APPENDIX 6-3

AQUATIC ASSESSMENT

Aquatic baseline report for Ballivor wind farm, Co. Meath/Westmeath

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1. Introduction

1.1 Background

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 Ballivor wind farm, located near Ballivor, Co. Meath.

Undertaken on a catchment-wide scale, the baseline surveys focused on aquatic habitats in relation to fisheries potential for species of high conservation value (i.e., salmonids, eel and lamprey), white-clawed crayfish (*Austropotamobious pallipes*) and other aquatic invertebrates. It also considered macrophytes and aquatic bryophytes, aquatic invasive species, and otter (*Lutra lutra*) which may use the watercourses in the vicinity of the proposed project. Aquatic surveys were undertaken in May and July 2021.

The *n*=20 aquatic survey sites were located within the Deel (Raharney) and Stoneyford River sub-basins, in the wider River Boyne catchment (Boyne_SC_040 and Boyne_SC_050). Whilst not located within a European site, the proposed wind farm site (via several watercourses) shared downstream hydrological connectivity with the River Boyne and River Blackwater SAC (002299).

1.2 Project description

The proposed Bord na Móna Ballivor wind farm is located on the Ballivor, Bracklin, Carranstown, Lisclogher and Lisclogher West bogs located in Counties Meath and Westmeath. The closest large settlements to the site are Ballivor which is located approximately 2km to the east, Delvin which is located approximately 2.5km to the northwest and Raharney which is located 3km to the west.

A full description of the proposed project is provided in Chapter 2 of the EIAR.

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed wind farm project were considered as part of the current assessment. A total of *n*=20 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's (EPA) online map viewer.

Aquatic survey sites were present on the Cartenstown Stream (EPA code: 07C60), Stonestown River (07S11), Ballinn Stream (07B47), Bolandstown River (07B45), Woodtown West Stream (07W06), Stonyford River (07S02), Carranstown Little River (07C87), Killaconnigan Stream (07K34), Kilballivor Stream (07B35), Ballivor River (07B52) and two unnamed tributaries, Graffanstown Stream (07G10), Ballynaskeagh Stream (07B24), Mucklin Stream (07M13), River Deel (07D01), Craddanstown Stream (07C550), Clondalee More Stream (07C77) and River Boyne (07B04) (**Table 2.1**). The survey sites on the Stonyford River, River Deel and River Boyne were located within the River Boyne and River Blackwater SAC (002299).

Surveys at each of these sites included a fisheries assessment (electro-fishing, habitat appraisal), and (where suitable) biological water quality sampling (Q-sampling) (**Figure 2.1**). White-clawed crayfish (sweep netting & hand searching) surveys were also undertaken at each site, in addition to macrophyte & aquatic bryophyte and otter surveys. This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed wind farm project.

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 wind farm project were conducted in July 2021. Survey effort focused on both instream and riparian habitats in the vicinity of each sampling point (see **Figure 2.1** above). The watercourses at each survey site were described in terms of the important aquatic habitats and species. This helped to evaluate species and habitats of ecological value in the vicinity of each site. The aquatic baseline prepared would inform mitigation for the wind farm project.

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

- Physical watercourse/waterbody characteristics (i.e., width, depth etc.)
- Substrate type, listing substrate fractions in order of dominance (i.e., bedrock, boulder, cobble, gravel, sand, silt etc.)

- River profile in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

Table 2.1 Location of *n*=20 aquatic survey sites in the vicinity of Ballivor wind farm near Ballivor, Co. Meath.

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Cartenstown Stream	07C60	Ballyhealy	661703	759056
A2	Stonestown River	07S11	Cartenstown Stream confluence	663011	759233
A3	Ballinn Stream	07B47	Local road crossing, Lisclogher Great	664937	760833
A4	Bolandstown River	07B45	Local road crossing, Bracklin	662455	758674
A5	Cartenstown Stream	07C60	Local road crossing, Coolronan	666077	756898
A6	Woodtown West Stream	07W06	Lisclogher Great	666459	758978
A7	Stonyford River	07S02	Cloghbrack Bridge	667624	758158
A8	Carranstown Little River	07C87	Coolronan	664558	756649
B1	Killaconnigan Stream	07K34	Grange More	664652	754555
B2	Kilballivor Stream	07K35	Killconnigan	667115	755088
B3	Unnamed stream	n/a	Clonycavan	667308	753476
B4	Unnamed stream	n/a	Local road crossing, Clonycavan	666871	752716
B5	Ballivor River	07B52	Local road crossing, Clonycavan	667266	751725
C1	Graffanstown Stream	07G10	Local road crossing, Bracklin	659139	757974
C2	Ballynaskeagh Stream	07B24	Local road crossing, Ballynaskeagh	659022	756531
C3	Mucklin Stream	07M13	Local road crossing, Craddanstown	659139	755895
C4	River Deel	07D01	Raharney Bridge, R156 road crossing	660041	753049
C5	Craddanstown Stream	07C55	Local road crossing, Riverdale	663341	751542
C6	Clondalee More Stream	07C77	Local road crossing, Clondalee More	664753	750982
D1	River Boyne	07B04	Scarriff Bridge, R156 road crossing	673349	752700

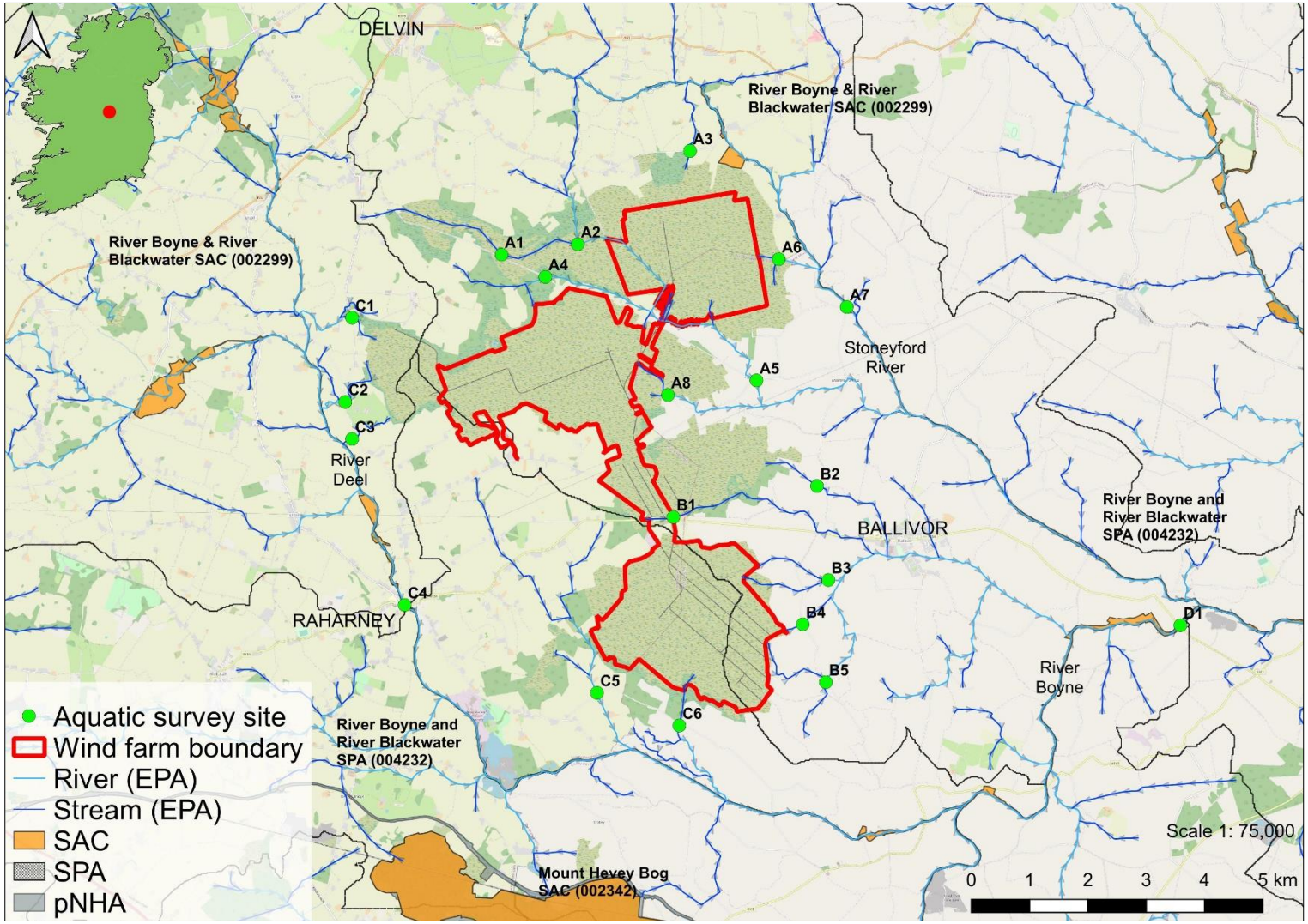

Figure 2.1 Overview of the *n*=20 aquatic survey site locations for the proposed Ballivor wind farm project, Co. Meath

2.3 Catchment-wide electro-fishing

A catchment-wide electro-fishing (CWEF) survey of the watercourses within the vicinity of the proposed wind farm (*n*=20 sites, **Figure 2.1**) was conducted on the 14-16th July 2021, under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) license. The survey was undertaken in accordance with best practice and Section 14 licencing requirements.

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

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

2.4 White-clawed crayfish survey

White-clawed crayfish (*Austropotamobius pallipes*) surveys were undertaken at the aquatic survey sites in July 2021 under a National Parks and Wildlife (NPWS) open licence (no. C145/2021), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2021), to capture and release crayfish to their site of capture, under condition no. 6 of the licence. As per Inland Fisheries Ireland recommendations, the crayfish license 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). Trapping of crayfish was not feasible given the small nature of most aquatic survey sites sampled. An appraisal of white-clawed crayfish habitat at each site was conducted based on physical channel attributes, water chemistry and incidental records in mustelid spraint. Additionally, a desktop review of crayfish records within the wider Ballivor wind farm survey area was completed.

2.5 Biological water quality (Q-sampling)

The aquatic survey sites were assessed for biological water quality through Q-sampling in May 2021. Some sites were unsuitable for Q-sampling during the survey period given low water levels/flows and the non-perennial nature of some watercourses (see section 4). Sites A2 (Stonestown River), B1 (Killaconnigan Stream), B2 (Kilballivor Stream), B4 (Ballivor River) and C3 (Mucklin Stream) were dry or semi-dry during the sampling period (i.e., non-perennial channels) and, thus, it was not possible to take biological water quality (Q) samples at these sites. A total of *n*=15 sites were sampled (i.e., sites A1, A3, A4, A6, A7, A8, A9, B3, B5, C1, C2, C4, C5, C6 & D1; **Figure 2.2**).

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

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

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

2.6 Otter signs

The presence of otter (*Lutra lutra*) was determined through the recording of otter signs within 150m of the aquatic survey sites. This also helped to determine the presence of white-clawed crayfish, whose remains may be found in otter spraint. The location of signs was recorded via handheld GPS.

2.7 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).

2.8 Biosecurity

A strict biosecurity protocol including the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. 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.

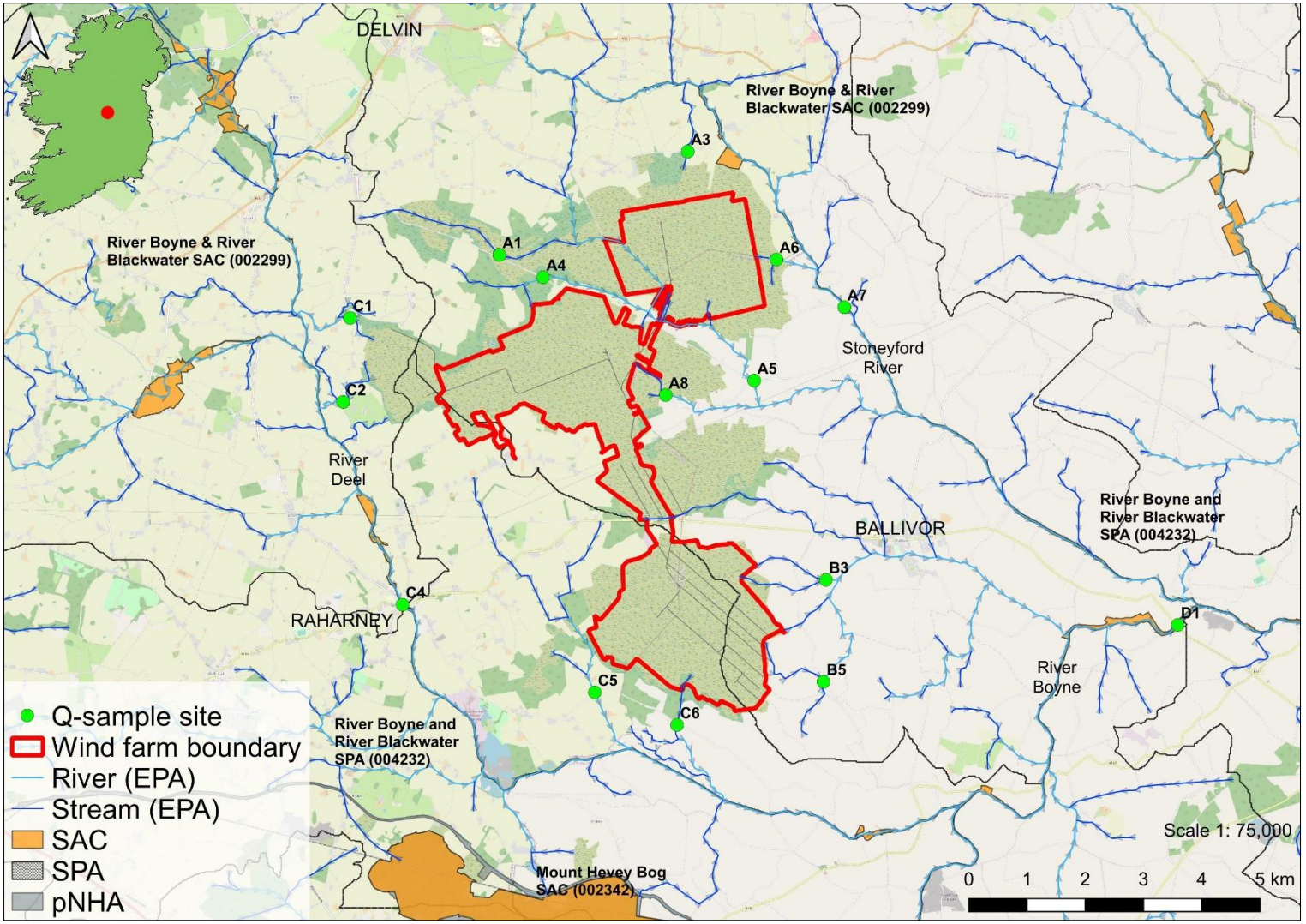

Figure 2.2 Overview of the biological water quality (Q-sampling) survey locations for the proposed Ballivor wind farm project, Co. Meath

3. Receiving environment

3.1 Sites designated for aquatic interests

There was a single European site with downstream hydrological connectivity to the proposed Ballivor wind farm project, namely the River Boyne and River Blackwater SAC (site code: 002299) (**Figure 2.1**).

3.1.1 River Boyne and River Blackwater SAC (002299)

This site comprises the freshwater element of the River Boyne as far as the Boyne Aqueduct, the Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers. These riverine stretches drain a considerable area of Meath and Westmeath, and smaller areas of Cavan and Louth. The Boyne and its tributaries form one of Ireland's premier game fisheries and the area offers a wide range of angling, from fishing for spring salmon and grilse to seatrout fishing and extensive brown trout fishing. Atlantic Salmon (*Salmo salar*) use the tributaries and headwaters as spawning grounds. The River Blackwater is a medium sized limestone river which is still recovering from the effects of the arterial drainage scheme of the 1970s. Salmon stocks have not recovered to the numbers that existed pre drainage. The Deel, Riverstown, Stoneyford and Tremblestown Rivers are all spring-fed, with a continuous high volume of water. They are difficult to fish because some areas are overgrown, while others have been affected by drainage with resultant high banks due to deepening. This River Boyne & Blackwater SAC (002299) is also important for the populations of two other species listed on Annex II of the E.U. Habitats Directive which it supports, namely river lamprey (*Lampetra fluviatilis*), which is present in the lower reaches of the Boyne River, and otter (*Lutra lutra*), which can be found throughout the site (NPWS, 2014).

Potential downstream hydrological connectivity exists between the proposed wind farm site and River Boyne and River Blackwater SAC via all 19 no. survey watercourses (20 no. survey sites within), namely the Cartenstown Stream, Stonestown River, Ballinn Stream, Bolandstown River, Woodtown West Stream, Stonyford River, Carranstown Little River, Killaconnigan Stream, Kilballivor Stream, Ballivor River and two unnamed tributaries, Graffanstown Stream, Ballynaskeagh Stream, Mucklin Stream, River Deel, Craddanstown Stream, Clondalee More Stream and River Boyne (**Figure 2.1**).

The survey sites on the Stonyford River (A7), River Deel (C4) and River Boyne (D1) were located within the River Boyne and River Blackwater SAC (002299) (**Figure 2.2**). The River Boyne and River Blackwater SAC is designated for the following qualifying interests (NPWS, 2021), namely;

- [1106] *Salmo salar* (Atlantic salmon)
- [1355] *Lutra Rivertown* (otter)
- [1099] *Lampetra fluviatilis* (river lamprey)
- [91E0] Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
- [7230] Alkaline fens

3.2 Sensitive species data request

A sensitive species data request was submitted (13/07/21) to the National Parks and Wildlife Service for the 10km grid squares containing and adjoining the proposed wind farm project (i.e., N55, N65, N66, N75) and was received on the 23rd July 2021. Records for a number of rare or protected species were available although most did not overlap directly with the survey area (**Figure 3.1**).

Records for white-clawed crayfish (*Austropotamobius pallipes*) widespread within the survey area, on the Deel, Stonyford and Boyne rivers (**Figure 3.1**). However, the bulk of these records were historical only (i.e., 1971-1985). A low number of contemporary records (2006-2009) were available for the upper reaches of the Stonyford River, although a single record was available for Stonyford Bridge near the River Boyne confluence (downstream of survey area) in 2009.

