Appendix K

Part 1a - Fisheries Surveys - 2018
Part 1b - Fisheries Surveys - 2023
Part 2 - Aquatic Baseline Report - 2023

ARUP

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K.1 Part 1a - Fisheries Surveys - 2018

Triturus

Fisheries Assessment for the N6 Galway City Transport Project

May 2018

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1. Introduction

Triturus Environmental Services were contracted by Scott Cawley Ltd. (ecological consultants) to conduct a fisheries assessment of watercourses along the corridor of the proposed N6 Galway City Transport Project, here and after referred to as the proposed road development. This included watercourses crossed by the proposed road and of watercourses with downstream hydrological connectivity. The work was prepared to collect baseline fisheries data that would inform the preparation of the Environmental Impact Assessment prepared as part of the planning requirements.

Triturus Environmental Services 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 quantitative electro-fishing surveys of small rivers/ streams along the corridor of the proposed road alignment development (see Figures 3.1 and 3.3). Small river and stream habitats were thus surveyed by electro-fishing or if a very minor channel, appraised for their fisheries value. The surveys were conducted at intersections with the proposed road development and at accessible downstream locations. This included an assessment of each riverine habitat as spawning, nursery and holding habitat for fish.

The field survey was designed to help contextualise sensitive fisheries habitat relative to the proposed road development works, including the downstream habitat that may be impacted from water borne pollutants. Furthermore, baseline biological water quality (i.e. Q-values) were collected at each watercourse crossing where suitable habitat existed. This will also help relate water quality baselines to fish population data (i.e. clean water salmonid etc.). The biological water quality collected would also provide baseline readings against which future water quality targets could be gauged. These values should not deteriorate as a result of works associated with the proposed road development. According to the Water Framework Directive (2000/60/EEC), all watercourses should aim to maintain or achieve target 'good status' water quality.

Background

The proposed road development is approximately 17km in length. As described moving from the west eastwards, the proposed road development ties into the existing R336 Coast Road at an at-grade roundabout junction (Bearna West Roundabout) approximately 2km to the west of Bearna Village (see Figure 1.1). The proposed road development then proceeds north before veering eastwards to the north of Bearna Village and onwards towards the townland of Letteragh to a grade separated junction (N59 Letteragh Junction) to connect the N59. The N59 Link Road connects the proposed road development to the N59 to the north of Bushypark Church and to the Letteragh Road and Rahoon Road to the south.

The proposed road development then continues in sections of cut and fill, travelling over the N59 at Dangan, through National University of Ireland Galway's recreational lands and over the River Corrib on a bridge structure. To the east of the river, the proposed road development is generally on embankments or viaduct structures, before entering a section of cut preceding a tunnel at Lackagh Quarry. After exiting the tunnel, it continues on embankments and passes over the N84. Grade separated signalised junctions are provided at the N84 (N84 Headford Road Junction) and the N17 (N17 Tuam Road and Parkmore Junction). The proposed road development then proceeds in a cut and cover tunnel to the north of Galway Racecourse before turning south to connect to a free-flow grade separated junction to the south of the existing Briarhill Junction, in the townland of Coolagh, Briarhill. The proposed road development then ties in to the existing N6 dual carriageway at Coolagh, Briarhill.

The proposed road development overlaps three hydrometric areas (HA 29, 30 & 31) containing the watercourses that formed the basis of this fisheries assessment (see Figure 1.1 below). The watercourses overlapping or connected downstream of the proposed road development were dominated by small to medium stream and river habitats that included Sruthán na Libeirtí, Trusky Stream, Bearna Stream & tributary, Tonabrocky Stream, Knocknacarragh Stream, Terryland River and Merlin Stream (see Table 1.1 below). The larger rivers and stream sites were visible on the OSI 1:50,000 scale mapping. On the OSI mapping rivers were defined as dark blue lines and streams defined as light blue lines. Smaller streams or ephemeral (seasonal) streams and ditches were not visible. In addition to the main channels of the streams listed above, small low order tributaries that were not consistently visible on OSI 1:50,000 scale mapping, were also appraised. These small watercourses were connected hydraulically to the larger stream catchments and were identified from hydrological GIS map layers. Two lake systems were also surveyed given downstream hydraulic connectivity to the proposed road development. These were the Coolagh Lakes and Ballindooley Lough (immediately north of Galway City) both of which are contained within the Lower Corrib catchment and within hydrometric area 30. Ballindooley Lough is an isolated valley basin lake and not connected to a major river system. In contrast the Coolagh Lakes are connected to the River Corrib by a small reeded channel. All of the watercourses within the study site are located within the Western River Basin District.

The streams west of the River Corrib, and contained within hydrometric area 31, are situated on geologies of Siluro-Devonian Granitic Rocks and Appinite according to the Geological Survey of Ireland. These watercourses may be considered less alkaline as a result of the underlying geologies, as was reflected by the plant communities present including alternate water milfoil *Myriophyllum alterniflorum* and *Fontinalis squamosa*.

The watercourses east of the River Corrib (i.e. Terryland River, Merlin Stream, Coolagh Lakes and Ballindooley Lough) are situated on Visean Limestone and Calcareous Shale. These watercourses are therefore considered more alkaline and this was reflected by the macrophyte

plant communities present that included common club rush *Schoenoplectus lacustris*, Chara species and Alkaline fen vegetation (i.e. Ballindooley Lough).

Table 1.1. Watercourses surveyed as part of the proposed road development

Watercourse name	Type	EPA Code	Hydrometric Area	River Basin
Sruthán na Libeirtí	Medium sized stream	31F01	31	Western
Trusky Stream	Medium sized stream	31B02	31	Western
Bearna Stream & tributary	Large Stream	31O05	31	Western
Tonabrocky Stream (forms tributary with the Bearna Stream at Ballard)	Large stream	31B01	31	Western
Knocknacarragh	Small stream	31K16	31	Western
Terryland River	Large stream	30T01	30	Western
Merlin Stream	Seasonal stream	No EPA code	29	Western
Coolagh Lakes & river tributary	Natural lake	No EPA code	30	Western
Ballindooley Lough	Valley Fen Lake	No EPA code	30	Western

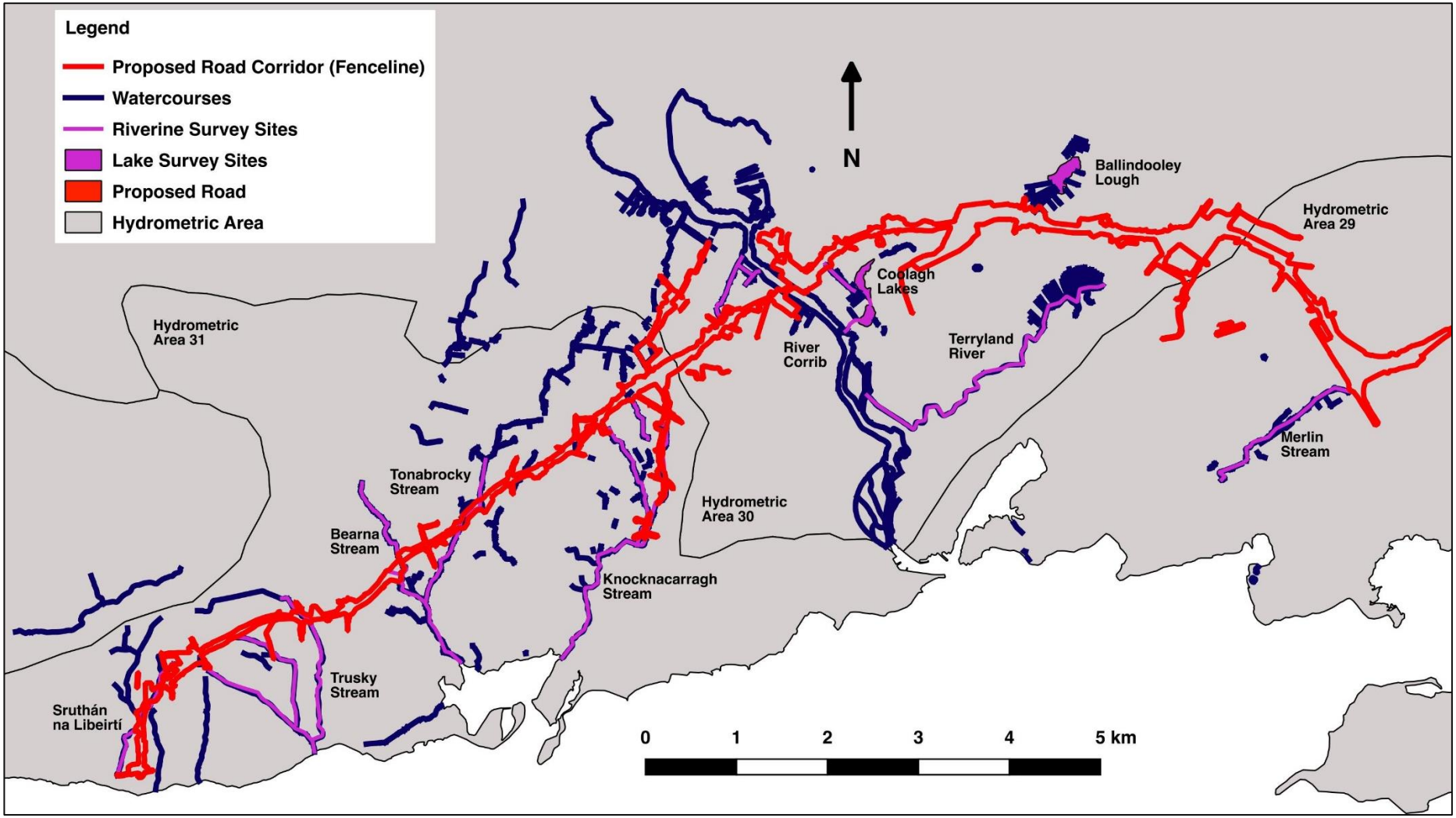

Figure 1.1. Watercourses surveyed (survey sites highlighted in purple with proposed road development highlighted in red) prepared using Quantum GIS 2.18)

2. Methodology

This section summarises the methodologies employed for the various sub components of the site surveys. It includes the following elements as described in the sections below, macro-invertebrate (Q sampling), electro-fishing practice, lamprey surveys, salmonid surveys, optimum survey times and bio-security protocol.

Macro-invertebrate (Q Sampling)

Macro-invertebrate samples were collected at the stream sites crossed by the proposed road development between the 22nd and 30th September 2015 in advance of the fisheries surveys. Samples were collected at the nearest location containing riffle/ glide habitat downstream of proposed crossings. The samples were collected by 'kick' sampling for approximately 2.5 minutes in the faster flowing areas (riffles) of the streams using a standard hand net (250 mm width, mesh size 500 micron). The samples were collected from seven stream sites, Sruthán na Libeirtí, Trusky Stream, Bearna Stream tributary, Bearna Stream, Tonabrocky Stream, Knocknacarragh Stream and the Terryland River (see Figure 3.1 below for locations). The samples were collected by moving across the riffle zone and also involved washing large rocks from the riffle zone to ensure a full representation of the species composition. Collected samples were elutriated, and fixed in 70% ethanol prior to identification.

The macro-invertebrates were later identified using a Nikon SMZ 1000 stereo microscope and Freshwater Biological Association invertebrate keys. Invertebrate taxa were identified to species level where possible and grouped based on the Environmental Protection Agency (EPA) categories from pollution intolerant to very pollution tolerant on a moving scale from A to E (see Appendix I of Water Quality in Ireland 2001-2003, Toner et al., 2005).

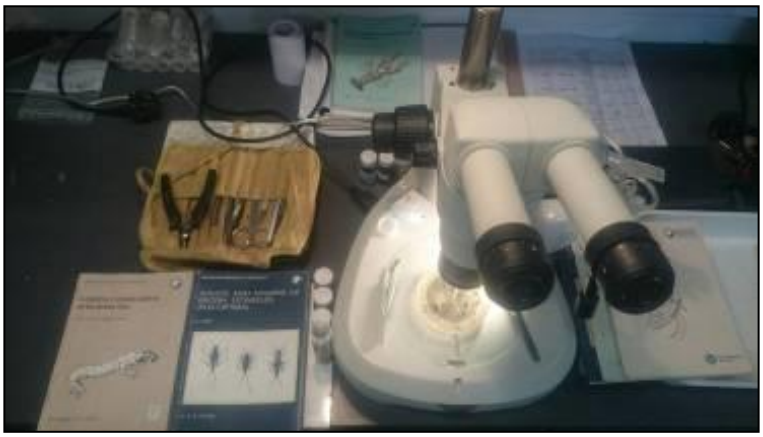

Plate 1.1 – Nikon SMZ 1000 microscope and FBA keys used for macro-invertebrate identification

Electro-fishing practice

An electro-fishing survey of the existing fish stocks within each watercourse was undertaken between the 22nd of September and 30th September 2015 in the environs of Galway City (see Figure 2.1 below for site locations).

The surveys were undertaken along sections of watercourses crossed by the proposed road development or, where the channel was seasonal or inaccessible, at the closest location downstream. The survey sections were 50m in length and sealed off with stop nets, effectively acting as fish barriers for the depletion survey.

