APPENDIX 6-3

AQUATIC SURVEY REPORT

Aquatic baseline report for Lemanaghan Wind Farm, Co. Offaly

Triturus

Prepared by Triturus Environmental Ltd. for MKO

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1. Introduction

1.1 Background

Triturus Environmental Ltd. was commissioned by MKO to conduct baseline aquatic surveys to inform EIAR preparation for the proposed Lemanaghan Wind Farm (hereafter referred to as the Proposed Project). The Proposed Project is located approximately 3 kilometres (km) northeast of Ferbane and approximately 2.5 km southwest of the village of Ballycumber in Co. Offaly. 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. The surveys serve to update the previous aquatic and fisheries survey work undertaken during August 2021 (Triturus, 2022) to contemporise the data.

Undertaken on a catchment-wide scale, the baseline surveys focused on aquatic habitats in relation to fisheries potential (including both salmonid and lamprey habitat), white-clawed crayfish (*Austropotamobious pallipes*), macro-invertebrates, macrophytes and aquatic bryophytes, aquatic invasive species, and fish of conservation value which may use the watercourses in the vicinity of the proposed project. Aquatic surveys were undertaken during September 2024.

The *n*=16 aquatic survey sites were located within the Brosna_SC_060 and Shannon [Lower]_SC_010 river sub-catchments. Whilst not located within a European site, the Proposed Project site (via several watercourses) shared downstream hydrological connectivity with the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096).

1.2 Project referencing

The Proposed Project will be known as Lemanaghan Wind Farm and for the purposes of the EIAR:

- Where the 'Proposed Project' is referred to this encompasses the entirety of the project for the purposes of this EIA in accordance with the EIA Directive. The Proposed Project is described in detail in Chapter 4 of this EIAR.
- Where the 'Proposed Wind Farm' is referred to, this refers to turbines and associated foundations and hard-standing areas, meteorological mast, access roads, temporary construction compounds, underground cabling, peat and spoil management, borrow pits, site drainage, biodiversity enhancement, amenity, turbine delivery route and associated junction accommodation works, and all ancillary works and apparatus. The Proposed Wind Farm is described in detail in Chapter 4 of the EIAR.
- Where the 'Proposed Grid Connection' is referred to, this refers to the onsite 220kV substation, wind farm control building, associated temporary construction compound, overhead line to connect to the existing Shannonbridge-Maynooth 220kV OHL, temporary access track, proposed new lattice loop-in/loop-out masts and existing lattice loop-in/loop-out mast, crane pads, tower pads and all ancillary works and apparatus. The Proposed Grid Connection is described in detail in Chapter 4 of the EIAR.
- Where the 'Proposed Project site' or 'site' is referred to, this relates to the primary study area for the EIAR, as delineated by the EIAR Site Boundary

1.3 Project description

A full description of the proposed project is provided in the accompanying EIAR.

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the Proposed Project were considered as part of the current assessment. A total of *n*=13 riverine and *n*=3 pond 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) mapping.

Aquatic survey sites were present on the on the Ballynahown River (aka The Brook; EPA code: 26B17), Fortified House Castlearmstrong Stream (26F69), Lemanaghan Stream (26L04), River Brosna (26B09), Kilcolgan Beg Stream (26Q21) and Ferbane Stream (26F31) (**Table 2.1**). The *n*=16 aquatic survey sites were located within the were located within the Brosna_SC_060 and Shannon [Lower]_SC_010 river sub-catchments.

The Proposed Project and all associated infrastructure are not located within a European Site, although downstream hydrological connectivity exists with the River Shannon Callows SAC (000216) and the Middle Shannon Callows SPA (004096) via the Ballynahown and Brosna Rivers.

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

2.2 Aquatic site surveys

Surveys of the watercourses within the vicinity of the Proposed Project sitewere conducted in September 2024. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (see **Figure 2.1** above). Surveys at each of these sites included a fisheries assessment (electro-fishing, habitat appraisal), white-clawed crayfish, macrophyte & aquatic bryophyte surveys and (where suitable) biological water quality sampling (Q-sampling at riverine sites) (**Figure 2.1**). The survey approach ensured that any habitats and species of high conservation value would be detected to best inform mitigation for the Proposed Project.

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

Table 2.1 Summary of *n*=16 aquatic survey sites in the vicinity of the Proposed Project site

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
Riverine sites					
A1	Ballynahown River	26B17	Togher	612333	731145
A2	Ballynahown River	26B17	N62 road crossing	610071	733463
B1	Fortified House Castlearmstrong Stream	25F69	Killaghintober	615951	730348
B2	Fortified House Castlearmstrong Stream	25F69	Castlearmstrong	617922	729779
B3	Fortified House Castlearmstrong Stream	25F69	Leabeg	619448	729218
B4	Lemanaghan Stream	25L04	Straduff	615356	728152
B5	Lemanaghan Stream	25L04	Lemanaghan	616165	728024
B6	Lemanaghan Stream	25L72	Lemanaghan	617915	727642
B7	Lemanaghan Stream	25L04	L3002 road crossing	618261	726263
B8	River Brosna	25B09	Pollagh	618958	725725
B9	Kilcolgan Beg Stream	25Q21	L3002 road crossing	616152	724877
B10	River Brosna	25B09	Kilcolgan Bridge	614902	723767
B11	Ferbane Stream	25F31	Ferbane	612154	724601
Lacustrine sites					
P1	Pond	n/a	Cornafurrish & Corrabeg	618519	729576
P2	Pond	n/a	Cornafurrish & Corrabeg	618537	729549
P3	Pond	n/a	Cornafurrish & Corrabeg	618560	729522

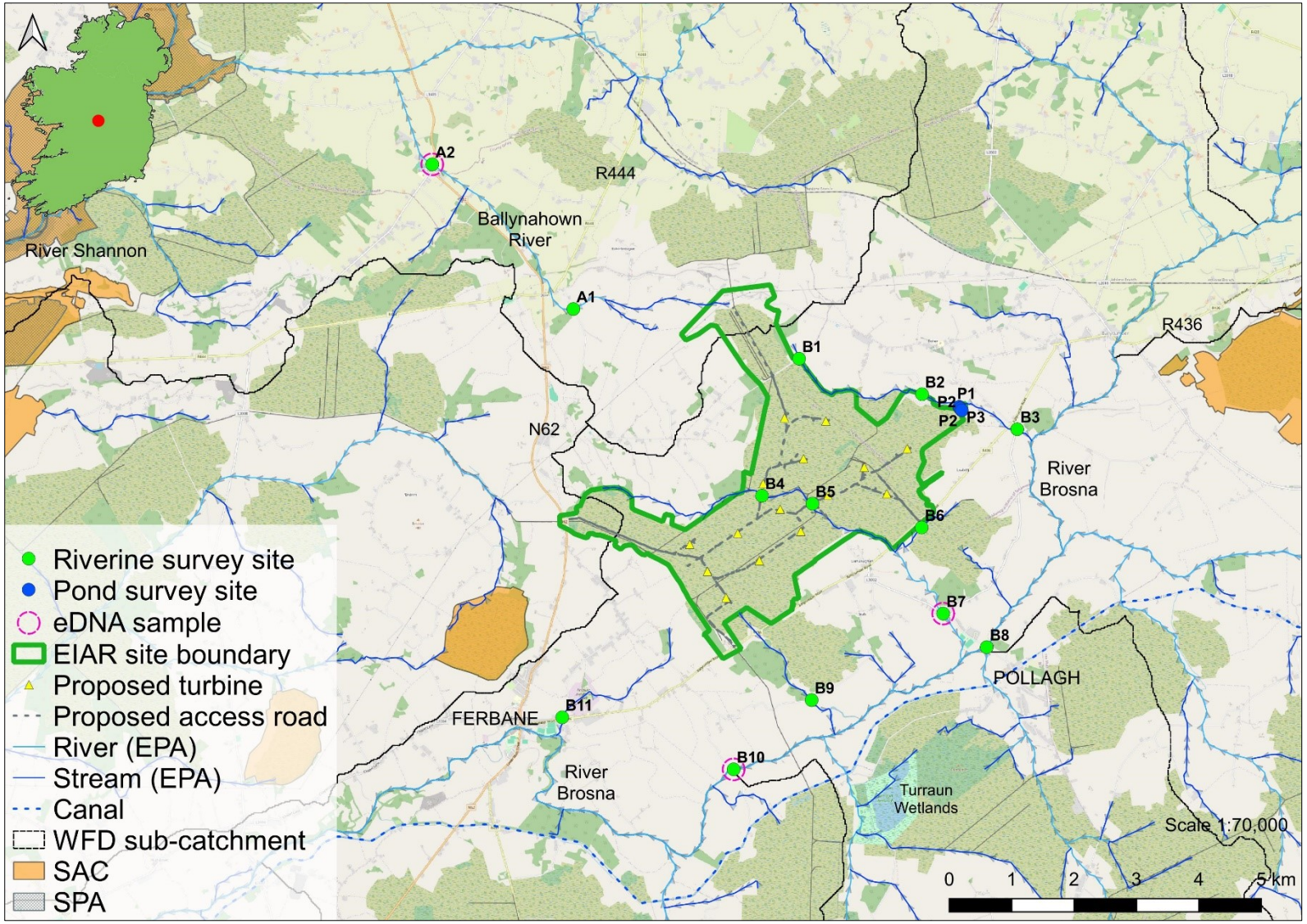

Figure 2.1 Overview of the *n*=16 aquatic survey site locations for the Proposed Project site

2.3 Catchment-wide electro-fishing

A catchment-wide electro-fishing (CWEF) survey of the watercourses within the vicinity of the Proposed Project site (*n*=13 riverine sites, **Figure 2.1**) was conducted between the 18th-19th September 2024, under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) licence. The survey was undertaken in accordance with best practice (CEN, 2003; CFB, 2008) and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the watercourses in the vicinity of the Proposed Project site (**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 or holding habitat for salmonids and lamprey within the vicinity of the survey sites. Please note electro-fishing was not possible on the *n*=3 pond sites. The ponds were subject to a fisheries appraisal and also included eDNA sampling. For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A.**

2.4 White-clawed crayfish survey

White-clawed crayfish (*Austropotamobius pallipes*) surveys were undertaken at the aquatic survey sites in September 2024 under a National Parks and Wildlife (NPWS) open licence (no. C20/2024), as prescribed by Sections 23 and 34 of the Wildlife Act (1976-2021), to capture and release crayfish to their site of capture. As per Inland Fisheries Ireland (IFI) 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 transfer 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 habitat attributes (Gammell et al., 2021; Peay, 2003), water chemistry and incidental records in mustelid spraint. Additionally, a desktop review of crayfish records within the wider survey area was completed.

2.5 eDNA analysis

To further validate site surveys and to detect potentially cryptically low populations of protected and or rare aquatic species within the study area, composite water samples were collected from the Ballynahown River (site A2), Lemanaghan Stream (B7), River Brosna (B10) and pond sites P1, P2 and P3 in September 2024 (**Figure 2.1; Table 2.1**). The riverine samples were analysed for freshwater pearl mussel (*Margaritifera margaritifera*), white-clawed crayfish and crayfish plague (*Aphanomyces astaci*). The pond samples were analysed for brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), white-clawed crayfish and smooth newt (*Lissotriton vulgaris*) environmental DNA (eDNA).

In accordance with laboratory guidance, 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 and fixed on site using a sterile proprietary eDNA sampling kit. The sample was stored at room temperature and sent to the laboratory for analysis with 48 hours of collection. A total of *n*=12 qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR

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

2.6 Biological water quality (Q-sampling)

The aquatic survey sites were assessed for biological water quality through Q-sampling in September 2024. Site B6 was dry at the time of survey and, thus, it was not possible to collect a biological water sample at this location. Therefore, a total of *n*=12 sites were sampled for biological water quality (i.e., sites A1, A2, B1, B2, B3, B4, B5, B7, B8, B9, B10 & B11; **Figure 2.1).**

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

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

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 Lacustrine macro-invertebrate communities

Pond sites P1, P2 and P3 were sampled for macro-invertebrates via sweep netting. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats.

2.8 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the survey sites, with specimens collected (by hand or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species listed under the Flora (Protection) Order, 2022, Irish Red list for vascular plants (Wyse-Jackson et al.,

2016) and or aquatic bryophytes (Lockhart et al., 2012), 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').

2.9 Otter signs

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

2.10 Aquatic ecological evaluation

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

2.11 Biosecurity

A strict biosecurity protocol including IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Particular cognisance was given towards preventing the spread or introduction of crayfish plague (*Aphanomyces astaci*) given the known distribution of white-clawed crayfish (*Austropotamobius pallipes*) in the wider survey area. 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 Survey area description

The Proposed Project is located in an area of cutover blanket bog (Lemanaghan Bog) in north-west Co. Offaly, approximately 4km north-east of Ferbane (**Figure 2.1**). The Proposed Wind Farm is within the Shannon River Basin District and within hydrometric area 26 (Upper Shannon). The aquatic survey sites were located within the Brosna_SC_060 and Shannon [Lower]_SC_010 river sub-catchments (**Figure 2.1**). The following watercourses drained the Proposed Wind Farm: Ballynahown River (aka The Brook; 26B17), Fortified House Castlearmstrong Stream (26F69), Lemanaghan Stream (26L04), River Brosna (26B09), Kilcolgan Beg Stream (26Q21) and Ferbane Stream (26F31) (**Table 2.1**).

The watercourses and aquatic surveys sites in the vicinity of the Proposed Project site were typically small, lowland depositing channels (FW2; Fossitt, 2000) and peat drainage ditches (FW4). Section 4 of this report provides comprehensive details of nature of each aquatic survey area. Land use practices in the wider survey area were of peatland bogs (CORINE 412) or bordered by pastures (231). Predominantly, the watercourses flowed over areas of Carboniferous limestone and shale (Geological Survey of Ireland data).

3.2 Fisheries

The River Brosna rises in Lough Ennell near Mullingar in Co. Westmeath and is a major tributary of the River Shannon. The Brosna catchment is calcareous but also contains one of the largest areas of peat bog and peat harvesting in the country, resulting in a major influx of peat silt and sediment into the river (O'Reilly, 2009). In addition, the Brosna catchment has been arterially drained. The river is noted for having good stocks of brown trout (*Salmo trutta*) and coarse fish and is thus a popular angling destination (O'Reilly, 2009). The Brosna is known to support a range of fish species including Atlantic salmon (*Salmo salar*), brown trout, European eel (*Anguilla anguilla*), *Lampetra* sp., roach (*Rutilus rutilus*), perch (*Perca fluviatilis*), pike (*Esox lucius*), gudgeon (*Gobio gobio*), minnow (*Phoxinus phoxinus*), bream (*Abramis brama*) and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2015, 2010).

Brown trout and lamprey (*Lampetra* sp.) were recorded during the 2021 electro-fishing surveys (Triturus, 2022) from the Ballynahown River and Fortified House Castlearmstrong Stream. Three-spined stickleback was the only fish species recorded from the Ferbane Stream in 2021.

Fisheries data for the other watercourses within the survey area was not available at the time of survey. However, the Boor River, to which the Ballynahown River connects, is known to support brown trout, Atlantic salmon, *Lampetra* sp., perch, roach, gudgeon, minnow, stone loach, three-spined stickleback and European eel (Kelly et al., 2014, 2010).

3.3 Protected aquatic species data

Records for white-clawed crayfish (*Austropotamobius pallipes*) are widespread within the respective 10km grid squares and were available for numerous watercourses including the Boor River, Clodiagh River, River Brosna, Pollagh Stream, Silver River and Grand Canal (**Figure 3.1**). However, the bulk of these records were historical only (i.e. 1978-2005). Only a low number of contemporary records (2008-

2014) were available and these were primarily for the Boor River, Ballynahown River, Boora River and the River Blackwater. A single (adult) crayfish was recorded on the Ballynahown River at survey site A1 during the previous 2021 survey (Triturus, 2022).

Records for Annex II otter (*lutra lutra*) were also widespread throughout the relevant grid squares, with contemporary records available for several watercourses including the Boor River, Blackwater River, River Shannon and Grand Canal (**Figure 3.1**; 2010-2018 period). Most records available for the respective grid squares were historical only (i.e. 1980-1982, data not shown). No otter signs were recorded in the vicinity of the Proposed Project during the previous 2021 aquatic surveys (Triturus, 2022).

The Red-listed duck mussel (*Anodonta anatina*), listed as vulnerable in Ireland (Byrne et al., 2009), was recorded on the Fortified House Castlearmstrong Stream (current site B3) and the Lemanaghan Stream (between current sites B4 & B5) during previous aquatic surveys in September 2021 (Triturus, 2022).

A low number of smooth newt (*Lissotriton vulgaris*) records were available for the N12 10km grid squares in Bord na Móna wetlands at Turraun and Finnamores Lakes (NBDC data; 2010-2012 period).

Furthermore, a review of the NPWS Flora Protection Order bryophytes database did not uncover any known records of protected aquatic bryophytes in the study area. However, the Flora (Protection) Order, 2022 macrophyte species opposite-leaved pondweed (*Groenlandia densa*) is known from the Grand Canal near Tullamore (10km grid square N22) for the 1992-1993 period.

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the Proposed Project. Only recent water quality (i.e. since 2015) is summarised below. There were no existing EPA biological monitoring data available for the Ballynahown River (aka The Brook; 26B17), Fortified House Castlearmstrong Stream (26F69), Lemanaghan Stream (26L04), Kilcolgan Beg Stream (26Q21) or Ferbane Stream (26F31).

