Fisheries assessment of Garrane wind farm, Co. Cork

Prepared by Triturus Environmental Ltd. for

AQUAFACT International Services Ltd.

October 2023

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by AQUAFACT International Services Ltd. to undertake a baseline fisheries assessment of watercourses in the vicinity of the proposed Garrane wind farm, located near Charleville, Co. Cork (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project, which comprises;

- 9 no. wind turbines with a blade tip height of 170m, turbine foundations and crane pad hardstanding areas
- upgrade of existing site tracks and construction of new site tracks, watercourse crossings and associated drainage
- temporary site entrance on the N20 for turbine component deliveries only and permanent site entrance on the L1537 for construction and operation
- 110kV electrical "Loop-in" substation or 38kV electrical substation to ESB/Eirgrid specification to include control building with welfare facilities, wastewater holding tank, water connection, car parking, security fencing and lighting, etc.
- all associated underground electrical and communications cabling connecting the turbines to the proposed electrical substation
- temporary construction compound
- permanent meteorological mast
- temporary improvements and modifications to public roads to facilitate delivery of abnormal loads
- grid connection from the wind farm site to the proposed 110kV substation or Charleville 110kV substation within the public road,
- all associated site works and ancillary development including signage.

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*=17 riverine sites was undertaken (**Table 2.1; Figure 2.1**). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, European eel (*Anguilla anguilla*) and lamprey species. The fisheries survey also documented other fish species of lower conservation value 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 Garrane wind farm. The survey was undertaken on the 24th, 25th, and 26th July and 14th August 2023.

1.2 Fisheries asset of the survey area

The fisheries survey sites were located numerous watercourses within the Maigue_SC_010, Maigue_SC_020 and Awbeg[Buttevant]_SC_010 river sub-catchments (**Table 2.1**).

The River Maigue, a major tributary of the lower River Shannon, is known to support a range of fish species including Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), lamprey (*Lampetra* sp.), European eel (*Anguilla anguilla*), stone loach (*Barbatula barbatula*), minnow (*Phoxinus phoxinus*) and three-spined stickleback (*Gasterosteus aculeatus*) (Holmes et al., 2022; Kelly et al., 2017; IFI, 2015). Dace (*Leuciscus leuciscus*), an invasive cyprinid, have been known in the lower reaches of the Maigue since 1990 (Caffrey et al., 2007).

The River Loobagh, a tributary of the Maigue (to which it joins within the survey area), is known to support Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), European eel, minnow and stone loach (IFI, 2015; Triturus data).

Fisheries data for the remaining watercourses within the survey area was not available prior to this survey.

2. Methodology

2.1 Fisheries assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish *n*=19 sites on watercourses in the vicinity of Garrane wind farm during July and August 2023 following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The fisheries survey sites were located on the River Maigue (EPA code: 24M01), Loobagh River (24L28), Charleville Stream (24C02), Graigues River (24G37), Creggane Stream (23C50), Broghill North Stream (24B96), Rathnacally Stream (18R32), Foxhall East River (24F13), Rathluirc Stream (24R11) and the Garrynderk Stream (24G33) (**Table 2.1; Figure 2.1**). Survey sites C1 and C2 on the River Maigue downstream of the River Loobagh confluence were added at the request of Inland Fisheries Ireland.

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. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g., CFB, 2008).

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.

2.2 Fisheries habitat

A fisheries habitat appraisal of all aquatic survey sites was undertaken to establish their fisheries value. The surveys focused on evaluating the spawning, nursery and or holding habitat for salmonids and lamprey species but also considered European eel and other fish species.

2.3 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Specific consideration will be given to the highly virulent crayfish plague (*Aphanomyces astaci*) given the known distribution of white-clawed crayfish (*Austropotamobius pallipes*) in the wider survey area. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced.

Table 2.1 Location of *n*=19 electro-fishing survey sites in the vicinity of the proposed Garrane wind farm, Charleville, Co. Cork

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
F1	River Maigue	24M01	Ballynagoul	554292	627735
F2	Loobagh River	24L28	Ballynagoul	554516	627404
F3	Loobagh River	24L28	Ballynagoul	554435	626767
F4	Charleville Stream	24C02	Ballynagoul	554280	627263
F5	Graigues River	24G37	Creggane	553896	626844
F6	Creggane Stream	24C50	Creggane	553897	627215
F7	Charleville Stream	24C02	Ballynagoul	554178	626813
F8	River Maigue	24M01	Creggane	553743	627406
F9	Broghill North Stream	24B96	N20 road crossing	553535	625671
F10	Charleville Stream	24C02	Ballynagoul	554267	626239
A1	Rathnacally River	18R32	Garrynagrannoge	552400	620517
A2	Foxhall East River	24F13	Ballydaheen	550556	623162
A3	Broghill North Stream	24B96	Liscullane	552297	625002
B1	Charleville Stream	24C02	Rathgoggan Middle	553763	622660
B2	Charleville Stream	24C02	Rathgoggan Middle	553985	623170
B3	Rathluirc Stream	24R11	Ballincolly	554626	623415
B4	Garrynderk South Stream	24G33	Ballincolly	554927	623859
C1	River Maigue	24M01	Garrane	554300	627985
C2	River Maigue	24M01	Garrane	554271	628237

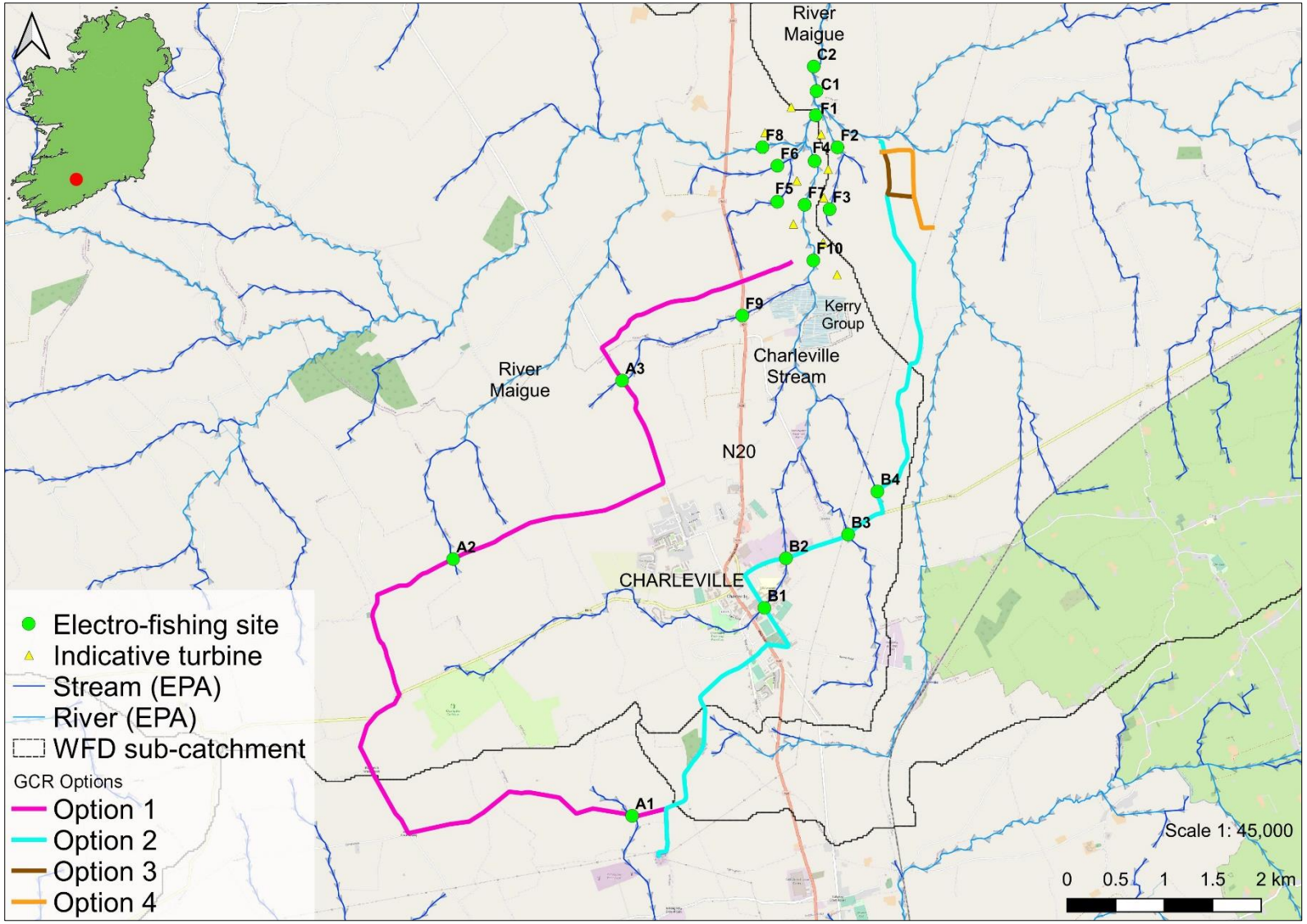

Figure 2.1 Overview of the electro-fishing survey site locations in the vicinity of the proposed Garrane wind farm. Co. Cork

3. Results

3.1 Fisheries assessment (electro-fishing)

3.1.1 Site F1 – River Maigue, Ballynagoul

Site F1 was located on the River Maigue (24M01) approximately 100m upstream of the River Loobagh confluence. The lowland depositing river (FW2; Fossitt, 2000) had been historically realigned and deepened throughout, resulting in a steep trapezoidal channel with 5-6m high banks. The river averaged 6m wide and 0.8-1.2m deep. The profile comprised exclusively of deep slow-flowing glide. The substrata were dominated by bedded mixed gravels with compacted sand and silt. Siltation was high overall (depositional glide). Macrophyte coverage was high with abundant common clubrush (*Schoenoplectus lacustris*) and branched bur-reed (*Sparganium erectum*) with occasional perfoliate pondweed (*Potamogeton perfoliatus*) and yellow lily (*Nuphar lutea*). The riparian areas supported rank grasses, nettle (*Urtica dioica*), great willowherb (*Epilobium hirsutum*) and hedge bindweed (*Calystegia sepium*) with no mature trees. The site was bordered by heavily improved pasture (GA1).