Water with a low conductivity has a higher resistance to the passage of an electric current through it. This means that in high conductivity waters the current for a given voltage is higher than in low conductivity water and the threshold values for different fish responses are also lower (Zalewski and Cowx, 1990). Given this fact, the lower conductivity waters to the west of the River Corrib (i.e. Sruthán na Libeirtí, Trusky and Tonabrocky) were fished between 250-300 volts salmonids / 100volts for lamprey. In the more alkaline watercourses to the east of the River Corrib electro-fishing was conducted at 225volts for salmonids / 100volts for lamprey. Similarly where no suitable upstream habitat was available (as was the case at two sites (i.e. Trusky and Knocknacarragh Streams) the high conductivity transitional reaches were surveyed (i.e. adjoining tidal channel sections in the lower Trusky & and Knocknacarragh streams). Consequentially a lower voltage of 75-100volts was utilised given the higher conductivity. Other settings i.e. frequency, duty cycle etc. are discussed below. Depletion electro-fishing of each site was conducted by two operators in an upstream direction using a single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output). In order to minimise potential damage and undue stress to lamprey species and Atlantic salmon, electro-fishing settings were modified to target specific species at the site (see lamprey section below). Larval lamprey species, for example, were specifically targeted in areas of low/reduced flow and with a higher proportion of soft sediment. However, this habitat was recorded as very localised or entirely absent in many watercourses with the exception of the Terryland River.

Plate 1.2 – Electro-fishing the Terryland River

Salmonids typically require a higher frequency (and also voltage) than lamprey species in order to sufficiently stun them for capture. Unless amended, these settings can result in the inadvertent electro-narcosis of buried ammocoetes, resulting in failure to emerge and recording of absence, as well as damage to the fish (Thompson et al. 2010). Therefore soft sediment areas were identified and targeted first following stop netting.

Fisheries Habitat Suitability

Small stream habitats (typically less than 1m wide) were assessed for their fisheries habitat suitability (see Figure 2.1 below). These streams were typically heavily choked with vegetation or seasonal and in general were considered unsuitable for electro-fishing.

These were characteristically degraded watercourses of low or no fisheries value. Nonetheless they were still visited to validate whether any fisheries value existed. The appraisal included for spawning habitat (i.e. fast water and clean gravel habitat for recruiting adults), nursery habitat (i.e. juvenile fish habitat with faster riffle habitat for salmonids and good instream structure or fine sediment for lamprey) and holding habitat (deeper pool habitat with cover for adult fish).

Lamprey

Settings for lamprey followed those recommended and used by APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water surface, approximately 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[1] are collected by a second operator using a fine-mesh hand net as they emerge. During this survey, settings utilised to capture juvenile lamprey were a frequency of 25Hz, voltage of 100V and a duty cycle of approximately 12% (pulse width 6ms).

Salmonids

As salmonids typically require a higher frequency than lamprey ammocoetes, the frequency was set at 40Hz frequency, a voltage of between 225V and 300V (dependant on local water conductivity) and a duty cycle of 18%. The higher voltage was used in waters west of the River Corrib, where conductivity was lower.

Multiple-pass depletion electro-fishing methodology was employed and followed those outlined by Carle & Strub (1978) and Lockwood & Schneider (2000). Population estimates were made utilising the following equations:

$$T = \sum_{i=1}^{k} C_i ,$$

$$X = \sum_{i=1}^{k} (k-i) C_i ,$$

[1] Ammocoetes are the juvenile larval stage of lamprey

where,

i = pass number

k = number of removals (passes)

Ci = number of fish caught in the sample

X = an intermediate statistic used below

T = total number of fish caught in all passes

The maximum likelihood estimate of N was determined by an iterative process by substituting values for n until:

$$\left[\frac{n+1}{n-T+1}\right] \prod_{i=1}^{k}\left[\frac{kn-X-T+1+(k-i)}{kn-X+2+(k-i)}\right]_i \leq 1.0,$$

Where n is the smallest integer satisfying the above equation.

The probability of capture, p, and variance of N are then estimated by:

$$p = \frac{T}{kN-X},$$

$$\text{Variance of } N = \frac{N(N-T)T}{T^2 - N(N-T)\left[\frac{(kp)^2}{(1-p)}\right]},$$

$$\text{Standard error of } N = \sqrt{\text{Variance of } N}.$$

Additionally, a goodness of fit test evaluating the power of capture probability was also implemented following the method of White et al. (1982) where;

$$E(C_1) = Np,$$

and for $i>1$.

$$E(C_i) = N(1-p)^{i-1}p$$

Calculated χ^2 then is:

$$\chi^2 = \frac{[C_1 - E(C_1)]^2}{E(C_1)} + \frac{[C_2 - E(C_2)]^2}{E(C_2)} + \cdots + \frac{[C_i - E(C_k)]^2}{E(C_k)}.$$

Fyke Netting

Boat based fyke netting surveys were undertaken at Ballindooley Lough and Coolagh Lakes (see Figure 2.1 below for site locations). In advance of setting the nets a high resolution transducer was used to locate fish markings and establish a depth profile of the lake basins. This facilitated the positioning of the fyke nets near shelf drop offs and helped establish distributional patterns of fish. Five 1.5 meter diameter (D shaped) fyke nets with multi panel mesh were placed in the margins of the lakes in the littoral zones (windward bank) and shallow bay areas overnight and retrieved within 24 hours. The fish captured were measured by two personnel and length frequency graphs and species composition graphs were constructed. All fish were processed quickly and returned alive to the lakes.

Optimum Survey Period

The electro-fishing survey was undertaken between the 22nd and 30th of September 2015. This choice of survey period avoided a clash in spawning and upstream migration of both lamprey species and Atlantic salmon. It is considered that by undertaking electro-fishing surveys for salmonids during or post-August (in this case September) that the juvenile fish (including young-of-the-year individuals) are of sufficient size to recover following a survey which was conducted according to Inland Fisheries Ireland best practice (IFI pers. comm. 2015). In addition, the metamorphosis of lamprey usually takes place between July and September. It is therefore recommended that surveys for ammocoetes are carried out in July at the earliest but preferably between August and October in order to detect the presence of transformed ammocoetes (Harvey & Cowx, 2003). Additionally, by undertaking fyke netting before the end of September, it facilitates the detection of fish species that during the colder periods (i.e. winter) move to the deeper water of lakes and thus can remain undetected.

Biosecurity Protocol

All equipment and personal protection equipment (PPE) used was disinfected with Virkon® prior to and post-survey completion. Best practice precautions were employed to prevent the potential spread of invasive species and water-borne pathogens, according to standard Inland Fisheries Ireland (IFI) biosecurity protocols.

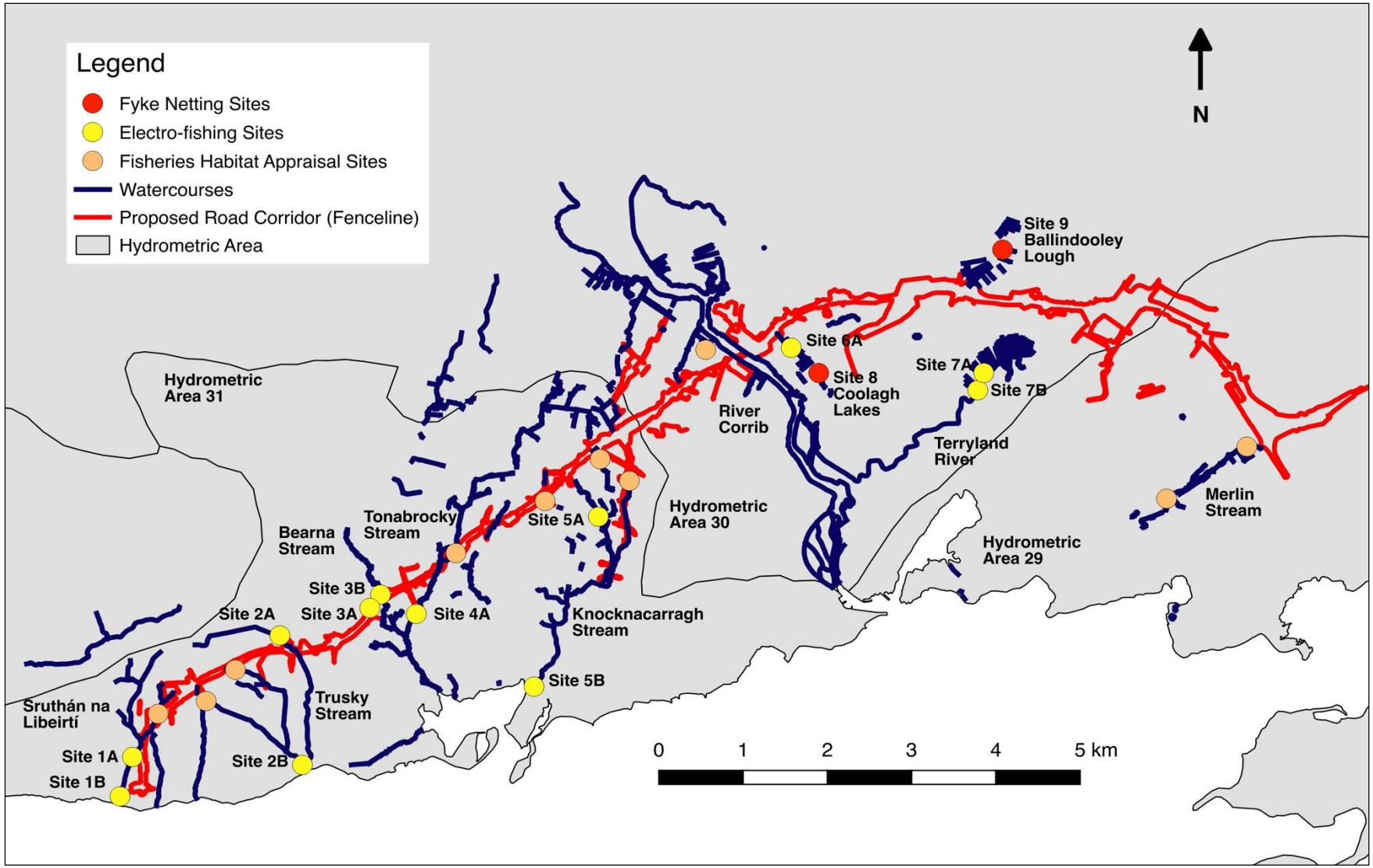

Figure 2.1. Location of Fisheries Survey Sites along the proposed road development (prepared using Quantum GIS 2.18)

3. Results

A) Biological Water Quality

Existing Water Quality Records

No biological water quality sampling has been previously recorded by the EPA in the stream sites overlapping the proposed road development. As such biological water data was collected immediately downstream of the proposed road crossing locations (where feasible) during September 2015 to determine baseline biological water quality for each of the stream sites surveyed. Where the channel was dry, too deep and thus unsuitable for Q sampling the closest downstream location was chosen to collect the sample. The biological water quality data recorded during the surveys is summarised below.

The EPA Q Sampling methodology is described in the EPA document Water Quality in Ireland 2001-2003 (Toner et al. 2005). The system groups macro-invertebrates into classes (A-E), whereby pollution intolerant species are denoted class A and species with greater pollution tolerances fall into successive classes (i.e. class E being very pollution tolerant). As such the presence or absence of these groups and their relative abundances facilitates an assessment of biological river health know as a Q Rating with Q1 being the poorest water quality rating and Q5 the highest water quality rating. The results of the 2015 data collection are discussed in this context in order to interpret changes in the river community composition. Refer to Figure 3.1 below for locations and Figure 3.2 for a summary of the Q Ratings at each of the sites surveyed (i.e. sites 1 through 7 downstream of the proposed road development). Table 3.3 lists all of the macro-invertebrate species recorded and represents by colour separation the EPA taxonomic classes as prescribed above. A summary of the Q Ratings are also provided in the table below.

Site 1 was located on Sruthán na Libeirtí, a small upland eroding watercourse heavily encroached by bracken, bramble and gorse scrub. The stream site evidently was suffering from organic enrichment given the exuberant growth of lesser water parsnip *Berula erecta*, fool's watercress *Apium nodiflorum* and common duckweed *Lemna minor* where light penetration permitted growth. This was also reflected in the macro-invertebrate community by the absence of cleanwater stoneflies and mayflies. The dominance of crustaceans (*Aselus aquaticus* and *Gammarus duebenii*), particularly the pollution tolerant *Aselus aquaticus* in very high numbers indicates at least moderate levels of pollution. The absence of both class A and B clean water taxa accounted for a Q rating of 3 in An Sruthán na Libeirtí.

The Trusky Stream (main channel) rises at An Chloch Scoilte north of Bearna. The stream then flows west and south adjoining two small low order tributaries in Bearna Village before discharging to the sea adjacent to Bearna Pier. The Trusky stream catchment, comprised predominantly shallow drainage channels that were heavily vegetated with herbaceous species including yellow flag *Iris pseudacorus*, fool's watercress, lesser water parsnip and common starwort *Calitriche stagnalis* instream.

The upper reaches of the catchment channels were largely dry with the exception being the tributary at An Chloch Scoilte north of Bearna Village that had shallow flowing water. The kick sample collected here on the Trusky Stream had a very low diversity of macro-invertebrates (n=5), possibly as a consequence of being seasonal (likely dries up in warm years) and also as a result of evident organic enrichment. The species composition was dominated by *Aselus aquaticus* and *Gammarus duebenii* and had no clean water stoneflies, mayflies or cased caddis species present. As such a Q rating of 3 was recorded in the Trusky Stream.

A small tributary of the Bearna Stream rising in the valley escarpments of 'Na hAille' to the west formed a confluence with the Bearna Stream north of Ballard. The stream was located in very dense bracken and gorse scrub and was shallow and swift flowing. The stream substrata comprised a coarse gravel and cobble base. It was seasonal further downstream, grading into a vegetated ditch on its approach to the Bearna Stream from the west. The stream had a low species diversity (n=5) dominated by casless caddis (*Plectronemia conspersa* & *Wormaldia occipitalis*) and pollution tolerant gastropods species (*Lymnaea peregra* & *Planorbis carinatus*). Given the seasonal nature of the stream and the dominance of class C and D invertebrates, a Q value of 3 was recorded at the site.

