptible flows and averaged just 0.5m wide and 0.05-0.1m deep. The bed was dominated by peat with scattered cobble, gravels and sand. The substrata were heavily bedded with a very high cover of iron-oxidising bacterial deposits and floc, indicating lower pH conditions. The site did not support macrophytes given the heavy shading but small patches of *Pellia* sp. liverwort were present on peaty banks. The riparian areas supported frequent scrubby grey willow, bramble, blackthorn, hawthorn, wild angelica and soft rush (*Juncus effusus*) that graded into adjoining upland blanket bog (PB3) and conifer plantation (WD4).

No fish were recorded via electro-fishing at site B4 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows, shallow depths and heavy siltation, in addition to high cover of floc on the substrata. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.11 Representative image of site B4 on an unnamed stream, July 2022

4.1.12 Site B5 – Snaty River, Aughnagourney Bridge

Site B5 was located on the Snaty River (27S34) at Aughnagourney Bridge (R471), approx. 2.5km downstream of site B2. The medium-sized upland eroding spate channel (FW1) averaged 2-4m wide and 0.2-0.4m deep with 2m high banks and a sinuous, semi-natural profile in vicinity of the road crossing. The profile comprised boulder-cascade sequences with associated glide and pool areas. The high energy site featured a bed of boulder and cobble with small, mixed gravel patches locally. The small areas of gravel were clean with only light siltation. Given the high energy of the river, no macrophytes were recorded. The instream boulders supported the liverwort *Chiloscyphus polyanthos* and *Hygroamblystegium* sp. moss. The site had a mature riparian zone of hazel and grey willow with bramble and bracken scrub. It was bordered by wet grassland (GS4) outside of small patches of hazel woodland (WN2).

Brown trout was the only fish species recorded via electro-fishing at site B5 (**Appendix A**). The site was a very good salmonid nursery habitat with broken oxygenated water and boulder refugia. The site also provided good spawning characteristics with patches of good quality spawning habitat between exposed large boulders. God quality holding habitat was present, associated with deep pools below cascade areas. While suitability for European eel existed in terms of refugia, the high gradient and high energy of the stream reduced suitability. The high energy upland eroding site was unsuitable for lamprey or white-clawed crayfish. There was no suitability for freshwater pearl mussel. Despite some low foraging suitability, no otter signs were recorded in the vicinity of the 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.

Plate 4.12 Representative image of site B5 on the Snaty River at Aughnagourney Bridge, July 2022

4.1.13 Site B6 - West Cloontra Stream, Callaghan's Bridge

Site B6 was located on the West Cloontra Stream (27W36) at Callaghan's Bridge (R471). The small upland eroding stream (FW1) suffered from low summer water levels at the time of survey with very slow flowing water. The stream averaged 2m wide and 0.05-0.1m deep with a semi-natural, sinuous channel and 1m high banks. The substrata comprised mixed coarse, medium and fine gravels with scattered cobble and boulder. Shallow, superficial silt deposits were present locally. However, these were bedded with moderate to heavy siltation and the stream was heavily stained by suspended solids at the time of the survey. Macrophytes were limited to water starwort (*Callitriche* sp.) with only occasional *Scapania undulata* present on larger boulder. Cover of filamentous algae was high (20%), indicating significant enrichment. The stream was lined by grey willow, hawthorn and ash with herbaceous understories. The site was bordered by scrub (WS1) and improved pasture (GA1).

Brown trout and three-spined stickleback were the only fish species recorded via electro-fishing at site B6 (**Appendix A**). The site was a poor quality salmonid nursery given low flows, heavy siltation and evident enrichment. The stream also offered moderate spawning characteristics given the presence of mixed gravels albeit siltation and enrichment reduced the quality of the habitat. Adult salmonid holding areas were very localised with limited deeper pools (poor quality overall). There was limited suitability for European eel given limited cover of large substrata and limited pool habitat. While some low suitability for lamprey spawning was recorded, no ammocoetes were recorded from shallow silt deposits. The fisheries value would likely improve under higher flows. There was poor suitability for white-clawed crayfish (none recorded) and no suitability for freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.13 Representative image of site B6 on the West-Cloontra Stream at Callaghan's Bridge, July 2022

4.1.14 Site B7 – O'Neill's Stream, Cloontra East

Site B7 was located on the upper reaches of the O'Neill's Stream (25O02) adjacent to the proposed site boundary. The small upland eroding spate stream (FW1) suffered from very low summer water levels at the time of survey with poor flows. The stream averaged 1m wide and 0.05-0.1m deep and flowed in a naturally incised, V-shaped valley. The profile was of boulder-cascade and associated pools. The substrata were dominated by bedrock, small boulder and cobble with patches of mixed gravels. These were moderately bedded given the high energy nature of the site. Siltation was moderate with iron-oxidising bacterial deposits and floc on gravels. No filamentous algae cover was present and no macrophytes were present due to the high energy. However, the exposed bedrock and boulders supported the liverwort *Chiloscyphus polyanthos* with occasional *Hygroamblystegium* sp. on boulder tops. The riparian areas supported mature ash and grey willow woodland (WN6) with bramble in the understories. The site was bordered by semi-improved pasture (GA1) and wet grassland (GS4).

No fish were recorded via electro-fishing at site B7 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows and shallow depths, in addition to high cover of floc on the substrata. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.14 Representative image of site B7 on the O'Neill's Stream, July 2022

4.1.15 Site B8 – Knockshanvo Stream, Mountrice

Site B8 was located on the upper reaches of the Knockshanvo Stream (25K82), a tributary of the O'Neill's Stream, adjoining the site boundary. The swift flowing upland eroding spate stream (FW1) averaged 1.5-2m wide and 0.1-0.2m deep. Contained in a naturally incised, V-shaped valley, the profile was of boulder-cascade and associated pools. The substrata were dominated by bedrock, small boulder and cobble with patches of mixed gravels. These were moderately bedded given the high energy nature of the site. Siltation was moderate with peat deposits on the bed. Given the high energy characteristics, the site did not support macrophytes. However, the exposed bedrock and boulders supported the liverwort *Chiloscyphus polyanthos* with occasional *Hygroamblystegium* sp. on larger boulder. The riparian areas supported mature ash and grey willow with dense bramble, gorse and bracken scrub (WS1). The site was bordered by wet improved pasture (GA1).

Brown trout was the only fish species recorded via electro-fishing at site B8 (**Appendix A**). The site was considered a moderate salmonid nursery only, given more limited oxygenated riffle and glide habitat and a dominance of high energy boulder cascade pool areas. Spawning habitat was moderate quality at best given limited gravels and siltation of same. The paucity of deeper pool areas reduced the value for adult salmonids (none recorded). Suitability for European eel was relatively poor given the shallow, high energy nature of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey or white-clawed crayfish. There was no suitability for freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

Plate 4.15 Representative image of site B8 on the Knockshanvo Stream, July 2022

4.1.16 Site B9 – O'Neill's Stream, Knockshanvo Stream confluence

Site B9 was located on the O'Neill's Stream (25O02) at the Knockshanvo Stream confluence, approx. 2.8km downstream of site B7. The stream at this location had been historically straightened and deepened but retained some semi-natural characteristics. The upland eroding watercourse (FW1) (with increasingly frequent depositing characteristics) averaged 2m wide and 0.1-0.2m deep. As per upstream the stream suffered from low summer water levels at the time of survey with only moderate flows present. The profile was of riffle and glide with occasional small pools. The substrata comprised abundant fine-medium gravels with more localised silt and sand in depositing pool areas. The substrata were bedded with moderate to heavy siltation and the water was heavily stained by suspended solids at the time of the survey. Given high riparian shading, no macrophytes or aquatic bryophytes were recorded. The channel was lined with narrow treeline of scattered mature ash, grey willow and osier with dense scrub in the understories comprising gorse, bramble, meadowsweet and wild angelica. The site was bordered by improved pasture (GA1).

Brown trout and lamprey (*Lampetra* sp.) were the only fish species recorded via electro-fishing at site B9 (**Appendix A**). The site was considered a moderate quality salmonid nursery given the presence of oxygenating riffle and glide over mixed gravels. These gravels also provided moderate to good quality spawning habitat for both salmonids and lamprey, though the quality was reduced somewhat by siltation. The site provided poor quality holding habitat due to very limited pools. Whilst larval lamprey habitat was present this was sub-optimal and localised, supporting a very low density of ammocoetes. European eel habitat was poor overall due to a paucity of deeper pool and suitable instream refugia. There was low suitability for white-clawed crayfish and none were recorded. No otter signs were recorded in the vicinity of the site.

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.

Plate 4.16 Representative image of site B9 on the O'Neill's Stream, July 2022

4.1.17 Site B10 – Mountrice River, Sallybank

Site B10 was located on the upper reaches of the Mountrice River (25M03) within the site boundary. The upland eroding spate river (FW1) had been realigned historically but retained a semi-natural character. The slow flowing channel suffered from low water levels at the time of survey and averaged 2m wide (4m wide channel) and 0.1-0.2m deep. The profile comprised boulder-cascade reaches with associated pools. The substrata were dominated by small boulder and cobble with patches of mixed gravels. These were moderately bedded given the high energy nature of the site. Siltation was moderate with peat deposits on the bed. Given the high energy characteristics, the site did not support macrophytes. However, instream boulders supported frequent *Chiloscyphus polyanthos* with occasional *Hygroamblystegium* sp. Riparian areas supported mature ash and downy birch (*Betula pubescens*), with an area of coniferous clear-fell (WS5) on the west bank. The site was bordered by extensive mature conifer plantations (WD4) with broadleaved buffers.

Brown trout was the only fish species recorded via electro-fishing at site B10 (**Appendix A**). The site was considered a moderate quality nursery for salmonids although low summer flows and recent clear-fell had caused sedimentation of the river, thus reducing the nursery value. Moderate quality spawning habitat was present but localised and the site provided poor holding value for adults (none recorded) given a paucity of deeper pool areas. Suitability for European eel was relatively poor given the shallow, high energy nature of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey or white-clawed crayfish. There was no suitability for freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

Plate 4.17 Representative image of site B10 on the upper reaches of the Mountrice River, July 2022

4.1.18 Site B11 – East Cloontra Stream, Sallybank

Site B11 was located on the East Cloontra Stream (25E28) approx. 1.8km upstream of the Mountrice River confluence. The small upland eroding watercourse (FW1) had been heavily modified historically (straightened and deepened), resulting in a 1.5m wide U-shaped channel with 1m high banks and poor hydromorphology and intermittent fluvial connectivity. The stream suffered from very low summer water levels at the time of survey with no flow and localised stagnant pools of water of 0.2-0.3m deep. The channel bed was dominated by deep silt with exposed localised mixed gravels. Given high riparian shading (local tunnelling), macrophytes were limited to occasional common water starwort (*Callitriche stagnalis*) (often on the exposed bed) and common duckweed (*Lemna minor*). The stream was lined with dense scrub supporting bramble, bracken, gorse and grey willow. The site was bordered by improved pasture (GA1).

No fish were recorded via electro-fishing at site B11 (**Appendix A**). The site was not of fisheries value at the time of survey given an absence of flows, shallow depths and heavy siltation, in addition to poor fluvial connectivity with downstream habitats. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site. However, both common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris*) (**Plate 4.19**) were recorded via sweep netting of stagnant pools at the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.18 Representative image of site B11 on the East Cloontra Stream, July 2022

Plate 4.19 Smooth newt (*Lissotriton vulgaris*) eft recorded in a pool of the East Cloontra Stream with a dense surface layer of common duckweed

4.1.19 Site B12 – Mountrice River, Cloghera Bridge

Site B12 was located on the Mountrice River (25M03) at Cloghera Bridge (R471 road crossing), approx. 5km downstream of site B10. The upland eroding spate river (FW1) had been historically deepened but retained some good semi-natural characteristics. The river flowed over a moderate gradient and averaged 2-4m wide and 0.1-0.3m deep. The profile was dominated by shallow riffle and glide with localised pools. The substrata comprised abundant small boulder and cobble with localised fine to medium gravels. These were moderately bedded given the high energy nature of the site. Siltation was moderate, with plumes underfoot. Given the high energy characteristics and high riparian shading, no macrophytes were present. Larger boulder supported occasional *Chiloscyphus polyanthos*. Riparian areas supported mature ash, grey willow, sycamore and poplar (*Populus* sp.) with dense bracken and bramble scrub in the understories. The site was bordered by improved pasture (GA1).

Atlantic salmon, brown trout and stone loach were recorded via electro-fishing at site B12 (**Appendix A**). The site was a moderate to good quality salmonid nursery given the presence of oxygenating riffle and glide habitat. Gravel substrata also provided moderate quality spawning habitat, although this was reduced given siltation and compaction. Holding opportunities for adult salmonids was poor due to the paucity of deeper pool areas. Likewise, suitability for European was also poor. The high energy upland eroding site was unsuitable for lamprey and provided sub-optimal conditions for white-clawed crayfish (none recorded). There was no suitability for freshwater pearl mussel. Despite some foraging suitability and historical records at this location, no otter signs were recorded in the vicinity of the site.

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.

Plate 4.20 Representative image of site B12 on the Mountrice River at Cloghera Bridge, July 2022

4.1.20 Site B13 – River Blackwater, Killally's Bridge

Site B13 was located on the River (Clare) Blackwater (25B06) at Killally's Bridge, adjacent to a livestock crossing point. The large upland eroding watercourse had been historically deepened upstream of the bridge but retained many semi-natural characteristics. The river flowed over a low gradient and averaged 10-12m wide and 0.3-0.6m deep. Deep glide habitat predominated with occasional pool and riffle. The substrata were dominated by small boulder and cobble with patches of coarse gravel, sand and silt. The substrata were moderately bedded and silted and cover of filamentous algae and floc was high (c.40%), indicating enrichment. Macrophytes were limited to occasional common water starwort, fool's watercress and hemlock water dropwort. Redshank (Persicaria maculosa) was frequent on exposed sand bars. Submerged boulders and cobbles supported the liverwort *Chiloscyphus polyanthos* with occasional *Hygroamblystegium* sp. on boulder tops. The riparian areas supported mature alder, ash and ivy (*Hedera hibernica*) with bramble in the understories. The site was bordered by improved pasture (GA1).

A total of five fish species were recorded via electro-fishing at site B13, namely Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow (*Phoxinus phoxinus*) and stone loach (**Appendix A**). The site

was considered a good quality salmonid nursery, particularly for brown trout. The presence of mixed cohorts of fish supported this observation, albeit the numbers of 0+ fish were lower than expected. This was likely a result of enrichment and sedimentation in addition to historical deepening of the channel. The spawning attributes were considered locally good in the tailing of deep glide and pool where patches of mixed gravels were present. The holding value was good with ample deep glide and pool for adult salmonids. The site was of good value for European eel given the presence of suitable boulder and cobble refugia although none were recorded. Some suitability for lamprey existed in very localised sub-optimal areas of shallow silt and floc, with a single ammocoete recorded. The site had some suitability for white-clawed crayfish given suitable refugia but none were recorded via hand searching. However, the species was detected via eDNA sampling (**Table 4.1**). There was no suitability for freshwater pearl mussel and none were detected via eDNA sampling. Suitability for otter was high due to abundant prey resources. A regular spraint site was recorded underneath the bridge (ITM 558948, 665668).

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.