Otter (*lutra lutra*) records were also widespread throughout the relevant grid squares, with records available for the River Deel, Stonyford River and River Boyne. Historical records (1980) were available for the Cartenstown Stream and Bolandstown River within the vicinity of the proposed wind farm planning boundary.

Numerous kingfisher (*Alcedo atthis*) records were available for the survey area, including along the Deel, Stonyford and Boyne Rivers (all from 2010). Historical records were also available for these watercourses from data held by the National Biodiversity Data Centre (NBDC). There were no kingfisher records available for the watercourses within the proposed site boundary.

Common frog (*Rana temporaria*) were widespread throughout 10km grid squares S22, S23, S24, S33 and S34, with a low number of records available for Culronan Bog, located within the proposed site boundary.

3.3 Ballivor wind farm catchment and survey area description

The proposed Ballivor wind farm is located on the Ballivor, Bracklin, Carranstown, Lisclogher and Lisclogher West bogs located in Counties Meath and Westmeath. The closest large settlements to the site are Ballivor which is located approximately 2km to the east, Delvin which is located approximately 2.5km to the northwest and Raharney which is located 3km to the west. The proposed wind farm site is within the Eastern River Basin District and within hydrometric area 7 (Boyne). This catchment includes the area drained by the River Boyne and by all streams entering tidal water between The Haven and Mornington Point, Co. Meath, draining a total area of 2,694km². The aquatic survey sites were located within the Deel (Raharney) and Stoneyford River sub-basins, in the wider River Boyne catchment (Boyne_SC_040 and Boyne_SC_050) (**Figure 2.1**).

The following watercourses drained the proposed wind farm site: Cartenstown Stream (07C60), Stonestown River (07S11), Ballinn Stream (07B47), Bolandstown River (07B45), Woodtown West Stream (07W06), Stoneyford River (07S02), Carranstown Little River (07C87), Killaconnigan Stream (07K34), Kilballivor Stream (07K35), Ballivor River (07B52), Graffanstown Stream (07G10), Ballynaskeagh Stream (07B24), Mucklin Stream (07M13), River Deel (07D01), Craddanstown

Stream (07C55), Clondalee More Stream (07C77), River Boyle (07B04) and an unnamed stream near the townland of Clonycavan.

The watercourses and aquatic surveys sites in the vicinity of Ballivor wind farm were typically small, lowland depositing channels (FW2; Fossitt, 2000) and drainage ditches (FW4) (see **section 4** for more details). The three major watercourses with hydrological connectivity to the site were the River Deel, Stoneyford River and River Boyne. Land use practices in the wider survey area were primarily peat bogs (CORINE 412) bordered by agricultural pasture (231) and non-irrigated arable land (211).

Predominantly, the watercourses flowed over areas of Visean or Tournaisian limestone and calcareous shale limestone (Geological Survey of Ireland data).

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed wind farm project. Only recent water quality (i.e., since 2015) is summarised below. There were no existing EPA biological monitoring data available for the smaller watercourses surveyed, namely the Cartenstown Stream (07C60), Stonestown River (07S11), Ballinn Stream (07B47), Bolandstown River (07B45), Woodtown West Stream (07W06), Carranstown Little River (07C87), Killaconnigan Stream (07K34), Kilballivor Stream (07K35), Ballivor River (07B52), Graffanstown Stream (07G10), Ballynaskeagh Stream (07B24), Mucklin Stream (07M13), Craddanstown Stream (07C55) or Clondalee More Stream (07C77).

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 Stoneyford River

The Stoneyford River (EPA code: 07S02) flowed parallel to the proposed eastern site boundary. There were a number of EPA biological monitoring stations which have been recently monitored on the river (since 2015). In the vicinity of the wind farm site, the uppermost of these (station code RS07S020075) was located at Stonestown Bridge upstream of the proposed site boundary, and achieved Q3 (poor status) water quality in 2020. Station RS07S020100, located at Rathkenna Bridge, downstream of the site boundary and downstream of aquatic survey site A7, achieved Q4 (good status) water quality in 2015. At Stonyford Bridge (station RS07S020400) near the River Boyne confluence, the river achieved Q3-4 (moderate status) in 2020.

At the time of report drafting, there was no WFD status (2013-2018) or River Waterbodies Risk score available for the Stoneyford River.

3.4.2 River Deel

The River Deel (07D01) ran parallel (loosely north to south) to the western site boundary, draining several small watercourses to the west and south of the proposed site. At both Cummer Bridge (station RS07D010200) and Raharney Bridge (RS07D010300, survey site C4) the Deel achieved Q4 (good status) in 2020 and 2018, respectively. At Inan Bridge (RS07D010400), located south of the

wind farm site, the river achieved Q3-4 (moderate status) in 2020. The lowermost monitoring station on the river, at the R161 road bridge (RS07D010600), the river achieved Q4 (good status) in 2020.

Upstream of the wind farm, the Deel (Raharney)_030 sub-catchment was of moderate WFD status. Downstream, the Deel (Raharney)_040 and Deel (Raharney)_060 sub-catchments were of good WFD status (2013-2018). Downstream of Raharney, the Deel (Raharney)_050 sub-catchment was of moderate WFD status. At the time of report drafting, there was no River Waterbodies Risk score available for the River Deel.

3.4.3 River Boyne

The River Deel and Stoneyford River both joined the River Boyne (07B04) to the south of the proposed site (i.e., downstream connectivity). At Inchamore Bridge (RS07B040800), downstream of the Deel confluence, the Boyne achieved QQ4-5 (high status) in 2015. However, at Scarriff Bridge (RS07B040900, aquatic survey site D1), the river achieved Q3-4 (moderate status) in 2015. Downstream of the Stoneyford confluence, the Boyne typically achieved Q3-4 (moderate status) for the length of its course (EPA data 2015-2020).

Whilst the WFD status of the Boyne was good upstream of Scarriff Bridge, downstream it fell to moderate status and was generally considered 'at risk' in terms of the Waterbodies Risk score.

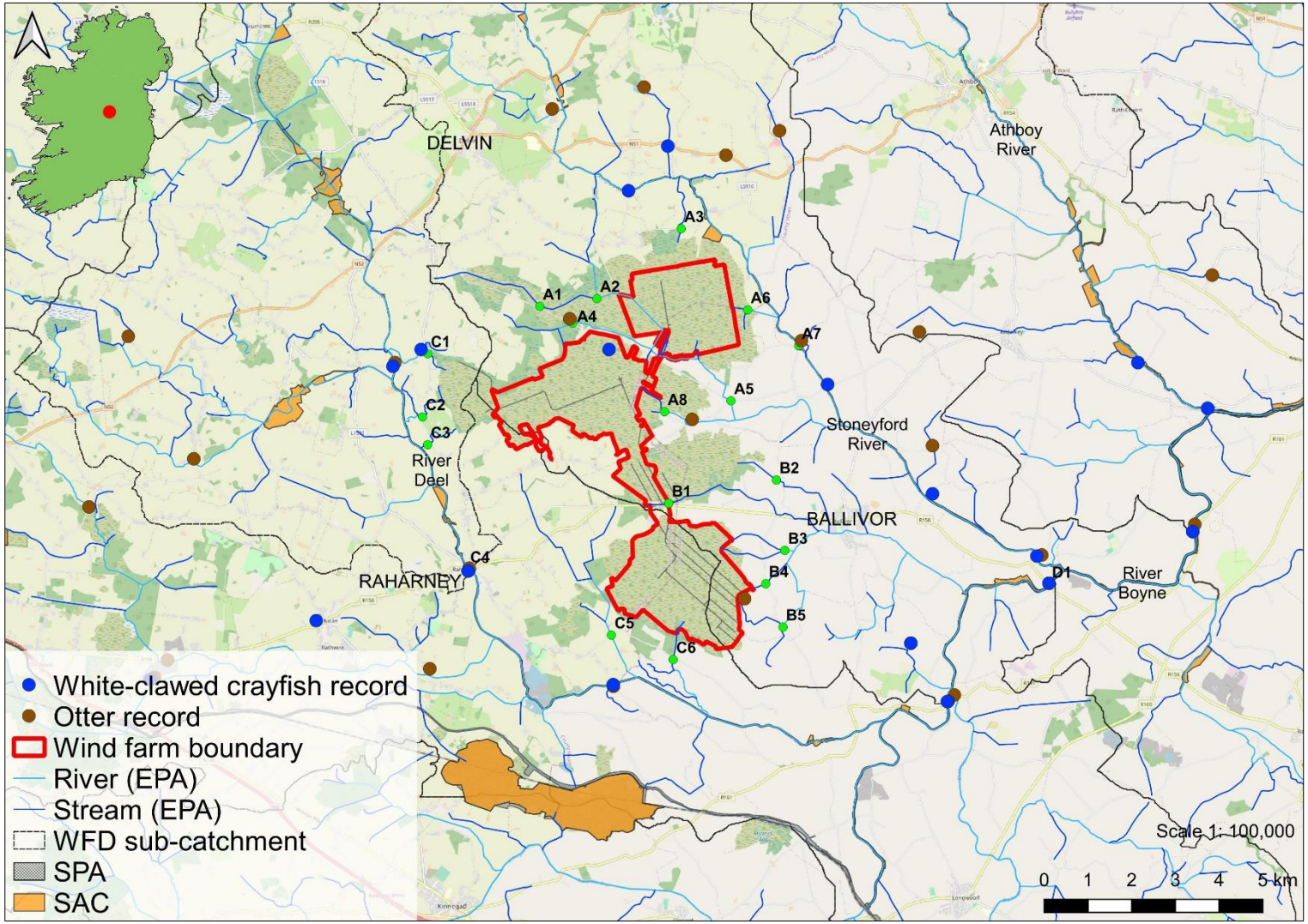

Figure 3.1 Distribution of white-clawed crayfish and otter records in the vicinity of the proposed Ballivor wind farm (source: NPWS data)

4. Results of aquatic surveys

The following section summarises each of the *n*=20 survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, white-clawed crayfish and macrophyte/aquatic bryophyte communities. The aquatic sites were surveyed in July 2021. Please refer to **Appendix A** (fisheries assessment report) for detailed fisheries results. Biological water quality (Q-sample) results are also summarised for each sampling site (*n*=15) in Appendix B. Habitat codes are listed according to Fossitt (2000). Scientific names are provided at first mention only. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.1**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Cartenstown Stream, Ballyhealy

Site A1 was located on the upper reaches of the Cartenstown Stream in area of cutover bog (PB4). The stream was a very narrow (<0.5m wide) modified drainage channel that had been straightened and deepened historically with bankfull heights of 1.5-2m. The channel was deeply cut into peat and, resultingly, the channel bed comprised 100% soft peat with no hard substrata. The site featured 100% slow-flowing glide habitat and was considered likely non-perennial (i.e., dries up seasonally), being 0.05-0.1m deep with a slight flow. Instream encroachment by downy birch (*Betula pubescens*), purple moor grass (*Molinia caerulea*), heather (*Calluna vulgaris*), grey willow (*Salix cinerea*) and other terrestrial grasses obstructed the flow considerably. Shading was also high given the steep (often vertical) cut banks. The channel was bordered by cutover bog dominated by heather with cottongrass (*Eriophorum angustifolium*), occasional tormentil (*Potentilla erecta*) and scattered downy birch and Scots pine (*Pinus sylvestris*). Macrophytes and aquatic bryophytes were absent due to the peat-stained water, likely non-perennial nature and shading.

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. The site offered no suitability for white-clawed crayfish or otter with no evidence of either species recorded during the survey.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that, given the poor flows and heavily silted nature, 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.

The aquatic ecological evaluation of site A1 was of **local importance (lower value)** (**Table 4.1**).

Plate 4.1 Representative image of site A1 on the Cartenstown Stream, May 2021

4.1.2 Site A2 – Stonestown River, Cartenstown Stream confluence

Site A2 was located on the Stonestown River (07S11) at the Cartenstown Stream confluence. The channel had been modified historically (straightened and deepened) and was 100% dry at the time of survey, with no pools of standing water remaining. The non-perennial channel drained cutover peat bog (PB4) and averaged 1.5-2m wide in a shallow U-shaped channel. The river featured a 100% peat base and was evidently dry for much of the year. The channel was heavily scrubbed with willow (*Salix* sp.) and bramble (*Rubus fruticosus* agg.) vegetation.

The river had no aquatic or fisheries value given the lack of water. However, the downstream-connecting Cartenstown Stream featured low flows at the time of survey and had some low fisheries and aquatic value.

Site A2 was not suitable for Q-sampling during the survey period due to its dry nature and lack of flow. Thus, it was not possible to assess biological water quality at this site.

The aquatic ecological evaluation of site A2 was of **local importance (lower value) (Table 4.1).**

Plate 4.2 Representative image of site A2 on the Stonestown River, May 2021 (channel 100% dry)

4.1.3 Site A3 – Ballinn Stream, Lisclogher Great

Site A3 was located on the upper reaches of the Ballinn Stream (07B47) at a local road crossing north of the wind farm site boundary. The stream represented a 1.5-2m-wide peat drainage channel (FW4) that had been straightened and deepened historically, with bankfull heights of 2m-2.5m in a steep U-shaped channel. The channel had been excavated to a uniform depth of 0.6-0.7m and was heavily silted (peat deposition). Some fine to medium gravels were present underfoot but these were heavily bedded in silt. Peat staining was high. The stream adjoined another channel along the adjacent local road which featured greater depths to 0.8m in a 2m wide channel. The site was heavily covered with terrestrial and aquatic vegetation. Macrophytes recorded included occasional watercress (*Nasturtium officinale*) and common duckweed (*Lemna minuta*) with >90% cover of bentgrass (*Agrostis* sp.) instream, creating extensive floating mats. Reed canary grass (*Phalaris arundinacea*) was also present along the banks and instream. There was no open water present. Flow was very slow at the time of survey (even following rainfall). Upstream of the confluence, the Ballinn Stream was heavily shaded by riparian scrub with frequent downy birch and grey willow treelines. To the west, cutover bog (PB4) with high birch cover was present, with GA1 (sheep grazing) to the west and downstream of the road crossing (pipe culvert).

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel was present but none were recorded. The site offered no suitability for white-clawed crayfish or otter.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that, given the poor flows and absence of faster flowing riffle and glide habitat heavily, 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.

The aquatic ecological evaluation of site A3 was of **Local importance (lower value)** (**Table 4.1**).

Plate 4.3 Representative image of site A3 on the Ballinn Stream, May 2021 (stream is in background, with adjoining drainage channel in foreground)

4.1.4 Site A4 – Bolandstown River, Bracklin

Site A4 was located on the upper Bolandstown River (07B45) at a local road crossing. The river was a small lowland depositing watercourse (FW2) which had been historically straightened and deepened. Recent maintenance (bank clearance and excavation) was evident upstream of the bridge. The river averaged 2m wide and 0.1-0.2m deep in a deep V-shaped channel with 2-3m bankfull heights. The site predominantly featured shallow moderate flowing glide habitat with occasional riffle areas and even more occasional pools (max depth 0.4m). The water was heavily peat-stained at the time of survey (following recent rain) and the substrata were moderately to heavily silted with flocculent peat. The bed was dominated by soft sand (low compaction) with frequent silt deposits (some >15cm deep). Exposed gravels were rare but present (tailings of pools etc.) but these were compacted/bedded. Boulder and cobble were absent. Instream macrophytes were limited to emergent species given the high peat-staining with occasional watercress, brooklime (*Veronica beccabunga*) and water speedwell (*Veronica* sp.) along channel margins. Downstream of the bridge, the river was adjoined by improved pasture (GA1) and scrubby woodland dominated by willow, birch and occasional ash (*Fraxinus excelsior*) along the channel with frequent cherry laurel (*Prunus laurocerasus*). An area of clear-fell (WS5) was located adjacent to the channel upstream of the bridge (south bank).

Three-spined stickleback and *Lampetra* sp. were the only species recorded via electro-fishing (**Appendix A**). Site A4 had low nursery, spawning and holding value for salmonids given the poor thalweg and very high levels of siltation and none were recorded during electro-fishing. The channel was not considered of value to European eel given the absence of refugia such as cobble and boulder. The channel was however of some value to lamprey given pockets of fine silt with a high organic content up to 20cm deep adjoining areas with finer gravels (albeit degraded by silt). Low to moderate densities of lamprey were recorded at 2.8 per m^2 ($5m^2$ of habitat targeted and 14 ammocoetes captured). The site offered no suitability for white-clawed crayfish, given heavy siltation. Although no otter signs were recorded, there was some low foraging potential for the species.

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.

The aquatic ecological evaluation of site A3 was of **Local importance (higher value)** (**Table 4.1**).

Plate 4.4 Representative image of site A4 on the Bolandstown River, May 2021

4.1.5 Site A5 – Cartenstown Stream, Coolronan

Site A5 was located on the Cartenstown Stream (07C60) at a local road crossing, approx. 1.6km downstream of the wind farm boundary. The stream was a small, swift-flowing lowland depositing watercourse (FW2) that had been straightened and deepened historically, both upstream and downstream of the bridge. The channel averaged 2.5-3m wide in a deep steep U-shaped channel with bankfull heights often exceeding 2.5m. Channel depths were between 0.1m and 0.5m deep. The site was dominated by glide and pool habitat with occasional riffles upstream and downstream in association with instream large woody debris (LWD). The water was very heavily peat-stained at the time of survey. Instream substrata were dominated by bedded mixed gravels

and cobble with frequent boulder. Sand was frequent and sand/silt accumulations were present in channel margins and slacks. The bridge featured a concrete apron with harder substrata atop. Overall, siltation (peat derived) was moderate. Given high peat staining, there were no visible macrophytes or aquatic bryophytes. The stream flowed through improved pasture (GA1) with associated riparian treelines (WL2) and hedgerows of hawthorn (*Crataegus monoygna*), elder (*Sambucus nigra*), willow, privet (*Ligustrum vulgare*) and scrubby bramble understories.