Brown trout (*Salmo trutta*) (*n*=5), European eel (*Anguilla anguilla*) (*n*=2), minnow (*Phoxinus phoxinus*) (*n*=6), stone loach (*Barbatula barbatula*) (*n*=2) and three-spined stickleback (*Gasterosteus aculeatus*) (*n*=5) were recorded via electro-fishing at site F1 (**Figure 3.1**). The site was of very poor value as a salmonid spawning or nursery habitat (siltation, drainage pressures) although deep glide with high macrophyte cover provided good quality holding areas for adult salmonids. There was moderate quality habitat for European eel given macrophyte cover and prey resources with a low density recorded. While some lower quality lamprey ammocoete habitat existed, the silts were too compacted and shallow to support the species. The enriched conditions benefited cyprinid fish such as minnow and stone loach, in addition to three-spined stickleback.

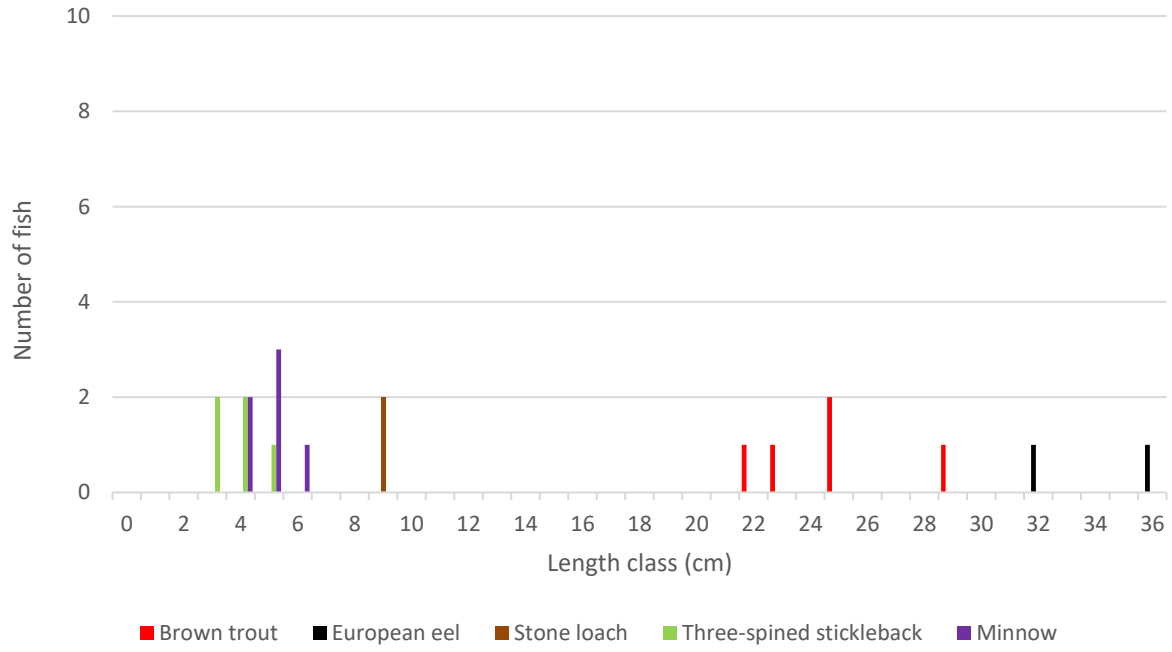

Figure 3.1 Length frequency distribution recorded via electro-fishing at site F1 on the River Maigue, July 2023

Plate 3.1 Adult brown trout recorded at site F1 on the upper reaches of the River Maigue, July 2023

Plate 3.2 Representative image of site F1 on the upper reaches of the River Maigue, July 2023

3.1.2 Site F2 – Loobagh River, Ballynagoul [1]

Site F2 was located on the Loobagh River (24L28), a minor tributary of the River Maigue. The small lowland depositing channel (FW2) had been historically straightened and deepened, resulting in very poor hydromorphology. The river represented a drainage channel and suffered from low water levels at the time of survey with an imperceptible flow and frequent instream impoundments/ponding of water. The channel averaged 1.5m wide and <0.1m deep (even following significant rainfall). The substrata were dominated by deep soft sediment accumulations, much derived from livestock poaching. Scattered superficial gravels and small boulder were also present (but bedded in silt). The site was heavily vegetated with locally abundant branched bur-reed and frequent fool's watercress (*Apium nodiflorum*), water forget-me-not (*Myosotis scorpioides*) and water mint (*Mentha aquatica*), with occasional water starwort (*Callitriche* sp.) and common duckweed (*Lemna minor*). Filamentous algal cover was very high in rare isolated areas of channel (i.e. sections exposed to livestock poaching). The narrow channel was heavily encroached by abundant reed canary grass (*Phalaris arundinacea*), great willowherb, nettle and bramble (*Rubus fruticosus* agg.) with scattered hawthorn (*Crataegus monogyna*). The site was located in wet semi-improved pasture (GA1).

Three-spined stickleback (*n*=6) were the only fish species recorded via electro-fishing at site F2 (**Figure 3.2**). With the exception of stickleback, the site was not of fisheries value given gross siltation, poor flows, heavy modifications, poor hydromorphology and very poor connectivity with superior downstream fisheries habitats (i.e. River Maigue).

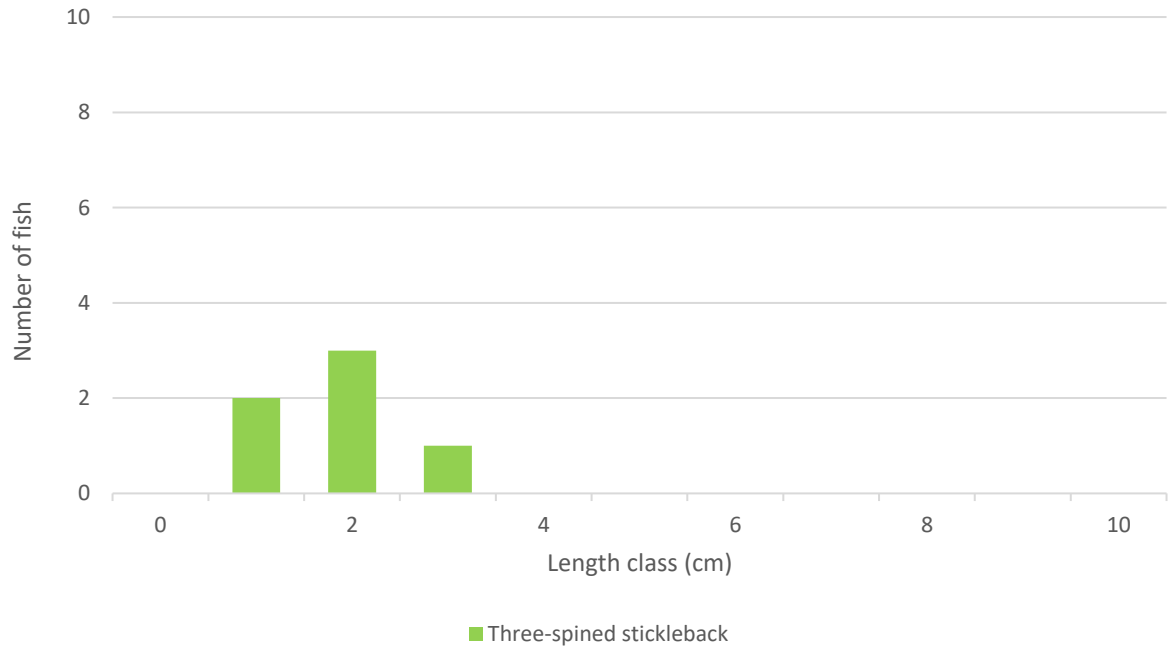

Figure 3.2 Length frequency distribution recorded via electro-fishing at site F2 on the Loobagh River, July 2023

[1] Please note that this is a separate watercourse the larger and adjacent River Loobagh (EPA code: 24L01)

Plate 3.3 Juvenile three-spined stickleback recorded at site F2 on the Loobagh River, August 2023

Plate 3.4 Representative image of site F2 on the Loobagh River, August 2023

3.1.3 Site F3 – Loobagh River, Ballynagoul

Site F3 was located on the uppermost reaches of the Loobagh River (24L28), approximately 0.7km upstream of site F2. The small lowland channel (FW2) had been extensively straightened and deepened historically, resulting in very poor hydromorphology. The river represented a drainage channel and averaged <2m wide and 0.1m deep with a bed comprised entirely of deep, clay-dominated soft sediment. Livestock poaching was evident throughout and was contributing to

siltation and impeding flows locally. The river was stagnant at this location at the time of survey with ponding of water in vicinity of a livestock access bridge. The channel was heavily vegetated with abundant branched bur-reed and water mint. Water starwort (*Callitriche* sp.) was locally frequent with occasional fool's watercress. Terrestrial encroachment was high with abundant great willowherb and bramble scrub along the otherwise open (cleared & grazed) banks. The site was bordered by wet grassland (GS4) dominated by iris (*Iris psuedacorus*) with significant livestock grazing.