Plate 4.21 Representative image of site B13 on the River Blackwater at Killally's Bridge, July 2022

4.1.21 Site B14 – Kyleglass Stream, Kilmore

Site B14 was located on the Kyleglass Stream (25K83), a tributary of the Glenomra Wood Stream, at the R465 road crossing. The small upland eroding stream (FW1) suffered from low summer water levels at the time of survey with very slow flowing water. The stream averaged 1m wide and 0.05m deep. The channel had a sinuous semi-natural profile with 0.25m high banks grading into adjoining wet grassland (GS4) and mixed broadleaved woodland (WD1). The profile comprised boulder-cascade and associated shallow pool sequences. The bed was dominated by small boulder and cobble (much of which were exposed) given the steep gradient of the stream Mixed gravels were present but limited. The substrata were bedded due to the site characteristics and siltation was high. Given the high energy nature of the site, macrophytes were not present. Water mint was scattered along the channel margins and on the low-lying banks. The aquatic bryophytes *Scapania undulata* and *Jungermannia* sp.

were present locally on boulders. The site was bordered by wet grassland (GS4) to the south with mixed broad-leaved woodland (WD1), supporting grey willow, sycamore, horse chestnut and cherry laurel, to the north.

No fish were recorded via electro-fishing at site B14 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows, shallow depths, heavy siltation and naturally high gradients. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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 rating given poor flows and lack of suitable riffle areas for sampling (as per Toner *et al.*, 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.22 Representative image of site B14 on the Kyleglass Stream, July 2022

4.1.22 Site C1 – Rocks Stream, Crean Stream confluence

Site C1 was located on the Rocks Stream (27R07) at the Crean Stream confluence, north of the proposed site boundary. The small swift flowing upland eroding spate channel (FW1) averaged 1.5-2m wide and 0.05-0.1m deep and flowed over a moderate gradient in a naturally incised V-shaped valley. The stream had a sinuous natural profile with a profile typified by boulder-cascade and associated shallow pools. The riverbed was dominated by exposed small boulder, cobble and abundant mixed coarse gravels that suffered from moderate siltation and natural compaction. The did not macrophytes given high riparian shading and the high energy of the river channel. The exposed boulder and cobble supported occasional *Pellia* sp. and *Jungermannia* sp. liverwort with frequent *Hyocomium armoricum* and *Hygroamblystegium* sp. mosses. The river was situated in a valley supporting mature hazel woodland (WN2) with wood sorrel (*Oxalis acetosella*), ivy, herb Robert (*Geranium robertianum*) and Hart's-tongue fern (*Asplenium scolopendrium*) in the understories. The site was bordered by improved grassland (GA1).

No fish were recorded via electro-fishing at site C1 (**Appendix A**). The site was not of fisheries value at the time of survey given very low flows and shallow depths, in addition to high natural gradients

downstream. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the 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.

Plate 4.23 Representative image of site C1 on the Rocks Stream, July 2022

4.1.23 Site N1 – Snaty Stream, Snaty

Site N1 was located on the Snaty Stream[5] (27S13), located to the north of the proposed site boundary. The small upland eroding watercourse (FW1) averaged just 0.5m wide and 0.05m deep. The channel had a U-shaped profile with 0.6m high banks. The profile comprised boulder-cascade sequences with associated pools. The substrata were dominated by bedrock (given high gradients) with limited gravels. High riparian shading precluded the presence of macrophytes or aquatic bryophytes. The stream was heavily tunnelled with dense gorse, grey willow, rowan and bramble. The site was bordered by wet grassland (GS4) dominated by rushes (*Juncus* spp.).

No fish were recorded via electro-fishing at site N1 (**Appendix A**). The stream was not of fisheries value at this location given shallow depths, high natural gradients and the location of the site in the uppermost reaches of the catchment. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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

[5] A separate watercourse to the Snaty River which drains south of the proposed site

Plate 4.24 Representative image of site N1 on the Snaty Stream, July 2022

4.1.24 Site N2 – Glenomra Wood Stream, Kilmore

Site N2 was located on the upper reaches of the Glenomra Wood Stream (25G12) approx. 1km upstream of the site boundary of Glenomra Wood SAC (001013). The natural upland eroding watercourse (FW1) flowed over a moderate gradient and averaged 2-4m wide and 0.1-0.3m deep. The sinuous channel featured low-lying banks of 0.5m. The profile comprised equal proportions of pool, riffle and shallow glide with cascading areas where the stream increased in gradient. The bed was dominated by small boulder and cobble with frequent patches of mixed gravels at the tailings of pools and also in shallow low-gradient glide areas. Finer gravel and sand accumulations were also present in depositing areas between small boulders. The bed was uncompacted and had light to moderate siltation (silt plumes underfoot). The site was of too high energy to support macrophytes. However, the liverwort *Chiloscyphus polyanthos* was abundant on boulder tops with frequent *Rhynchostegium riparoides*. The site was located in woodland (WN2) supporting mature hazel, ash and downy birch.

Brown trout was the only fish species recorded via electro-fishing at site N2 (**Appendix A**). The site was considered a good quality salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Good quality spawning habitat was present locally, reduced somewhat due to the higher energy of the stream and also evident siltation. Some good quality holding habitat for small salmonids was present locally. Suitability for European eel was high with good riparian shading and abundant cobble and boulder refugia, although none were recorded. The high energy upland eroding site was unsuitable for lamprey and provided sub-optimal conditions for white-clawed crayfish (none recorded). There was no suitability for freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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.

Plate 4.25 Representative image of site N2 on the upper reaches of the Glenomra Wood Stream, July 2022

4.1.25 Site N3 – Springmount Stream, Springmount

Site N3 was located on the Springmount Stream (25S93), a tributary of the Glenomra Wood Stream. The natural upland eroding watercourse (FW1) suffered from low summer water levels at the time of survey with very low flows. The sinuous stream averaged 2-2.5m wide and 0.05m deep. The profile comprised boulder-cascade sequences and associated shallow pool. The substrata were dominated by small boulder, cobble and coarse gravels, many of which were exposed due to low water levels. Given the site characteristics and high shading, macrophytes were not present. However, the liverwort species *Chiloscyphus polyanthos* was present on boulders, in addition to *Hygroamblystegium* sp. moss. The stream was lined by frequent hazel and willow and the site was bordered by mature sitka spruce conifer plantations (WD4), wet grassland (GS4) and improved grassland (GA1).

No fish were recorded via electro-fishing at site N3 (**Appendix A**). The site was not of fisheries value at the time of survey given shallow depths, high natural gradients and the location of the site in the upper reaches of the catchment. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in the vicinity of the site.

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.

Plate 4.26 Representative image of site N3 on the Springmount Stream, July 2022

4.1.26 Site N4 – Glenomra Wood Stream, Tooreen

Site N2 was located on the lower reaches of the Glenomra Wood Stream (25G12) at the R471 road crossing, approx. 4kmdownstream of site N2. The large upland eroding watercourse (FW1) averaged 4-6m wide and 0.2-0.5m deep with a semi-natural sinuous profile and 1m high banks. The profile was of equal proportions of pool, riffle and shallow glide. The substrata comprised mixed with boulder, cobble, mixed gravels and sand. The bed was moderately compacted with moderate siltation (silt plumes underfoot and partial movement in the sediment when disturbed). Macrophytes were limited to occasional hemlock water dropwort. The liverwort species *Chiloscyphus polyanthos* was frequent on instream boulders with *Hygroamblystegium* sp. moss being recorded as rare. The riparian areas supported mature sycamore, blackthorn, ash and hazel with bracken and bramble scrub in the understories. The site was bordered by improved grassland (GA1).

Atlantic salmon and brown trout were the only fish species recorded via electro-fishing at site N4 (**Appendix A**). The site was considered a very good quality salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Spawning habitat was of good quality, locally, being reduced due to limited gravel areas and also evident siltation. Some good quality holding habitat for adult salmonids was present in association with meanders and natural bank scours. Suitability for European eel was good given abundant instream refugia although none were recorded. The high energy upland eroding site was unsuitable for lamprey. The site had some good suitability for white-clawed crayfish given abundant instream refugia although none were recorded via hand searching. However, the species was detected via eDNA sampling (see section 4.3). A single old otter spraint was located downstream of the bridge on a crack willow (*Salix fragilis*) limb (ITM 559970, 665854) and good suitability for otter existed given the healthy salmonid prey resource.

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.

Plate 4.27 Representative image of site N4 on the Glenomra Wood Stream, July 2022

3.3 eDNA analysis

White-clawed crayfish eDNA was detected in both composite water samples collected from the River Blackwater (site A13) and Glenmora Wood Stream (N4) (12 and 9 positive qPCR replicates out of 12, respectively) (**Table 4.1; Appendix C**). These results were considered as evidence of the species' absence at and or upstream of the sampling locations. White-clawed crayfish were not detected in the Owengarney River sample (site A7), in keeping with the known distribution of the species in the wider survey area.

Sites on the Owengarney River (site A7), River Blackwater (site A13) and Glenmora Wood Stream (N4) all tested positive for crayfish plague (*Aphanomyces astaci*) (12, 12 and 9 positive qPCR replicates out of 12, respectively) (**Table 4.1**).

No freshwater pearl mussel eDNA was detected at the three sampling locations (**Table 4.1**), in keeping with the known absence of the species in the wider survey area.

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

Sample	Watercourse	Freshwater pearl mussel	White-clawed crayfish	Crayfish plague
FK599	Owengarney River (site A7)	Negative (0/12)	Negative (0/12)	**Positive (12/12)**
FK595	River Blackwater (site B13)	Negative (0/12)	**Positive (1/12)**	**Positive (12/12)**
FK602	Glenomra Wood Stream (site N4)	Negative (0/12)	**Positive (9/12)**	**Positive (9/12)**

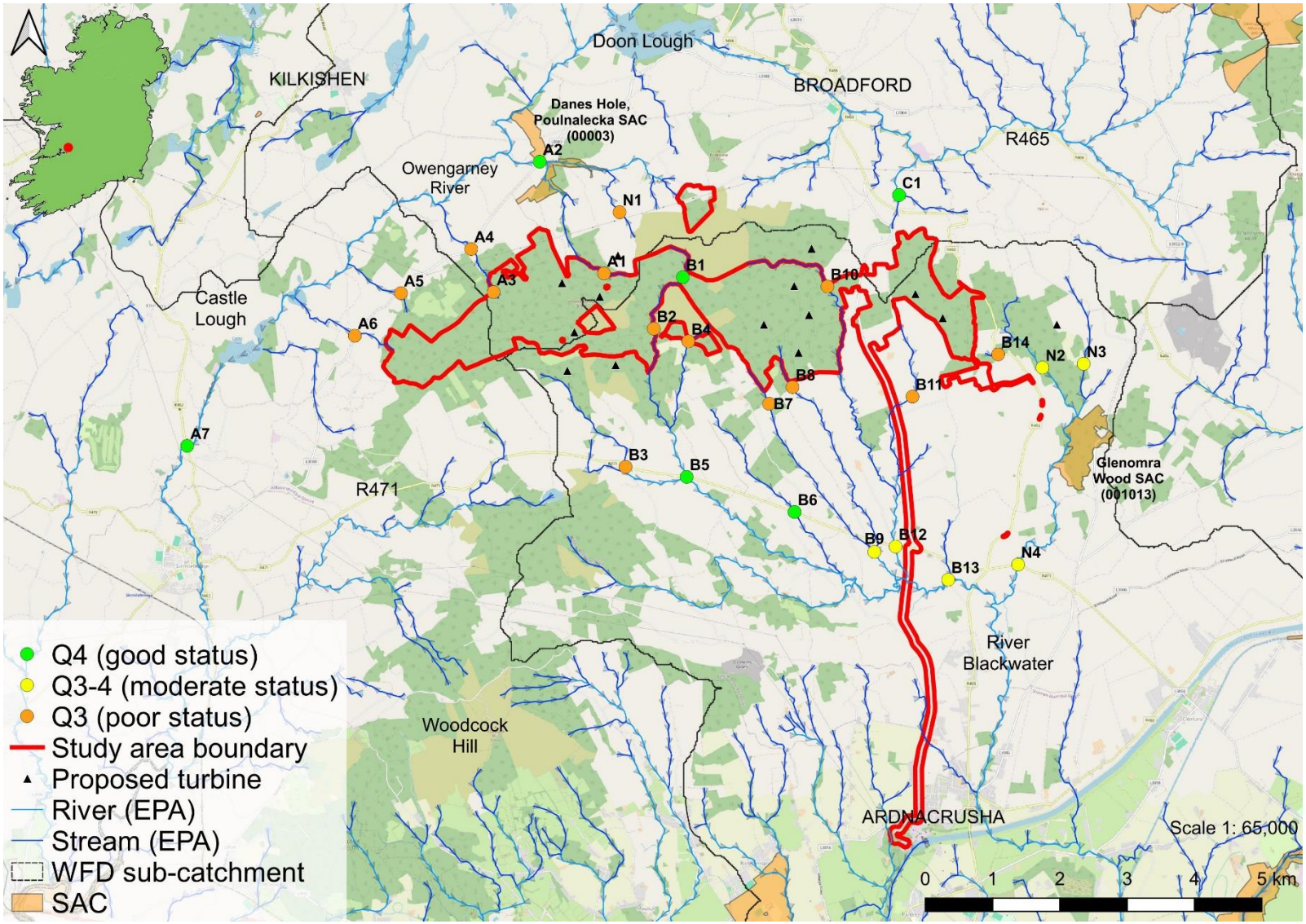

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Knockshanvo wind farm project, Co. Clare, July 2022

4. Discussion

The watercourses surveyed in the sub catchments draining the proposed wind farm development area were upland eroding in nature and suffered from low (summer) water levels and flows during July 2022, resulting in reduced habitat and water quality and, in some cases, poor fluvial connectivity, habitat fragmentation and fish passage issues. Broadly speaking, the most important watercourses for aquatic ecology within vicinity of the proposed development were the larger Owenogarney River, River Blackwater and Glenomra Wood Stream. These supported higher conservation value species such as Atlantic salmon, lamprey (*Lampetra* sp.), European eel, otter and or white-clawed crayfish (**Table 4.1, 4.2**). Localised areas of higher value aquatic habitats (e.g. salmonid spawning/nursery) were also present on smaller watercourses including the Clashduff Stream and Mountrice River. No rare or protected macro-invertebrates (with the exception of crayfish), macrophytes, aquatic bryophytes or Annex I habitats were recorded in any of the survey watercourses.

Apart from site B3 on the Oatfield Stream (three-spined stickleback only), salmonids were recorded at all 13 no. sites supporting fish during the survey. Atlantic salmon were present at 5 no. sites, on the Clashduff Stream (A2), Owenogarney River (A7), Mountrice River (B12), River Blackwater (B13) and Glenomra Wood Stream (N4). Brown trout populations were widespread in the survey area. Lamprey ammocoetes (*Lampetra* sp.) were recorded from 2 no. sites on the River Blackwater (B13) and its tributary the O'Neill's Stream (B9). European eel were only recorded in low densities from site A7 on the Owenogarney River at Annagore Bridge (**Table 4.2; Appendix A**).

Otter signs (spraints) were only recorded at a total of 3 no. sites on the Owenogarney River (A7), River Blackwater (B13) and the Glenomra Wood Stream (N4). The paucity of signs was considered to mainly reflect the high energy characteristics of most watercourses in the survey area, as well as the influence of low (summer) water levels and flows on fish distribution and populations. No breeding (holt) or couch (resting) areas were identified in the vicinity of the survey sites in July 2022.

No freshwater pearl mussel eDNA was detected in samples collected from the Owenogarney River (A7), River Blackwater (B13) or Glenomra Wood Stream (N4) in July 2022 (**Table 4.1**; **Appendix C**). Suitability was poor or absent throughout the survey sites (heavy siltation, historical modifications, small and or spate channels, low summer flows etc.). These results were in keeping with the known absence of this species within the wider survey area (Ross, 2017).