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

3.4.1 River Brosna

The River Brosna (26B09) flowed to the east and then south of the site before joining the River Shannon near Shannon Harbour, approx. 22km downstream of aquatic survey site B8 (L3002 road bridge). The River Brosna achieved Q3-4 (moderate status) at this road bridge (station RS25B090760) in 2013. Upstream of any potential hydrological pathways from the Proposed Project, at Ballycumber Bridge (station RS25B090700), the river also achieved Q4 (good status) in 2023. At stations RS25B090800 (near Kilcolgan) and RS25B090950 (Ferbane Bridge), i.e. downstream of the Proposed Project, the Brosna also achieved Q4 (good status) at both stations in 2023.

Overall, much of the Brosna was of moderate WFD status in the 2016-2021 period and was considered 'at risk' of not achieving good status at the time of writing of this report (i.e. Brosna_100, Brosna_110

& Brosna_120). Water quality risks were primarily from hydromorphology and agriculture (sediment) (EPA, 2024).

No biological water quality data was available for the Ballynahown River. However, the downstream connecting Boor River (station RS26B071200) achieved moderate status (Q3-4) biological water quality in 2023. Despite an absence of biological water quality monitoring stations, the Ballynahown River (part of the Boor_020 sub-catchment) achieved moderate WFD status in the 2016-2021 period but was considered 'not at risk' according to the EPA.

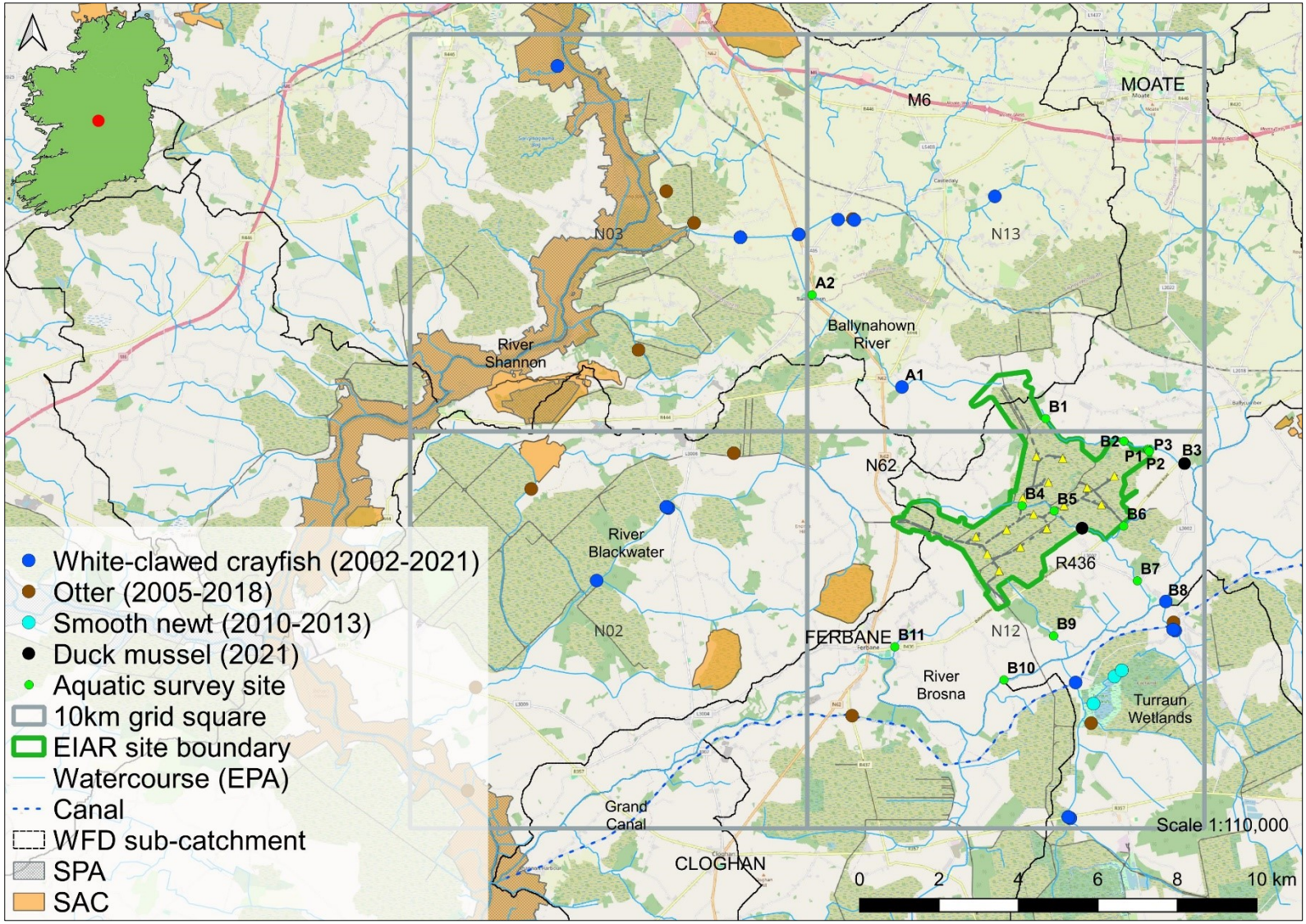

Figure 3.1 Distribution of selected protected aquatic species records in the vicinity of the Proposed Project (source: Triturus, NPWS & NBDC data)

4. Results of aquatic surveys

The following section summarises each of the *n*=16 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 (*n*=13) and summarised in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in September 2024. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.4**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Ballynahown River, Togher

Site A1 was located on the Ballynahown River (EPA code: 26B17) at a local road crossing. The channel had been historically straightened and over-deepened upstream and downstream of the road crossing, with bankfull heights of 3m. The steep U-shaped soil banks were scrubbed over with bramble (*Rubus fruticosus*, nettle (*Urtica dioica*) and rosebay willowherb (*Chamaenerion angustifolium*) (**Plate 4.1**). The channel was 1.5-2m wide and 0.1-0.3m deep, with shallow glide and pool. Riffle areas were rare given historical dredging. The survey site suffered from gross siltation, with deep deposits of up to 0.3m present. Superficial fine to medium gravels were present but heavily bedded in clay and silt. Underneath the fine sediment layers some localised gravels and small cobble were present. Boulders were occasional. Upstream of the bridge, the river was very heavily vegetated with abundant lesser water parsnip (*Berula erecta*) and fool's watercress (*Helosciadium nodiflorum*) (>95% cover). Branched bur-reed (*Sparganium erectum*) was recorded as rare. However, downstream, the river was heavily tunnelled by a hawthorn (*Crataegus monoygna*), blackthorn (*Prunus spinosa*), willow (*Salix* sp.), sycamore (*Acer psuedoplatanus*) and ash (*Fraxinus excelsior*) treeline which precluded the presence of macrophytes apart from localised fool's watercress and yellow iris (*Iris psuedacorus*) along the channel margins. Aquatic bryophytes were not recorded. The riparian zones were heavily scrubbed and shaded. The adjoining land use was improved agricultural grassland (GA1).

Three-spined stickleback (*Gasterosteus aculeatus*) were the only fish species recorded via electro-fishing from site A1 (**Appendix A**). With the exception of low densities of this species, the river was of very low fisheries value at this location given significant siltation pressures. There was no salmonid nursery or spawning value due to siltation of substrata. However, despite some low suitability for European eel, none were recorded (few deep pools or refugia present). The clay banks provided some burrowing habitat for white-clawed crayfish, although only two adults were recorded (c.30 refugia identified and searched). No otter signs were recorded in 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 presence of white-clawed crayfish, the aquatic ecological evaluation of site A1 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.1 Representative image of site A1 on the heavily modified Ballynahown River, September 2024

4.1.2 Site A2 – Ballynahown River, N62 road crossing

Site A2 was located on the Ballynahown River (26B17) at the N62 road crossing approx. 3.4km downstream from site A1. The river at this location had been historically straightened and deepened, with steep bank heights of 3-4m. The V-shaped channel was 3m wide and 0.1-0.2m deep with only very localised shallow pool to 0.6m max. Shallow homogenous glide predominated with localised riffles near the bridge apron (cobble) and in association with instream large woody debris (LWD). The substrata comprised frequent small patches of fine to medium superficial gravels with only very localised cobble and small boulder. These larger substrata were invariably bedded/compacted due to siltation and moderate flows. Although the survey site was heavily silted, the flow resulted in only moderate siltation of the gravels. Soft sediment beds were abundant along channel margins (good lamprey habitat). The survey site was heavily shaded (not tunnelled) by mature riparian treelines and macrophytes were limited to very localised watercress (*Nasturtium officinale*) and fool's watercress in more open areas of channel., with rare branched bur-reed. Aquatic bryophytes were limited to very occasional semi-aquatic liverwort *Pellia endiviifolia* and the moss *Cinclidotus fontinaloides* on tops of boulders. The survey site was bordered by improved agricultural grassland (GA1) on both banks with mature treelines of sycamore, hawthorn, ash and beech (*Fagus sylvatica*).

A total of three fish species were recorded via electro-fishing from site A2 (**Appendix A**). Brown trout (*Salmo trutta*) dominated the survey site, with a relatively high number of juveniles present in addition to a small number of adults. *Lampetra* sp. ammocoetes were recorded at a low density of 2 per m^2 in flocculent soft sediment habitat. A low density of three-spined stickleback was also captured (*n*=2). The survey site provided moderate quality salmonid nursery habitat, with the value being reduced by considerable siltation pressures inclusive of historical drainage pressures. Spawning habitat was present but rare and compromised by siltation. Holding habitat was limited, and this was reflected in the paucity of adult salmonids. Some good quality lamprey ammocoetes burial habitat was present

along the channel margins. However, lamprey spawning habitat was localised and compromised by siltation. European eel habitat was poor overall and none were recorded. Despite some suitability (clay banks for burrowing, macrophytes and boulder refugia etc.), no white-clawed crayfish were recorded. No otter signs were recorded in 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 presence of a salmonid population and *Lampetra* sp., the aquatic ecological evaluation of site A2 was of **local importance (higher value) (Table 4.4).**

Plate 4.2 Representative image of site A2 on the Ballynahown River, September 2024

4.1.3 Site B1 – Fortified House Castlearmstrong Stream, Killaghintober

Site B1 was located on the uppermost reaches of the Fortified House Castlearmstrong Stream (25F69). The stream had been straightened and over-deepened historically with bankfull heights of 2-3m in a steep, near vertical-sided channel. The stream was heavily peat-stained at the time of survey with frequently exposed peat banks. The stream was 1.5m wide and 0.2-0.5m deep, with localised deep pool to >1m downstream of the road culvert. Slow-flowing glide and pool predominated with only very localised riffle present immediately downstream of the culvert. The stream was heavily silted (peat) and the substrata were dominated by silt. Occasional boulders were present (exposed during historical excavation). An area of fine to medium gravels was present in vicinity of the culvert but these were heavily silted. The stream was heavily shaded and tunnelled and, as a result, macrophyte and aquatic bryophyte growth was absent. The survey site was bordered by improved agricultural grassland (GA1) to the east with cutover bog (PB4) to the west. The riparian zone supported dense scrub (WS1) with an intermittent willow-dominated treeline along the west bank.

Three-spined stickleback were the only fish species recorded via electro-fishing at site B1 (**Appendix A**). With the exception of low densities of this species, the survey site was of very low fisheries value at this location given low flows and significant siltation pressures. Despite the presence of very localised gravels near the culvert, there was no salmonid nursery or spawning value. There was some low suitability for European eel but the species was not recorded. There was no suitability for white-clawed crayfish and the species was not recorded. No otter signs were recorded in 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 species or habitats of high conservation value, , the aquatic ecological evaluation of site B1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.3 Representative image of site B1 on the Fortified House Castlearmstrong Stream, September 2024

4.1.4 Site B2 – Fortified House Castlearmstrong Stream, Castlearmstrong

Site B2 was located on the Fortified House Castlearmstrong Stream (25F69) c. 2.4km downstream of site B1. The stream flowed through a disused quarry (ED3) and had been straightened and deepened historically. Bank heights were 3-4m. The stream, however, demonstrated some localised recovery. The stream was 2-2.5m wide and 0.2-0.3m in depth, with localised deeper pool to 0.6m. Slow-flowing glide predominated with frequent pool areas (often near stagnant). The substrata were dominated by fine to medium gravels which were moderately to heavily silted (depending on local flows). Cobble and small boulder was present but rare. Some areas of the stream were vegetated and the majority of the channel featured deep peat deposits. Fool's watercress and branched bur-reed were occasional. The riparian areas were heavily scrubbed, being dominated by bramble (*Rubus fruticosus* agg.) with willow and hawthorn. Riparian shading was high. Locally, the channel margins also supported well-

developed herbaceous layer of great willowherb (*Epilobium hirsutum*), water mint (*Mentha aquatica*), meadowsweet (*Filipendula ulmaria*) and other calcicolous species such as wild carrot (*Daucus carota*).

Three-spined stickleback and *Lampetra* sp. ammocoetes were the only two fish species recorded via electro-fishing at site B2 (**Appendix A**). Ammocoetes were present at low densities (2 per m^2 targeted habitat). The survey site was evidently not of value as a salmonid habitat (none recorded), although there was some low suitability as a nursery habitat. The survey site was, however, of moderate value to *Lampetra* sp., with a low density present in peat-dominated. Lamprey spawning habitat was present but highly localised near faster flowing pockets of water. Despite some suitability, no European eel or white-clawed crayfish were recorded. No otter signs were recorded in 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 presence of *Lampetra* sp., the aquatic ecological evaluation of site B2 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.4 Representative image of site B2 on the Fortified House Castlearmstrong Stream, September 2024

4.1.5 Site B3 – Fortified House Castlearmstrong Stream, Leabeg

Site B3 was located on the Fortified House Castlearmstrong Stream (25F69) c. 1.7km downstream of site B2, at a local road crossing (pipe culvert). The lowland depositing watercourse (FW2) had been historically deepened and straightened although some semi-natural sinuosity remained. The channel was 2.5-3m wide and 0.2-0.4m deep with only very localised shallow pool to 0.5m.. Shallow, slow-flowing glide dominated with localised riffle near the bridge. Downstream and upstream the stream was slower-flowing given heavy siltation and profuse macrophyte growth. The substrata were dominated by silt (high clay fractions and some peat) with superficial and scattered patches of fine to

medium gravels. Small cobble and small boulder were occasional and bedded in silt/clay. The substrata were also bedded in general. Soft sediment areas were frequent along the channel margins and these supported excellent ammocoete habitat. Macrophyte coverage was high. Branched bur reed and water mint were frequent, with occasional small stands of water starwort *(Callitriche* sp.) and water plantain (*Alisma plantago-aquatica*). Greater duckweed (*Spirodela polyrhiza*) was occasional. Watercress was frequent along channel margins. Despite historical dredging and more recent bank clearance works along the channel (north bank), the channel margins supported a well-developed herbaceous layer composed of great willowherb, meadowsweet, water mint, purple loosestrife (*Lythrum salicaria*), hedge bindweed (*Calystegia sepium*), angelica (*Angelica sylvestris*) and reed canary grass (*Phalaris arundinacea*). Despite its small extent, this community was considered to be representative of the Annex I habitat 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]' based on the presence of multiple indicator species (EC, 2013; Devaney et al., 2013). An intermittent treeline of ash, willow, sycamore and hawthorn lined the south bank (had been cleared from north). The survey site was bordered by improved pasture (GA1) and a residential property.

Three fish species (brown trout, lamprey and three-spined stickleback) were recorded via electro-fishing from site B3 (**Appendix A**). Despite having poor hydromorphology given historical drainage with poor flow heterogeneity and bed condition the channel supported a low density brown trout population. Localised poorer quality spawning habitat existed immediately downstream of the road culvert that provided enough spawning to support the low density but mixed cohort trout population. The stream supported enough summer flows in localised riffle habitat and water depth to provide some nursery conditions for juvenile trout as reflected by the presence of a lower density of 0+ fish. While the stream had some suitability for eel (i.e. vegetated and shaded with ample prey resources) the species was not recorded present. A low density lamprey (*Lampetra* sp.) population was also recorded. There was both localised spawning habitat and lamprey ammocoete burial habitat present. However, bed compaction, a higher clay component in the substrata and the historical channel drainage impacts created poorer conditions for the species. No white-clawed crayfish were recorded, despite some suitability (poor number of refugia present). A low number of Red-listed duck mussel (*Anodonta anatina*) (Byrne et al., 2009) were recorded from areas of superficial gravel/silt (hand searching & sweep netting). No otter signs were recorded in 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 the Annex I habitat 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]', the aquatic ecological evaluation of site B3 was of **county importance** (**Table 4.4**).

Plate 4.5 Representative image of site B3 on the Fortified House Castlearmstrong Stream, September 2024

4.1.6 Site B4 – Lemanaghan Stream, Straduff

Site B4 was located on the uppermost reaches of the Lemanaghan Stream (25L04), in an area of cutover bog (PB4). The stream at this location represented a peat drainage channel (FW4) that had been extensively straightened and deepened historically. The channel was 2m wide (widening downstream) and between 1.5m-2m deep. The channel had a deep U-shaped profile with 4m high banks. The flow profile was of very slow moving deep glide and pool. The bed comprised of extensive soft peat. The channel supported no macrophytes given deep peat stained water. The channel riparian areas supported dense bramble, gorse, bracken with grey willow.

