APPENDIX 6-3

AQUATIC BASELINE REPORT

Aquatic Baseline Report for Lackareagh Wind Farm, Co. Clare

Prepared by Triturus Environmental Ltd. for MKO

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by MKO to conduct baseline aquatic surveys to inform EIAR preparation for the proposed Lackareagh wind farm. The following report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected aquatic species and habitats in the vicinity of the Proposed Project, located approx. 5km east of Broadford, Co. Clare.

Undertaken on a catchment-wide scale, the baseline surveys focused on the detection of freshwater habitats and species of high conservation value. These included surveys for white-clawed crayfish (*Austropotamobius pallipes*), freshwater pearl mussel (*Margaritifera margaritifera*) (eDNA only), macro-invertebrates (biological water quality) and fish of high conservation value, inclusive of supporting habitat. The surveys also documented macrophyte and aquatic bryophyte communities including Annex I habitat associations in the vicinity of the project (**Figure 2.1**). Aquatic surveys were undertaken during July 2022.

1.2 Project description

A full description of the Proposed Project is provided in the accompanying Environmental Impact Assessment Report (EIAR).

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the Proposed Wind Farm were considered as part of the current baseline. A total of *n*=19 riverine sites were selected for detailed aquatic assessment (see **Table 2.1, Figure 2.1** below). The nomenclature for the watercourses surveyed is as per the Environmental Protection Agency (EPA). Aquatic survey sites were present on the Ballymoloney Stream (EPA code: 27B14), Broadford River (27B02), Cloonconry Beg Stream (27C17) and two unnamed tributaries, Kilbane Stream (27K05), Killeagy Stream (27K11), Kilbane 27 Stream (27K13) and the Ardcloony River (25A03) (**Table 2.1**). The aquatic survey sites were located within the Owenogarney_SC_010 and Shannon[Lower]_SC_080 river sub-catchments. The proposed wind farm and associated infrastructure overlapped with the Slieve Bernagh Bog SAC (002312), a site designated for terrestrial habitats (NPWS, 2016). There was potential downstream hydrological connectivity (via the Ardcloony River) with Lower River Shannon SAC (002165), a site with numerous aquatic qualifying interests (NPWS, 2012).

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

2.2 Aquatic site surveys

Aquatic surveys of the watercourses within the vicinity of the Proposed Wind Farm site were conducted on Wednesday 6th to Friday 8th 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**).

Suitability for freshwater pearl mussel was assessed at each survey site with environmental DNA (eDNA) sampling undertaken for the species at *n*=2 strategically chosen riverine locations within the vicinity of the project. These water samples were also analysed for white-clawed crayfish and crayfish plague (*Aphanomyces astaci*). This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed project and ensured that any habitats and species of high conservation value would be detected to best inform mitigation.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). This broad characterisation helped define the watercourses' conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. 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 and bordering land uses

Table 2.1 Location of *n*=19 aquatic survey sites in the vicinity of the Proposed Wind Farm site (* denotes eDNA sampling)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Ballymoloney Stream	27B14	Ballymoloney	562558	670954
A2	Broadford River	27B02	Aghnagor Bridge	562357	670799
A3	Unnamed stream	n/a	L7080 road crossing	563137	672633
A4	Unnamed stream	n/a	Killeagy	562827	672274
A5	Cloonconry Beg Stream	27C17	Ballymoloney	563208	671950
A6	Cloonconry Beg Stream	27C17	L3022-8 road crossing	562386	671848
A7	Broadford River	27B02	Scott's Bridge	561013	672106
A8	Kilbane Stream	27K05	Shannaknock	562605	674057
A9	Kilbane Stream	27K05	Shannaknock	562463	673418
A10	Killeagy Stream	27K11	Killeagy	562658	673485
A11	Kilbane Stream	27K05	Shannaknock	561988	672642
A12	Kilbane 27 Stream	27K13	Kilbane	561615	672878
A13	Kilbane Stream	27K05	Kilbane	561008	672139
A14	Broadford River	27B02	Formoyle More	559175	671984
A15	Broadford River	27B02	Derry	558179	672323
A16*	Broadford River	27B02	Killaderry Bridge	555671	673485
B1	Ardcloony River	25A03	L7080 road crossing	565269	672497
B2	Ardcloony River	25A03	Ballycorney Bridge	566922	670713
B3*	Ardcloony River	25A03	Ardcloony Bridge, R463	567508	669243

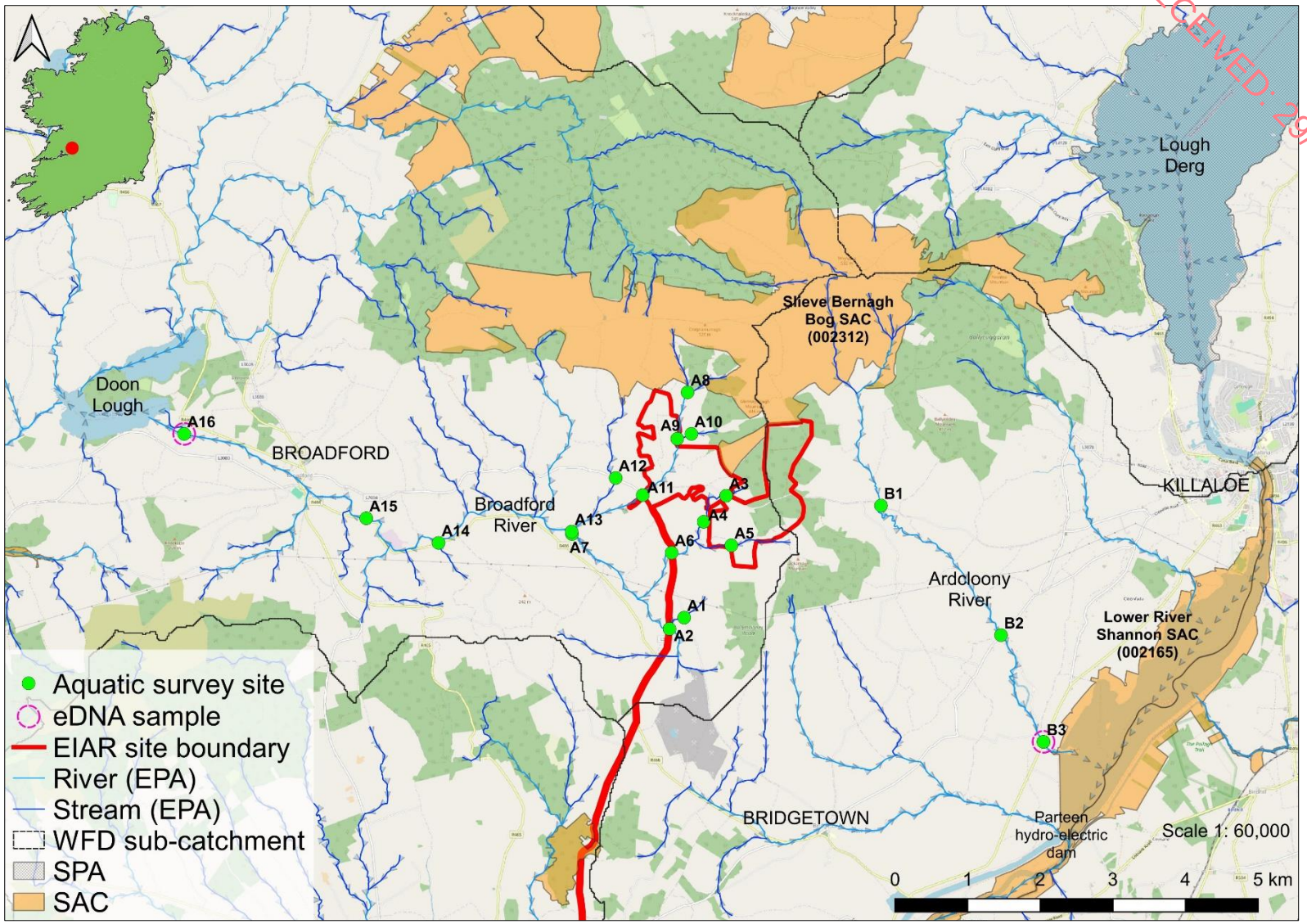

Figure 2.1 Overview of the *n*=19 aquatic survey site locations for the proposed Lackareagh wind farm, Co. Clare, July 2022

2.3 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 Wind Farm site 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.

Furthermore, a fisheries habitat appraisal of the aquatic survey sites (**Figure 2.1**) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within the vicinity of the survey sites. For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A.**

2.4 White-clawed crayfish survey

White-clawed crayfish surveys were undertaken at the aquatic survey sites in July 2022 under a National Parks and Wildlife (NPWS) open licence (no. C31/2022), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2021), to capture and release crayfish to their site of capture, under condition no. 6 of the licence. As per Inland Fisheries Ireland 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.

Hand-searching of instream refugia and sweep netting was undertaken according to Reynolds et al. (2010). An appraisal of white-clawed crayfish habitat at each site was conducted based on physical channel attributes, water chemistry and incidental records in mustelid spraint. Additionally, a desktop review of crayfish records within the wider Lackareagh wind farm survey area was completed.

2.5 eDNA analysis (including freshwater pearl mussel)

To validate site surveys and to detect potentially cryptically low populations of freshwater pearl mussel and white-clawed crayfish within the study area, *n*=2 composite water samples were collected from the Broadford River (site A16) and Ardcloony River (B3) (**Figure 2.1**). This would help validate the presence and or absence of freshwater pearl mussel and white-clawed crayfish given that no data was available on the status of these species within the sub-catchments of the Broadford and Ardcloony Rivers. The samples were also analysed for crayfish plague given that the absence of crayfish records may be explained by the prevalence of crayfish plague if detected present. The water samples were collected on 7th July 2022, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection).

In accordance with best practice, a composite (500ml) water sample was collected from the sampling point, maximising the geographic spread at the site (20 x 25ml samples at each site), thus increasing the chance of detecting the target species' DNA. The composite sample was filtered on-site using a sterile proprietary eDNA sampling kit. The fixed sample was stored at room temperature and sent to the laboratory for analysis within 48 hours of collection. A total of *n*=12 qPCR replicates were analysed

for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at and or upstream of the sampling point. Please refer to **Appendix C** for full eDNA laboratory analysis methodology.

2.6 Biological water quality (Q-sampling)

The 19 no. riverine 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, as per 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 and fixed in 70% ethanol for subsequent laboratory identification. Samples were converted to Q-ratings as per Toner et al. (2005) and assigned to WFD status classes. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

Table 2.2 Reference categories for EPA Q-ratings (Q1 to Q5)

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

2.7 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the *n*=19 riverine 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 (Flora Protection Order or Wyse-Jackson et al., 2016) or habitats corresponding to the Annex I habitats, e.g., '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').

2.8 Otter signs

The presence of otter (*Lutra lutra*) at each aquatic survey site was determined through the recording of otter signs within 150m of each survey site. Notes on the age and location (ITM coordinates) were made for each otter sign recorded, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, crustaceans, molluscs etc.).

2.9 Aquatic ecological evaluation

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

2.10 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. 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. 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.

3. Desktop review

3.1 Proposed Wind Farm site catchment and survey area description

The Proposed Wind Farm site is located in an upland area within the townlands Shannaknock, Killeagy, Magherareagh, Lackareagh Beg and Ballymoloney near Glenagalliagh and Lackareagh Mountains, approximately 5km east of Broadford, Co. Clare (**Figure 2.1**). The Proposed Wind Farm site is situated within the Shannon River Basin District and within hydrometric areas 25 (Lower Shannon) and 27 (Shannon Estuary North). The aquatic survey sites were located within the Owenogarney_SC_010 and Shannon[Lower]_SC_080 river sub-catchments. The proposed wind farm site is drained by the Kilbane Stream (27K05), Killeagy Stream (27K11) and the Cloonconry Beg Stream (27C17) and unnamed tributary (**Table 2.1** & **Figure 2.1**).

The watercourses and aquatic surveys sites in the vicinity of the Proposed Wind Farm site are typically small, upland eroding channels (FW1; Fossitt, 2000). Predominantly, the watercourses flow over areas of Silurian mudstone, greywacke & conglomerate in upland areas with old red sandstone, sandstone, conglomerate & mudstone in the adjoining lowlands (Geological Survey of Ireland data). Land use practices in the wider survey area are dominated by coniferous forest (CORINE 312) with more localised areas of moors or heathlands (CORINE 322) and transitional woodland scrub (CORINE 324). The study area also supported extensive pastures in lowland areas (CORINE 231).

3.2 Fisheries

The Broadford River (also known as the Glenomra River in its upper reaches) rises near Lackareagh Mountain and flows westwards for some 10km before flowing through the Doon Lough complex, emerging as the Owenogarney River. Upstream of Doon Lough the river is known to support Atlantic salmon (*Salmo salar*) brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), gudgeon (*Gobio gobio*), perch (*Perca fluviatilis*), minnow (*Phoxinus phoxinus*) and three-spined stickleback (*Gasterosteus aculeatus*) (Malachy Walsh, 2019; Triturus, 2017; Kelly et al., 2009, 2014). The non-native, invasive cyprinid species dace (*Leuciscus leuciscus*) has been recorded in Doon Lough and the Owenogarney River system since 1980 (Caffrey et al., 2007), with invasive roach (*Rutilus rutilus*) present since the early 1980s (Brazier, 2018). The Doon Lough complex and the wider Owenogarney system is also known locally to contain stocks of other coarse fish species including bream (*Abramis brama*), rudd (*Scardinius erythropthalmus*), tench (*Tinca tinca*) and pike (*Esox lucius*) (pers. obs.).

Fisheries data for the other watercourses surveyed, including the Ardcloony River, was not available at the time of survey.

3.3 Protected aquatic species

A comprehensive desktop review of available data (NPWS, NBDC, BSBI & other data) for 10km grid squares adjoining the project (i.e. R57, R66 & R67) identified a low number of records for rare and or protected aquatic species within the vicinity of the proposed wind farm.

A low number of records for Annex II and V white-clawed crayfish (*Austropotamobius pallipes*) were available for the Glenomra Wood Stream (1996 & 1999) (R66) but this watercourse is located within a separate sub-catchment to the proposed project (**Figure 3.1**).

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; data not shown). Contemporary records were available for the Ardcloony River at Ballycorney Bridge (survey site B2) and Ardcloony Bridge (survey site B3) (NPWS & NBDC data; **Figure 3.1**).

A single historical record (unspecified date) for Annex II and V allis shad (*Alosa alosa*) was available for the River Shannon upstream of Killaloe (R67).

Two records were available for opposite-leaved pondweed (*Groenlandia densa*) in the River Shannon at Killaloe (R66) but these were historical only (1970). The species is listed under the Flora (Protection) Order 2022 (S.I. No. 235/2022).

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).

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the Proposed Wind Farm site. Only recent water quality is summarised below. There was no contemporary EPA biological monitoring data available for a number of the surveyed watercourses, namely the Clashduff Stream (EPA code: 27C44), Gortadroma Stream (27G12), Snaty Stream (27S13), Ballyvorgal North Stream (27B47), Belvoir Stream (27B45), Snaty River (25S34),East Cloontra Stream (25E29), Knockshanvo Stream (25K82), Oatfield Stream (25O07), O'Neill's Stream (25O02), Rocks Stream (27R07), Kyleglass Stream (25K83), West Cloontra Stream (25W36) or Springmount Stream (27S93).

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.

3.4.1 Broadford River

There are 4 no. contemporary EPA biological monitoring stations located on the Broadford River (27B02), all of which were monitored in 2022. At Scott's Bridge (station RS27B020500, survey site A7) the river achieved Q3-4 (moderate status) in 2022. Moving downstream, the river also achieved Q3-4 (moderate status) at station RS27B020600 (survey site A14), improved to Q4 (good status) in Broadford village (station RS27B020700) and again achieved Q3-4 (moderate status) Killaderry Bridge (station RS27B020800, survey site A16).

The Broadford River is divided into the Broadford_010, _020 and _030 river waterbodies. The Broadford_010 river waterbody achieved moderate status in the 2016-2021 period and was considered 'at risk' of not achieving good ecological status (WFD Risk 3rd cycle). Channelisation (hydromorphology) is the primary threat to water quality in this river waterbody (EPA, 2018). Downstream, the Broadford_020 river waterbody achieved good status in the same period but was 'at risk' of not achieving good ecological status (WFD Risk 3rd cycle). The lower reaches of the river, the Broadford_030 river waterbody, achieved moderate status in the 2016-2021 period and was considered 'not at risk' of failing to achieve good ecological status (WFD Risk 3rd cycle).

The Broadford_010 river waterbody has been identified as a priority area for action (PAA) (LAWPRO, 2020).

3.4.2 Kilbane Stream

A single contemporary EPA biological monitoring station was located on the Kilbane Stream (27K05). The river achieved Q4-5 (high status) at station RS27K050300 (near survey site A13) in 2022.

The Kilbane Stream is located within the Broadford_010 river waterbody, which achieved moderate status in the 2016-2021 period and was considered 'at risk' of not achieving good ecological status (WFD Risk 3rd cycle). Channelisation, causing siltation, is the primary threat to water quality in this river waterbody (EPA, 2018).

3.4.3 Ardcloony River

A single contemporary EPA biological monitoring station was located on the Ardcloony River (25A03). The river achieved Q4 (good status) at Ballycorney Bridge (station RS25A030100) in 2021.

The Ardcloony River (Ardcloony_010 river waterbody) was of good status in the 2016-2021 period and was considered 'not at risk' of failing to achieve good ecological status (WFD Risk 3rd cycle).