Only a total of 6 no. sites on the Clashduff Stream (site A2), Owenogarney River (A7), Snaty River (C1), Snaty Stream (B5), West Cloontra Stream (B6) and Rocks Stream (C1) achieved **Q4 (good status)** water quality and therefore met the target good status (≥Q4) water quality requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**). No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from 26 riverine sites in July 2022 (**Appendix B**).

Whilst no white-clawed crayfish were detected via hand searching (26 sites) or field examination of otter spraint, white-clawed crayfish eDNA was detected at sites B13 on the River Blackwater and N4 on the Glenomra Wood Stream in July 2022 (**Table 4.1**; **Appendix C**). These results support the known historical distribution of the species in the wider survey area, i.e. only present in the River (Clare) Blackwater catchment (**Figure 3.1**).

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6. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

Fisheries assessment of Knockshanvo wind farm, Co. Clare

Prepared by Triturus Environmental Ltd. for MKO

December 2022

Please cite as:

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by MKO to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Knockshanvo wind farm, located approx. 5km north-east of Sixmilebridge, Co. Clare (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed project, a catchment-wide electro-fishing survey across *n*=26 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 (*Lampetra* sp.) and European eel (*Anguilla anguilla*). Other species of lower conservation value were also recorded. The presence and or absence of fish populations and or associated supporting habitat would help inform impact assessment and any subsequent mitigation for the project.

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake a catchment-wide electro-fishing survey in the vicinity of the proposed Knockshanvo wind farm. Permission was granted on the 30th June 2022 and the survey was undertaken during Monday 25th to Thursday 28th July 2022.

1.2 Fisheries asset of the survey area

The *n*=26 aquatic survey sites were located within the Owenogarney_SC_010, Owenogarney_SC_012 and Shannon[Lower]_SC_100 river sub-catchments. The proposed wind farm was not located within a European site although there was downstream hydrological connectivity (via several watercourses) with Danes Hole, Poulanecka SAC (000003) and Glenomra Wood SAC (001013). Fisheries survey sites were present on the Ballyvorgal North Stream (EPA code: 27B47), Belvoir Stream (27B45), Snaty Stream (27S13), Clashduff Stream (27C44), East Cloontra Stream (25E29), Glenomra Wood Stream (25G12), Gortadroma Stream (27G12), Knockshanvo Stream (25K82), Kyleglass Stream (25K83), Mountrice River (25M03), Oatfield Stream (25O07), O'Neill's Stream (25O02), Owenogarney River (27O01), River (Clare) Blackwater (25B06), Rocks Stream (27R07), Snaty River (25S34), Springmount Stream (27S93), West Cloontra Stream (25W36) and an unnamed stream (**Table 2.1**).

The Owenogarney (Owengarney) River, also known locally as the Doon River, Ahaclare River and, lower down, the Ratty River, rises near Moylussa Mountain and flows for some 37km through Doon Lough, Ballymulcashel (Pollagh) Lough and Castle Lough before joining the Shannon Estuary downstream of Bunratty. The river is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*) and European eel (pers. obs.). Nationally the Owenogarney is ranked 45th in terms of the amount of fluvial habitat accessible to Atlantic salmon (0.41% of national; McGinnity et al., 2003). The Owenogarney system is also known locally to contain stocks of coarse fish species including bream (*Abramis brama*), rudd (*Scardinius erythropthalmus*), tench (*Tinca tinca*), perch (*Perca fluviatilis*), pike (*Esox lucius*), gudgeon (*Gobio gobio)* and minnow (*Phoxinus phoxinus*) (pers. obs.). The non-native,

invasive cyprinid species dace (*Leuciscus leuciscus*) has been recorded in the Owenogarney River system since 1980 (Caffrey et al., 2007), with invasive roach (*Rutilus rutilus*) present since the early 1980s (Brazier, 2018). Additionally, the lower reaches are known historically to support both river (*Lampetra fluviatilis*) and sea lamprey (Ross, 2017; Igoe et al, 2004) and a spawning site for European smelt (*Osmerus eperlanus*) has been recorded downstream of Sixmilebridge (Quigley et al., 2004).

The River (Clare) Blackwater is known to support Atlantic salmon and brown trout and European eel, with a wide range of coarse fish species, including non-native dace, in the lower reaches. Brook lamprey have previously been recorded throughout the river by Ross (2017).

Whilst data is deficient for the majority of the watercourses in the vicinity of the proposed project, many were surveyed by Triturus as part of the then Oatfield wind farm project (Triturus, 2017). In July 2017 Atlantic salmon were recorded from sites on the Snaty Stream, Mountrice River (Cloghera Bridge), River Blackwater and Clashduff Stream, with brown trout and, to a lesser extent, European eel widespread throughout the catchment. Lamprey (*Lampetra* sp.) were recorded from sites on the Cloontra West Stream (Callaghan's Bridge) and the River Blackwater (Triturus, 2017).

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 Knockshanvo wind farm on the 25th to 28th July 2022 following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

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

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

The catchment-wide electro-fishing (CWEF) survey was undertaken across *n*=26 sites (see **Table 2.1, Figure 2.1**).

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. Discrepancies in fishing effort (CPUE) between sites are accounted for in the subsequent results section (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the low to moderate conductivity waters of the sites (draining mixed geologies) a voltage of 220-280v, frequency of 35-40Hz and pulse duration of 3.5-4ms 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. 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

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

2.2 Fisheries habitat

A broad appraisal / overview 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 following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Particular cognisance was given towards preventing the spread or introduction of crayfish plague given the known distribution of white-clawed crayfish in the wider survey area. Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=26 electro-fishing survey sites in the vicinity of Knockshanvo wind farm, Co. Clare

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Clashduff Stream	27C44	Snaty	553836	670219
A2	Clashduff Stream	27C44	Druminakella Bridge	552881	671880
A3	Gortadroma Stream	27G12	Crag	552195	669943
A4	Gortadroma Stream	27G12	Crag Bridge	551863	670582
A5	Belvoir Stream	27B45	Belvoir Bridge	550819	669926
A6	Ballyvorgal North Stream	27B47	Glenwood Bridge	550133	669294
A7	Owenogarney River	27O01	Annagore Bridge	547643	667656
B1	Snaty River	25S34	Ballykelly	555008	670164
B2	Snaty River	25S34	Cloontra	554575	669398
B3	Oatfield Stream	25O07	R471 crossing, Oatfield	554155	667344
B4	Unnamed stream	n/a	Cloontra West	555089	669210
B5	Snaty River	25S34	Aughnagourney Bridge	555064	667195
B6	West Cloontra Stream	25W36	Callaghan's Bridge	556667	666673
B7	O'Neill's Stream	25O02	Cloontra East	556288	668282
B8	Knockshanvo Stream	25K82	Mountrice	556637	668529
B9	O'Neill's Stream	25O02	Knockshanvo Stream confluence	557852	666079
B10	Mountrice River	25M03	Sallybank	557156	670025
B11	East Cloontra Stream	25E29	Sallybank	558419	668388
B12	Mountrice River	25M03	Cloghera Bridge	558168	666159
B13	River (Clare) Blackwater	25B06	Killally's Bridge	558950	665665
B14	Kyleglass Stream	25K83	R465 road crossing	559692	669016
C1	Rocks Stream	27R07	Crean Stream confluence	558219	671385
N1	Snaty Stream	27S13	Snaty	554067	671130
N2	Glenomra Wood Stream	25G12	Kilmore	560350	668820
N3	Springmount Stream	27S93	Springmount	560962	668876
N4	Glenomra Wood Stream	25G12	R471 road crossing	559988	665891

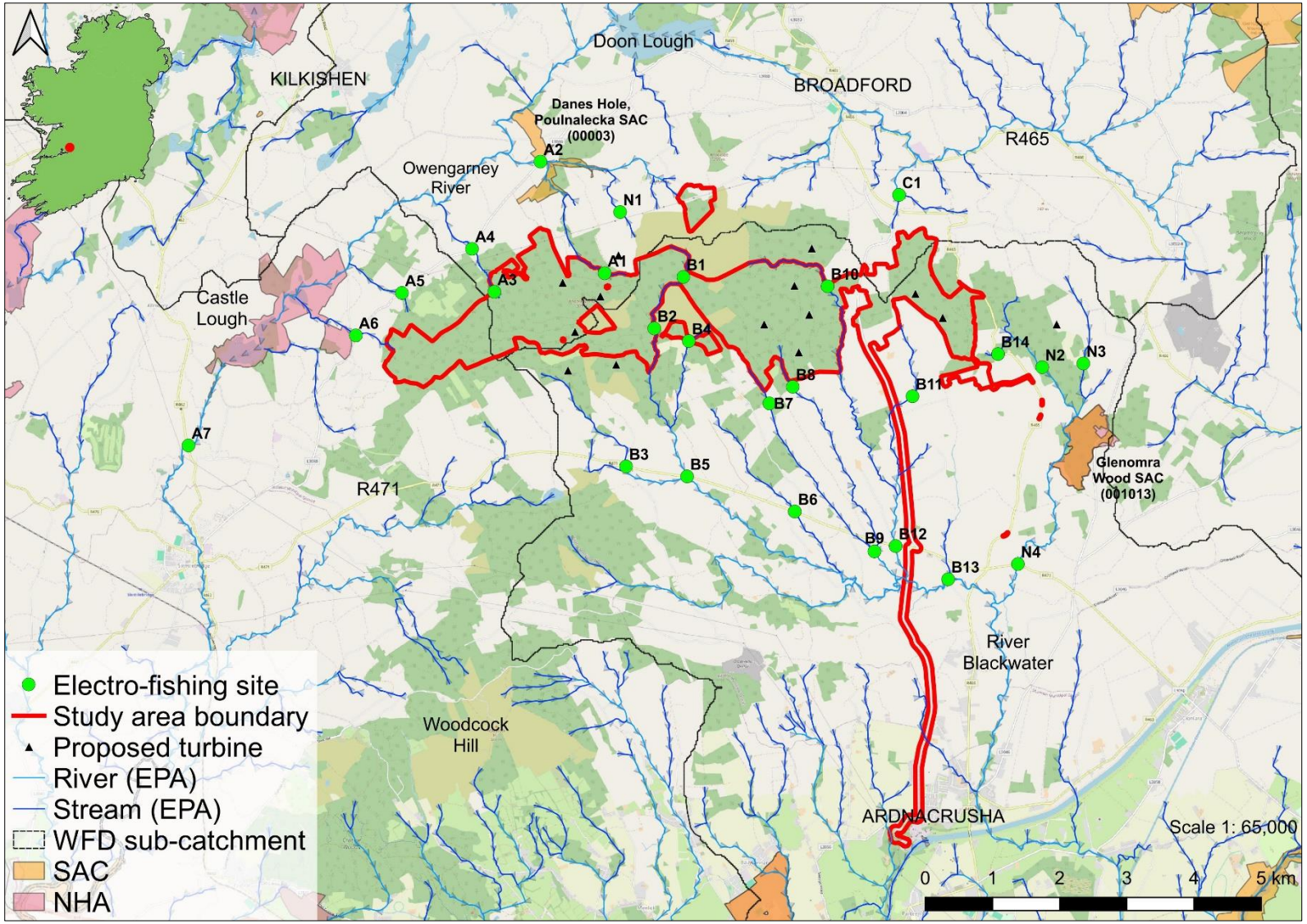

Figure 2.1 Overview of the *n*=26 electro-fishing survey site locations for the proposed Knockshanvo wind farm, Co. Clare

3. Results

A catchment-wide electro-fishing survey of *n*=26 riverine sites in the vicinity of the proposed Knockshanvo wind farm was conducted on the 25th to 28th July 2022 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – Clashduff Stream, Snaty

No fish were recorded via electro-fishing at site A1. The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which precluded upstream fish passage. Spawning habitat for salmonids was also absent given the predominance of bedrock substrata and smothering of the bed by iron-oxidising bacteria.

Plate 3.1 Representative image of site A1 on the Clashduff Stream, July 2022 (no fish recorded)

3.1.2 Site A2 – Clashduff Stream, Druminakella Bridge

Atlantic salmon (*Salmo salar*) (*n*=7) and brown trout (*Salmo trutta*) (*n*=17) were the only two fish species recorded via electro-fishing at site A2 (**Figure 3.1**).

The stream at this location was considered a good salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Spawning habitat was of moderate quality locally, being reduced due to a paucity of smaller substrata and also evident siltation. Good quality holding areas were associated with pool areas on meanders. The site was considered a good quality European eel nursery with good riparian shading and abundant cobble and boulder refugia (none recorded). The high energy upland eroding site was unsuitable for lamprey.

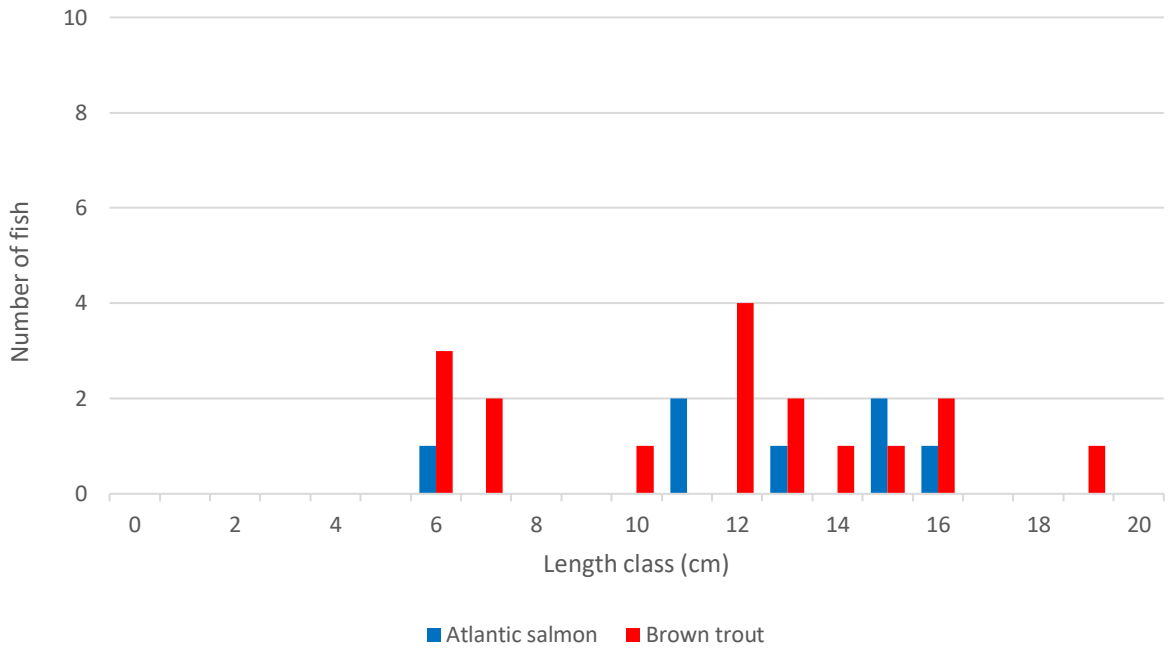

Figure 3.1 Length frequency distribution recorded via electro-fishing at A2 on the Clashduff Stream, July 2022

Plate 3.2 Brown trout (top) and Atlantic salmon (bottom) recorded at site A2 on the Clashduff Stream downstream of Druminakella Bridge, July 2022

3.1.3 Site A3 - Gortadroma Stream, Crag

No fish were recorded via electro-fishing at site A3. The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which precluded upstream fish passage. Spawning habitat for salmonids was also absent given the predominance of bedrock substrata and smothering of the bed by iron-oxidising bacteria.