The deep peat stained water and very heavy shading created very poor conditions for fish. Therefore, the channel was not considered of fisheries value apart from supporting a low density of three-spined stickleback (**Appendix A**). The stream was not of value to white-clawed crayfish given gross siltation (from peat) and limited flows. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given poor flows and an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value,, the aquatic ecological evaluation of site B4 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.6 Representative image of site B4 on the upper reaches of the Lemanaghan Stream, September 2024

4.1.7 Site B5 – Lemanaghan Stream, Lemanaghan

Site B5 was located on the Lemanaghan Stream (25L04) c. 3.9km downstream of site B4, adjacent to an area of cutover bog within the EIAR site boundary. As per upstream, the stream had been extensively straightened and deepened, historically, with steep bank heights of 3-6m. The stream represented a slow-flowing lowland depositing watercourse (FW2), of variable width 1-5m wide and on average >1m deep. The substrata were 100% deep peat, with high peat-staining at the time of survey. The channel flowed through a narrow pipe culvert underneath a bog access track (the 'Offaly Way'). No submerged macrophytes were recorded although localised emergent common reed (*Phragmites australis*) and branched bur-reed were present. Bog cotton (*Eriophorum angustifolium*), bottle sedge (*Carex rostrata*) and bog pondweed (*Potamogeton polygonifolius*) and water mint were recorded as rare. Aquatic bryophytes were absent. The channel was largely open with only scattered willow and common reed along the channel, in addition to scrubbed-over banks supporting scrub (WS1) and dry meadows and grassy verge (GS2) habitats. The survey site drained and was bordered by cutover bog (PB4) to the north, with improved agricultural grassland (GA1) downstream, to the west.

Site B5 was too deep for safe or effective electro-fishing (not undertaken). Based on a fisheries appraisal, the site was of little value to salmonids given the slow flows and heavily silted (peat) nature. The channel had some moderate value as an eel nursery area. Given the low flows and peat-dominated substrata, there was no value for lamprey. White-clawed crayfish suitability was low and none were recorded. A low number of Red-listed duck mussel (Byrne et al., 2009) were recorded during searching and sweep netting. Common frog (*Rana temporaria*) were recorded in the channel and in adjoining areas. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given poor flows and an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of common frog and Red-listed duck mussel, the aquatic ecological evaluation of site B5 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.7 Representative image of site B5 on the Lemanaghan Stream, September 2024

4.1.8 Site B6 – Lemanaghan Stream, Lemanaghan

Site B6 was located on the Lemanaghan Stream (25L04), a heavily modified artificial peatland drainage channel (FW4) that was 2m wide with 2m high banks. The channel had a deep U-shaped profile with a dry peat base. The channel contained no water at the time of the survey and was therefore a seasonal waterbody. The riparian areas supported mature downy birch (*Betula pubescens*) with dense bramble and bracken (*Pteridium aquilinum*) in the understories. Given the seasonal nature of the channel it was not of fisheries or aquatic value. No otter signs were recorded in vicinity of the site.

It was not possible to collect biological water quality data due to the dry nature of the channel. Given the seasonal nature of the channel with low aquatic value it was of **local importance (lower value)** (**Table 4.4**).

Plate 4.8 Representative image of site B6 on the Lemanaghan Stream, September 2024 (dry channel)

4.1.9 Site B7 – Lemanaghan Stream, L3002 road crossing

Site B7 was situated on the Lemanaghan Stream (25L04) at the L3002 road crossing. At this location the stream was a heavily modified 2m wide channel with 2-2.5m high banks. The channel was deep U-shaped (being historically deepened and straightened) and was between 0.2-0.6m deep. The flow profile was of very slow flowing glide and pool. The bed had patches of mixed coarse gravel with frequent pockets of silt. The bed was heavily compacted overall with high siltation. The channel supported abundant macrophytes. This included frequent branched bur-reed with occasional common water starwort (*Callitriche stagnalis*), blue-water speedwell (*Veronica anagallis-aquatica*), water mint, fool's watercress and common duckweed (*Lemna minor*). The channel riparian zone supported mainly dense scrub comprising of bramble, hedge bindweed (*Calystegia sepium*), nettle, hedge woundwort (*Stachys sylvatica*), reed canary grass (*Phalaris arundinacea*), hogweed (*Heracleum sphondylium*) and great willowherb (*Epilobium hirsutum*).

Brown trout, three-spined stickleback and minnow (*Phoxinus phoxinus*) were recorded via electro-fishing at site B7 (**Appendix A**). Despite having poor hydromorphology given historical drainage with poor flow heterogeneity and bed condition, the channel supported a low density brown trout population. It is likely that some localised upstream spawning habitat exists capable of supporting the low density but mixed cohort trout population. The stream supported enough flow and water depth to provide some nursery conditions for juvenile trout as reflected by the presence of a low density of 0+ fish. The bed was too compacted to support lamprey and the species was not recorded present. While the stream had some suitability for eel (i.e. deep, vegetated and with ample prey resources) the species was not recorded present. The stream also had some moderate suitability for crayfish given ample depth with macrophyte refugia. However, no crayfish were recorded present. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). However, it should be noted that this was a tentative rating given poor flows and an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a small brown trout population, the aquatic ecological evaluation of site B6 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.9 Representative image of site B7 on the Lemanaghan Stream, September 2024

4.1.10 Site B8 – River Brosna, Pollagh Bridge

Site B8 was located on the River Brosna (25B09) at Pollagh Bridge on the L3002 road. The large, lowland depositing river (FW2) had been extensively straightened and deepened historically with flood embankments present on both banks. The river was 25-30m wide and 1.8-2.5m deep at this location, with localised deeper glide. The substrata were dominated by softer substrata with high clay fractions (exposed clay on banks) and occasional boulders. Moderate-flowing glide predominated with no shallower riffle areas present. Depositional areas (marginal slacks) were common. The canalised river supported occasional beds of clubrush (*Schoenoplectus lacustris*) with frequent marginal beds of branched bur-reed and unbranched bur-reed (*Sparganium emersum*). Slacks supported scattered yellow lily (*Nuphar lutea*), water starwort (*Callitriche* sp.), water speedwell (*Veronica* sp.), perfoliate pondweed (*Potamogeton perfoliatus*) and, rarely, mare's-tail (*Hippuris vulgaris*). Given the fragmented nature of this community, it was not considered representative of the Annex I floating river vegetation habitat (3260). The margins were lined by reed canary grass and occasional reed sweet grass (*Glyceria maxima*), with water pepper (*Persicaria hydropiper*) also on the paludal areas. In terms of aquatic bryophytes, some *Fontinalis antipyretica* was visible on the exposed bridge apron/arches. The survey site was bordered by improved agricultural grassland (GA1) on both banks, with a broadleaf plantation (WS2) upstream on the east bank.

Site B8 was too deep for safe or effective electro-fishing (not undertaken). Based on a fisheries appraisal, the survey site was of most value as a coarse fish habitat, with species such as roach (*Rutilus rutilus*), perch (*Perca fluviatilis*) and pike (*Esox lucius*) known from the river (Kelly et al., 2015, 2010). Macrophyte beds provided good-quality coarse fish nursery and spawning habitat. Minnow were observed in the channel margins. Brown trout were likely present but the value was low overall given the predominance of deep, depositional glide. The survey site was of considerable value as a European eel habitat. Suitability for white-clawed crayfish was moderate but despite historical records for this site (from 2002) no crayfish were recorded via sweep netting or hand searching. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the high regional value of the River Brosna as an ecological corridor, the aquatic ecological evaluation of site B8 was of **county importance** (**Table 4.4**).
(**Table 4.4**).

Plate 4.10 Representative image of site B8 on the River Brosna, September 2024 (facing downstream from bridge)

4.1.11 Site B9 – Kilcolgan Beg Stream, L3002 road crossing

Site B9 was located on the upper reaches of the Kilcolgan Beg Stream (25Q21) in an area of cutover bog, c. 0.2km upstream of the R436 road crossing. The stream had been straightened and over-deepened historically, with steep banks of up to 4m. The modified stream (FW2) averaged 1.5-2m wide and 0.1-0.2m deep, with very slow-flowing glide predominating. The channel was heavily silted (peat) with deep, flocculent deposits on the bed and no harder substrata present. Exposed clay and

some clay slumping from the banks was present. This created frequent blockages/dams to flow. Given high shading and high peat-staining, no macrophytes or aquatic bryophytes were recorded, with the exception of very localised emergent branched bur-reed. The channel riparian zone supported abundant mature crack willow (*Salix fragilis* agg.), hawthorn (*Crataegus monogyna*) and ash (*Fraxinus excelsior*). The understories supported bramble, reed canary grass, hedge bindweed, ivy, hedge woundwort, meadow buttercup (*Ranunculus acris*) and herb Robert (*Geranium robertianum*).

Three-spined stickleback were the only fish species recorded via electro-fishing at site B9 (**Appendix A**). Apart from low densities of this species, the channel was of very poor fisheries value due to high siltation, poor flows and the absence of hard substrata. The channel was too heavily modified with too poor hydromorphology to support salmonid fish (i.e. absence of swift moving riffle and glide) with heavy siltation. Fisheries value was significantly improved downstream towards the River Brosna confluence. There was poor suitability for white-clawed crayfish and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given poor flows and an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of species or habitats of high conservation value, , the aquatic ecological evaluation of site B9 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.11 Representative image of site B9 on the Kilcolgan Beg Stream, September 2024

4.1.12 Site B10 – River Brosna, Kilcolgan Bridge

Site B10 was located on the River Brosna (25B09) at Kilcolgan Bridge. The large, lowland depositing river (FW2) had been extensively straightened and deepened historically. The river averaged 20m wide

and between 1.8-2.5m deep (locally shallower 1m on bridge apron) at this location. The flow profile was dominated by deep glide with occasional deeper pool. No riffle habitat was present. The channel bed comprised of localised boulder, cobble and mixed gravels with extensive silt. The silty areas were compacted. The channel supported frequent heterophyllous clubrush with occasional water lily (*Nuphar lutea*), blue water speedwell, branched bur-reed, fool's watercress and water mint. The riparian areas comprised of mature osier, grey willow and hawthorn. The channel was bordered by improved grassland (GA1). The channel was predominantly a coarse fish habitat given the predominance of slow moving vegetated deep-glide and pool.

It was only possible to locally electro-fish the bridge apron where shallower 1m deep water existed (too deep elsewhere). Small numbers of gudgeon, stone loach and three-spined stickleback were captured (**Appendix A**). While small numbers of Atlantic salmon and brown trout are known from the River Brosna, historical drainage and associated poor hydromorphology has created poor spawning and nursery conditions for the species. While the channel had some localised suitability for lamprey (i.e. spawning and nursery) the species was not recorded present. The compacted nature of the bed created poorer nursery conditions for the species (i.e. compacted bed). However, local improved nursery conditions may exist downstream (e.g. pockets of improved burial habitat) and improved local spawning conditions. While not captured during electro-fishing, the River Brosna at site B10 was of also of good value as a European eel habitat given deep water and food resources. The River Brosna is known to support species such as roach (*Rutilus rutilus*), perch (*Perca fluviatilis*) and pike (*Esox lucius*) known from the river (Kelly et al., 2015, 2010). Suitability for white-clawed crayfish was assessed as moderate but no crayfish were recorded via sweep netting or hand searching. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). However, given the lack of suitable riffle areas for sampling this is a tentative Q-rating. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the high regional value of the River Brosna as an ecological corridor, the aquatic ecological evaluation of site B10 was of **county importance** (**Table 4.4**).

Plate 4.12 Representative image of site B10 on the River Brosna at Kilcolgan Bridge, September 2024

4.1.13 Site B11 – Ferbane Stream, Ferbane

Site B11 was located on the lower reaches of the Ferbane Stream (25F31) immediately upstream of the R436 road crossing, approx. 2km downstream of site B10. The stream (FW2) had been extensively straightened and deepened historically, with a deep U-shaped channel and bankfull heights of 2-2.5m. The stream flowed under the R436 road via a narrow pipe culvert. The stream was <1m wide and 0.05-0.1m deep. The flow profile was dominated by very slow flowing glide. The substrata were dominated by fine to medium gravels which were partially bedded and exposed to moderate siltation pressures. Cobble and boulder substrata were very occasional. The channel supported frequent fool's watercress with more localised wild angelica (*Angelica sylvestris*).The riparian zones supported occasional wych elm (*Ulmus glabra*) and ash. The channel was also densely encroached by bramble, hedge bindweed, great willowherb and nettle.

Three-spined stickleback were the only fish species recorded via electro-fishing at site B11 (**Appendix A**). With the exception of low densities of this species, the survey site was of very low fisheries value at this location given low flows and significant siltation pressures. Despite the presence of abundant gravels near the culvert, there was no salmonid nursery or spawning value given the very shallow nature of the watercourse at this location. Despite some low suitability, no European eel were recorded. There was limited suitability for white-clawed crayfish and the species was not recorded present. No otter signs were recorded in 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 species or habitats of high conservation value, , the aquatic ecological evaluation of site B11 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.13 Representative image of site B11 on the Ferbane Stream, September 2024

4.1.14 Site P1 – unnamed pond

Site P1 was a linear-shaped attenuation pond basin 0.175 hectares in size with very steep 3-4m high banks. The pond was 1.5-2m deep with moderately peat stained water. The pond had a silt base and supported abundant macrophytes including branched bur-reed, common water-plantain and water starwort (*Callitriche* sp.). The pond supported three-spined stickleback and brown trout that were observed during the site visit. The survey area also had moderate suitability for eel given ample prey resources and refugia in deep water. As the pond was also connected hydrologically to the Castlearmstrong Stream via an outfall it is accessible by European eel and brown trout. Both brown trout and eel were detected in the eDNA sample collected from the site (**Appendix C**). The pond has some moderate suitability for white-clawed crayfish but the species was not recorded during sweep sampling or via eDNA (**Appendix C**). Despite moderate suitability for smooth newt (*Lissotriton vulgaris*),i.e. weeded pond and steep banks, none were recorded during sweep netting or via eDNA sampling (**Appendix C**). No otter signs were recorded in vicinity of the site.

During sweep sampling carried out at the pond 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 brown trout and red-listed European eel the aquatic ecological evaluation of site P1 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.13 Representative image of site P1 (unnamed pond), September 2024

4.1.15 Site P2 – unnamed pond

Site P2 was a linear-shaped peat attenuation pond basin adjacent to pond P1. It was 0.155 hectares in size (slightly smaller than Pond P1). The pond was 1.5-2m deep with moderately peat stained water and had steep 3-4m high banks. The pond had a peat and silt base and was very similar in character to pond P1. It was bounded by dense growth of branched-bur reed that formed a full ring around the littorals of the pond circumference. The pond supported three-spined stickleback (captured in a sweep net) and brown trout were observed foraging for insects at the pond surface. The pond had moderate suitability for eel given the presence of ample prey resources and deep water refugia. As the pond was connected to the Castlearmstrong Stream (as with connecting pond P1) it was accessible to both European eel and trout. However, eel were not detected in the eDNA sample collected at the site (**Appendix C**). The pond also has some moderate suitability for white-clawed crayfish but the species was not recorded during sweep sampling or via eDNA (**Appendix C**). Despite moderate suitability for newt (i.e. weeded pond) despite steep banks, none were recorded during sweep netting or in eDNA (**Appendix C**). No otter signs were recorded in vicinity of the site.

During sweep sampling carried out at the pond no macro-invertebrate species of conservation value greater than 'least concern', according to national red lists.

Given the presence of brown trout, the aquatic ecological evaluation of site P2 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.14 Representative image of site P2 (unnamed pond), September 2024

4.1.16 Site P3 – unnamed pond

Site P3 was a linear-shaped peat attenuation pond basin 0.135 hectares in size. This was the smallest of the three connecting ponds. The pond was 1.5-2.5m deep with moderately peat stained water. It had with very steep banks that were 3-4m high and a supported a deep peat base. Pond P3 had scattered pockets of branched-bur reed around the littorals of the pond circumference. The pond supported three-spined stickleback (captured in a sweep net) while trout were observed feeding from the pond surface. As the pond was connected to the Castlearmstrong Stream it could be accessed by European eel and trout (used as a nursery habitat, as with ponds P1 and P2). Brown trout were recorded via eDNA sampling at the pond but eel were not (**Appendix C**). The pond also has some moderate suitability for white-clawed crayfish but the species was not recorded during sweep sampling or in eDNA (**Appendix C**).The pond had moderate suitability for newt (i.e. weeded pond). A low concentration of newt eDNA was recorded during sweep netting or in eDNA (**Appendix C**). No otter signs were recorded in vicinity of the site.

During sweep sampling carried out at the pond no macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of a brown trout population and also smooth newt (via eDNA), the aquatic ecological evaluation of site P3 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.16 Representative image of site P3 (unnamed pond), September 2024

4.2 White-clawed crayfish

A low number of white-clawed crayfish adults (*n*=2) were recorded via hand searching and sweep netting of c.30 instream refugia at site A1 on the Ballynahown River in October 2024. This corresponded to a low population density (as per Peay, 2003).

No white-clawed crayfish were recorded via hand-searching or sweep netting at any of the aquatic survey sites. Furthermore, eDNA sampling of pond sites P1, P2 and P3 did not detect the presence of the species (**Table 4.1**).

Table 4.1 eDNA results in the vicinity of the Proposed Project, September 2024 (positive qPCR replicates out of 12 in parentheses)

Site	Watercourse	Freshwater pearl mussel	White-clawed crayfish	Crayfish plague	Brown trout	European eel	Smooth newt
A2	Ballynahown River	Negative (0/12)	**Positive (12/12)**	Negative (0/12)	n/a	n/a	n/a
B7	Lemanaghan Stream	Negative (0/12)	Negative (0/12)	Negative (0/12)	n/a	n/a	n/a
B10	River Brosna	Negative (0/12)	Negative (0/12)	Negative (0/12)	n/a	n/a	n/a
P1	Unnamed pond	n/a	Negative (0/12)	n/a	**Positive (12/12)**	**Positive (4/12)**	Negative (0/12)
P2	Unnamed pond	n/a	Negative (0/12)	n/a	**Positive (11/12)**	Negative (0/12)	Negative (0/12)
P3	Unnamed pond	n/a	Negative (0/12)	n/a	**Positive (12/12)**	Negative (0/12)	**Positive (1/12)**

4.3 eDNA analysis

White-clawed crayfish were detected via eDNA sampling at site A2 on the Ballynahown River (12 positive qPCR replicates out of 12, respectively) (**Table 4.1; Appendix C**). The species was not detected at riverine sites B7 or B10 or the three pond sites (P1, P2, P3).