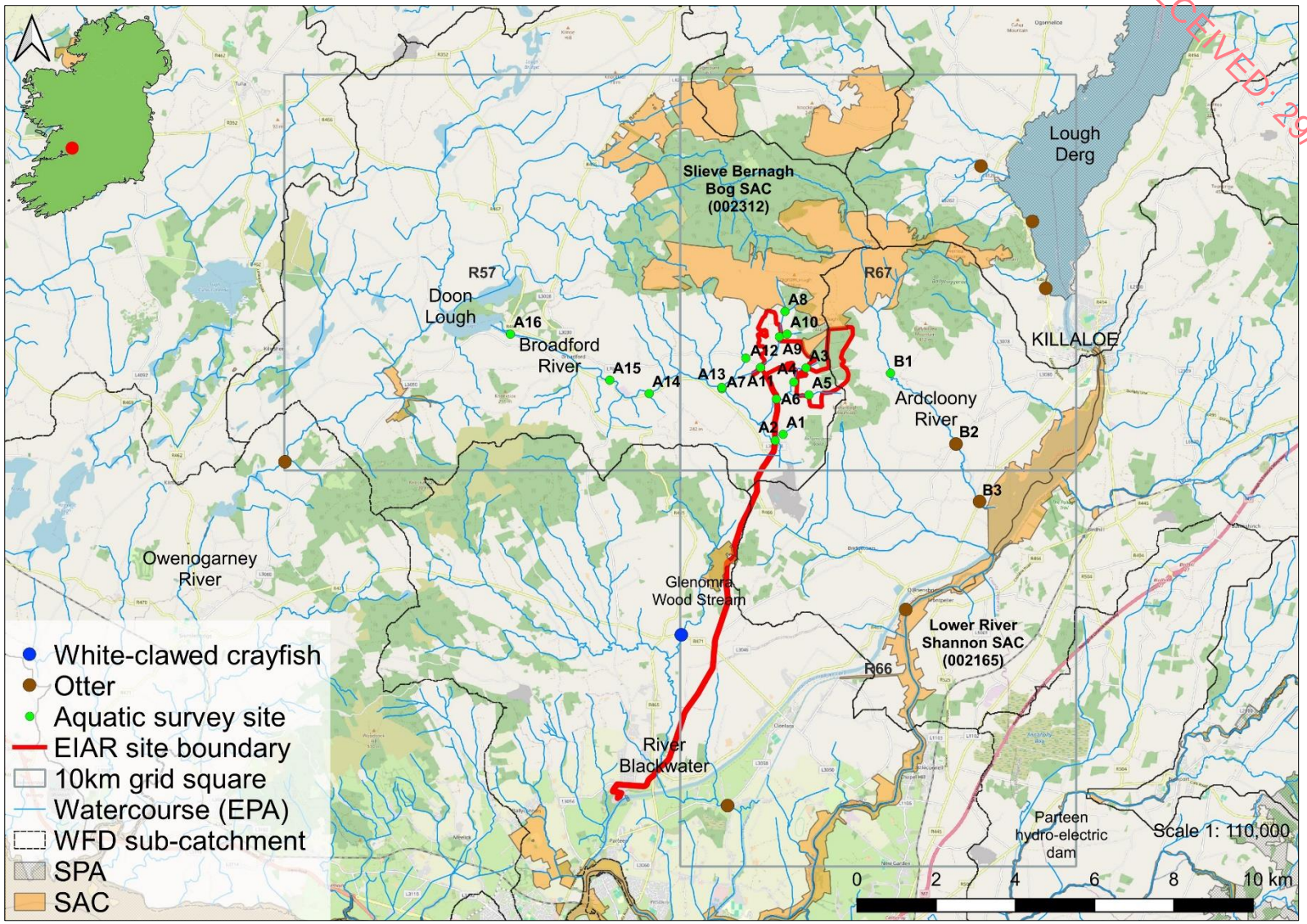

Figure 3.1 Selected protected aquatic species records in the vicinity of the Proposed Wind Farm site (source: NPWS & NBDC data, 1996-2011)

4. Results of aquatic surveys

The following section summarises each of the *n*=19 survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, white-clawed crayfish and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each riverine sampling site and in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in July 2022. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. A summary of the fish species recorded at each survey site is provided in **Table 4.2**. A summary of the aquatic species and habitats of high conservation concern recorded during the surveys is provided in **Table 4.3**. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.4**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Ballymoloney Stream, Ballymoloney

Site A1 was located on the upper reaches of the Ballymoloney Stream (27B14) at a local road crossing. The small upland eroding stream (FW1) crossed under the road via a twin wall pipe culvert. The stream had been culverted underground through improved agricultural grassland upstream of the road crossing, apart from a short 5m section immediately above the culvert. The channel was open downstream. The stream averaged <0.5m wide and <0.05m deep and it was considered likely to be ephemeral at this location. The substrata were dominated by heavily silted fine gravels and small cobble, with only very small boulder present occasionally. Shallow silt and sand deposits were also present. Macrophytes were limited to occasional brooklime (*Veronica beccabunga*), water mint (*Mentha aquatica*) and hemlock water dropwort (*Oenanthe crocata*), with fool's watercress (*Apium nodiflorum*) present downstream of the culvert. Aquatic bryophytes were not recorded. The very narrow stream meandered through improved pasture (GA1) and rough pasture (GS2) and was heavily encroached by forbs and rank grass vegetation.

No fish were recorded via electro-fishing at site A1 (**Appendix A**). The site was not of fisheries value given the very shallow nature (likely ephemeral channel), location in the uppermost reaches of the catchment and evident siltation pressures. The upland site was unsuitable for white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (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.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site A1 was of **local importance (lower value) (Table 4.4).**

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

4.1.2 Site A2 – Broadford River, Aghnagor Bridge

Site A2 was located on the upper reaches of the Broadford River (27B02) at Aghnagor Bridge. The river at this location was a small upland channel (FW1) with some depositing characteristics. Flows were low at the time of survey and the river averaged 1.5-2m wide and 0.05-0.1m deep. The river had been historically straightened and partially deepened in the downstream vicinity of the road crossing (bridge arch) but was natural upstream. The profile was of very shallow glide and riffle with only very localised pool to a maximum depth of 0.2m. The substrata were dominated by mixed gravels with occasional cobble, which were heavily silted. Soft sediment accumulations were frequent, given low flows. Large woody debris (LWD) was also frequent instream, forming debris dams. Given high shading, macrophytes were limited, with occasional hemlock water dropwort, fool's watercress, water forget-me-not (*Myosotis scorpioides*) and water mint. Aquatic bryophytes were absent. Filamentous algae were present, indicating enrichment sources. The river was fringed by well-developed grassland (rough pasture, GS2) with mosaics of wet grassland (GS4), with improved grassland (GA1) on the south bank downstream of the road crossing. Upstream, the river flowed through an area of freshwater marsh (GM1) dominated by iris (*Iris psuedacorus*). The river was also flanked by treelines of willow (*Salix* spp.), oak (*Quercus* sp.), ash (*Fraxinus excelsior*), gorse (*Ulex europaeus*), hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*) and sycamore (*Acer psuedoplatanus*) with heavy tunnelling present downstream.

No fish were recorded via electro-fishing at site A2 (**Appendix A**). The site was not of fisheries value given the very shallow nature of the Broadford River given its location in the uppermost reaches of the catchment and evident siltation and enrichment pressures. The upland site was unsuitable for white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey 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.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site A2 was of **local importance (lower value) (Table 4.4).**

Plate 4.2 Representative image of site A2 on the upper reaches of the Broadford River, July 2022

4.1.3 Site A3 – unnamed stream, Killeagy

Site A3 was located on the uppermost reaches of an unnamed small stream at the L7080 road crossing (box culvert). The narrow upland eroding watercourse (FW1) averaged <0.75m wide and <0.05m deep in a high gradient, deeply incised channel. The gradient increased further downstream of the culvert. The diminutive stream was evidently seasonal (ephemeral) in nature, with only very low flows at the time of survey. The Cloonconry Beg River tributary at the study area featured a bed of fine gravels which were heavily silted. The site did not support macrophytes or aquatic bryophytes given its ephemeral nature and very high riparian shading. The channel was heavily tunnelled by dense scrub (WS1) dominated by bramble (*Rubus fruticosus* agg.), nettle (*Urtica dioica*) and bracken (*Pteridium aquilinum*). The site was bordered by improved pasture (GA1) with patches of gorse-dominated scrub (WS1).

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 gradients which precluded upstream fish passage. 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.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site A3 was of **local importance (lower value) (Table 4.4).**

Plate 4.3 Representative image of site A3 on the upper reaches of an unnamed Cloonconry Beg River tributary, July 2022

4.1.4 Site A4 - unnamed stream, Killeagy

Site A4 was located on the upper reaches of an unnamed Cloonconry Beg River tributary at a farm access crossing, approx. 0.6km downstream of site A3. The high gradient upland eroding spate watercourse (FW1) averaged 2-2.5m wide and 0.1-0.2m deep. The stream had been historically straightened in vicinity of a perched pipe culvert but meandered through a natural incised valley with bank full heights of 2.5-3m and steeply sloping banks. The profile was dominated by shallow glide and riffle with very limited pool. Pool habitat where present was very shallow (0.25m) with the exception of a deeper plunge pool at the culvert which was 0.5m deep. The substrata comprised angular cobble, coarse gravels and sand with occasional small boulder. Siltation was moderate (plumes underfoot) with livestock poaching and natural erosion evident. The substrata were moderately compacted given high flow rates (spate channel). Macrophytes were absent given high shading and high energy conditions. Aquatic bryophytes were limited to only very occasional *Chiloscyphus polyanthos* and *Rhynchostegium riparioides* on more stable, larger boulder. The channel was heavily shaded by mature sycamore, ash and elder (*Sambucus nigra*) with scrubby understories. Upstream of the culvert, the channel was of higher gradient, narrower and tunnelled in dense bramble scrub. The site was bordered by intensive agricultural grassland (GA1).

No fish were recorded via electro-fishing at site A4 (**Appendix A**). The site was not of fisheries value given its location in the uppermost reaches of the catchment. The fisheries value was further compromised by evident siltation and low seasonal flows, in addition to a lack of deeper pool areas and the presence of instream barriers (both natural and artificial) (e.g. the perched culvert had a fall of 0.7m at low flows and would be impassable to all fish species). The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Given the largely natural character of the survey site and the presence of Q4 (good status) water quality, the aquatic ecological evaluation of site A4 was of **local importance (higher value) (Table 4.4).**

Plate 4.4 Representative image of site A4 on an unnamed Cloonconry Beg River tributary, July 2022

4.1.5 Site A5 – Cloonconry Beg River, Ballymoloney

Site A5 was located on the uppermost reaches of the Cloonconry Beg River (27C17), at a local farm access crossing. The upland eroding spate stream (FW1) had been historically straightened throughout and flowed over a moderate to high gradient through improved pasture (GA1). The stream was more natural >150m upstream where it flowed through a natural, deeply incised valley (bank heights >8m). At the farm access crossing (perched pipe culvert), the stream averaged <1m wide (2m high banks) and <0.05m deep at the time of survey. The profile was of shallow riffle with very localised small pool to 0.1m. The substrata comprised angular cobble and small boulder with localised mixed gravels. These were exposed to moderate siltation (plumes underfoot). Given high riparian shading (tunnelling), macrophytes and aquatic bryophytes were absent. The stream flowed through very

dense cover of bramble, dog rose (*Rosa canina*) and blackthorn with scattered mature sycamore. The invasive plant Japanese knotweed (*Reynoutria japonica*) was abundant along the channel.

No fish were recorded via electro-fishing at site A5 (**Appendix A**). The site was not of fisheries value given its location in the uppermost reaches of the catchment and high natural gradients. The fisheries value was further compromised by evident siltation and low seasonal flows, in addition to a lack of deeper pool areas and the presence of instream barriers (culverts) (e.g. the perched culvert had a fall of 0.5m at low flows and would be impassable to all fish species). The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Despite the presence of Q4 (good status) water quality, given the heavily modified nature of the survey site the aquatic ecological evaluation of site A5 was of **local importance (lower value) (Table 4.4).**

Plate 4.5 Representative image of site A5 on the upper reaches of the Cloonconry Beg River, July 2022

4.1.6 Site A6 – Cloonconry Beg River, Killeagy

Site A6 was located on the Cloonconry Beg Stream (27C17) at a local road crossing, approx. 1km downstream of site A5. Despite some local modifications, the upland eroding watercourse (FW1) retained a semi-natural profile possessing regular meanders in a deep U-shaped channel with bank heights of 1.5-2m. The river averaged between 2-2.5m wide and was 0.1-0.2m deep. The profile comprised of shallow glide and riffle with only very localised shallow pool with a maximum depth of 0.3m. The substrata were dominated by angular cobble with frequent small boulder. Mixed gravels, sands and silt were present interstitially between the coarser bed substrata. The stream was exposed

to heavy siltation pressures. Regular livestock poaching was evident on both banks. Macrophytes were limited to very occasional watercress (*Nasturtium officinale*), fool's watercress and brooklime along channel margins. Bryophyte coverage was low with *Rhynchostegium riparioides* occasional on larger boulder. The channel was lined by mature beech (*Fagus sylvatica*), ash, sycamore and elder with hawthorn and bramble scrub on the east bank, with the west bank open (semi-improved grassland).

Despite some good physical habitat suitability for salmonids and, less so, European eel (*Anguilla anguilla*), no fish were recorded via electro-fishing at site A6 (**Appendix A**). This was considered to reflect evident siltation pressures from livestock and water quality issues (**Plate 4.7**). The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey 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.

Given the absence of aquatic species or habitats of higher conservation value, in addition to moderate status water quality, the aquatic ecological evaluation of site A6 was of **local importance (lower value) (Table 4.4).**

Plate 4.6 Representative image of site A6 on the Cloonconry Beg River, July 2022

Plate 4.7 An image taken at site A6 during the survey showing gross discolouration and evident water quality issues (exact origin unknown but domestic point source likely)

4.1.7 Site A7 – Broadford River, Scott's Bridge

Site A7 was located on the Broadford River (27B02) immediately upstream of the Kilbane Stream confluence at Scott's Bridge. The lowland depositing river had been historically straightened and deepened in vicinity of the bridge (both upstream and downstream), resulting in a narrow, deep channel with poor hydromorphology. This improved downstream of the Kilbane Stream confluence, where upland eroding characteristics dominated. The river averaged 2m wide in a heavily vegetated channel of up to 4m in width. The river averaged 1m deep in homogenous, very slow-flowing glide. The substrata were dominated by deep silt (up to 0.3m) with only localised superficial fine gravels and no larger substrata. Cleaner gravels were only present at the Kilbane Stream confluence (higher energy area). Macrophyte coverage was very high (>75%) with abundant fool's watercress along the channel margins and instream. Broad-leaved pondweed (*Potamogeton natans*) was occasional with frequent water-forget-me-not (*Myosotis scorpioides*), hemlock water dropwort (*Oenanthe crocata*) and abundant reed canary grass (*Phalaris arundinacea*) along the channel margins. Aquatic bryophytes were absent given gross siltation. The river was bordered by dense bramble, gorse and willow scrub with herbaceous vegetation. The invasive plant Japanese knotweed was abundant along the north bank. The site was bordered by both low-intensity pasture (GA1) and wet grassland (GS4).

Small number of brown trout (*Salmo trutta*), European eel and three-spined stickleback (*Gasterosteus aculeatus*) were recorded via electro-fishing at site A7 (**Appendix A**). However, despite the presence of salmonids and eel, the site provided very poor quality fisheries habitat given extensive historical modifications and water quality issues (gross siltation). Salmonid spawning habitat was absent except for a very short (2m) section at the Kilbane Stream confluence. The slow-flowing deep glide offered some physical suitability as holding habitat for adult salmonids but the low flows reduced the value considerably as a nursery habitat. European eel habitat was moderate with superior habitat present

downstream. Despite the presence of some lamprey ammocoete burial habitat, no suitable spawning habitat was present and the species was not recorded during electro-fishing. There was no suitability for white-clawed crayfish or freshwater pearl mussel. No otter signs were recorded in vicinity of the survey 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.

Given the presence of salmonids and Red-listed European eel, the aquatic ecological evaluation of site A7 was of **local importance (higher value) (Table 4.4).**

Plate 4.8 Representative image of site A7 on the Broadford River at Scott's Bridge, July 2022 (facing upstream to bridge)

4.1.8 Site A8 – Kilbane Stream, Shannaknock

Site A8 was located on the uppermost reaches of the Kilbane Stream (27K05) at a farm track crossing. The small upland eroding watercourse (FW1, spate channel) flowed briefly over a moderate gradient before a perched pipe culvert (1m fall) and then over a very steep gradient through a natural, deeply incised valley. The small stream averaged <2m wide and <0.1m deep, with frequent plunge pools to 0.3m. The substrata were dominated by angular cobble and boulder derived from natural scree on the steep valley escarpments. Coarse sand and mixed gravels were also present locally. Siltation was low although the sediment load (mostly from clay) likely increases periodically (i.e. during spate events). The high energy site was typified by steep cascades with associated plunge pools and riffle zones. Whilst open upstream of the road crossing, the stream was typically very heavily tunnelled by scrub and thus, macrophyte growth was absent. Given the highly mobile substrata and high seasonal flows, aquatic bryophyte coverage was low, with only occasional *Rhynchostegium riparoides* on more stable boulder. The steep banks of the stream at this location were heavily scrubbed and dominated by

willow with bramble, bracken, foxglove (*Digitalis purpurea*), angelica (*Angelica sylvestris*), meadowsweet (*Filipendula ulmaria*) and willowherbs (*Epilobium* spp.). The site was bordered by scrub with coniferous afforestation (WD4) upstream. Dense bracken (HH3) habitat lined the valley downstream.

No fish were recorded via electro-fishing at site A8 (**Appendix A**). The site was not of fisheries value given its high gradient and small size. However, salmonids were present c.1km downstream where the stream increased in size (see site A9 below). 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.

Given the natural character of the survey site and the presence of Q4 (good status) water quality, the aquatic ecological evaluation of site A8 was of **local importance (higher value) (Table 4.4).**

Plate 4.9 Representative image of site A8 on the uppermost reaches of the Kilbane Stream, July 2022

4.1.9 Site A9 – Kilbane Stream, Shannaknock

Site A9 was located on the Kilbane Stream (25K05) approximately 0.7km downstream of site A8. The high energy upland eroding watercourse (FW1) at this location had a natural steep gradient profile flowing in a deeply incised valley. The bank heights were variable and ranged between 5-10m in an undulating valley form. The stream averaged between 5 and 10m wide and was 0.1-0.3m deep. The profile was dominated by shallow fast glide and riffles between natural cascades over bedrock. Small pools were frequent with large plunge pools confined to cascade areas. The substrata comprised cobble and boulder with abundant mixed gravels. Sand accumulations were also present. Siltation was low given the high flow rates. The site did not support macrophytes due to high flow rates and high

riparian shading. Aquatic bryophyte coverage was moderate, with *Rhynchostegium riparoides* frequent on stable boulder and cobble. The moss *Thamnobryum* sp. was abundant on rocky banks. The stream flowed through mature sycamore and hazel (*Corylus avellana*) woodland (WN1) with occasional oak, with an ivy-dominated understorey. Outside the mature riparian buffer, the site was adjoined by intensive pasture (GA1).

Brown trout was the only fish species recorded via electro-fishing at site A9 (**Appendix A**). The site was a good quality salmonid habitat, although only supported a small brown trout population given downstream barriers to fish passage (see section 4.1.13). The site provided a combination of good quality spawning, nursery and holding habitat. European eel habitat was moderate at best, being reduced by the gradients and downstream barriers. The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Given the presence of salmonids, in addition to high status water quality, the aquatic ecological evaluation of site A9 was of **local importance (higher value) (Table 4.4).**

Plate 4.10 Representative image of site A9 on the Kilbane Stream, July 2022

4.1.10 Site A10 – Killeagy Stream, Killeagy

Site A10 was located on the Killeagy Stream (27K11) at a local farm track crossing, approx. 0.2km upstream of the Kilbane Stream confluence. The small upland eroding watercourse (FW1) flowed in a natural meandering channel over a moderate gradient in vicinity of a perched pipe culvert and averaged 1.5m wide and <0.1m deep. The small spate channel featured bank heights of up to 3m in

an incised valley. The profile comprised shallow glide and riffle with only very localised shallow plunge pools associated with natural cascades. The substrata were dominated by cobble with frequent small boulder and mixed gravels. These were exposed to moderate siltation. The site did not support macrophytes due to the high energy nature and high riparian shading. Aquatic bryophyte coverage was low, with very occasional *Rhynchostegium riparoides* on more stable boulder and cobble. The moss *Thamnobryum* sp. was abundant on rocky banks. The stream was lined by mature sycamore and hazel treelines with bramble-dominated scrub. The site was bordered by intensive pasture (GA1). Small-scale water abstraction was evident.