Plate 3.3 Representative image of site A3 on the Gortadroma Stream, July 2022 (no fish recorded)

3.1.4 Site A4 - Gortadroma Stream, Crag Bridge

Brown trout (*n*=3) was the only fish species recorded via electro-fishing at site A4 (**Figure 3.2**).

The site was considered a moderate salmonid nursery, given more limited oxygenated riffle and glide habitat and a dominance of heavily shaded, high energy boulder cascade pool areas. No juvenile fish were recorded. Spawning habitat was moderate quality at best given limited gravels and dominance of coarse substrata. The paucity of deeper pool areas reduced the value for adult salmonids, which were present in low densities only. Suitability for European eel was relatively poor given the high energy, steep gradient of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey.

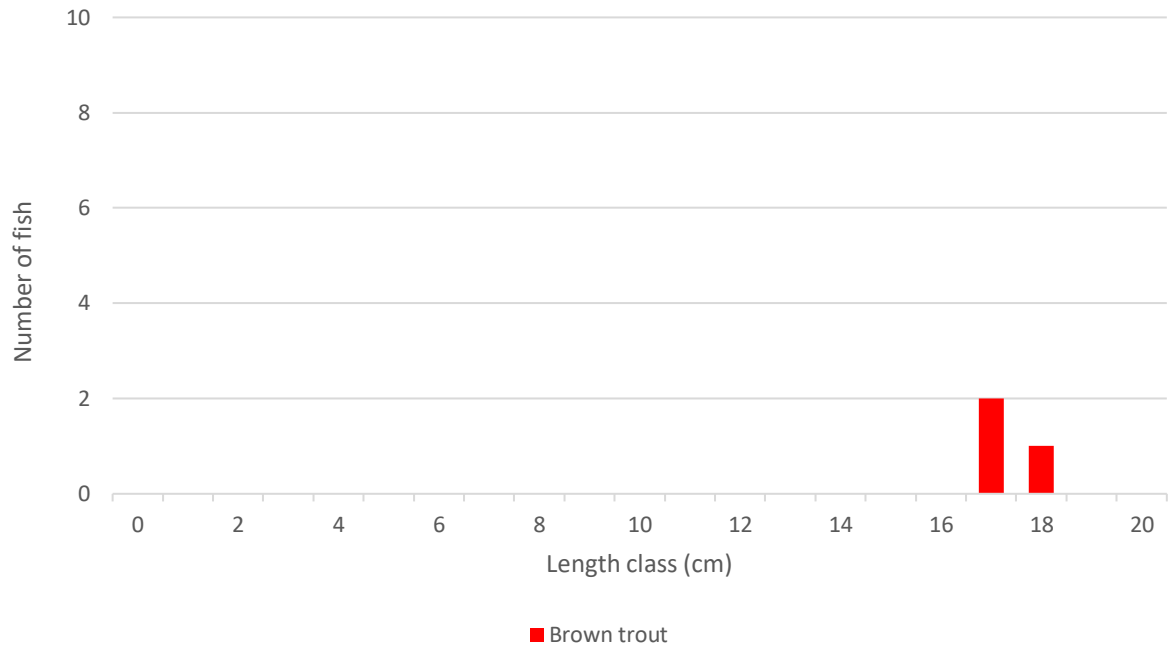

Figure 3.2 Length frequency distribution recorded via electro-fishing site A4 on the Gortadroma Stream, July 2022

Plate 3.4 Representative image of site A4 on the Gortadroma Stream, July 2022

3.1.5 Site A5 – Belvoir Stream, Belvoir Bridge

No fish were recorded via electro-fishing at site A5. The site was not of fisheries value at the time of survey given very low flows and shallow depths although given some physical suitability and proximity to the Owenogarney River (0.9km downstream), there may be some low salmonid and European value during higher water levels.

Plate 3.5 Representative image of site A5 on the Belvoir Stream, July 2022 (no fish recorded)

3.1.6 Site A6 – Ballyvorgal North Stream, Glenwood Bridge

No fish were recorded via electro-fishing at site A6. The site was not of fisheries value at the time of survey given very low flows and shallow depths (<0.05m deep with imperceptible flows).

Plate 3.6 Representative image of site A6 on the Ballyvorgal North Stream, July 2022 (no fish recorded)

3.1.7 Site A7 – Owenogarney River, Annagore Bridge

A total of six fish species were recorded via electro-fishing at site A7, namely Atlantic salmon (*n*=72), European eel (*Anguilla anguilla*) (*n*=3), gudgeon (*Gobio gobio*) (*n*=2), stone loach (*Barbatula barbatula*) (*n*=1) and the non-native species roach (*Rutilus rutilus*) (*n*=1) and dace (*Leuciscus leuciscus*) (*n*=1) (**Figure 3.3**). This was the highest fish diversity recorded during the survey and the highest density of Atlantic salmon recorded.

The site was considered an excellent salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Atlantic salmon parr were abundant. Good quality spawning habitat was present in the tailings of pools but was reduced in glide areas due to compaction and siltation. Holding habitat was of good quality in the more localised deeper glide and pool. The site was also a good quality European eel habitat due to ample boulder and cobble refugia, with a low density recorded via electro-fishing. The high energy site was unsuitable for lamprey.

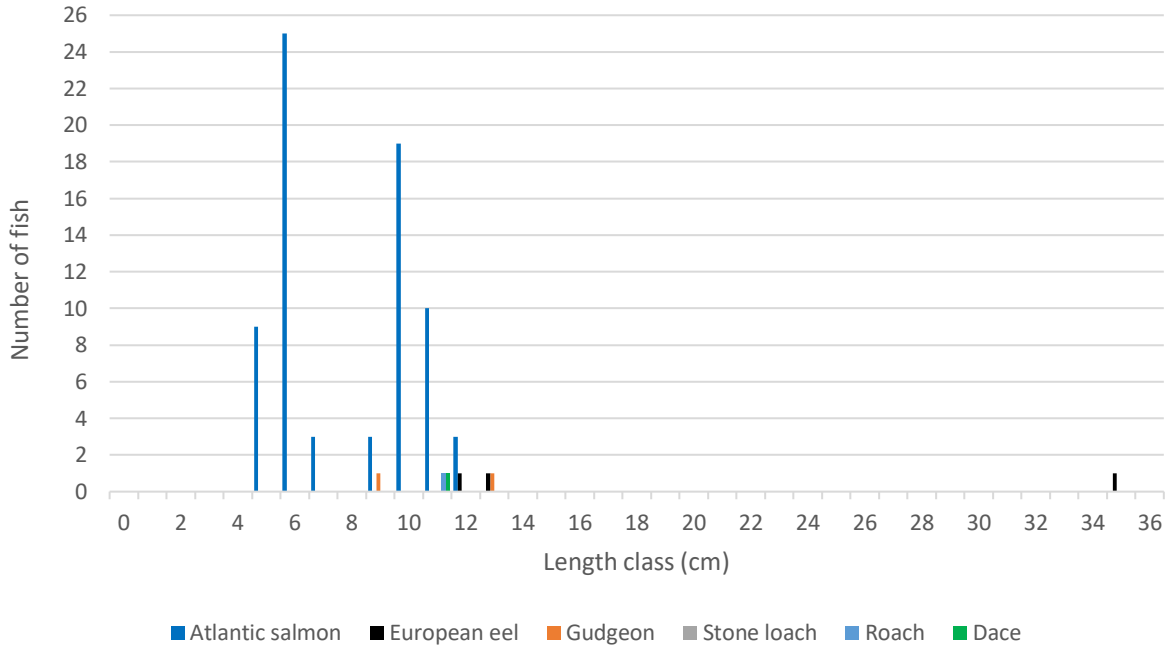

Figure 3.3 Length frequency distribution recorded via electro-fishing at site A7 on the Owengarney River at Annagore Bridge, July 2022

Plate 3.7 Gudgeon and stone loach recorded at site A7 on the Owengarney River, July 2022

3.1.8 Site B1 – Snaty River, Ballykelly

No fish were recorded via electro-fishing at site B1. The site was not of fisheries value at the time of survey given very low flows, shallow depths (<0.1m) and heavy siltation and its location in the upper reaches of the catchment.

Plate 3.8 Representative image of site B1 on the upper reaches of the Snaty River, July 2022 (no fish recorded)

3.1.9 Site B2 – Snaty River, Cloontra

No fish were recorded via electro-fishing at site B2. The site was not of fisheries value given its location in the headwaters of the stream and high natural downstream gradients which precluded upstream fish passage. Spawning habitat for salmonids was also absent given siltation (peat) and smothering of the bed by iron-oxidising bacteria.

Plate 3.9 Representative image of site B2 on the Snaty River, July 2022 (no fish recorded)

3.1.10 Site B3 – Oatfield Stream, Oatfield

Three-spined stickleback (*Gasterosteus aculeatus*) (*n*=12) was the only fish species recorded via electro-fishing at site B3 (**Figure 3.4**).

Apart from low densities of this species in localised pools, the site was not of fisheries value given its diminutive nature, low summer flows and heavy siltation.

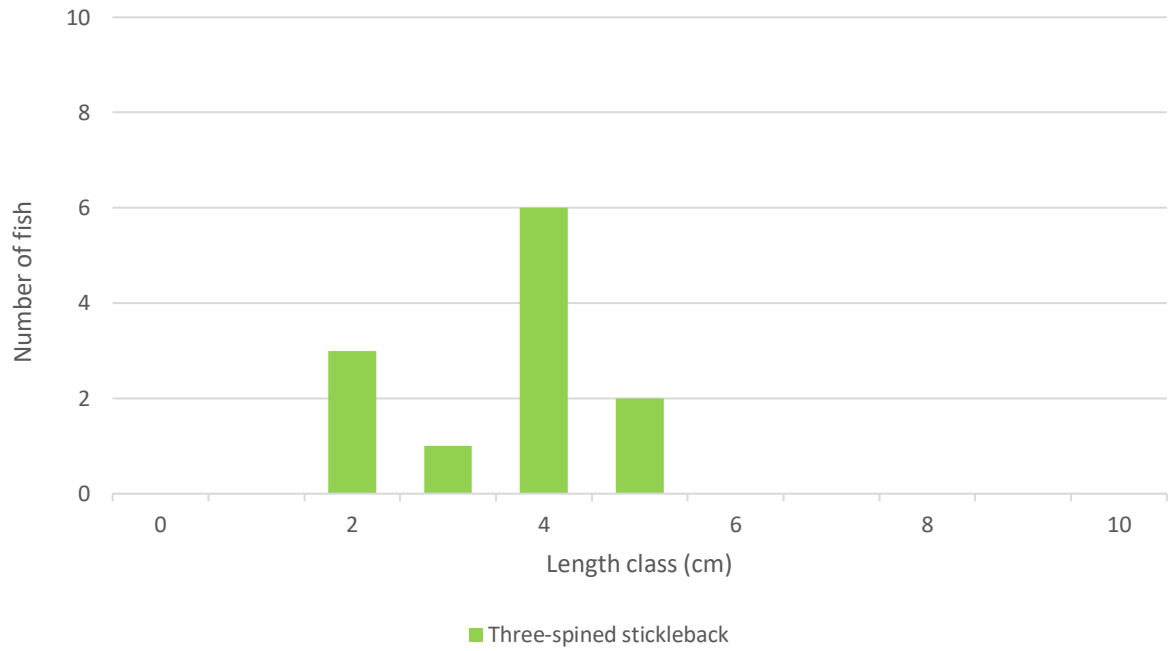

Figure 3.4 Length frequency distribution recorded via electro-fishing at B3 on the Oatfield Stream, July 2022

Plate 3.10 Representative image of site B3 on the Oatfield Stream, July 2022

3.1.11 Site B4 – unnamed Stream, Cloontra West

No fish were recorded via electro-fishing at site B4. The site was not of fisheries value at the time of survey given very low flows, shallow depths, historical modifications and heavy siltation, in addition to high cover of floc on the substrata.

Plate 3.11 Representative image of site B4 on an unnamed Snaty River tributary, July 2022 (no fish recorded)

3.1.12 Site B5 – Snaty River, Aughnagourney Bridge

Brown trout (*n*=33) was the only fish species recorded via electro-fishing at site B5 (**Figure 3.5**). The site was a very good salmonid nursery habitat with broken oxygenated water and boulder refugia. The site also provided good spawning characteristics with patches of good quality spawning habitat between large, exposed boulders. God quality holding habitat was present, associated with deep pools below cascade areas. While suitability for European eel existed in terms of refugia, the high gradient and high energy of the stream reduced suitability. The high energy upland eroding site was unsuitable for lamprey.

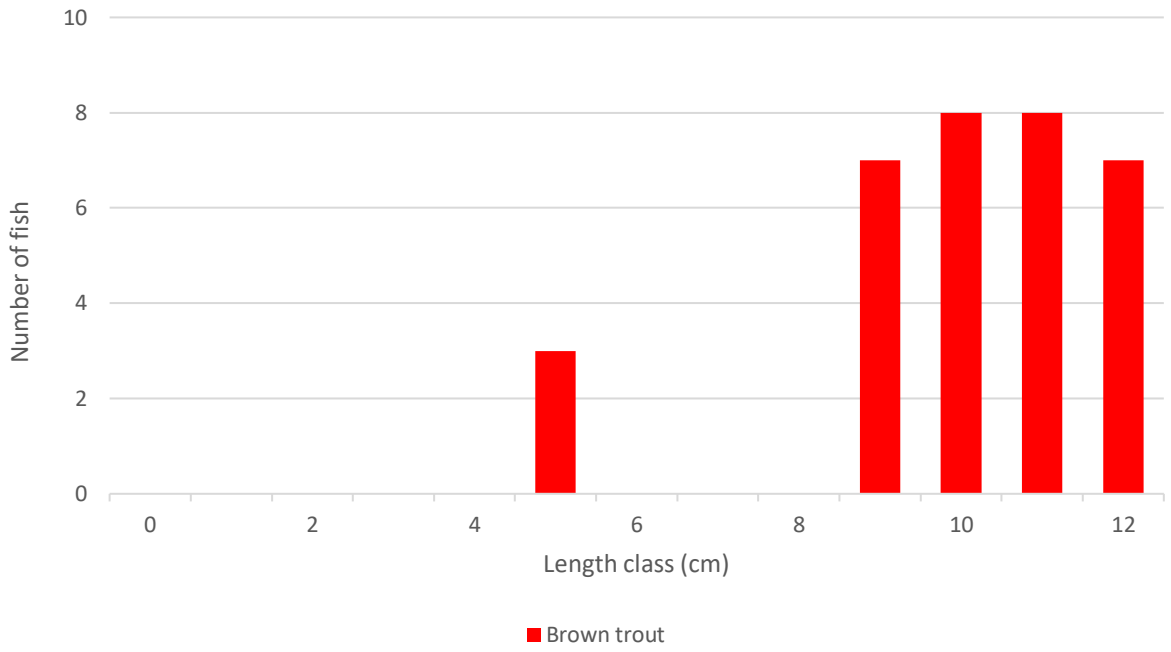

Figure 3.5 Length frequency distribution recorded via electro-fishing at B3 on the Oatfield Stream, July 2022

Plate 3.12 Representative image of site B5 on the Snaty River at Aughnagourney Bridge, July 2022

3.1.13 Site B6 - West Cloontra Stream, Callaghan's Bridge

Brown trout (*n*=3) and three-spined stickleback (*n*=7) were the only fish species recorded via electro-fishing at site B6 (**Figure 3.6**).