No fish were recorded via electro-fishing at site F3. The site was not of fisheries value given gross siltation, intermittent flows, heavy modifications, poor hydromorphology and very poor connectivity with superior downstream fisheries habitats (i.e. River Maigue).

Plate 3.5 Representative image of site F3 on the Loobagh River, July 2023

3.1.4 Site F4 – Charleville Stream, Ballynagoul

Site F4 was located on the lower reaches of the Charleville Stream (24C02) approximately 0.25km upstream of the River Maigue confluence. The lowland depositing river (FW2) had been straightened and deepened throughout with poor hydromorphology in a steep trapezoidal channel with banks of up to 3m in height. However, some instream recovery of the planform was evident. The river averaged 2-2.5m wide and 0.4-0.75m deep with a profile dominated by homogenous slow-flowing glide and pool. Riffle areas were absent. The substrata were dominated by fine and medium gravels and sands with very occasional cobble and scattered small boulder. However, these were heavily silted. Soft sediment accumulations, dominated by clay, were frequent. Given steep banks and riparian encroachment, macrophyte growth was sparse with occasional spiked-water milfoil (*Myriophyllum spicatum*) and more occasional fennel pondweed (*Stuckenia pectinata*). Water mint and fool's watercress (*Nasturtium officinale*) were also occasional. The banks had been historically cleared with abundant herbaceous vegetation and scattered hawthorn. The site was bordered by improved pasture (GA1).

Brown trout (*n*=5), and minnow (*n*=1) were the only fish species recorded via electro-fishing at site F4 (**Figure 3.4**). The site was of moderate value for salmonids, supporting a low density of brown trout. The paucity of juvenile salmonids was indicative of siltation plus hydromorphological and eutrophication pressures which reduced the quality of spawning habitat. Salmonid nursery habitat was poor quality given siltation pressures. However, the site was of good value as a holding habitat for adults with frequent scoured banks, overhanging herbaceous vegetation, macrophyte beds and deep glide/pool areas. These areas also provided good quality European eel habitat although none were recorded. Whilst soft sediment accumulations were frequent these were typically clay-dominated and sub-optimal for lamprey ammocoetes (none recorded). Lamprey spawning habitat was present locally but was again impacted by siltation.

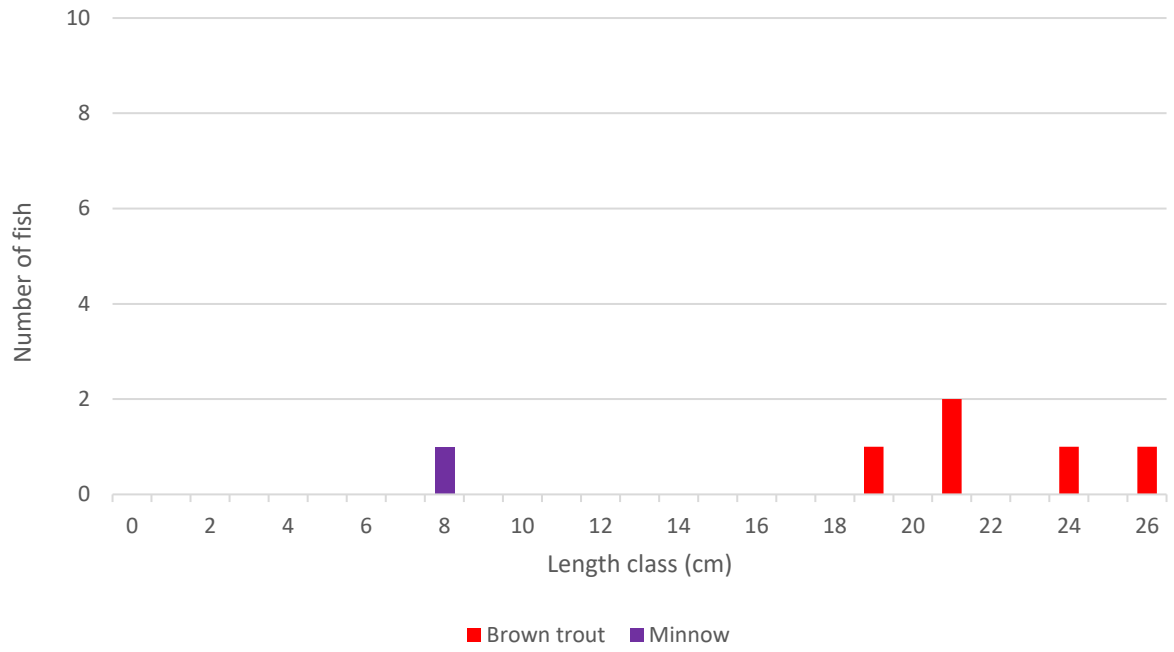

Figure 3.3 Length frequency distribution recorded via electro-fishing at site F4 on the Charleville Stream, July 2023

Plate 3.6 Adult brown trout recorded at site F4 on the Charleville Stream, July 2023

Plate 3.7 Representative image of site F4 on the on the Charleville Stream, July 2023

3.1.5 Site F5 – Graigues River, Creggane

Site F5 was located on the Graigues River (24G37), a minor tributary of the Charleville Stream. The lowland depositing river (FW2) had been extensively straightened and deepened with resulting poor hydromorphology. The river suffered from poor flows at the time of survey with a profile of near stagnant glide and pool (no riffles). The river averaged 1.5-2m wide and 0.3m deep in a dep U-shaped channel. Bank heights were up to 2m. The bed of the heavily modified channel was dominated by deep, clay-dominated soft sediment accumulations with a near absence of harder substrata. The river was heavily vegetated with frequent branched bur-reed, occasional water starwort (*Callitriche* sp.) and water mint. The immediate riparian zone supported abundant reed canary grass which was encroaching on the narrow channel. The banks had been historically cleared and supported only scattered hawthorn, grey willow (*Salix cinerea*) and ash (*Fraxinus excelsior*).

Three-spined stickleback (*n*=16) was the only fish species recorded via electro-fishing at site F5 (**Figure 3.4**). With the exception of stickleback, the site was not of fisheries value given gross siltation, poor flows, heavy modifications, poor hydromorphology and poor connectivity with superior downstream fisheries habitats (i.e. Charleville Stream).

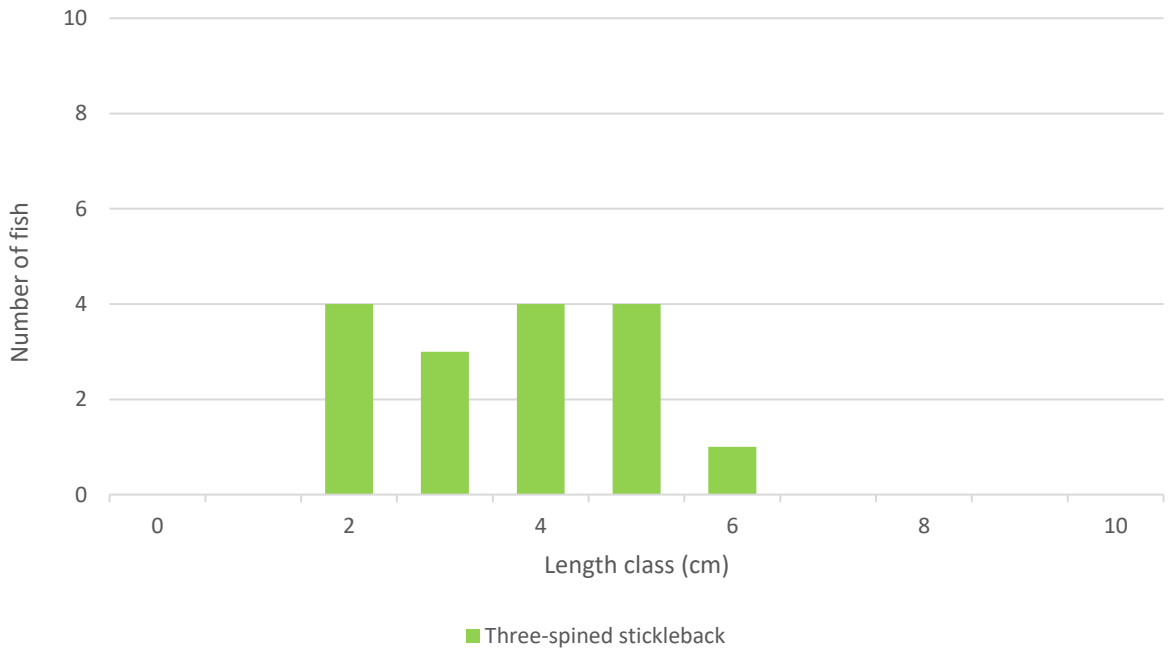

Figure 3.4 Length frequency distribution recorded via electro-fishing at site F5 on the Graigues River, July 2023