Brown trout eDNA was detected in all 3 no. pond samples (12, 11 & 12 positive qPCR replicates out of 12, respectively) (**Table 4.1; Appendix C**). European eel and smooth newt were detected at sites P1 and P3, respectively.

No freshwater pearl mussel or crayfish plague eDNA was detected in the riverine samples (0 positive qPCR replicates out of 12, respectively). These results were considered as evidence of the species' absence at and or upstream of the sampling locations.

4.4 Biological water quality (macro-invertebrates)

Red-listed duck mussel (*Anodonta anatina*) were recorded from site B3 on the Fortified House Castlearmstrong Stream and site B5 on the Lemanaghan Stream. The species is listed as vulnerable in Ireland (Byrne et al., 2009). No other rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from the remaining 11 no. riverine sites or 3 no. pond sites (**Appendix B**).

Site B7 on the Lemanaghan Stream, B10 on the River Brosna and B11 on the Ferbane Stream achieved **Q4 (good status)** water quality given the presence of low numbers of the group A (most sensitive) mayfly species *Ephemera danica* or the stonefly *Nemurella pictetii* (**Appendix B**). Thus, these 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). However, it should be noted that these are considered tentative Q-ratings given the lack of suitable riffle areas for sampling at these sites (as per Toner et al., 2005).

Site B3 on the Fortified House Castlearmstrong Stream achieved **Q3-4 (moderate status)** water quality. Despite the presence of the EPA group A stonefly *Nemurella pictetii*, these were only recorded in low numbers (<5% of total sample) and thus did not meet the qualifying criteria for good status as set out by Toner et al. (2005).

Survey sites on the Ballynahown River (sites A1 & A2), Fortified House Castlearmstrong Stream (B1, B2), Lemanaghan Stream (B4, B5), River Brosna (B8) and Kilcolgan Beg Stream (B9) achieved **Q3 (poor status)** based on the absence of group A species, low numbers of group B (less sensitive) species such as the stonefly *Leuctra hippopus* and cased caddis *Limnephilus* spp., and a dominance of group C (pollution tolerant) species such as freshwater shrimp (*Gammarus duebeni*) or the mayfly *Baetis rhodani*.

In addition to sites B7, B10 and B11, the ratings for several other sites (i.e. sites B4, B5, B8, B9) were also tentative given poor summer flows and an absence of riffle areas for sampling (as per Toner et al., 2005).

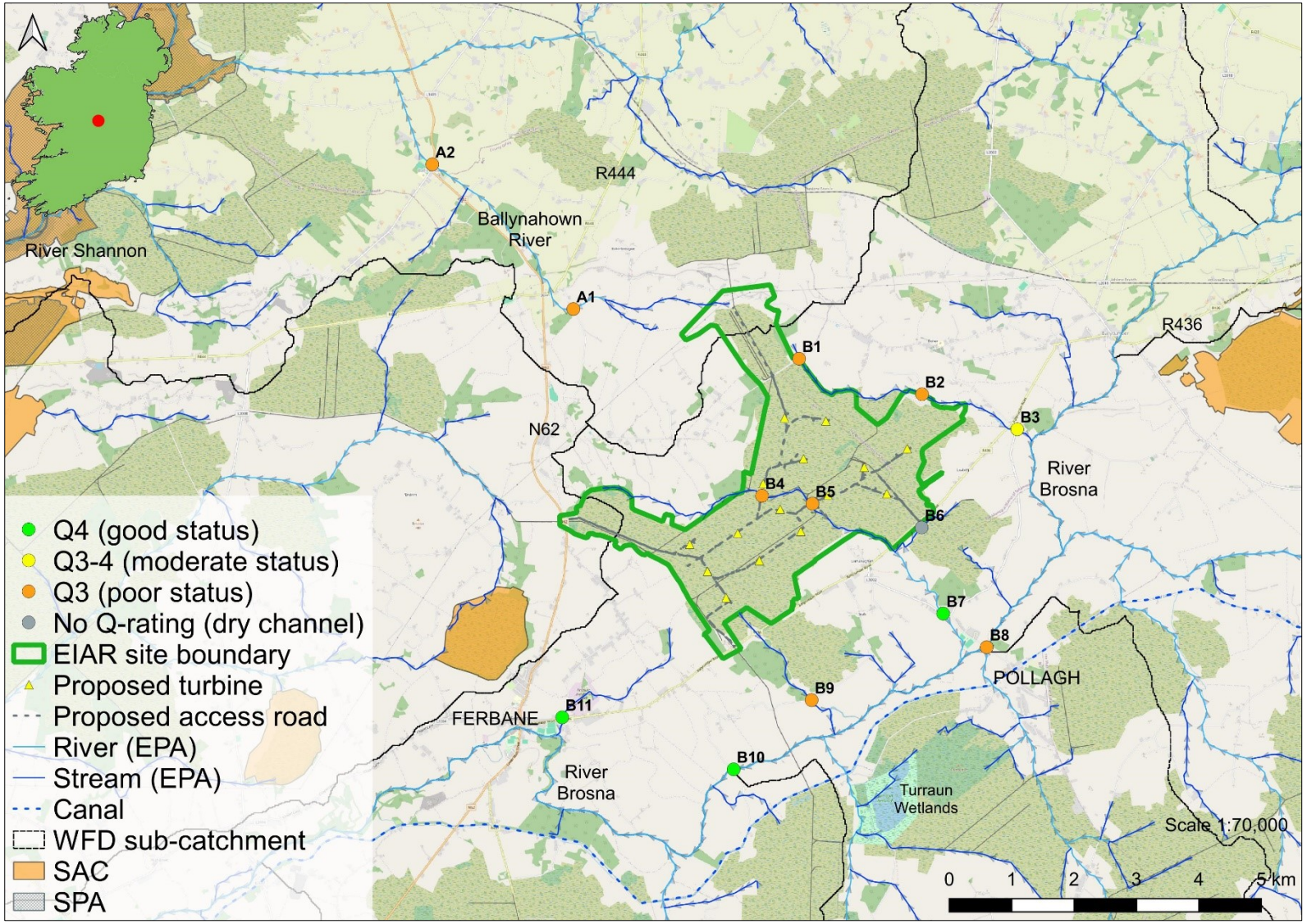

Figure 4.1 Overview of the biological water quality status in the vicinity of the Proposed Project site

Table 4.2 Comparison of 2021 and 2024 biological water quality (Q-ratings) at riverine sites in vicinity of the Proposed Project

			August 2021		September 2024	
Site no.	Watercourse	EPA code	Q-rating	WFD status	Q-rating	WFD status
A1	Ballynahown River	26B17	Q3	Poor	Q3	Poor
A2	Ballynahown River	26B17	Q3	Poor	Q3	Poor
B1	Fortified House Castlearmstrong Stream	25F69	Q3	Poor	Q3	Poor
B2	Fortified House Castlearmstrong Stream	25F69	Q3	Poor	Q3	Poor
B3	Fortified House Castlearmstrong Stream	25F69	Q3	Poor	Q3-4	Mod
B4	Lemanaghan Stream	25L04	n/a – not surveyed		*Q3	Poor
B5	Lemanaghan Stream	25L04	n/a – not surveyed		*Q3	Poor
B6	Lemanaghan Stream	25L04	n/a – not surveyed		n/a	n/a
B7	Lemanaghan Stream	25L04	n/a – not surveyed		*Q4	Good
B8	River Brosna	25B09	*Q4	Good	*Q3	Poor
B9	Kilcolgan Beg Stream	25Q21	n/a – not surveyed		*Q3	Poor
B10	River Brosna	25B09	n/a – not surveyed		*Q4	Good
B11	Ferbane Stream	25F31	Q3	Poor	*Q4	Good

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

Table 4.3 Summary of aquatic species and habitats of higher conservation value recorded in the vicinity of the Proposed Project, October 2024

Site	Watercourse	Freshwater pearl mussel	White-clawed crayfish	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	Ballynahown River		**2 no. adults recorded**	No signs recorded	Not present	None recorded	None recorded	None recorded
A2	Ballynahown River	Negative eDNA sample	None recorded	No signs recorded	Not present	None recorded	None recorded	**Lamprey (*Lampetra* sp.)**
B1	Fortified House Castlearmstrong Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B2	Fortified House Castlearmstrong Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	**Lamprey (*Lampetra* sp.)**
B3	Fortified House Castlearmstrong Stream		None recorded	No signs recorded	**Hydrophilous tall herb (6430)**	None recorded	**Duck mussel (vulnerable in Ireland; Bryne et al., 2009)**	None recorded
B4	Lemanaghan Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B5	Lemanaghan Stream		None recorded	No signs recorded	Not present	None recorded	**Duck mussel (vulnerable in Ireland; Bryne et al., 2009)**	**Common frog**
B6	Lemanaghan Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B7	Lemanaghan Stream	Negative eDNA sample	None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B8	River Brosna		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B9	Kilcolgan Beg Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B10	River Brosna	Negative eDNA sample	None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
B11	Ferbane Stream		None recorded	No signs recorded	Not present	None recorded	None recorded	None recorded
P1	Unnamed pond		None recorded; negative eDNA sample	No signs recorded	Not present	None recorded	None recorded	**European eel (eDNA)**

Site	Watercourse	Freshwater pearl mussel	White-clawed crayfish	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
P2	Unnamed pond		None recorded; negative eDNA sample	No signs recorded	Not present	None recorded	None recorded	None recorded
P3	Unnamed pond		None recorded; negative eDNA sample	No signs recorded	Not present	None recorded	None recorded	**Smooth newt (eDNA)**

Conservation value: White-clawed crayfish (*Austropotamobius pallipes*) are listed under Annex II of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and protected under the Irish Wildlife Acts 1976-2023. White-clawed crayfish (Füreder et al., 2010) are listed as 'Endangered' according to the IUCN Red List. 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).Common frog (*Rana temporaria*) are protected under Annex V of the EU Habitats Directive and both common frog and smooth newt (*Lissotriton vulgaris*) are protected under the Irish Wildlife Acts 1976-2023.

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

Table 4.4 Aquatic ecological evaluation summary of the survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Ballynahown River	26B17	**Local importance (higher value)**	White-clawed crayfish recorded (at low densities)
A2	Ballynahown River	26B17	**Local importance (higher value)**	Brown trout & *Lampetra* sp. recorded
B1	Fortified House Castlearmstrong Stream	25F69	Local importance (lower value)	No aquatic species or habitats of high conservation value; Q3 (poor status) water quality
B2	Fortified House Castlearmstrong Stream	25F69	**Local importance (higher value)**	*Lampetra* sp. recorded
B3	Fortified House Castlearmstrong Stream	25F69	**County importance**	Annex I hydrophilous tall herb habitat (6430) present
B4	Lemanaghan Stream	25L04	Local importance (lower value)	No aquatic species or habitats of high conservation value; Q3 (poor status) water quality (tentative rating)
B5	Lemanaghan Stream	25L04	**Local importance (higher value)**	Common frog and Red-listed duck mussel recorded
B6	Lemanaghan Stream	25L04	Local importance (lower value)	No aquatic species or habitats of high conservation value; seasonal channel
B7	Lemanaghan Stream	25L04	**Local importance (higher value)**	Brown trout recorded
B8	River Brosna	25B09	**County importance**	High regional value as an ecological corridor
B9	Kilcolgan Beg Stream	25Q21	Local importance (lower value)	No aquatic species or habitats of high conservation value; Q3 (poor status) water quality (tentative rating)
B10	River Brosna	25B09	**County importance**	High regional value as an ecological corridor
B11	Ferbane Stream	25F31	Local importance (lower value)	No aquatic species or habitats of high conservation value; Q3 (poor status) water quality
P1	Unnamed pond	n/a	**Local importance (higher value)**	Brown trout & Red-listed European eel recorded (via eDNA)
P2	Unnamed pond	n/a	**Local importance (higher value)**	Brown trout recorded (via eDNA)
P3	Unnamed pond	n/a	**Local importance (higher value)**	Brown trout & smooth newt recorded (via eDNA)

Conservation value: White-clawed crayfish (*Austropotamobius pallipes*) are listed under Annex II of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and protected under the Irish Wildlife Acts 1976-2023. White-clawed crayfish (Füreder et al., 2010) are listed as 'Endangered' according to the IUCN Red List. 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).Common frog (*Rana temporaria*) are protected under Annex V of the EU Habitats Directive and both common frog and smooth newt (*Lissotriton vulgaris*) are protected under the Irish Wildlife Acts 1976-2023. With the exception of the Fisheries Acts 1959 to 2019, brown trout and coarse fish species have no legal protection in Ireland. Duck mussel (*Anodonta anatina*) are classed as a 'vulnerable' species in Ireland (Byrne et al., 2009).

5. Discussion

The surveyed watercourses in the vicinity of the Proposed Project site were typically small lowland channels draining areas of peatland that had been historically straightened and deepened. In keeping with previous surveys (August 2021), these hydromorphological pressures in addition to siltation had significantly reduced the quality of aquatic habitats and biological water quality on the Ballynahown River, Fortified House Castlearmstrong Stream, Lemanaghan Stream, River Brosna, Kilcolgan Beg Stream and Ferbane Stream.

However, in keeping with previous 2021 surveys, several aquatic species of high conservation value were recorded in the survey area, including Annex II lamprey (*Lampetra* sp.) and white-clawed crayfish, amphibians, Red-listed European eel and Red-listed duck mussel. Their presence resulted in the evaluation of 5 no. sites on the Ballynahown River (site A1, A2), Fortified House Castlearmstrong Stream (B2) and Lemanaghan Stream (B5, B7) as being of **local importance (higher value)** in terms of their aquatic ecology **(Table 4.4)**. Environmental DNA confirmed that the three pond sites (P1, P2 & P3) supported either brown trout, European eel and or smooth newt and thus were also of **local importance (higher value)**. Site B3 on the Fortified House Castlearmstrong Stream was considered of **county importance** due to the presence of the Annex I hydrophilous tall herb habitat (6430) (as per NRA, 2009). Sites B8 and B10 on the River Brosna were also of **county importance** given the river's high regional value as an ecological corridor.

Typically, larger watercourses with higher flow rates, such as the Ballynahown River, Fortified House Castlearmstrong Stream and River Brosna are better able to buffer against such impacts and these watercourses supported the best quality aquatic habitat within the vicinity of the proposed project. This was primarily in respect of supporting habitat for aquatic receptors of conservation value, including salmonids, *Lampetra* sp., white-clawed crayfish and amphibians.

5.1 Fisheries

A typical diversity of fish species for the Brosna_SC_060 and Shannon [Lower]_SC_010 river sub-catchments was recorded during the electro-fishing survey, with brown trout, lamprey (*Lampetra* sp.), stone loach, minnow and three-spined stickleback captured. A similar fish assemblage was recorded at comparable sites in the previous 2021 surveys (**Appendix A**). Siltation (primarily from peat) and historical drainage (i.e. straightening and deepening) had reduced the quality of available salmonid and lamprey spawning habitat throughout the survey sites.

Brown trout were recorded (via electro-fishing) from 3 no. sites on the Ballynahown River (A2),Fortified House Castlearmstrong Stream (B3) and Lemanaghan Stream B7). As per previous surveys, no Atlantic salmon or European eel were recorded during the electro-fishing survey. However, eel were detected via eDNA sampling from a peat settlement pond at site P1 (**Table 4.1**).

Lamprey ammocoetes (*Lampetra* sp.) were recorded from three survey sites, namely sites B2 and B3 on the Fortified House Castlearmstrong Stream as well as site A2 on the Ballynahown River. Low densities of lamprey were recorded across at these sites, between 1-2 per m^2. However, previously at site B3 in 2021 (Triturus, 2022), a density of 22 ammocoetes per m^2 of targeted larval habitat was recorded. The densities recorded are lower than those recorded historically on other Irish river

catchments (e.g., O'Connor, 2007, 2006, 2004). It is likely that increased sedimentation and poorer spawning across the survey area may have contributed to lower densities of lamprey recorded in the current survey.

5.2 Otter

No otter signs were recorded during the survey, although the species is known historically from the wider survey area (**Figure 3.1**; NPWS & NBDC data). The small size and often heavily vegetated nature of the survey watercourses limited commuting pathways for otter apart from the River Brosna, the largest and most suitable river in the study area for the species. While not detected at the survey sites the river had high suitability for the species given the mixed prey resources and low levels of human activity, despite historical drainage pressures.

No otter breeding (holt) or couch (resting) areas were identified in the vicinity of the survey sites in September 2024 or the previous August 2021 surveys.

5.3 Macro-invertebrates & biological water quality

In keeping with previous surveys (August 2021), Red-listed duck mussel (*Anodonta anatina*) (Byrne et al., 2009) were recorded on the Fortified House Castlearmstrong Stream (site B3) and Lemanaghan Stream (B5). The species is listed as vulnerable in Ireland and was also recorded from the Fortified House Castlearmstrong Stream in the previous surveys (Triturus, 2022). In contrast to freshwater pearl mussel (not recorded or known in the survey area) which require salmonids as obligate intermediate hosts to complete their life cycle, *Anodonta* sp. glochidia may develop in a wide range of fish species, including brown trout as well as cyprinids (Huber & Geist, 2020; Dias et al., 2020; Chowdhury et al., 2018). With the exception of duck mussel, no other rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from the remaining riverine sites or from the *n*=3 pond sites (**Appendix B**).

With the exception of sites B7 on the Lemanaghan Stream, B10 on the River Brosna and B11 on the Ferbane Stream which achieved **Q4 (good status)**, all survey sites failed to meet the good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). Historical drainage pressures (hydromorphology) and siltation (including from peat escapement) are the primary threats to water quality in the survey area (EPA, 2024) and matched the observations during the current (2024) and previous (2021) site surveys.