Brown trout (*Salmo trutta*) and *Lampetra* sp. were the only species recorded via electro-fishing (**Appendix A**). The site had low nursery, spawning and holding value for salmonids given the poor thalweg and very high levels of siltation. These were exacerbated by historical channelization and sedimentation pressures from the adjoining improved grassland. Only small numbers of 0+ brown trout were recorded, exemplifying the poor value of the site for salmonids. The channel was considered of only moderate value to European eel (none recorded). The channel was however of some value to lamprey given pockets of fine silt with a high organic content up to 15cm deep adjoining areas with finer gravels (albeit degraded by silt). Very low densities of lamprey were recorded at 0.4 per m^2 ($10m^2$ of habitat targeted and 4 ammocoetes captured) despite targeted electro-fishing of soft sediment areas being undertaken. The site offered no suitability for white-clawed crayfish, given heavy siltation. Although no signs were recorded, there was some low potential for foraging otter.

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.

The aquatic ecological evaluation of site A5 was of **Local importance (higher value)** (**Table 4.1**).

Plate 4.5 Representative image of site A5 on the Cartenstown Stream, May 2021 (facing downstream from underneath road bridge)

4.1.6 Site A6 – Woodtown West Stream, Lisclogher Great

Site A6 was located on the on the Woodtown West Stream (07W06) was located in cutover bog (PB4) downstream of the wind farm site boundary. The stream was a heavily-modified bog drainage channel (FW4) which averaged 1-1.5m in width and 0.2-0.3m deep. The channel had been historically straightened and deepened adjacent to a working area of cutover bog. The stream had an imperceptible flow with numerous instream blockages (100% standing water/ponding). The channel was considered non-perennial at this location. The drainage channel was grossly silted (several silt dams present). The channel and banks comprised 100% soft peat. No macrophytes were present in the heavily peat-stained water. However, *Sphagnum* sp. moss was abundant within the channel and filamentous algae was also present (10% cover). Encroachment of terrestrial grasses (e.g., *Juncus* sp.) was high and often coverage exceeded 80%. The channel adjoined an area of cutover bog with birch-dominated woodland/scrub present along the south bank, with frequent heather, soft rush (*Juncus effusus*) and occasional willow. Improved pasture (GA1) was present to the south.

No fish species were recorded via electro-fishing (**Appendix A**) and the heavily silted channel was of no fisheries value, given the lack of flow and heavily-silted (peat) nature. The site offered no suitability for white-clawed crayfish or otter and the species were not recorded during the survey. However, both common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris*) were recorded via sweep netting.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that, given the poor flows and absence of faster flowing riffle and glide habitat heavily, 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 presence of both smooth newt and common frog, the aquatic ecological evaluation of site A6 was of **local importance (higher value)** (**Table 4.1**).

Plate 4.6 Representative image of site A6 on the Woodtown West Stream, May 2021

4.1.7 Site A7 – Stonyford River, Cloghbrack Bridge

Site A7 was located on the Stoneyford River (07S02) at Cloghbrack Bridge. The river at this location was a high energy lowland depositing watercourse (FW2). The had been historically straightened and over-deepened, with bankfull heights of 3-4m. The channel was 7-8m in width in a steep V-shaped channel that had been excavated down to clay. Thus, the substrata were very compacted/bedded, with calcified deposits present also further reducing availability of the bed to aquatic biota. The site was typified by fast glide averaging 0.4-0.8m in depth. Small pools to 1m+ were present but rare with deep glide predominating upstream and downstream of the bridge structure. Riffles were present locally upstream of the bridge. A small drain adjoined the south bank of the river which carried a significantly higher peat loading (stained water). Peat staining of the main river was low. The heavily compacted bed featured mostly cobble and boulder with interstitial bedded coarse gravels and some sand. Soft sediment deposits were not present. Instream macrophytes were not recorded owing to high flow rates, relatively high riparian shading and compacted substrata although the cover of Kneiff's feather moss (*Leptodictyum riparium*) was relatively high (20%), with submerged *Pellia* sp. liverwort being occasional on boulders. Filamentous algae was also present at low coverage (<2%). The riparian zone supported mature treelines of ash, alder (*Alnus glutinosa*), willow and hazel (*Corylus avellana*) with occasional sycamore (*Acer psuedoplatanus*). The understorey was dominated by bramble scrub (WS1). The site was adjoined by improved pasture (GA1) on all sides.

Brown trout, Atlantic salmon (*Salmo salar*) and *Lampetra* sp. ammocoetes were recorded via electro-fishing (**Appendix A**). The channel featured moderate quality nursery and spawning habitat, given that both were compromised by historical dredging. This had resulted in a channel with limited riffle habitat and localised patches of gravel between paths of argillaceous clay. The holding value for salmonids was good due to the presence of deep glide and pool with

overhanging trees, undercut banks etc. The site was not considered of good quality for European eel given the limited presence of accessible refugia such as cobble and boulder. The site was of only moderate value for lamprey, with both sub-optimal adult (spawning) and ammocoete burial habitat present. Low densities of larval lamprey were recorded at 1.75 per m^2 ($4m^2$ of habitat targeted and *n*=7 ammocoetes captured). The site offered poor suitability for white-clawed crayfish given a paucity of suitable refugia and no crayfish were recorded during targeted surveys. Although no signs were recorded, there was some good potential for foraging otter given the presence of salmonids.

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

Given the location of the Stoneyford River within the River Boyne and River Blackwater SAC (002299), the aquatic ecological evaluation of site A7 was of **international importance.**

Plate 4.7 Representative image of site A7 on the Stonyford River, May 2021 (facing downstream towards bridge)

4.1.8 Site A8 – Carranstown Little River, Coolronan

Site A8 was located on the upper reaches of the Carranstown Little River (07C87), downstream of the wind farm site boundary. Situated at a drainage channel confluence, site A8 was a 2m-wide historically modified, swift-flowing lowland depositing watercourse with some eroding characteristics. The river averaged 0.2-0.3m deep with occasional pools >0.5m. The river had been straightened and deepened with bank heights exceeding 2.5m in a steep U-shaped channel. The substrata were dominated by bedded/compacted mixed gravels and small cobble with occasional boulder in faster flowing areas near the bridge culvert, with sand heavily intermixed with peat dominating in slower flowing glide. The river drained an area of adjacent cutover bog (PB4) and

peat staining was very high at the time of survey. Silt accumulations were present and, despite having high fractions of sand, were invariably soft (uncompacted). Glide habitat dominated with only occasional pool and even more occasional riffle areas. Instream macrophytes were absent given the peat-staining but the semi-aquatic moss *Brachythecium rivulare* was present on the lip of the bridge apron (2ft fall, barrier to fish at low flows) and on larger boulders. The site adjoined cutover bog and improved grassland (GA1), with scattered treelines of willow, elder and downy birch and scrubby understories adjoining the channel.

No fish were recorded via electro-fishing at site A8 (**Appendix A**). Suitability was limited to three-spined stickleback, although none were recorded present. The channel featured poor quality salmonid nursery and spawning habitat, given high levels of peat-derived siltation. The site was not considered of good quality for European eel given the limited presence of accessible refugia such as cobble and boulder. Despite the presence of soft sediment accumulations, these were humic in nature (i.e., peat-dominated) and not suitable for larval lamprey. The site offered no suitability for white-clawed crayfish given high levels of siltation. Potential for otter was low given the evidently poor fish prey resource.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of fish species and poor status water quality, the aquatic ecological evaluation of site A8 was of **local importance (lower value).**

Plate 4.8 Representative image of site A8 on the Carranstown Little River, May 2021

4.1.9 Site B1 – Killaconnigan Stream, Grange More

Site B1 was located on the uppermost reaches of the Killaconnigan Stream (07K34), adjacent to the R156 near the Ballivor Bord na Móna factory. The stream represented a semi-dry bog drainage channel (FW4), that averaged 2m wide and <0.1m deep. The channel had been straightened and over-deepened historically, with poor recovery evident. The stream was located in a deeply excavated, steep U-shaped channel with bankfull heights of 2-2.5m. There was no flow at the time of survey with stagnant water (ponding) present. The site drained an extensive area of cutover bog (PB4) to the north and was heavily silted, with no harder substrata present (i.e., 100% soft peat). The banks were heavily scrubbed with downy birch, willow and bramble. As such, riparian shading was high and no instream macrophytes were present.

No fish were recorded via electro-fishing of stagnant pools (**Appendix A**). Other than very low suitability for three-spined stickleback in the wider area, site B1 was not of fisheries value given its heavily-silted nature with limited water. There was some suitability for common frog (although none were recorded via sweep netting). The site had no suitability or white-clawed crayfish or otter and the species was not recorded.

Site B1 was not suitable for Q-sampling during the survey period due to its semi-dry nature and lack of flow. Thus, it was not possible to assess biological water quality at this site.

Given the non-perennial nature of the stream at this location, the aquatic ecological evaluation of site B1 was of **local importance (lower value).**

Plate 4.9 Representative image of site B1 on the Killaconnigan Stream, May 2020 (semi-dry channel)

4.1.10 Site B2 – Kilballivor Stream, Killconnigan

Site B2 was located on the upper reaches of the Kilballivor Stream, approx. 1km downstream of an extensive area of cutover bog. The site was 100% dry at the time of survey and, evidently, had not conveyed water for a considerable period. The 2-2.5m wide, U-shaped drainage channel (FW4) had been historically straightened and realigned through improved agricultural grassland. Bankfull heights were 1-1.5m. The channel base was dry mud (i.e., no evidence of recent flows or standing water) and was colonised by ruderal species such as nettle. The non-perennial site was heavily shaded by a mature treeline/hedgerow of ash, elder and hawthorn with bramble scrub. The site was adjoined by improved grassland on both banks.

The stream had no aquatic or fisheries value given the lack of water at the time of survey and would appear to offer no aquatic value for much of the year. No signs of otter were recorded.

Site B4 was not suitable for Q-sampling during the survey period due to its dry nature and lack of flow. Thus, it was not possible to assess biological water quality at this site.

The aquatic ecological evaluation of site B2 was of **local importance (lower value) (Table 4.1).**

Plate 4.10 Representative image of site B2 on the Kilballivor Stream, May 2020 (100% dry channel)

4.1.11 Site B3 – Unnamed stream, Clonycavan

Site B3 was located at the confluence of two unnamed tributaries (no EPA code) of the Ballivor River, approx. 1.4km downstream of the site boundary. Bordered by intensive pasture (GA1), both channels had been extensively straightened and deepened in the recent past with poor recovery evident. Downstream and upstream of the confluence, the channel averaged 2m in width and 0.1-0.2m deep. The steep V-shaped profile featured bankfull heights of 2.5m throughout. Slow-

flowing glide dominated with an absence of pool habitat apart from the confluence. The northern channel featured a greater flow than the southern channel, which was more representative of a drainage ditch habitat (near stagnant and very heavily silted apart from near road crossing, where dredging had not been undertaken). As a result of dredging, the substrata were very heavily silted with very limited harder substrata present. These were restricted to localised medium-coarse gravels and small cobble in areas of faster flow (riffle zones) and partially bedded in peat/silt. Sand was frequent but overwhelmingly the bed was composed of silt (often >15cm in depth). The southern channel was heavily peat-stained whilst the northern channel was much less turbid. Instream macrophytes were limited to occasional watercress, fool's watercress (*Apium nodiflorum*) and brooklime in channel margins, with very occasional water starwort (*Callitriche stagnalis*) present in slacker areas. Aquatic bryophytes were not present given recent channel modifications. The riparian zone (which had been flailed and recently cut) supported treelines and hedgerows of hawthorn, willow, elder, holly (*Ilex aquifolium*) and ash with scrubby understories of mostly bramble. The southern bank had been cleared to the banktop.

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of low densities of this species, the heavily-silted channel was of very poor fisheries value, i.e., not of value to salmonids given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel and *Lampetra* sp. was present but none were recorded. The site offered no suitability for white-clawed crayfish and none were recorded. No signs of otter were recorded.

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.

The aquatic ecological evaluation of site B3 was of **local importance (lower value).**

Plate 4.11 Representative image of site B3, May 2021

4.1.12 Site B4 – Unnamed stream, Clonycavan

Site B3 was located in the upper reaches of an unnamed Ballivor River tributary (no EPA code) at a local road crossing, approx. 0.3km downstream of the site boundary. The historically straightened and deepened channel averaged 1-1.5m wide with bankfull heights of up to 2m. The channel was 100% dry at the time of survey, with no ponding or stagnant water present (i.e., non-perennial channel). The base comprised 100% mud (i.e., no hard substrata). The site was bordered by improved agricultural grassland (GA1) and a mature treeline of sycamore, hawthorn and ash.

The river had no aquatic or fisheries value given the lack of water at the time of survey and no otter signs were recorded. The channel was considered likely to convey water intermittently during the year given a damp, muddy base. The downstream-connecting Ballivor River (0.7km downstream) was of some moderate fisheries and aquatic value.

Site B4 was not suitable for Q-sampling during the survey period due to its dry nature and lack of flow. Thus, it was not possible to assess biological water quality at this site.

The aquatic ecological evaluation of site A2 was of **local importance (lower value) (Table 4.1).**

Plate 4.12 Representative image of site B4 on unnamed Ballivor River tributary, May 2021 (dry channel)

4.1.13 Site B5 – Ballivor River, Clonycavan

Site B5 was located on the upper reaches of the Ballivor River (07B52) at a local road crossing, approx. 1.5km downstream of the site boundary. The lowland depositing watercourse (FW2/FW4) had been straightened and deepened historically, with more recent maintenance evident downstream of the bridge. The channelised river was 3m wide and 0.2-0.3m deep on average. The water was peat-stained and had a moderate flow rate, but no broken riffle or glide

habitat was present. The river was very heavily silted with extremely localised superficial patches of fine to medium gravels atop deep silt deposits in vicinity of the bridge. The bed comprised 99% silt, often deeper than 0.5m. The river had been extensively straightened and deepened upstream of the bridge (to the north) and suffered from imperceptible flows and gross siltation. The profile was of shallow glide with an absence of pooling areas and no riffle zones (typical of a dredged channel section). The river was contained in an excavated deep U-shaped channel with 2-2.5m bankfull heights. Instream macrophytes were limited to occasional unbranched bur reed (*Sparganium erectum*) with very occasional water starwort. The site adjoined agricultural pasture (GA1) with a mature scrubby treeline of ash, sycamore, elder, Scots pine and abundant hawthorn and bramble along the north bank. The south bank had been cleared historically (to banktop) with the steeply sloping bank colonised by grasses and nitrophilous species like nettle (*Urtica dioica*) and hogweed (*Heracleum sphondylium*).

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel was present but none were recorded. The site offered no suitability for white-clawed crayfish and the species was not recorded. A regular otter spraint site was recorded on a ledge underneath the bridge (ITM 667172, 751822) (invertebrate remains only, no fish or crayfish).

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that, given the absence of faster flowing riffle and glide habitat heavily, 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 presence of otter, the aquatic ecological evaluation of site B5 was of **Local importance (higher value).**

Plate 4.13 Representative image of site B5 on the Ballivor River, May 2021 (facing downstream from bridge)

4.1.14 Site C1 – Graffanstown Stream, Bracklin

Site C1 was located on the Graffanstown Stream (07G10) at a local road crossing, approx. 1.2km upstream of the River Deel confluence and River Boyne and River Blackwater SAC (002299). The lowland depositing watercourse (FW2) emanated from cutover bog and had been extensively straightened and over-deepened, historically. Upstream of the single pipe culvert at the road crossing, the stream was contained within a 3m-wide, deep U-shaped channel with bankfull heights of >2.5m. The stream averaged 2.5m wide and <0.15m deep. The site comprised 95% shallow, slow-flowing glide with very limited pool. The flow was slow at the time of survey. Gravels were present underfoot but these were underneath 0.2-0.3m of silt deposits. The stream bed was very heavily silted (peat derived) with deep deposits (to 0.25m) present. Whilst some limited sands and fine gravels were present on top of the flocculent sediment in places (e.g., near meander 40m upstream of culvert), these were also heavily silted. Peat staining was low at the time of survey. However, instream macrophytes were limited to only occasional lesser water parsnip (*Berula erecta*) along channel margins. No aquatic bryophytes were recorded (no suitable substrata or flow for such species). The site was bordered by improved pasture (GA1) to the south and an area of mixed broadleaved woodland (WD1) to the north. The banks of the channel were heavily scrubbed with willow and bramble along the north bank, with the adjoining pasture extending to the banktop on the south.

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of very low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Despite an abundance of soft sediment accumulations, these were not of value for larval lamprey given the flocculent and or high humic content, in addition to poor flows.

The site offered no suitability for white-clawed crayfish and none were recorded. No otter signs were recorded.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that, given the absence of faster flowing riffle and glide habitat heavily, 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.

The aquatic ecological evaluation of site C1 was of **local importance (lower value).**

Plate 4.14 Representative image of site C1 on the Graffanstown Stream, May 2021 (facing upstream from road culvert)

4.1.15 Site C2 – Ballynaskeagh Stream, Ballynaskeagh

Site C2 was located on the Ballynaskeagh Stream (07B24) at a local road crossing, approx. 0.6km upstream of the River Deel confluence and River Boyne and River Blackwater SAC (002299). The stream was a small, shallow, moderate-energy lowland depositing watercourse (FW2), with low flows at the time of survey. The stream was considered likely to be non-perennial at this location. The channel had been straightened and deepened historically, with bankfull heights of >2m. The stream averaged 1-1.5m wide and <0.05m deep at the time of survey (July 2021). Shallow glide and riffle dominated with only very localised shallow pool to 0.1m depth. The bed featured fine, medium and coarse gravels with low sand fractions. However, these were often heavily silted and bound in peat. Cobble and small boulder were occasional. Peat agglomerations were present on top of the substrata in some areas (the stream drained cutover bog upstream). The site was bordered by residential properties (GA2) and scrub, with a mature treeline of sycamore, hawthorn and elder. The channel was very heavily shaded upstream and downstream of the road bridge by riparian scrub, with tunnelling present in most areas. This precluded the presence of instream macrophytes although very limited *Leptodictyum riparium* present.

No fish were recorded via electro-fishing (**Appendix A**). Despite some low physical habitat suitability for salmonids and lamprey, these species were absent. This was considered a result of very low water levels at the time of survey (average depth <0.05m) and the stream's likely non-perennial nature. Nevertheless, even during higher water levels (e.g., winter), the site would only provide (at best) moderate suitability, given high rates of siltation and compacted substrata. There was some low suitability for European eel, albeit none were recorded. The site offered no suitability for white-clawed crayfish or otter and neither species was recorded.