Plate 3.8 Representative image of site F5 on the Graigues River, July 2023

3.1.6 Site F6 – Creggane Stream, Creggane

Site F6 was located on the Creggane Stream (24C50), a tributary of the Graigues River. The small lowland watercourse (FW2) had been extensively straightened and deepened throughout with resulting very poor hydromorphology. The channel supported only a slight flow at the time of survey (even following significant rainfall) and was likely ephemeral at this location. The deep V-shaped channel had banks of up to 3m in height and a profile of near stagnant glide and pool, with ponding of water present. The heavily modified channel featured a bed comprised exclusively of clay with no hard substrata present. Some slumping of the steep banks had deposited some mixed gravels along channel margins. The site was heavily vegetated with abundant branched-bur reed and occasional fool's watercress. The stream was heavily encroached with terrestrial vegetation, dominated by reed canary grass, meadowsweet (*Filipendula ulmaria*), great willowherb and rank grasses. The site was bordered by improved and re-seeded pasture (GA1) and an immature broadleaf plantation (WS2).

No fish were recorded via electro-fishing at site F6. The site was not of fisheries value given gross siltation, poor (possibly ephemeral) flows, heavy modifications, poor hydromorphology and very poor connectivity with superior downstream fisheries habitats.

Plate 3.9 Representative image of site F6 on the Creggane Stream, July 2023

3.1.7 Site F7 – Charleville Stream, Ballynagoul

Site F7 was located on the Charleville Stream (24C02) approximately 0.5km upstream of site F4. The lowland depositing river (FW2) had been straightened and deepened throughout, resulting in a trapezoidal channel with poor hydromorphology. However, some instream recovery of the planform was evident. The river averaged 2-2.5m wide and 0.3-0.6m deep with a profile dominated by moderate-flowing glide and pool. Riffle areas were present but highly localised. The substrata were dominated by fine and medium gravels and sands with frequent cobble and scattered small boulder. However, these were heavily silted. Livestock poaching was widespread. Soft sediment accumulations, dominated by clay, were frequent. Given steep banks and riparian encroachment, macrophyte growth was sparse with occasional lesser water parsnip (*Berula erecta*), fool's watercress and occasional watercress. Branched bur-reed was present locally. Water starwort (*Callitriche* sp.) was rare. Aquatic bryophytes were limited to the liverwort *Pellia endiviifolia*. The banks had been historically cleared with herbaceous vegetation, scattered bramble scrub and isolated hawthorn remaining. The site was bordered by improved pasture (GA1) and wet grassland (GS4) (used for grazing).

Atlantic salmon (*n*=1), brown trout (*n*=6) and minnow (*n*=92) were recorded via electro-fishing at site F7 (**Figure 3.5**). The site was of moderate value for salmonids, supporting a low density of brown trout and a single Atlantic salmon parr. The paucity of juvenile salmonids was indicative of siltation plus hydromorphological and eutrophication pressures which reduced the quality of spawning habitat. Salmonid nursery habitat was present but localised and of relatively poor quality given siltation pressures (would have been very good otherwise). However, the site was of good value as a holding habitat for adults with frequent scoured banks, overhanging herbaceous vegetation, macrophyte beds and deep glide/pool areas. These areas also provided good quality European eel habitat although none were recorded. Whilst soft sediment accumulations were frequent these were typically clay-dominated and sub-optimal for lamprey ammocoetes (none recorded). Lamprey spawning habitat was

present locally but was again impacted by siltation pressures. The very high density of minnow recorded was further indicative of significant enrichment and siltation pressures.

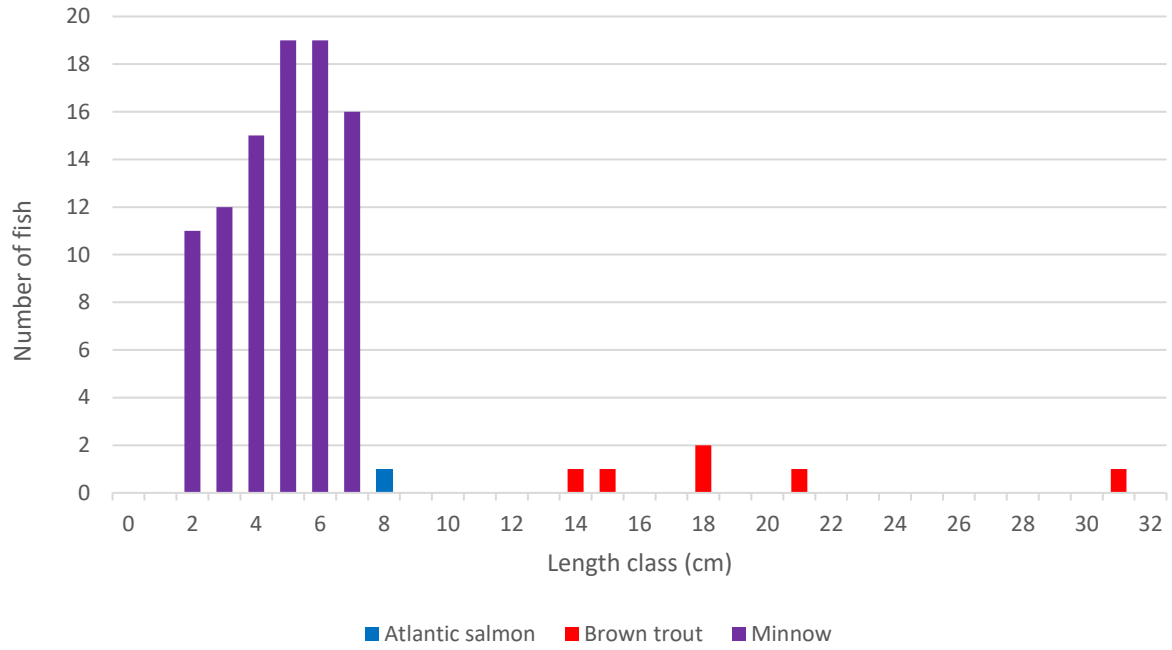

Figure 3.5 Length frequency distribution recorded via electro-fishing at site M5 on the Garrane South River, July 2023

Plate 3.10 Atlantic salmon and minnow recorded at site F7 on the Charleville Stream, July 2023

Plate 3.11 Representative image of site F7 on the Charleville Stream, July 2023

3.1.8 Site F8 – River Maigue, Creggane

Site F8 was located on the River Maigue (24M01) approximately 0.4km downstream of the N20 road crossing. The lowland depositing river (FW2) had been historically straightened and deepened throughout, resulting in a steep trapezoidal channel with 4m high banks. The river averaged 6-8m wide and 0.2-0.5m deep. The profile was dominated by deeper glide with occasional pool (no riffle). The substrata comprised heavily bedded mixed gravels with compacted sand and silt. Scattered boulder and cobble were also present. The substrata suffered from heavy siltation. Exuberant macrophyte growth was present with abundant heterophyllous common clubrush, lesser water parsnip, spiked water milfoil and curled pondweed (*Potamogeton crispus*) with water starwort (*Callitriche* sp.) in the margins. The historically cleared riparian areas supported rank grasses, nettle and scattered grey willow. The site was bordered by heavily improved pasture (GA1).

Atlantic salmon (*n*=1), brown trout (*n*=6), minnow (*n*=15, stone loach (*n*=2) and three-spined stickleback (*n*=3) were recorded via electro-fishing at site F8 (**Figure 3.6**). The site was of poor value as a salmonid spawning or nursery habitat due to siltation and drainage pressures, although deep glide with high macrophyte cover provided good quality holding areas for adult salmonids. There was moderate quality habitat for European eel given macrophyte cover and prey resources although none were recorded. While some lower quality lamprey ammocoete habitat existed, the silts were too compacted and shallow to support the species. The enriched conditions benefited cyprinid fish such as minnow and stone loach, in addition to three-spined stickleback.