5.4 White-clawed crayfish

Despite good habitat suitability at survey sites on the Ballynahown River, Fortified House Castlearmstrong Stream and Lemanaghan Stream, white-clawed crayfish (2 no. adults) were only recorded from a single survey site on the Ballynahown River (site A1). They were also detected via eDNA at site A2 on the Ballynahown River, c. 3.5km downstream of site A1. Despite no crayfish being recorded at site A2 during physical searches it is likely that the species' presence upstream at site A1 caused a positive eDNA result for crayfish downstream at site A2 (**Appendix C**). White-clawed crayfish were also recorded on the Ballynahown River during the previous 2021 survey (Triturus, 2022). As

with fisheries habitat, the quality of crayfish habitat was reduced considerably due to siltation pressures and also by historical drainage.

5.5 Annex I habitats

No examples of the Annex I habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] ('floating river vegetation') were recorded. This habitat is better associated with streams with good hydromorphology and given historical drainage pressures conditions inimical to support floating river vegetation were observed. However, given the presence of several indicator species (EC, 2013; Devaney et al., 2013), a representative example (albeit limited in area) of the Annex I habitat 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430)' was present at site B3 on the Fortified House Castlearmstrong Stream. No other survey sites supported this Annex I habitat.

5.6 Freshwater pearl mussel

Freshwater pearl mussel were not recorded from the survey area via eDNA sampling (**Appendix C**), in keeping with the absence of records for the the Brosna_SC_060 and Shannon [Lower]_SC_010 river sub-catchments (NPWS data). The extensive historical drainage in the respective catchment coupled with siltation and enrichment pressures has created conditions inimical for the species survival.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

Fisheries assessment of Lemanaghan Wind Farm, Co. Offaly

Prepared by Triturus Environmental Ltd. for MKO

December 2024

Please cite as:

Triturus (2024). Fisheries assessment for Lemanaghan Wind Farm, Co. Offaly. Report prepared by Triturus Environmental Ltd. for MKO. December 2024.

Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by MKO to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Lemanaghan Wind Farm (hereafter referred to as the Proposed Project), located near Ferbane, Co. Offaly (**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 fisheries value of the riverine watercourses within the vicinity of the Proposed Project, a catchment-wide electro-fishing survey across *n*=13 sites was undertaken (**Table 2.1; Figure 2.1**). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey and European eel (*Anguilla anguilla*), as well as other species, and helped to further inform impact assessment and any subsequent mitigation for the project. Furthermore, a fisheries appraisal was undertaken at the three unnamed pond sites (**Table 2.1; Figure 2.1**). The fisheries appraisal was supported by environmental DNA (eDNA) sampling to detect the presence of fish of high conservation value (**Appendix A**). The current fisheries surveys would update the previous fisheries survey work undertaken during August 2021 (Triturus, 2022) to contemporise the data.

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 Project. Permission was granted in early September 2024 and the survey was undertaken between the 18th and 19th September.

1.2 Fisheries (desktop review)

The River Brosna rises in Lough Ennell near Mullingar in Co. Westmeath and is a major tributary of the River Shannon. The Brosna catchment is calcareous but also contains one of the largest areas of peat bog and peat harvesting in the country, resulting in a major influx of peat silt and sediment into the river (O'Reilly, 2009). In addition, the Brosna catchment has been arterially drained by the OPW. The river is noted for having good stocks of brown trout (*Salmo trutta*) and coarse fish and is thus a popular angling destination (O'Reilly, 2009). The Brosna is known to support a range of fish species including Atlantic salmon (*Salmo salar*), brown trout, European eel (*Anguilla anguilla*), *Lampetra* sp., roach (*Rutilus rutilus*), perch (*Perca fluviatilis*), pike (*Esox lucius*), gudgeon (*Gobio gobio*), minnow (*Phoxinus phoxinus*), bream (*Abramis brama*) and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2015, 2010).

Brown trout and lamprey (*Lampetra* sp.) were recorded during the 2021 electro-fishing surveys (Triturus, 2022) from the Ballynahown River and Fortified House Castlearmstrong Stream. Three-spined stickleback was the only fish species recorded from the Ferbane Stream in 2021.

Fisheries data for the other watercourses within the survey area was not available at the time of survey. However, the Boor River, to which the Ballynahown River connects, is known to support brown trout, Atlantic salmon, *Lampetra* sp., perch, roach, gudgeon, minnow, stone loach, three-spined stickleback and European eel (Kelly et al., 2014, 2010).

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 Lemanaghan wind farm between the 18th-19th August 2024, following notification to Inland Fisheries Ireland (IFI) and under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) license. 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*=13 sites while a fisheries appraisal was undertaken at the three unnamed pond sites (see **Table 2.1, Figure 2.1**).

Table 2.1 Summary of proposed electro-fishing & fisheries appraisal survey sites in the vicinity of the Proposed Project site

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
Riverine sites					
A1	Ballynahown River	26B17	Togher	612333	731145
A2	Ballynahown River	26B17	N62 road crossing	610071	733463
B1	Fortified House Castlearmstrong Stream	25F69	Killaghintober	615951	730348
B2	Fortified House Castlearmstrong Stream	25F69	Castlearmstrong	617922	729779
B3	Fortified House Castlearmstrong Stream	25F69	Leabeg	619448	729218
B4	Lemanaghan Stream	25L04	Straduff	615356	728152
B5	Lemanaghan Stream	25L04	Lemanaghan	616165	728024
B6	Lemanaghan Stream	25L72	Lemanaghan	617915	727642
B7	Lemanaghan Stream	25L04	L3002 road crossing	618261	726263
B8	River Brosna	25B09	Pollagh	618958	725725
B9	Kilcolgan Beg Stream	25Q21	L3002 road crossing	616152	724877

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
B10	River Brosna	25B09	Kilcolgan Bridge	614902	723767
B11	Ferbane Stream	25F31	Ferbane	612154	724601
Lacustrine sites					
P1	Pond	n/a	Cornafurrish & Corrabeg	618519	729576
P2	Pond	n/a	Cornafurrish & Corrabeg	618537	729549
P3	Pond	n/a	Cornafurrish & Corrabeg	618560	729522

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 approximately 30-75m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages.

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 moderate to high conductivity waters of the sites a voltage of 200-250v, frequency of 35-40Hz and pulse duration of 3.5-4ms was utilised to draw fish to the anode without causing physical damage.

2.1.1 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, approximately 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

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

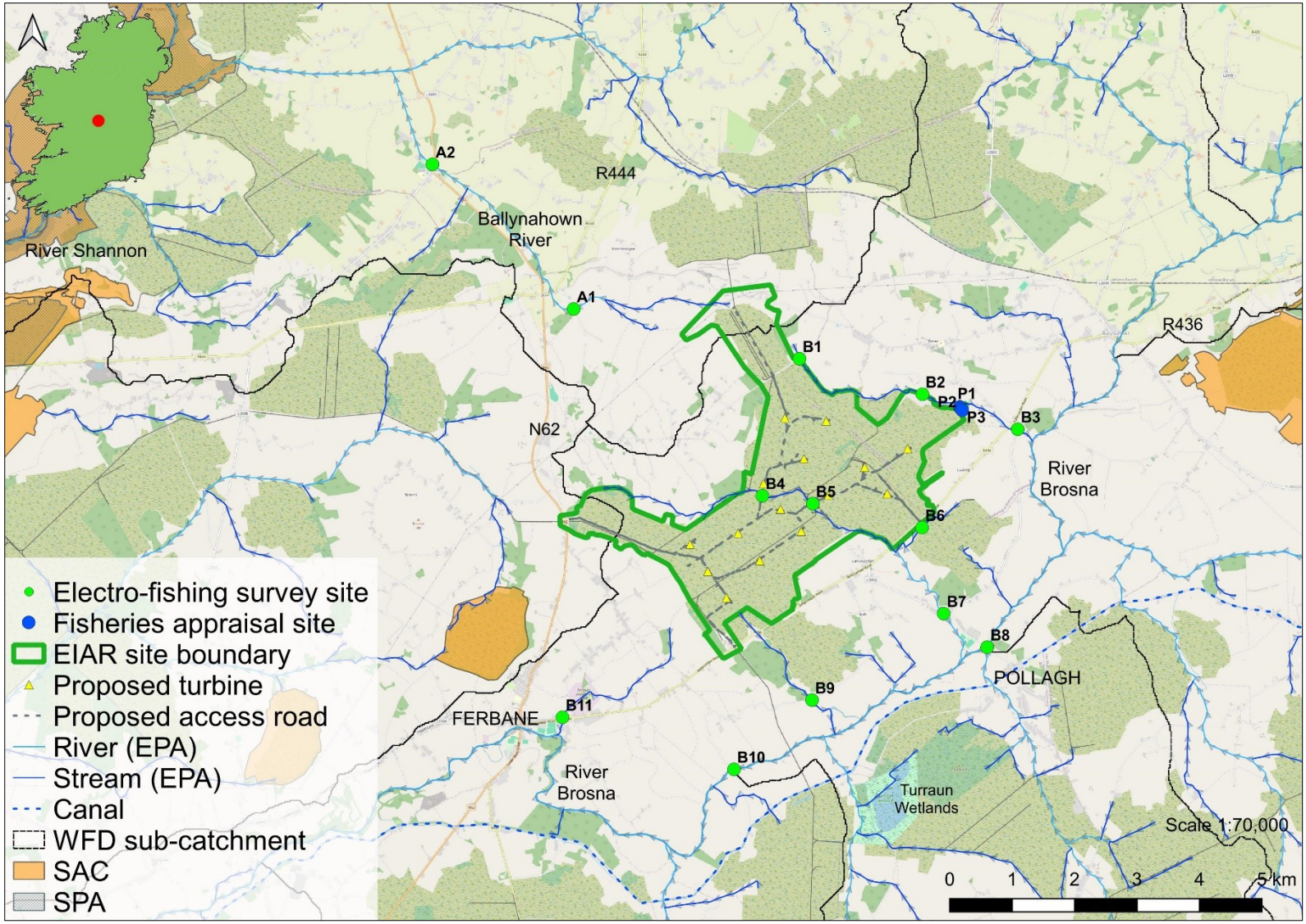

Figure 2.1 Location overview of the electro-fishing and fisheries appraisal sites in vicinity of the Proposed Project site

2.2 Fisheries habitat

A fisheries habitat appraisal of all 16 no. sites was undertaken to establish the importance of the supporting habitats as nursery, spawning and or holding habitats. The appraisal surveys focused on evaluating the spawning, nursery and or holding habitat for salmonids and lamprey species but also considered European eel and other fish species. The appraisals of salmonids and lamprey were cognisant of species-specific habitat requirements and preferences as outlined in O'Grady (2006), Hendry et al. (2003), Armstrong et al. (2003), Harvey & Cowx (2003), Maitland (2003) and Hendry & Cragg-Hine (1997). River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata etc.).

2.3 eDNA

To assess the presence of fish of high conservation value in the absence of electro-fishing, eDNA samples were collected from the three unnamed ponds (sites P1, P2 & P3) at the townlands of Cornafurrish & Corrabeg (**Figure 2.1**). The three pond samples were tested for European eel and brown trout eDNA given these species may be present in light of hydrological connectivity with the Fortified House Castlearmstrong Stream. The eDNA results are summarised in **Appendix A**.

In accordance with laboratory guidance, 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 and fixed on site using a sterile proprietary eDNA sampling kit. The sample was stored at room temperature and sent to the laboratory for analysis with 48 hours of collection. A total of n=12 qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT).

2.4 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was employed during the survey. Equipment and PPE used was disinfected with Virkon® between survey sites to prevent the transfer of pathogens and/or invasive species between survey areas. Particular cognisance was given to preventing the introduction or spread of crayfish plague (*Aphanomyces astaci*) given the known presence of white-clawed crayfish in the wider survey area. As per best practice, surveys were undertaken at sites in a downstream order (i.e. uppermost site surveyed first etc.) to prevent the upstream mobilisation of invasive propagules and pathogens.

3. Results

A catchment-wide electro-fishing survey of the *n*=13 riverine sites and a pond fisheries appraisal (combined with eDNA analysis) was undertaken at the *n*=3 pond sites in the vicinity of the Proposed Project between the 18th- 19th September 2024 following notification to IFI. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – Ballynahown River, Togher

Three-spined stickleback (*Gasterosteus aculeatus*) were the only fish species recorded via electro-fishing from site A1 (**Figure 3.1**). With the exception of low densities of this species (*n*=7), the river was of very low fisheries value at this location given very significant siltation pressures. There was no salmonid nursery or spawning value due to siltation. However, despite some low suitability for European eel, none were recorded (few deep pools or refugia present).

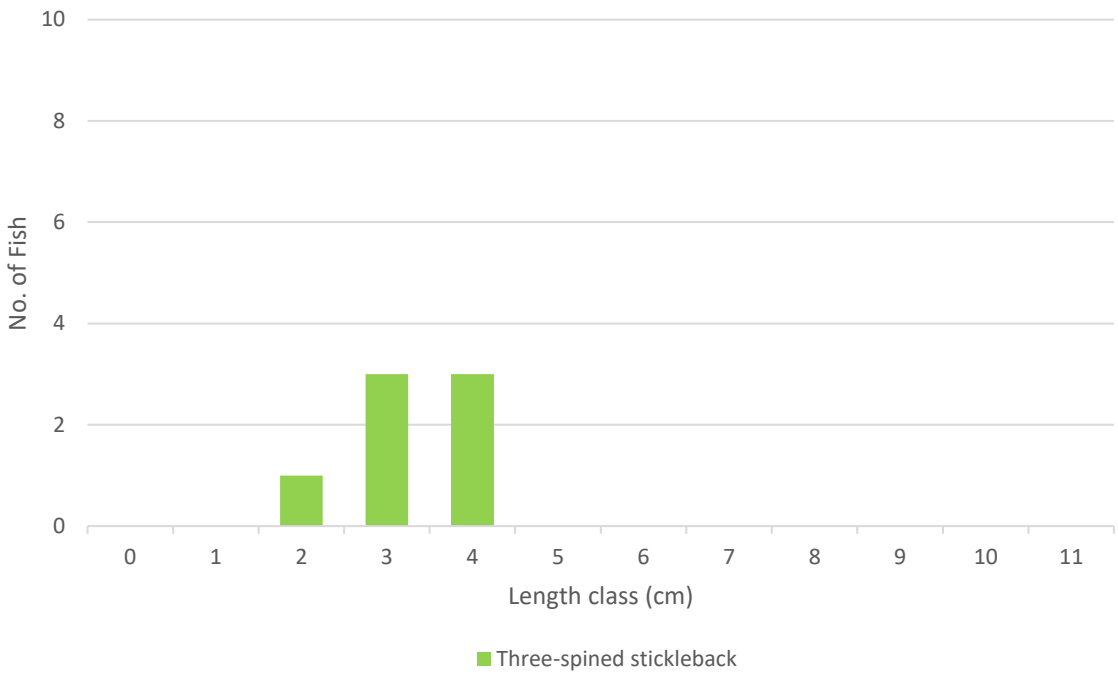

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on the Ballynahown River, August 2024

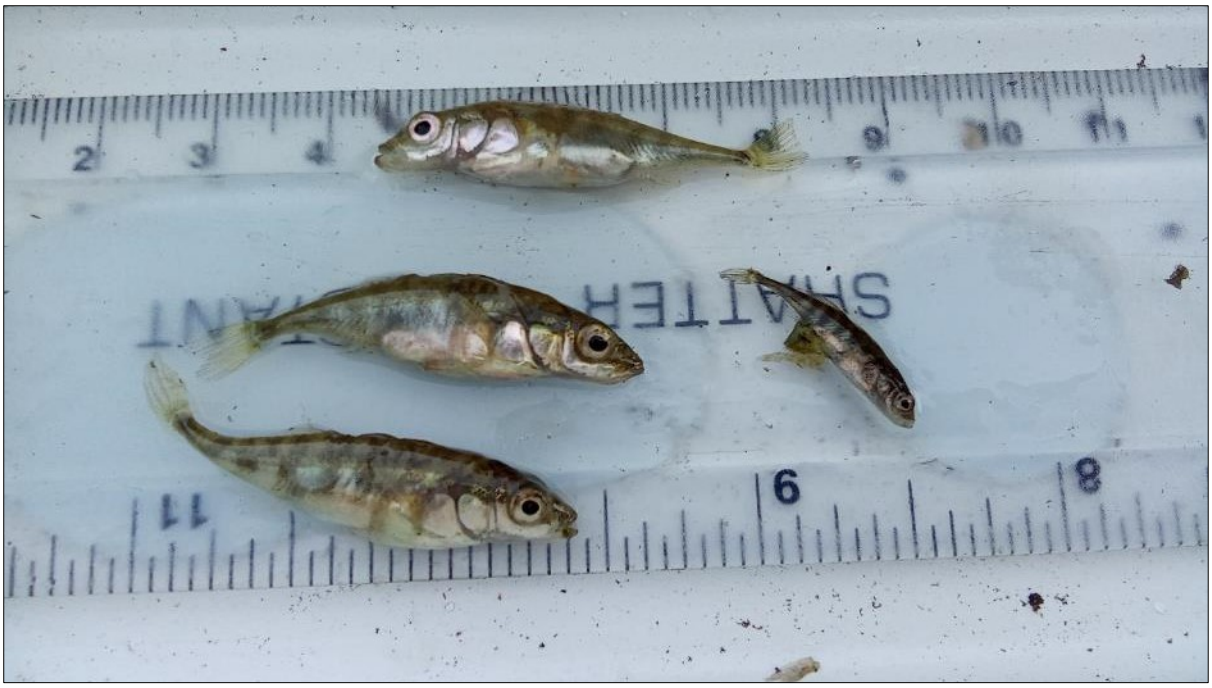

Plate 3.1 Three-spined stickleback recorded from site A1 on the Ballynahown River

3.1.2 Site A2 – Ballynahown River, N62 road crossing

A total of three fish species were recorded via electro-fishing from site A2 (**Figure 3.2**). Brown trout (*Salmo trutta*) dominated the survey site, with a low density (*n*=8) mixed-cohort population of juveniles and adults. *Lampetra* sp. ammocoetes were also recorded at low density (*n*=4 total), with a density of 2 per m^2 recorded from targeted pockets of silt. Two three-spined stickleback were also captured.