The Tonabrocky Stream rises at Tonabrocky and flows south west into Rusheen Bay, west of Rusheen Point. It has a large tributary, the Bearna Stream, that rises at Lough Cnoc an Champa and then flows south east before forming a confluence with the Tonabrocky Stream at Ballard. The Tonabrocky Stream and its tributary the Bearna Stream are both fast flowing salmonid streams with clean gravels and limited macrophyte plant growth with the exception of liverworts, mosses and small stands of alternate water milfoil *Myriophyllum alterniflorum*. Localised sections also have stands of lesser water parsnip and fool's watercress. The evident low levels of enrichment were reflected in the macro-invertebrate communities of both streams that contained three families (Chloroperlidae, Nemouridae & Leuctridae) of clean water stonefly species (EPA Class A and B). The streams also contained clean water cased caddis families (EPA class B) Odontoceridae and Seracostomatidae. The presence of good numbers of EPA class A and B macro-invertebrates indicated unpolluted water (Q4) in both the Tonabrocky Stream and its major tributary the Bearna Stream.

The Knocknacarragh Stream rises west of Letteragh and flows south west into Rusheen Bay (entering north of Blake's Hill). The upper catchment low order tributaries were predominantly seasonal drainage channels. However, one small tributary north-west of Ballyburke contained a shallow flowing stream where it was possible to collect a kick sample. The Knocknacarragh Stream itself is considered seasonal and this was reflected by the poor diversity of macro-invertebrates (n=6). It is situated in a catchment supporting beef cattle and was suffering from organic enrichment given the presence of abundant algae. This was also reflected by virtue of the absence of clean water macro-invertebrates with the exception of the (EPA class B) cased caddis species *Seracostoma personatum*.

This cased caddis species however is considered more tolerant to pollution than other cased caddis families (e.g. Goeridae, Limnephilidae, Odontoceridae etc.). The macro-invertebrates recorded at the site indicated an equivalent Q rating of 3 (i.e. moderately polluted water quality.

The Terryland River rises in the urbanised area of north east Galway City (i.e. Terryland). The river is situated on karstic limestone and unusually can flow in both directions, either towards the River Corrib at Jordan's Island or in the opposite direction towards Terryland. It was the largest of the river and stream sites surveyed. The presence of the nitrate loving *Sparganium erectum* in abundance, a species favouring soft bottomed enriched and modified channels indicated historical deepening/ straightening of the the river channel. Furthermore, enrichment of the stream was evident by the presence of the exuberant growth of water milfoil *Myriophyllum spicatum* and common starwort *Callitriche stagnalis* but also pondweeds *Potamogeton spp*. The macro-invertebrate community also indicated gross pollution. The absence of cleanwater Class A & B macro-invertebrates and the presence of pollution tolerant forms (EPA class E, *Chironomus riparius* & *Tubifex sp*.) indicated more heavily polluted water quality (i.e. Q2-3).

In summary the water quality was of poor status (i.e. Q2-3 & Q3) at all stream sites with the exception being the Bearna Stream and the Tonabrocky Stream where water quality was of good status (i.e. Q4). Figure 3.2 below presents the Q sampling results at each survey site. The red colour on the graph identifies Q3 moderately polluted water quality, orange colour identifies Q2-3 seriously polluted water quality and green colour identifies Q4 good water quality which is the Water Framework Directive target status.

Site 1 (Sruthán na Libeirtí)	**Q3** - Moderately Polluted (Poor Status)
Site 2 (Trusky Stream)	**Q3** - Moderately Polluted (Poor Status)
Site 3 (Bearna Stream tributary)	**Q3** - Moderately Polluted (Poor Status)
Site 4 (Bearna Stream)	**Q4** - Unpolluted (Good Status)
Site 5 (Tonabrocky Stream)	**Q4** - Unpolluted (Good Status)
Site 6 (Knocknacarragh Stream)	**Q3** - Moderately Polluted (Poor Status)
Site 7 (Terryland River)	**Q2-3** - Seriously Polluted (Poor Status)

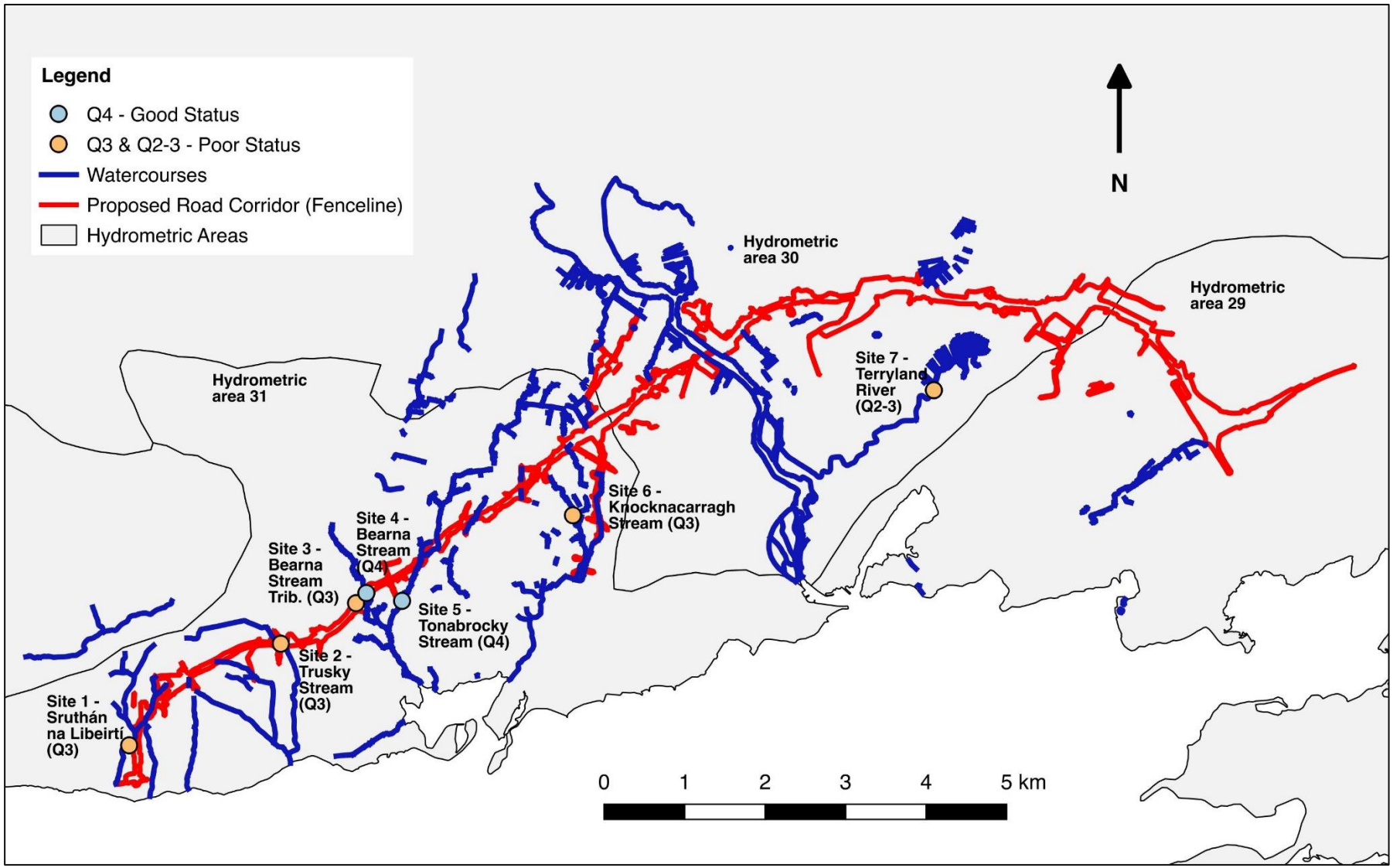

Figure 3.1. Q sampling sites downstream of the proposed road development (prepared using QGIS 2.18)

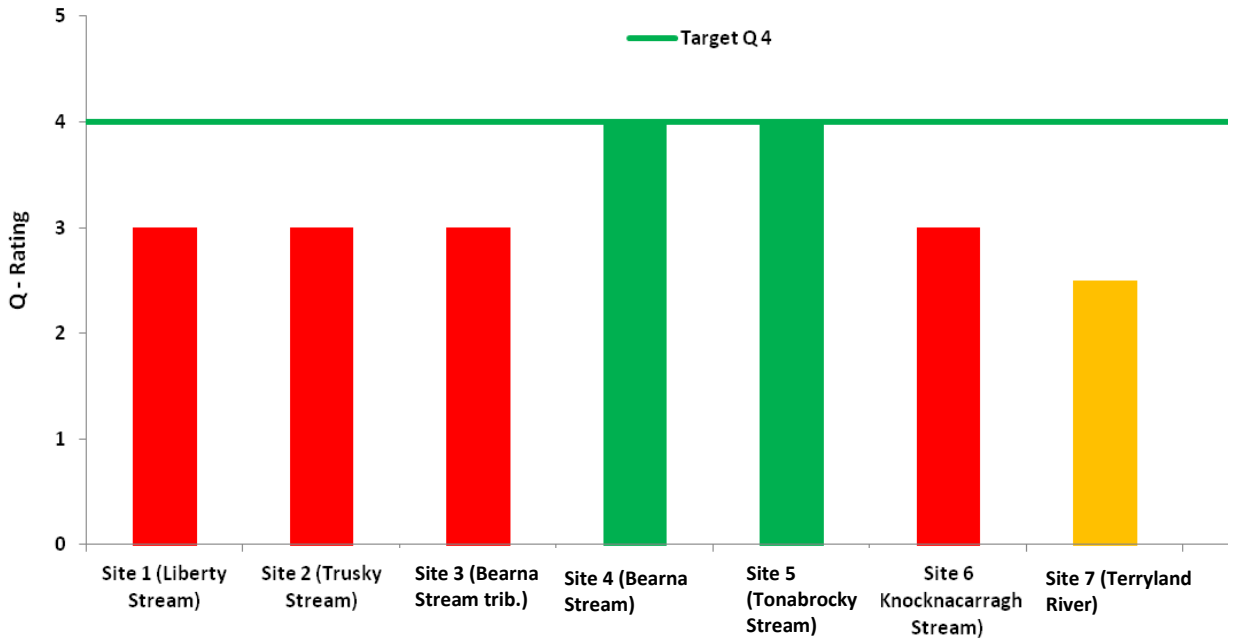

Figure 3.2. Biological Q-Ratings of riverine sites downstream of the proposed road development

Table 3.2. Macro-invertebrate species composition of riverine sites downstream of the proposed road development

Group	Family	Species	Site 1 Sruthán na Libeirtí Stream	Site 2 Trusky Stream	Site 3 Bearna Stream trib.	Site 4 Bearna Stream	Site 5 Tonabrocky Stream	Site 6 Knocknacarragh Stream	Site 7 Terryland River	EPA Class
Stoneflies (Class A)	Chloroperlidae	*Chloroperla torrentium*					9			**A**
		Chloroperla tripunctata				9	11			**A**
	Nemouridae	*Amphinemura sulcicolis*				3				**A**
Stoneflies (Class B)	Leuctridae	*Leuctra inermis*				6	5			**B**
Cased Caddis (Class B)	Seracostomatidae	*Sercacotoma personatum*				5	3	1		**B**
	Odontoceridae	*Odontocerum albicorne*				2				**B**
Mayflies (Class C)	Baetidae	*Baetis rhodani*				5	8			**C**
Caseless Caddis (Class C)	Hydropsychidae	*Hydropsyche siltalai*				1	1			**C**
	Polycentropdidae	*Plectronemia conspersa*	12		6				2	**C**
		Polycentropus kingi				1		1		**C**
	Philopotamidae	*Wormaldia occipitalis*			2					**C**
	Ryacophilidae	*Ryacophila dorsalis*					1			**C**
Crustaceans (Class C)	Gammaridae	*Gammarus duebenii*	47	29	4	7	23	8	76	**C**
Beetles (Class C)	Elmidae	*Limnius volckmari*	2			4	8	1		**C**
		Elmis aenea	9			2	1	5		**C**
		Oulimnius sp.				3	2			**C**
	Dytiscidae	*Dytiscus sp.*							2	**C**
	Hydraenidae	*Hydraena sp.*	5							**C**
Dipterans (Class C)	Chironomidae	*Orthocladius sp.*			2	2	3			**C**
	Simulidae	*Simulium sp.*	6	4						**C**

Group	Family	Species	Site 1 Sruthán na Libeirtí Stream	Site 2 Trusky Stream	Site 3 Bearna Stream trib.	Site 4 Bearna Stream	Site 5 Tonabrocky Stream	Site 6 Knocknacarragh Stream	Site 7 Terryland River	EPA Class
	Tipulidae	*Tipula sp.*								**C**
Gastropods (Class C)	Hydrobiidae	*Potamopyrgus antipodarum*	5	31	11	4		6		**C**
	Succineidae	*Succinea putris*	1							**C**
	Valvatidae	*Valvata piscinalis*	1							**C**
		Valvata cristata							1	**C**
	Bithyniidae	*Bithynia tentaculata*							1	**C**
Freshwater Limpet (Class C)	Ancylidae	*Ancylus fluviatilis*	2	2	5	4				**C**
Freshwater Bug (Class C)	Corixidae	*Hespocorixa linnaei*							4	**C**
	Lymnaeidae	*Lymnaea peregra*			2				2	**D**
	Planorbidae	*Planorbis carinatus*			1					**No Class**
Freshwater Hoglouse (Class D)	Aselidae	*Asellus aquaticus*	61	43	6		1		35	**D**
Leeches (Class D)	Erpobdellidae	*Erpodella octoculata*			1		1			**D**
	Glossiphoniidae	*Glossiphonia heteroclita*			1					**D**
Freshwater Worms (No Class)	Oligochaeta	*Stylodrilus heringianus*	3		1					**No Class**
Non-biting midge (Class E)	Chironomidae	*Chironomus riparius*							15	**E**
Freshwater Worms (Class E)	Tubificidae	*Tubifex sp.*							4	**E**
Total Abundance			153	109	52	54	64	22	148	
N			12	5	13	15	13	6	10	
Q Rating			**Q3**	**Q2-3**	**Q3**	**Q4**	**Q4**	**Q3**	**Q2-3**	

B) Fisheries

Stream Sites

An electro-fishing survey of the existing fish stocks on stream sites overlapping the corridor of the proposed road development was conducted between the 22nd of September and 30th September 2015, following notification to Pat Gorman, regional inspector for Inland Fisheries Ireland Galway. The results of the survey are discussed below in terms of fish population structure and the typical value of the surveyed areas as nursery, spawning and holding habitats for various fish species. Seven stream catchments were electro-fished (refer to Table 3.2 for a list of the surveyed watercourses and Figure 2.1 for a location map). These were typically small streams between 0.5m and 2m in width, some of which were seasonal and not of fisheries value. The Terryland River was the largest watercourse surveyed at between 5-8m in width. One large stream channel, the Merlin Stream was surveyed at two sites but did not contain water at either site at the time of the survey and thus is not discussed further. A summary of the recorded fish species and their abundances is provided in Table 3.2. Length-frequency plots of fish species recorded at each stream site are provided in Figures 3.4-3.9 and described in the text below. Depletion curves for electro-fishing effort are illustrated in Figures 3.10-3.12 and also described in the text below.