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.

The aquatic ecological evaluation of site C2 was of **local importance (lower value).**

Plate 4.15 Representative image of site C2 on the Ballynaskeagh Stream, July 2021

4.1.16 Site C3 – Mucklin Stream, Craddanstown

Site C3 was located on the lowermost reaches of the Mucklin Stream (07M13), approx. 0.2km upstream of the River Deel confluence and River Boyne and River Blackwater SAC (002299). The channel was 100% dry at the time of survey, with no ponding or stagnant water present (i.e., non-perennial channel). The historically straightened and deepened channel averaged <1m wide with bankfull heights of 0.5-1m. The base comprised 100% mud (i.e., no hard substrata). The site was bordered by improved agricultural grassland (GA1) and a mature hawthorn hedgerow.

The stream had no aquatic or fisheries value given the lack of water at the time of survey. The channel was considered likely to convey water intermittently during the year (but mostly dry). The fisheries and aquatic value was superior in the nearby downstream-connecting River Deel,

located <200m downstream. The lowermost reaches of the channel were likely of some low fisheries and aquatic value during high water levels (i.e., refuge from flood water on the River Deel).

Site B4 was not suitable for Q-sampling during the survey period due to its dry nature and lack of flow. Thus, it was not possible to assess biological water quality at this site.

The aquatic ecological evaluation of site C3was of **local importance (lower value) (Table 4.1).**

Plate 4.16 Representative image of site C3 on the Mucklin Stream, July 2021 (100% dry channel)

4.1.17 Site C4 – River Deel, Raharney Bridge

Site C4 on the River Deel (07D01) was located at Raharney Bridge on the R156 in Raharney village. The River Deel was a medium-sized high-energy lowland river (FW2) which averaged 6-7m wide and 0.2-0.5m deep. Fast glide dominated with localised pools to 0.8m and very occasional riffle areas. The river had been historically straightened and deepened (embankments still present) but good natural recovery had occurred both in the riparian zone and instream. Small cobble and boulder dominated the substrata with localised areas of medium to very coarse gravels present, intestinally. Given the fast flow, the substrata were clean from siltation with little or no silt accumulations present (apart from those associated with macrophytes). Water turbidity was very low and, coupled with only moderate shading and evidently good water quality, the site featured a relatively high coverage of macrophytes. Water crowfoot (*Ranunculus* sect. *Batrachium*) dominated (25% cover) with frequent submerged form of lesser water parsnip plus fool's watercress and frequent fine-leaved dropwort (*Oenanthe aquatica*) along channel margins. *Callitriche* sp. was rare but present. Pellia sp. liverwort was submerged on cobble. The aquatic smaller lattice moss (*Cinclidotus fontinaloides*) was also frequent on larger cobble and boulder. The presence of more than three indicator species meant the site's aquatic plant community was considered representative of the Annex I habitat 'Water courses of plain to montane levels with

the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]'. Filamentous algae was present, indicating some enrichment, but coverage was low (<2%). The fast-flowing site was contained in a deep U-shaped channel with mature riparian treelines along the west bank supporting sycamore, ash, elder and willow. Butterbur (*Petasites hybridus*) was frequent along the west bank downstream of the bridge. The eastern bank was an ornamental/biodiversity garden (BC4) with associated flood walls. Herbaceous vegetation recorded downstream of the bridge supported watercress, great willowherb (*Epilobium hirsutum*), water mint (*Mentha aquatica*), fool's watercress, bindweed (*Calystegia* sp.) and meadowsweet (*Filipendula ulmaria*), thus indicating linkages with the Annex I habitat 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]' (see EC, 2013; Devaney et al., 2013).

Brown trout and Atlantic salmon were the only two fish species recorded via electro-fishing (**Appendix A**). Both were present in several cohorts and in relatively high densities. The site provided excellent-quality salmonid nursery habitat with well-oxygenated broken glide and riffle sequences and cover in macrophyte vegetation. The cobble substrata also provided good cover for juvenile salmonids. Good-quality spawning habitat was also present given unbedded, well-sorted mixed gravels between cobble areas. These had light siltation only. Holding habitat was also very good in deep glide and localised pool with overhanging tree cover and good shading. The site was also considered good for European eel, with ample boulder and cobble refugia, albeit none were recorded. No soft sediment lamprey habitat was identified present but the quality of spawning habitat was considered good. Lamprey species likely occur downstream of the survey area in suitable depositing areas. Despite some good suitability, no white-clawed crayfish were recorded and no contemporary records were available for the river (1980s only: see section 3.1). Otter foraging potential was high although no otter signs were recorded during the survey.

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

Given the location of the site within the River Boyne and River Blackwater SAC (002299), in addition to the presence of two Annex I aquatic habitats and qualifying interest Atlantic salmon, the aquatic ecological evaluation of site C4 was of **international importance.**

Plate 4.17 Representative image of site C4 on the River Deel at Raharney Bridge, May 2021

4.1.18 Site C5 – Craddanstown Stream, Riverdale

Site C5 was located on the Craddanstown Stream (07C55) at a local road crossing, south of the proposed wind farm site boundary. The stream represented a small lowland depositing watercourse (FW2) that had been straightened and deepened historically. The stream was contained in a deep U-shaped channel with bankfull heights varying between 1.8-3m. The canalised stream averaged 2.5m in width and 0.2-0.4m in depth, with occasional pools to 0.75m. Moderate-flowing glide dominated the site with a lack of riffle areas and only localised pool. The stream bed was composed almost entirely of soft silt (peat-derived) although some compacted sands were present on top of the silt locally. The sediment was a mixture of clay and peat and often exceeded 0.2m in depth. Instream macrophytes were limited to very sparse growth of unbranched bur reed (more present upstream of the bridge). No aquatic bryophytes were recorded. The site adjoined improved pasture (GA1) with narrow riparian treelines supporting mature ash, hawthorn, elder, grey willow and alder.

Low numbers of brown trout, *Lampetra* sp. and three-spined stickleback were recorded via electro-fishing (**Appendix A**). The channel had negligible nursery, spawning and holding value for salmonids given the absence of riffle, glide and pool sequences and extreme levels of siltation. These were exacerbated by historical channelisation and sedimentation pressures from the adjoining improved grassland. Only a single 0+ brown trout was recorded, exemplifying the poor value of the site for salmonids. The channel was not considered of value to European eel given the absence of refugia such as cobble and boulder and the shallow nature. The channel was, however, of some value to *Lampetra* sp. given pockets of fine silt with a high organic content up to 15cm deep. These adjoined degraded areas of fine gravel that provided some local spawning habitat for the species. Low densities of larval lamprey were recorded at 0.8 per m^2 ($10m^2$ of habitat targeted and *n*=8 ammocoetes captured). Despite some physical suitability (i.e., soft

loamy banks in which to burrow) the extensive channel modifications and high siltation created conditions inimical to white-clawed crayfish. A regular otter spraint site with associated prints was recorded on a muddy paludal area underneath the bridge (ITM 663341, 751542).

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 brown trout, *Lampetra* sp. and otter, the aquatic ecological evaluation of site C5 was of **local importance (higher value).**

Plate 4.18 Representative image of site C5 on the Craddanstown Stream, May 2021 (facing downstream from bridge)

4.1.19 Site C6 – Clondalee More Stream, Clondalee More

Site C6 was located on the Clondalee More Stream (07C77) at a local road crossing, approx. 0.6km south of the site boundary. The stream represented a small lowland depositing watercourse (FW2) that had been extensively straightened and deepened. Whilst some recovery of the banks had occurred, instream recovery was poor. The stream averaged 1.5-2m wide with bankfull heights of up to 2.5m in a deep U-shaped channel. Shallow glide predominated with only very localised riffle and pool areas. The stream bed comprised 100% soft silt, with peat agglomerations (sods) on top of the bed. The soft (largely peat) sediment was up to 0.3m deep locally. Slumping of the peat banks due to floods and widespread livestock poaching (sheep) was evident. Peat-staining was moderate at the time of survey. No instream macrophytes were recorded growing on the soft (often flocculent) bed. The site adjoined improved pasture (GA1) with a small area of mixed broadleaved woodland (WD1) upstream (supporting mostly beech and sycamore). A disjunct riparian treeline was present downstream of the road culvert (1m pipe) supporting

hawthorn, alder and willow with occasional bramble understorey (all grazed). The south bank was farmed to the edge with no riparian buffer.

Three-spined stickleback was the only fish species recorded via electro-fishing (**Appendix A**). With the exception of low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Despite an abundance of soft sediment accumulations, these were not of value for larval lamprey given the flocculent and or high humic content, in addition to high clay fractions, locally, resulting in compaction. Suitability or European eel was low given the open, shallow nature of the site and paucity of suitable refugia. The site offered no suitability for white-clawed crayfish and none were recorded. No otter signs were recorded.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

The aquatic ecological evaluation of site C6 was of **local importance (lower value).**

Plate 4.19 Representative image of site C6 on the Clondalee More Stream, May 2021

4.1.20 Site D1 – River Boyne, Scarriff Bridge

Site D1 was located on the River Boyne (07B04) at Scarriff Bridge, approx. 7km downstream of the site boundary (shortest hydrological distance). The Boyne at this location was a large lowland depositing watercourses (FW2) that averaged 20m in width and 0.4-0.7m deep. Fast glide dominated with occasional pools to >1m. Localised shallower riffle areas were resent downstream of the bridge. Given high flow rates, the substrata were compacted with cobble and coarse gravels dominating between argillaceous clay banks. Boulder was frequent but scattered. There were no sediment accumulations recorded outside of the margins. The river had been

historically straightened (possibly deepened) with embankments present. The channel showed good recovery, however. Instream macrophytes were limited although the cover of aquatic bryophytes such *Pellia* sp. were frequent on more stable substrata. Unbranched bur reed was present in channel margins and here some soft sediment accumulations suitable for larval lamprey were present (albeit very shallow). The riparian zone supported typical species such as hogweed, bramble, willowherb, nettle and frequent willow. The north bank upstream of the bridge featured a mature riparian treeline of alder/willow and had been cleared to the edge downstream (agricultural grassland).

Atlantic salmon, brown trout, stone loach (*Barbatula barbatula*) and minnow (*Phoxinus phoxinus*) were recorded via electro-fishing (**Appendix A**). Historical alterations had reduced the salmonid nursery value of the site. The spawning value was moderate as spawning gravels were restricted to isolated pockets between banks of argillaceous clay given historical deepening works. Holding habitat was very good. While no large salmonids were captured, larger fish were observed in deep pool adjoining the glide habitat surveyed - these areas were outside of wadable reach electro-fishing. Lamprey burial habitat was rare but present in association with marginal bur reed beds (however, no ammocoetes were recorded). European eel habitat was moderate with refugia largely limited to overhanging trees and scattered boulders. Some crayfish habitat was present but the bedded nature of the substrata and sparse macrophyte growth, in addition to the compacted banks, reduced the value overall in the vicinity of the bridge. The River Boyne also has a history of crayfish plague (*Aphanomyces astaci*) outbreaks which have periodically eradicated the species. Otter potential was high although no signs were recorded (few marking opportunities given the removal of boulder outcrops during historical dredging).

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

Given the location of the site within the River Boyne and River Blackwater SAC (002299), in addition to the presence of qualifying interest Atlantic salmon, the aquatic ecological evaluation of site D1 was of **international importance.**

Plate 4.20 Representative image of site D1 on the River Boyne, May 2021 (facing downstream)

4.2 Biological water quality (macro-invertebrates)

Sites A7 (Stonyford River), C4 (River Deel) and D1 (River Boyne) achieved **Q4** (good status) and thus met the good status (**≥Q4**) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**, **Appendix B**). These sites supported low numbers of Group A species such as the mayfly *Ecdyonurus dispar*, *Heptagenia sulphurea* and or *Rhithrogena semicolorata,* as well as the stonefly species *Isoperla grammatica* and *Nemurella picteti.* The presence of these species at sites C4 and D1 elevated the water quality status to **Q4** (good status).

Water samples from sites A1, A3, A4, A5, A6, A8, B3, B5, C1, C2, C5 and C6 achieved **Q2-3** or **Q3** (poor status) water quality and, therefore, 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). Whilst some of these sites supported group B species such as cased caddis *Limnephilus* spp., the dominance of group C species such as *Gammarus duebeni,* the mayfly species *Baetis rhodani* and Simuliidae larvae, as well as the presence of group D *Asellus aquaticus,* reduced the Q-rating to that of poor status (i.e., **Q2-3** or **Q3**).

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=15 sites (**Figure 4.1, Appendix B**).

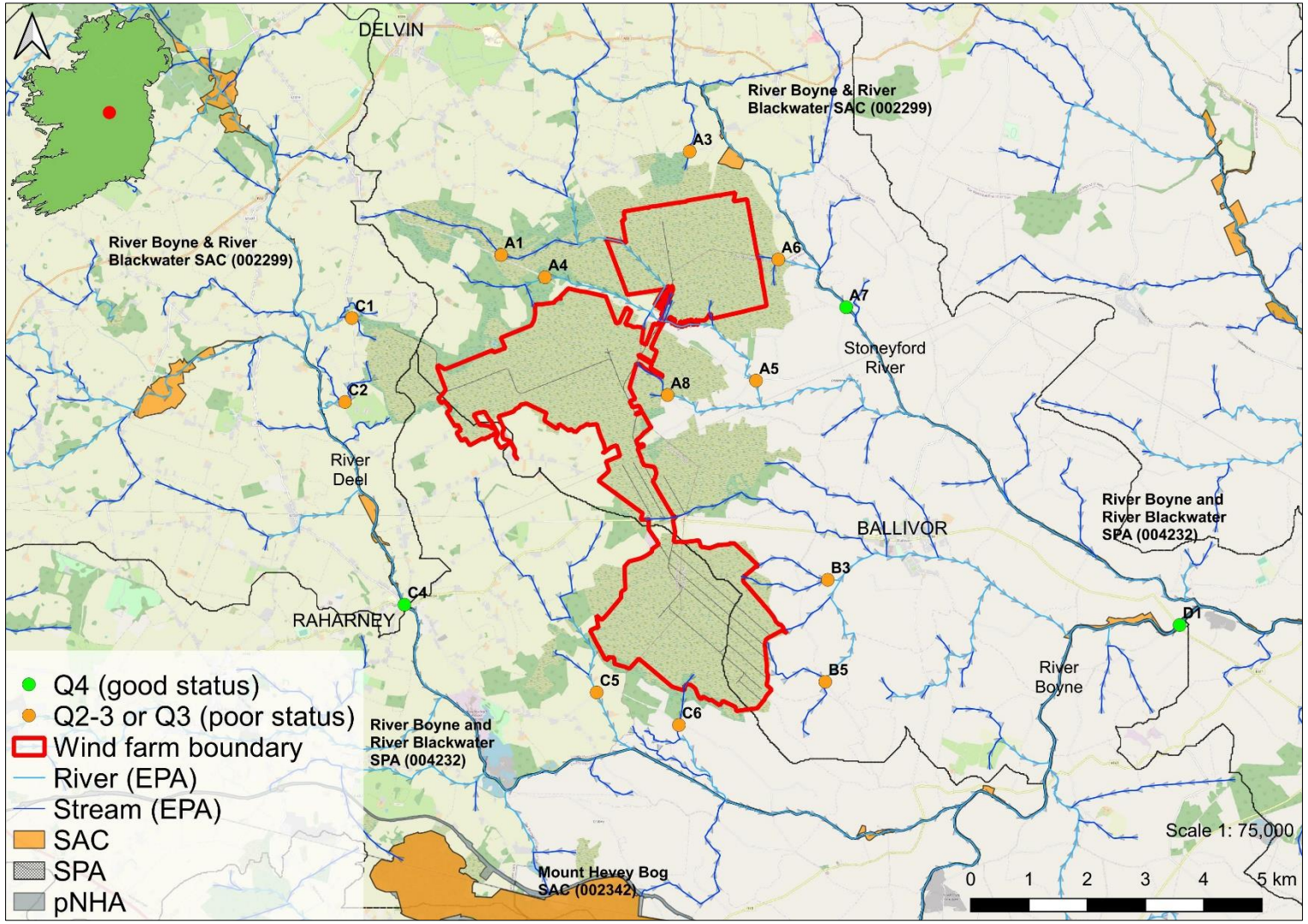

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Ballivor wind farm project, Co. Meath

4.3 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of electro-fishing (i.e., presence of fish of conservation value), the presence of protected or rare invertebrates (i.e., white-clawed crayfish), the presence of rare macrophytes and aquatic bryophytes and or associated representations of Annex I habitats. Furthermore, biological water quality status, the presence of otter and or situation within a protected site also informed the evaluation (**Table 4.1**).

Sites A7 (Stonyford River), C4 (River Deel) and D1 (River Boyne) were evaluated as **international importance** given their location within the River Boyne and River Blackwater SAC (002299).

None of the other aquatic survey sites were evaluated as greater than **local importance (higher value)**. The **local importance (higher value)** sites were present on the Bolandstown River (A4), Cartenstown Stream (A5), Woodtown West Stream (A6), Ballivor River (B5), Craddanstown Stream (C5), given the presence of salmonids, *Lampetra* sp., otter and or other aquatic species of conservation value (e.g., smooth newt recorded at site A6).

The remaining sites (i.e., A1, A2, A3, A8, B1, B2, B3, B4, C1, C2, C3 & C6) were evaluated as **local importance (lower value)**.