Brown trout was the only fish species recorded via electro-fishing at site A10 (**Appendix A**). The site was a moderate quality salmonid habitat, supporting a low density of juvenile trout and small adults. The site was of moderate value as a salmonid nursery with localised spawning habitat but was of poor value as a holding habitat for adults. European eel habitat was moderate at best, given the high flow rates and none were recorded. The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Given the presence of salmonids, in addition to a semi-natural channel with high status water quality, the aquatic ecological evaluation of site A10 was of **local importance (higher value) (Table 4.4).**

Plate 4.11 Representative image of site A10 on the Killeagy Stream, July 2022

4.1.11 Site A11 – Kilbane Stream, Shannaknock

Site A11 was located on the Kilbane Stream (27K05) at an unnamed bridge in Kilbane village, approximately 1km downstream of site A9. The stream at this location was a semi-natural upland eroding watercourse (FW1) which had only been modified locally in the vicinity of the bridge crossing (old retaining walls etc.). The stream flowed over a moderate gradient and averaged 5-7m wide in an often V-shaped, incised channel. Fast riffle and shallow glide predominated with frequent small pools associated with cascades. The depth averaged 0.2-0.4m deep with only very localised deeper plunge pools. The substrata were dominated by bedrock and angular boulder typical of an upland spate channel. Partially compacted cobble and mobile coarse gravels were present locally between boulder pockets. Sand accumulations were present in depositing margins of the stream. Fine sediment was otherwise absent given the high flow rates. Macrophytes were limited to occasional hemlock water dropwort along channel margins. However, aquatic bryophyte coverage was high given the dominance of large substrata with abundant *Rhynchostegium riparioides* resent and *Hyocomium armoricum* present on the splash zone. The liverwort *Marchantia polymorpha* was present on the faces of the stream banks. The stream was moderately shaded by mature treelines of sycamore with frequent invasive Japanese knotweed in addition to elder, fuchsia (*Fuchsia magellanica*), cotoneaster (*Cotoneaster* sp.), ivy (*Hedera helix*), angelica, butterbur (*Petasites hybridus*) and ferns. The site was bordered by local roads (BL3) and improved agricultural grassland (GA1).

Brown trout and European eel were the only fish species recorded via electro-fishing at site A11 (**Appendix A**). The site was a moderate value salmonid habitat and supported a low density of brown trout. Atlantic salmon were absent and this may be attributed to the historical weir near survey site A13 (c.1km downstream) that was considered a significant barrier to anadromous salmonids. The site was of moderate value as a nursery and spawning habitat with poor quality holding areas for adults given the shallow, cascading nature. European eel habitat was moderate given high flow rates and paucity of suitable refugia, albeit the site did support a low density population. The upland eroding conditions yielded conditions inimical for the presence of lamprey and white-clawed crayfish. There was no suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Given the presence of salmonids, European eel, in addition to good status water quality and the semi-natural character of the stream the aquatic ecological evaluation of site A11 was of **local importance (higher value) (Table 4.4).**

Plate 4.12 Representative image of site A11 on the Kilbane Stream, July 2022 (downstream of bridge)

4.1.12 Site A12 – Kilbane 27 Stream, Kilbane

Site A12 was located on the Kilbane 27 Stream[1] (27K11) at a local road crossing, approx. 0.6km upstream of the Kilbane Stream (27K05) confluence. The narrow upland eroding watercourse (FW1) flowed over a moderate gradient in a naturally steep incised channel with banks of 2.5-3m in height (characteristic of a spate channel). Bank erosion (scour) was frequent. The stream averaged 2-2.5m wide and was 0.05-0.15m deep, with only very localised small pools. The profile comprised shallow riffle and glide with occasional small cascades over instream large woody debris. The substrata were dominated by coarse gravels and small cobble with occasional small angular boulder. Sand was present along channel margins. Macrophytes were limited to scattered hemlock water dropwort. Aquatic bryophytes were limited to rare *Rhynchostegium riparoides* on infrequent larger boulder. The site was heavily shaded (tunnelled) by sycamore, willow, hawthorn and dense bramble and bracken scrub. Invasive Japanese knotweed was present both upstream and downstream of the bridge. The site was bordered by improved pasture (GA1).

No fish were recorded via electro-fishing at site A12 (**Appendix A**). Despite some physical suitability for salmonids and to a lesser degree European eel, the site was not of fisheries value. 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.

[1] A separate watercourse to, and tributary of, the Kilbane Stream (EPA code: 27K05)

Given the natural physical character of the survey site and the presence of Q4 (good status) water quality, the aquatic ecological evaluation of site A12 was of **local importance (higher value) (Table 4.4).**

Plate 4.13 Representative image of site A12 on the Kilbane Stream, July 2022

4.1.13 Site A13 – Kilbane Stream, Kilbane

Site A13 was located on the Kilbane Stream (27K05) at the Broadford River confluence, approx. 1.1km downstream of site A11. The high energy upland eroding watercourse (FW1) averaged 3m wide and 0.2-0.4m deep, with localised deeper pool to 0.6m. The profile comprised of riffle, glide and pool sequences, with a deep trapezoidal channel shape (bank heights 2m) and frequent bank scouring indicative of its spate nature. A historical weir (and associated plunge pool to 2m) was located 25m upstream of the confluence. The small spate channel featured substrata dominated by relatively clean and mobile mixed gravels with sand and occasional cobble. Boulder was absent. Siltation was light overall. Macrophyte growth was limited to only very occasional water starwort (*Callitriche* sp.) and hemlock water dropwort. Water crowfoot (*Ranunculus* sp.) was present but rare. The channel margins at the confluence supported sparse water-forget-me-not, redshank (*Persicaria maculosa*), fool's watercress and brooklime. Aquatic bryophytes were absent given the highly mobile substrata. There were no filamentous algae present. The riparian zone supported bramble, nettle, foxglove, gorse, soft rush (*Juncus effusus*), common valerian (*Valeriana officinalis*) and occasional sycamore. Invasive Japanese knotweed was frequent, mostly on the north bank. The site was bordered by low-intensity pasture (GA1) and scrub (WS1).

Atlantic salmon (*Salmo salar*), brown trout, European eel and three-spined stickleback were recorded via electro-fishing at site A13 (**Appendix A**). The site was a good quality salmonid nursery with excellent-quality spawning habitat. Pool, whilst present, was localised (e.g. weir pool). The weir (ITM 560982, 672130) at site A13 was a significant instream barrier to fish migration and was not considered passable to salmonids or European eel. The high-energy spate channel was unsuitable for

lamprey and none were recorded. European eel habitat was moderate overall given the presence of a gravel dominated bed with swift flows (reduced due to instream barriers). There was no suitability for white-clawed crayfish and none were recorded. There was no suitability for freshwater pearl mussel. Despite some foraging suitability, no otter signs were recorded in vicinity of the survey site.

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

Given the presence of salmonids (including Atlantic salmon) and European eel, in addition to high status water quality, the aquatic ecological evaluation of site A13 was of **local importance (higher value) (Table 4.4).**

Plate 4.14 Representative image of site A13 on the Kilbane Stream, July 2022

4.1.14 Site A14 – Broadford River, Formoyle More

Site A14 was located on the Broadford River (27B02) upstream of Moroney's Quarry, approx. 2.2km downstream of site A7. The river at this location was a natural swift-flowing, meandering lowland watercourse with some depositing characteristics (FW2). The river averaged 4-5m wide and 0.3-0.6m deep, with locally deeper pool to 1.4m. Bank full heights ranged from 2-2.5m in a deep U-shaped channel. Deep glide predominated with pool and occasional riffle at the tailings of pools. The substrata were dominated by clean, uncompacted mixed gravels and cobble, with occasional larger boulder. Sand was also present in depositional area of the channel margins and associated with instream macrophyte beds. Silt was absent given the high flow rates of the site. The site supported a range of macrophytes with frequent water starwort (*Callitriche* sp.), occasional broad-leaved pondweed and fool's watercress. Unbranched bur-reed (*Sparganium emersum*) was locally frequent. In terms of aquatic bryophytes, *Fontinalis antipyretica* was present on infrequent larger boulder with *Chiloscyphus polyanthos* recorded as rare. This aquatic vegetation community corresponded to the

Annex I habitat 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* or aquatic mosses [3260]'. Hemlock water dropwort was common both instream and along the banks. Reed canary grass was abundant along channel margins. The riparian zone supported abundant reed canary grass with frequent bramble, bracken, hedge bindweed (*Calystegia sepium*), nettle, gorse and scattered grey willow (*Salix cinerea*). The site was bordered by rough pasture (GS2) with mosaics of wet grassland (GS4).

Atlantic salmon, brown trout, European eel and minnow (*Phoxinus phoxinus*) were recorded via electro-fishing at site A14 (**Appendix A**). The site was an excellent quality salmonid habitat overall, with excellent-quality spawning habitat present locally. Good quality holding habitat was associated with deep pools and undercut banks (with overhanging vegetation). The site was also evidently a good quality salmonid nursery. European eel habitat was good overall, though only a low density was recorded. The higher energy nature of the site presented conditions unsuitable for lamprey and none were recorded. Suitability for white-clawed crayfish was moderate given the deep macrophyte-rich glide and pool habitat, although none were recorded. Despite good foraging suitability, no otter signs were recorded in the vicinity of the site and limited spraint marking areas existed.

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

Given the presence of salmonids (including Atlantic salmon), Red-listed European eel and Annex I floating river vegetation [3260], in addition to good status water quality, the aquatic ecological evaluation of site A14 was of **local importance (higher value) (Table 4.4).**

Plate 4.15 Representative image of site A14 on the Broadford River, July 2022

4.1.15 Site A15 – Broadford River, Derry

Site A15 was located on the Broadford River (27B02) at a farm bridge crossing, approx. 1.4km downstream of site A14. The river at this location was a medium-sized upland eroding watercourse (FW1) that averaged 5-7m wide and 0.4-0.5m. Despite historical modifications (deepening & local bank modifications), recovery was good. Bankfull heights were 2-2.5m with steeply sloping banks. The semi-natural profile was characterised by high-energy glide with occasional pool and riffle. The substrata were dominated by boulder and cobble with localised patches of coarse gravel and sand. Given the high flow rates, no soft sediment accumulations were present. The substrata were moderately compacted given the spate nature of the channel. The site supported frequent water crowfoot (*Ranunculus* sp.) with occasional hemlock water dropwort. Water starwort (*Callitriche* sp.) was present but rare (pool areas only). Aquatic bryophyte coverage was high given the large proportion of stable boulder. *Fontinalis antipyretica* was common, with localised *Rhynchostegium riparoides* and rare *Chiloscyphus polyanthos*. The macrophyte and bryophyte community was considered representative of the Annex I habitat 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* or aquatic mosses [3260]'. *Marchantia polymorpha* was present on muddy areas of bank. The site was moderately shaded by dense riparian scrub comprising bracken and bramble and occasional mature ash. The site was bordered by improved grassland (GA1), dry meadow (GS2) and scrub (WS1) along the riparian corridor.

Atlantic salmon and brown trout were the only fish species recorded via electro-fishing at site A15 (**Appendix A**). The site was an excellent quality salmonid nursery, particularly for Atlantic salmon, with macrophytes beds and frequent boulder providing valuable refugia for a moderate density of juveniles. Similarly, undercut banks and locally deeper glide and pool areas provided good holding habitat for adults. Spawning habitat, whilst present, was localised and given the size of substrata, more suited to Atlantic salmon as opposed to brown trout. European eel habitat was of good quality, although none were recorded. The spate nature of the site precluded the presence of lamprey. No white-clawed crayfish were recorded and suitability was low given the spate nature of the river at this location (none known in the catchment). There was no suitability for freshwater pearl mussel. Despite good foraging suitability, 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.

Given the presence of salmonids (including Atlantic salmon) and Annex I floating river vegetation habitat [3260], the aquatic ecological evaluation of site A15 was of **local importance (higher value) (Table 4.4).**

Plate 4.16 Representative image of site A15 on the Broadford River, July 2022

4.1.16 Site A16 – Broadford River, Killaderry Bridge

Site A16 was located on the Broadford River (27B02) at Killaderry Bridge, approx. 3km downstream of site A15 and 0.5km upstream of the Doon Lough confluence. The river at this location was a high-energy watercourse with some lowland (depositing) characteristics. The river had been historically straightened and deepened but good recovery was evident. The river averaged 6-7m wide and 0.3-0.6m deep, with locally deeper pool and glide to 1.4m. Riffles were associated with instream macrophyte beds. The substrata were dominated by clean, mobile well-mixed gravels and sand. Cobble and boulder, whilst present, were rare overall (largely confined to the natural bridge apron). Soft sediment accumulations were present along channel margins and in association with macrophyte beds but were sand-dominated and shallow (due to the spate nature of the watercourse). Water crowfoot (*Ranunculus* sp.) was frequent with occasional hemlock water dropwort and very localised fool's watercress. Yellow iris (*Iris pesedacorus*) was also present very locally along the channel margins. The paucity of stable substrata limited the coverage of aquatic bryophytes, with only highly localised *Rhynchostegium riparoides* and *Chiloscyphus polyanthos* present. Due to the fragmented nature of the habitat, this community was not considered representative of Annex I floating river vegetation habitat [3260]. The riparian zone supported dense herbaceous vegetation comprising reed canary grass, water figwort (*Scrophularia umbrosa*), great willowherb (*Epilobium hirsutum*), hedge bindweed, hemlock water dropwort, common valerian, bramble and nettle. The site was bordered by rough pasture (GS2) with scattered treelines of downy birch (*Betula pubescens*), grey willow and osier (*Salix viminalis*).

Atlantic salmon, brown trout, European eel and gudgeon (*Gobio gobio*) were recorded via electro-fishing at site A16 (**Appendix A**). Despite historical modifications, the site was an excellent quality salmonid spawning and nursery habitat, particularly for Atlantic salmon. The clean, well-sorted fine gravels also provided some highly suitable spawning habitat for *Lampetra* sp. Holding habitat for adult

salmonids, whilst present, was localised (e.g. undercut banks). Although sand accumulations with high organic fractions present throughout the site provided some good suitability for lamprey ammocoetes, none were recorded during targeted electro-fishing. This was taken to be indicative of the high-energy nature of the Broadford River in general (conditions inimical for the settlement and establishment of *Lampetra* ammocoetes). European eel habitat was of good quality, with ample refugia and a good prey base present. No white-clawed crayfish were recorded and suitability was low given the spate nature of the river at this location. There was no suitability for freshwater pearl mussel. An eDNA sample collected at the site did not detect white-clawed crayfish or freshwater pearl mussel (see section 4.3 below). A regular otter spraint site was recorded under the bridge (ITM 555663, 673479). The spraint site featured superimposition (marking) by non-native mink (*Neovison vison*).

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

Given the presence of salmonids (including Atlantic salmon), in addition to utilisation by otter, the aquatic ecological evaluation of site A16 was of **local importance (higher value) (Table 4.4).**

Plate 4.17 Representative image of site A16 on the lower reaches of the Broadford River at Killaderry Bridge, July 2022

4.1.17 Site B1 – Ardcloony River, Lackareagh Beg

Site B1 was located on the upper reaches of the Ardcloony River (25A03) at a local ford crossing. The swift-flowing upland eroding river (FW1) had been modified historically in vicinity of the bridge crossing (ford and local straightening) but good recovery was evident. The river flowed over a slight gradient and averaged 3m wide and 0.2-0.3m deep. The profile was of shallow glide and riffle with only very localised limited pool (to 0.4m deep). The substrata were dominated by cobble and mixed gravels and sand, with only light siltation. Boulder was rare and small, where present. Soft sediment

(silt) accumulations were present along pool slacks and margins but these were shallow and superficial. Given mobile substrata and high energy conditions, macrophytes were absent except for very occasional hemlock water dropwort on exposed gravel bars. Aquatic bryophyte coverage was very low and limited to very occasional *Rhynchostegium riparoides* on more stable boulder. *Thamnobryum* sp. moss was present on shaded banks. Downstream of the bridge, the channel was largely open with scrub along the immediate riparian zone providing valuable shade. Upstream of the bridge supported mature treelines of sycamore and ash which provided a high degree of shading. The site was bordered by rough pasture (GS2) with mosaics of marsh (GM1) and wet grassland (GS4).

Atlantic salmon and brown trout were the only fish species recorded via electro-fishing at site B1 (**Appendix A**). The site was evidently an excellent salmonid habitat, with widespread excellent quality spawning habitat (clean, mixed gravels and small cobble). Nursery habitat was of good quality albeit the value was reduced given the paucity of larger refugia and instream macrophyte beds. Holding habitat for adult salmonids, whilst very limited in extent, was present locally. Localised small pools under overhanging scrub vegetation provided highly valuable habitat for brown trout, with Atlantic salmon parr more common in open fast glide and riffle areas. European eel habitat was moderate only given a paucity of suitable refugia and deeper pool areas (none recorded). The upland eroding site was not suitable for lamprey, with any soft sediment accumulations superficial only. The site was also unsuitable for white-clawed crayfish and freshwater pearl mussel. Despite the presence of suitable marking sites, and a suitable prey resource, no otter signs were recorded.

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

Given the presence of salmonids (including Atlantic salmon), in addition to good status water quality, the aquatic ecological evaluation of site B1 was of **local importance (higher value) (Table 4.4).**

Plate 4.18 Representative image of site B1 on the upper reaches of the Ardcloony River, July 2022

4.1.18 Site B2 – Ardcloony River, Ballycorney Bridge

Site B2 was located on the Ardcloony River (25A03) at Ballycorney Bridge, approx. 5km downstream of site B1. The high energy river in the vicinity of the bridge crossing has not been modified historically and was a good example of a natural cascading upland eroding watercourse (FW1). The 8-10m wide spate river flowed over a moderate gradient in a naturally steep, incised valley. The profile was dominated by bedrock and boulder cascade with frequent associated plunge pools (steps) to 2m (often <1.2m). Shallow riffle/cascade areas and glide averaged 0.3-0.5m depth. These areas supported frequent cobble substrata with clean well-mixed gravels present current refugia and at the tailing of pools. Sand was also frequent but no siltation was observed. The high energy of the river did not facilitate the establishment of macrophytes apart from very localised hemlock water dropwort, a species often associated with spate channels. However, the coverage of aquatic bryophytes was high given abundant stable boulder and bedrock. *Rhynchostegium riparoides* was abundant (30% cover) with *Thamnobryum* sp. and *Hyocomium armoricum* on tops of larger boulders. The liverwort *Marchantia polymorpha* and *Pellia epiphylla* were present occasionally on larger boulder and muddy banks. The river flowed through a linear block of mixed broadleaved woodland (WD1) supporting mature sycamore, oak, beech and willow with an understorey of great wood-rush (*Luzula sylvatica*), herb Robert (*Geranium robertianum*), bramble, ivy and fern species. The site was bordered by semi-improved pasture (GA1).

Atlantic salmon, brown trout and European eel were recorded via electro-fishing at site B2 (**Appendix A**). The site was of very high value for salmonids, with combinations of excellent quality spawning, nursery and holding habitat. Excellent quality spawning habitat (loose mobile gravels grading into cobble) was present upstream of the bridge crossing at the tailings of deep plunge pools associated with the increasing frequency of cascades. European eel habitat was moderate, at best, given the high flow rates and none were recorded. The upland site was unsuitable for lamprey and white-clawed crayfish, with none recorded. There was some low suitability for freshwater pearl mussel. No otter signs were recorded in vicinity of the survey site.