Sruthán na Libeirtí

No fish were captured from site (1A) in the upper reaches of the Sruthán na Libeirtí Stream. While some apparent moderate quality salmonid habitat existed (i.e. riffle, glide and pool habitat) with cobble and gravel substrata no fish were recorded as present. Records show that the stream dried up in the upper reaches during the warm summers of 2013-2014 and this may account for the absence of fish. The stream has also been modified historically (localised straightening & deepening). Further downstream at site 1B (circa 200m from the sea), two European eel *Anguilla anguilla* were captured. Both were silvered and ready to return to sea to spawn (see Plate 3.1 and Figure 3.3 below). The lower reaches of the Sruthán na Libeirtí stream had good flows of water, averaging 0.4m deep with good quantities of gravel and cobble. Again while some moderate quality salmonid habitat existed no salmonids were recorded during the survey.

Plate 3.1. Sruthán na Libertí

Trusky Stream

Two sites were surveyed on the Trusky Stream. Much of the upper catchment and lower order tributaries were seasonal ditches that were heavily vegetated channels, with the exception of a small flowing stream at An Chloch Scoilte (site 2A). Here the stream had a cobble and gravel and base and a good profile with riffle and glide habitat and localised pool. Despite an electro-fishing effort over two 25m sections no fish were recorded as present.

The compacted and bedded gravels in addition to the shallow nature of the stream indicated it would have limited capacity to support salmonids. The stream was also suffering from organic enrichment from agriculture in the upper catchment. As such, a secondary site (2B) was surveyed downstream at Bearna Village, where greater flows of water and a larger channel were present given that the site was below the confluence of three smaller tributaries. This section of channel was tidal (on spring tides) and proved to be an excellent nursery for flounder *Platichthys flesus*, European eel and three-spined stickleback *Gasterosteus aculeatus* (see Figure 3.4). Small numbers of adult brown trout *Salmo trutta* were also present. The brown trout population was small with only two fish present and given the limited better quality habitat available upstream the total stream population size must also be comparably small. Some moderate to good quality spawning habitat did exist in the lower 100m of the stream catchment. This area is likely to be the main area for recruitment in the stream given the poor quality upstream salmonid habitat.

Plate 3.2. Trusky Stream

Bearna Stream

The Bearna Stream was an excellent salmonid river with widespread clean and un-compacted spawning gravels and swift flows of water in the corridor for the proposed road development (Site 3B). The river had a well defined profile, characteristic of good quality salmonid habitat with stretches of riffle grading into glide and pool habitat. This created an excellent salmonid nursery habitat and good areas of adjoining pool to support older adult year classes. This was reflected in the good numbers of brown trout recorded at the site (see Figure 3.5). European eel were also recorded present further exemplifying the high quality fisheries value of the stream. A small tributary of the Bearna Stream was also surveyed (i.e. site 3A) but given it was a shallow, small (<0.5m wide) and seasonal stream no fish were recorded present.

Plate 3.3. The Bearna Stream

Tonabrocky Stream

The Tonabrocky Stream in its upper reaches in the vicinity of the proposed road development had poor quality fisheries habitat being predominantly a dry drainage channel with localised pockets of water. Downstream however the habitat improved significantly, turning into a swift flowing stream with a gravel base and clean water (e.g. site 4A). Here small numbers of brown trout were recorded (see Figure 3.6). At this location and all the way downstream to Rusheen Bay, the stream had good quality salmonid habitat with nursery, spawning and holding habitat present over much of the channel length.

Plate 3.4. Tonabrocky Stream

Knocknacarragh Stream

The upper reaches of the Knocknacrragh Stream were of poor fisheries value (e.g. site 5A). No fish were recorded in the upper reaches. However, a small stretch of water emanating from a culvert on approach to Rusheen Bay (site 5B) proved to be a good nursery for estuarine fish and small numbers of European eel. At this location the stream became tidal with a cobble, sand and gravel base that supported sand goby *Pomatoschistus minutes*, grey mullet *Chelon labrosus*, three spined stickleback and small numbers of European eel (see Figure 3.7).

Plate 3.5. Knocknacrragh Stream

Coolagh Lakes tributary

A small tributary entering the western bank of the upper Coolagh Lakes (site 6A) was surveyed to establish whether the habitat was of value to salmonids, eel or lamprey. The channel was deep 1.2-2.0m and was heavily vegetated with lesser water parsnip, fool's watercress and common reed *Phragmites australis* and reed canary grass *Phalaris arundinacea*.

Plate 3.6. Coolagh Lakes tributary

Despite electro-fishing two 25m sections in sequence no fish were recorded as present. The channel was largely stagnant and had a soft base with limited gravels. It therefore was not considered of importance to salmonids and suboptimal for lamprey. The channel most likely is of some value to coarse fish during the spring when species such as roach present in Coolagh Lakes may migrate to the vegetated channel to spawn.

Terryland River

The Terryland River was surveyed at two locations (7A & 7B), with only two European eel being captured during the survey at the lower site (7B) (see Figure 3.8). The river site was predominantly deep (0.9-2.2m) and heavily vegetated with pondweeds, water starwort, strap weeds and spiked water milfoil. The watercourse was evidently heavily enriched from urban storm water runoff and other sources. It also appeared to have been straightened and deepened historically. As such very little natural habitat remained and as a consequence was of limited fisheries value apart from European eel that can access the channel via its connection with the River Corrib at Jordan's Island.

Plate 3.7. Terryland River

Table 3.3. Summary of fisheries results for each riverine catchment surveyed

River Catchment	No. E-Fish Sites	Site No.	No. Fish Species Recorded (species in parenthesis)	Total number of fish (n)	Target Notes
1 - Sruthán na Libeirtí Stream	2	1A	None	0	Seasonal stream with some semi natural salmonid and eel habitat. Stream suffering from organic enrichment and has had historical channel modifications.
		1B	1 (European eel)	2	Moderate quality eel and salmonid habitat, however salmonids recorded as absent.
2- Trusky Stream	2	2A	None	0	Seasonal stream with some semi natural salmonid habitat. Stream has been impacted by organic enrichment.
		2B	4 (Flounder, European eel, 3 Spined Stickleback, Brown trout)	43	Swift flowing and good quality nursery and spawning habitat in lower reaches (approximately 100m of better quality habitat, upper system poor).
3A – Bearna Stream	2	3A	None	0	Seasonal stream with some semi natural salmonid and eel habitat.

River Catchment	No. E-Fish Sites	Site No.	No. Fish Species Recorded (species in parenthesis)	Total number of fish (n)	Target Notes
					Further downstream fisheries habitat poor as stream grades into seasonal ditch and wet grassland before forming confluence with the Bearna Stream.
		3B	2 (Brown Trout, European eel)	32	Excellent quality salmonid and eel habitat. Very good nursery and spawning with moderate quality adult holding habitat.
4 – Tonabrocky Stream	1	4A	1 (Brown Trout)	2	Moderate quality trout stream with low density of juvenile trout, perhaps colonising from better quality downstream habitat. Further upstream channel becomes a seasonal drainage channel.
5 – Knocknacarragh Stream	2	5A	None	0	Most western tributary in Knocknacarragh catchment has some moderate quality salmonid habitat but is seasonal. No fish recorded during survey. Other upper tributaries heavily modified and generally shallow, without water or culverted (moving downstream).
		5B	4 (European eel, Grey mullet, Sand goby, Flounder)	48	Transitional habitat emerging from culvert in lower reaches on approach to Rusheen Bay a good nursery for estuarine fish and to a lesser extent European eel despite evident sewage waste water present.
6 – Coolagh Lakes Stream tributary	1	6A	None	0	Deep slow moving section of drainage ditch connected to the upper Coolagh Lake. May be of importance for spawning coarse fish species during spring but not considered of value to salmonids or lamprey. None recorded during survey.
7 – Terryland River	2	7A	None	0	Both sites on the Terryland River were suffering from serious pollution (gross organic enrichment and other sources). Exuberant plant growth and historical channel deepening and straightening. Only 2 adult eel recorded during survey.
		7B	1 (European eel)	2	

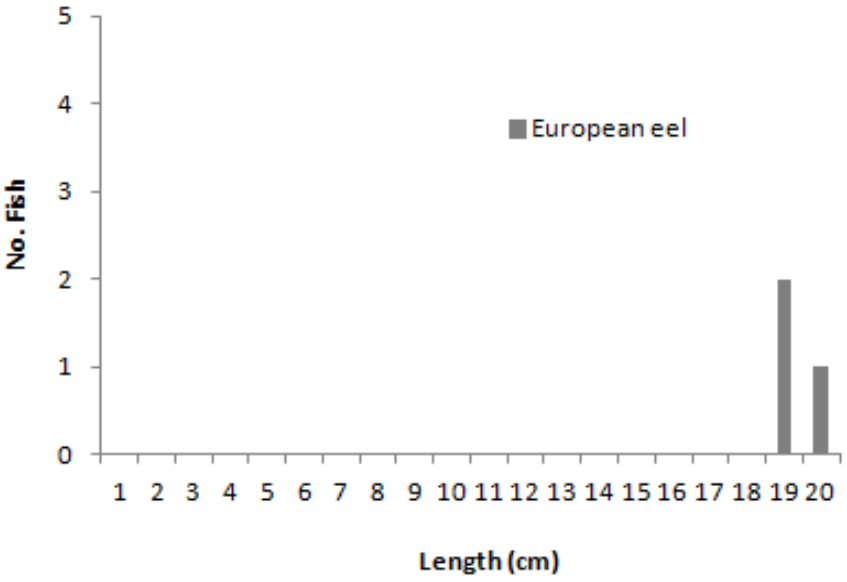

Figure 3.3. Length Frequency distribution of fish species captured in Sruthán na Líbeirtí Stream

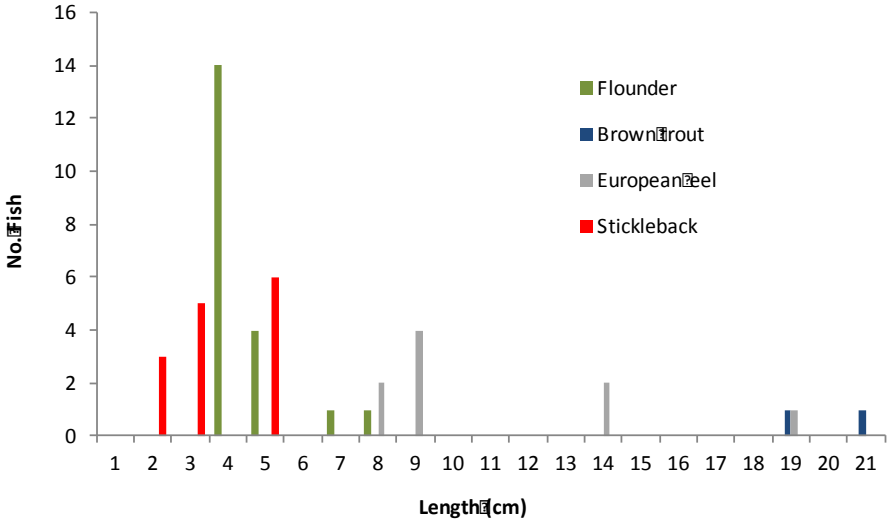

Figure 3.4. Length Frequency distribution of fish species captured in the Trusky Stream