Table 4.1 Aquatic ecological evaluation summary of the survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Cartenstown Stream	07C60	Local importance (lower value)	Very low fisheries value overall; three-spined stickleback recorded at low densities via electro-fishing; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value recorded present
A2	Stonestown River	07S11	Local importance (lower value)	No aquatic value due to non-perennial nature of channel; not possible to assess biological water quality due to lack of water; no aquatic species or habitats of high conservation value recorded present
A3	Ballinn Stream	07B47	Local importance (lower value)	Very low fisheries value overall; three-spined stickleback recorded at low densities via electro-fishing; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value recorded present
A4	Bolandstown River	07B45	**Local importance (higher value)**	Moderate fisheries value overall; *Lampetra* sp. ammocoetes & three-spined stickleback recorded at low densities via electro-fishing; Q3 (poor status) water quality; no other aquatic species or habitats of high conservation value recorded present
A5	Cartenstown Stream	07C60	**Local importance (higher value)**	Poor-quality salmonid, lamprey & European eel habitat present but only brown trout and *Lampetra* sp. ammocoetes recorded in low densities via electro-fishing; Q3 (poor status) water quality; no other aquatic species or habitats of high conservation value recorded present
A6	Woodtown West Stream	07W06	**Local importance (higher value)**	Very low fisheries value overall; no fish recorded via electro-fishing; Q3 (poor status) water quality; smooth newt[1] and common frog[1] present; no other aquatic species or habitats of high conservation value recorded present
A7	Stonyford River	07S02	**International importance**	Located within River Boyne and River Blackwater SAC (002299); moderate-quality salmonid & lamprey habitat; Atlantic salmon, brown trout & *Lampetra* sp. ammocoetes recorded via electro-fishing; Q4 (good status) water quality
A8	Carranstown Little River	07C87	Local importance (lower value)	Poor-quality salmonid, lamprey and European eel habitat present; no fish recorded via electro-fishing; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value recorded present
B1	Killaconnigan Stream	07K34	Local importance (lower value)	Very low fisheries value overall; no fish recorded via electro-fishing; non-perennial channel; not possible to assess biological water quality

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
				due to lack of water; no aquatic species or habitats of high conservation value recorded present
B2	Kilballivor Stream	07K35	Local importance (lower value)	No aquatic value due to dry and non-perennial nature of channel; not possible to assess biological water quality due to lack of water; no aquatic species or habitats of high conservation value recorded present
B3	Unnamed stream	n/a	Local importance (lower value)	Low fisheries value overall; three-spined stickleback recorded at low densities via electro-fishing; Q3 (poor status) water quality; no aquatic species or habitats of high conservation value recorded present
B4	Unnamed stream	n/a	Local importance (lower value)	No aquatic value due to non-perennial nature of channel; not possible to assess biological water quality due to lack of water; no aquatic species or habitats of high conservation value recorded present
B5	Ballivor River	07B52	**Local importance (higher value)**	Some poor-quality salmonid, lamprey & European eel habitat present but none recorded; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality; otter spraint recorded (no crayfish remains); no other aquatic species or habitats of high conservation value recorded present
C1	Graffanstown Stream	07G10	Local importance (lower value)	Some poor-quality salmonid, lamprey & European eel habitat present but none recorded; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality); no aquatic species or habitats of high conservation value recorded present
C2	Ballynaskeagh Stream	07B24	Local importance (lower value)	Poor-quality salmonid, lamprey & European eel habitat present; no fish recorded via electro-fishing; Q3 (poor status) water quality; likely non-perennial site; no aquatic species or habitats of high conservation value recorded present
C3	Mucklin Stream	07M13	Local importance (lower value)	No aquatic value due to non-perennial nature of channel; not possible to assess biological water quality due to lack of water; no aquatic species or habitats of high conservation value recorded present
C4	River Deel	07D01	**International importance**	Located within River Boyne and River Blackwater SAC (002299); excellent-quality salmonid habitat & moderate lamprey & European eel habitat present; Atlantic salmon & brown trout recorded via electro-fishing; Annex I 'floating river vegetation' and 'Hydrophilous tall herb' habitats present[2]; Q4 (good status) water quality); no other aquatic species or habitats of high conservation value recorded present

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
C5	Craddanstown Stream	07C55	**Local importance (higher value)**	Poor-quality salmonid, lamprey & European eel habitat present; brown trout, *Lampetra* sp. & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality; otter present (spraint); no other aquatic species or habitats of high conservation value recorded present
C6	Clondalee More Stream	07C77	Local importance (lower value)	Poor-quality salmonid, lamprey & European eel habitat present but these species were not recorded; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality); no aquatic species or habitats of high conservation value recorded present
D1	River Boyne	07B04	**International importance**	Located within River Boyne and River Blackwater SAC (002299); moderate-quality salmonid, lamprey & European eel habitat; Atlantic salmon, brown trout, stone loach & minnow recorded via electro-fishing; Q4 (good status) water quality; no other aquatic species or habitats of high conservation value recorded present

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

[2] Both Annex I habitats 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]'. And 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]' recorded at site C4

*** Conservation value:** Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (L*ampetra planeri*), river lamprey (*Lampetra fluviatilis*), white-clawed crayfish (*Austropotamobius pallipes*) and otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon, river lamprey, white-clawed crayfish and otter are also listed under Annex V of the Habitats Directive [92/42/EEC]. Otters, along with their breeding and resting places, are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Fisheries Acts 1959 to 2019, brown trout have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

Sites A7 (Stonyford River), C4 (River Deel) and D1 (River Boyne) were evaluated as **international importance** given their location within the River Boyne and River Blackwater SAC (002299). These sites also supported qualifying interest Atlantic salmon and Q4 (good status) water quality. None of the other aquatic survey sites were evaluated as greater than **local importance (higher value)**. The higher value sites were present on the Bolandstown River (A4), Cartenstown Stream (A5), Woodtown West Stream (A6), Ballivor River (B5), Craddanstown Stream (C5), given the presence of salmonids, *Lampetra* sp., otter and or other aquatic species of conservation value (e.g., smooth newt). The remaining sites (i.e., A1, A2, A3, A8, B1, B2, B3, B4, C1, C2, C3 & C6) were evaluated as **local importance (lower value)**, primarily due to poor flows and poor quality of aquatic habitats.

Atlantic salmon were recorded (via electro-fishing) from a total of three sites on Stonyford River (A7), River Deel (C4) and River Boyne (D1), with brown trout recorded from a total of five sites on the Cartenstown Stream (A5), Stonyford River (A7), River Deel (C4), Craddanstown Stream (C5) and River Boyne (D1). *Lampetra* sp. ammocoetes were recorded from a total of four sites on the Bolandstown River (A4), Cartenstown Stream (A5), Stonyford River (A7) and Craddanstown Stream (C5). Despite some low to moderate suitability across numerous survey sites, no European eel were recorded during the survey. The fisheries value of these watercourses is addressed in further detail in **Appendix A**.

Otter signs (spraint and or prints) were recorded at sites B5 (Ballivor River) and C5 (Craddanstown Stream). Smaller, narrower, modified channels with limited vegetation (such as those in the vicinity of the proposed wind farm) are known to be negative determinants of otter presence (Bailey & Rochford, 2006; Reid et al., 2013). Therefore, wider, less-modified watercourses with improved fisheries habitat, such as the Craddanstown Stream, Stoneyford River and River Deel, have higher inherent value for otter. This would also reflect the distribution of otter records in the vicinity of the proposed project, presented in **Figure 3.1** (sensitive species data request), i.e., primarily located in the middle to lower reaches of larger watercourses.

A single adult smooth newt (*Lissotriton vulgaris*), protected under the Wildlife Act (1976-2021), was recorded during sweep sampling at site A6 on the Woodtown Stream. Although records for white-clawed crayfish widespread within the wider survey area (Deel, Stonyford and Boyne rivers), the bulk of these records were historical only (i.e., 1971-1985). No white-clawed crayfish were recorded during the aquatic surveys. No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=15 sites.

Good status (Q4) water quality was only recorded from sites A7 (Stonyford River), C4 (River Deel) and D1 (River Boyne). Primarily due to peat harvesting pressures, all remaining survey sites achieved Q2-3 or Q3 (poor status) water quality and, thus, 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).

Examples of the Annex I habitats 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]' and 'Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]' were present at site C4 on the River Deel (Raharney Bridge). No other survey sites supported examples these Annex I habitats.

In summary, the majority of watercourses in the vicinity of the proposed Ballivor wind farm were of **local importance (higher value)** in terms of their aquatic ecology. However, historical drainage pressures and ongoing peat escapement (siltation) had significantly reduced the quality and or presence of aquatic habitats on the Cartenstown Stream (EPA code: 07C60), Stonestown River (07S11), Ballinn Stream (07B47), Bolandstown River (07B45), Woodtown West Stream (07W06), Carranstown Little River (07C87), Killaconnigan Stream (07K34), Kilballivor Stream (07B35), Ballivor River (07B52) and two unnamed tributaries, Graffanstown Stream (07G10), Ballynaskeagh Stream (07B24), Mucklin Stream (07M13), Craddanstown Stream (07C550) and Clondalee More Stream (07C77). Typically, larger watercourses with higher flow rates are better able to buffer against such impacts and these proved the better-quality aquatic habitat (i.e., Stonyford River, River Deel, River Boyne). With the exception of survey sites on these three watercourses, biological water quality was of ≤Q3 (poor status) across all survey sites sampled and this contributed to the reduction in habitat quality for salmonids, macro-invertebrates (including white-clawed crayfish) and other aquatic species and habitats of conservation value.

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Appendix A:
Fisheries assessment of Ballivor wind farm, Co. Meath/Westmeath

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

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by McCarthy Keville O' Sullivan to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Ballivor wind farm, located near Ballivor, Co. Meath (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project (**Figure 2.1**). In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed project, a catchment-wide electro-fishing survey across *n*=20 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.

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 Ballivor wind farm. Permission was granted on Friday 25th June 2021 and the survey was undertaken on Wednesday 14th to Friday 16th July 2021.

1.2 Fisheries asset of the survey area

The aquatic survey sites were located within the Deel (Raharney) and Stoneyford River sub-basins, in the wider River Boyne catchment (Boyne_SC_040 and Boyne_SC_050). Whilst not located within a European site, the proposed wind farm site (via several watercourses) shared downstream hydrological connectivity with the River Boyne and River Blackwater SAC (002299).

Fisheries survey sites were present on the Cartenstown Stream (EPA code: 07C60), Stonestown River (07S11), Ballinn Stream (07B47), Bolandstown River (07B45), Woodtown West Stream (07W06), Stonyford River (07S02), Carranstown Little River (07C87), KIllaconnigan Stream (07K34), Kilballivor Stream (07B35), Ballivor River (07B52) and two unnamed tributaries, Graffanstown Stream (07G10), Ballynaskeagh Stream (07B24), Mucklin Stream (07M13), River Deel (07D01), Craddanstown Stream (07C550, Clondalee More Stream (07C77) and River Boyne (07B04) (**Table 2.1**). The survey sites on the Stonyford River, River Deel and River Boyne were located within the River Boyne and River Blackwater SAC (002299).

The Stoneyford River rises south of Oldcastle, at the base of Slieve na Caillaigh, Co. Meath. It then flows south easterly for 25km through counties Meath and Westmeath. It enters the River Boyne half a mile downstream of Scarriff Bridge. Recreational brown trout fishing is popular along this river (O'Reilly, 2009). In terms of genetic stock, the Stonyford is known to be a significant contributor of brown trout to the main Boyne channel (one of the three most important spawning tributaries in the middle-Boyne; Mariani & Massa-Gallucci, 2012). Whilst

The River Deel emanates from Lough Lene, Lough Bane and the Ben Loughs (Westmeath) and then flows for 35km in a south easterly direction through Raharney, Co. Westmeath before joining with the River Boyne 2km upstream of Inchamore Bridge. The River Deel is a limestone river with high water clarity, renowned as a wild brown trout fishery (O'Reilly, 2009). *Lampetra* sp. ammocoetes (likely brook lamprey *Lampetra planeri*) are widespread throughout both the Stonyford and Dee rivers. Densities of lamprey have been recorded as low (O'Connor, 2006) and the species is known to suffer from the impacts of continued arterial drainage that have been undertaken in the catchment (IFI, 2013).

The River Boyne rises in Co. Kildare and flows for over 110km in a north easterly direction through counties Offaly, Meath and Louth before entering the Irish Sea at Drogheda. The Boyne is a designated salmonid watercourse under the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293/1988) and is a renowned wild brown trout, Atlantic salmon and (in its lower reaches) sea trout fishery (O'Reilly, 2009). As well as salmonids, the river is known to support *Lampetra* sp., European eel (*Anguilla anguilla*), stone loach (*Barbatula barbatula*), minnow (*Phoxinus phoxinus*) and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2011a, 2011b). A number of other cyprinid species are also known from the river, including roach (*Rutilus rutilus*) and bream (*Abramis brama*), primarily in the middle to lower reaches (pers. obs.).

Whilst *Lampetra* sp. ammocoetes (likely brook lamprey *Lampetra planeri*) are widespread throughout both the Boyne, Stonyford and Deel rivers, densities have been recorded as low (O'Connor, 2006) and the species is known to suffer from the impacts of continued arterial drainage throughout the catchment (IFI, 2013).

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

2. Methodology

2.1 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Ballivor wind farm on the Wednesday 14th to Friday the 16th July 2021, following notification to Inland Fisheries Ireland and under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

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

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

The catchment-wide electro-fishing (CWEF) survey was undertaken across *n*=20 sites (see **Table 2.1, Figure 2.1**).

Table 2.1 *n*=20 electro-fishing survey site locations in the vicinity of the proposed Ballivor wind farm project, Co. Meath

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Cartenstown Stream	07C60	Ballyhealy	661703	759056
A2	Stonestown River	07S11	Cartenstown Stream confluence	663011	759233
A3	Ballinn Stream	07B47	Local road crossing, Lisclogher Great	664937	760833
A4	Bolandstown River	07B45	Local road crossing, Bracklin	662455	758674
A5	Cartenstown Stream	07C60	Local road crossing, Coolronan	666077	756898
A6	Woodtown West Stream	07W06	Lisclogher Great	666459	758978
A7	Stonyford River	07S02	Cloghbrack Bridge	667624	758158
A8	Carranstown Little River	07C87	Coolronan	664558	756649
B1	Killaconnigan Stream	07K34	Grange More	664652	754555
B2	Kilballivor Stream	07K35	Killconnigan	667115	755088
B3	Unnamed stream	n/a	Clonycavan	667308	753476

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
B4	Unnamed stream	n/a	Local road crossing, Clonycavan	666871	752716
B5	Ballivor River	07B52	Local road crossing, Clonycavan	667266	751725
C1	Graffanstown Stream	07G10	Local road crossing, Bracklin	659139	757974
C2	Ballynaskeagh Stream	07B24	Local road crossing, Ballynaskeagh	659022	756531
C3	Mucklin Stream	07M13	Local road crossing, Craddanstown	659139	755895
C4	River Deel	07D01	Raharney Bridge, R156 road crossing	660041	753049
C5	Craddanstown Stream	07C55	Local road crossing, Riverdale	663341	751542
C6	Clondalee More Stream	07C77	Local road crossing, Clondalee More	664753	750982
D1	River Boyne	07B04	Scarriff Bridge, R156 road crossing	673349	752700

2.1.1 Salmonids and European eel

For salmonid species and European eel, as well as all other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 40-100m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages. At certain, more minor watercourse sites or sites with limited access, it was more feasible to undertake electro-fishing for a 5-minute CPUE. Discrepancies in fishing effort (CPUE) between sites are accounted for in the subsequent results section (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the moderate conductivity waters of the sites (most draining calcareous geologies) a voltage of 200-230v, frequency of 35-45Hz and pulse duration of 3.5-4ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 Lamprey

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

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

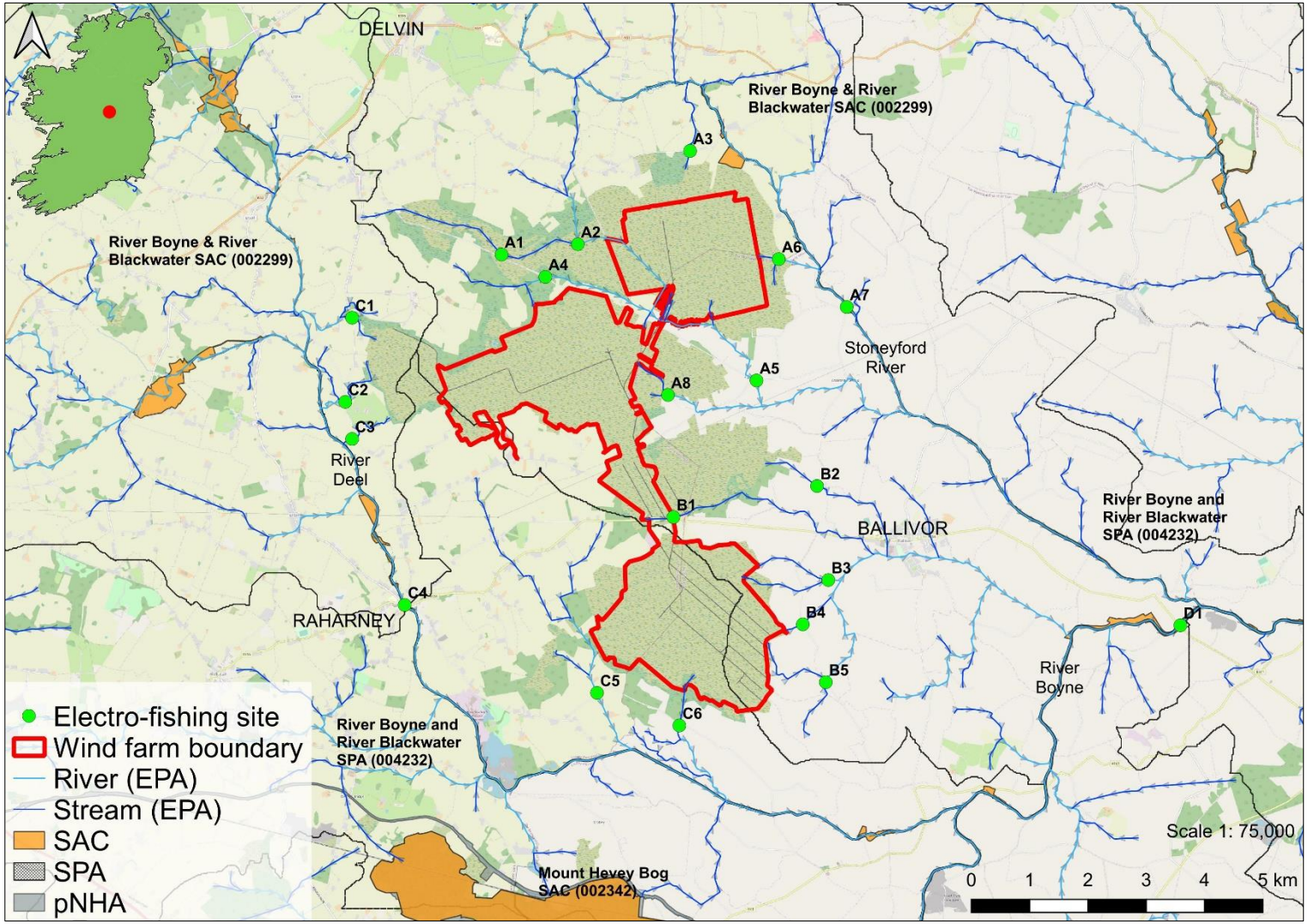

Figure 2.1 Location overview of the *n*=20 electro-fishing sites in vicinity of the proposed Ballivor wind farm, Co. Meath.