The site was a poor quality salmonid nursery given low flows, heavy siltation and evident enrichment. The stream also offered moderate spawning characteristics given the presence of mixed gravels albeit siltation and enrichment reduced the quality of the habitat. Adult salmonid holding areas were very localised with limited deeper pools (poor quality overall). There was limited suitability for European eel given limited cover of large substrata and limited pool habitat. While some low suitability for

lamprey spawning was recorded, no ammocoetes were recorded from shallow silt deposits (ammocoetes recorded at this site in 2017; Triturus, 2017). The overall fisheries value would likely improve under higher flows.

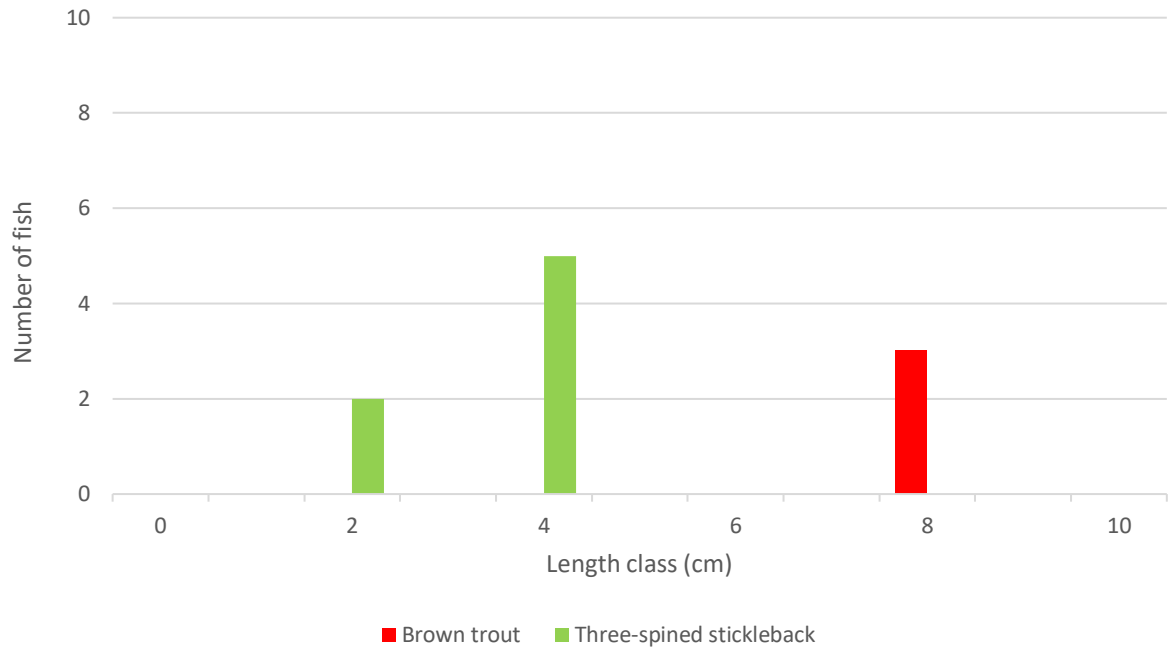

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B6 on the West-Cloontra Stream, July 2022

Plate 3.13 Representative image of site B6 on the West-Cloontra Stream at Callaghan's Bridge, July 2022

3.1.14 Site B7 – O'Neill's Stream, Cloontra East

No fish were recorded via electro-fishing at site B7. The site was not of fisheries value at the time of survey given very low flows and shallow depths, in addition to high cover of floc on the substrata.

Plate 3.14 Representative image of site B7 on the O'Neill's Stream, July 2022 (no fish recorded)

3.1.15 Site B8 – Knockshanvo Stream, Mountrice Site

Brown trout (*n*=3) was the only fish species recorded via electro-fishing at site B8 (**Figure 3.7**).

The site was considered a moderate salmonid nursery only, given more limited oxygenated riffle and glide habitat and a dominance of high energy boulder cascade pool areas. Spawning habitat was moderate quality at best given limited gravels and siltation of same. The paucity of deeper pool areas reduced the value for adult salmonids (none recorded). Suitability for European eel was relatively poor given the shallow, high energy nature of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey.

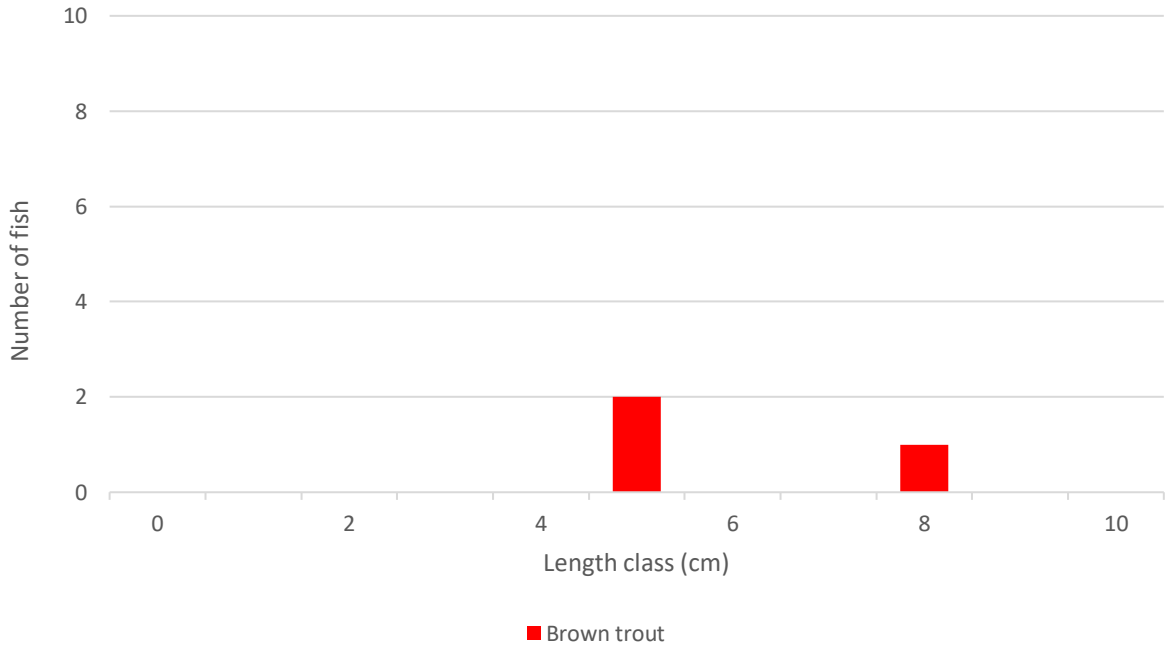

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B8 on the Knockshanvo Stream, July 2022

Plate 3.15 Representative image of site B8 on the Knockshanvo Stream, July 2022

3.1.16 Site B9 – O'Neill's Stream, Knockshanvo Stream confluence

Brown trout and lamprey (*Lampetra* sp.) were the only fish species recorded via electro-fishing at site B9 (**Figure 3.8**).

The site was considered a moderate quality salmonid nursery given the presence of oxygenating riffle and glide over mixed gravels. These gravels also provided moderate to good quality spawning habitat for both salmonids and lamprey, though the quality was reduced somewhat by siltation. The site provided poor quality holding habitat due to very limited pools. Whilst larval lamprey habitat was present this was sub-optimal and localised, supporting a very low density of ammocoetes. European eel habitat was poor overall due to a paucity of deeper pool and suitable instream refugia.

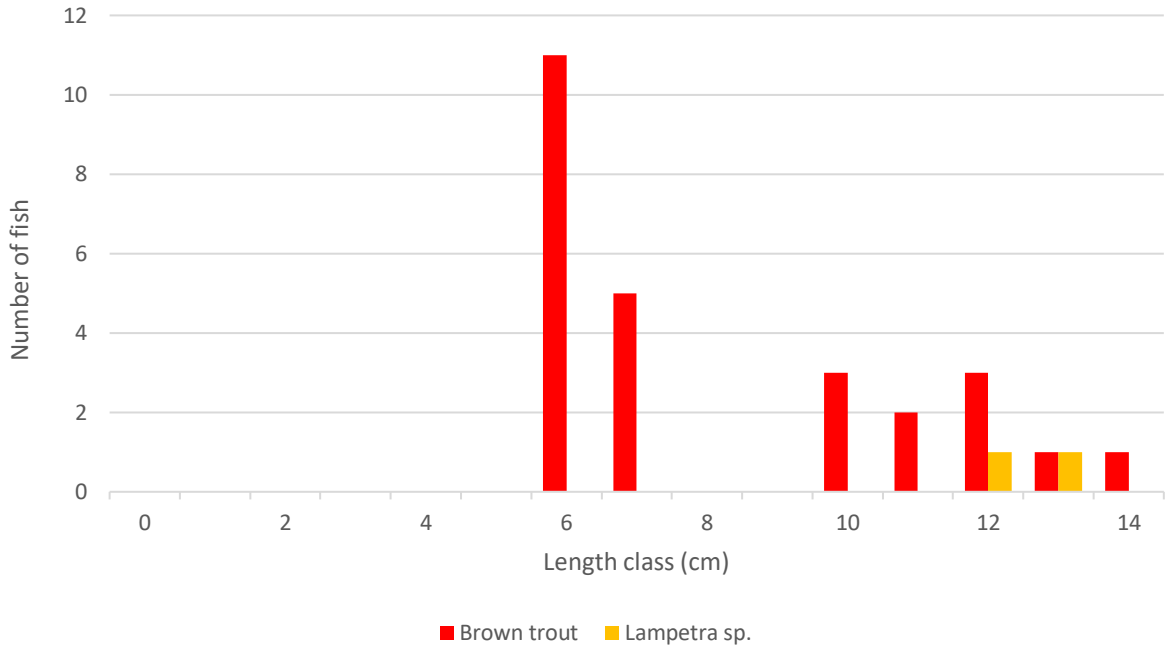

Figure 3.8 Length frequency distribution recorded via electro-fishing at site B9 on the O'Neill's Stream, July 2022

Plate 3.16 *Lampetra* sp. ammocoete recorded at site B9 on the O'Neill's Stream, July 2022

3.1.17 Site B10 – Mountrice River, Sallybank

Brown trout (*n*=8) was the only fish species recorded via electro-fishing at site B10 (**Figure 3.9**).

The site was considered a moderate quality nursery for salmonids although low summer flows and recent clear-fell had caused sedimentation of the river, thus reducing the nursery value. Moderate quality spawning habitat was present but localised and the site provided poor holding value for adults (none recorded) given a paucity of deeper pool areas. Suitability for European eel was relatively poor given the shallow, high energy nature of the channel (none recorded). The high energy upland eroding site was unsuitable for lamprey.

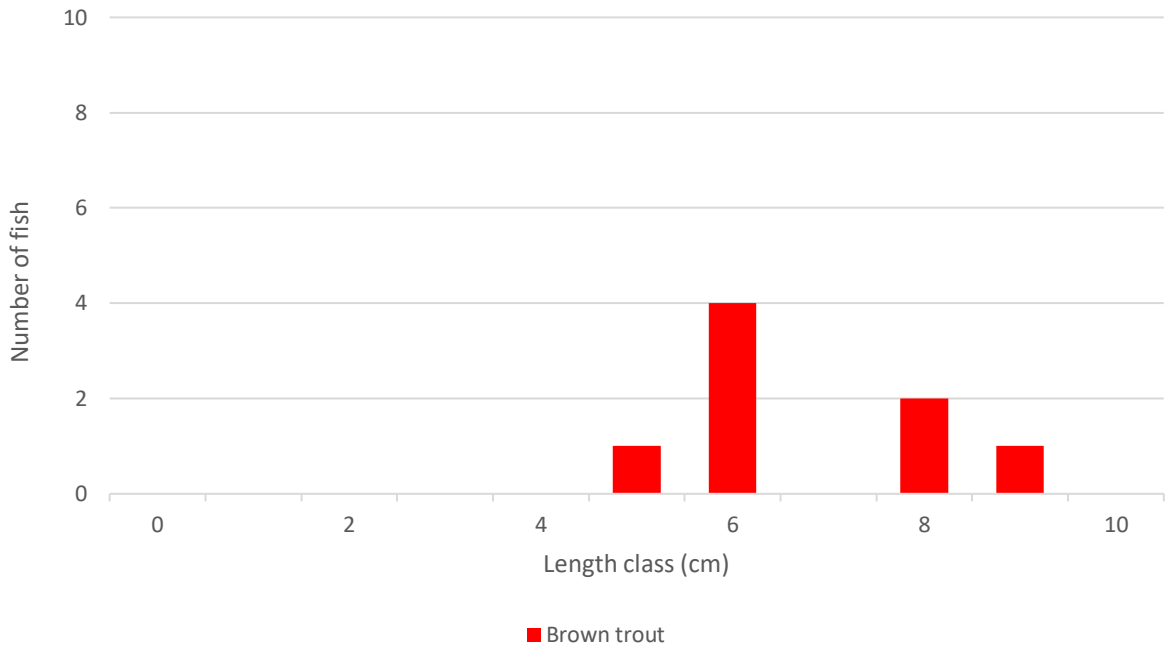

Figure 3.9 Length frequency distribution recorded via electro-fishing at B10 on the Mountrice River, July 2022

Plate 3.17 Juvenile brown trout recorded at site B10 on the upper reaches of the Mountrice River, July 2022

3.1.18 Site B11 – East Cloontra Stream, Sallybank

No fish were recorded via electro-fishing at site B11. The site was not of fisheries value at the time of survey given an absence of flows, shallow depths and heavy siltation, in addition to poor fluvial connectivity with downstream habitats.

Plate 3.18 Representative image of site B11 on the East Cloontra Stream, July 2022 (no fish recorded)

3.1.19 Site B12 – Mountrice River, Cloghera Bridge

Atlantic salmon (*n*=5), brown trout (*n*=14) and stone loach (*n*=1) were recorded via electro-fishing at site B12 (**Figure 3.10**).

The site was a moderate to good quality salmonid nursery given the presence of oxygenating riffle and glide habitat. Gravel substrata also provided moderate quality spawning habitat, although this was reduced given siltation and compaction. Holding opportunities for adult salmonids was poor due to the paucity of deeper pool areas. Likewise, suitability for European was also poor. The high energy upland eroding site was unsuitable for lamprey.