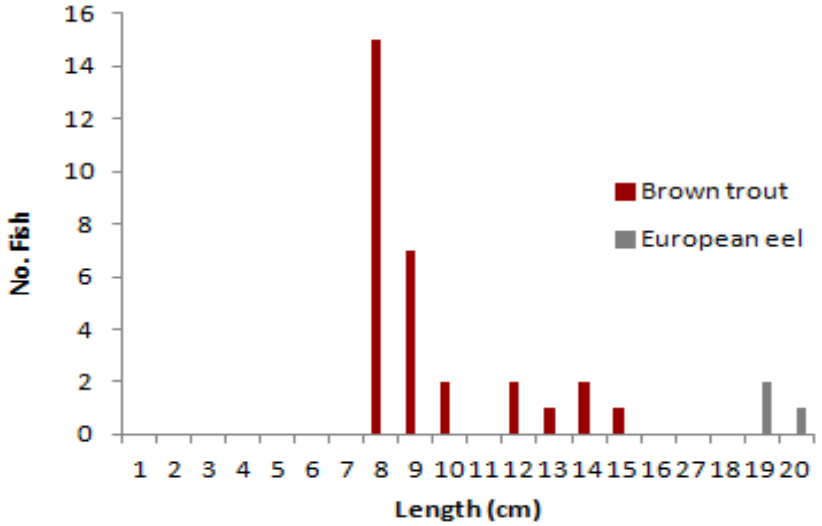

Figure 3.5. Length Frequency distribution of fish species captured in the Bearna Stream

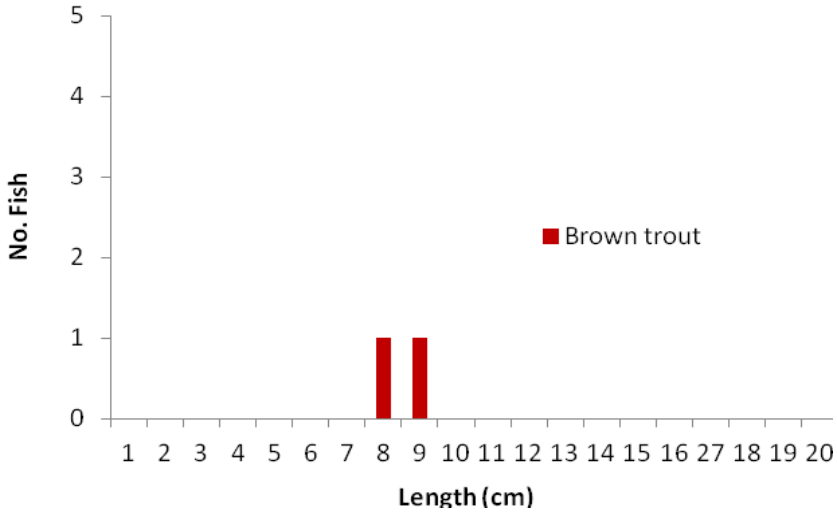

Figure 3.6. Length Frequency distribution of fish species captured in the Tonabrocky Stream

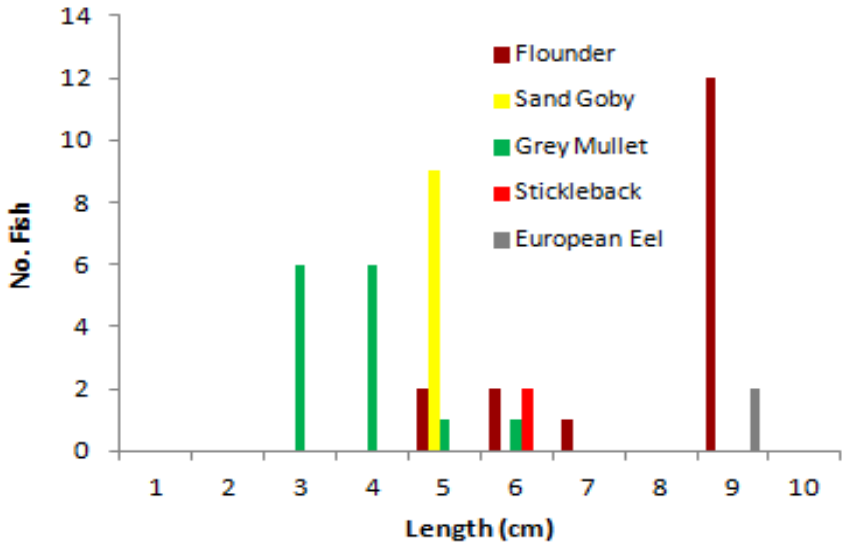

Figure 3.7. Length Frequency distribution of fish species captured in the Knocknacarragh Stream

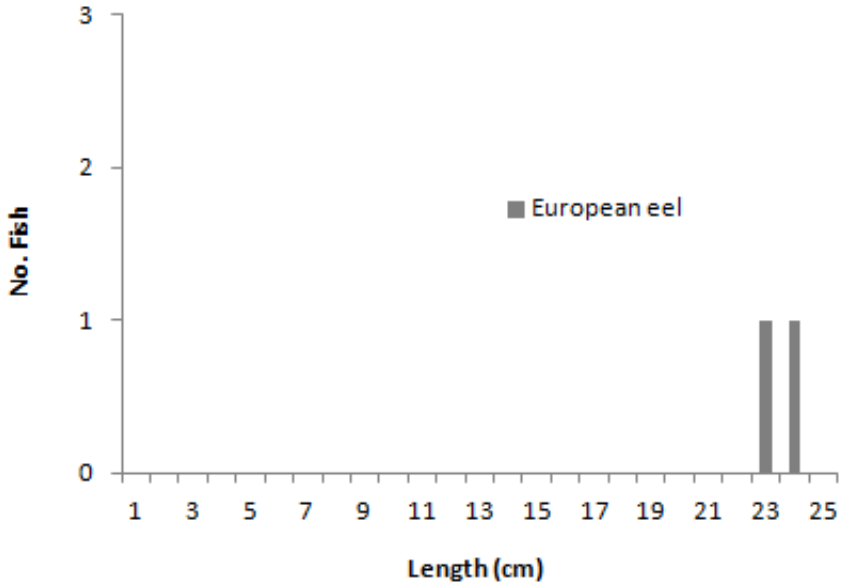

Figure 3.8. Length Frequency distribution of fish species captured in the Terryland River

Fish population size estimation

Fish population size estimates were calculated using the stream fish population estimate methodologies of Carle & Strub (1978) and Lockwood & Schneider (2000). The population estimates were calculated for river sites where >20 fish were recorded. Smaller numbers of fish do not fit the Carl & Strub equations. As such, the depletion statistics were only calculated for the Trusky, the Bearna and Knocknacarragh Streams, as sufficient quantities of fish were captured, in these watercourses.

The accuracy of the estimated N was tested using the goodness of fit test (as per White et al., 1982). Given that $\chi 2 < \chi 0.95$ for the three watercourses tested there was no significant difference between the calculated capture probabilities, meaning that the rate of fish removal (depletion) can be considered as constant and in agreement with the depletion curves calculated (see Figures 3.10-3.12 and Table 3.3 below). The consistent depletion was achieved given experienced operators of electro-fishing equipment and the efficient use of stop nets. The correct use of the Smyth-Root electro-fishing gear current settings in a range of site conditions with different levels of capture efficiency (i.e. high conductivity, low conductivity, cobble / boulder dominated, deep, shallow, weeded etc.) ensured that population estimates could be improved.

Table 3.4. Depletion statistics for the Trusky, Bearna and Knocknacarragh Streams

Site	Captured population	Carl & Strub Pop. Est. with 95% confidence limits (NL & NU) in parenthesis	χ 2 (Goodness of fit)	χ 2 < χ 0.95	Constant Rate Depletion
Trusky	43	37 (46, 55)	1.276	(5.991, d.f.=2, p=0.581)	Yes
Bearna	31	36 (33, 37)	1.090	(5.991, d.f.=2, p=0.574)	Yes
Knocknacarragh	48	61 (35, 87)	0.817	(5.991, d.f.=2, p=0.333)	Yes

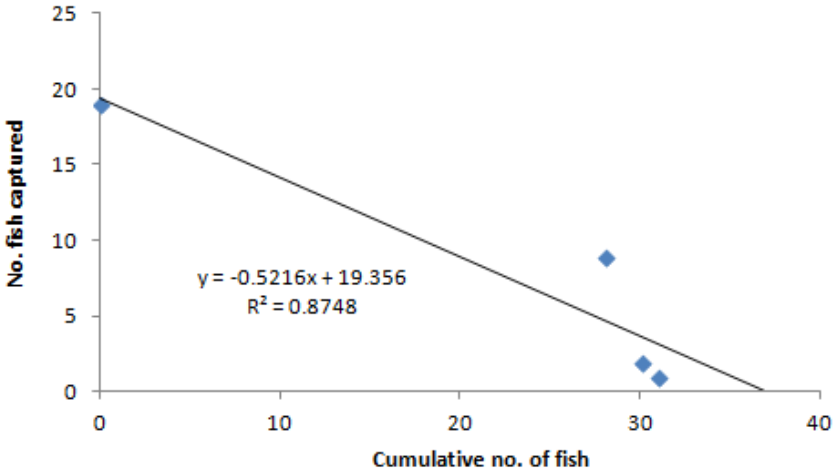

Figure 3.9. Depletion curve calculated for the Bearna Stream

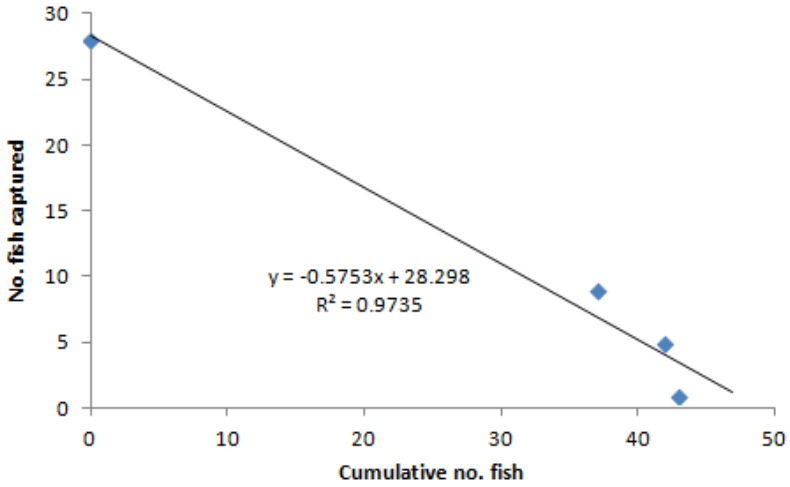

Figure 3.10. Depletion curve calculated for the Trusky Stream

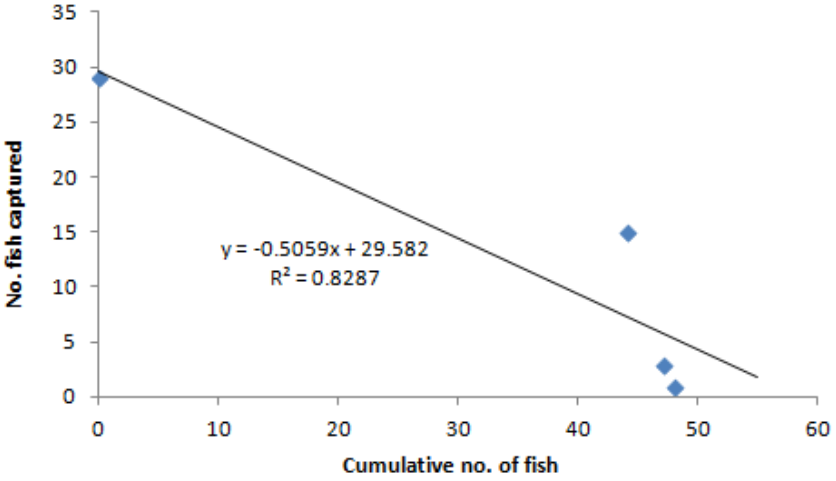

Figure 3.11. Depletion curve calculated for the Knocknacarragh Stream

Plate 3.8. Silvered European eel (*Anguilla anguilla*) captured in the lower reaches of the Sruthán na Libeirtí Stream

Plate 3.9. European eel elvers captured in the lower reaches of the Trusky Stream

Plate 3.10. Brown trout (*Salmo trutta*) captured in the Trusky Stream

Plate 3.11. Young Brown trout captured in the salmonid nursery of the Bearna Stream

Plate 3.12. Juvenile flounder (*Platichthys flesus*) captured in the transitional reaches of the Knocknacarragh Stream

Plate 3.13. Three spined stickleback (*Gasterosteus aculeatus*) captured in the Trusky Stream

Lake Sites

Ballindooley Lough and Coolagh Lakes (map sites 8 & 9 respectively on Figure 2.1 were surveyed between the 22nd and 24th of September 2015. The nets were positioned to maximise the capture rates from the lake meso-habitats (see Appendix B for depth profiles and Appendix C for fyke net locations). The positioning of the fyke nets included the windward bank on the Chara zones of the shelving margins, shallow bays and at oblique angles to natural points in the reed swamp littoral zones.

A total of four fish species were recorded from Ballindooley Lough. These included benthivorous tench *Tinca tinca*, pelagic rudd *Scardinius erythropthalmus* and piscivorous perch *Perca fluviatilis* and pike *Esox lucius*. Only two species were recorded from the Coolagh Lakes: roach *Rutilus rutilus* that are considered an invasive fish species, and perch. Only one specimen of European eel was also captured from the Coolagh Lakes despite connection to the River Corrib. No salmonids were recorded during the survey.

A summary of the numbers of fish captured and of the length frequency distributions for each species are summarised in Table 3.4 and Figures 3.12 and 3.13 below.