2.2 Fisheries habitat

2.2.1 General fisheries habitat

A broad appraisal / overview of the upstream and downstream habitat at each site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (Environment Agency, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata etc.).

2.3 Biosecurity

A strict biosecurity protocol following 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 Boyne catchment. 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 *n*=20 sites in the vicinity of the proposed Ballivor wind farm was conducted on Wednesday 14th to Friday 16th July 2021 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – Cartenstown Stream, Ballyhealy

Three-spined stickleback was the only fish species recorded via electro-fishing (**Figure 3.1**). With the exception of low densities of this species, the narrow, historically straightened and deepened channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. The site featured 100% slow-flowing glide habitat and was considered likely non-perennial (i.e., dries up seasonally). Fisheries value improved further downstream where the channel became wider, deeper and more supportive of perennial aquatic habitats.

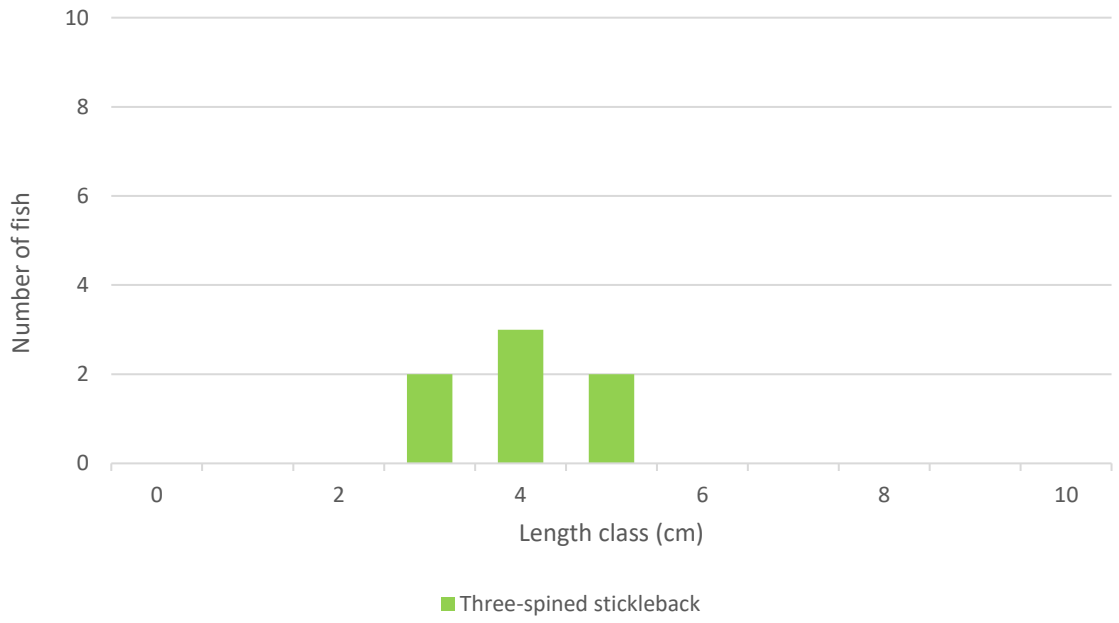

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on the Cartenstown Stream, July 2021

Plate 3.1 Representative image of site A1 on the Cartenstown Stream, May 2021

3.1.2 Site A2 – Stonestown River, Cartenstown Stream confluence

No fish were recorded from site A2 on the Stonestown River. The channel had been modified historically (straightened and deepened) and was 100% dry at the time of survey, with no pools of standing water remaining. Thus, the site had no fisheries value. The non-perennial channel drained cutover peat bog (PB4) and was evidently dry for much of the year.

Plate 3.2 Representative image of site A2 on the Stonestown River, May 2021

3.1.3 Site A3 – Ballinn Stream, Lisclogher Great

Three-spined stickleback was the only fish species recorded via electro-fishing from site A3 on the Ballinn Stream (**Figure 3.2**). All mature male sticklebacks recorded (*n*=10) were an uncommon melanic form (**Plate 3.3**). Melanic male three-spined stickleback are associated with waterbodies that are red-shifted due to the presence of tannins (e.g., peat-stained), where the ambient light environment is dominated by long wavelengths, and is hypothesised to have either a sexual selection or dietary basis (Smith et al., 2020; Flamarique et al., 2011; Reimchen, 1989). With the exception of low densities of this species, the heavily-silted peat drainage channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel was present but none were recorded.

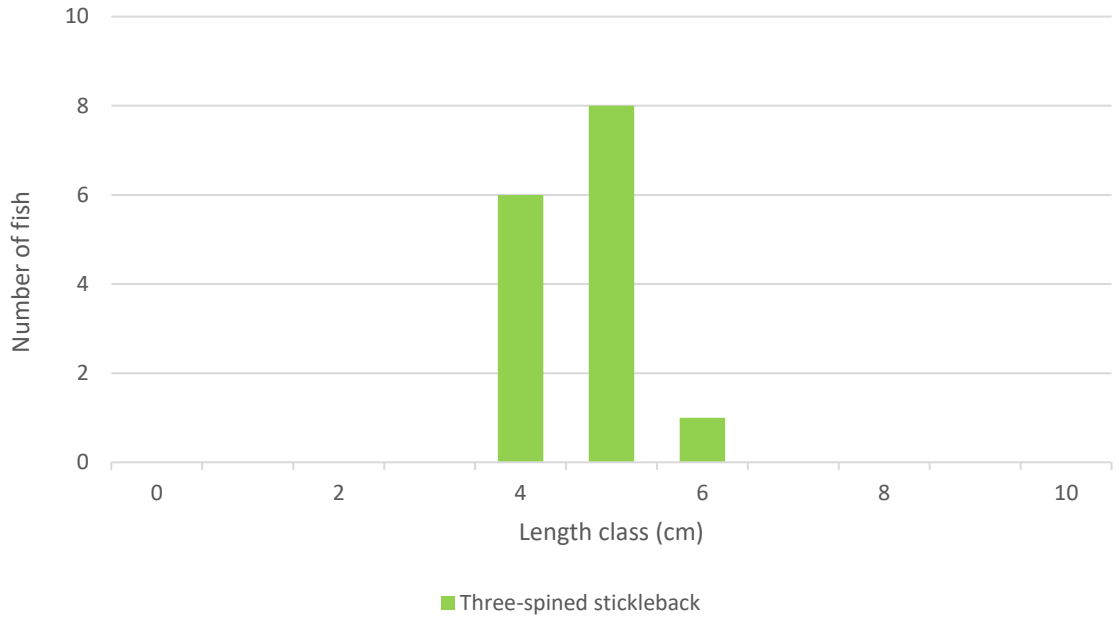

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A3 on the Ballinn Stream, July 2021

Plate 3.3 Rare melanic (pigmented) male three-spined stickleback recorded from the Ballinn Stream, July 2021

3.1.4 Site A4 – Bolandstown River, Bracklin

A total of two fish species were recorded via electro-fishing from site A4 on the Bolandstown River (**Figure 3.3**). Low densities of three-spined stickleback (*n*=5) and *Lampetra* sp. ammocoetes (*n*=14) were captured. Low to moderate densities of ammocoetes (likely brook lamprey) were recorded at 2.8 per m^2 ($5m^2$ of habitat targeted and 14 ammocoetes captured), with two distinct size classes present.

Site A4 had low nursery, spawning and holding value for salmonids given the poor thalweg and very high levels of siltation and none were recorded during electro-fishing. The channel was not considered of value to European eel given the absence of refugia such as cobble and boulder. The channel was however of some value to lamprey given pockets of fine silt with a high organic content up to 20cm deep adjoining areas with finer gravels (albeit degraded by silt).

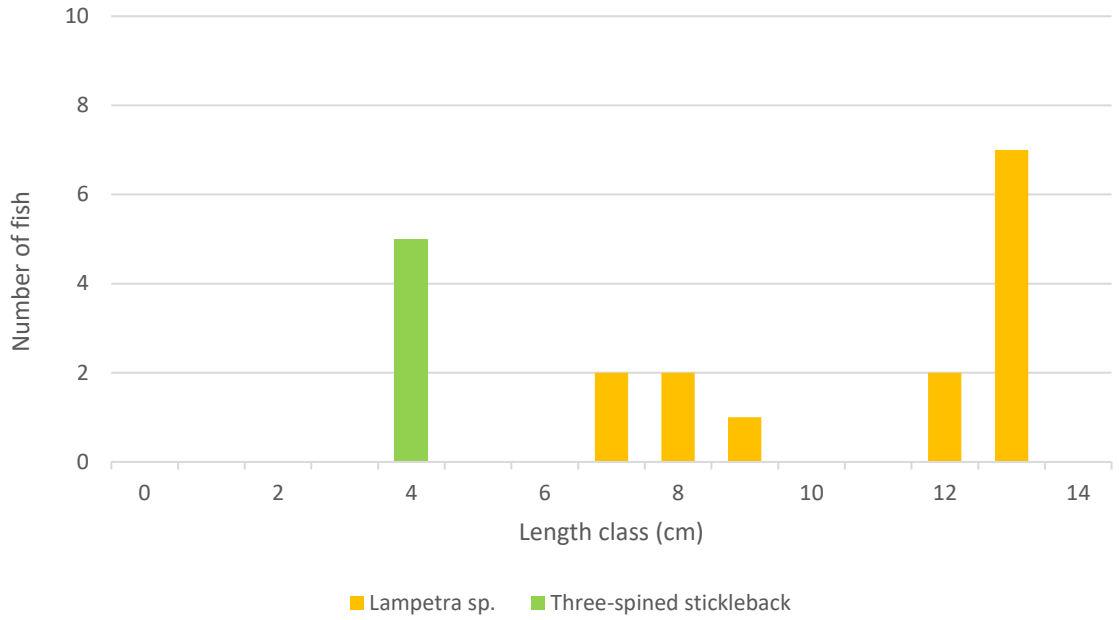

Figure 3.3 Length frequency distribution recorded via electro-fishing at site A4 on the Bolandstown River, July 2021

Plate 3.4 Representative image of site A4 on the Bolandstown River, May 2021

3.1.5 Site A5 – Cartenstown Stream, Coolronan

Brown trout (*Salmo trutta*) and *Lampetra* sp. were the only species recorded via electro-fishing from site A5 on the Cartenstown Stream (**Figure 3.5**). Both were present in low densities and represented single age cohorts, respectively. Only small numbers of 0+ brown trout were recorded, exemplifying the poor value of the site for salmonids Very low densities of lamprey were recorded at 0.4 per m^2 ($10m^2$ of habitat targeted and 4 ammocoetes captured) despite targeted electro-fishing of soft sediment areas being undertaken.

The site had low nursery, spawning and holding value for salmonids given the poor thalweg and very high levels of siltation. These were exacerbated by historical channelization and sedimentation pressures from the adjoining improved grassland. The channel was considered of only moderate value to European eel (none recorded). The channel was however of some value to lamprey given pockets of fine silt with a high organic content up to 15cm deep adjoining areas with finer gravels (albeit degraded by silt).

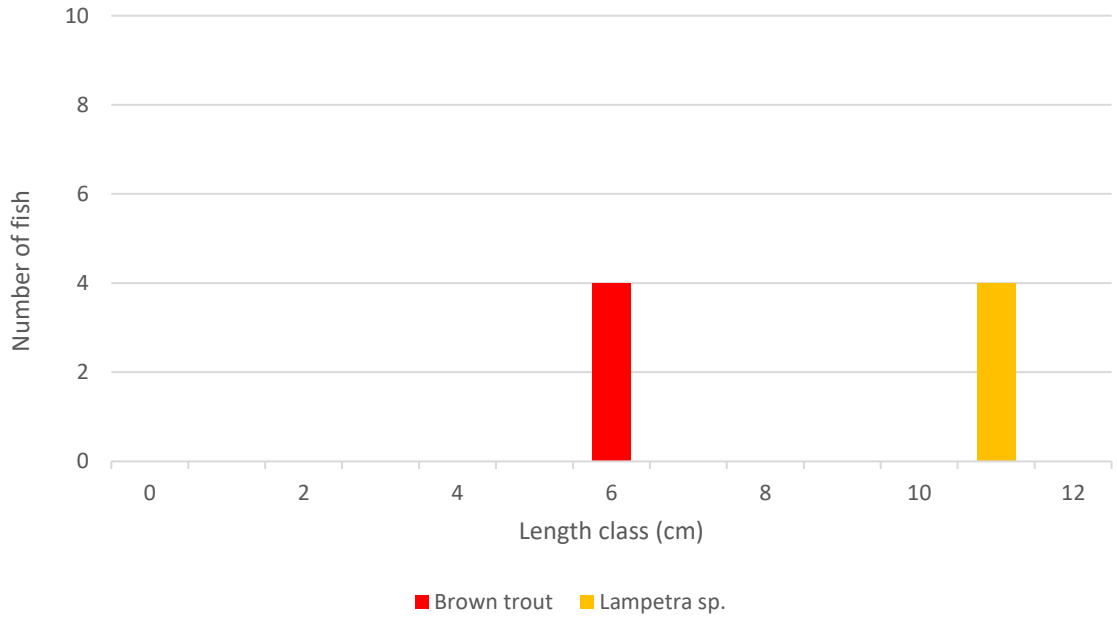

Figure 3.4 Length frequency distribution recorded via electro-fishing at site A5 on the Cartenstown Stream, July 2021

Plate 3.5 *Lampetra* sp. ammocoetes recorded from site A5 on the Cartenstown Stream, July 2021

3.1.6 Site A6 – Woodtown West Stream, Lisclogher Great

No fish species were recorded via electro-fishing at site A6 on the Woodtown West Stream. The peat drainage channel was of no fisheries value, given the lack of flow and heavily-silted (peat) nature. The stream had an imperceptible flow with numerous instream blockages (100% standing water/ponding). The drainage channel was grossly silted (several silt dams present). Deeper pool areas downstream of the survey site may have supported low densities of three-spined stickleback, although the intermittent/non-perennial nature of the stream likely precluded fish presence in the upper reaches. Both common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris*) were recorded via sweep netting during the site visit.

Plate 3.6 Representative image of site A6 on the Woodtown West Stream, May 2021

3.1.7 Site A7 – Stonyford River, Cloghbrack Bridge

A total of three fish species were recorded via electro-fishing at site A7 on the Stonyford River (**Figure 3.5**). Brown trout dominated the site, with a range of juvenile and adult cohorts present (*n*=19 total). Two Atlantic salmon (*Salmo salar*) parr were also recorded (likely 1+ cohort). A low density of *Lampetra* sp. ammocoetes were recorded from sub-optimal marginal silt accumulations (1.75 per m^2, 4m^2 of habitat targeted and *n*=7 ammocoetes captured).

The site featured moderate-quality salmonid nursery and spawning habitat, given that both were compromised by historical dredging. This had resulted in a channel with limited riffle habitat and localised patches of gravel between paths of argillaceous clay. The holding value for salmonids was good due to the presence of deep glide and pool with overhanging trees, undercut banks etc. The site was of only moderate value for lamprey, with both sub-optimal adult (spawning) and ammocoete burial habitat present. The site was not considered of good quality for European eel given the limited presence of accessible refugia such as cobble and boulder (compacted substrata) and none were recorded.

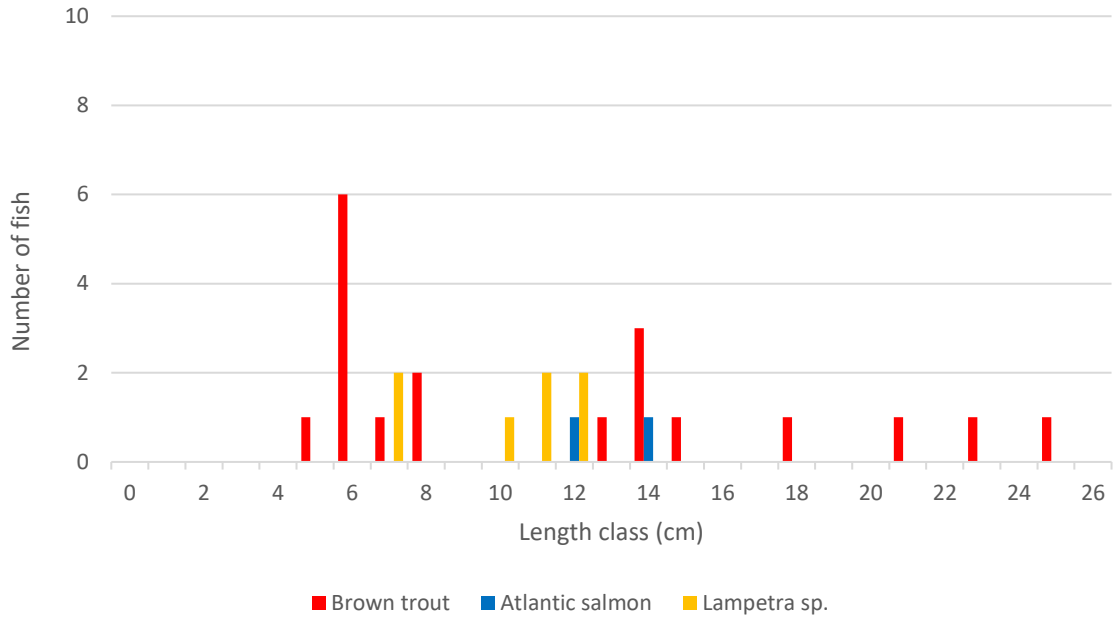

Figure 3.5 Length frequency distribution recorded via electro-fishing at site A7 on the Stonyford River, July 2021

Plate 3.7 Atlantic salmon parr recorded from site A7 on the Stonyford River, July 2021

3.1.8 Site A8 – Carranstown Little River, Coolronan

No fish were recorded via electro-fishing at site A8 on the Carranstown Little River. Suitability was limited to three-spined stickleback, although none were recorded present. The channel featured poor-quality salmonid nursery and spawning habitat, given high levels of peat-derived siltation (site drained an area of cutover bog). The site was not considered of good quality for European eel given the limited presence of accessible refugia such as cobble and boulder. Despite the presence of soft sediment accumulations, these were humic in nature (i.e., peat dominated) and not suitable for larval lamprey.