The survey site provided moderate to quality salmonid nursery habitat being reduced by considerable siltation pressures. Spawning habitat was present but rare and compromised by siltation as with the nursery habitat. Holding habitat was limited, and this was reflected in the paucity of adult salmonids. Some good quality lamprey ammocoete habitat was present along the channel margins but only supported low densities as stated. Lamprey spawning habitat was present but highly localised (again compromised by siltation). European eel habitat was poor overall and none were recorded.

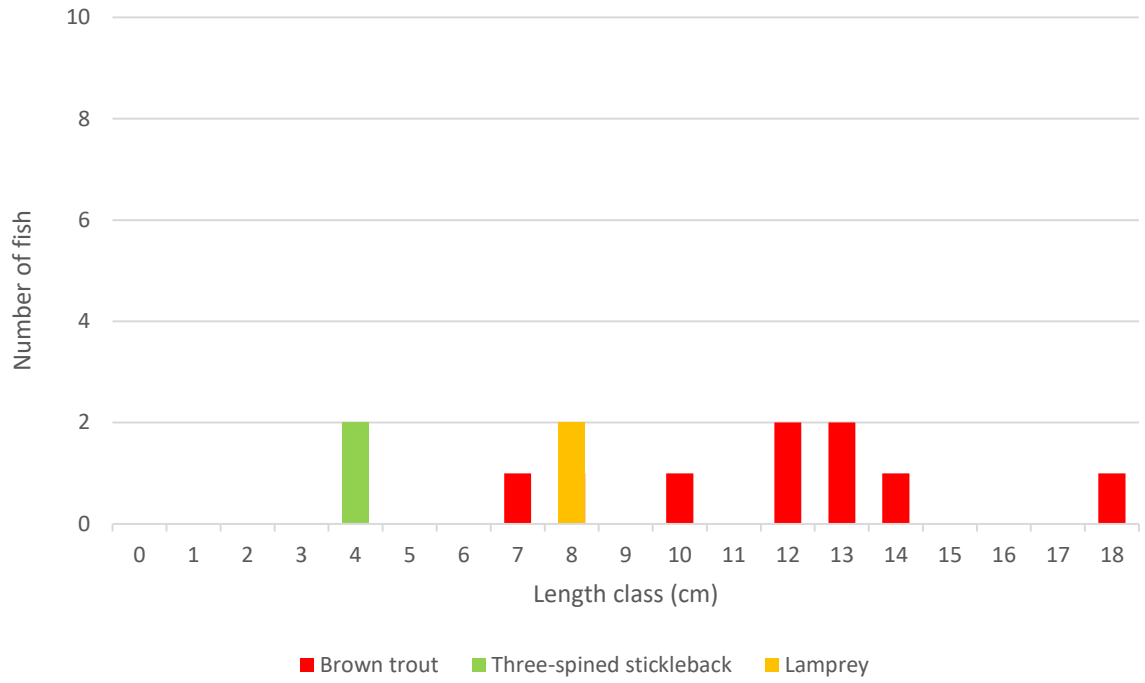

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A2 on the Ballynahown River, August 2024

Plate 3.2 Adult brown and lamprey ammocoetes recorded from site A2 on the Ballynahown River, August 2024

3.1.3 Site B1 – Fortified House Castlearmstrong Stream, Killaghintober

Three-spined stickleback were the only fish species recorded via electro-fishing at site B1 (**Figure 3.3**). With the exception of low densities of this species (*n*=19), the survey site was of very low fisheries value at this location given low flows and significant siltation pressures. Despite the presence of very localised gravels near the culvert, there was no salmonid nursery or spawning value. Despite some low suitability, no European eel were recorded.

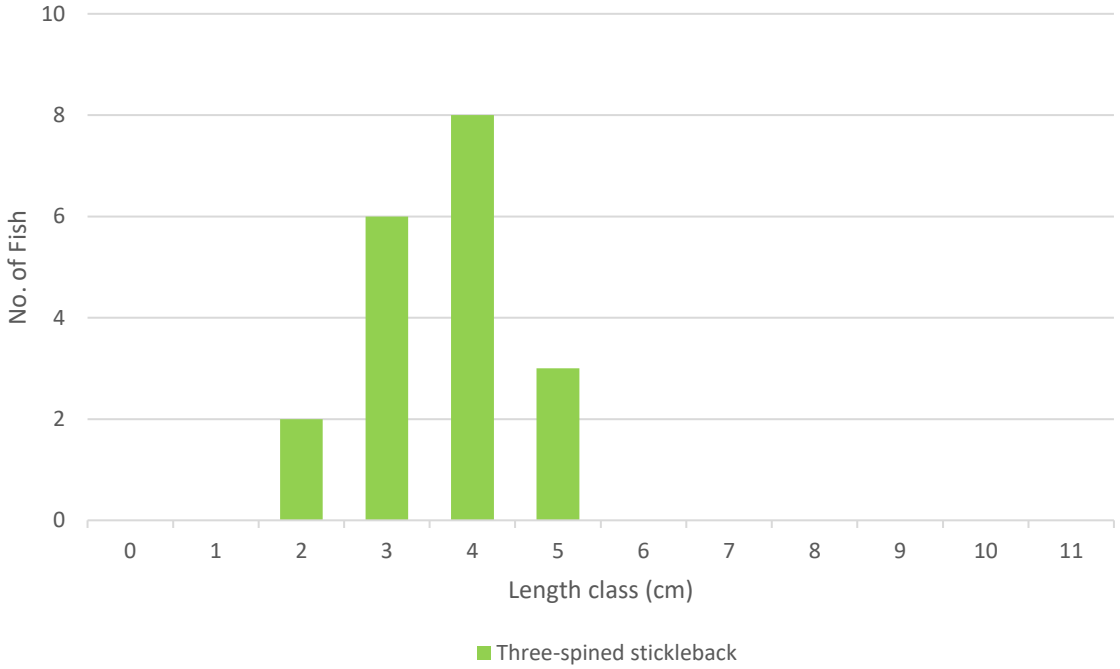

Figure 3.3 Length frequency distribution recorded via electro-fishing at site B1 on the Fortified House Castlearmstrong Stream, August 2024

3.1.4 Site B2 – Fortified House Castlearmstrong Stream, Castlearmstrong

Three-spined stickleback and low densities of *Lampetra* sp. ammocoetes were the only two fish species recorded via electro-fishing at site B2 (**Figure 3.4**). Ammocoetes were present at low densities (2 per m^2 fished), with low numbers of stickleback also recorded (*n*=6). The survey site was evidently not of value as a salmonid habitat (none recorded), although there was some low suitability as a nursery habitat. The survey site was, however, of moderate value to *Lampetra* sp., with a low density present in peat-dominated, sub-optimal habitat located alongside faster-flowing areas. Lamprey spawning habitat was present but highly localised. Despite some suitability, no European eel were recorded.

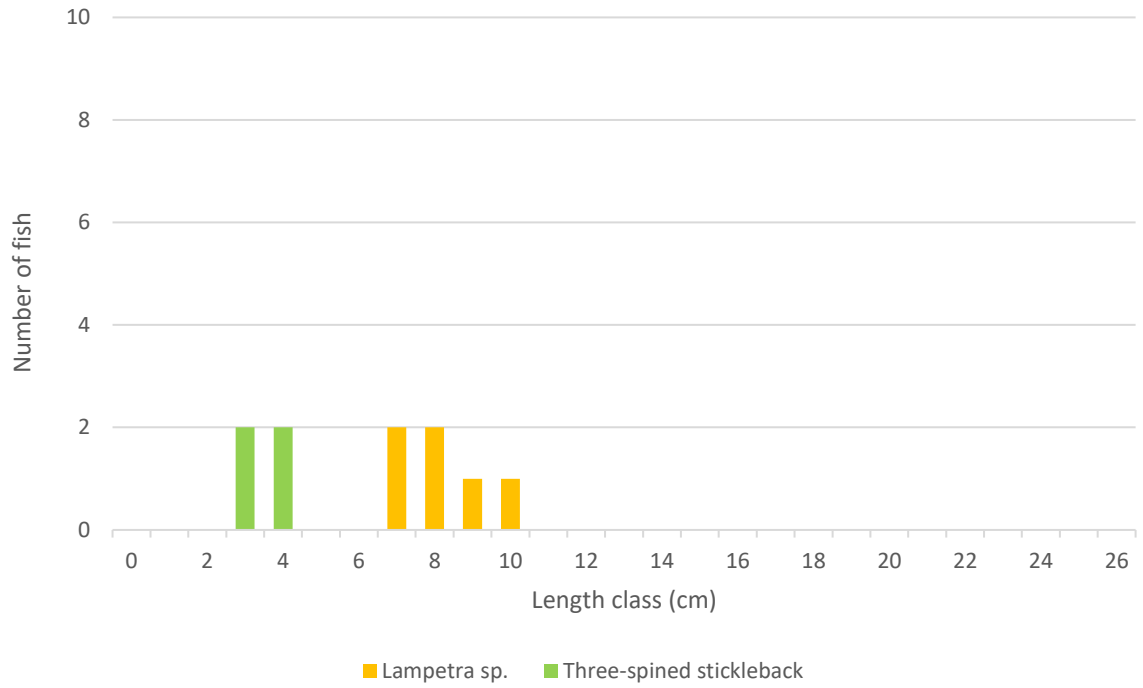

Figure 3.4 Length frequency distribution recorded via electro-fishing at site B2 on the Fortified House Castlearmstrong Stream, August 2024

Plate 3.3 *Lampetra* sp. ammocoete recorded from site B2 on the Fortified House Castlearmstrong Stream

3.1.5 Site B3 – Fortified House Castlearmstrong Stream, Leabeg

A total of three fish species were recorded via electro-fishing from site B3 (**Figure 3.5**). Low numbers of brown trout were present (*n*=8), in addition to low numbers (*n*=2) of stone loach (*Barbatula barbatula*) and low numbers of *Lampetra* sp. ammocoetes (*n*=4).

The survey site was of moderate value as a salmonid habitat (at best) given high rates of siltation and generally poor flows. Despite some moderate suitability for European eel, none were recorded. The survey site was of most value as a lamprey ammocoete habitat, with good quality burial habitat. However, only low numbers of ammocoetes recorded (c. 1 per m^2 fished). Spawning habitat was limited in extent and compromised by siltation (some near culvert, in faster-flowing areas, however).

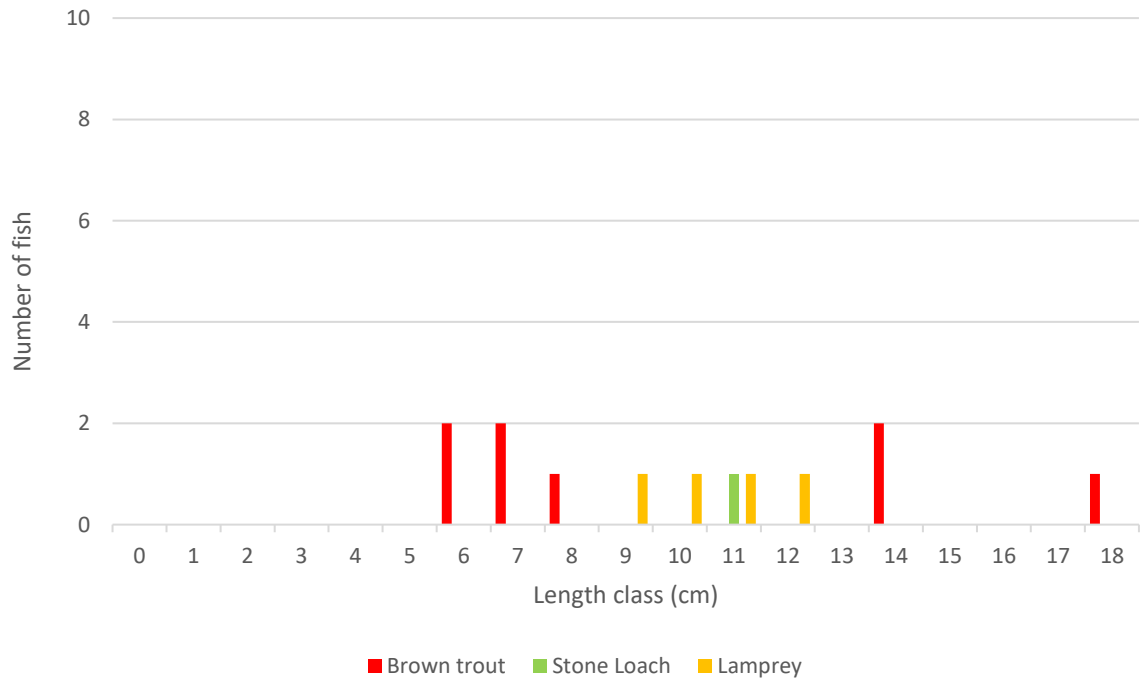

Figure 3.4 Length frequency distribution recorded via electro-fishing at site B3 on the Fortified House Castlearmstrong Stream, August 2024

Plate 3.4 Example of adult brown trout recorded from site B3

3.1.6 Site B4 – Lemanaghan Stream, Straduff

Three-spined stickleback were the only fish species recorded via electro-fishing (**Figure 3.5**). Apart from moderate densities of this species (*n*=12), the channel was of very poor fisheries value. The stream was not of value to salmonids, eel, lamprey or white-clawed crayfish given gross siltation (from peat) and limited flows. Fisheries value was significantly improved downstream.

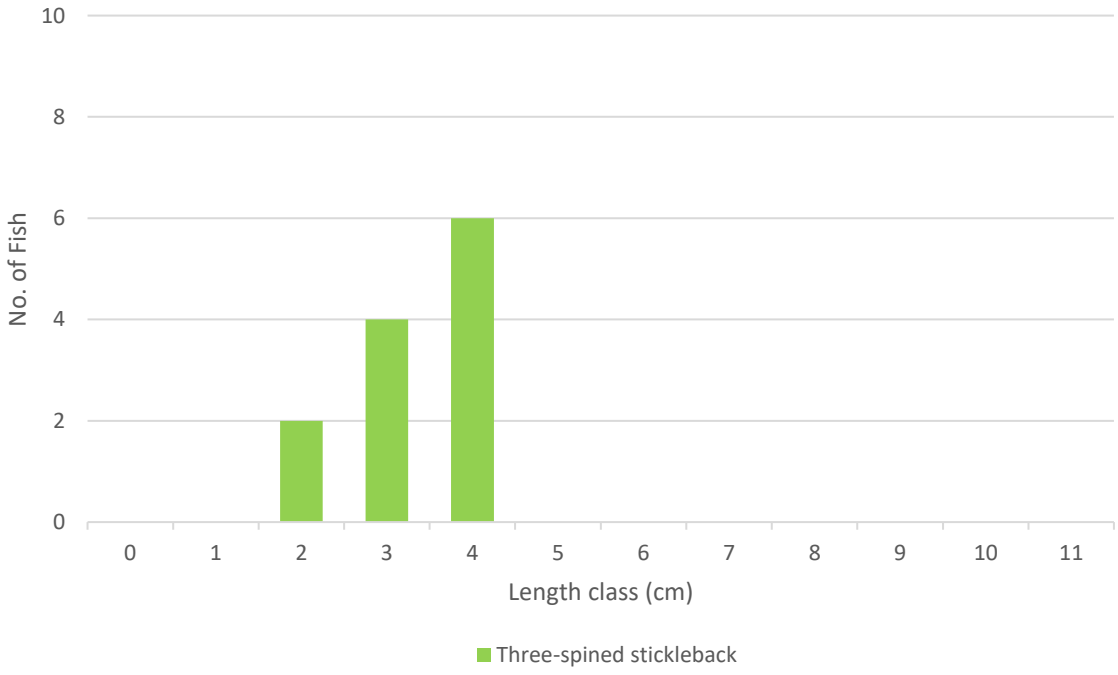

Figure 3.5 Length frequency distribution recorded via electro-fishing at site B4 on the Lemanaghan Stream, August 2024

3.1.7 Site B5 – Lemanaghan Stream, Lemanaghan

Site B5 was too deep for safe or effective electro-fishing. However, the survey site was of little value to salmonids given the slow flows and heavily silted (peat) nature. However, there was some value in the deep glide habitat for brown trout, three-spined stickleback and European eel. Given the low flows and peat-dominated substrata, there was no value for lamprey.

Plate 3.5 Representative image of the deep peat stained channel at site B5 on the Lemanaghan Stream, August 2024

3.1.8 Site B6 – Lemanaghan Stream, Lemanaghan

Site B6 was situated on a very heavily modified artificial peatland drainage channel (FW4) that was 2m wide with 2m high banks. The channel had a deep U-shaped profile with a peat base. The channel contained no water at the time of the survey therefore was not of fisheries value.

Plate 3.6 Site B6 on the Lemanaghan Stream, a dry channel, September 2024

3.1.9 Site B7 – Lemanaghan Stream, L3002 road crossing

A total of three fish species were recorded via electro-fishing at site B7 (**Figure 3.6**). Low densities of brown trout (*n*=5), minnow (n=11) and three-spined stickleback (*n*=2) were recorded. The survey site had moderate potential as a salmonid nursery and spawning area given high rates of siltation resulting due to historical drainage. Similarly, the slower flows and heavy (peat-dominated) siltation precluded the presence of lamprey ammocoetes. Despite some moderate suitability, no European eel were recorded.