Table 3.5. Fish species recorded during fyke net surveys at Ballindooley Lough and Coolagh Lakes

Scientific Name	Common Name	Ballindooley Lough	Coolagh Lakes
Esox Lucius	Pike	3	
Perca fluviatilis	Perch	11	13
Rutilus rutilus	Roach		6
Scardinius erythropthalmus	Rudd	3	
Tinca tinca	Tench	6	
Anguilla Anguilla	Eel		1

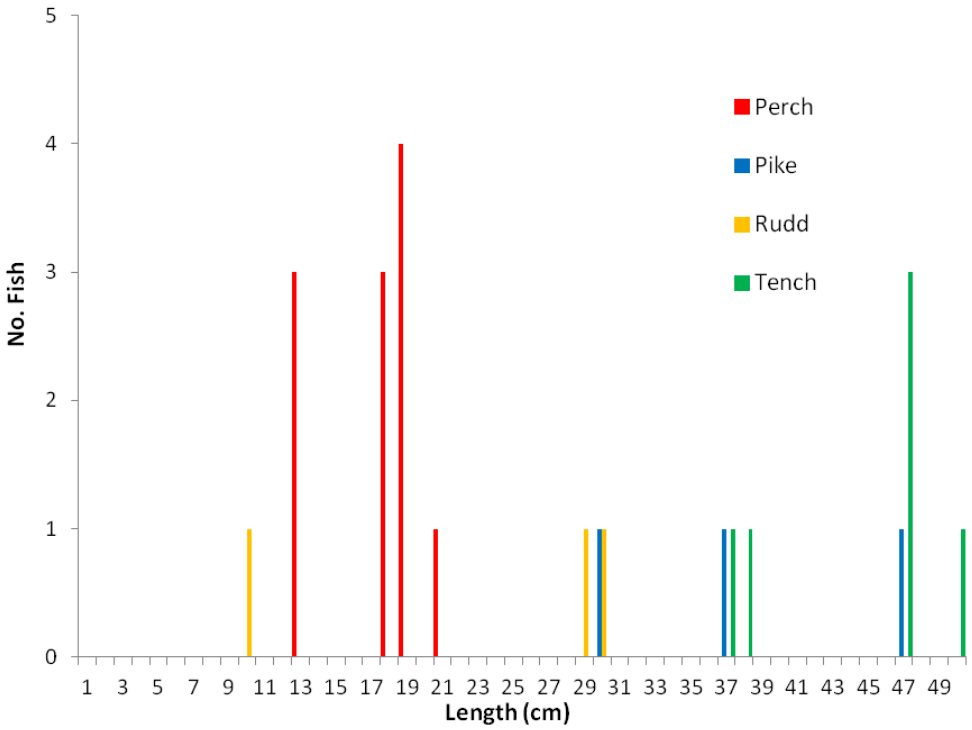

Figure 3.12. Length Frequency distribution of fish species captured at Ballindooley Lough

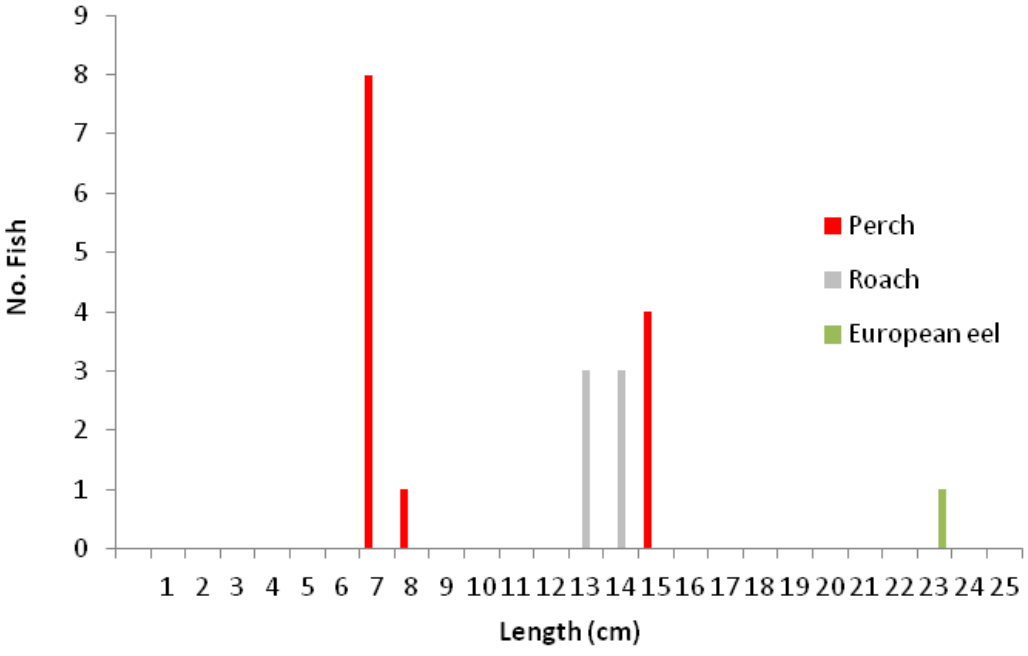

Figure 3.13. Length Frequency distribution of fish species captured at Coolagh Lakes

Plate 3.14. Juvenile Perch *Perca fluviatilis* captured in the Coolagh Loughs

Plate 3.15. Roach *Rutilus rutilus* captured in the Coolagh Loughs

Plate 3.16. Tench *Tinca tinca* captured in Ballindooley Lough

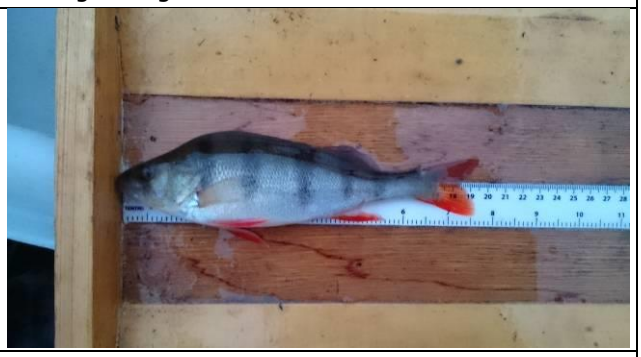

Plate 3.17.Adult Perch captured in Ballindooley Lough

Plate 3.18. Rudd *Scardinius erythropthalmus* captured in Ballindooley Lough

Plate 3.19. Pike *Esox lucius* captured in Ballindooley Lake

Fisheries Habitat Evaluation

Watercourses containing good salmonid habitat can be considered of at least high value local ecological importance (NRA, 2009). While some of the habitats contained salmonid habitat (e.g. the Tonabrocky Stream and the Bearna Stream) others had poorer quality fisheries habitat (e.g. Terryland River). In some instances, where salmonid habitat was not present or poor, habitat supporting European eel and or estuarine fish species was present. Where shallow stream gradients permitted (e.g. lower reaches of the Knocknacrragh and Trusky Streams), good quality transitional nursery habitat for estuarine fish species was present. The evaluation of the stream sites and of the two lake habitats surveyed are appraised and summarised below.

Table 3.6. Fisheries Evaluation of Watercourses surveyed as part of the proposed road development

Watercourse Name	Characteristics (upper to middle reaches i.e. overlapping road footprint)	Characteristics (lower reaches)	Fisheries Notes	Evaluation
Sruthán na Libeirtí	The river is shallow (<0.3m) deep and seasonal, typically <0.5m wide. Heavily encroached by bracken, bramble and gorse scrub. Of no fisheries value in upper reaches. Upper reaches dried up during 2013-2014 hot summers.	Swift flowing with a depth of 0.5m. Historically straightened in middle reaches but retaining some good pool, riffle and glide sequences. Gobble & gravel beds and patches of soft sediment present.	The lower reaches have some moderate quality salmonid and European eel habitat. Only European eel present in small numbers.	Of local importance (lower value) for European eel. No salmonids present.
Trusky Stream	Shallow & small river in upper reaches (<1m wide & 0.2m deep) with some moderate quality salmonid habitat in upper reaches given riffle, glide and pool sequences. However, despite some salmonid habitat being present no salmonids were recorded.	The lower reaches of the Trusky Stream were wider (circa 3m) and deeper (0.5m) than the upstream habitat, given the confluence of three small tributaries. The habitat was dominated by faster flowing glide which was considered tidal during spring tides.	Lower reaches of some importance to brown trout and of high importance to European eel elver and juvenile flounder as a nursery habitat. Some spawning habitat for trout exists in the lower sections of the stream but the spawning areas are limited and the trout population size is considered small as a consequence.	Of local importance (higher value) for salmonids, European eel & as a nursery for flounder
Tonabrocky Stream	The upper reaches of the Tonabrocky Stream	The Lower reaches of the Tonabrocky	Upper reaches seasonal but moving	Of local importance (higher

Watercourse Name	Characteristics (upper to middle reaches i.e. overlapping road footprint)	Characteristics (lower reaches)	Fisheries Notes	Evaluation
	agglomerate were not considered of fisheries value. However moving downstream of the road alignment the habitat improves considerably with sequences of riffle, glide & localised pool. The gravel base of the stream also provides some spawning opportunity for trout. Small numbers of trout recorded upstream in the poorer quality habitat.	Stream have good quality salmonid habitat (both juvenile & adults). Some good quality spawning habitat present and localised holding pools for adult fish. Overall the stream increases considerably in size moving downstream and as such becomes a better salmonid habitat. In the lower reaches the stream had very swift flowing water with well defined riffle, pool and glide sequences.	downstream the habitat becomes an important salmonid river.	value) for brown trout
Bearna Stream	The Bearna Stream tributary of the Tonabrocky Stream is an excellent salmonid habitat throughout its upper reaches and considered the highest quality salmonid habitat of all of the tributaries surveyed along the corridor of the proposed road development.	Lower reaches contain excellent salmonid spawning and nursery habitat as do the upper reaches.	The Bearna Stream was considered an excellent nursery salmonid stream with good numbers of juvenile brown trout and small numbers of European eel. The habitat has excellent quality spawning habitat that was widespread.	Of local importance (higher value) for brown trout & European eel
Knocknacarragh Stream	The upper reaches of Knocknacarragh Stream were largely seasonal grassy ditches with the exception of one small section of channel downstream of Ballagh that retained some natural characteristics. Overall of no fisheries value.	The lower reaches of the Knocknacarragh Stream are heavily culverted. However a short section of open channel downstream of the R336 provides important habitat for juvenile estuarine fish and European eel.	Upper reaches of no fisheries value but lower reaches near estuary are of importance to as a transitional nursery habitat for estuarine fish & European eel.	Of local importance (higher value) for European eel & as a nursery for estuarine fish (sand goby, flounder & grey mullet)
Terryland River	The Terryland River in its upper	The lower reaches of the	Small numbers of European eel	Of local importance

Watercourse Name	Characteristics (upper to middle reaches i.e. overlapping road footprint)	Characteristics (lower reaches)	Fisheries Notes	Evaluation
	reaches is a heavily modified and polluted stream habitat of limited fisheries value.	Terryland River continue to be impacted by urban pollution and are of limited fisheries value.	recorded during the survey but otherwise of limited fisheries value.	(lower value) for European eel.
Ballindooley Lough	Ballindooley Lough is considered an excellent coarse fishery, but not of importance as a salmonid fishery. It has very clean water and has had low levels of human impact.		Good numbers of tench, pike, rudd and perch recorded indicating the lake is a coarse fishery.	Of local importance (higher value) for coarse fish species.
Coolagh Lakes	The Coolagh Lakes are of some value to coarse fish but are not considered of importance for salmonids. They are deep and steep shelving lakes with cold water fed by springs and the River Corrib.		Despite connection to the River Corrib of limited or no value to salmonids. Only coarse fish recorded during survey (i.e. Perch & Roach) & one European eel	Of local importance (lower value) for coarse fish species & European eel.

5. Discussion

Currently, the biological water quality of streams along the proposed road development are not achieving target good status (Q4), with the exception of the Tonabrocky Stream and its tributary the Bearna Stream. Rivers with good status typically are better quality fisheries. The baseline fisheries habitat and stock compositions are discussed below.

River Habitats

Salmonids

Atlantic salmon *Salmo salar* and sea trout *Salmo trutta* (migratory form) were not recorded present during the surveys, likely because the watercourses surveyed were small and shallow. Consequentially, accessible good quality spawning habitat for migratory salmonids was limited. Brown trout *Salmo trutta* were however recorded in good numbers in the Bearna Stream (site 3B), while small populations were also found present in the Tonabrocky Stream (site 4A) and in the lower Trusky Stream (site 2A). Given that these sites contain wild brown trout populations all efforts should be made to prevent or minimise impacts to river substrata, river profile and water quality. Wild Irish Brown trout populations are considered to be genetically diverse with numerous strains (Taggart et al. 1981; Ferguson, 2006) and, thus, are important for the wider conservation and management of the species in Europe.

The Trusky Stream may be considered the most vulnerable salmonid bearing stream overlapping the proposed road development given the low population size of trout in the stream. This reflected by the small numbers captured (n=2) and because of the very limited spawning, nursery and holding habitat present (i.e. restricted to 200m in lower reaches). As such every effort should be made to ensure that potential impacts from upstream at the proposed road development crossing do not impact the downstream habitat.

The middle-upper reaches of the Tonabrocky Stream also had low densities of trout. However, given that abundant higher quality salmonid bearing habitat was present downstream, it would have better prospects for recovery should water quality impacts damage the fishery. The Tonabrocky Streams major tributary, the Bearna Stream contained the highest quality salmonid habitat of all the stream sites surveyed. It had excellent nursery, spawning and holding habitat that was reflected by the healthy population structure comprising good densities of juvenile and adult trout. Given that both the Tonabrocky Stream and the Bearna Stream had good quality salmonid habitat it is important to prevent impacts to the existing excellent instream spawning habitat, good sinuous river profile and water quality. With regards the Bearna Stream where excellent salmonid habitat exists above the proposed road development crossing it is especially important to facilitate fish passage at the crossing.

European Eel

The critically endangered European eel *Anguilla anguilla* (Freyhoff & Kottelat, 2010) are considered to be the most threatened fish species in Ireland as indicated from a recent red listed publication on Irish Fish (King *et al*. 2011).