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

Given the presence of salmonids (including Atlantic salmon) and Red-listed European eel, in addition to good status water quality, the aquatic ecological evaluation of site B2 was of **local importance (lower value) (Table 4.4).**

Plate 4.19 Representative image of site B2 on the Ardcloony River upstream of Ballycorney Bridge, July 2022

4.1.19 Site B3 – Ardcloony River, Ardcloony Bridge

Site B3 was located on the lower reaches of the Ardcloony River (25A03) at Ardcloony Bridge, approx. 1.8km downstream of site B2. The upland eroding watercourse (FW1) had been historically modified (straightened) in vicinity of the bridge (old boulder revetment) but good recovery was evident. Fisheries enhancement had also been carried out (cutwaters) in the recent past. The spate channel flowed over a slight gradient and averaged 8-10m wide in a 10-12m wide channel with steeply sloping (sometimes near vertical) banks of 2-2.5m high. The site was dominated by fast, shallow glide and riffle between 0.2 and 0.4m depth. Localised shallow pool to 0.6m depth was also present while slow moving glide habitat predominated upstream of the bridge. The high energy of the river featured relatively mobile substrata dominated by cobble with frequent boulder and a high fraction of coarse sand. Fine gravels were present interstitially and in marginal slacks. There was no siltation observed. Due to shading, high flow rates and mobile substrata, macrophytes were absent. Aquatic bryophyte coverage was low (<1%) and limited to rare *Rhynchostegium riparoides* on larger boulder. The site was situated in a narrow linear woodland (WD1) of beech with occasional oak, sycamore and willow, with an understorey of wood rush, pignut (*Conopodium majus*), wood avens (*Geum urbanum*) and abundant ivy. The site was bordered by rough pasture (GA1, GS2) and wet grassland (GS4).

Atlantic salmon, brown trout, European eel and stone loach (*Barbatula barbatula*) were recorded via electro-fishing at site B3 (**Appendix A**). The site was of high value for salmonids, with excellent quality spawning habitat by virtue of abundant clean gravels and cobbles. Good quality nursery habitat was present (particularly for Atlantic salmon given flow rates) but the value was reduced given a paucity of larger refugia, bryophytes and macrophytes. Occasional pools provided valuable holding areas for adult salmonids. The site was of moderate value for European eel given a paucity of larger instream refugia, with only a low density recorded. The site was unsuitable for lamprey or white-clawed crayfish

given the high energy nature of the river. There was limited suitability for freshwater pearl mussel. An eDNA sample collected at the site did not detect white-clawed crayfish or freshwater pearl mussel (see section 4.3 below). Despite some suitability, no otter signs were recorded in the vicinity of the bridge.

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

Given the presence of salmonids (including Atlantic salmon) and Red-listed European eel, in addition to high status water quality, the aquatic ecological evaluation of site B3 was of **local importance (lower value) (Table 4.4).**

Plate 4.20 Representative image of site B3 on the lower reaches of the Ardcloony River at Ardcloony Bridge, July 2022

4.2 White-clawed crayfish survey

No white-clawed crayfish were recorded via hand-searching or sweep netting of instream refugia during the survey and no crayfish remains were identified in otter spraint sites recorded during the survey.

Furthermore, white-clawed crayfish eDNA was not detected in samples collected from the Broadford River (site A16) or Ardcloony River (site B3) (section 4.3 below) supporting the species absence from the sub catchments. The presence of crayfish plague in the Broadford and Ardcloony Rivers also supports the absence of crayfish (section 4.3 below).

4.3 eDNA analysis

No white-clawed crayfish or freshwater pearl mussel eDNA was detected in composite water samples collected from the Broadford River (site A16) or Ardcloony River (B3) (0 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. These results were in keeping with the known distribution (absence) of the species in the wider survey area.

Both sites on the Broadford River (site A16) and Ardcloony River (B3) tested positive for crayfish plague (*Aphanomyces astaci*) (5 and 12 positive qPCR replicates out of 12, respectively) (**Table 4.1**).

Table 4.2 eDNA results in the vicinity of the Proposed Wind Farm site, (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	Freshwater pearl mussel	White-clawed crayfish	Crayfish plague
FK302	Broadford River (site A16)	Negative (0/12)	Negative (0/12)	**Positive (5/12)**
FK178	Ardcloony River (site B3)	Negative (0/12)	Negative (0/12)	**Positive (12/12)**

4.4 Otter signs

Only a single otter sign was recorded across 19 no. survey sites during the aquatic surveys undertaken in July 2022. A regular spraint site was recorded under Killaderry Bridge on the lower reaches of the Broadford River (site A16) (ITM 555663, 673479).

No breeding (holts) or resting (couch) areas were identified in the vicinity of the survey sites in July 2022.

4.5 Invasive aquatic species

Apart from the detection of crayfish plague (see above), no aquatic invasive species were recorded during surveys undertaken in July 2022.

Incidentally, the invasive terrestrial plant Japanese knotweed (*Reynoutria japonica*), commonly found along watercourses, was abundant at site A5 on the Cloonconry Beg River and was also present at sites A7 on the Broadford River. It was also detected locally in the riparian areas at sites A12 and A13 on the Kilbane Stream. This species is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and is considered a high-risk invasive species in Ireland (O' Flynn et al., 2014).

A spraint site of American mink (*Neovison vison*) was recorded at site A16 on the Broadford River at Killaderry Bridge, superimposed on a regular otter spraint site. This species is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and is considered a high-risk invasive species in Ireland (O' Flynn et al., 2014).

4.6 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=19 sites in July 2022 (**Appendix B**).

Sites on the Kilbane Stream (A9 & A13) and Ardcloony River (B3) achieved **Q4-5 (high status)** water quality and thus met the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**). This was given the presence of ≥5 no. group A taxa at each site, including an Ephemeroptera taxon of ≥15% abundance (as per Toner et al., 2005). The samples were dominated by Ephemeropteran taxa, namely the flattened mayfly *Rithrogena semicolorata*, with low numbers of stoneflies including *Siphonoperla torrentium*, *Dinocras cephalotes* and (at site A9) *Perla bipunctata* (**Appendix B**).

A total of 9 no. sites on the Cloonconry Beg River (A5) and unnamed tributary (A4), Kilbane Stream (A8, A11 & A13), Killeagy Stream (A10), Kilbane 27 Stream (A12), Broadford River (A14) and the Ardcloony River (B1 & B2) achieved **Q4 (good status)** water quality and thus met the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**). This was given the presence of at least one group A taxa in fair numbers (5% of total abundance). Invariably, this was *Rithrogena semicolorata* although *Electrogena lateralis* was also present in significant numbers at sites A5, A8 and A12. Most good status sites also supported at least one Chloroperlidae, Perlidae and or Nemouridae taxa (i.e. stoneflies) (**Appendix B**).

A total of 3 no. sites on the Cloonconry Beg Stream (A6) and Broadford River (A15 & A16) achieved **Q3-4 (moderate status)** water quality (**Figure 4.1**). This was given the low numbers (<5%) of group A species, namely the mayflies *Ecdyonurus dispar*, *Rhithrogena semicolorata or Electrogena lateralis*; low to moderate abundances of group B species such as the stonefly *Leuctra hippopus* and a dominance of group C species such as the mayflies *Baetis rhodani* and *Seratella ignita* and freshwater shrimp (*Gammarus duebeni*) (**Appendix B**).

The remaining 4 no. sites on the Ballymoloney Stream (A1), Broadford River (A2 & A7) and an unnamed stream (A3) achieved **Q2-3** (A1) **or Q3 (poor status)** based on an absence of group A species; low numbers of group B species and a dominance of group C species, particularly *Gammarus duebeni* (**Appendix B**).

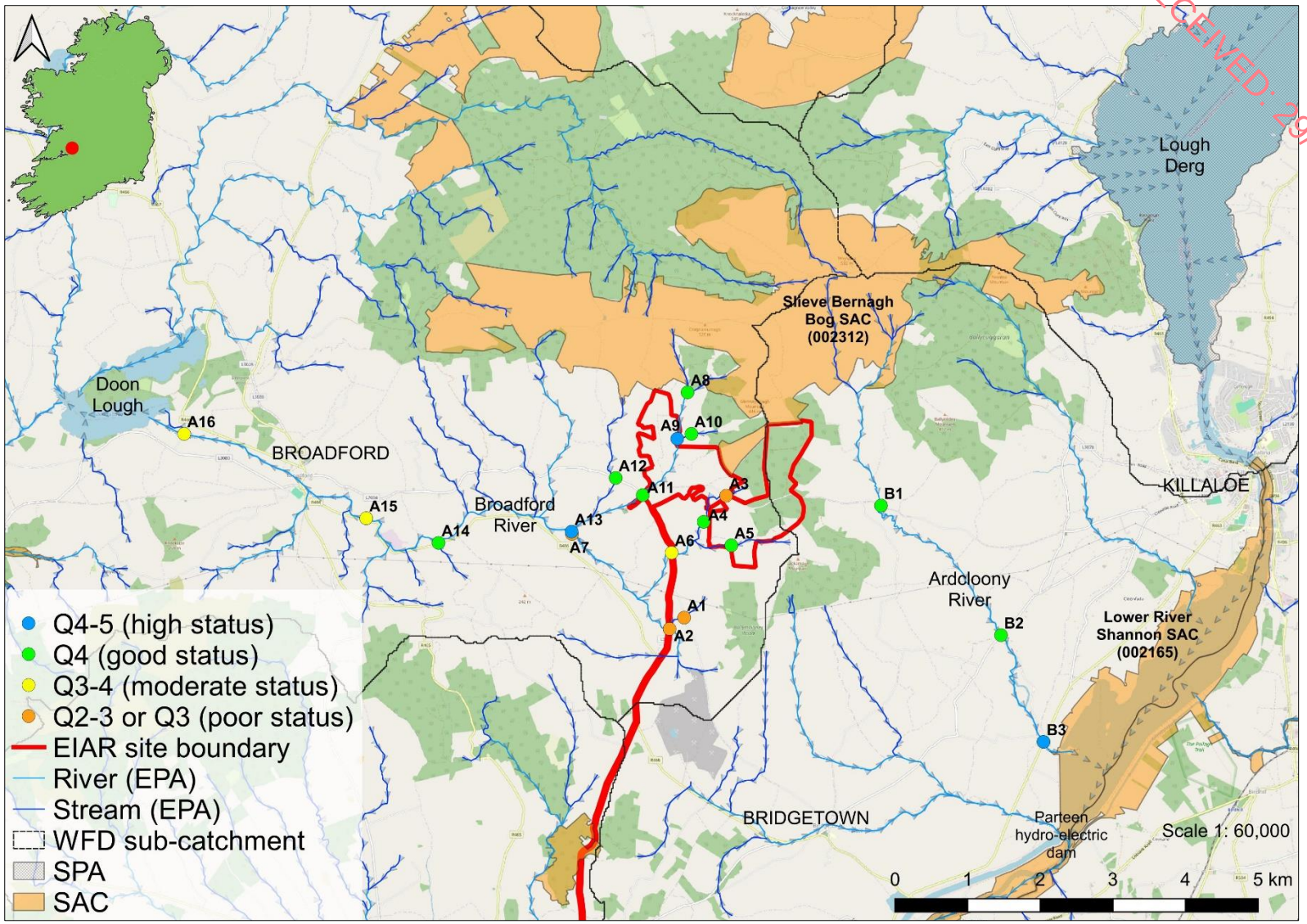

Figure 4.1 Overview of the biological water quality status in the vicinity of the Proposed Wind Farm site, Co. Clare, July 2022

4.7 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the *n*=19 survey sites in July 2022.

The Annex I habitat ‘‘Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* or aquatic mosses [3260]’ (‘floating river vegetation’, FRV) was recorded at sites A14 and A15 on the Broadford River. This was given the presence of multiple indicator species (Weekes et al., 2018; EC, 2013; Kelleher et al., 2011), including frequent water crowfoot (*Ranunculus* sp.) (site A14), water starwort (*Callitriche* sp.), pondweeds (*Potamogeton* spp.) (site A15) and aquatic mosses such as *Fontinalis antipyretica*, in addition to a high coverage of vegetation at these sites.

4.8 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of desktop review (i.e., presence of species of high conservation value), fisheries assessments and habitat assessments, the presence of protected or rare invertebrates (e.g. white-clawed crayfish, freshwater pearl mussel), environmental DNA analysis, the presence of rare macrophytes and aquatic bryophytes and or associated representations of Annex I habitats. Furthermore, biological water quality status also informed the aquatic evaluation (**Table 4.4**).

None of the aquatic survey sites were evaluated as greater than **local importance (higher value).** The 14 no. **local importance (higher value)** sites were present on an unnamed stream (A4), Broadford River (A7, A14, A15 & A16), Kilbane Stream (A8, A9, A11 & A13), Killeagy Stream (A10), Kilbane 27 Stream (A12) and Ardcloony River (B1, B2 & B3). This evaluation was primarily due to the presence of salmonids and or ≥Q4 (good status) water quality (**Table 4.4**).

The remaining 5 no. sites on the Ballymoloney Stream (A1), Broadford River (A2) and the Cloonconry Beg Stream (A5 & A6) and an unnamed tributary (A3) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic species or habitats of high conservation value and or less than Q4 (good status) water quality.

Table 4.2 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 Lackareagh wind farm, July 2022

Site	Watercourse	Relative abundance				
		Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Other species
A1	Ballymoloney Stream	No fish recorded				
A2	Broadford River	No fish recorded				
A3	Unnamed stream	No fish recorded				
A4	Unnamed stream	No fish recorded				
A5	Cloonconry Beg Stream	No fish recorded				
A6	Cloonconry Beg Stream	No fish recorded				
A7	Broadford River		Low	Not recorded	Low	Three-spined stickleback
A8	Kilbane Stream	No fish recorded				
A9	Kilbane Stream		Medium	Not recorded		
A10	Killeagy Stream		Medium	Not recorded		
A11	Kilbane Stream		Medium	Not recorded	Low	
A12	Kilbane 27 Stream	No fish recorded				
A13	Kilbane Stream		**High**	Not recorded	Low	Three-spined stickleback
A14	Broadford River		Medium	Not recorded	Low	Minnow
A15	Broadford River	**High**	Medium	Not recorded		
A16	Broadford River	**High**	Low	Not recorded	Low	Gudgeon
B1	Ardcloony River	Low	**High**	Not recorded		
B2	Ardcloony River	Low	Very high	Not recorded	Low	
B3	Ardcloony River	Low	High	Not recorded	Low	Stone loach

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 4.3 Summary of aquatic species (**excluding fish**) & habitats of higher conservation value recorded in the vicinity of the Proposed Wind Farm site

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	Ballymoloney Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A2	Broadford River	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A3	Unnamed stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A4	Unnamed stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A5	Cloonconry Beg Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A6	Cloonconry Beg Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A7	Broadford River	None recorded; negative eDNA result at site		No signs	Not present	None recorded	None recorded	None recorded
A8	Kilbane Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A9	Kilbane Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A10	Killeagy Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A11	Kilbane Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A12	Kilbane 27 Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A13	Kilbane Stream	None recorded		No signs	Not present	None recorded	None recorded	None recorded
A14	Broadford River	None recorded		No signs	**FRV [3260] present**	None recorded	None recorded	None recorded
A15	Broadford River	None recorded		No signs	**FRV [3260] present**	None recorded	None recorded	None recorded
A16	Broadford 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	Ardcloony River	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
B2	Ardcloony River	None recorded		No signs	Not present	None recorded	None recorded	None recorded
B3	Ardcloony River	None recorded; negative eDNA result at site	Negative eDNA result at site, no records in catchment	No signs	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.

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

Table 4.4 Aquatic ecological evaluation summary of the Proposed Wind Farm site according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Ballymoloney Stream	27B14	Local importance (lower value)	Upper reaches of small, shallow, historically modified upland eroding stream with ephemeral characteristics & siltation pressures; no fish recorded via electro-fishing & not of fisheries value; **Q2-3** (poor status) water quality; no aquatic species or habitats of high conservation value
A2	Broadford River	27B02	Local importance (lower value)	Upper reaches of small, historically modified upland eroding stream with low flows & siltation pressures; no fish recorded via electro-fishing & not of fisheries value; **Q3** (poor status) water quality; no aquatic species or habitats of high conservation value
A3	Unnamed stream	n/a	Local importance (lower value)	Upper reaches of very small, high gradient ephemeral upland eroding stream with heavy tunnelling; no fish recorded via electro-fishing & not of fisheries value; **Q3** (poor status) water quality; no aquatic species or habitats of high conservation value
A4	Unnamed stream	n/a	**Local importance (higher value)**	Small, largely natural, high gradient upland eroding spate stream with high shading; no fish recorded via electro-fishing despite some physical suitability; **Q4** (good status) water quality
A5	Cloonconry Beg Stream	27C17	Local importance (lower value)	Small, heavily modified, moderate gradient upland eroding spate channel with siltation pressures & low summer flows, not of fisheries value & no fish recorded via electro-fishing; no fish recorded via electro-fishing & not of fisheries value; **Q4** (poor status) water quality; no aquatic species or habitats of high conservation value
A6	Cloonconry Beg Stream	27C17	Local importance (lower value)	Small meandering upland eroding stream with significant siltation & water quality pressures; no fish recorded via electro-fishing despite good physical suitability (evidently related to water quality issues); **Q3-4** (moderate status) water quality; no aquatic species or habitats of high conservation value
A7	Broadford River	27B02	**Local importance (higher value)**	Heavily modified section of upland eroding watercourse with localised depositing characteristics & poor hydromorphology; brown trout, European eel & three-spined stickleback recorded via electro-fishing but a poor quality fisheries habitat; **Q3** (poor status) water quality
A8	Kilbane Stream	27K05	**Local importance (higher value)**	Headwaters of small, high gradient, naturally cascading spate channel; no fish recorded via electro-fishing & not of fisheries value due to high natural gradients; **Q4** (good status) water quality
A9	Kilbane Stream	27K05	**Local importance (higher value)**	Medium sized, highly natural upland eroding, cascading spate channel in deeply incised valley; medium density of brown trout recorded via electro-fishing; **Q4-5** (high status) water quality
A10	Killeagy Stream	27K11	**Local importance (higher value)**	Small, semi-natural, shallow upland eroding stream with siltation pressures; medium density of brown trout recorded via electro-fishing; **Q4** (good status) water quality

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A11	Kilbane Stream	27K05	**Local importance (higher value)**	Medium sized, largely natural upland eroding spate channel; brown trout and European eel recorded via electro-fishing; **Q4** (good status) water quality
A12	Kilbane 27 Stream	27K13	**Local importance (higher value)**	Small, natural upland eroding spate channel flowing in deeply incised valley; no fish recorded via electro-fishing despite good physical suitability (related to natural & anthropogenic fish passage barriers); **Q4** (good status) water quality
A13	Kilbane Stream	27K05	**Local importance (higher value)**	Medium sized, largely natural upland eroding spate channel below historical weir of high value as a salmonid spawning & nursery habitat; Atlantic salmon, brown trout, European eel & three-spined stickleback recorded via electro-fishing; **Q4-5** (high status) water quality
A14	Broadford River	27B02	**Local importance (higher value)**	Medium sized, swift-flowing meandering lowland spate river with some depositing characteristics of high fisheries value; Atlantic salmon, brown trout, European eel & minnow recorded via electro-fishing; Annex I floating river vegetation habitat present; **Q4** (good status) water quality
A15	Broadford River	27B02	**Local importance (higher value)**	Medium sized, high-energy lowland spate river of very high value for salmonids; Atlantic salmon (high abundance) & brown trout recorded via electro-fishing; Annex I floating river vegetation habitat present; **Q3-4** (moderate status) water quality
A16	Broadford River	27B02	**Local importance (higher value)**	Historically modified medium sized, swift-flowing lowland spate river with some depositing characteristics of very high value as salmonid spawning & nursery habitat; Atlantic salmon (high abundance), brown trout, European eel & gudgeon recorded via electro-fishing; **Q3-4** (moderate status) water quality
B1	Ardcloony River	25A03	**Local importance (higher value)**	Upper reaches of small, historically modified high energy spate river with good recovery and high value as a salmonid spawning & nursery habitat; Atlantic salmon & brown trout (high abundance) recorded via electro-fishing; **Q4** (good status) water quality
B2	Ardcloony River	25A03	**Local importance (higher value)**	Medium sized, highly natural, high-energy cascading spate channel of very high value for salmonids; Atlantic salmon, brown trout & European eel recorded via electro-fishing; **Q4** (good status) water quality
B3	Ardcloony River	25A03	**Local importance (higher value)**	Lower reaches of medium sized, historically modified, high-energy cascading spate channel with good recovery & of high value for salmonids; Atlantic salmon (high abundance), brown trout, European eel & stone loach recorded via electro-fishing; **Q4-5** (high status) water quality

Conservation value: Atlantic salmon (*Salmo salar*), *Lampetra* spp. and otter (*Lutra lutra*) are all listed under Annex II of the Habitats Directive [92/42/EEC]. Furthermore, Atlantic salmon, *Lampetra* spp. are also listed under Annex V of the Habitats Directive [92/42/EEC] while otter are also listed on under Annex IV of the Habitats Directive [92/42/EEC]. Otters (along with their breeding and resting places) are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

None of the 19 no. aquatic survey sites in the vicinity of the Proposed Wind Farm site were evaluated as of greater than **local importance (higher value)** in terms of their aquatic ecology and fisheries. Nevertheless, most sites were of **local importance (higher value).**

A total of 14 no. on an unnamed stream (A4), Broadford River (A7, A14, A15 & A16), Kilbane Stream (A8, A9, A11 & A13), Killeagy Stream (A10), Kilbane 27 Stream (A12) and Ardcloony River (B1, B2 & B3) were evaluated as **local importance (higher value)**. All survey sites on the Kilbane Stream and Ardcloony River were of **local importance (higher value).**

This evaluation was primarily due to the presence of salmonids (*n*=11 sites) and or ≥**Q4 (good status)** water quality (*n*=12 sites) (**Table 4.4**). Other aquatic species of high conservation value, such as Red-listed European eel (A7) and otter (A16) were also present at certain sites (**Table 4.2. 4.3**). Sites A14 and A15 on the Broadford River supported Annex I floating river vegetation habitat [3260].