Plate 3.8 Representative image of site A8 on the Carranstown Little River, May 2021

3.1.9 Site B1 – Killaconnigan Stream, Grange More

No fish were recorded via electro-fishing at site B1 on the Killaconnigan Stream, located adjacent to the R156 near the Ballivor Bord na Móna factory. The stream represented a semi-dry bog drainage channel (FW4) at the time of survey, with only pools of stagnant (standing) water present, i.e., no flow. The stream was evidently non-perennial at this location. Other than very low suitability for three-spined stickleback in the wider area (i.e., downstream of survey site), site B1 was not of fisheries value given its non-perennial and heavily-silted nature.

Plate 3.9 Representative image of site B1 on the Killaconnigan Stream, May 2020

3.1.10 Site B2 – Kilballivor Stream, Killconnigan

No fish were recorded from site B2 on the Kilballivor Stream. The channel had been modified historically (straightened and deepened) and was 100% dry at the time of survey, with no pools of standing water remaining. Thus, the site had no fisheries value. The non-perennial channel drained cutover peat bog (PB4) and was evidently dry for much of the year.

Plate 3.10 Representative image of site B2 on the Kilballivor Stream, May 2020 (100% dry)

3.1.11 Site B3 – Unnamed stream, Clonycavan

Three-spined stickleback was the only fish species recorded via electro-fishing at site B3 on an unnamed Ballivor River tributary (**Figure 3.6**). With the exception of low densities of this species, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel and *Lampetra* sp. was present but none were recorded. The site had been extensively straightened and deepened in the recent past with poor instream recovery evident.

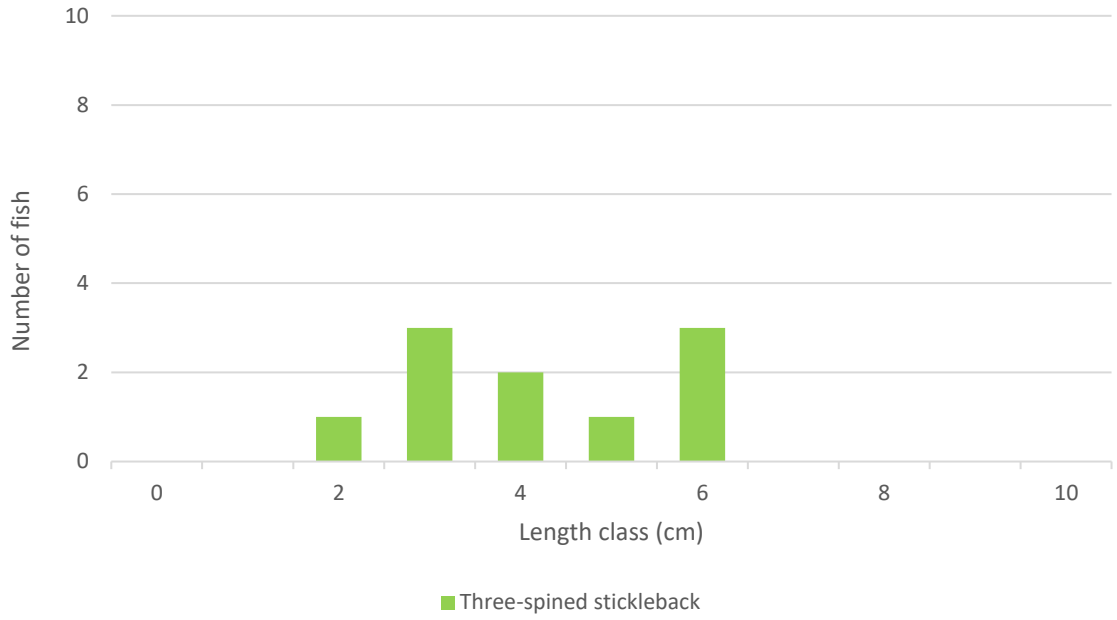

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B3 on an unnamed Ballivor River tributary, July 2021

Plate 3.11 Representative image of site B3 at the confluence of two unnamed streams, May 2021

3.1.12 Site B4 – Unnamed stream, Clonycavan

No fish were recorded via electro-fishing at site B4 on an unnamed Ballivor River tributary. The channel was 100% dry at the time of survey, with no ponding or stagnant water present (i.e., non-perennial channel). The river had no aquatic or fisheries value given the lack of water at the time of survey. The channel was considered likely to convey water intermittently during the year (i.e., mostly dry) and thus may have some very low value as a stickleback habitat. The downstream-connecting Ballivor River (0.7km downstream) was of some moderate fisheries and aquatic value.

Plate 3.12 Representative image of site B4 on unnamed Ballivor River tributary, May 2021 (dry channel)

3.1.13 Site B5 – Ballivor River, Clonycavan

Three-spined stickleback was the only fish species recorded via electro-fishing at site B5 on the Ballivor River (**Figure 3.7**). The lowland depositing watercourse (FW2/FW4) had been straightened and deepened historically, with more recent maintenance evident downstream of the bridge. With the exception of low densities of stickleback, the heavily silted channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Some low potential for European eel was present but none were recorded.

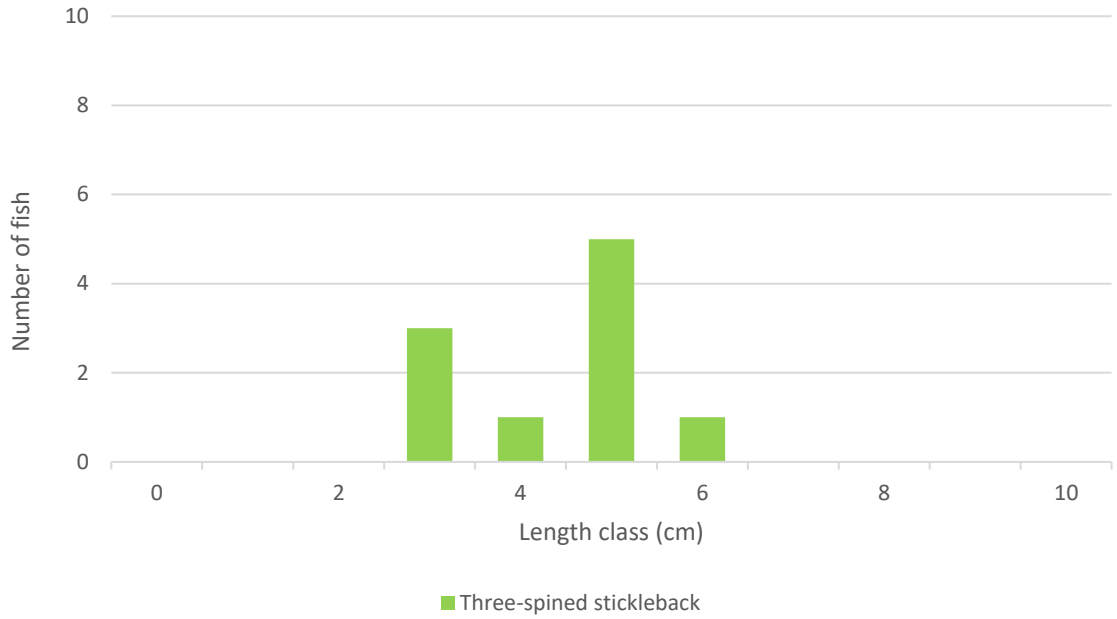

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B5 on the Ballivor River, July 2021

Plate 3.13 Representative image of site B5 on the Ballivor River, May 2021 (facing downstream from bridge)

3.1.14 Site C1 – Graffanstown Stream, Bracklin

Three-spined stickleback was the only fish species recorded via electro-fishing at site C1 on the Graffanstown Stream (**Figure 3.8**). With the exception of very low densities of this species, the heavily silted and enriched drainage channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Whilst some limited sands and fine gravels were present on top of the flocculent sediment in places (e.g., near meander 40m upstream of culvert), these were also heavily silted. Despite an abundance of soft sediment accumulations, these were not of value for larval lamprey given the flocculent and or high humic content, in addition to poor flows.

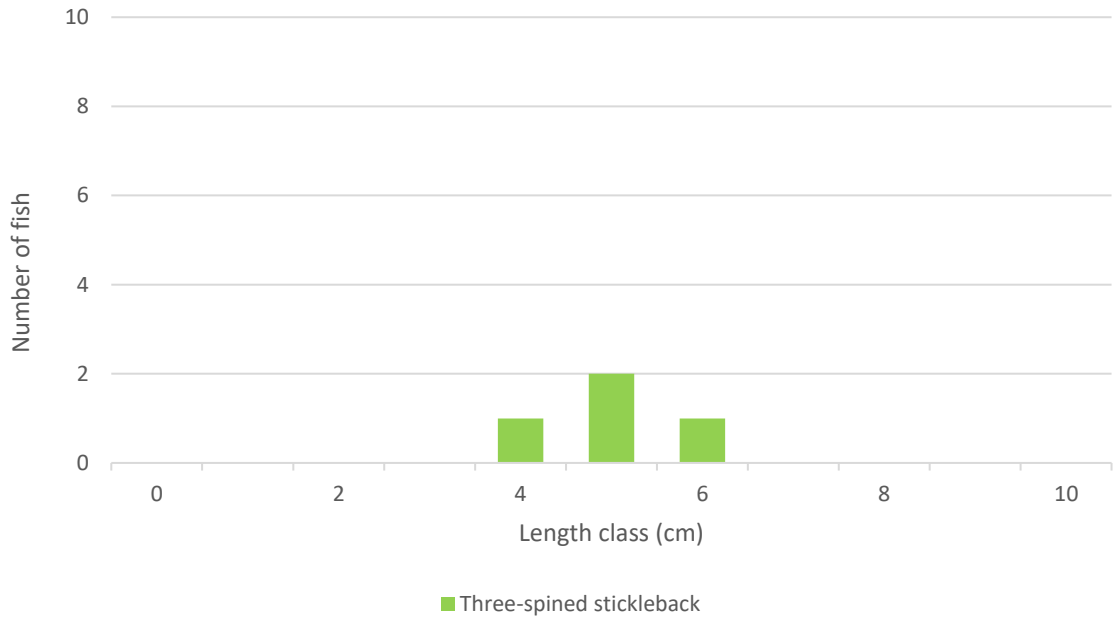

Figure 3.8 Length frequency distribution recorded via electro-fishing at site C1 on the Graffanstown Stream July 2021

Plate 3.14 Representative image of site C1 on the Graffanstown Stream, May 2021 (facing upstream from road culvert)

3.1.15 Site C2 – Ballynaskeagh Stream, Ballynaskeagh

No fish were recorded via electro-fishing at site C2 on the Ballynaskeagh Stream. Despite some moderate physical habitat suitability for salmonids and lamprey, these species were absent. This was considered a result of very low water levels at the time of survey (average depth <0.05m) and the stream's likely non-perennial nature. Nevertheless, even during higher water levels (e.g., winter), the site would only provide (at best) moderate suitability, given high rates of siltation and compacted substrata. There was some low suitability for European eel, albeit none were recorded. Improved fisheries habitat was present in the lowermost reaches at the River Deel confluence and River Boyne and River Blackwater SAC (002299) site boundary.

Plate 3.15 Representative image of site C2 on the Ballynaskeagh Stream, July 2021

3.1.16 Site C3 – Mucklin Stream, Craddanstown

No fish were recorded via electro-fishing at site C2 on the Mucklin Stream. The channel was 100% dry at the time of survey, with no ponding or stagnant water present (i.e., non-perennial channel). Thus, the stream had no aquatic or fisheries value given the lack of water at the time of survey. The channel was considered likely to convey water intermittently during the year (but mostly dry). Fisheries and aquatic value was high in the downstream-connecting River Deel, located <200m downstream. The lowermost reaches of the channel were likely of some low fisheries and aquatic value during high water levels (i.e., refuge from flood water on the River Deel).

Plate 3.16 Representative image of site C3 on the Mucklin Stream, July 2021 (100% dry channel)

3.1.17 Site C4 – River Deel, Raharney Bridge

A total of two fish species were recorded via electro-fishing at site C4 on the River Deel (**Figure 3.9**). Brown trout dominated the site (*n*=40), with a range of cohorts present. Adults were more numerous than juveniles. Two distinct cohorts of Atlantic salmon parr (likely 0+ and 1+) were also recorded (*n*=21 in total).

The site provided excellent-quality salmonid nursery habitat with well-oxygenated broken glide and riffle sequences and cover in macrophyte vegetation. The cobble substrata also provided good cover for juvenile salmonids. Good-quality spawning habitat was also present given unbedded, well-sorted mixed gravels between cobble areas. These had light siltation only. Holding habitat was also very good in deep glide and localised pool with overhanging tree cover and good shading. The site was also considered good for European eel, with ample boulder and cobble refugia, albeit none were recorded. No soft sediment lamprey habitat was identified present but the quality of spawning habitat was considered good. The species likely occur downstream of the survey area in suitable depositing areas.

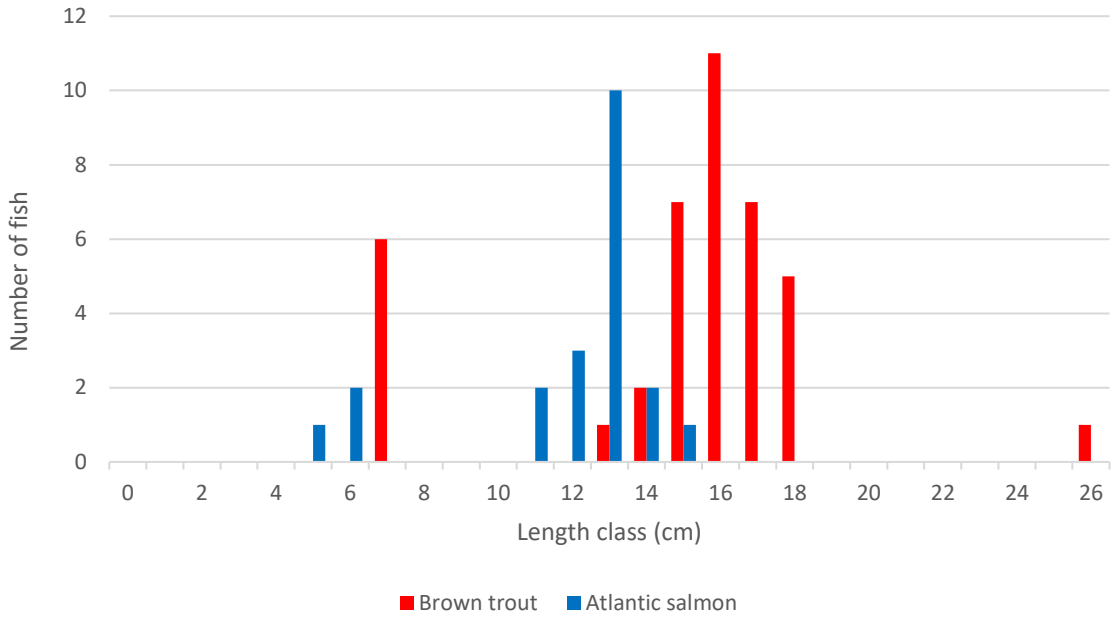

Figure 3.9 Length frequency distribution recorded via electro-fishing at site C4 on the River Deel, July 2021

Plate 3.17 Atlantic salmon (top) and brown trout (bottom) recorded from site C4 on the River Deel at Raharney Bridge, July 2021

3.1.18 Site C5 – Craddanstown Stream, Riverdale

A total of three fish species were recorded via electro-fishing at site C5 on the Craddanstown Stream (**Figure 3.10**). Low densities of three-spined stickleback (*n*=3) and *Lampetra* sp. (*n*=8) were recorded, in addition to a single juvenile (0+) brown trout. Low densities of larval lamprey were recorded at 0.8 per m^2 ($10m^2$ of habitat targeted and *n*=8 ammocoetes captured).

The historically straightened site had negligible nursery, spawning and holding value for salmonids given the absence of riffle, glide and pool sequences and extreme levels of siltation. These were exacerbated by historical channelisation and sedimentation pressures from the adjoining improved grassland. The channel was not considered of value to European eel given the absence of refugia such as cobble and boulder and the shallow nature. The channel was, however, of some value to *Lampetra* sp. given pockets of fine silt with a high organic content up to 15cm deep. These adjoined degraded areas of fine gravel that provided some local spawning habitat for the species.