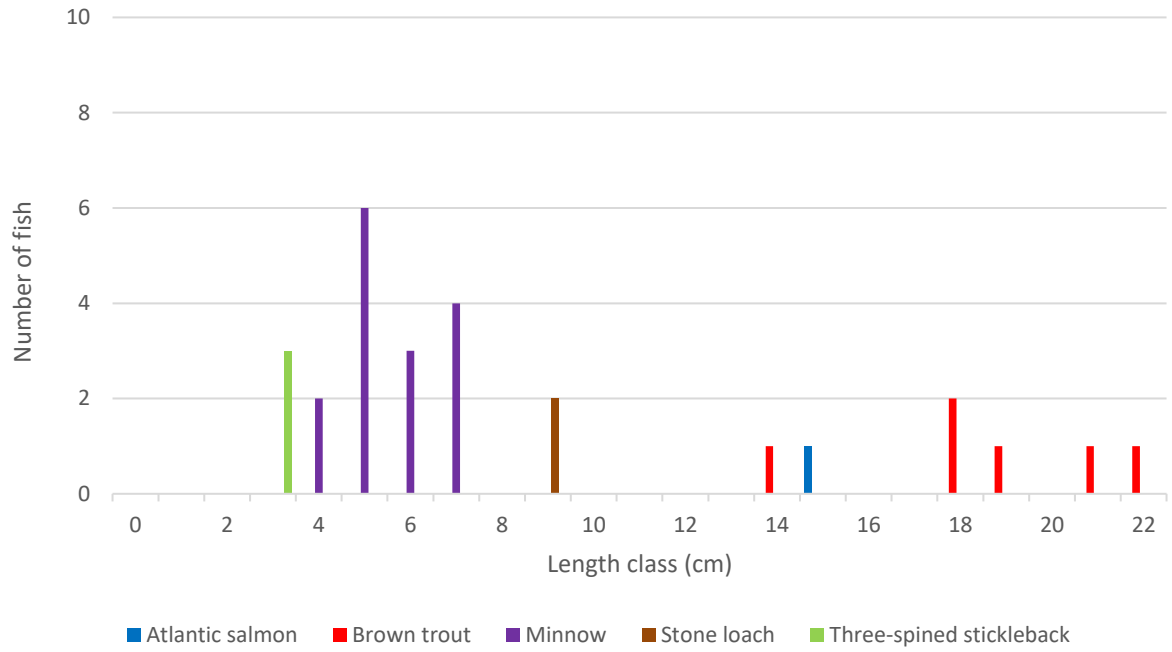

Figure 3.6 Length frequency distribution recorded via electro-fishing at site F8 on the River Maigue, August 2023

Plate 3.12 Brown trout and Atlantic salmon parr recorded at site F8 on the River Maigue, August 2023

Plate 3.13 Representative image of site F8 on the River Maigue, August 2023

3.1.9 Site F9 – Broghill North Stream, N20 road crossing

Site F9 was located on the Broghill North Stream (24B96), a Charleville Stream tributary, at the N20 road crossing. The lowland depositing watercourse (FW2) had been extensively straightened and deepened historically with very poor resulting hydromorphology. The stream averaged a homogenous 3m wide and 0.2-0.4m deep in a deep U-shaped channel with steep modified/slumping/poached banks of up to 3m in height. The substrata were dominated by clay-dominated soft sediment with occasional superficial fine to medium gravels and occasional scattered boulder. Bank slumping (livestock poaching) was frequent and was contributing to siltation of the already very heavily silted channel. The stream suffered from low flows at the time of survey, with only a slight flow present in glide and pool habitat. Cover of macrophytes was relatively high with locally abundant lesser water parsnip and frequent common duckweed. Iris was present occasionally. The steep gravelly-clay banks supported abundant nettle, cleavers (*Galium aparine*) and bramble with some reed canary grass. The banktop (often unfenced) was lined with hawthorn and ash-dominated hedgerows and treelines. The site was bordered by intensive pasture (GA1).

Minnow (*n*=6) and three-spined stickleback (*n*=3) were the only fish species recorded via electro-fishing at site F9 (**Figure 3.7**). The site was of poor fisheries value given gross siltation and poor hydromorphology (including low flows). However, the site supported low densities of minnow and stickleback. The stream was unsuitable for salmonids at this location given very heavy siltation and a resulting absence of spawning habitat. The homogenous nature of the historically modified channel also resulted in a paucity of suitable nursery and holding areas. Whilst soft sediment accumulations were abundant, these were typically unsuitable for lamprey given their compacted/clay nature. There was low suitability for European eel and none were recorded.

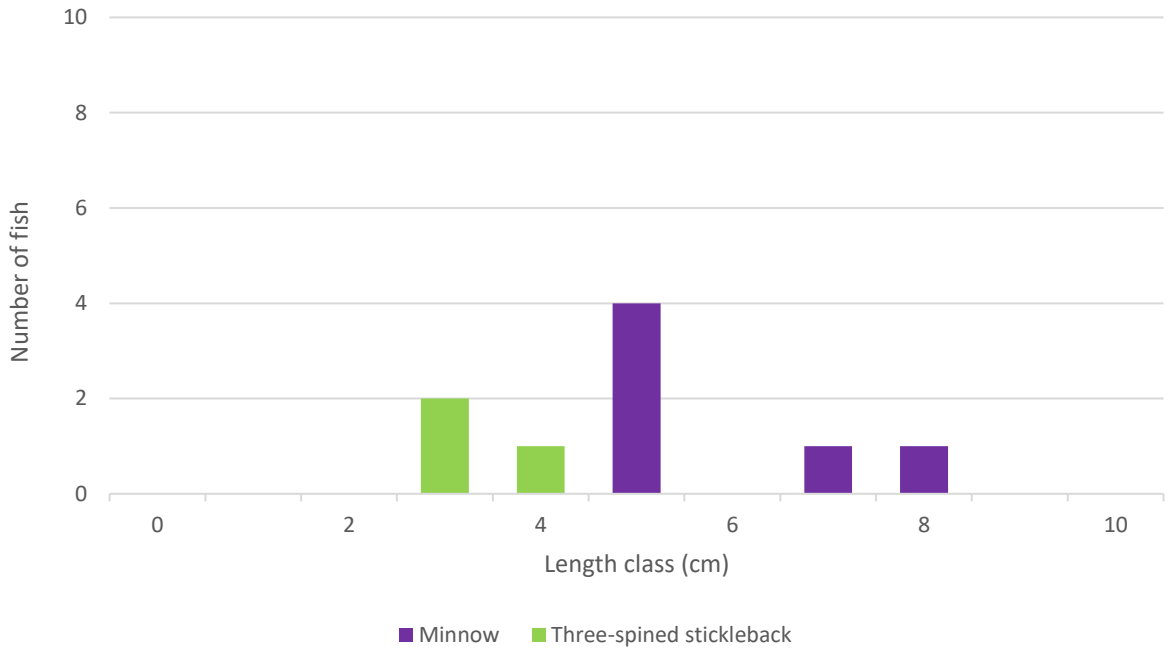

Figure 3.7 Length frequency distribution recorded via electro-fishing at site F9 on the Broghill North Stream, July 2023

Plate 3.14 Minnow recorded at site F9 on the Broghill North Stream, July 2023

Plate 3.15 Representative image of site F9 on the Broghill North Stream, July 2023

3.1.10 Site F10 – Charleville Stream, Ballynagoul

Site F10 was located on the Charleville Stream (24C02) approximately 0.6km upstream of site F7. The lowland depositing river (FW2) had been historically deepened and straightened locally but retained some semi-natural characteristics with some instream recovery evident (e.g. meanders). The swift-flowing river averaged 3-3.5m wide and 0.3-0.6m deep, with locally deeper pool. The profile was of swift glide and pool with only occasional riffle areas. The river flowed in a deep trapezoidal channel with banks of up to 2.5m in height. The substrata were dominated by mixed gravels and cobble with frequent boulder. However, these were compacted with moderate to heavy siltation locally. Sand and soft sediment accumulations were also present. Given heavy shading and a compacted bed, macrophyte growth was sparse with only occasional fool's watercress and brooklime (*Veronica* beccabunga). Filamentous agal cover was high in open areas of channel, indicating significant enrichment. Aquatic bryophytes were limited to occasional *Rhynchostegium riparioides*. The river was heavily shaded by dense riparian scrub and treelines dominated by bramble, willow and hawthorn. The site was bordered by heavily improved pasture (GA1) with narrow borders.

Atlantic salmon (*n*=1), brown trout (*n*=8), minnow (*n*=42) and stone loach (*n*=3) were recorded via electro-fishing at site F10 (**Figure 3.8**). The site was of moderate value for salmonids, supporting a low density of brown trout, with a single Atlantic salmon parr also captured. The paucity of juvenile salmonids was indicative of siltation plus hydromorphological and eutrophication pressures which reduced the quality of spawning habitat. Salmonid nursery habitat was present but localised and of relatively poor quality given siltation pressures and compaction. However, the site was of good value as a holding habitat for adults with frequent scoured banks and deep glide/pool areas, often associated with meanders and instream large woody debris. These areas also provided good quality European eel habitat although none were recorded. Whilst soft sediment accumulations were frequent these were typically clay-dominated and sub-optimal for lamprey ammocoetes (none

recorded). Lamprey spawning habitat was present locally but was again impacted by siltation pressures.