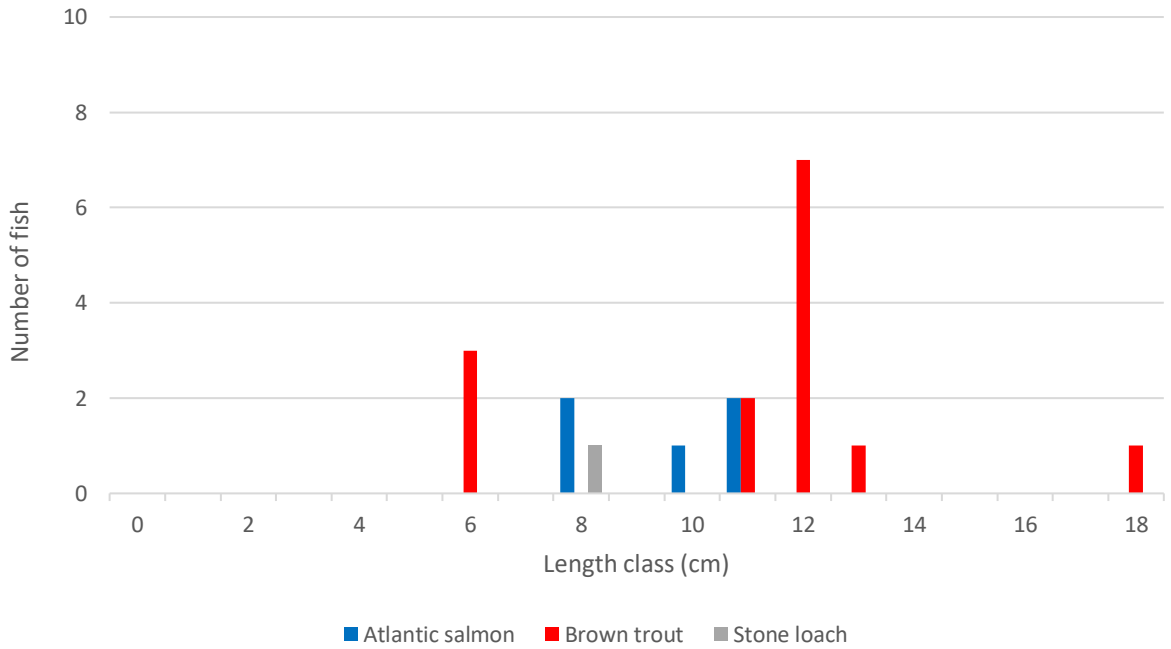

Figure 3.10 Length frequency distribution recorded via electro-fishing at B12 on the Mountrice River, July 2022

Plate 3.19 Atlantic salmon parr with *Piscicola* sp. leech recorded at site B12 on the Mountrice River at Cloghera Bridge, July 2022

3.1.20 Site B13 – River Blackwater, Killally's Bridge

A total of five fish species were recorded via electro-fishing at site B13, namely Atlantic salmon (*n*=4), brown trout (*n*=38), lamprey (*Lampetra* sp.) (*n*=1), minnow (*Phoxinus phoxinus*) (*n*=4) and stone loach (*n*=11) (**Figure 3.11**).

The site was considered a good quality salmonid nursery, particularly for brown trout. The presence of mixed cohorts of fish supported this observation, albeit the numbers of 0+ fish were lower than expected. This was likely a result of enrichment and sedimentation in addition to historical modification (deepening) of the channel. The spawning attributes were considered locally good in the tailing of deep glide and pool where patches of mixed gravels were present. The holding value was good with ample deep glide and pool for adult salmonids. The site was of good value for European eel given the presence of suitable boulder and cobble refugia although none were recorded. Some suitability for lamprey existed in very localised sub-optimal areas of shallow silt and floc, with a single ammocoete recorded.

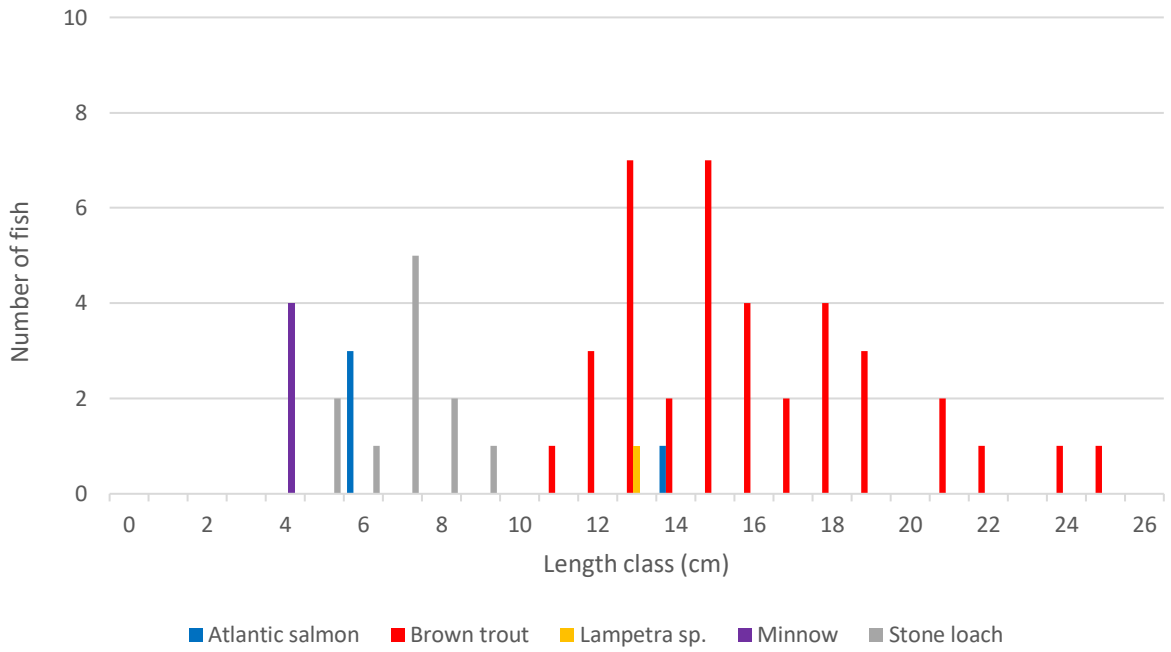

Figure 3.11 Length frequency distribution recorded via electro-fishing at B13 on the River Blackwater, July 2022

Plate 3.20 Male minnow in full spawning colours recorded at site B13 on the River Blackwater at Killally's Bridge, July 2022

3.1.21 Site B14 – Kyleglass Stream, Kilmore

No fish were recorded via electro-fishing at site B14. The site was not of fisheries value at the time of survey given very low flows, shallow depths, heavy siltation and naturally high gradients.

Plate 3.21 Representative image of site B14 on the Kyleglass Stream, July 2022 (no fish recorded)

3.1.22 Site C1 – Rocks Stream, Crean Stream confluence

No fish were recorded via electro-fishing at site C1. The site was not of fisheries value at the time of survey given very low flows and shallow depths, in addition to high natural gradients downstream.

Plate 3.22 Representative image of site C1 on the Rocks Stream, July 2022 (no fish recorded)

3.1.23 Site N1 – Snaty Stream[1], Snaty

No fish were recorded via electro-fishing at site N1. The stream was not of fisheries value at this location given shallow depths, high natural gradients and the location of the site in the uppermost reaches of the catchment.

[1] A separate watercourse to the Snaty River (sites B1, B2 & B5) which drains south of the proposed site

Plate 3.23 Representative image of site N1 on the Snaty Stream, July 2022 (no fish recorded)

3.1.24 Site N2 – Glenomra Wood Stream, Kilmore Bridge

Brown trout (*n*=28) was the only fish species recorded via electro-fishing at site N2 (**Figure 3.12**).

The site was considered a good quality salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Good quality spawning habitat was present locally, reduced somewhat due to the higher energy of the stream and also evident siltation. Some good quality holding habitat for small salmonids was present locally. Suitability for European eel was high with good riparian shading and abundant cobble and boulder refugia, although none were recorded. The high energy upland eroding site was unsuitable for lamprey.

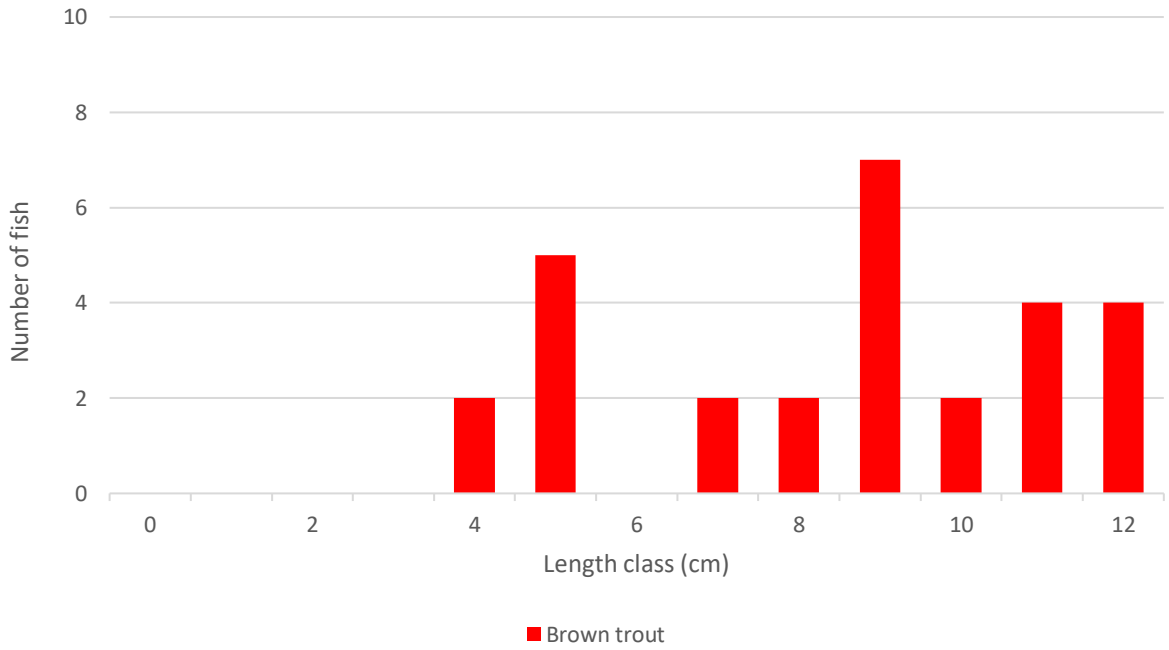

Figure 3.12 Length frequency distribution recorded via electro-fishing at site N2 on the Glenomra Wood Stream, July 2022

Plate 3.24 Representative image of site N2 on the upper reaches of the Glenomra Wood Stream, July 2022

3.1.25 Site N3 – Springmount Stream, Springmount

No fish were recorded via electro-fishing at site N3. The site was not of fisheries value at the time of survey given shallow depths, high natural gradients and the location of the site in the upper reaches of the catchment.

Plate 3.25 Representative image of site N3 on the Springmount Stream, July 2022 (no fish recorded)

3.1.26 Site N4 – Glenomra Wood Stream, Tooreen

Atlantic salmon (*n*=4) and brown trout (*n*=41) were the only fish species recorded via electro-fishing at site N4 (**Figure 3.13**).

The site was considered a very good quality salmonid nursery, given ample oxygenated riffle and glide with cobble and small boulder refugia. Spawning habitat was of good quality, locally, being reduced

due to limited gravel areas and also evident siltation. Some good quality holding habitat for adult salmonids was present in association with meanders and natural bank scours. Suitability for European eel was good given abundant instream refugia although none were recorded. The high energy upland eroding site was unsuitable for lamprey.

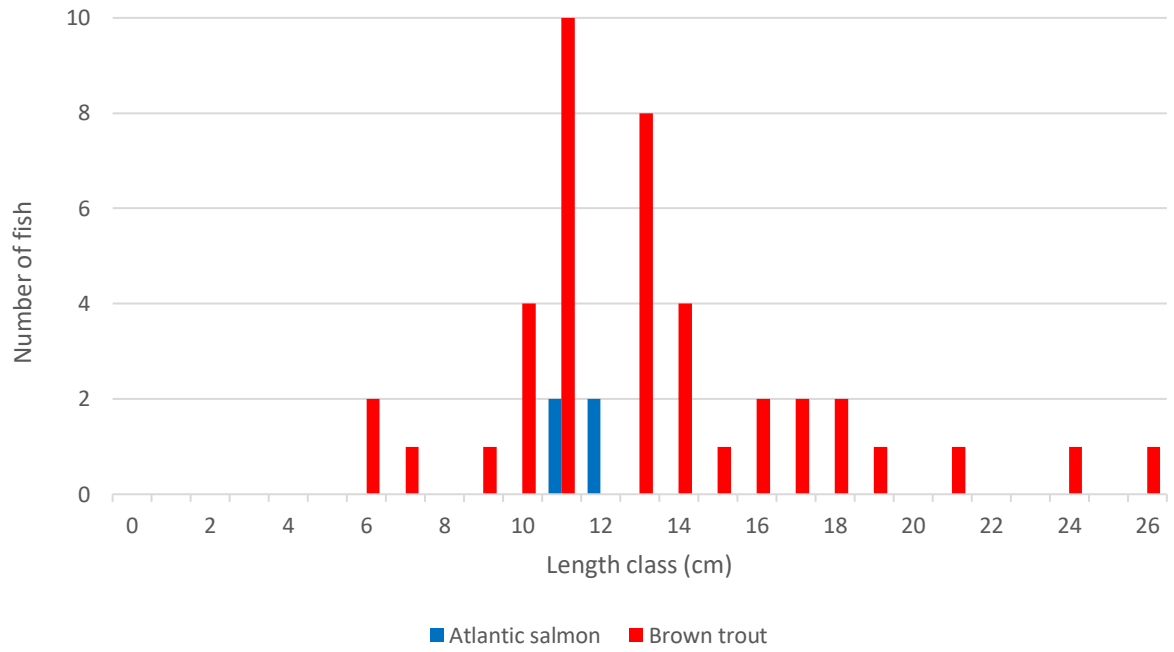

Figure 3.13 Length frequency distribution recorded via electro-fishing at site N4 on the Glenomra Wood Stream, July 2022

Plate 3.26 Adult brown trout recorded at site N4 on the Glenomra Wood Stream, July 2022

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of the proposed Knockshanvo wind farm via electro-fishing in July 2022 (values in bold represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)									
				Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Stone loach	Gudgeon	Three-spined stickleback	Minnow	Roach	Dace
A1	Clashduff Stream	5	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A2	Clashduff Stream	5	120	0.058	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A3	Gortadroma Stream	5	90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A4	Gortadroma Stream	10	150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A5	Belvoir Stream	5	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A6	Ballyvorgal North Stream	5	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A7	Owenogarney River	10	400	**0.180**	0.000	0.000	**0.008**	0.003	**0.005**	0.000	0.000	**0.003**	**0.003**
B1	Snaty River	5	20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B2	Snaty River	5	35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B3	Oatfield Stream	5	25	0.000	0.000	0.000	0.000	0.000	0.000	**0.480**	0.000	0.000	0.000
B4	Unnamed stream	5	40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B5	Snaty River	10	250	0.000	0.132	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B6	West Cloontra Stream	5	80	0.000	0.038	0.000	0.000	0.000	0.000	0.100	0.000	0.000	0.000
B7	O'Neill's Stream	5	60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B8	Knockshanvo Stream	10	130	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B9	O'Neill's Stream	10	200	0.000	0.135	**2 per m^2**	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)									
				Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Stone loach	Gudgeon	Three-spined stickleback	Minnow	Roach	Dace
B10	Mountrice River	10	100	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B11	East Cloontra Stream	5	40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B12	Mountrice River	10	200	0.025	0.070	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000
B13	River (Clare) Blackwater	10	300	0.013	0.127	0.5 per m^2	0.000	**0.037**	0.000	0.000	**0.013**	0.000	0.000
B14	Kyleglass Stream	5	75	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C1	Rocks Stream	10	180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N1	Snaty Stream	5	35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N2	Glenomra Wood Stream	10	250	0.000	0.112	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N3	Springmount Stream	5	110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N4	Glenomra Wood Stream	10	250	0.016	**0.164**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	
A1	Clashduff Stream	No fish recorded				
A2	Clashduff Stream	Medium	Medium			
A3	Gortadroma Stream	No fish recorded				
A4	Gortadroma Stream		Low			
A5	Belvoir Stream	No fish recorded				
A6	Ballyvorgal North Stream	No fish recorded				
A7	Owenogarney River	Very high			Low	Gudgeon, stone loach, dace & roach
B1	Snaty River	No fish recorded				
B2	Snaty River	No fish recorded				
B3	Oatfield Stream					Three-spined stickleback
B4	Unnamed stream	No fish recorded				
B5	Snaty River		High			
B6	West Cloontra Stream		Low			Three-spined stickleback
B7	O'Neill's Stream	No fish recorded				
B8	Knockshanvo Stream		Low			
B9	O'Neill's Stream		High	Low		
B10	Mountrice River		Low			
B11	East Cloontra Stream	No fish recorded				
B12	Mountrice River	Low	Medium			Stone loach
B13	River (Clare) Blackwater	Low	High	Low		Minnow, stone loach
B14	Kyleglass Stream	No fish recorded				
C1	Rocks Stream	No fish recorded				
N1	Snaty Stream	No fish recorded				
N2	Glenomra Wood Stream		High			
N3	Springmount Stream	No fish recorded				
N4	Glenomra Wood Stream	Low	High			

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

4. Discussion

The majority of surveyed watercourses in the vicinity of the study area were small and upland eroding in nature and suffered from low (summer) water levels and flows during July 2022, resulting in reduced habitat and water quality and, in some cases, poor fluvial connectivity, habitat fragmentation and fish passage issues. High energy, upland eroding/spate watercourses flowing over higher gradients are typically unproductive in terms of fish (Wood & Budy, 2009; O'Grady, 2006; Amiro, 1993; Richardson, 1993). Half of the survey sites (i.e. A1, A3, A5, A6, B1, B2, B4, B7, B11, B14, C1, N1 & N3) did not support fish at the time of survey. These sites provided poor quality habitat for salmonids, European eel or other fish species given their diminutive nature, historical modifications, siltation pressures, low or intermittent flows and or high natural gradients (instream barriers) which precluded resident fish from the upper reaches of some watercourses (e.g. Clashduff Stream, O'Neill's River, Mountrice River, Rocks Stream).