The remaining 5 no. sites on the Ballymoloney Stream (A1), Broadford River (A2) and the Cloonconry Beg Stream (A5 & A6) and an unnamed tributary (A3) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic species or habitats of high conservation value and or **less than Q4 (good status)** water quality.

5.1.1 Fish species of high conservation value

Apart from sites A6 (significant water quality pressures) and A12 (downstream barriers), all survey sites with physically suitable habitat supported salmonids (11 no. sites). Brown trout were present at all 11 no. sites (i.e. A7, A9, A10, A11, A13, A14, A15, A16, B1, B2 & B3), with Atlantic salmon present at a total of 5 no. sites on the Broadford River (A15 & A16) and Ardcloony River (B1, B2 & B3). These Broadford River, Ardcloony River and the Kilbane Stream, were the most important salmonid habitats in the survey area (**Appendix A**). The upper reaches of surveyed watercourses such as the Broadford River, Cloonconry Beg Stream and Kilbane Stream did not support salmonids (or other fish species), as would be expected for higher-gradient, small spate streams (**Appendix A**). The occurrence of low numbers of mixed-cohort Atlantic salmon in the Ardcloony River (sites B1, B2 & B3) is especially notable given that the river joins the Lower River Shannon upstream of Parteen hydro-electric dam, a significant migration barrier.

No lamprey ammocoetes (*Lampetra* sp.) were recorded during targeted electro-fishing across the 19 no. survey sites in the vicinity of the proposed Lackareagh wind farm project (**Table 4.2; Appendix A**). This reflected the upland, higher-energy, spate nature of the survey watercourses which present conditions inimical for lamprey population establishment and persistence (i.e. no suitable burial habitat for ammocoetes and no spawning areas). Furthermore, natural and anthropogenic instream barriers for anadromous lamprey species in the wider survey area precluded the species presence (**Appendix A**). The results are in keeping with the known distribution (absence) of *Lampetra* sp. in the surveyed areas.

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). European eel were relatively widespread in the survey area and were recorded in low densities from a total of 7 no. sites on the Broadford River (A7, A14 & A16), Kilbane Stream (A11 & A13) and the Ardcloony River (B2 & B3) (**Table 4.2; Appendix A**). The absence of eel from other physically suitable survey sites primarily reflects the upland/spate nature of the surveyed watercourses (which provide sub-optimal eel habitat) and high natural gradients within the survey area which restrict upstream fish passage (**Appendix A**).

5.1.2 Otter

Despite good suitability elsewhere, otter signs were only recorded at site A16 on the lower reaches of the Broadford River, where a regular spraint site was identified under the Killaderry Bridge structure. This paucity of signs was considered to reflect the upland, higher-gradient, higher-energy nature of the survey watercourses which generally provide more restricted, stochastic prey resources and reduced foraging opportunities for otter (Sittenthaler et al., 2019; Scorpio et al., 2016; Remonti et al., 2009). Furthermore, numerous survey sites were located at elevations >100-50m ASL and otter occurrence is known to be negatively correlated with increasing elevation (Brazier & Macklin, 2020; Hong et al., 2020; Reid et al., 2013), primarily due to impacts on foraging. No breeding (holt) or couch (resting) areas were identified in the vicinity of the survey sites in July 2022.

5.1.3 Freshwater pearl mussel

No freshwater pearl mussel eDNA was detected in samples collected from the Broadford River (A16), or Ardcloony River (B3) in July 2022 (0 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C**). Suitability was poor or absent throughout the survey sites (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; NPWS data).

5.1.4 White-clawed crayfish & crayfish plague

No white-clawed crayfish were not detected via hand searching (*n*=19 sites) or field examination of otter spraint. No white-clawed crayfish was detected in eDNA which validated the site surveys when tested for in the Broadford River (A16) and Ardcloony River (B3) during July 2022 (0 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C**). These results support the known absence of the species in the wider survey area (Owenogarney_SC_010 and Shannon[Lower]_SC_080 river sub-catchments). The survey area was considered largely unsuitable for white-clawed crayfish given the presence of lower alkalinity, siliceous geologies (Demers et al., 2005; Lucey & McGarrigle, 1987), in addition to a predominance of higher-energy, spate watercourses.

Despite the current and historical absence of white-clawed crayfish from the wider survey area, crayfish plague was detected on both the Broadford River (A16) and Ardcloony River (B3) (5 and 12 positive qPCR replicates out of 12, respectively) (**Table 4.1**). These results represent the first known records of the pathogen in the Broadford River or Ardcloony River (as per the data of Swords et al., 2021, 2020; White et al., 2019). In close proximity to the survey area, crayfish plague has recently been detected via eDNA analysis in the Owenogarney River, River Blackwater and Glenomra Wood Stream (Triturus, 2022).

Crayfish plague is listed at one of the world's 100 worst invasive species (GISD, 2022; Lowe et al., 2000) and is becoming highly prevalent across Ireland. Generally, *Aphanomyces astaci* is considered an obligate crayfish parasite not capable of surviving for a long period outside a crayfish host (Strand et al., 2011; Söderhall & Cerenius, 1999). Thus, the detection of crayfish plague in watercourses devoid of crayfish is indicative of the ongoing spread of the pathogen across Irish catchments (pers. obs.), likely by a multitude of anthropogenic and natural vectors (Svoboda et al., 2020, 2016).

5.1.5 Macro-invertebrates & biological water quality

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=19 riverine sites in July 2022 (**Appendix B**).

Sites on the Kilbane Stream (A9 & A13) and Ardcloony River (B3) achieved **Q4-5 (high status)** water quality, with a further 9 no. sites on the Cloonconry Beg River (A5) and unnamed tributary (A4), Kilbane Stream (A8, A11 & A13), Killeagy Stream (A10), Kilbane 27 Stream (A12), Broadford River (A14) and the Ardcloony River (B1 & B2) achieving **Q4 (good status)** water quality. Thus, a total of 12 no. survey sites met the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**).

In general, the biological water quality of the survey area was good although impacts from agriculture (siltation) and instream modifications (hydromorphology) were noted during the site visits. Channelisation, causing siltation, is the primary threat to water quality in the Broadford_010 river waterbody, containing the Kilbane Stream and upper reaches of the Broadford River (EPA, 2018).

5.2 Aquatic ecology summary

The majority of surveyed watercourses in vicinity of the proposed project were natural or semi-natural in character, maintained good summer flows and were of high aquatic value for both fish and macro-invertebrates. Most were evaluated as **local importance (higher value)** given the presence of aquatic species of high conservation value and or ≥**Q4 (good status)** water quality. Of note is the presence of **Q4-5 (high status)** biological water quality at sites on the Kilbane Stream and Ardcloony River. High status waterbodies continue to decline significantly in Ireland (Trodd et al., 2022) and thus these watercourses require strict protection in light of proposed construction works that can result in impacts through siltation, enrichment and or hydrocarbons.

Brown trout and European eel were relatively widespread within the study area, with Atlantic salmon demonstrating a more restricted distribution (only recorded in the Broadford & Ardcloony Rivers). Freshwater pearl mussel and white-clawed crayfish were not recorded during the surveys, in keeping with the known distribution of these species in the sider survey area (i.e. both absent). No rare or protected macro-invertebrates, macrophytes or aquatic bryophytes were recorded. However, good examples of Annex I floating river vegetation habitat [3260] were present in the lower reaches of the Broadford River (sites A14 and A15). Broadly speaking, the highest value watercourses within vicinity of the project were the Broadford River, Kilbane Stream and, to the east of the proposed project, the Ardcloony River.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

Fisheries assessment for Lackareagh wind farm, Co. Clare

Triturus

Prepared by Triturus Environmental Ltd. for MKO

January 2023

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 Lackareagh wind farm, located approx. 5km east of Broadford, 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*=19 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 Lackareagh wind farm. Permission was granted on the 16th June 2022 and the survey was undertaken on Wednesday 6th to Friday 8th July 2022.

1.2 Fisheries asset of the survey area

The *n*=19 fisheries survey sites were located within the Owenogarney_SC_010 and Shannon[Lower]_SC_080 river sub-catchments. The proposed wind farm and associated infrastructure overlapped with the Slieve Bernagh Bog SAC (002312), a site designated for terrestrial habitats (NPWS, 2016). There was potential downstream hydrological connectivity (via the Ardcloony River) with Lower River Shannon SAC (002165), a site with numerous aquatic qualifying interests (NPWS, 2012). Fisheries survey sites were present on the Ballymoloney Stream (EPA code: 27B14), Broadford River (27B02), Cloonconry Beg Stream (27C17) and two unnamed tributaries, Kilbane Stream (27K05), Killeagy Stream (27K11), Kilbane 27 Stream (27K13) and the Ardcloony River (25A03) (**Table 2.1**).

The Broadford River (also known as the Glenomra River in its upper reaches) rises near Lackareagh Mountain and flows westwards for some 10km before flowing through the Doon Lough complex, emerging as the Owenogarney River. Upstream of Doon Lough the river is known to support Atlantic salmon (*Salmo salar*) brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), gudgeon (*Gobio gobio*), perch (*Perca fluviatilis*), minnow (*Phoxinus phoxinus*) and three-spined stickleback (*Gasterosteus aculeatus*) (Malachy Walsh, 2019: Triturus, 2017; Kelly et al., 2009, 2014). The non-native, invasive cyprinid species dace (*Leuciscus leuciscus*) has been recorded in Doon Lough and the Owenogarney River system since 1980 (Caffrey et al., 2007), with invasive roach (*Rutilus rutilus*) present since the early 1980s (Brazier, 2018). The Doon Lough complex and the wider Owenogarney

system is also known locally to contain stocks of other coarse fish species including bream (*Abramis brama*), rudd (*Scardinius erythropthalmus*), tench (*Tinca tinca*) and pike (*Esox lucius*) (pers. obs.).

Fisheries data for the other watercourses surveyed, including the Ardcloony River, was not available at the time of survey.

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 Lackareagh wind farm on the Wednesday 6th to Friday 8th 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*=19 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 sandstone) a voltage of 230-280v, 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 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. 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. 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*=19 electro-fishing survey sites in the vicinity of Lackareagh wind farm, Co. Clare

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Ballymoloney Stream	27B14	Ballymoloney	562558	670954
A2	Broadford River	27B02	Aghnagor Bridge	562357	670799
A3	Unnamed stream	n/a	L7080 road crossing	563137	672633
A4	Unnamed stream	n/a	Killeagy	562827	672274
A5	Cloonconry Beg Stream	27C17	Ballymoloney	563208	671950
A6	Cloonconry Beg Stream	27C17	L3022-8 road crossing	562386	671848
A7	Broadford River	27B02	Scott's Bridge	561013	672106
A8	Kilbane Stream	27K05	Shannaknock	562605	674057
A9	Kilbane Stream	27K05	Shannaknock	562463	673418
A10	Killeagy Stream	27K11	Killeagy	562658	673485
A11	Kilbane Stream	27K05	Shannaknock	561988	672642
A12	Kilbane 27 Stream	27K13	Kilbane	561615	672878
A13	Kilbane Stream	27K05	Kilbane	561008	672139
A14	Broadford River	27B02	Formoyle More	559175	671984
A15	Broadford River	27B02	Derry	558179	672323
A16	Broadford River	27B02	Killaderry Bridge	555671	673485
B1	Ardcloony River	25A03	L7080 road crossing	565269	672497
B2	Ardcloony River	25A03	Ballycorney Bridge	566922	670713
B3	Ardcloony River	25A03	Ardcloony Bridge, R463	567508	669243

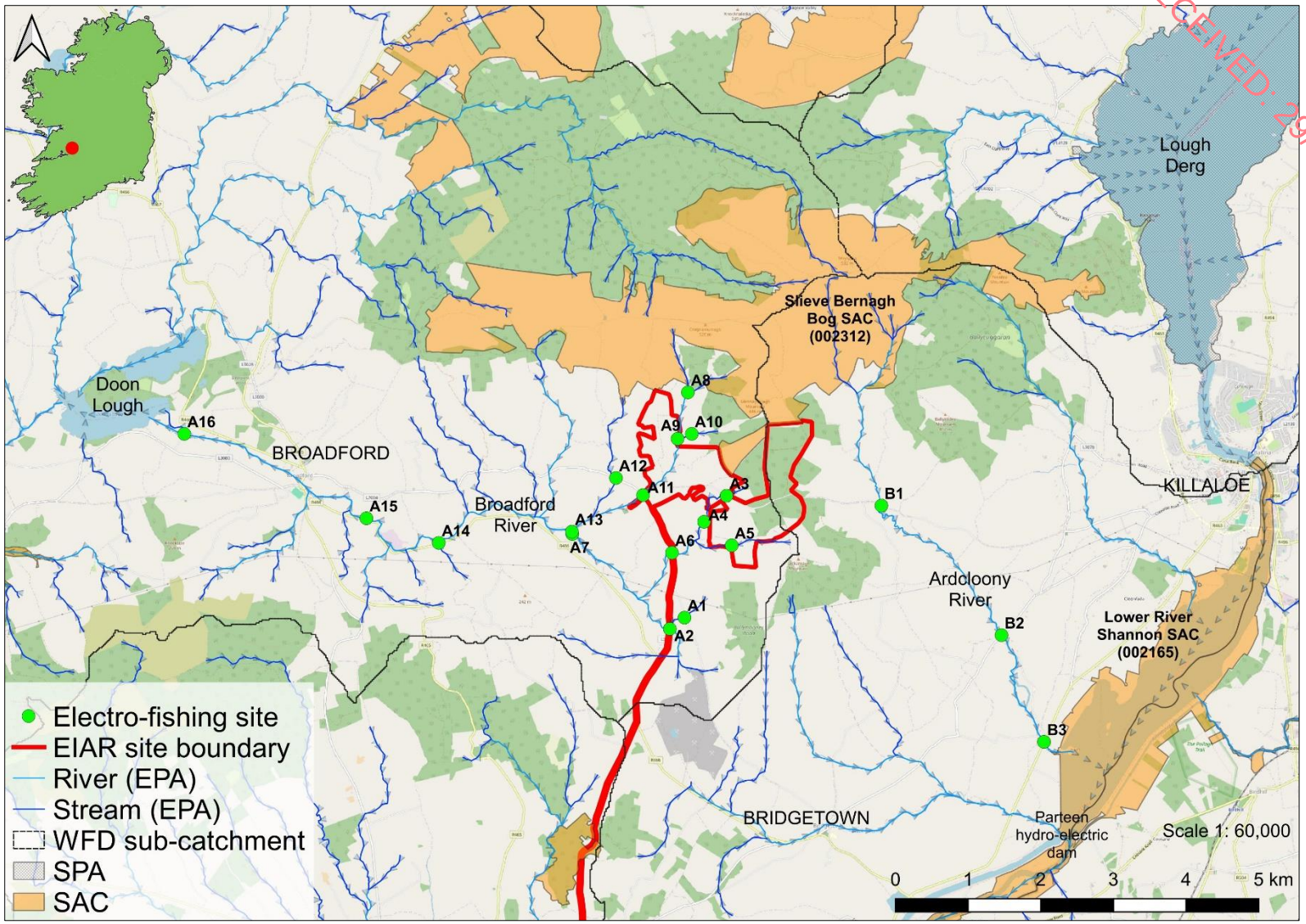

Figure 2.1 Overview of the *n*=19 electro-fishing survey site locations for the proposed Lackareagh wind farm, Co. Clare

3. Results

A catchment-wide electro-fishing survey of *n*=19 riverine sites in the vicinity of the proposed Lackareagh wind farm was conducted on Wednesday 6th to Friday 8th 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 Fisheries assessment & appraisal

3.1.1 Site A1 – Ballymoloney Stream, Ballymoloney

No fish were recorded via electro-fishing at site A1 on the Ballymoloney Stream. The site was not of fisheries value given the very shallow nature (likely ephemeral channel), location in the uppermost reaches of the catchment and evident siltation pressures.

Plate 3.1 Representative image of site A1 on the Ballymoloney Stream, July 2022

3.1.2 Site A2 – Broadford River, Aghnagor Bridge

No fish were recorded via electro-fishing at site A2 on the Broadford River. The site was not of fisheries value given the very shallow nature, location in the uppermost reaches of the catchment and evident siltation and enrichment pressures.

Plate 3.2 Representative image of site A2 on the upper reaches of the Broadford River, July 2022

3.1.3 Site A3 – unnamed stream, Killeagy

No fish were recorded via electro-fishing at site A3 on an unnamed Cloonconry Beg Stream tributary. The site was not of fisheries value given its location in the headwaters of the stream and high natural gradients which precluded upstream fish passage.

Plate 3.3 Representative image of site A3 on the upper reaches of an unnamed Cloonconry Beg River tributary, July 2022

3.1.4 Site A4 - unnamed stream, Killeagy

No fish were recorded via electro-fishing at site A4 on an unnamed Cloonconry Beg Stream tributary. The site was not of fisheries value given its location in the uppermost reaches of the catchment. The fisheries value was further compromised by evident siltation and low seasonal flows, in addition to a lack of deeper pool areas and the presence of instream barriers (both natural and artificial) (e.g. the perched culvert had a fall of 0.7m at low flows and would be impassable to all fish species). The upland site was unsuitable for lamprey, with none recorded.