The European eel has protective status under the European Eel Regulation EC No. 1100/2007 to facilitate the recovery of the eel stocks since the large decline in the 1980's. Of the stream sites surveyed, the lower transitional reaches of the Trusky and Knocknacarragh Streams were good eel nurseries. Silver migratory adult eel were also recorded in the lower reaches of the Sruthán na Libeirtí Stream despite the upper reaches being devoid of fish. This exemplifies that the lower reaches of many of the stream catchments were of some value to European eel, even in the instances where the middle and upper reaches were of no fisheries value (e.g. Sruthán na Libeirtí, Trusky & Knocknacarragh). European eel were also recorded at low densities in the Bearna Stream and the Terryland River. Given that water borne pollutants can travel from the upper reaches of catchments to downstream, European eel nursery habitat within these reaches are especially important to protect (e.g. Trusky Stream). Similarly, where small and cryptic residual populations of eel persist in otherwise seasonal catchments, it is very important to prevent impacts to these fisheries. Measures would include prevention of downstream pollution, ensuring that downstream river profiles are not impacted, maintaining pockets of pool habitat and preserving fish passability. Recent evidence suggests that large numbers of juvenile 'glass' eels are returning to European rivers (Jackoby & Gollock, 2014) meaning it is important to capitalise on higher returning numbers by protecting both juvenile and adult eel habitat. This will help ensure numbers increase into the future given the large historical declines.

Lamprey species

According to Igoe et al. (2004) both sea lamprey *Petromyzon marinus* and brook lamprey *Lampetra planeri* are present in the River Corrib catchment (hydrometric areas 29 & 30; see Figure 2.1 for hydrometric divisions). Interestingly, no lamprey species have been recorded in hydrometric area 31 (Kelly & King, 2001) in which the majority of the surveyed stream sites are located. Detailed lamprey distribution surveys conducted by O' Connor (2007) indicated that lamprey distribution was patchy in the wider Corrib catchment and largely restricted to brook lamprey. While sea lamprey species are known to occur in the River Corrib they are now thought to be restricted below the Salmon Weir constructed in the 1960's (O' Connor, 2007).

Many of the watercourses surveyed for the proposed road development had compacted gravels and limited fine sediment deposition that are not conducive to larval lamprey settlement (e.g. Sruthán na Libeirtí and Trusky). Some localised areas of soft sediment were present within the Bearna Stream and the Tonabrocky Stream but more extensive areas of fines present in the Terryland River. Nonetheless, despite the presence of some suitable lamprey spawning and burrowing habitat, no larval lamprey were recorded at any of the survey sites. It must be noted, though, that this survey focused on small electro-fishing footprints area (typically between 25m^2 and 100m^2). Therefore, the presence of larval lamprey further downstream of the proposed road development is considered possible in the Bearna Stream, the Tonabrocky Stream and Terryland River, albeit the noted suitable habitat was limited. This was considered following downstream fisheries habitat appraisals that identified localised larval lamprey habitat downstream of the electro-fishing areas.

The other stream habitats contained sub-optimal compacted cobble-gravel strewn streambed habitat that was contained in open, comparatively high-velocity streams (i.e. in the less seasonal tributaries). These included the Sruthán na Libeirtí, Trusky and Knocknacrragh Streams.

In summary, potential for lamprey to occur downstream of electro-fished sites existed only in the Tonabrocky, the Bearna and Terryland catchments. While this may indicate the possible presence of low densities of juvenile lamprey downstream of the proposed road development, the Tonabrocky Stream and the Bearna Stream are located in hydrometric area 31 where no lamprey are known to occur (Kelly & King, 2001). While lamprey species are known to be present in the River Corrib to which the Terryland River is a tributary, gross pollution (i.e. Q2-3) was recorded in the Terryland River meaning the species is unlikely to persist as its tolerances typically relate to Q3 rivers and above.

Potential sea lamprey spawning areas downstream of the proposed road development are very unlikely. Sea lamprey typically utilise similar (or even the same) spawning areas to Atlantic salmon; spawning in coarse gravel, pebbles and sand, where the diameter of the gravel can vary from 1–11cm, the overlying water column has a depth of 40–60cm (Igoe *et al*., 2004) and which are frequently found at the tail end of pools or conversely the upstream ends of rapids and riffles in relatively strong currents of up to 1–2ms^{-1} (APEM, 2004). The water depths recorded in the surveyed streams with the exception of the Terryland River would unlikely support the species. The Terryland River itself was heavily polluted and primarily comprised soft silt channel bed and is not considered suitable for the sea lamprey adults. Furthermore, sea lamprey are thought to be restricted below the Galway Salmon Weir because it acts as a barrier to mitigation (O' Connor, 2007) and therefore they are unlikely to be able to access the Terryland River.

Estuarine Fish

Where the gradients of the lower reaches of stream habitat adjoining estuaries facilitates the deposition of gravels and fines they can be important fish nurseries for estuarine species. Two stream sites contained such habitat, i.e. the Trusky Stream & the Knocknacarragh Stream. Both sites had moderate flow rates and mixed sediment substrata comprising cobbles, gravels and coarse sand. The lower Trusky Stream was an excellent nursery for European eel elvers (young eel), flounder and three-spine stickleback despite poor fisheries habitat upstream. While the Knocknacarragh Stream contained similar habitat it was more saline and had the highest diversity of fish species of all the stream sites surveyed. Grey mullet *Chelon labrosus*, sand *goby Pomatoschistus minutus*, flounder *Platichthys flesus*, three spined stickleback *Gasterosteus aculeatus* and European eel were recorded as present. The presence of good transitional nursery habitat where stream sites discharge into estuaries exemplified the importance of stream catchments longitudinally as far downstream as the estuarine reaches. This is especially important when seemingly poor upstream and middle reach habitat exists, meaning the lower reaches can be overlooked, if one were to consider the upper catchments as an indicator of the importance of lower catchment alone.

Lake Habitats

Ballindooley Lough

Ballindooley Lough was considered an excellent mixed stock coarse fishery based on the findings of the survey. Rudd *Scardinius erythropthalmus* were detected at low densities in one fyke net in the windward and shallow north basin of Ballindooley Lough. Here the expansive beds of *Chara spp*. and *Utricularia sp.* vegetation provide refugia for rudd and grazing opportunities. Furthermore, rudd, with their characteristic upturned mouth, feed on emerging aquatic insects that attach to submerged vegetation. As such, rudd as a species requires reeded littorals for cover and feeding. In contrast perch were detected in the deeper water, where the younger year classes would graze on plankton. Where rudd and perch co-exist in a medium sized waterbody i.e. 30 acres the later species tends to be numerically more abundant given they are superior planktivores in open water, in addition to becoming piscivorous as adults. Rudd in contrast to perch, have a herbivorous component to their diet eating Chara vegetation in addition to feeding aerial aquatic insects and zooplankton. As such in larger watercourses they tend to be restricted to shallower weeded bays (Kennedy & Fitzmaurice, 1973) as was found during the current survey.

Perch were recorded at moderate densities and in three fyke nets and appeared to be very numerous in the open and deeper water of the lake based on high resolution transducer readings. The absence of roach detected during the survey would indicate that the open water pelagic fish are likely to be perch rather than other species. Perch are considered a non-native fish species in Ireland (King et al., 2011).

Pike were detected in two fyke nets. The species also appeared in the deeper open water on transducer readings below perch shoals. Pike are a top predator and are obligate piscivores, but also eat small amphibians, mammals and waterfowl. They are nonetheless considered an important species for recreational angling and for the sustenance of balanced coarse fisheries (Arlinghaus et al., 2010). While pike were considered non-native historically more recent evidence suggests that early colonisation of the species may have been independent of humans (Pedreschi et al., 2013).

Tench were detected at moderate densities during the survey being recorded in 4 fyke nets on the western shore. The abundant beds of Chara vegetation and sheltered nature of the lake with limited direct cooling from rivers created a very good quality tench habitat in Ballindooley Lough. The species can thrive in small and medium sized waterbodies where marginal vegetated lake shelves in higher alkalinity lakes provide rich invertebrate feeding. They typically graze molluscs attached to Chara beds and rarely leave the seclusion of these habitats. As with pike, perch and rudd they are an important recreational angling quarry.

The basinal characteristics of Ballindooley Lough facilitate a habitat supporting number of different coarse fish species with different biological requirements. The open water provides good habitat for perch and pike with the weedy margins providing good habitat for rudd and tench.

Weeded margins also provide habitat for pike which use these areas for ambush predation. Ballindooley Lough is not considered of value as a game fishery (i.e. brown trout) as no salmonids were recorded during the survey. As it has no direct connection to adjoining rivers it is neither of importance to anadromous or catadromous fish. This conclusion is drawn based on the absence of both salmonids and European eel during the survey.

Overall Ballindooley Lough is considered a very high quality mixed coarse fishery. In this fashion it is a similar fishery to the nearby Ballyquirke and Ross Loughs to the south west of Lough Corrib, as both fisheries are considered also important as recreational coarse fisheries. These Lakes contrast to the internationally important game fisheries of Lough Corrib and Lough Mask that are famous for the brown trout and the ferox subspecies they support.

Coolagh Lakes

The Coolagh lakes are reed fringed and up to 18m deep as recorded on high resolution transducers. The two basins are connected by a narrow reed fringed channel with the northern basin being slightly shallower (12m) and spring fed. The lakes are largely inaccessible from the shoreline and were accessed by boat from a connecting channel via the River Corrib. Three species of fish were recorded at the Coolagh Lakes, namely roach, perch and European eel. Roach are classified as a 'non-native, non-benign' invasive species in Irish waters (Stokes *et al*., 2004; King *et al*., 2011) and is placed under restrictions according to Articles 49 and 50 of the S.I. 477 of the European Communities (Birds and Natural Habitats) Regulations 2011. Their environmental plasticity and ability to compete with other native fish species, such as Atlantic salmon and brown trout, for food means that they can have negative impacts on native fish populations. Unfortunately, roach are now widespread in the Corrib catchment colonising through the interconnecting channels and lakes. Given that the Coolagh Lakes are connected to the River Corrib, roach would have naturally colonised from this point. Interestingly despite this connection to the river no trout were recorded and only one specimen of European eel was found present. Overall the Coolagh Lakes are not considered of high fisheries value, rather of local importance as a coarse fishery.

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Appendix A – Electro-fishing License

Roinn Cumarsáide,
Fuinnimh & Acmhainní Nádúrtha
Department of Communications,
Energy & Natural Resources

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

The Minister for Communications, Energy and Natural Resources in exercise of the powers conferred on him by Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962 hereby authorises:

Mr Ross Macklin, Triturus Environmental Services, 42 Norwood Court, Rochestown, Cork City. and or person(s) nominated by him to undertake an electro fishing surveys in relation to proposed N6 Galway City Transport Project. The works involve the undertaking of quantitative electro-fishing surveys of small rivers/ streams (n=7) along the alignment of the proposed N6 Galway City Transport Project and the quantitative assessment of the fisheries status of two lake systems that are connected hydrologically to the scheme, by means of fyke netting.

The following locations have been proposed for the survey: 1. Liberty (West of River Corrib); 2. Trusky (West of River Corrib); 3. Bearna (West of River Corrib); 4. Rusheen Bay (West of River Corrib); 5. Coolagh lakes stream (East of River Corrib); 6. Terryland Stream (East of River Corrib); 7. Merlin Park Stream (East of River Corrib); 8. Coolagh Lakes (East of River Corrib); and 9. Ballindooly Lough (East of River Corrib). Electro-fishing will be undertaken in locations 1-7 and fyke netting will be undertaken in locations 8 and 9 (site details and map are included in the original application).

Roinn Cumarsáide,
Fuinnimh & Acmhainní Nádúrtha
Department of Communications,
Energy & Natural Resources

This authorisation is granted subject to the following conditions:

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

   (a) any rights or title which the holder would not have had if this Authorisation had not been given, or;

   (b) any authority in any way to interfere with or infringe the lawful rights of any other person.