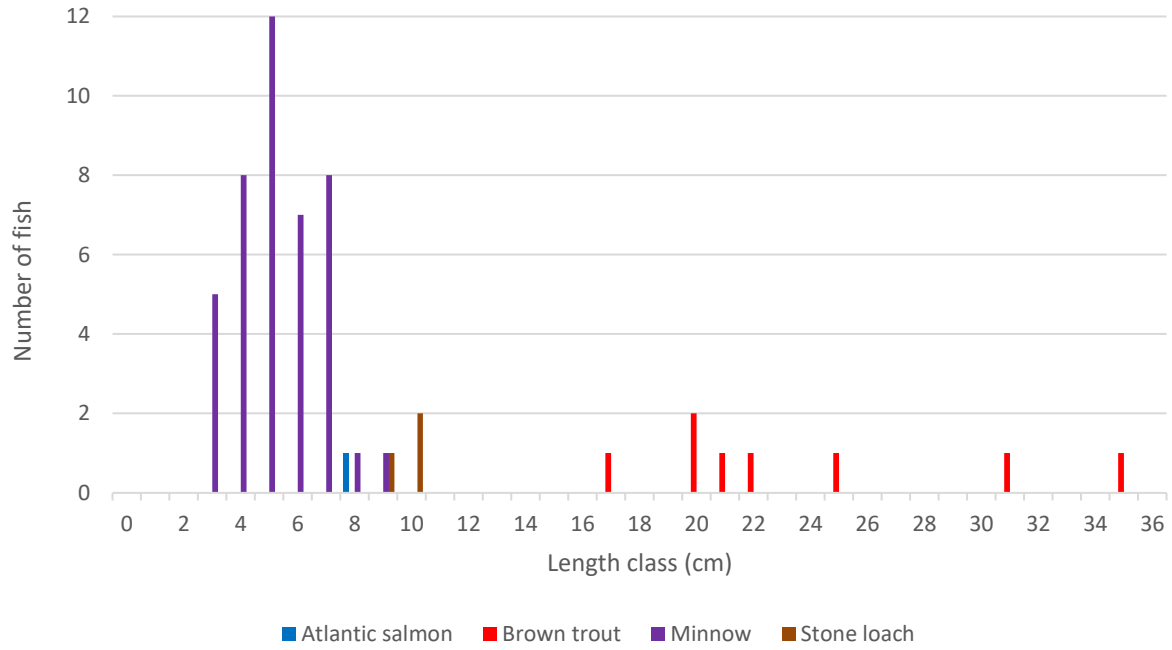

Figure 3.8 Length frequency distribution recorded via electro-fishing at site F10 on the Charleville Stream, July 2023

Plate 3.16 Large adult brown trout recorded at site F10 on the Charleville Stream, July 2023

Plate 3.17 Representative image of site F10 on the Charleville Stream, July 2023

3.1.11 Site A1 – Rathnacally River, Garrynagrannoge

Site A1 was located on the uppermost reaches of the Rathnacally Stream (18R32), at a local road and proposed GCR crossing. The lowland stream (FW2) represented a small, historically straightened and deepened drainage channel with stagnant water at the time of the survey. The channel averaged <1m wide and <0.05m deep (even following significant rainfall). The channel was likely ephemeral at this location. The substrata were comprised exclusively of deep silt. Macrophytes were limited to occasional fool's watercress with encroaching iris also present instream. The narrow channel was typically heavily shaded by dense hedgerows supporting hawthorn and blackthorn (*Prunus spinosa*). The site was bordered by improved pasture (GA1).

No fish were recorded via electro-fishing at site A1. The site was not of fisheries value given heavy siltation, intermittent flows, heavy modifications, poor hydromorphology and very poor connectivity with superior downstream fisheries habitats.

Plate 3.18 Representative image of site A1 on the uppermost reaches of the Rathnacally River, July 2023

3.1.12 Site A2 – Foxhall East River, Ballydaheen

Site A2 was located on the headwaters of the Foxhall East River (24F13) at a local road and proposed GCR crossing. The diminutive stream (FW1) flowed in a steep V-shaped channel over a moderate to steep gradient (pipe culvert under road). The stream (FW1) averaged <1m wide and 0.05m deep, with deeper plunge pools to 0.2m. The stream suffered from low flows even following significant rainfall. Typical of stream headwaters, the substrata were dominated by cobble and mixed gravels with occasional boulder. Natural bank scouring was frequent and was contributing silt to the channel (moderate to high overall). Given very high shading (tunnelling), macrophytes and aquatic bryophytes were absent. The channel was heavily tunnelled upstream of the road crossing with dense cotoneaster (*Cotoneaster* sp.), ash and sycamore (*Acer psuedoplatanus*).

No fish were recorded via electro-fishing at site A2. The site was not of fisheries value given heavy siltation, poor flows, heavy modifications, poor hydromorphology and poor connectivity with superior downstream fisheries habitats.

Plate 3.19 Representative image of site A2 on the Foxhall East River, July 2023

3.1.13 Site A3 – Broghill North Stream, Liscullane

Site A3 was located on the upper reaches of the Broghill North Stream (24B96) at a local road and proposed GCR crossing, approximately 1.6km upstream of site F9. The small stream (FW1) had been historically straightened and deepened in vicinity of the road crossing (pipe culvert) and suffered from very low flows at the time of survey. The stream averaged <1m wide and <0.05m deep with only a slight flow observed in very shallow riffle and glide habitat. The substrata were dominated by mixed gravels with scattered cobble and small boulder. These were exposed to heavy siltation. Given high shading, macrophyte growth was sparse with only occasional fool's watercress. The channel was lined by mature treelines dominated by ash. The site was bordered by improved pasture (GA1) and residential properties (BL3, GA2).

No fish were recorded via electro-fishing at site A3. The site was not of fisheries value given heavy siltation, poor flows, heavy modifications, poor hydromorphology and poor connectivity with superior downstream fisheries habitats.

Plate 3.20 Representative image of site A3 on the Broghill North Stream, July 2023

3.1.14 Site B1 – Charleville Stream, Rathgoggan Middle

Site B1 was located on the upper reaches of the Charleville Stream (24C02) on the outskirts of Charleville town. The small swift-flowing stream (FW2) had been heavily modified historically with realignment, culverting and deepening evident. From this point, the stream was culverted under the road through industrial and urban areas for a considerable distance. The stream averaged 2-2.5m wide and 0.1-0.2m deep with a profile comprised of shallow swift glide, riffle and only occasional small pool. The substrata were dominated by compacted cobble with frequent mixed gravel and occasional small boulder. Some sand and soft sediment beds were present along the margins. Siltation was moderate overall. Macrophytes were limited to occasional fool's watercress. The steep banks were heavily scrubbed with nettle, great willowherb, bramble and ornamental hedging. The site was bordered by residential and urban areas (BL3).

Brown trout (*n*=4) and three-spined stickleback (*n*=2) were the only fish species recorded via electro-fishing at site B1 (**Figure 3.9**). The site was of moderate value only for salmonids given historical modifications and siltation pressures although a small mixed cohort trout population was recorded. The quality of salmonid and lamprey spawning habitat was reduced by siltation (but was nonetheless present). Holding habitat for adult salmonids was largely absent with relatively poor quality nursery habitat in swift glide. Soft sediment accumulations had some low, sub-optimal suitability for lamprey ammocoetes although none were recorded. The shallow site was of poor value for European eel given a paucity of suitable refugia.

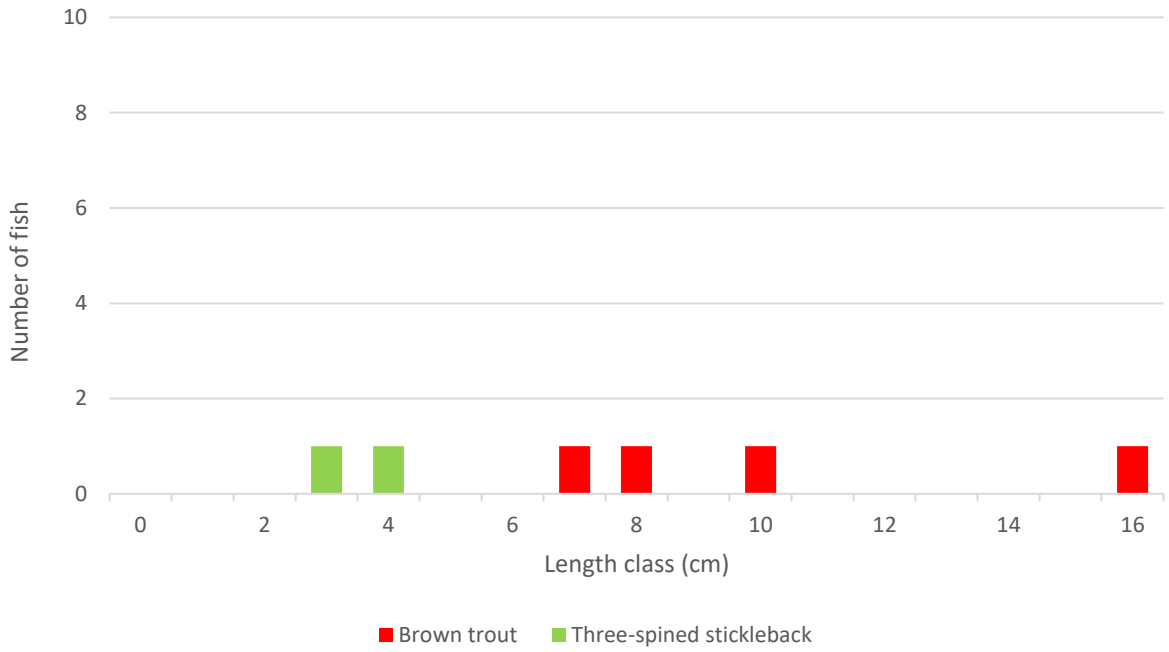

Figure 3.9 Length frequency distribution recorded via electro-fishing at site M5 on the Garrane South River, July 2023