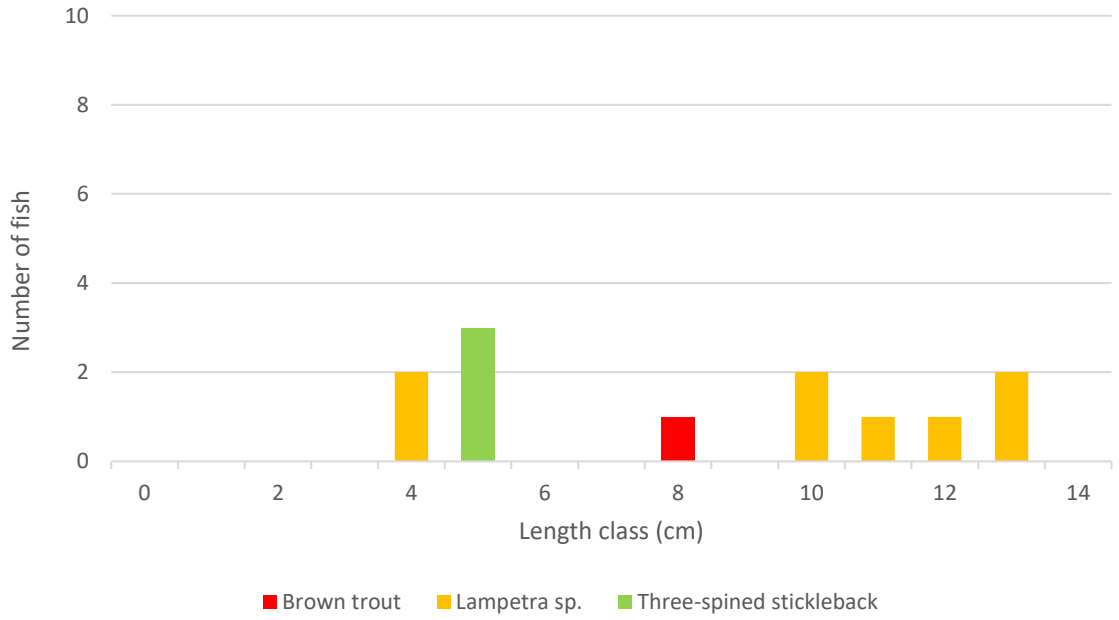

Figure 3.10 Length frequency distribution recorded via electro-fishing at site C5 on the Craddanstown Stream, July 2021

Plate 3.18 Representative image of site C5 on the Craddanstown Stream, May 2021 (facing downstream from bridge)

3.1.19 Site C6 – Clondalee More Stream, Clondalee More

Three-spined stickleback was the only fish species recorded via electro-fishing at site C6 on the Clondalee More Stream (**Figure 3.11**). With the exception of low densities of this species, the historically straightened channel was of very poor fisheries value, i.e., not of value to salmonids or lamprey species given the lack of flow and heavily-silted (peat) nature. Despite an abundance of soft sediment accumulations, these were not of value for larval lamprey given the flocculent and or high humic content, in addition to high clay fractions, locally, resulting in compaction. Suitability or European eel was low given the open, shallow nature of the site and paucity of suitable refugia.

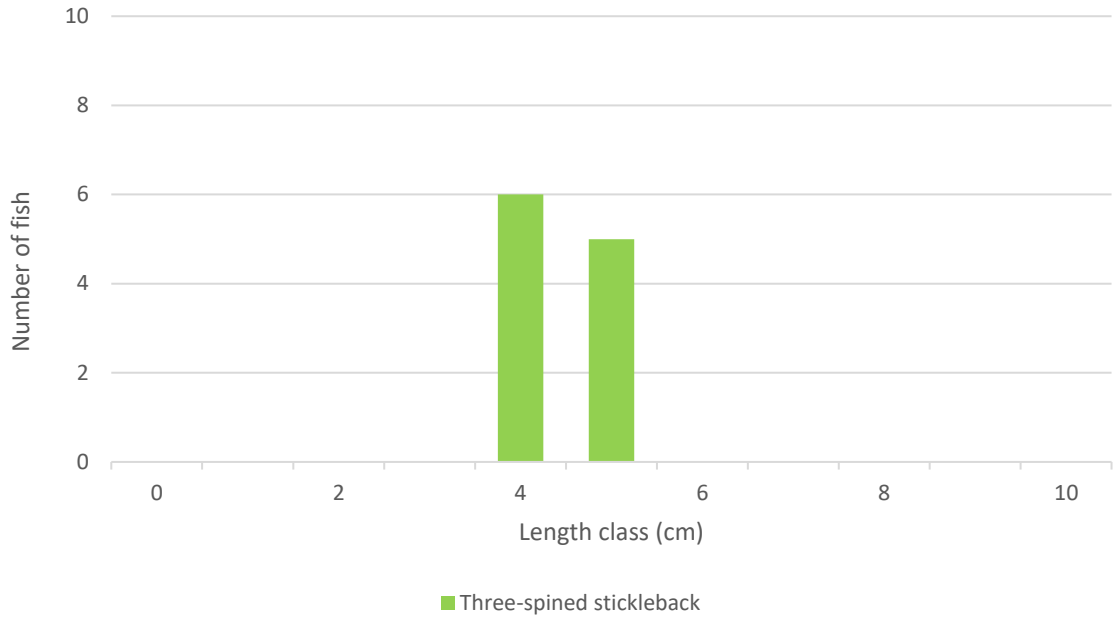

Figure 3.11 Length frequency distribution recorded via electro-fishing at site C6 on the Clondalee More Stream, July 2021

Plate 3.19 Representative image of site C6 on the Clondalee More Stream, May 2021

3.1.20 Site D1 – River Boyne, Scarriff Bridge

A total of four fish species were recorded via electro-fishing at site D1 on the River Boyne (**Figure 3.12**). Low numbers of both Atlantic salmon parr (*n*=9) and brown trout (*n*=5) were recorded, in addition to low numbers of minnow (*n*=5) and stone loach (*n*=4). With the exception of one adult brown trout, all salmonids captured were of the 0+ cohort.

Historical alterations had reduced the salmonid nursery value of the site. The spawning value was moderate as spawning gravels were restricted to isolated pockets between banks of argillaceous clay given historical deepening works. Holding habitat was very good. While no large salmonids were captured, larger fish were observed in deep pool adjoining the glide habitat surveyed - these areas were outside of wadable reach electro-fishing. Lamprey burial habitat was rare but present in association with marginal bur reed beds (however, no ammocoetes were recorded). European eel habitat was moderate with refugia largely limited to overhanging trees and scattered boulders.

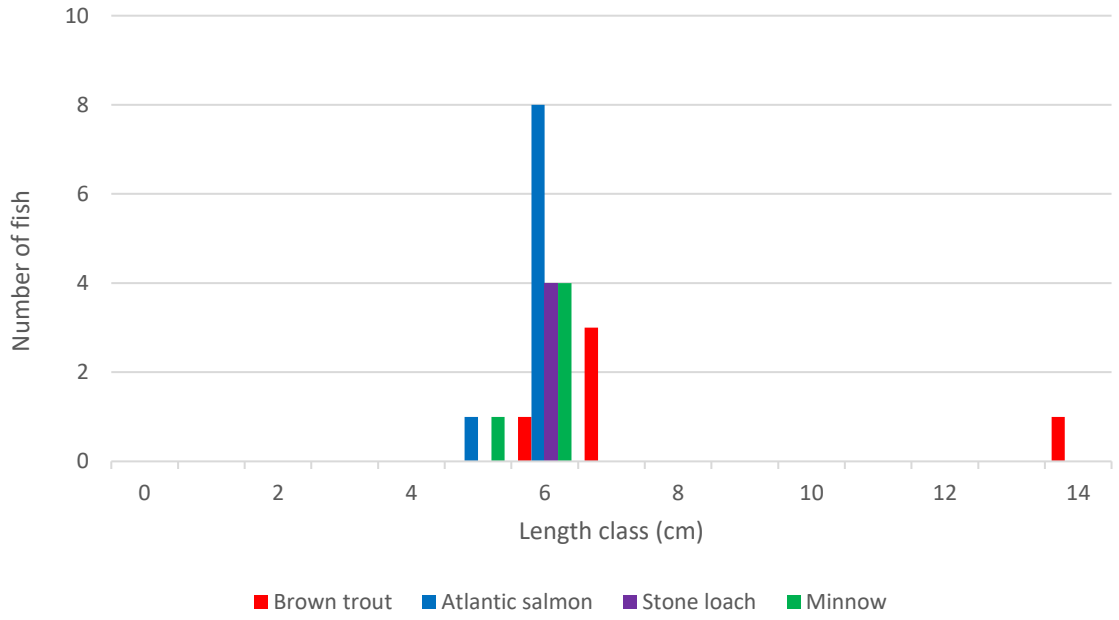

Figure 3.12 Length frequency distribution recorded via electro-fishing at site D1 on the River Boyne, July 2021

Plate 3.20 Stone loach recorded from site D1 on the River Boyne, July 2021

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of Ballivor wind farm via electro-fishing in July 2021. 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	Atlantic salmon	*Lampetra* sp.	Three-spined stickleback	Minnow	Stone loach
A1	Cartenstown Stream	5	25	0.000	0.000	0.000	**0.280**	0.000	0.000
A2	Stonestown River	n/a	Dry channel	n/a	n/a	n/a	n/a	n/a	n/a
A3	Ballinn Stream	5	50	0.000	0.000	0.000	0.240	0.000	0.000
A4	Bolandstown River	10	140	0.000	0.000	***2.8**	0.036	0.000	0.000
A5	Cartenstown Stream	10	200	0.020	0.000	*0.4	0.000	0.000	0.000
A6	Woodtown West Stream	5	25	0.000	0.000	0.000	0.000	0.000	0.000
A7	Stonyford River	10	400	0.048	0.005	*1.75	0.000	0.000	0.000
A8	Carranstown Little River	10	150	0.000	0.000	0.000	0.000	0.000	0.000
B1	Killaconnigan Stream	5	20	0.000	0.000	0.000	0.000	0.000	0.000
B2	Kilballivor Stream	n/a	Dry channel	n/a	n/a	n/a	n/a	n/a	n/a
B3	Unnamed stream	10	160	0.000	0.000	0.000	0.063	0.000	0.000
B4	Unnamed stream	n/a	Dry channel	n/a	n/a	n/a	n/a	n/a	n/a
B5	Ballivor River	10	180	0.000	0.000	0.000	0.056	0.000	0.000
C1	Graffanstown Stream	10	100	0.000	0.000	0.000	0.040	0.000	0.000
C2	Ballynaskeagh Stream	5	45	0.000	0.000	0.000	0.000	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)					
				Brown trout	Atlantic salmon	*Lampetra* sp.	Three-spined stickleback	Minnow	Stone loach
C3	Mucklin Stream	n/a	Dry channel	n/a	n/a	n/a	n/a	n/a	n/a
C4	River Deel	10	320	**0.125**	**0.066**	0.000	0.000	0.000	0.000
C5	Craddanstown Stream	10	190	0.005	0.000	*0.8	0.016	0.000	0.000
C6	Clondalee More Stream	10	160	0.000	0.000	0.000	0.069	0.000	0.000
D1	River Boyne	10	340	0.015	0.026	0.000	0.000	**0.015**	**0.012**

4. Discussion

4.1 Most valuable sites

4.1.1 Salmonids

A total of five sites supported brown trout at the time of survey, namely sites A5 (Cartenstown Stream), A7 (Stonyford River), C4 (River Deel), C5 (Craddanstown Stream) and D1 (River Boyne). Sites A7, C4 and D1 also supported Atlantic salmon. The quality of salmonid habitat was typically poor to moderate, with better-quality habitat only present on the Stonyford River, River Deel and River Boyne. The best quality salmonid habitat was present on the River Deel at site C4, where nursery, spawning and holding habitat were all evaluated as excellent quality.

In general, salmonid habitat in the vicinity of the proposed Ballivor wind farm was poor due to historical drainage pressures, low or intermittent/seasonal flows and often excessive siltation (primarily from peat escapement). Diffuse siltation is one of the greatest threats to salmonid populations. Sediment not only blocks interstitial spaces in substrata and limits oxygen supply to salmonid eggs (required for healthy embryonic development and successful hatching) but can also smother substrata, thus reducing available spawning habitat and impact macro-invertebrate communities on which salmonids feed (Soulsby et al., 2001; Walling et al., 2003; Heywood & Walling, 2007; Louhi et al., 2008, 2011; Cocchiglia et al., 2012; Conroy et al., 2016; Davis et al., 2018; Kelly-Quinn et al., 2020). Sedimentation of salmonid habitat is a particular problem in Irish rivers flowing through modified catchments (Evans et al., 2006).

4.1.2 Lamprey

Lampetra sp. ammocoetes were recorded from a total of four sites, namely sites A4 (Bolandstown River), A5 (Cartenstown Stream), A7 (Stonyford River) and C5 (Craddanstown Stream). The highest density recorded were present at sites A4 and A7 (2.8 and 1.75 ammocoetes per m^2 of ammocoete habitat fished, respectively).

However, lamprey habitat was generally poor across the survey area. Owing to their relatively small morphologies, *Lampetra* species such as brook lamprey require clean, fine gravels in which to dig their redds (Lasne et al., 2010; Rooney et al., 2013; Dawson et al., 2015) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010). Spawning habitat in the vicinity of the proposed Ballivor wind farm 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 (Gardiner, 2003; Goodwin et al., 2008; Aronsuu & Virkkala, 2014). Peat-dominated substrata (i.e., humic deposits), such as those typically found in the vicinity of the proposed Ballivor wind farm, do not provide suitable burial/burrowing habitat complexity or structure for ammocoetes given their invariably fine and flocculent nature (pers. obs.).

4.1.3 European eel

On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011). Despite some suitability across the survey area, no European eel were recorded during the current survey. This was considered as a result of significant siltation (peat sedimentation) pressures within the vicinity of the proposed wind farm, in addition to a paucity of suitable diurnal refugia and low/intermittent flows in numerous watercourses. Nevertheless, even smaller 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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8. Appendix B – Q-sample results (biological water quality)

Table 8.1 Macro-invertebrate Q-sampling results for aquatic survey sites A1, A3, A4, A6, A7, A8, A9, B3, B5, C1, C2, C4, C5, C6 & D1

Group	Family	Species	A1	A3	A4	A5	A6	A7	A8	B3	B5	C1	C2	C4	C5	C6	D1	EPA group
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*						1						3			14	A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*												10			7	A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*															1	A
Plecoptera	Perlodidae	*Isoperla grammatica*												1			2	A
Plecoptera	Nemouridae	*Nemurella pictetii*														1		A
Ephemeroptera	Leptophlebiidae	*Leptophlebia vespertina*																B
Ephemeroptera	Baetidae	*Baetis muticus*						8						2			7	B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*													2			B
Trichoptera	Hydroptilidae	*Hydroptila* sp.												3			2	B
Trichoptera	Limnephilidae	Unidentified species		1										2				B
Trichoptera	Limnephilidae	*Limnephilus* sp.		1		3			1	3								B
Trichoptera	Limnephilidae	*Drusus annulatus*						3									1	B
Trichoptera	Limnephilidae	*Limnephilus auricula*									4	2				6		B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*											1				3	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*												1	7		1	B
Odonata	Coenagrionidae	*Pyrrhosoma nymphula*	1	1														B
Odonata	Calopterygidae	*Calopteryx splendens*															1	B
Ephemeroptera	Baetidae	*Baetis rhodani*			50	2		84	4	5				6	32		4	C
Ephemeroptera	Ephemerellidae	*Serratella ignita*						2						3			3	C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*						6						3			11	C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*						4						6			2	C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*	6						1									C
Trichoptera	Polycentropodidae	*Polycentropus kingi*				1											1	C
Trichoptera	Polycentropodidae	*Polycentropus flavomaculatus*				3												C

Group	Family	Species	A1	A3	A4	A5	A6	A7	A8	B3	B5	C1	C2	C4	C5	C6	D1	EPA group
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*			3													C
Coleoptera	Hydraenidae	*Hydraena gracilis*	1															C
Coleoptera	Hydraenidae	*Limnebius* sp.	1															C
Coleoptera	Dytiscidae	Dytiscidae larva		1			1											C
Coleoptera	Dytiscidae	*Nartus (Rhantus) grapii*		1														C
Coleoptera	Dytiscidae	*Hydroporus* sp.		3														C
Coleoptera	Elmidae	*Elmis aenea*			3	1							2	8	2		4	C
Coleoptera	Dytiscidae	*Agabus fuscipes*			3									3				C
Coleoptera	Gyrinidae	*Gyrinus substriatus*					1											C
Coleoptera	Elmidae	*Limnius volckmari*												4			2	C
Coleoptera	Dytiscidae	*Nebrioporus depressus*													1		1	C
Coleoptera	Haliplidae	*Brychius elevatus*															2	C
Crustacea	Gammaridae	*Gammarus duebeni*			4	12		5	5	62	5	8	40	4	11	2	4	C
Diptera	Chironomidae	Unidentified larvae	7		1		3	1	1	4	3	6	3	2	1	10	6	C
Diptera	Dixidae	Unidentified species	1	1			1											C
Diptera	Simuliidae	Unidentified larvae	1		6			23					1	12				C
Diptera	Pediciidae	*Dicranota* sp.	1		2					1		1	4		2	1		C
Diptera	Tipuliidae	*Tipula* sp.				1												C
Diptera	Ceratopogonidae	Ceratopogonidae larva				1												C
Diptera	Chaoboridae	Chaoboridae larva					3											C
Diptera	Pediciidae	*Pedicia* sp.							2									C
Diptera	Limoniidae	*Antocha*larva												1				C
Arachnida	Hydrachnidiae	Unidentified species	1							1	1	3						C
Hemiptera	Veliidae	*Velia caprai*	2								1							C
Hemiptera	Corixidae	*Corixida* nymph					3											C
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*					2											C

Group	Family	Species	A1	A3	A4	A5	A6	A7	A8	B3	B5	C1	C2	C4	C5	C6	D1	EPA group
Hemiptera	Corixidae	*Siagara* sp.																C
Gastropoda	Sphaeriidae	Unidentified species	8								3				3	3		C
Gastropoda	Lymnaeidae	*Galba truncatula*		3														C
Gastropoda	Planorbidae	*Planorbis planorbis*									1							C
Gastropoda	Bithnyiidae	*Bithynia tentaculata*												1			3	C
Gastropoda	Planorbidae	*Ancylus fluviatilis*															6	C
Gastropoda	Lymnaeidae	*Ampullaceana (Radix) balthica*															4	C
Megaloptera	Sialidae	*Sialis* sp.		1		1												D
Crustacea	Asellidae	*Asellus aquaticus*	19	170	8	7	1		28	57	25	87	14		5	173	2	D
Hirudinidae	Glossiphoniidae	Unidentified species								1	2	3				4		D
Hirudinidae	Erpobdellidae	Unidentified species														1		D
Oligochaeta	Lumbricidae	Unidentified species			1	1			5	3			1	1				n/a
Abundance			**49**	**183**	**81**	**33**	**15**	**137**	**47**	**137**	**45**	**110**	**66**	**76**	**66**	**201**	**94**	
Q-rating			2-3*	2-3*	3	3	3*	4	2-3	3	2-3*	2-3*	3	4	3	2-3	4	
WFD status			Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Good	

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