Plate 3.7 Representative image of site B7 on the Lemanaghan Stream, September 2024

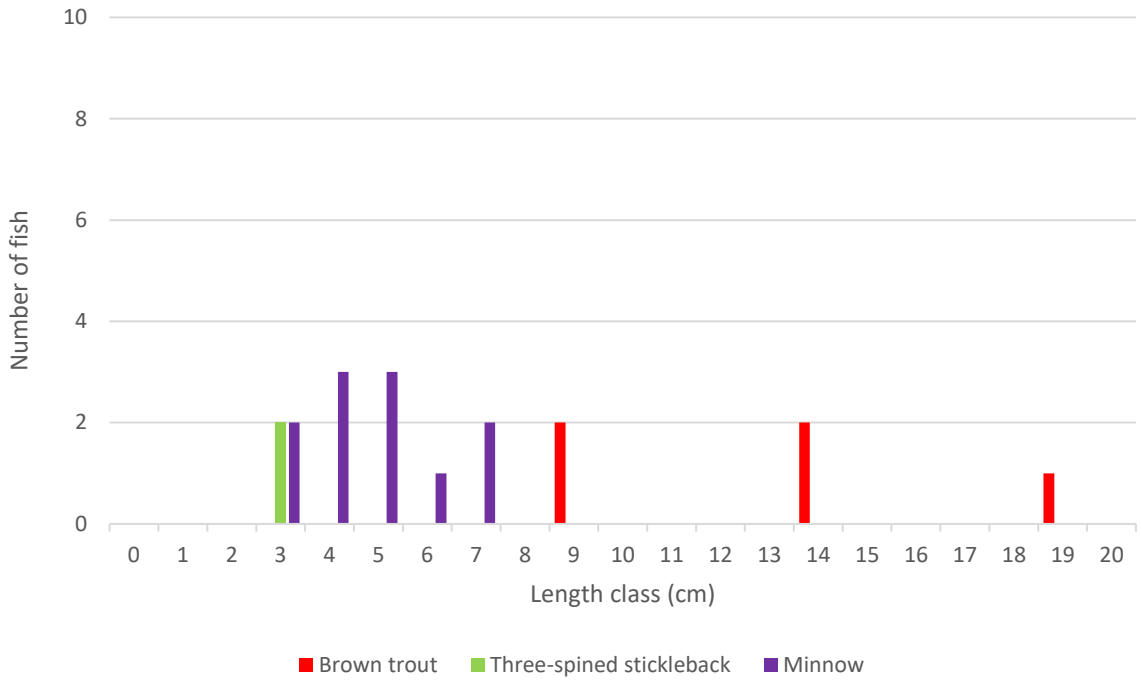

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B7 on the Lemanaghan Stream, August 2024

3.1.10 Site B8 – River Brosna, Pollagh Bridge

Site B8 was too deep for safe or effective electro-fishing. The survey site was of most value as a coarse fish habitat, with species such as roach (*Rutilus rutilus*), perch (*Perca fluviatilis*), pike (*Esox lucius*), gudgeon (*Gobio gobio*), minnow and European eel recorded (boat-based electro-fishing) in 2008 and 2014, in addition to brown trout and *Lampetra* sp. (Kelly et al., 2015, 2010).

Macrophyte beds provided good-quality coarse fish nursery and spawning habitat. Minnow were observed in the channel margins. Adult brown trout were likely present but the value was low overall given the predominance of deep, depositional glide. Some moderate-quality salmonid holding habitat was present, however. The survey site was of considerable value as a European eel habitat given deep glide and macrophyte refugia.

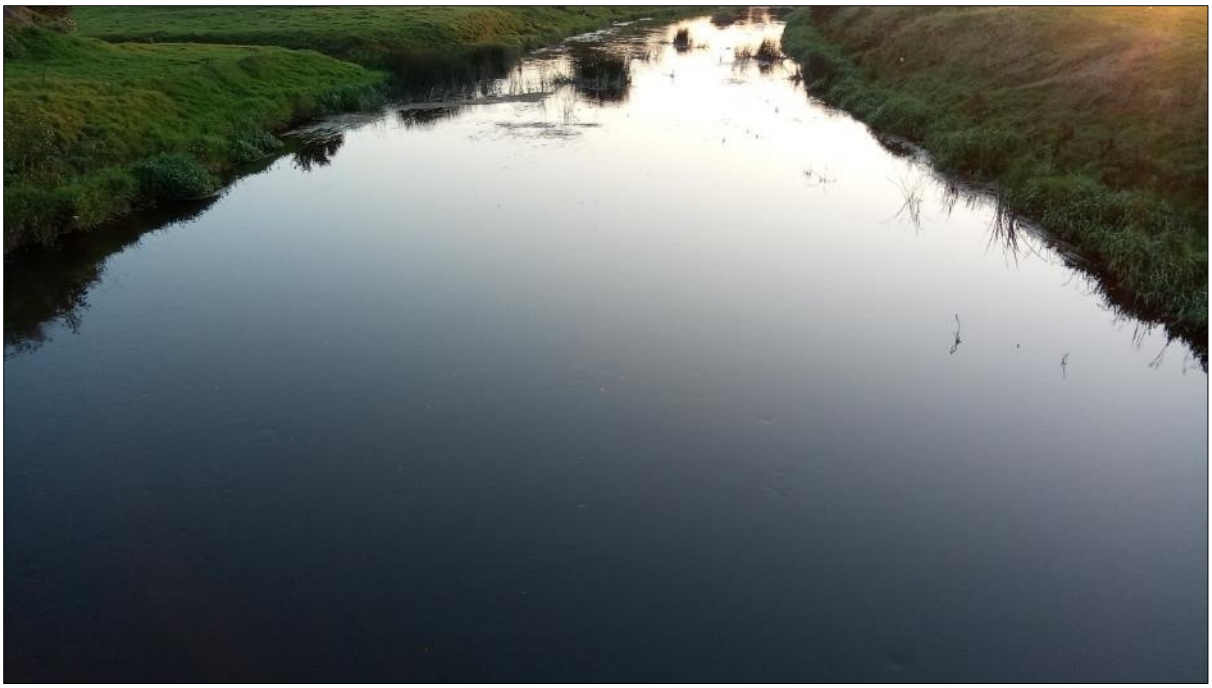

Plate 3.8 Representative image of site B8 on the River Brosna at Pollagh Bridge, September 2024 (facing downstream from bridge)

3.1.11 Site B9 – Kilcolgan Beg Stream, L3002 road crossing

Three-spined stickleback were the only fish species recorded via electro-fishing at site B9 (**Figure 3.7**). Apart from low densities of this species (*n*=11), the channel was of very poor fisheries value. The stream was not of value to salmonids, eel or lamprey given gross siltation (from peat) and limited flows. Fisheries value was significantly improved downstream towards the River Brosna confluence.

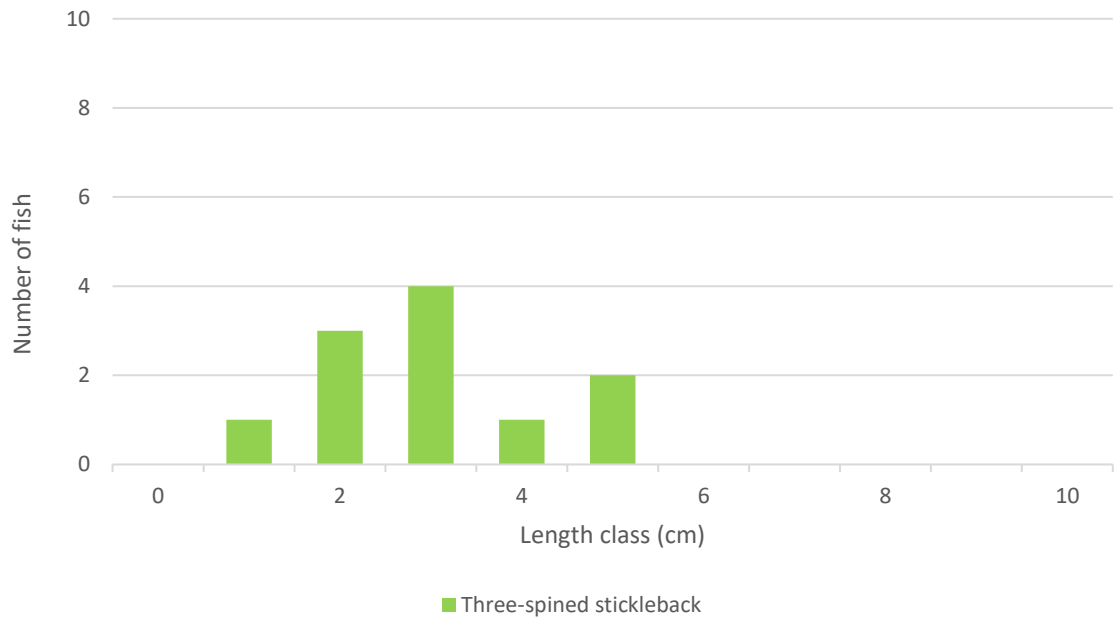

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B9, September 2024

3.1.12 Site B10 – River Brosna, Kilcolgan Bridge

Site B10 was situated on the River Brosna a heavily modified lowland depositing river 18m wide and between 1-3m deep. The flow profile was dominated by deep glide with occasional deeper pool. No riffle habitat was present. The channel bed comprised of localised boulder, cobble and mixed gravels with extensive silt. The silty areas were compacted. The channel supported frequent heterophyllous common clubrush (*Schoenoplectus lacustris*). The channel was predominantly a coarse fish habitat given the predominance of slow moving vegetated deep-glide and pool. It is known to support pike, roach, perch, minnow, gudgeon, stone loach with lower densities of Atlantic salmon, brown trout and European eel at the survey location. However, only small numbers of gudgeon (*n*=3), stone loach (*n*=4) and three-spined stickleback (*n*=5) were recorded during electro-fishing of a localised area under the bridge apron where wadable depths facilitated electro-fishing (**Figure 3.8**). It was too deep elsewhere. While small numbers of trout and salmon are also known from the River Brosna (as stated), historical drainage (including associated poor hydromorphology) has created limited spawning and nursery conditions for salmonids. While the channel had some localised suitability for lamprey (i.e. spawning and nursery) the species was not recorded present. The compacted nature of the bed created poorer nursery conditions for the species (i.e. compacted bed). However, local improved nursery conditions may exist downstream (e.g. pockets of improved burial habitat) and improved local spawning conditions. European eel habitat was good given ample deep water refugia and food resources.

Plate 3.9 Representative image of site B10 on the River Brosna, Kilcolgan Bridge

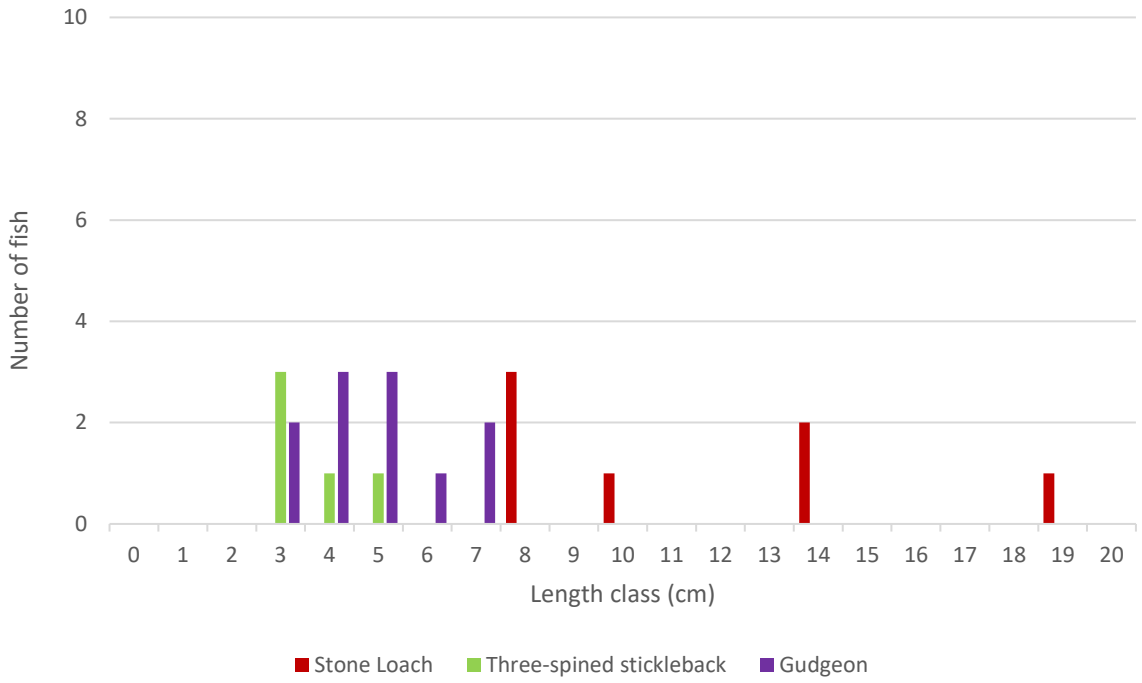

Figure 3.8 Length frequency distribution recorded via electro-fishing at site B10, September 2024

3.1.13 Site B11 – Ferbane Stream, Ferbane

Three-spined stickleback were the only fish species recorded via electro-fishing at site B11 (**Figure 3.9**). With the exception of low densities of this species (*n*=5), the survey site was of very low fisheries value at this location given low flows and significant siltation pressures (consequential of drainage pressures). There was no salmonid nursery or spawning or nursery value given the very shallow nature and poor flows in the stream. While some localised gravels existed they were very heavily silted. Despite some low suitability (as a nursery habitat), no European eel were recorded. No lamprey were recorded present, likely because of poor flows and poor quality spawning habitat.

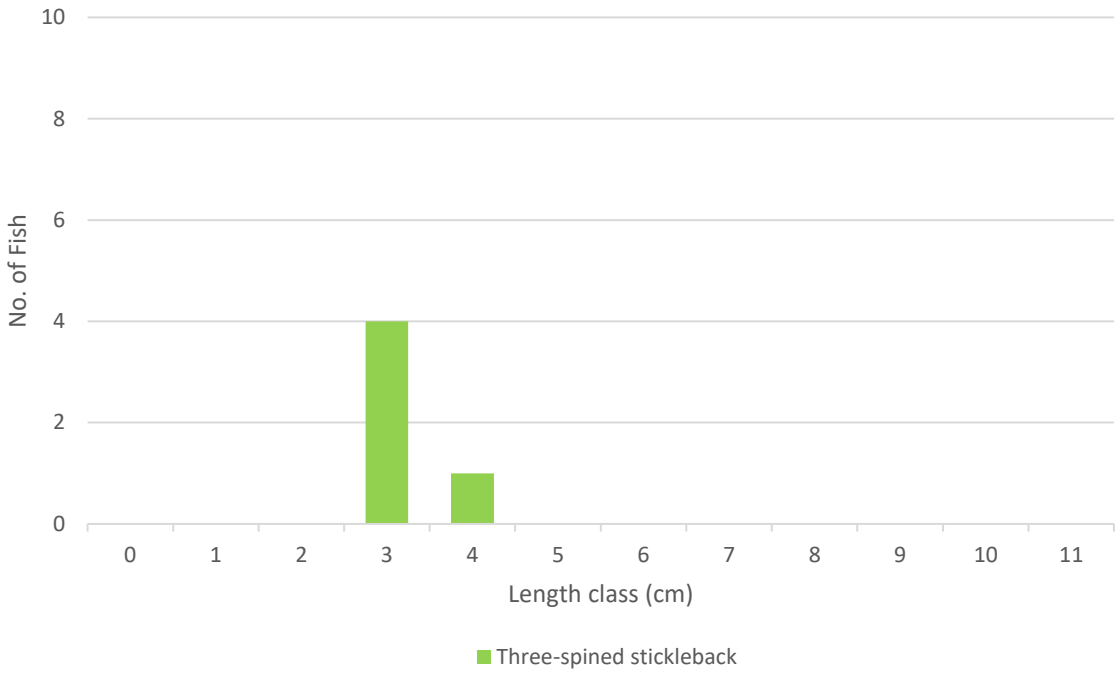

Figure 3.9 Length frequency distribution recorded via electro-fishing at site B11 on the Ferbane Stream, September 2024

Plate 3.10 Three-spined stickleback recorded from site B11 on the Ferbane Stream, September 2024

3.1.14 Site P1 – Unnamed Pond

Site P1 was a linear-shaped attenuation pond basin 0.175 hectares in size with very steep 3-4m high banks. The pond was 1.5-2m deep with moderately peat stained water. The pond supported three-spined stickleback and brown trout that were observed during the site visit. The survey area also had moderate suitability for European eel given ample prey resources and refugia in deep water. As the pond was also connected hydrologically to the Castlearmstrong Stream via an outfall it is accessible by European eel and brown trout. Both brown trout and eel were detected in eDNA samples collected from the site (**Appendix A**). The pond has some moderate suitability for white-clawed crayfish but the species was not recorded during sweep sampling or in eDNA (**Appendix A**).

Plate 4.13 Representative image of site P1 (unnamed pond), September 2024

3.1.15 Site P2 – Unnamed Pond

Site P2 was a linear-shaped peat attenuation pond basin adjacent to pond P1. It was 0.155 hectares in size (slightly smaller than Pond P1). The pond was 1.5-2m deep with moderately peat stained water and had steep 3-4m high banks. The pond had a peat and silt base and was very similar in character to pond P1. It was bounded by dense growth of branched-bur reed that formed a full ring around the littorals of the pond circumference. The pond supported three-spined stickleback (captured in a sweep net) and brown trout were observed foraging for insects at the pond surface. The pond had moderate suitability for eel given the presence of ample prey resources and deep water refugia. However, the species was not detected in the eDNA sample collected at the site (**Appendix A**). As the pond was connected to the Castlearmstrong Stream (as with connecting pond P1) it is accessible to both European eel and trout.