Plate 3.21 Brown trout recorded at site B1 on the Charleville Stream, July 2023

Plate 3.22 Representative image of site B1 on the Charleville Stream, July 2023

3.1.15 Site B2 – Charleville Stream, Rathgoggan Middle

Site B2 was located on the Charleville Stream (24C02) upstream of the R615 road and proposed GCR crossing, approximately 0.5km downstream of site B1. The small lowland stream (FW2) had been extensively straightened and deepened with resulting very poor hydromorphology in a deep trapezoidal channel. The stream averaged 0.5-1m wide and <0.1m deep with only a slight flow at the time of survey, even after heavy rainfall (likely flow impediments present in upstream culverts). The substrata were dominated by soft sediment (silt\clay) with occasional superficial fine to medium gravels. Small boulder was occasional. The site was very heavily shaded by mature riparian treelines and scrub, with no macrophyte growth. Aquatic bryophytes were limited to occasional *Fissidens* sp. moss on instream substrata. The site was bordered by rough pasture (GA1) and industrial areas (BL3).

No fish were recorded via electro-fishing at site B2. The site was not of fisheries value given extensive historical modifications, poor hydromorphology and siltation pressures. The stream was <0.1m deep at the time of survey even after heavy rainfall and likely suffers from very low flows, deterring resident fish. The shallow nature and modifications (including underground culverting) significantly impacted the fisheries value of the stream. However, brown trout and three-spined stickleback were present upstream at site B1.

Plate 3.23 Representative image of site B2 on the Charleville Stream, July 2023

3.1.16 Site B3 – Rathluirc Stream, Ballincolly

Site B3 was located on the Rathluirc Stream (24R11), a tributary of the Charleville Stream, at the R515 road and proposed GCR crossing. The small stream (FW2) had been extensively straightened and deepened historically (box culvert under road), with resulting very poor hydromorphology. The stream, which represented a drainage channel, averaged 1-1.5m wide and 0.2m deep with only a very slight flow even following heavy rainfall. The profile was of near stagnant glide and pool with an absence of riffles. The stream flowed in a deep U-shaped channel with a bed dominated by deep soft sediment accumulations. Small boulder and cobble were scattered but bedded in silt. The stream was very heavily shaded my dense bramble-dominated scrub and ash-sycamore-willow treelines. As a result, macrophytes and aquatic bryophytes were absent. The site was bordered by improved pasture (GA1) and residential properties (BL3, GA2).

Three-spined stickleback (*n*=4) were the only fish species recorded via electro-fishing at site B3 (**Figure 3.10**). With the exception of low densities of stickleback, site B3 was not of fisheries value given extensive historical modifications, poor hydromorphology and significant siltation pressures. The stream likely suffers from very low flows or even dries up, seasonally. The shallow nature, instream modifications (including underground culverting upstream of the road crossing through residential properties) and poor connectivity with downstream habitats significantly impacted the fisheries value of the stream.

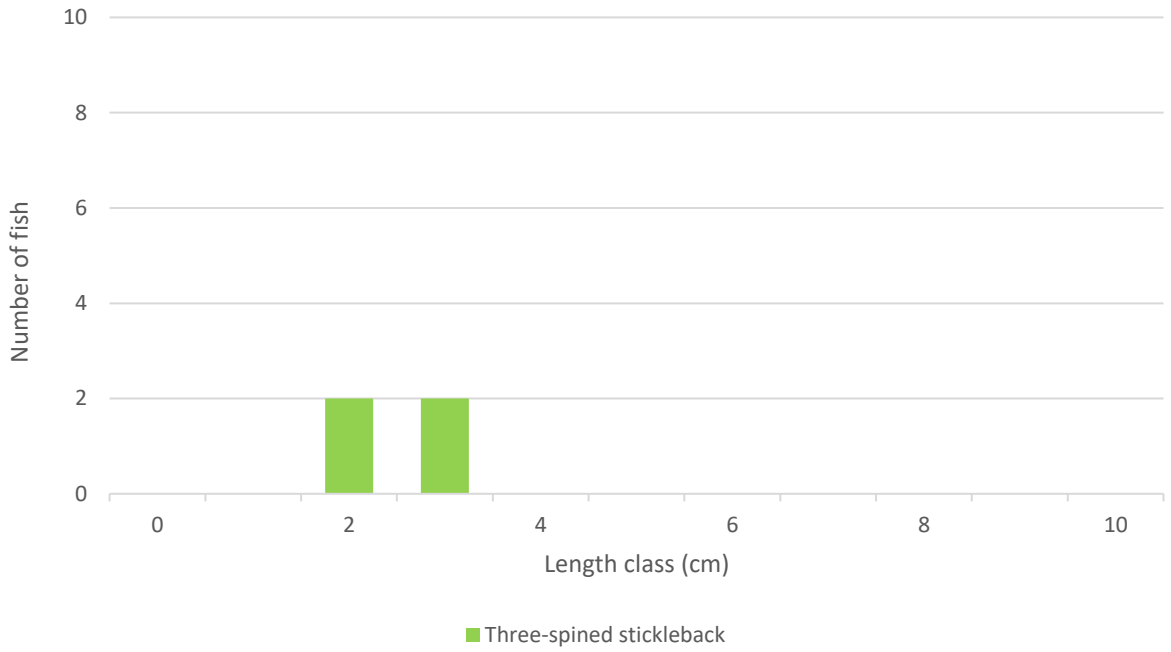

Figure 3.10 Length frequency distribution recorded via electro-fishing at site B3 on the Rathluirc Stream, July 2023

Plate 3.24 Representative image of site B3 on the Rathluirc Stream, July 2023

3.1.17 Site B4 – Garrynderk South Stream, Ballincolly

Site B4 was located on the Garrynderk South Stream (24G33), a tributary of the Charleville Stream, at a local road and proposed GCR crossing. The stream (FW2) had been extensively straightened and deepened throughout with resulting very poor hydromorphology. The stream represented a stagnant drainage channel and averaged a homogenous 1m wide and 0.3m deep with bank heights of up to 2m

in a steep V-shaped channel. There were no flows at the time of survey with the site downstream of the road pipe culvert holding a significant volume of stagnant water. The substrata comprised clay-dominated soft sediment with scattered gravels and small boulder (from historical excavations). The site was heavily vegetated with abundant fool's watercress and watercress. The steep sided channel was heavily shaded by dense bramble-dominated scrub, with open banks downstream (cleared along agricultural track).

No fish were recorded via electro-fishing at site B4. The site was not of fisheries value given extensive historical modifications, poor hydromorphology and eutrophication issues. The stream likely suffers from very low flows or even dries up, seasonally. The stagnant nature, instream modifications and poor connectivity with downstream habitats significantly impacted the fisheries value of the stream.

Plate 3.25 Representative image of site B4 on the Garrynderk South Stream, July 2023

3.1.18 Site C1 – River Maigue, Garrane

Site C1 was located on the River Maigue (24M01) at a Kerry Group waste water discharge approximately 150m downstream of the River Loobagh confluence. The lowland depositing river (FW2) had been historically realigned and deepened throughout, resulting in a steep trapezoidal channel with 5m high banks. The river averaged 8m wide and 1.2-2m deep although an isolated riffle area (0.2-0.4m deep) was present immediately upstream of the discharge point. Otherwise, the profile comprised deep glide and pool. The substrata were dominated by compacted cobble and boulder with occasional bedded mixed gravels. These were heavily silted. The discharge point was evidently discolouring and enriching the river with a milky green discolouration observed downstream of the outfall. The site supported scattered stands of common clubrush, spiked water milfoil and curled pondweed. Water crowfoot (*Ranunculus* sp.) was locally frequent in riffle habitat. The steep banks supported rank grasses, reed canary grass, nettle, great willowherb and scattered white willow (*Salix alba*). The site was bordered by heavily improved pasture (GA1).