Plate 3.4 Representative image of site A4 on an unnamed Cloonconry Beg River tributary, July 2022

3.1.5 Site A5 – Cloonconry Beg River, Ballymoloney

No fish were recorded via electro-fishing at site A5 on the Cloonconry Beg River. The site was not of fisheries value given its location in the uppermost reaches of the catchment and high natural gradients. The fisheries value was further compromised by evident siltation and low seasonal flows, in addition to a lack of deeper pool areas and the presence of instream barriers (culverts) (e.g. the perched culvert had a fall of 0.5m at low flows and would be impassable to all fish species). The upland site was unsuitable for lamprey, with none recorded.

3.1.6 Site A6 – Cloonconry Beg River, Killeagy

Despite some good physical habitat suitability for salmonids and, less so, European eel (*Anguilla anguilla*) no fish were recorded via electro-fishing at site A6 on the Cloonconry Beg Stream. This was considered to reflect evident siltation pressures from livestock and water quality issues (**Plate 3.6**). The upland site was unsuitable for lamprey and none were recorded during the survey.

Plate 3.5 Representative image of site A5 on the upper reaches of the Cloonconry Beg River, July 2022

Plate 3.6 Representative image of site A6 on the Cloonconry Beg River, July 2022 showing gross discolouration and evident water quality issues (exact origin unknown but domestic point source likely)

3.1.7 Site A7 – Broadford River, Scott's Bridge

Brown trout (*Salmo trutta*) (*n*=3), European eel (*n*=3) and three-spined stickleback (*Gasterosteus aculeatus*) (*n*=16) were recorded via electro-fishing at site A7 on the Broadford River (**Figure 3.1**).

However, despite the presence of low abundance so fish, the site provided very poor quality fisheries habitat given extensive historical modifications and water quality issues (gross siltation). Salmonid spawning habitat was absent with the exception of a very short (2m) section at the Kilbane Stream confluence. The slow-flowing deep glide offered some physical suitability as holding habitat for adult salmonids but the low flows reduced the value considerably. European eel habitat was moderate, at best (and superior downstream). Poor flows and gross siltation (smothering spawning areas) precluded the presence of lamprey and none were recorded.

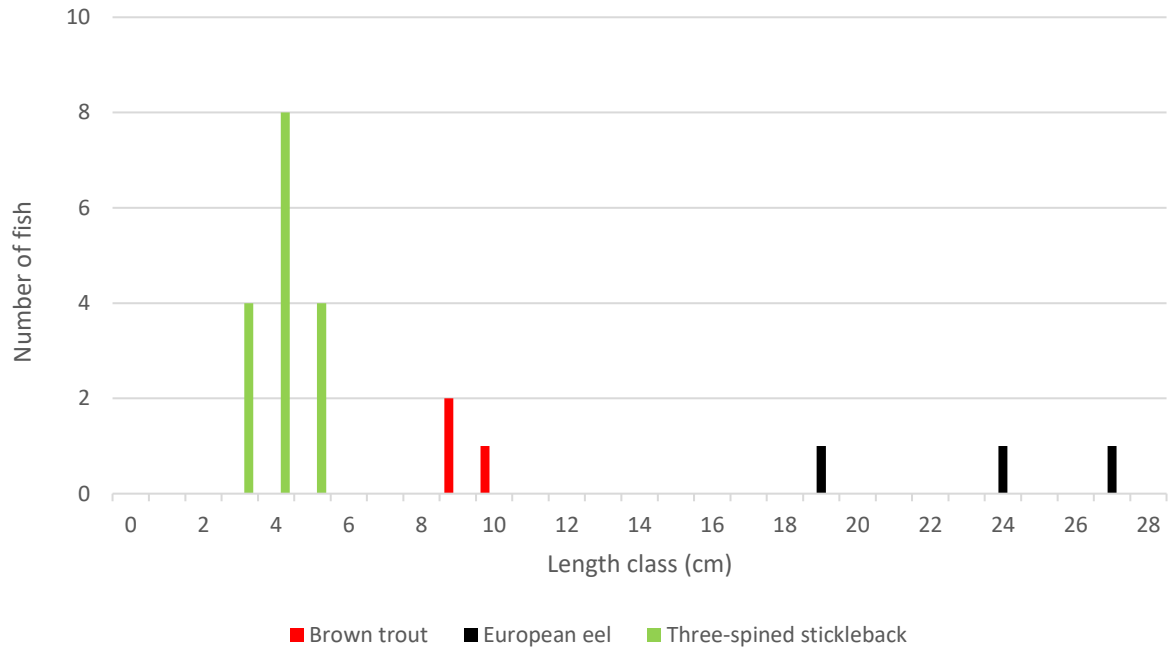

Figure 3.1 Length frequency distribution recorded via electro-fishing at A7 on the Broadford River, July 2022

Plate 3.7 European eel recorded at A7 on the Broadford River at Scott's Bridge, July 2022

3.1.8 Site A8 – Kilbane Stream, Shannaknock

No fish were recorded via electro-fishing at site A8 on the uppermost reaches of the Kilbane Stream. The site was not of fisheries value given the very shallow nature, location in the headwaters of the stream and high natural gradient with more limited flows. However, salmonids are present c.1km downstream (see site A9 below).

Plate 3.8 Representative image of site A8 on the uppermost reaches of the Kilbane Stream, July 2022

3.1.9 Site A9 – Kilbane Stream, Shannaknock

Brown trout (*n*=15) was the only fish species recorded via electro-fishing at site A9 on the Kilbane Stream (**Figure 3.2**).

The site was a good quality salmonid habitat, although only supported a small mixed cohort brown trout population given downstream barriers to fish passage. The site provided a combination of good quality spawning, nursery and holding habitat. European eel habitat was moderate at best, given the high flow rates and none were recorded. The upland site was unsuitable for lamprey, with none recorded.

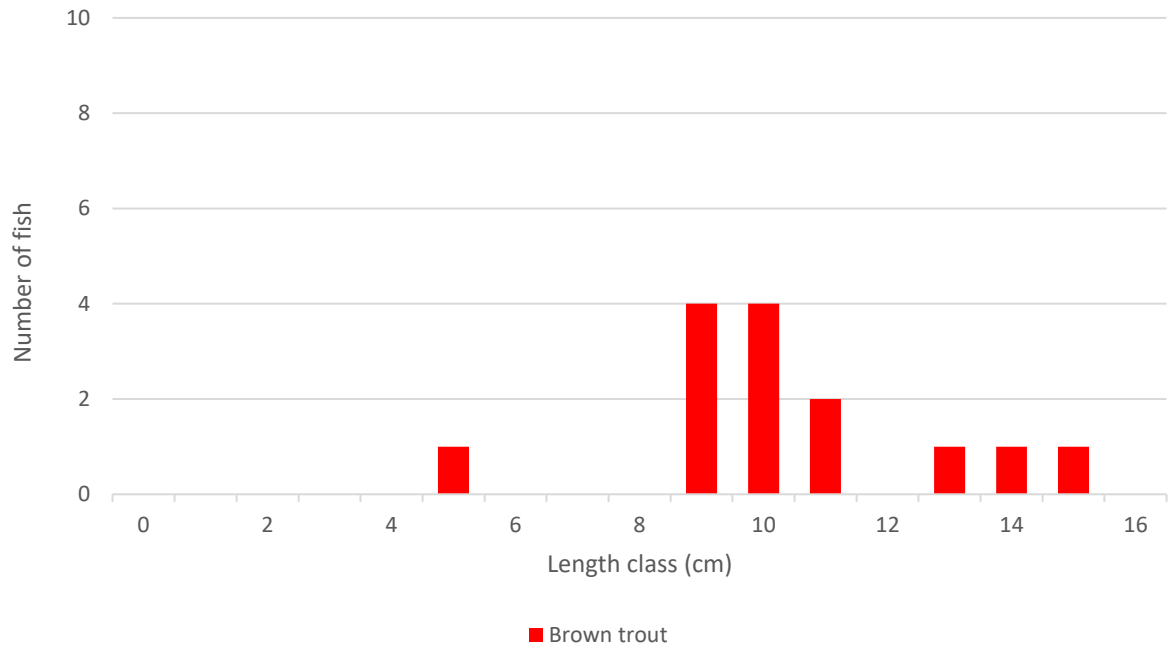

Figure 3.2 Length frequency distribution recorded via electro-fishing at A9 on the Kilbane Stream, July 2022

Plate 3.9 Mixed cohort brown trout recorded at site A9 on the Kilbane Stream, July 2022

3.1.10 Site A10 – Killeagy Stream, Killeagy

Brown trout (*n*=17) was the only fish species recorded via electro-fishing at site A10 on the Killeagy Stream (**Figure 3.3**).

The site was a moderate quality salmonid habitat, supporting a small density of juveniles and small adult brown trout. The site was of moderate value as a salmonid nursery with localised spawning habitat but was of poor value as a holding habitat for adults. European eel habitat was moderate at best, given the high flow rates and none were recorded. The upland site was unsuitable for lamprey, with none recorded.

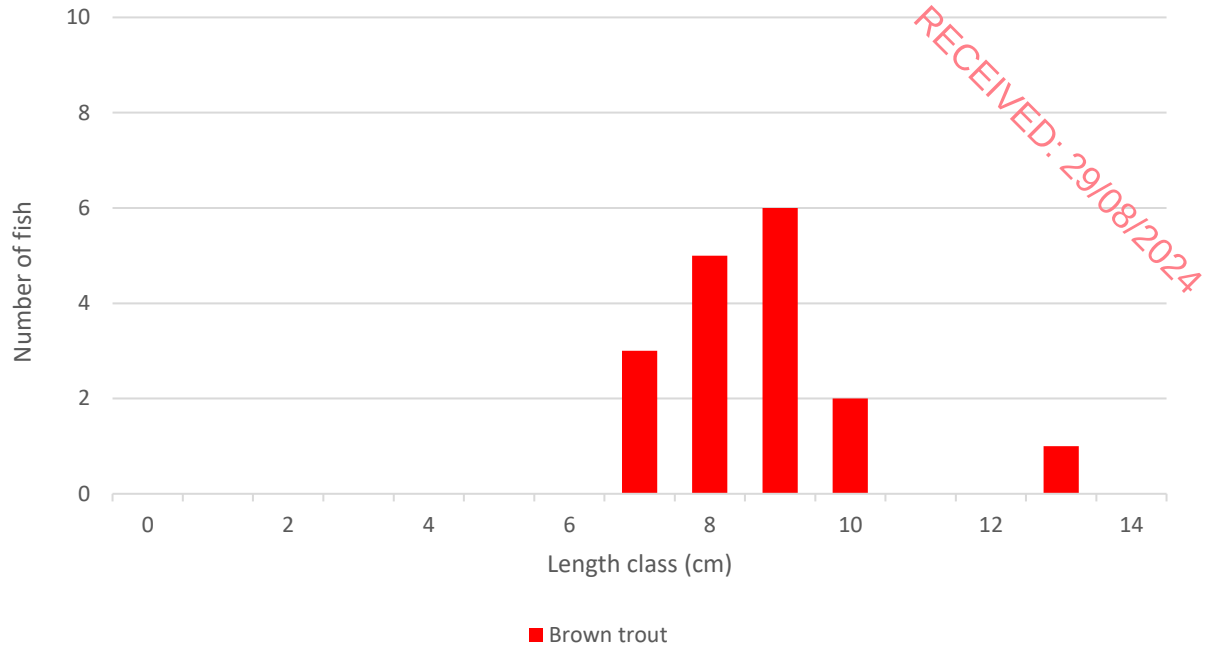

Figure 3.3 Length frequency distribution recorded via electro-fishing at A10 on the Killeagy Stream, July 2022

Plate 3.10 Representative image of site A10 on the Killeagy Stream, July 2022

3.1.11 Site A11 – Kilbane Stream, Shannaknock

Brown trout (*n*=26) and European eel (*n*=3) were the only fish species recorded via electro-fishing at site A11 on the Kilbane Stream (**Figure 3.4**).

The site was a moderate value salmonid habitat, supporting a low density of brown trout. Atlantic salmon were absent, indicating the historical weir near survey site A13 (c.1km downstream) serves as a significant barrier to anadromous salmonids. The site was of moderate value as a nursery and spawning habitat with poor quality holding areas for adults given the shallow, cascading nature. European eel habitat was moderate given high flow rates and paucity of suitable refugia, although the site did support a low density. The upland eroding conditions precluded the presence of lamprey.

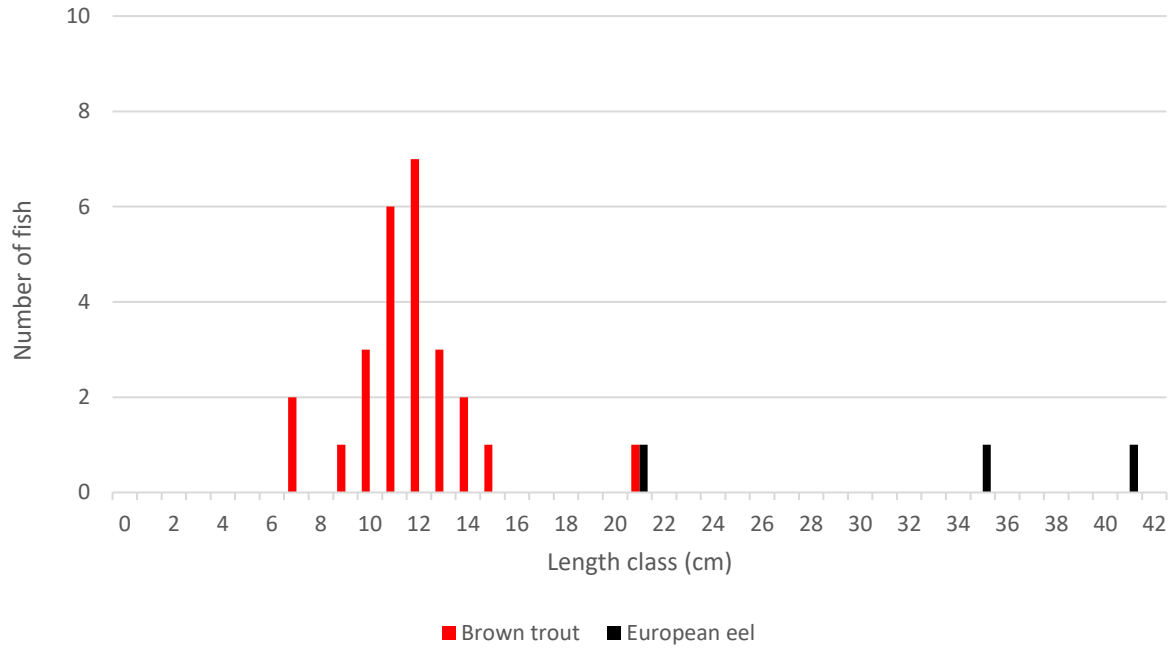

Figure 3.4 Length frequency distribution recorded via electro-fishing at A11 on the Kilbane Stream, July 2022

Plate 3.11 Representative image of site A11 on the Kilbane Stream, July 2022

3.1.12 Site A12 – Kilbane 27 Stream, Kilbane

No fish were recorded via electro-fishing at site A12 on the Kilbane 27 Stream. Despite some physical suitability for salmonids and, less so, European eel, the site was not of fisheries value given its location in the upper reaches of the catchment. The shallow nature of the stream, small size and high natural gradients precluded upstream fish passage and diminished the overall capacity of the habitat to support fish.

Plate 3.12 Representative image of site A12 on the Kilbane Stream, July 2022

3.1.13 Site A13 – Kilbane Stream, Kilbane

Atlantic salmon (*Salmo salar*) (*n*=11), brown trout (*n*=25), European eel (*n*=3) and three-spined stickleback (*n*=7) were recorded via electro-fishing at site A13 on the Kilbane Stream (**Figure 3.5**).

The site was a good quality salmonid nursery with excellent-quality spawning habitat. Pool, whilst present, was localised (e.g. weir pool). The weir (ITM 560982, 672130) was a significant instream barrier to fish migration and was not considered passable to salmonids or European eel. The high energy spate channel was unsuitable for lamprey and none were recorded. European eel habitat was moderate overall given the generally shallow nature of the stream.

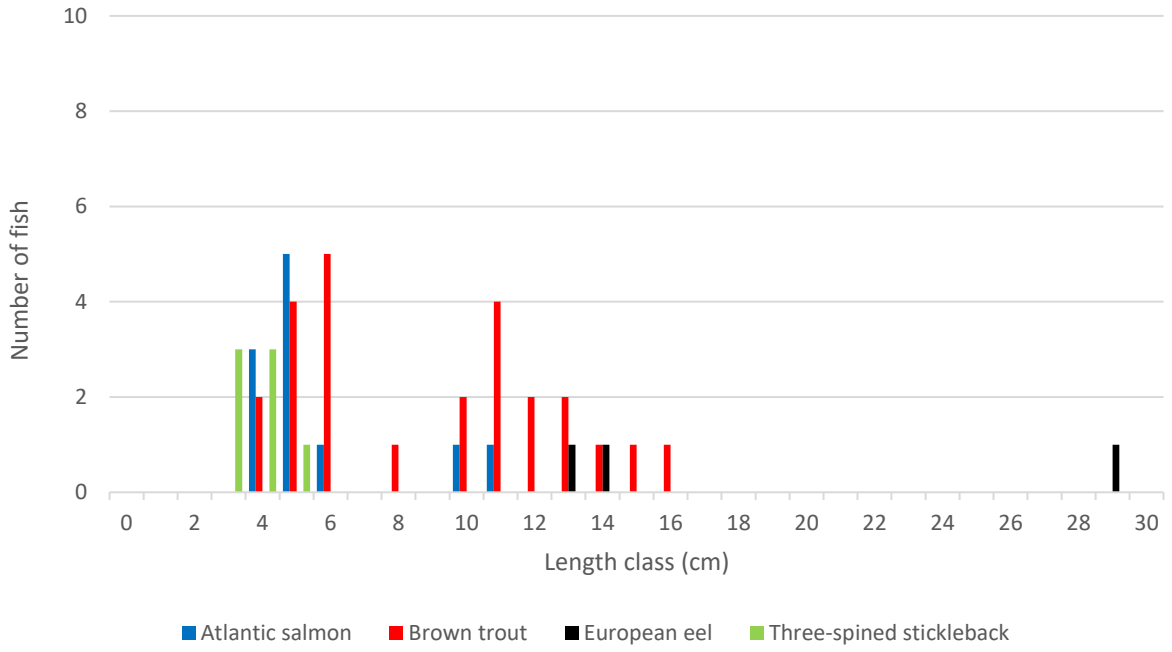

Figure 3.5 Length frequency distribution recorded via electro-fishing at A13 on the Kilbane Stream, July 2022

Plate 3.13 Brown trout and Atlantic salmon parr (middle) recorded at site A13 on the Kilbane Stream, July 2022

3.1.14 Site A14 – Broadford River, Formoyle More

Atlantic salmon (*n*=9), brown trout (*n*=14), European eel (*n*=1) and minnow (*Phoxinus phoxinus*) (*n*=41) were recorded via electro-fishing at site A14 on the Broadford River (**Figure 3.6**).

The site was an excellent quality salmonid habitat overall, with excellent-quality spawning habitat and holding areas present locally. Good quality holding habitat was associated with deep pools and undercut banks (with overhanging vegetation). The site was also evidently a good quality salmonid nursery. European eel habitat was good overall, though only a low density was recorded. The higher energy nature of the site presented conditions inimical for lamprey (i.e. absence of soft sediment and suitable spawning areas) with none recorded during the survey.