Plate 4.13 Representative image of site P2 (unnamed pond), September 2024

3.1.16 Site P3 – Unnamed Pond

Site P3 was a linear-shaped peat attenuation pond basin 0.135 hectares in size. This was the smallest of the three connecting ponds. The pond was 1.5-2.5m deep with moderately peat stained water. It had with very steep banks that were 3-4m high and a supported a deep peat base. Pond P3 had scattered pockets of branched-bur reed around the littorals of the pond circumference. The pond supported three-spined stickleback (captured in a sweep net) while trout were observed feeding from the pond surface. Trout were also recorded in the eDNA sample collected. The pond had moderate suitability for European eel given ample prey resources and refugia in deep water. However, the species was not detected in via eDNA. As the pond was connected to the Castlearmstrong Stream it can be accessed by European eel and trout (used as a nursery habitat as with ponds P1 and P2).

Plate 4.13 Representative image of site P3 (unnamed pond), September 2024

Table 3.1 Comparison of fish species recorded via electro-fishing in 2021 and 2024 at sites in vicinity of the proposed Lemanaghan wind farm

Site no. (2024)	Watercourse	EPA code	Fish species recorded	
			August 2021	September 2024
A1	Ballynahown River	26B17	Three-spined stickleback	Three-spined stickleback
A2	Ballynahown River	26B17	Brown trout, *Lampetra* sp., three-spined stickleback	Brown trout, *Lampetra* sp., three-spined stickleback
B1	Fortified House Castlearmstrong Stream	25F69	Three-spined stickleback	Three-spined stickleback
B2	Fortified House Castlearmstrong Stream	25F69	*Lampetra* sp., three-spined stickleback	*Lampetra* sp., three-spined stickleback
B3	Fortified House Castlearmstrong Stream	25F69	Brown trout, *Lampetra* sp., stone loach, three-spined stickleback	Brown trout, *Lampetra* sp., three-spined stickleback
B4	Lemanaghan Stream	25L04	Not surveyed	Three-spined stickleback
B5	Lemanaghan Stream	25L04	Not surveyed	Not surveyed (site too deep for electro-fishing)
B6	Lemanaghan Stream	25L72	Not surveyed	n/a – site 100% dry
B7	Lemanaghan Stream	25L04	Not surveyed	Brown trout, minnow, three-spined stickleback
B8	River Brosna	25B09	Not surveyed (site too deep for electro-fishing)	Not surveyed (site too deep for electro-fishing)
B9	Kilcolgan Beg Stream	25Q21	Not surveyed	Three-spined stickleback
B10	River Brosna	25B09	Not surveyed	Stone loach, three-spined stickleback, gudgeon
B11	Ferbane Stream	25F31	Three-spined stickleback	Three-spined stickleback
P1	Pond	n/a	Not surveyed	Brown trout, European eel (via eDNA)
P2	Pond	n/a	Not surveyed	Brown trout (via eDNA)
P3	Pond	n/a	Not surveyed	Brown trout (via eDNA)

Table 3.2[1] Fish species densities per m^2 recorded at survey sites in the vicinity of the Proposed Project via electro-fishing in September 2024. Values in bold represent the highest densities recorded for each species, respectively. * = no. ammocoetes per m^2 of targeted habitat fished

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)					
				Brown trout	*Lampetra* sp.	Minnow	Stone loach	Three-spined stickleback	Gudgeon
A1	Ballynahown River	5	50	0.000	0.000	0.000	0.000	0.380	0.000
A2	Ballynahown River	10	180	0.044	**2.0***	0.000	0.000	0.011	0.000
B1	Fortified House Castlearmstrong Stream	5	40	0.000	0.000	0.000	0.000	0.475	0.000
B2	Fortified House Castlearmstrong Stream	5	30	0.000	**2.0***	0.000	0.000	0.200	0.000
B3	Fortified House Castlearmstrong Stream	10	150	0.053	1.0*	0.000	0.000	0.013	0.000
B4	Lemanaghan Stream	5	20	0.000	0.000	0.000	0.000	**0.600**	0.000
B5	Lemanaghan Stream	n/a	Site too deep	n/a	n/a	n/a	n/a	n/a	n/a
B6	Lemanaghan Stream	n/a	Site 100% dry	n/a	n/a	n/a	n/a	n/a	n/a
B7	Lemanaghan Stream	5	50	**0.100**	0.000	**0.220**	0.000	0.000	0.000
B8	River Brosna	n/a	Site too deep	n/a	n/a	n/a	n/a	n/a	0.000
B9	Kilcolgan Beg Stream	5	50	0.000	0.000	0.000	0.000	0.220	0.000
B10	River Brosna	5	75	0.000	0.000	0.000	**0.053**	0.066	**0.040**
B11	Ferbane Stream	5	30	0.000	0.000	0.000	0.000	0.166	0.000

[1] Please note sites P1, P2 & P3 were pond sites and thus were not subject to electro-fishing (fisheries appraisal only). Brown trout were detected via eDNA at all three ponds while European eel were detected at Pond P1

4. Discussion

4.1 Salmonids

Brown trout were recorded from three riverine sites on the Ballynahown River (A2), Fortified House Castlearmstrong Stream (B3) and the Lemanaghan Stream (B7). Brown trout were also observed and recorded via eDNA sampling in all three peat attenuation ponds P1, P2 and P3 (**Appendix A**). No Atlantic salmon were recorded during the survey, which reflected both siltation pressures and significant downstream migration barriers within the Shannon catchment (e.g., hydroelectric dams and significant weirs). However, very low densities of Atlantic salmon are known from the River Brosna (pers. obs.).

In general, the quality of salmonid habitat in the vicinity of the Proposed Project site was poor due to historical drainage pressures, low or intermittent/seasonal flows and often excessive siltation (primarily from peat escapement). Locally better-quality habitat was only present on the Ballynahown River (A2), Fortified House Castlearmstrong Stream (B3) and Lemanaghan Stream (B7) but historical drainage had impacted these rivers (i.e. deepening and straightening). The River Brosna also had habitat that supports low densities of trout and salmon (primarily adult holding habitat) but again has suffered from extensive drainage pressures (i.e. poor hydromorphology). Diffuse siltation is one of the greatest threats to salmonid populations and was observed as a pressure throughout the study area. Sediment not only blocks interstitial spaces in substrata and limits oxygen supply to salmonid eggs (required for healthy embryonic development and successful hatching) but can also smother substrata, thus reducing available spawning habitat and impact macro-invertebrate communities on which salmonids feed (Kelly-Quinn et al., 2020; Davis et al., 2018; Conroy et al., 2018; Cocchiglia et al., 2012; Louhi et al., 2008, 2011; Heywood & Walling, 2007; Walling et al., 2003; Soulsby et al., 2001). Sedimentation of salmonid habitat is a particular problem in Irish rivers flowing through modified catchments (Evans et al., 2006). Channels with higher proportions of peat substrata can also suffer from increased siltation of instream hard substrata necessary for salmonid spawning, further limiting local populations. Gravel compaction from sedimentation reduces the spawning capacity of a channel and it has been shown that eggs laid in clean gravels which have subsequently been silted over by peat have failed to hatch (Crisp 2000, 1993).

4.2 Lamprey

Lamprey ammocoetes (*Lampetra* sp.) were recorded from three survey sites, namely sites B2 and B3 on the Fortified House Castlearmstrong Stream as well as site A2 on the Ballynahown River. Low densities of lamprey were recorded at these sites between 1-2 per m^2. However, previously at site B3 in 2021 (Triturus, 2022), a density of 22 ammocoetes per m^2 of targeted larval habitat was recorded. The densities recorded are lower than those recorded historically on other Irish river catchments (e.g., O'Connor, 2007, 2006, 2004). It is likely that increased sedimentation and poorer spawning across the survey area may have contributed to lower densities of lamprey recorded in the current survey. Owing to their relatively small morphologies, *Lampetra* species such as brook lamprey require clean, fine gravels in which to dig their redds (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010). Spawning habitat in the vicinity of the Proposed Project was appreciably sparse and of poor quality due to significant (peat) siltation pressures (as outlined above). Furthermore, lamprey ammocoetes

require the deposition of fine, organic-rich sediment ≥5cm in depth in which to burrow and mature (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). Peat-dominated substrata (i.e., humic deposits), such as those typically found in the vicinity of the Proposed Project site, do not provide suitable burial/burrowing habitat complexity or structure for ammocoetes given their invariably fine and flocculent nature (pers. obs.).

4.3 European eel

On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011). Despite some suitability across the survey area, no European eel were recorded during the current survey apart from via eDNA recorded at attenuation pond site P1 (**Appendix A**). The very limited presence of eel was considered primarily as a result of significant downstream migration barriers within the Shannon catchment, in addition to siltation (peat escapement) pressures within the vicinity of the Proposed Project site. Nevertheless, even small channels with poor or little fisheries value overall can offer potential as European eel migratory pathways, provided they maintain downstream connectivity to larger channels. (e.g. adult migration seawards, usually from September/October onwards).

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6. Appendix A – eDNA analysis lab report

Triturus

Folio No:	3536-2024
Purchase Order:	eDNA Lemanaghan 24
Contact:	Triturus Environmental Ltd
Issue Date:	09.10.2024
Received Date:	27.09.2024

SureScreen Scientifics

eDNA Analysis

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

Lab ID	Site Name	OS Reference	Target Species	Sample Integrity Check	Result	Positive Replicates
FK2760	Lemanaghan - P2		Brown (sea) trout	Pass	Positive	11
			European eel	Pass	Negative	0
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2761	Lemanaghan - P1		Brown (sea) trout	Pass	Positive	12
			European eel	Pass	Positive	4
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2762	Lemanaghan - P3		Brown (sea) trout	Pass	Positive	12

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European eel	Pass	Negative	0
Smooth Newt	Pass	Positive	1
White-clawed crayfish	Pass	Negative	0

Matters affecting result: none

Reported by:Lauryn Jewkes

Approved by: Chelsea Warner

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Triturus

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Methodology

Samples have been analyzed for the presence of target species eDNA following readily available and scientifically published eDNA assays and protocols.

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 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 the risk of false positive and false negative results. 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. Stages of the analysis are also conducted in different buildings at our premises for added security. SureScreen Scientifics Ltd is ISO9001 accredited and participates in Natural England's proficiency testing scheme for GCN eDNA testing.

Interpretation of Results

Sample Integrity Check:

Laboratory Arrival:

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. Any samples which fail this test are rejected and eliminated before analysis.

Degradation and Inhibition check:

Analysis of the spiked DNA marker to see if there has been degradation or inhibition 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. If inhibition is detected, samples are purified and re-analyzed. 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.

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

Table 8.1 Macro-invertebrate Q-sampling results for aquatic survey sites A1, A2, B1, B2, B3, B4, B5, B6 (dry), B7, B8, B9, B10 & B11

Taxon	Family	Binomial name	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	EPA group
Ephemeroptera	Ephemeridae	*Ephemera danica*									1			1		**A**
Plecoptera	Nemouridae	*Nemurella pictetii*					1								5	**A**
Ephemeroptera	Baetidae	*Alainites muticus*		1			1								1	**B**
Trichoptera	Beraeidae	*Beraedoes minutus*	5										4			**B**
Trichoptera	Goeridae	*Silo pallipes*					2									**B**
Trichoptera	Limnephilidae	*Limnephilus marmoratus*				2	1					3				**B**
Trichoptera	Limnephilidae	Limnephilus sp.	2		1								2			**B**
Trichoptera	Phryganeidae	*Agrypnia obsoleta*						1								**B**
Trichoptera	Sericostomatidae	*Sericostoma personatum*				4										**B**
Odonata	Coenagrionidae	sp. indet.	1					1	1							**B**
Odonata	Calopterygidae	*Calopteryx splendens*					1				1	5				**B**
Odonata	Libellulidae	Sympetrum sp.							3							**B**
Ephemeroptera	Baetidae	*Baetis rhodani*		11			1						3	1		**C**
Ephemeroptera	Caenidae	*Caenis horaria*						7								**C**
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*					7									**C**
Trichoptera	Polycentropodidae	*Polycentropus kingi*									3					**C**
Coleoptera	Dytiscidae	*Colymbetes fuscus*							1							**C**
Coleoptera	Dytiscidae	Dytiscidae larva									1					**C**
Coleoptera	Dytiscidae	*Dytiscus dimidiatus*			1											**C**
Coleoptera	Dytiscidae	*Ilybius ater*							1							**C**
Coleoptera	Dytiscidae	*Ilybius fuliginosus*			1											**C**
Coleoptera	Dytiscidae	*Nebrioporus depressus*										1				**C**
Coleoptera	Elmidae	*Elmis aenea*	1				28					2	4			**C**
Coleoptera	Elmidae	*Limnius volckmari*					2									**C**
Coleoptera	Elmidae	*Oulimnius* sp.					1									**C**

Taxon	Family	Binomial name	A1	A2	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	EPA group
Coleoptera	Gyrinidae	*Gyrinus aeratus*										2				**C**
Coleoptera	Gyrinidae	*Gyrinus substriatus*			1											**C**
Coleoptera	Haliplidae	*Brychius elevatus*									1					**C**
Coleoptera	Haliplidae	*Haliplus flavicollis*										1				**C**
Coleoptera	Haliplidae	*Haliplus ruficollis* group	2													**C**
Crustacea	Gammaridae	*Gammarus duebeni*	3	15	6	8	4				2		14		16	**C**
Diptera	Chironomidae	Non-*Chironomus* spp.				2							6	1	1	**C**
Diptera	Simuliidae	sp. indet.					1						1	2	14	**C**
Gastropoda	Valvatidae	*Valvata piscinalis*										4		1		**C**
Gastropoda	Lymnaeidae	*Lymnaea stagnalis*												2		**C**
Gastropoda	Planorbidae	*Bathyomphalus contortus*													1	**C**
Gastropoda	Tateidae	*Potamopyrgus antipodarum*	3													**C**
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*	2													**C**
Hemiptera	Corixidae	*Hesperocorixa linnaei*										4		2		**C**
Hemiptera	Gerridae	*Gerris* sp.				4					1			1		**C**
Hemiptera	Notonectidae	*Notonecta viridis*							2							**C**
Hemiptera	Veliidae	*Velia caprai*	1													**C**
Hirudinidae	Piscicolidae	*Piscicola* sp.	1													**C**
Crustacea	Asellidae	*Asellus aquaticus*	2		1	2	3		1		1				4	**D**
Gastropoda	Lymnaeidae	*Ampullacaena balthica*							1							**D**
Diptera	Chironomidae	*Chironomus* spp.			1			1								**E**
Annelidae	Oligochaeta	sp. indet.											1			**n/a**
Abundance			**23**	**27**	**12**	**22**	**53**	**10**	**10**		**11**	**22**	**35**	**11**	**42**	
Q-rating			Q3	Q3	Q3	Q3	Q3-4	Q3	Q3	n/a	Q3-4	Q3	Q3	Q3-4	Q4	
WFD class			Poor	Poor	Poor	Poor	Mod	Poor	Poor	n/a	Mod	Poor	Poor	Mod	Good	

9. Appendix C – eDNA analysis lab report

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eDNA Analysis

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

Lab ID	Site Name	OS Reference	Target Species	Sample Integrity Check	Result	Positive Replicates
FK2755	Lemanaghan - B7		Crayfish plague	Pass	Negative	0
			Freshwater pearl mussel	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2756	Lemanaghan - B10		Crayfish plague	Pass	Negative	0
			Freshwater pearl mussel	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2759	Lemanaghan - A2		Crayfish plague	Pass	Negative	0
			Freshwater pearl mussel	Pass	Negative	0
			White-clawed	Pass	Positive	12

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SureScreen Scientifics

eDNA Analysis

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

Lab ID	Site Name	OS Reference	Target Species	Sample Integrity Check	Result	Positive Replicates
FK2760	Lemanaghan - P2		Brown (sea) trout	Pass	Positive	11
			European eel	Pass	Negative	0
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2761	Lemanaghan - P1		Brown (sea) trout	Pass	Positive	12
			European eel	Pass	Positive	4
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2762	Lemanaghan - P3		Brown (sea) trout	Pass	Positive	12

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European eel	Pass	Negative	0
Smooth Newt	Pass	Positive	1
White-clawed crayfish	Pass	Negative	0

Matters affecting result: none

Reported by:Lauryn Jewkes

Approved by: Chelsea Warner

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eDNA Analysis

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

Lab ID	Site Name	OS Reference	Target Species	Sample Integrity Check	Result	Positive Replicates
FK2760	Lemanaghan - P2		Brown (sea) trout	Pass	Positive	11
			European eel	Pass	Negative	0
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2761	Lemanaghan - P1		Brown (sea) trout	Pass	Positive	12
			European eel	Pass	Positive	4
			Smooth Newt	Pass	Negative	0
			White-clawed crayfish	Pass	Negative	0
FK2762	Lemanaghan - P3		Brown (sea) trout	Pass	Positive	12

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European eel	Pass	Negative	0
Smooth Newt	Pass	Positive	1
White-clawed crayfish	Pass	Negative	0

Matters affecting result: none

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Methodology

Samples have been analyzed for the presence of target species eDNA following readily available and scientifically published eDNA assays and protocols.

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 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 the risk of false positive and false negative results. 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. Stages of the analysis are also conducted in different buildings at our premises for added security. SureScreen Scientifics Ltd is ISO9001 accredited and participates in Natural England's proficiency testing scheme for GCN eDNA testing.

Interpretation of Results

Sample Integrity Check:

Laboratory Arrival:

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. Any samples which fail this test are rejected and eliminated before analysis.

Degradation and Inhibition check:

Analysis of the spiked DNA marker to see if there has been degradation or inhibition 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. If inhibition is detected, samples are purified and re-analyzed. 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.

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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