Nevertheless, brown trout populations were widespread in the survey area, being typically restricted to lower-gradient reaches of watercourses (which offer superior fisheries habitat). The localised presence of Atlantic salmon, lamprey (*Lampetra* sp.) and European eel largely reflected the higher-energy, upland nature of the surveyed watercourses. The highest value watercourses for fish within vicinity of the project were the larger Owenogarney River, River Blackwater and Glenomra Wood Stream but localised areas of valuable fisheries habitat were also present (e.g. Clashduff Stream, Mountrice River).

Apart from site B3 on the Oatfield Stream (three-spined stickleback only), salmonids were recorded at all 13 no. sites supporting fish during the survey (**Table 3.2**). This was despite widespread low summer water levels/flows. Atlantic salmon were present at 5 no. sites, on the Clashduff Stream (A2), Owenogarney River (A7), Mountrice River (B12), River Blackwater (B13) and Glenomra Wood Stream (N4). The Owenogarney River, draining to the south-west of the proposed project, was the only one of these sites to support high densities of Atlantic salmon (**Table 3.1**), which were abundant at the site (*n*=72). Several sites in the Shannon[Lower]_SC_100 river sub-catchment, namely the River Blackwater and several tributaries, including the Glenomra Wood Stream, supported relatively high densities of brown trout in context of the survey area (**Table 3.1**).

Lamprey ammocoetes (*Lampetra* sp.) were only recorded from 2 no. sites on the River Blackwater (B13) and its tributary the O'Neill's Stream (B9). Neither site provided optimal larval habitat and the species was present in low densities only (2.0 & 0.5 per m^2, respectively). Ammocoetes were previously recorded from this site on the River Blackwater in 2017, in addition to the Cloontra West Stream at survey site B6 (Triturus, 2017). The restricted distribution in vicinity of the proposed project reflected the upland, higher-energy/spate nature of most of the survey watercourses; characteristics which reduce the extent of fine gravels required for spawning (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010) and discourages the deposition of fine, organic-rich sediment ≥5cm in depth generally required by larval *Lampetra* spp. (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). No sea lamprey (*Petromyzon marinus*) were recorded during these surveys, which was unsurprising given that the channels in question represented small tributaries as opposed to the main rivers in the catchment. Sea (and river) lamprey are known to spawn on the lower Owengarney River, downstream of Sixmilebridge (Ross, 2017).

European eel were only recorded in low densities from site A7 on the Owenogarney River at Annagore Bridge (**Table 4.2; Appendix A**). European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). The absence of eel from many physically suitable sites (i.e. ample refugia etc.) primarily reflects the upland nature of the surveyed watercourses, which provide sub-optimal eel habitat (Matondo et al., 2021; Chadwick et al., 2007; Laffaille et al., 2003), as well as widespread low summer flow conditions.

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

Table 8.1 Macro-invertebrate Q-sampling results for sites A1, A2, A3, A4, A5, A6, A7, B1, B2, B3, B4, B5 & B6, July 2022

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*												3	10	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*							3							A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*		5											1	A
Plecoptera	Nemouridae	*Nemoura cinerea*								4						A
Plecoptera	Nemouridae	*Protonemura meyeri*												1		A
Ephemeroptera	Baetidae	*Alainites muticus*		1			1	5				8				B
Plecoptera	Leuctridae	*Leuctra hippopus*		10			2		5			5			1	B
Trichoptera	Cased Caddis Pupa	sp. indet.		7			3							1		B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*					1	14								B
Trichoptera	Goeridae	*Silo pallipes*		1											1	B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*		1					1			1			1	B
Trichoptera	Limnephilidae	*Drusus annulatus*													1	B
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*												2		B
Trichoptera	Sericostomatidae	*Sericostoma personatum*		2		1						2				B
Hemiptera	Aphelocheiridae	*Aphelocheirus aestivalis*							5							B
Ephemeroptera	Baetidae	*Baetis rhodani*	3	7	54	7	1		5		25			6	2	C
Ephemeroptera	Caenidae	*Caenis rivulorum*												4		C
Ephemeroptera	Ephemerellidae	*Serratella ignita*		14					17					15	6	C
Trichoptera	Hydropsychidae	*Diplectrona felix*	4													C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*							6							C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*							2							C
Trichoptera	Philopotamidae	*Chimarra marginata*							4							C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*	2		1	1	1	2		22	6	9	43			C
Crustacea	Gammaridae	*Gammarus duebeni*	45	3	51	7	2	5	2		2	2		1	3	C
Gastropoda	Neritidae	*Theodoxus fluviatilis*							6							C

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	EPA class
Coleoptera	Dytiscidae	Dytiscidae larva												1	1	C
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*												2	3	C
Coleoptera	Elmidae	*Elmis aenea*												3	2	C
Coleoptera	Elmidae	*Limnius volckmari*		2												C
Coleoptera	Hydraenidae	*Hydraena gracilis*		1										1		C
Coleoptera	Hydrophilidae	*Anacaena globulus*								2						C
Coleoptera	Scirtidae	sp. indet.	1													C
Diptera	Ceratopogonidae	sp. indet.		1												C
Diptera	Chironomidae	non-*Chironomus* spp.	4	4	2	4	2	2	1	6		5	6	8		C
Diptera	Culicidae	sp. indet.								1		1				C
Diptera	Limoniidae	*Antocha* sp.	1													C
Diptera	Pediciidae	*Dicranota* sp.		3			1	1				1		2	3	C
Diptera	Ptychopteridae	sp. indet.						1								C
Diptera	Simuliidae	sp. indet.		13		4	4							1	3	C
Arachnida	Hydrachnidiae	sp. indet.				1									1	C
Hemiptera	Veliidae	Veliidae nymph	1					1		1			2			C
Hirudinidae	Piscicolidae	*Piscicola* sp.									2					C
Crustacea	Asellidae	*Asellus aquaticus*							2							D
Gastropoda	Tateidae	*Potamopyrgus antipodarum*													1	D
Gastropoda	Lymnaeidae	*Ampullacaena balthica*							6							D
Hirudinidae	Glossiphoniidae	sp. indet.		1												D
Diptera	Chironomidae	*Chironomus* spp.											2	1		E
Annelidae	Oligochaeta	sp. indet.		1					1						2	n/a
Mollusca	Dreissenidae	*Dreissena polymorpha* †							1							n/a

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	B6	EPA class
Abundance			61	77	108	25	18	31	67	36	35	34	53	52	42	
Q-rating			Q3	Q4	Q3	Q3	Q3*	Q3*	Q4	Q4*	Q3	Q3*	Q3*	Q4	Q4*	
WFD status			Poor	Good	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Poor	Good	Good	

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

† invasive species listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011)

Table 8.2 Macro-invertebrate Q-sampling results for sites B7, B8, B9, B10, B11, B12, B13, B14, C1, N1, N2, N3 & N4, July 2022

Group	Family	Species	B7	B8	B9	B10	B11	B12	B13	B14	C1	N1	N2	N3	N4	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*			1			2	1							A
Ephemeroptera	Heptageniidae	*Ecdyonurus venosus*													1	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*													1	A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*							3		3			1	2	A
Plecoptera	Nemouridae	*Protonemura meyeri*											1			A
Plecoptera	Perlidae	*Perla bipunctata*						1								A
Ephemeroptera	Baetidae	*Alainites muticus*							2		4		1		1	B
Plecoptera	Leuctridae	*Leuctra hippopus*		2		2		3	13	1	19	2	1		2	B
Trichoptera	Cased Caddis Pupa	sp. indet.	1	1	1	1		2					3	2	1	B
Trichoptera	Goeridae	*Silo pallipes*	2													B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*		1						1		3	5			B
Trichoptera	Limnephilidae	*Drusus annulatus*											1			B
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*											4		2	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*		1												B
Trichoptera	Rhyacophilidae	*Rhyacophila munda*											4			B

Group	Family	Species	B7	B8	B9	B10	B11	B12	B13	B14	C1	N1	N2	N3	N4	EPA class
Odonata	Libellulidae	*Libellula quadrimaculata*					1									B
Ephemeroptera	Baetidae	*Baetis rhodani*	2	3	10			5	7	1		3	5	3	2	C
Ephemeroptera	Caenidae	*Caenis rivulorum*						1								C
Ephemeroptera	Ephemerellidae	*Serratella ignita*		1	14			14	14				3		63	C
Trichoptera	Hydropsychidae	*Diplectrona felix*									1					C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*			1											C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*							6							C
Trichoptera	Philopotamidae	*Philopotamus montanus*			1						3	1	2			C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*				1				1	3					C
Crustacea	Gammaridae	*Gammarus duebeni*	4	5	1	7		1	2	29	8	3	12	4	53	C
Coleoptera	Dytiscidae	Dytiscidae larva					5									C
Coleoptera	Dytiscidae	*Hydroporus angustatus*					4									C
Coleoptera	Dytiscidae	*Hydroporus tessellatus*								1						C
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*						1	1							C
Coleoptera	Elmidae	*Elmis aenea*			1				4				4		4	C
Coleoptera	Elmidae	*Esolus parallelepipedus*												1		C
Coleoptera	Elmidae	*Limnius volckmari*						1	7			2	1		1	C
Coleoptera	Halipliidae	*Brychius elevatus*							2							C
Coleoptera	Halipliidae	Haliplidae larva					1									C
Coleoptera	Hydraenidae	*Hydraena gracilis*		1					1				1			C
Coleoptera	Hydrophilidae	*Anacaena globulus*					1									C
Coleoptera	Scirtidae	sp. indet.	1							3			3			C
Diptera	Ceratopogonidae	sp. indet.											1			C
Diptera	Chironomidae	non-*Chironomus* spp.	1				2	1	6				3			C
Diptera	Culicidae	sp. indet.	1													C
Diptera	Dixidae	sp. indet.			1		4									C
Diptera	Limoniidae	*Antocha* sp.											2			C

Group	Family	Species	B7	B8	B9	B10	B11	B12	B13	B14	C1	N1	N2	N3	N4	EPA class
Diptera	Pediciidae	*Dicranota* sp.		1	1			2	13	1	1		3			C
Diptera	Simuliidae	sp. indet.			2				10		2	5	3	1	2	C
Arachnida	Hydrachnidiae	sp. indet.						1						1		C
Hemiptera	Corixidae	Corixidae nymph					4									C
Hemiptera	Veliidae	*Velia caprai*								1	1	2				C
Hemiptera	Veliidae	Veliidae nymph	1							2	2					C
Gastropoda	Tateidae	*Potamopyrgus antipodarum*			1			1								D
Hirudinidae	Glossiphoniidae	sp. indet.									1					D
Diptera	Chironomidae	*Chironomus* spp.			3	1									1	E
Annelidae	Oligochaeta	sp. indet.			1						1					n/a
Abundance			**13**	**16**	**39**	**12**	**22**	**36**	**92**	**41**	**49**	**21**	**63**	**13**	**136**	
Q-rating			Q3*	Q3	Q3-4	Q3	Q3*	Q3-4	Q3-4	Q3*	Q4	Q3*	Q3-4	Q3-4	Q3-4	
WFD status			Poor	Poor	Mod	Poor	Poor	Mod	Mod	Poor	Good	Poor	Mod	Mod	Mod	

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

8. Appendix C – eDNA analysis lab report

SureScreen Scientifics

Folio No: E15205
Report No: 1
Client: Triturus Enviornmental 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: 03/018/2022
Date results reported: 09/08/2022
Matters affecting result: None

TARGET SPECIES: Crayfish plague *(Aphanomyces astaci)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK595	B13 Violet Hill	-	Pass	Pass	Pass	Positive	12/12
FK599	A7 Violet Hill	-	Pass	Pass	Pass	Positive	12/12
FK602	N4 Violet Hill	-	Pass	Pass	Pass	Positive	9/12

Forensic Scientists and Consultant Engineers
SureScreen Scientifics Division Ltd, Morley Retreat, Church Lane, Morley, Derbyshire, DE7 6DE, UK
Tel: +44 (0)1332 292003 Email: scientifics@surescreen.com
Company Registration No. 08950940

SureScreen Scientifics

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

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK595	B13 Violet Hill	-	Pass	Pass	Pass	Negative	0/12
FK599	A7 Violet Hill	-	Pass	Pass	Pass	Negative	0/12
FK602	N4 Violet Hill	-	Pass	Pass	Pass	Negative	0/12

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

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK595	B13 Violet Hill	-	Pass	Pass	Pass	Positive	1/12
FK599	A7 Violet Hill	-	Pass	Pass	Pass	Negative	0/12
FK602	N4 Violet Hill	-	Pass	Pass	Pass	Positive	9/12

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

Reported by: **Chelsea Warner** Approved by: **Gabriela Danickova**

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SureScreen Scientifics

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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SureScreen Scientifics

INTERPRETATION OF RESULTS

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

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

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

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

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

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

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

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

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9. Appendix D – section 14 authorisation (electro-fishing licence)

CERTIFICATE OF AUTHORISATION UNDER SECTION 14 OF THE FISHERIES (CONSOLIDATION) ACT, 1959 AS SUBSTITUTED BY SECTION 4 OF THE FISHERIES (AMENDMENT) ACT, 1962

The Minister of the Environment, Climate and Communications in exercise of the powers conferred on him by Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962 hereby authorises: Mr. Bill Brazier, Triturus Environmental Ltd, 42 Norwood Court, Rochestown, Co. Cork (and or person(s) nominated by him), to undertake an electro-fishing survey for the proposed Violet Hill wind farm project, approximately 4km east of Broadford, Co. Clare' by Triturus Environmental Ltd.

This authorisation is granted subject to the following conditions:

1. This authorisation shall not confer on the holder thereof, independently of the conditions therein;

   (a) any rights or title which the holder would not have had if this Authorisation had not been given, or;
   (b)
   (c) any authority in any way to interfere with or infringe the lawful rights of any other person.