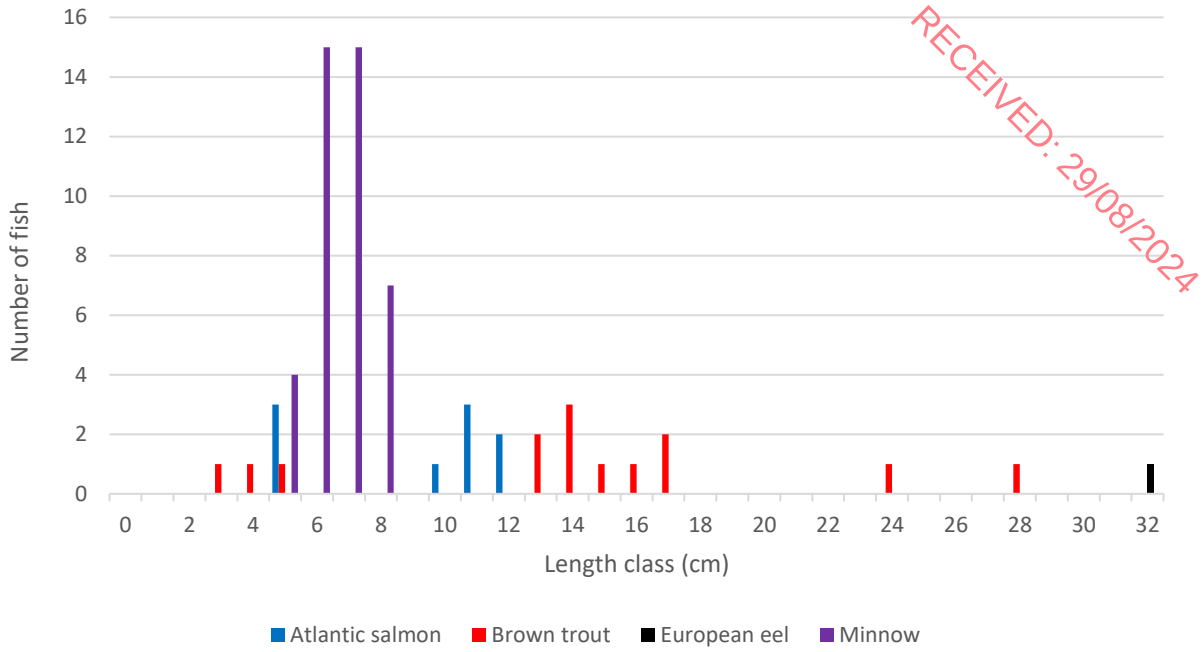

Figure 3.6 Length frequency distribution recorded via electro-fishing at A14 on the Broadford River, July 2022

Plate 3.14 Adult brown trout and adult male minnow recorded at site A14 on the Broadford River, July 2022

3.1.15 Site A15 – Broadford River, Derry

Atlantic salmon (*n*=29) and brown trout (*n*=13) were the only fish species recorded via electro-fishing at site A15 on the Broadford River (**Figure 3.7**). This was the highest density (per m^2) of Atlantic salmon recorded during the survey (**Table 3.1**).

The site was an excellent quality salmonid nursery, particularly for Atlantic salmon, with macrophytes beds and frequent boulder providing valuable refugia for a moderate density of juveniles. Similarly, undercut banks and locally deeper glide and pool areas provided good holding habitat for adults. Spawning habitat, whilst present, was localised and, given the size of substrata, more suited to Atlantic salmon as opposed to brown trout. European eel habitat was of good quality, although none were recorded. The spate nature of the site precluded the presence of lamprey.

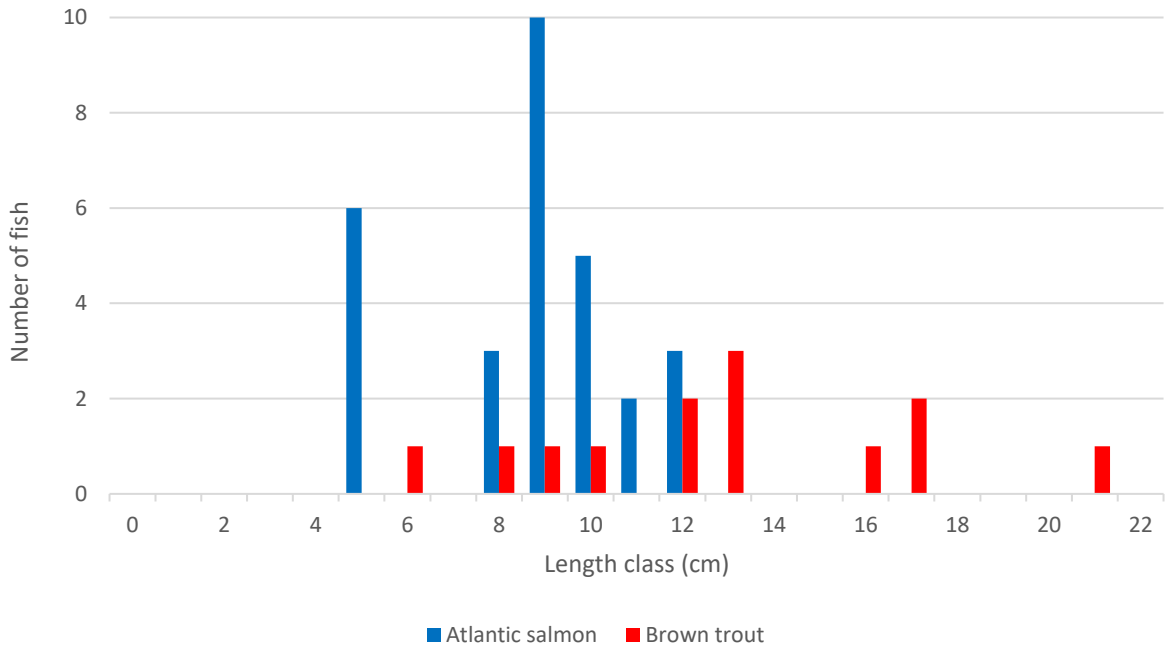

Figure 3.7 Length frequency distribution recorded via electro-fishing at A15 on the Broadford River, July 2022

Plate 3.15 Mixed cohort Atlantic salmon parr recorded at site A15 on the Broadford River, July 2022

3.1.16 Site A16 – Broadford River, Killaderry Bridge

Atlantic salmon (*n*=30), brown trout (*n*=9), European eel (*n*=2) and gudgeon (*Gobio gobio*) (*n*=17) were recorded via electro-fishing at site A16 on the lower reaches of the Broadford River (**Figure 3.8**).

Despite historical modifications, the site was an excellent quality salmonid spawning and nursery habitat, particularly for Atlantic salmon. A single salmon smolt (**Plate 3.17**), ready for its downstream migration to marine habitats, was recorded. The clean, well-sorted fine gravels also provided some highly suitable spawning habitat for *Lampetra* sp. Holding habitat for adult salmonids, whilst present, was localised (e.g. undercut banks). Although sand accumulations with high organic fractions present throughout the site provided some good suitability for lamprey ammocoetes, none were recorded during targeted electro-fishing; this was taken to be indicative of the high-energy/spate nature of the Broadford River in general (conditions inimical to *Lampetra* species). European eel habitat was of good quality, with ample refugia and a good prey base present.

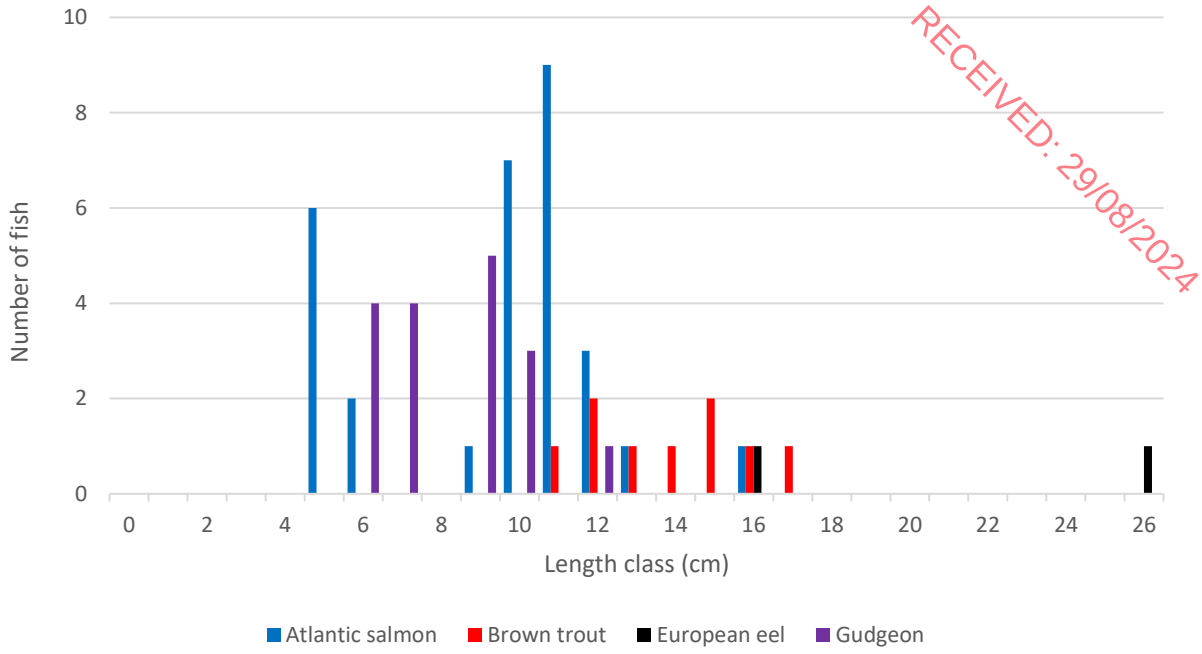

Figure 3.8 Length frequency distribution recorded via electro-fishing at A16 on the Broadford River, July 2022

Plate 3.16 Atlantic salmon smolt recorded at site A16 on the lower reaches of the Broadford River at Killaderry Bridge, July 2022 (approx. 0.5km upstream of Doon Lough)

3.1.17 Site B1 – Ardcloony River, Lackareagh Beg

Atlantic salmon (*n*=7) and brown trout (*n*=43) were the only fish species recorded via electro-fishing at site B1 on the upper reaches of the Ardcloony River (**Figure 3.9**). This was the highest density (per m^2) of brown trout recorded during the survey (**Table 3.1**).

The site was evidently an excellent salmonid habitat, with widespread excellent quality spawning habitat (clean, mixed gravels and small cobble). Nursery habitat was of good quality albeit the value was reduced given the paucity of larger refugia and instream macrophyte beds. Holding habitat for adult salmonids, whilst very limited in extent, was present locally. Localised small pools under overhanging scrub vegetation provided highly valuable habitat for brown trout, with Atlantic salmon parr more common in open fast glide and riffle areas. European eel habitat was moderate only given a paucity of suitable refugia and deeper pool areas (none recorded). The upland eroding site was not suitable for lamprey, with any soft sediment accumulations superficial only.

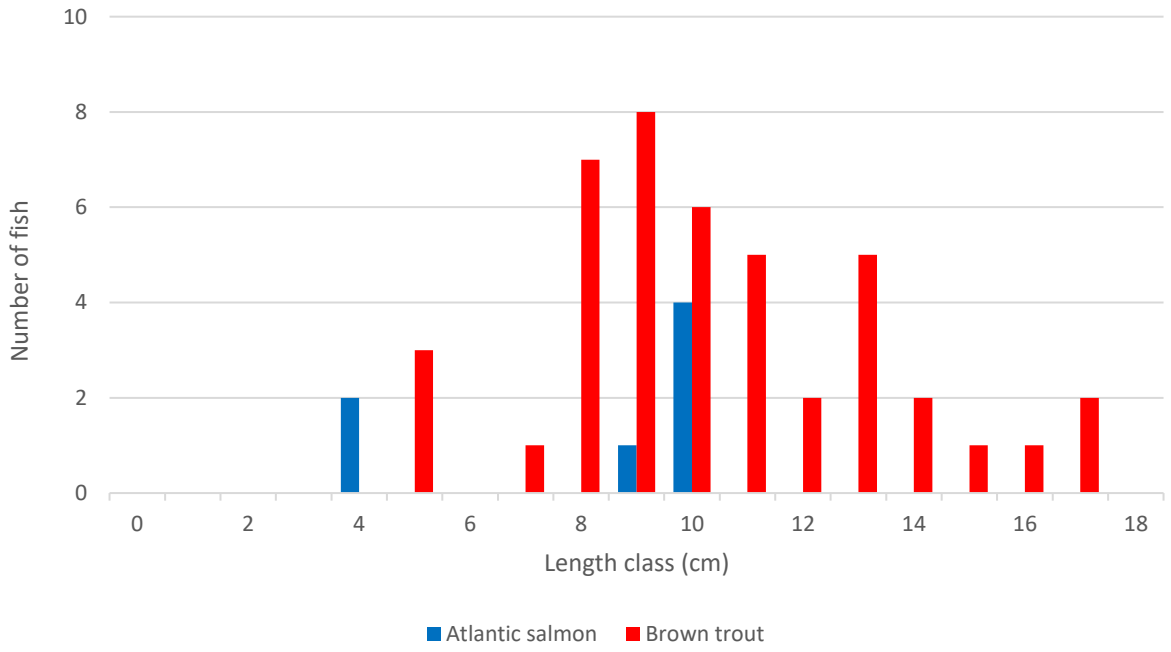

Figure 3.9 Length frequency distribution recorded via electro-fishing at B1 on the Ardcloony River, July 2022

Plate 3.17 Mixed cohort brown trout and Atlantic salmon parr (middle) recorded at site B1 on the upper reaches of the Ardcloony River, July 2022

3.1.18 Site B2 – Ardcloony River, Ballycorney Bridge

Atlantic salmon (*n*=4), brown trout (*n*=69) and European eel (*n*=1) were recorded via electro-fishing at site B2 on the Ardcloony River (**Appendix A**).

The site was of very high value for salmonids, with combinations of excellent quality spawning, nursery and holding habitat. The site was, however, of highest value as a salmonid nursery, supporting abundant juvenile brown trout, and a low number of Atlantic salmon parr. Excellent quality spawning habitat (loose mobile gravels grading into cobble) was present upstream of the bridge crossing at the tailings of deep plunge pools associated with the increasing frequency of cascades. European eel habitat was moderate, at best, given the high flow rates and none were recorded. The upland site was unsuitable for lamprey, with none recorded.

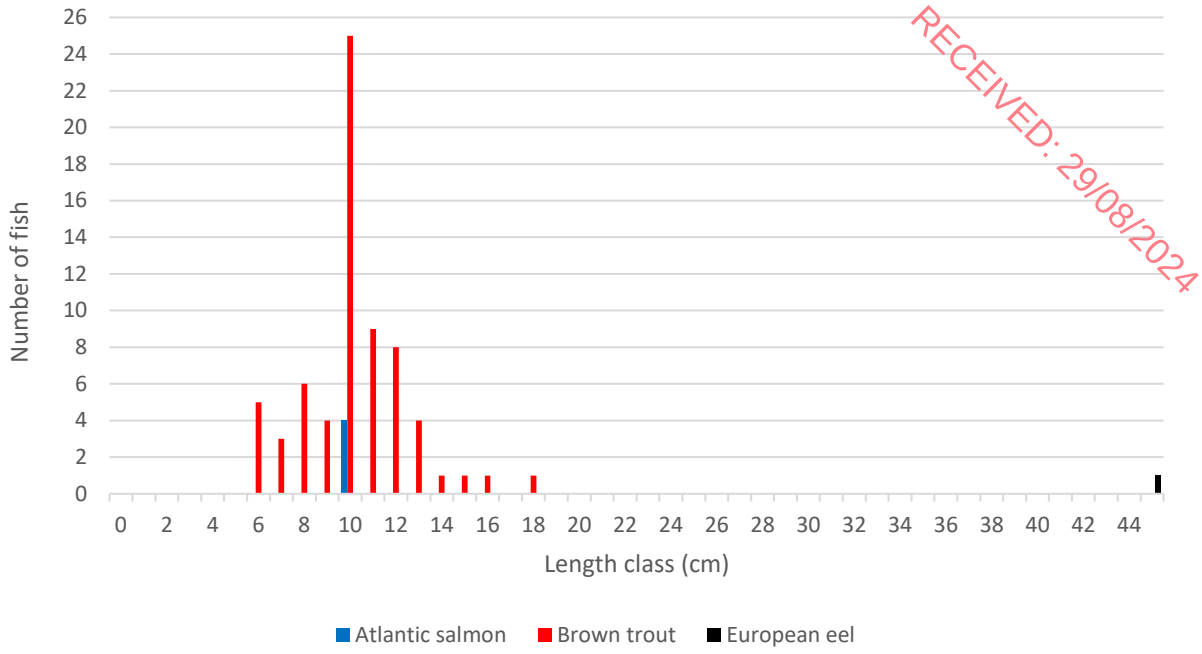

Figure 3.10 Length frequency distribution recorded via electro-fishing at B2 on the Ardcloony River, July 2022

Plate 3.18 Mixed cohort brown trout & Atlantic salmon recorded at site B2 on the Ardcloony River upstream of Ballycorney Bridge, July 2022

3.1.19 Site B3 – Ardcloony River, Ardcloony Bridge

Atlantic salmon (*n*=7), brown trout (*n*=32), European eel (*n*=1) and stone loach (*Barbatula barbatula*) (*n*=1) were recorded via electro-fishing at site B3 on the lower reaches of the Ardcloony River (**Figure 3.11**).

The site was of high value for salmonids, with excellent quality spawning habitat by virtue of abundant clean gravels and cobbles. Good quality nursery habitat was present (particularly for Atlantic salmon given flow rates) but the value was reduced given a paucity of larger refugia, bryophytes and macrophytes. Occasional pools provided valuable holding areas for adult salmonids. The site was of moderate value for European eel given a paucity of larger instream refugia, with only a low density recorded.