Atlantic salmon (*n*=9), brown trout (*n*=1), European eel (*n*=6), minnow (*n*=6) and stone loach (*n*=6) were recorded via electro-fishing at site C1 (**Figure 3.11**). The site was of moderate value for salmonids, with the value reduced given evident siltation and water quality issues. The salmonid spawning habitat was of moderate quality and compromised by siltation and enrichment pressures in additional to historical drainage. Localised *Ranunculus* stands provided some good quality salmonid nursery habitat. The holding habitat was good quality given the presence of abundant deeper glide and pool with macrophyte cover (but it was not possible to electro-fish the deeper glide upstream given prohibitive depths of between 1.5-2m). While some lower quality lamprey ammocoete habitat existed, the silts were too compacted and shallow to support the species. Good quality habitat for European eel was present given abundant prey resources and ample instream refugia.

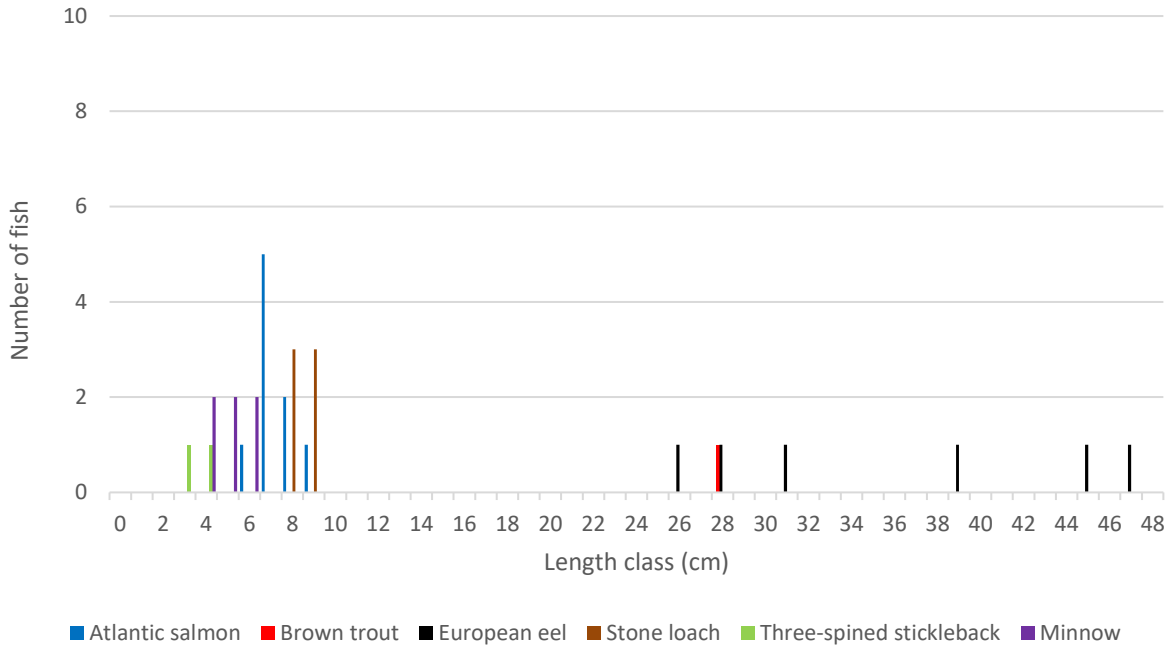

Figure 3.11 Length frequency distribution recorded via electro-fishing at site C1 on the River Maigue, August 2023

Plate 3.26 European eel recorded at site C1 on the River Maigue, August 2023

Plate 3.27 Representative image of site C1 on the River Maigue, August 2023 (discolouration from outfall evident)

3.1.19 Site C2 – River Maigue, Garrane

Site C2 was located on the River Maigue (24M01) approximately 250m downstream of site C1. The lowland depositing river (FW2) had been historically deepened throughout, resulting in a steep trapezoidal channel with 5m high banks. The river averaged 8m wide and 1.5-1.8m deep with a profile comprised of deep glide and pool (no riffle). The substrata were dominated by bedded mixed gravels

with silt and clay. These were heavily silted with evident discolouration from the upstream discharge point. The site featured scattered stands of common clubrush, branched bur-reed and more occasional curled pondweed. The steep banks supported rank grasses, reed canary grass, nettle, great willowherb and scattered white and grey and crack willow (*Salix fragilis*). The site was bordered by heavily improved pasture (GA1).

Electro-fishing was not undertaken at site C2 given prohibitive depths. However, the site was of high value as a salmonid holding habitat given the dominance of deep glide and pool with scattered macrophyte refugia and overhanging marginal vegetation. Suitability for European eel was also high in these areas. The site was also of some lower value as a salmonid nursery area. Salmonid and lamprey spawning opportunities were largely absent given siltation pressures. While some lower quality lamprey ammocoete habitat existed, the silts were too compacted and shallow to support the species. Evident enrichment likely suited pollution-tolerant species such as minnow and stone loach.

Plate 3.29 Representative image of site C2 on the River Maigue, August 2023

Table 3.1 Fish species densities and abundances recorded at sites in the vicinity of the proposed Garrane wind farm via electro-fishing in July 2023 (values in bold represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (no. per m^2)					
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Stone loach	Minnow
F1	River Maigue	5	150	0.000	0.033	0.013	0.033	0.013	0.040
F2	Loobagh River	5	75	0.000	0.000	0.000	0.080	0.000	0.000
F3	Loobagh River	5	60	0.000	0.000	0.000	0.000	0.000	0.000
F4	Charleville Stream	10	225	0.000	0.022	0.000	0.000	0.000	0.004
F5	Graigues River	5	75	0.000	0.000	0.000	0.213	0.000	0.000
F6	Creggane Stream	5	80	0.000	0.000	0.000	0.000	0.000	0.000
F7	Charleville Stream	10	250	0.004	0.024	0.000	0.000	0.000	**0.368**
F8	River Maigue	10	280	0.004	0.021	0.000	0.011	0.007	0.054
F9	Broghill North Stream	10	200	0.000	0.000	0.000	0.015	0.000	0.030
F10	Charleville Stream	10	280	0.004	0.029	0.000	0.000	0.000	0.150
A1	Rathnacally River	5	40	0.000	0.000	0.000	0.000	0.000	0.000
A2	Foxhall East River	5	30	0.000	0.000	0.000	0.000	0.000	0.000
A3	Broghill North Stream	5	40	0.000	0.000	0.000	0.000	0.000	0.000
B1	Charleville Stream	5	50	0.000	**0.100**	0.000	0.000	0.000	0.000
B2	Charleville Stream	5	45	0.000	0.000	0.000	0.000	0.000	0.000
B3	Rathluirc Stream	5	40	0.000	0.000	0.000	0.100	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (no. per m^2)					
				Atlantic salmon	Brown trout	European eel	Three-spined stickleback	Stone loach	Minnow
B4	Garrynderk South Stream	5	45	0.000	0.000	0.000	0.000	0.000	0.000
C1	River Maigue	5	150	**0.060**	0.007	**0.040**	0.000	**0.040**	0.040
C2	River Maigue	n/a	Too deep	n/a	n/a	n/a	n/a	n/a	n/a

4. Discussion

Despite extensive historical modifications and significant water quality pressures (i.e. siltation, eutrophication), the watercourses in the vicinity of the proposed Garrane windfarm were found to support fish species of high conservation value, namely Annex II Atlantic salmon and Red-listed European eel. Additionally, brown trout were also recorded in addition to more widespread pollution- and eutrophication-tolerant stone loach, minnow and three-spined stickleback.

The highest value salmonid habitats were present on the River Maigue and its tributary the Charleville Stream. Whilst both watercourses had been historically deepened and locally straightened in vicinity of the proposed project, some instream recovery had occurred and several areas provided good quality nursery habitat (Charleville Stream) and holding habitat (River Maigue). However, siltation pressures significantly reduced the spawning capacity of these watercourses. Salmonids were absent from all other watercourses surveyed (i.e. Loobagh River, Graigues River, Creggane Stream, Broghill North Stream, Rathnacally Stream, Foxhall East River, Rathluirc Stream & Garrynderk Stream), reflecting siltation and eutrophication pressures in addition to poor hydromorphology. Sites on the Loobagh River (F3), Creggane Stream (F6), Rathnacally River (A1), Foxhall East River (A2), Broghill North River (A3), Charleville Stream (A4) and Garrynderk South Stream (B4) did not support fish at the time of survey and were not of significant fisheries value.

Despite suitability elsewhere, European eel were only recorded from the River Maigue (sites F1 & C1). Here, deeper glide and pool areas with high macrophyte cover and broader prey resources provided superior eel habitat compared with other survey watercourses, albeit the species was present in very low densities. On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011).

No lamprey ammocoetes were recorded during the survey. Soft sediment accumulations were typically compacted, shallow and dominated by clay particles considered sub-optimal for ammocoete burial. Poor hydromorphology (as a result of historical modifications) and siltation pressures further reduced the suitability for *Lampetra* sp. within the survey area. *Lampetra* sp. are known from the River Maigue further downstream (Holmes et al., 2022; Kelly et al., 2017; IFI, 2015).

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