2. This authorisation is issued to and valid for use by Mr. Bill Brazier and or person(s) nominated by him.

3. The Director of the Shannon River Basin District, Mr. David McInerny (david.mcinerney@fisheriesireland.ie) and the Fisheries Environmental Officer, Ms. Jane Gilleran (jane.gilleran@fisheriesireland.ie), should be informed of the exact dates, locations and scope of the planned survey, two weeks prior to survey start. Any cancellations or changes to scheduled work should also be similarly communicated. Contact details are as follows:

   Inland Fisheries Ireland
   Ashbourne Business Park
   Dock Road
   Limerick
   V94 NPE0
   Ireland
   limerick@fisheriesireland.ie
   +353 (0) 61 300238 / +353 (0) 61 300308

4. This authorisation is valid to from 1st July to 30th September 2022. IFI recommend that electro-fishing should be carried out between 1st July and 30th September when juvenile salmonids (if present) are of a sufficiently large size to be caught by electro-fishing, to

minimise damage to the fish and to be distinguished from similar species (CEN, 2003 and CFB 2008 'Electric Fishing in Wadeable reaches' manual).

5. Electrofishing surveys must take place during appropriate conditions, including dry weather (no rain), low flow and water temperatures not exceeding 20°C. In general, the operators should be cognisant of the increased risk of mortalities occurring during warmer periods of weather or prolonged containment of fish and such fish should be regularly monitored for signs of stress and released in a timely manner to mitigate for any mortality risk.

6. No fish of any species should be sacrificed during the surveys. The number of fish killed (if any) is to be kept to an absolute minimum and IFI Limerick and Citywest are to be informed of any fish mortalities immediately after the survey. Details including the county, site number, river name, townland, Irish grid reference, and the species and numbers killed shall be communicated to IFI offices by telephone and a subsequent e-mail.

7. Triturus Environmental Ltd. have submitted a Method Statement, for the purpose of electrofishing, which is to be adhered to. Any changes to this method statement should be discussed with a relevant IFI officer.

8. As a number of sites to be sampled lie within 15km of two SAC's (Danes Hole, Poulnalecka and Glenomra Wood), IFI would wish to see evidence from NPWS to the effect that NPWS is satisfied that the proposed operations would not have any adverse impact on qualifying interests of the SAC.

9. The electro-fishing must be carried out only by nominated personnel with training and experience in such operations. All electro-fishing equipment must be available for inspection by an IFI officer during each survey.

10. Due care must be taken when catching lamprey and eels as they are listed in the IUCN Red List (No. 5, 2011) as "near threatened" and "critically endangered" respectively.

11. IFI request that any crayfish or lamprey captured during the work be measured (carapace length for crayfish, total length in mm for lamprey). This information should also be included on the IFI reporting template.

12. IFI recommends that the applicant seeks permission from fishery owners and informs local angling clubs of their plans for the surveys where relevant. The applicant must also seek permission from landowners to cross land, where relevant.

13. As part of the notification the following details should be e-mailed to the contacts above: the County, Site Number, River Name, Townland and Irish Grid Reference. A detailed map showing the site locations should also be provided.

14. Electro-fishing should be carried out between July and September particularly when juvenile salmonids are of a sufficiently large size to be caught by electro-fishing, assist with their identification and to minimise damage to these fish species (CEN, 2001 and CFB "Electric Fishing in Wadeable reaches" manual).

15. Electro-fishing should not be undertaken during exceptional periods of hot weather (as experienced in Ireland in June and July 2018) where the risk of fish mortalities is heightened.

    a. In such circumstances, prior to commencement of the fishing operations, ensure that the water temperature is checked and recorded; when the water temperature is near or exceeds 20°C the operation must be cancelled. While holding fish, please ensure they are kept in the shade in large containers, that water is regularly refreshed and that the water temperature is constantly monitored – no fish should be retained in water approaching 20°C.

16. The operators should be cognisant of the increased risk of mortalities occurring during warmer periods of weather or prolonged containment of fish and such fish should be regularly monitored for signs of stress and released in a timely manner to mitigate for any mortality risk.

17. The number of inadvertent fish mortalities resulting from the electro-fishing is to be kept to an absolute minimum and IFI inspectors are to be informed of any fish mortalities that occur immediately after the work concludes.

18. All equipment is treated in accordance with IFI's biosecurity measures (http://www.fisheriesireland.ie/Invasive-Species/biosecurity-protocol-for-field-survey-work.html and as directed by an IFI officer. The applicant has satisfactorily stated that they will implement biosecurity measures during the proposed work. These biosecurity measures should be strictly adhered to. Equipment must be disinfected prior to and after use to prevent the spread of disease, parasites or invasive species. The field operatives should be mindful of the potential occurrence of invasive alien species either in the watercourse being surveyed or in the adjoining riparian zone. Extra care should be taken to ensure that plant fragments and seeds of invasive plant species are not inadvertently transported on clothing, footwear or equipment. The recent outbreaks of crayfish plague in Ireland make it also imperative that biosecurity protocols are strictly adhered to.

19. The applicant must seek the permission of the fishery owner prior to conducting the survey and also seek permission from landowners to cross land, where relevant.

20. IFI recommends that the applicant informs local angling clubs of their plans for the work where relevant.

21. All electro-fishing equipment must be available for inspection by an IFI officer if required, during the electro-fishing operations.

22. A standard template for reporting data to IFI is attached. As acknowledged by the applicant, IFI request that a report and the data collected (in the attached standard IFI format) be provided, within 30 days of completion of the survey, in electronic format to sandra.doyle@fisheriesireland.ie . The report (hard and soft copies) is to include mortality data and a full account of qualitative/quantitative results related to the fish sampled. These

data will not be made publicly available, for a period of three years, without the permission of Triturus Environmental Ltd.

23. IFI request that any crayfish captured during the work be measured (carapace length in mm is standard). This information should also be included on the IFI reporting template.

24. As acknowledged by the applicant, IFI request that any lamprey captured in the survey be identified to species level if feasible and measured (total length in mm is standard). This information should also be included on the IFI reporting template.

25. As acknowledged by the applicant, if invasive species are encountered, the field operatives should record their presence; indicate their abundance and extent of occurrence, along with a geo-reference in their report material submitted to IFI.

26. The consent of the owners of the fishing rights in the waters fished shall be obtained before operations commence under the authority of this authorisation. It is also recommended that the applicant informs local angling clubs of their plans for the work where relevant. The applicant must also seek permission from landowners to cross land where relevant.

27. When doing anything pursuant to this authorisation, the holder shall, if requested by any person affected, produce this authorisation to that person.

28. Failure to comply with any condition of this Authorisation will result in immediate revocation of the Authorisation and will be taken into account in the event of applications for Authorisations made subsequently.

29. The holder of this authorisation shall indemnify and keep indemnified the State, the Minister of the Environment, Climate and Communications and the Minister for Finance against any claims, arising in any manner whatsoever in connection with the user of the fishing gear or in the exercise of the permission hereby granted.

30. Notwithstanding the foregoing, this authorisation may be revoked or amended by the Minister of the Environment, Climate and Communications without the payment of compensation to the holder on giving one week's notice in writing to the holder if he considers it necessary in the public interest to do so.

Dated this 30 June 2022

For the Minister of the Environment, Climate and Communications

Úna Ward

An officer authorised on that behalf by the said Minister

10. Appendix E – section 23 & 34 white-clawed crayfish licence

National Parks & Wildlife Service LICENCE

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

Licence No. C31/2022

NATIONAL PARKS & WILDLIFE SERVICE

Wildlife Acts 1976 to 2018 – Sections 23 and 34

LICENCE TO CAPTURE PROTECTED WILD ANIMALS FOR EDUCATIONAL, SCIENTIFIC OR OTHER PURPOSES

The Minister for Housing, Local Government and Heritage in exercise of the powers conferred on him by Sections 9, 23 and 34 of the Wildlife Acts 1976 to 2018 authorises:

Ross Macklin & Bill Brazier (Triturus Environmental Ltd.), 42 Norwood Court, Rochestown, Cork

To disturb specimens of **WHITE CLAWED CRAYFISH (Austropotamobius pallipes)** for educational, scientific or other purposes under Licence Type specified in Column 1, in the area specified in Column 2 under the means/activity specified in Column 3 and during period specified in Column 4 subject to the conditions agreed to in the application and those listed overleaf.

SCHEDULE

1	2	3	4
Licence Type	**Area**	**Means/Activity**	**Period**
FULL	**All 26 counties within the Republic of Ireland.**	**Surveys to measure presence and absence of the species and compilation of other data.**	**01/05/2022 to 31/10/2022**

Dated 3rd March 2022

For the Minister of Housing, Local Government and Heritage

Claire Cooley

Conditions

1. **The licensee(s) must adhere to the measures and restrictions relating to public health on Covid-19.**
2. Licence holders should use the established procedures described in following manuals as closely as possible:

   Reynolds, J.D., O'Connor, W., O'Keeffe, C. & Lynn, D. (2010) A technical manual for monitoring white-clawed crayfish *Austropotamobius pallipes* in Irish lakes. Irish Wildlife Manuals, No 45. National Parks and Wildlife Service, Department of the Housing, Local Government and Heritage, Dublin.

   O'Connor, W., Hayes G., O'Keeffe, C. & Lynn, D. (2009) Monitoring of white-clawed crayfish *Austropotamobius pallipes* in Irish lakes in 2007. Irish Wildlife Manuals, No 37. National Parks and Wildlife Service, Department of the Housing, Local Government and Heritage, Dublin.

   Peay S. (2003). Monitoring the White-clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1, English Nature, Peterborough.
3. STRICT biosecurity measures should be applied following the Inland Fisheries Ireland protocol (http://www.fisheriesireland.ie/Biosecurity/biosecurity-protocol-for-field-survey-work.html) for the purposes of preventing the introduction and spread of disease and alien species. All equipment should be appropriately treated before and after work and before moving to a new site.
4. Surveyors must familiarise themselves with crayfish identification. All crayfish should be positively identified as native White-clawed Crayfish *Austropotamobius pallipes* before release back into water. In the case of doubt, advice must be sought immediately from NPWS or a recognised expert on the group. **Under no circumstances must any crayfish which are suspected of being a non-native species be returned to the wild.**
5. Crayfish Plague. Surveyors should familiar with the symptoms and signs of Crayfish Plague and MUST report any suspicions of the disease to NPWS IMMEDIATELY. These signs include abnormal escape or other behaviour and presence of dead or dying individuals.
6. This licence permits capture, trapping and temporary confinement of crayfish for the purposes of presence/absence survey and proper identification but not translocation of crayfish from any area that is to be affected by any proposed works. All White-clawed Crayfish are to be returned to the point of capture/trapping location as soon as possible after capture.
7. This is a FULL LICENCE and the licence holder is responsible for reporting on the work conducted under this licence and the work of any Limited Licence holders working with the licence holder. This should be returned promptly (within 3 months of the expiry of the licence) to Dr Brian Nelson at the address below:

   Dr Brian Nelson, Invertebrate Ecologist, National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, 90 King Street North, DUBLIN, D07 N7CV, email Brian.Nelson@housing.gov.ie.

   All reports should contain full information on the work undertaken, a list of all the sites surveyed for crayfish and all the records (giving full date, 6 figure grid reference, site location, numbers of crayfish seen, recorder and identifier). **Photographs of a sample (at least one per main sampling location e.g. individual stream, or lake) of the crayfish recorded should be included with each report as verification of the identification.** These photographs should show the appropriate identification features.
8. Any query in relation to this licence should be addressed to National Parks and Wildlife Service, 90 North King Street, Dublin 7, D07 N7CV. Telephone: (01) 888 3287.

11. Appendix F – Aquatic and fisheries summaries

Table 11.1 Summary of fish species of higher conservation value and relative abundances (low, medium, high & very high) recorded via **electro-fishing** per survey site in the vicinity of the proposed Knockshanvo wind farm, July 2022

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	
A1	Clashduff Stream	No fish recorded				
A2	Clashduff Stream	Medium	Medium			
A3	Gortadroma Stream	No fish recorded				
A4	Gortadroma Stream		Low			
A5	Belvoir Stream	No fish recorded				
A6	Ballyvorgal North Stream	No fish recorded				
A7	Owenogarney River	Very high			Low	Gudgeon, stone loach, dace & roach
B1	Snaty River	No fish recorded				
B2	Snaty River	No fish recorded				
B3	Oatfield Stream					Three-spined stickleback
B4	Unnamed stream	No fish recorded				
B5	Snaty River		High			
B6	West Cloontra Stream		Low			Three-spined stickleback
B7	O'Neill's Stream	No fish recorded				
B8	Knockshanvo Stream		Low			
B9	O'Neill's Stream		High	Low		
B10	Mountrice River		Low			
B11	East Cloontra Stream	No fish recorded				
B12	Mountrice River	Low	Medium			Stone loach
B13	River (Clare) Blackwater	Low	High	Low		Minnow, stone loach
B14	Kyleglass Stream	No fish recorded				
C1	Rocks Stream	No fish recorded				
N1	Snaty Stream	No fish recorded				
N2	Glenomra Wood Stream		High			
N3	Springmount Stream	No fish recorded				
N4	Glenomra Wood Stream	Low	High			

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (L*ampetra planeri*) and river lamprey (*Lampetra fluviatilis*)

are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike *et al.*, 2020) and listed as 'critically engendered' in Ireland (King *et al.*, 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

Table 11.2 Summary of aquatic survey results for the proposed Knockshanvo wind farm

Site	Watercourse	White-clawed crayfish	Freshwater pearl mussel (eDNA)	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
A1	Clashduff Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A2	Clashduff Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A3	Gortadroma Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A4	Gortadroma Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A5	Belvoir Stream	None recorded; negative eDNA result at site		No signs	Not present	None recorded	None recorded	None recorded
A6	Ballyvorgal North Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A7	Owenogarney River	None recorded; negative eDNA result at site	Negative eDNA result at site, no records in catchment	**Regular spraint site**	Not present	None recorded	None recorded	None recorded
B1	Snaty Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B2	Snaty Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B3	Oatfield Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B4	Unnamed stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B5	Snaty Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B6	West Cloontra Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B7	O'Neill's Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B8	Knockshanvo Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B9	O'Neill's Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded

Site	Watercourse	White-clawed crayfish	Freshwater pearl mussel (eDNA)	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
B10	Mountrice River	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B11	East Cloontra Stream	None recorded		No signs	Not present	None recorded	None recorded	**Smooth newt & common frog**
B12	Mountrice River	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B13	River (Clare) Blackwater	**None recorded but positive eDNA result at site**	Negative eDNA result at site, no records in catchment	**Regular spraint site**	Not present	None recorded	None recorded	None recorded
B14	Kyleglass Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
C1	Rocks Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
N1	Snaty Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
N2	Glenomra Wood Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
N3	Springmount Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
N4	Glenomra Wood Stream	**None recorded but positive eDNA result at site**	Negative eDNA result at site, no records in catchment	**Old spraint site**	Not present	None recorded	None recorded	None recorded

Conservation value: White-clawed crayfish (*Austropotamobius pallipes*), freshwater pearl mussel (*Margaritifera margaritifera*) and Eurasian otter (*Lutra lutra*) are listed under Annex II and Annex V of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and all are protected under the Irish Wildlife Acts 1976-2021. White-clawed crayfish (Füreder *et al.*, 2010) and freshwater pearl mussel (Moorkens *et al.*, 2017) are also both listed as 'Endangered' according to the IUCN Red List. The European Union (Invasive Alien Species) (Freshwater Crayfish) Regulations 2018 (SI 354/2018) affords further protection to native white-clawed crayfish by prohibiting the introduction and spread of five no. invasive 'Union concern' crayfish species listed under EU Regulation 1143/2014. Smooth newt (*Lissotriton vulgaris*) and common frog (*Rana temporaria*) are protected under the Irish Wildlife Acts 1976-2021.

[4] Otter signs within 150m of the survey site

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