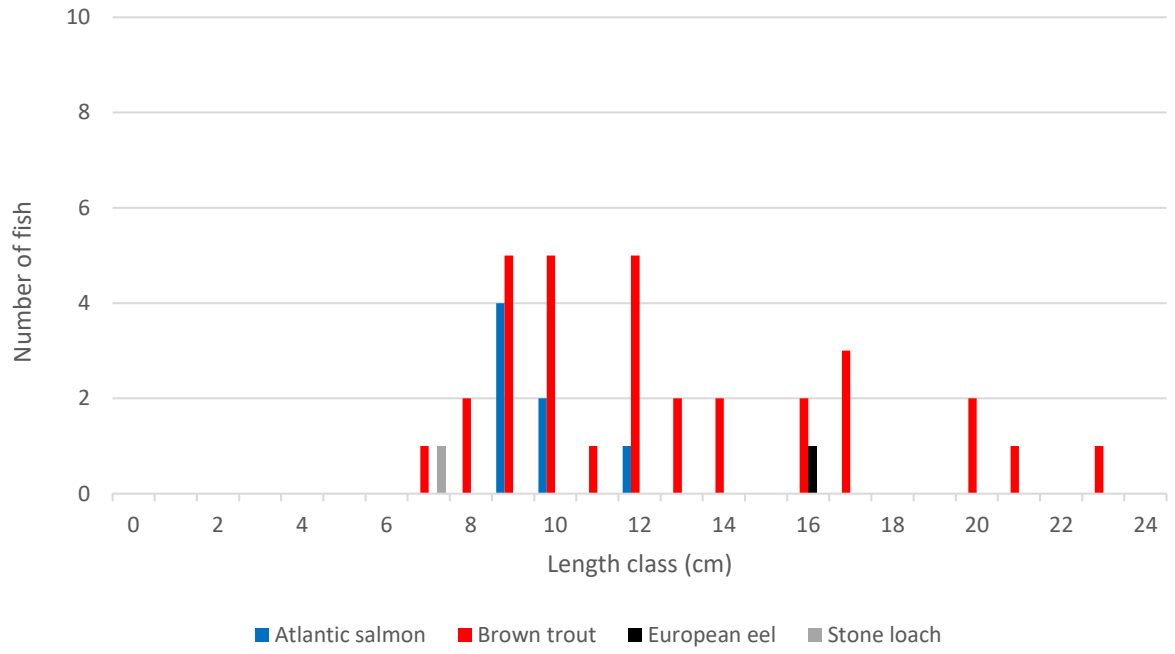

Figure 3.11 Length frequency distribution recorded via electro-fishing at B3 on the Ardcloony River, July 2022

Plate 3.19 Juvenile Atlantic salmon (top) and brown trout (bottom) recorded at site B3 on the lower reaches of the Ardcloony River at Ardcloony Bridge, July 2022

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of the proposed Lackareagh 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 (per m^2)						
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Stone loach	Gudgeon	Minnow
A1	Ballymoloney Stream	5	35	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A2	Broadford River	5	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A3	Unnamed stream	5	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A4	Unnamed stream	5	50	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A5	Cloonconry Beg Stream	5	30	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A6	Cloonconry Beg Stream	10	180	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A7	Broadford River	5	45	0.000	0.067	**0.067**	**0.356**	0.000	0.000	0.000
A8	Kilbane Stream	5	20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A9	Kilbane Stream	10	100	0.000	0.140	0.000	0.000	0.000	0.000	0.000
A10	Killeagy Stream	10	90	0.000	0.189	0.000	0.000	0.000	0.000	0.000
A11	Kilbane Stream	10	120	0.000	0.217	0.025	0.000	0.000	0.000	0.000
A12	Kilbane 27 Stream	5	40	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A13	Kilbane Stream	10	180	0.061	0.139	0.017	0.039	0.000	0.000	0.000
A14	Broadford River	10	240	0.038	0.058	0.004	0.000	0.000	0.000	**0.171**
A15	Broadford River	10	200	**0.145**	0.065	0.000	0.000	0.000	0.000	0.000
A16	Broadford River	10	300	0.100	0.030	0.007	0.000	0.000	**0.057**	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (per m^2)						
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Stone loach	Gudgeon	Minnow
B1	Ardcloony River	10	180	0.039	**0.239**	0.000	0.000	0.000	0.000	0.000
B2	Ardcloony River	10	320	0.013	0.216	0.003	0.000	0.000	0.000	0.000
B3	Ardcloony River	10	350	0.020	0.091	0.003	0.000	**0.003**	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 Lackareagh wind farm, July 2022

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	
A1	Ballymoloney Stream	No fish recorded				
A2	Broadford River	No fish recorded				
A3	Unnamed stream	No fish recorded				
A4	Unnamed stream	No fish recorded				
A5	Cloonconry Beg Stream	No fish recorded				
A6	Cloonconry Beg Stream	No fish recorded				
A7	Broadford River		Low	Not recorded	Low	Three-spined stickleback
A8	Kilbane Stream	No fish recorded				
A9	Kilbane Stream		Medium	Not recorded		
A10	Killeagy Stream		Medium	Not recorded		
A11	Kilbane Stream		Medium	Not recorded	Low	
A12	Kilbane 27 Stream	No fish recorded				
A13	Kilbane Stream		High	Not recorded	Low	Three-spined stickleback
A14	Broadford River		Medium	Not recorded	Low	Minnow
A15	Broadford River	High	Medium	Not recorded		
A16	Broadford River	High	Low	Not recorded	Low	Gudgeon
B1	Ardcloony River	Low	High	Not recorded		
B2	Ardcloony River	Low	Very high	Not recorded	Low	
B3	Ardcloony River	Low	High	Not recorded	Low	Stone loach

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.

4. Discussion

The majority of surveyed watercourses in vicinity of the proposed project were upland eroding, natural or semi-natural in character, maintained good summer flows and were of high value for salmonids and, to a lesser extent, European eel. Other fish species recorded included three-spined stickleback (sites A7 & A13), minnow (A14), gudgeon (A16) and stone loach (B3). The occurrence of a high abundance of minnow at site A14 on the Broadford River was indicative of the declining biological water quality moving downstream (i.e. Q3-4 moderate status). The increasing dominance of cyprinid species over salmonids is typically observed with declining trophic status and elevated levels of eutrophication (Kelly et al., 2007).

With the exception of sites A6 (significant water quality pressures; **Plate 3.6**) and A12 (downstream barriers), all survey sites with physically suitable habitat supported salmonids (11 no. sites). Brown trout were present at 11 no. sites on the Broadford River (sites A7, A14, A15 & A16), Kilbane Stream (A9, A11 & A13), Killeagy Stream (A10) and the Ardcloony River (B1, B2 & B3) (**Table 3.2**). Atlantic salmon were present at a total of 5 no. sites on the Broadford River (A15 & A16) and Ardcloony River (B1, B2 & B3). The highest densities of Atlantic salmon and brown trout were recorded from the Broadford River (A15) and Ardcloony River (B1), respectively (**Table 3.1**). These watercourses, along with the Kilbane Stream, were the most important salmonid habitats in the survey area. Sites A13 (Kilbane Stream), A14 & A16 (Broadford River) and B1, B2 & B3 (Ardcloony River) provided excellent quality spawning habitat, with sites A15, A16 and B2 providing the best quality nursery habitat of the sites surveyed.

Plate 4.1 The weir at site A13 on the Kilbane Stream was a significant barrier to fish

The upper reaches of surveyed watercourses such as the Broadford River, Cloonconry Beg Stream and Kilbane Stream did not support salmonids (or indeed any fish species). 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), and, as per this study, often

present instream barriers to fish passage caused by naturally high gradients (e.g. Kilbane 27 Stream, site A12). A clear anthropogenic barrier to fish passage in the study area was the weir present on the lowermost reaches of the Kilbane Stream near its confluence with the Broadford River at Scott's Bridge (**Plate 4.1**). Whilst not likely impassable (at least at higher water levels), no Atlantic salmon were recorded upstream of this point on the Kilbane Stream, despite some good habitat suitability. The occurrence of low numbers of mixed-cohort Atlantic salmon in the Ardcloony River (sites B1, B2 & B3) is especially notable given that the river joins the Lower River Shannon upstream of Parteen hydro-electric dam, a significant migration barrier.

No lamprey ammocoetes (*Lampetra* sp.) were recorded during targeted electro-fishing across the 19 no. survey sites (**Table 3.1, 3.2**). This reflected the upland, higher-energy, spate nature of the survey watercourses 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). Both high natural gradients and anthropogenic instream barriers (e.g. weirs, culverts) further decreased suitability for lamprey species. The results are in keeping with the known distribution (absence) of *Lampetra* sp. in the in the wider survey area. Sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*) are known to spawn on the lower Owengarney River, downstream of Sixmilebridge (Ross, 2017), to which the Broadford River is connected. *Lampetra* sp. lamprey are also known from the adjacent, but hydrologically unconnected, River (Clare) Blackwater (Triturus, 2017, 2022; Malachy Walsh, 2019; Ross, 2017).

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). European eel were relatively widespread in the survey area and were recorded in low densities from a total of 7 no. sites on the Broadford River (A7, A14 & A16), Kilbane Stream (A11 & A13) and the Ardcloony River (B2 & B3) (**Table 3.1, 3.2**). The absence of eel from other 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). Furthermore, eel abundance decreases with gradient and distance from marine habitats (Degerman et al., 2019).

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

Table 8.1 Macro-invertebrate Q-sampling results for sites A1 to A13, July 2022

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	EPA Group
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*													2	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*				2										A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*				5	10				35	2	22	14	21	A
Ephemeroptera	Heptageniidae	*Electrogena lateralis*					9	1		24		1	4	8	4	A
Plecoptera	Chloroperlidae	*Siphonoperla torrentium*					1				1				2	A
Plecoptera	Chloroperlidae	*Chloroperla tripunctata*														A
Plecoptera	Nemouridae	*Nemurella picteti*									1					A
Plecoptera	Nemouridae	*Protonemura meyeri*								4					2	A
Plecoptera	Perlidae	*Dinocras cephalotes*									2				4	A
Plecoptera	Perlidae	*Perla bipunctata*									1					A
Plecoptera	Perlodidae	*Isoperla grammatica*														A
Ephemeroptera	Baetidae	*Alainites muticus*		1		4	6	2		12		2	2	1	1	B
Plecoptera	Leuctridae	*Leuctra hippopus*				2			2	1	1			10	2	B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*		24		3					1				5	B
Trichoptera	Glossosomatidae	*Glossosoma boltoni*									1	2	1			B
Trichoptera	Goeridae	*Silo pallipes*								13						B
Trichoptera	Lepidostomatidae	*Lepidostoma hirtum*	1													B
Trichoptera	Leptophlebiidae	*Leptophlebia vespertina*							7							B
Trichoptera	Limnephilidae	*Anabolia nervosa*							1							B
Trichoptera	Limnephilidae	*Drusus annulatus*							1							B
Trichoptera	Limnephilidae	*Halesus radiatus*				1								1		B
Trichoptera	Limnephilidae	*Limnephilus lunatus*							1							B
Trichoptera	Limnephilidae	*Limnephilus marmoratus*							1							B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*					1			2	2					B

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	EPA Group
Trichoptera	Odontoceridae	*Odontocerum albicorne*									1			1	3	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*	1						1				3			B
Ephemeroptera	Baetidae	*Baetis rhodani*	3	87		7	15	25		16	11	13	62	3	38	C
Ephemeroptera	Caenidae	*Caenis rivulorum*														C
Ephemeroptera	Ephemerellidae	*Serratella ignita*						7	2		2		24	5		C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*			1											C
Trichoptera	Hydropsychidae	*Diplectrona felix*				3	1			6		1		2		C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*									24		2	6	17	C
Trichoptera	Philopotamidae	*Chimarra marginata*								1						C
Trichoptera	Philopotamidae	*Philopotamus montanus*					3			1		1	1	16	2	C
Trichoptera	Philopotamidae	*Wormaldia occipitalis*					1									C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*				3	2			1						C
Trichoptera	Polycentropodidae	*Polycentropus kingi*														C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*				1	3	1		2	1		2	1	4	C
Trichoptera	Rhyacophilidae	*Rhyacophila munda*														C
Crustacea	Gammaridae	*Gammarus duebeni*	2	106	28	74	43	41	73	4	32	5	2	12	8	C
Gastropoda	Tateidae	*Potamopyrgus antipodarum*				16		22						1		C
Gastropoda	Planorbidae	*Ancylus fluviatilis*					6			11		2				C
Coleoptera	Dytiscidae	Dytiscidae larva						2								C
Coleoptera	Dytiscidae	*Ilybius ater*			3											C
Coleoptera	Dytiscidae	*Ilybius fuliginosus*														C
Coleoptera	Dytiscidae	*Stictotarsus duodecimpustulatus*							7							C
Coleoptera	Elmidae	*Elmis aenea*		1							1					C
Coleoptera	Elmidae	*Esolus parallelepipedus*														C
Coleoptera	Elmidae	*Limnius volckmari*														C

Group	Family	Species	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	EPA Group
Coleoptera	Halipliidae	*Brychius elevatus*							1							C
Coleoptera	Hydraenidae	*Hydraena gracilis*														C
Coleoptera	Hydrophilidae	*Anacaena globulus*			1											C
Coleoptera	Scirtidae	*Scirtidae larva*					1									C
Diptera	Ceratopogonidae	sp. indet.												1		C
Diptera	Chironomidae	non-*Chironomus* spp.	2				1	26	4		2		1	5	2	C
Diptera	Pediciidae	*Dicranota* sp.						1					1	6		C
Diptera	Simuliidae	sp. indet.		18		3	4	91		10	10	3	3	8	9	C
Diptera	Thaumaleidae	sp. indet.												1		C
Diptera	Tipuliidae	*Tipula* sp.			1											C
Arachnida	Hydrachnidiae	sp. indet.														C
Crustacea	Asellidae	*Asellus aquaticus*														D
Hirudinidae	Glossiphoniidae	sp. indet.					1		1							D
Hirudinidae	Erpobdellidae	sp. indet.	2													D
Diptera	Chironomidae	*Chironomus* spp.		2				2					1			E
Annelidae	Oligochaeta	sp. indet.	2					2							1	n/a
Abundance			**13**	**239**	**34**	**124**	**108**	**223**	**102**	**108**	**129**	**32**	**131**	**102**	**127**	
Q-rating			**Q2-3**	**Q3**	**Q3**	**Q4**	**Q4**	**Q3-4**	**Q3**	**Q4**	**Q4-5**	**Q4**	**Q4**	**Q4**	**Q4-5**	
WFD status			Poor	Poor	Poor	Good	Good	Mod	Poor	Good	High	Good	Good	Good	High	

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	A14	A15	A16	B1	B2	B3	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*			2			1	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*							A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*	27	1	1	41	5	29	A
Ephemeroptera	Heptageniidae	*Electrogena lateralis*				6		2	A
Plecoptera	Chloroperlidae	*Siphonoperla torrentium*	2						A
Plecoptera	Chloroperlidae	*Chloroperla tripunctata*				1			A
Plecoptera	Nemouridae	*Nemurella picteti*							A
Plecoptera	Nemouridae	*Protonemura meyeri*							A
Plecoptera	Perlidae	*Dinocras cephalotes*	1				1	2	A
Plecoptera	Perlidae	*Perla bipunctata*					3		A
Plecoptera	Perlodidae	*Isoperla grammatica*						1	A
Ephemeroptera	Baetidae	*Alainites muticus*		1		10		3	B
Plecoptera	Leuctridae	*Leuctra hippopus*	2	2	14	1	1	2	B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*	1		1				B
Trichoptera	Glossosomatidae	*Glossosoma boltoni*						5	B
Trichoptera	Goeridae	*Silo pallipes*	2			4	2		B
Trichoptera	Lepidostomatidae	*Lepidostoma hirtum*							B
Trichoptera	Leptophlebiidae	*Leptophlebia vespertina*							B
Trichoptera	Limnephilidae	*Anabolia nervosa*							B
Trichoptera	Limnephilidae	*Drusus annulatus*							B
Trichoptera	Limnephilidae	*Halesus radiatus*							B
Trichoptera	Limnephilidae	*Limnephilus lunatus*							B
Trichoptera	Limnephilidae	*Limnephilus marmoratus*							B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*	3	1	8				B
Trichoptera	Odontoceridae	*Odontocerum albicorne*	1	1	1				B

Group	Family	Species	A14	A15	A16	B1	B2	B3	EPA class
Trichoptera	Sericostomatidae	*Sericostoma personatum*	1			2			B
Ephemeroptera	Baetidae	*Baetis rhodani*	6	16	9	28	4	18	C
Ephemeroptera	Caenidae	*Caenis rivulorum*	1	1					C
Ephemeroptera	Ephemerellidae	*Serratella ignita*	11	9	31	36	7	41	C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*		1					C
Trichoptera	Hydropsychidae	*Diplectrona felix*							C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*			3		8	7	C
Trichoptera	Philopotamidae	*Chimarra marginata*							C
Trichoptera	Philopotamidae	*Philopotamus montanus*							C
Trichoptera	Philopotamidae	*Wormaldia occipitalis*							C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*		1					C
Trichoptera	Polycentropodidae	*Polycentropus kingi*			1				C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*			1	1	1	1	C
Trichoptera	Rhyacophilidae	*Rhyacophila munda*		1					C
Crustacea	Gammaridae	*Gammarus duebeni*	31	33	25	4	9	24	C
Gastropoda	Tateidae	*Potamopyrgus antipodarum*			4				C
Gastropoda	Planorbidae	*Ancylus fluviatilis*							C
Coleoptera	Dytiscidae	*Dytiscidae larva*							C
Coleoptera	Dytiscidae	*Ilybius ater*							C
Coleoptera	Dytiscidae	*Ilybius fuliginosus*		1					C
Coleoptera	Dytiscidae	*Stictotarsus duodecimpustulatus*							C
Coleoptera	Elmidae	*Elmis aenea*	2	3	3	1			C
Coleoptera	Elmidae	*Esolus parallelepipedus*		1	2				C
Coleoptera	Elmidae	*Limnius volckmari*	6	1	8			4	C
Coleoptera	Halipliidae	*Brychius elevatus*							C
Coleoptera	Hydraenidae	*Hydraena gracilis*		1	4		1	2	C

Group	Family	Species	A14	A15	A16	B1	B2	B3	EPA class
Coleoptera	Hydrophilidae	*Anacaena globulus*							C
Coleoptera	Scirtidae	*Scirtidae larva*							C
Diptera	Ceratopogonidae	sp. indet.							C
Diptera	Chironomidae	non-*Chironomus* spp.	1	1	1	1		1	C
Diptera	Pediciidae	*Dicranota* sp.	1			2		3	C
Diptera	Simuliidae	sp. indet.		14	7	41	1	36	C
Diptera	Thaumaleidae	sp. indet.							C
Diptera	Tipuliidae	*Tipula* sp.					1		C
Arachnida	Hydrachnidiae	sp. indet.				2			C
Crustacea	Asellidae	*Asellus aquaticus*			1				D
Hirudinidae	Glossiphoniidae	sp. indet.				1			D
Hirudinidae	Erpobdellidae	sp. indet.							D
Diptera	Chironomidae	*Chironomus* spp.				1			E
Annelidae	Oligochaeta	sp. indet.					2		n/a
Abundance			**99**	**90**	**127**	**183**	**46**	**182**	
Q-rating			**Q4**	**Q3-4**	**Q3-4**	**Q4**	**Q4**	**Q4-5**	
WFD status			Good	Mod	Mod	Good	Good	High	

9. Appendix C – eDNA analysis lab report

Triturus

SureScreen Scientifics

RECEIVED: 29/08/2024

Folio No: E15141
Report No: 1
Client: Triturus Environmental Limited
Contact: Bill Brazier

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

SUMMARY

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

RESULTS

Date sample received in laboratory: 25/07/2022
Date results reported: 03/08/2022
Matters affecting result: None

TARGET SPECIES: Crayfish plague *(Aphanomyces astaci)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK178	Ardcloony River, Ardcloony Bridge (B3)	ITM567508 669243	Pass	Pass	Pass	Positive	12/12
FK302	Broadford River (A16)	ITM555671 673483	Pass	Pass	Pass	Positive	5/12

Forensic Scientists and Consultant Engineers
SureScreen Scientifics Division Ltd, Morley Retreat, Church Lane, Morley, Derbyshire, DE7 6DE, UK
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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
FK178	Ardcloony River, Ardcloony Bridge (B3)	ITM567508 669243	Pass	Pass	Pass	Negative	0/12
FK302	Broadford River (A16)	ITM555671 673483	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
FK178	Ardcloony River, Ardcloony Bridge (B3)	ITM567508 669243	Pass	Pass	Pass	Negative	0/12
FK302	Broadford River (A16)	ITM555671 673483	Pass	Pass	Pass	Negative	0/12

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

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

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METHODOLOGY

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

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

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

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

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

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INTERPRETATION OF RESULTS

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

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

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

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

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

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

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

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

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