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

3. **This authorisation is valid until 30 September 2015.**

4. **Inland Fisheries Ireland Galway (IFI) shall be notified at least 5 working days in advance of the proposed commencement of the electro-fishing operations. Please contact IFI Director John Conneely / Pat Gorman, IFI Fisheries Inspector. The holder of this authorisation shall comply with any instructions given to them in relation to fishing operations.**

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

6. **The electrofishing operation must be carried out during suitable weather and flow conditions.**

Roinn Cumarsáide,
Fuinnimh & Acmhainní Nádúrtha
Department of Communications,
Energy & Natural Resources

7. **Electro-fishing should, if possible, be carried out by the September 30th when juvenile salmonids (if present) are of a sufficiently large size to be caught by electro-fishing, to minimize damage and for them to be distinguished from similar species (CEN, 2001 and CFB/IFI 'Electric Fishing in Wadeable reaches' manual.**

8. **Fyke netting operations should be carried out by the 30th September 2015.**

9. **The applicant is fully aware of biosecurity concerns. IFI insists upon strict adherence to the Biosecurity Protocol for Field Survey Work, whereby equipment must be disinfected prior to and after use to prevent the spread of disease, parasites or invasive species (http://www.fisheriesireland.ie/Biosecurity/biosecurity-protocol-for-field-survey-work.html) (and as directed by an officer of IFI).**

10. **All equipment must be available for inspection by an IFI officer during the survey.**

11. **The fishing gear when not in use shall be kept in a secure place known to an Officer of the Western River Basin District of IFI and the local Garda Siochana.**

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

Roinn Cumarsáide,
Fuinnimh & Acmhainní Nádúrtha
Department of Communications,
Energy & Natural Resources

13. **Any fish captured shall be carefully handled and returned alive to the water from which they are taken, following the gathering of data. No fish of any species should be sacrificed during the appraisal, except in circumstances where tissue/body burden analysis is to be carried out. IFI Galway shall be informed of any fish mortalities immediately after the survey. Details including the County, Site number, River Name, Townland, Irish Grid Reference and the species.**

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

15. **The survey report including the survey quantitative data obtained in the appraisal shall be forwarded electronically in the standard IFI format to Sandra Doyle, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24, Sandra.doyle@fisheriesireland.ie within 30 days of completion of the survey. For ease of reference an electronic copy of IFI's standard template will be forwarded directly to the applicant. Report (hard and soft copies) to include mortality data and full account of qualitative/quantitative results. These data will not be made publically available, for a period of three years, without the permission of Triturus Environmental Services.**

16. **Failure to comply with any of the conditions of this authorisation may result in revocation of this authorisation.**

17. **The holder of this authorisation should be mindful of the potential occurrence of invasive alien species be recorded, IFI request that their location is recorded and submitted to IFI. It is likely that Japanese knotweed will be encountered in or around the survey locations.**

Roinn Cumarsáide,
Fuinnimh & Acmhainní Nádúrtha
Department of Communications,
Energy & Natural Resources

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

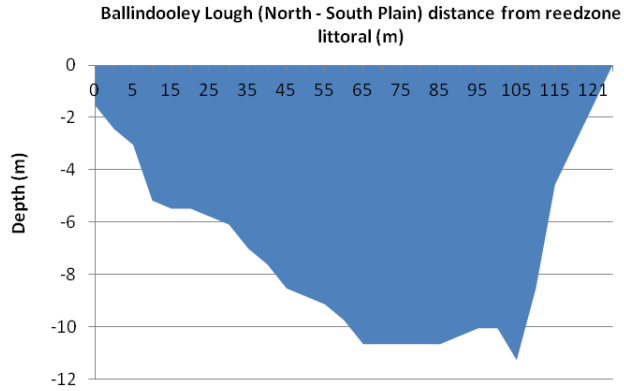
19. Notwithstanding the foregoing, this authorisation may be revoked or amended by the Minister for Communications, Energy and Natural Resources without the payment of compensation to the holder on giving one week's notice in writing to the holder if he considers it necessary in the public interest to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

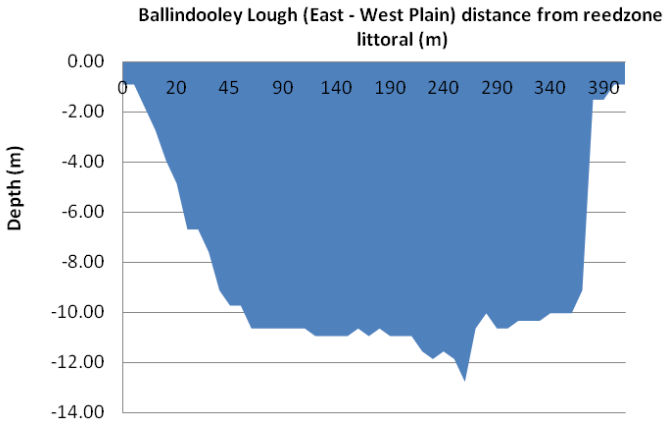
Dated this 11 September 2015

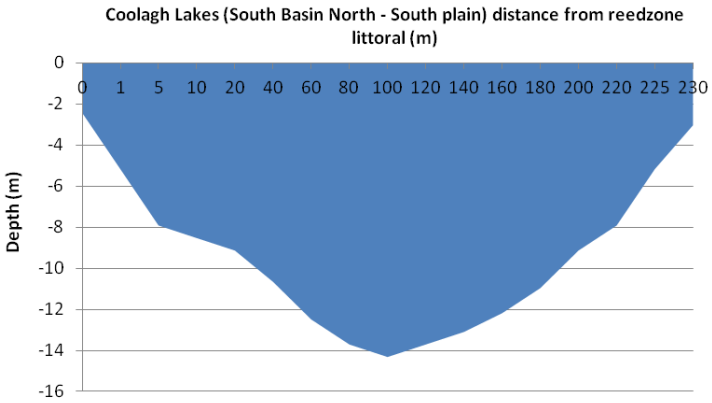
For the Minister for Communications, Energy and Natural Resources.

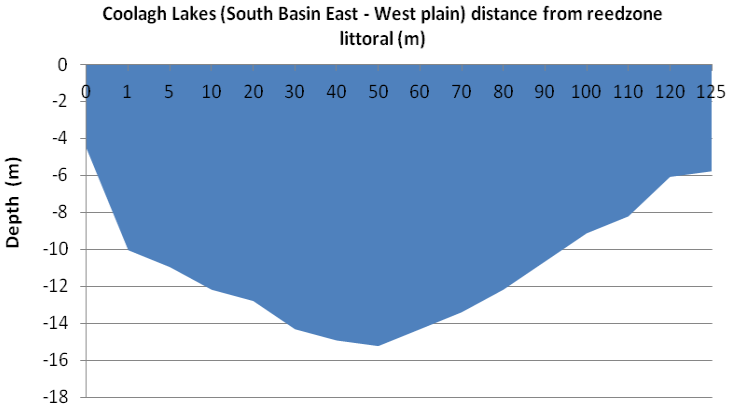
Gerry Clerkin
An officer authorised on that behalf by the said Minister

Appendix B – Lake Profiles


Ballindooley Lough (North - South Plain) distance from reedzone littoral (m)
Depth (m)
0
-2
-4
-6
-8
-10
-12
0 5 15 25 35 45 55 65 75 85 95 105 115 121


Ballindooley Lough (East - West Plain) distance from reedzone littoral (m)
Depth (m)
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
0 20 45 90 140 190 240 290 340 390


Coolagh Lakes (South Basin North - South plain) distance from reedzone littoral (m)
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
-16
0 1 5 10 20 40 60 80 100 120 140 160 180 200 220 225 230


Coolagh Lakes (South Basin East - West plain) distance from reedzone littoral (m)
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
0 1 5 10 20 30 40 50 60 70 80 90 100 110 120 125

Appendix C – Fyke Net Locations

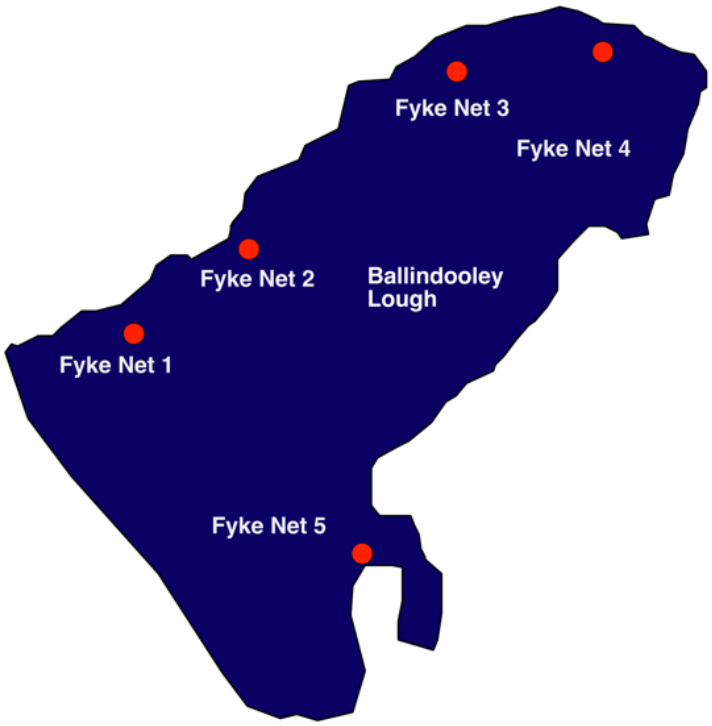


Figure C1. Location of Fyke Netting Sites on Ballindooley Lough

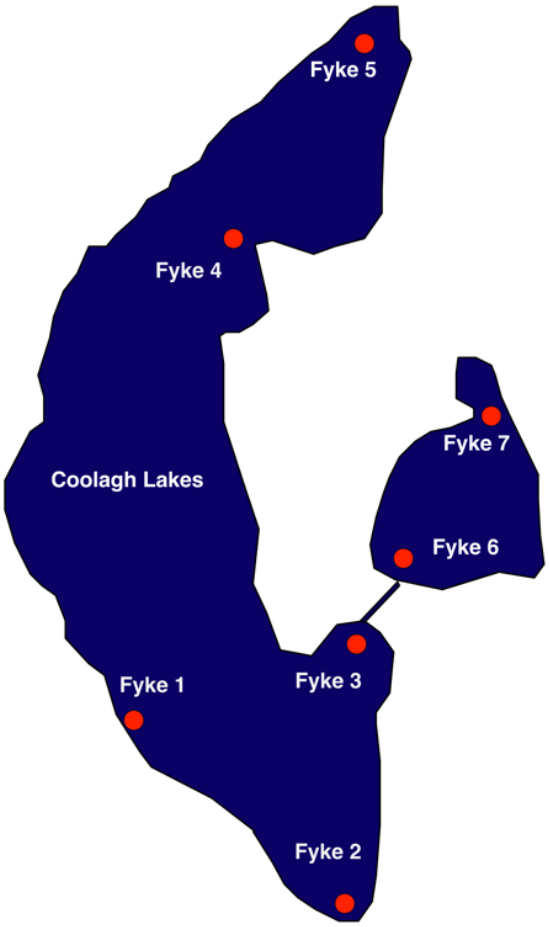


Figure C2. Location of Fyke Netting Sites on the Coolagh Lakes

K.1 Part 1b - Fisheries Surveys - 2023

Fisheries assessment of the proposed N6 Galway City Ring Road (GCRR)

Prepared by Triturus Environmental Ltd. for Scott Cawley Ltd.

December 2023

Please cite as:

Triturus (2023). Fisheries assessment of the proposed N6 Galway City Ring Road (GCRR). Report prepared by Triturus Environmental Ltd. for Scott Cawley Ltd. December 2023.

Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by Scott Cawley Ltd. to undertake a baseline fisheries assessment of riverine watercourses and lakes in the vicinity of the proposed N6 Galway City Ring Road (GCRR) scheme, located in the vicinity of Galway City (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the updated EIAR for the Project. To gain an overview of the fisheries value of the riverine watercourses and lakes within the vicinity of the Project, a catchment-wide electro-fishing survey across 26 no. riverine sites was undertaken (**Table 2.1; Figure 2.1**). A fisheries habitat appraisal of the three lake and two pond sites was also undertaken. The fisheries appraisal at the lake and pond sites was also supported by environmental DNA (eDNA) sampling to determine the presence of fish species of high conservation value.

Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for fish of high conservation value that included salmonids, European eel (*Anguilla anguilla*) and lamprey (*Lampetra* sp.). The presence of these species, inclusive of important supporting habitat, would inform mitigation to minimise potential impacts from 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 Project. The surveys were undertaken on the 29th, 30th & 31st August 2023, with fisheries habitat appraisals of lake sites completed on the 1st & 8th September 2023.

1.2 Fisheries asset of the survey area

The River Corrib is a nationally important Atlantic salmon habitat and is ranked 8th in Ireland with regards to fluvial accessible habitat to salmon (McGinnity et al., 2003). The River Corrib was not surveyed during catchment wide surveys carried out during 2020 as part of the National Research Survey Programme that informs WFD assessment (Gordon et al., 2021), and thus limited data exists for the river between Lough Corrib and the Galway Weir based on recent fisheries survey data. However, coarse fish species including pike (*Esox lucius*), perch (*Perca fluviatilis*) and invasive roach (*Rutilus rutilus*) are known from the lower River Corrib (pers. obs.). Both sea lamprey (*Petromyzon marinus*) and brook lamprey (*Lampetra planeri*) are known to occur in the River Corrib catchment (hydrometric area 30) with sea lamprey being known to spawn below the Galway weir (Igoe et al., 2004). Low densities of *Lampetra* sp. (likely brook lamprey given downstream barriers) were recorded by Triturus during September 2022 at Terryland on the east bank of the River Corrib downstream of Quincentennial Bridge. This was considered the first evidence of larval *Lampetra* sp. in the River Corrib downstream of Lough Corrib.

The Knocknacarra Stream is typically of poor fisheries value but is known to support European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) in its lower reaches (Triturus, 2018). The Trusky Stream is known to support these species in addition to brown trout (*Salmo trutta*)

and flounder (*Platichthys flesus*) (Triturus, 2018). The Bearna Stream and Tonabrocky Streams are known to support brown trout, with European eel also present in the Bearna Stream (Triturus, 2018). The Sruthán na Libeirtí Stream near Barna is known to support European eel (Triturus, 2018).

Ballindooley Lough is known to support a range of coarse fish species including tench (*Tinca tinca*), rudd (*Scardinius erythropthalmus*), pike (*Esox lucius*) and perch (*Perca fluviatilis*) (Triturus, 2018). The Coolagh Loughs support perch, roach (*Rutilus rutilus*) and European eel (Triturus, 2018).

Fisheries data for the other survey watercourse/waterbodies was not available prior to this survey.

2. Methodology

2.1 Fisheries assessment (electro-fishing) & appraisal

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on riverine watercourses in the vicinity of the Project in August 2023 following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The catchment-wide electro-fishing (CWEF) survey was undertaken across 26 no. riverine sites, with a fisheries habitat appraisal completed at 5 no. lacustrine (lake & pond) sites in September 2023 (see **Table 2.1, Figure 2.1**).

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

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 catch per unit effort (CPUE), an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 30-75m channel length was surveyed at each site, where feasible, to gain a better representation of fish stock assemblages. At certain sites with limited access (e.g. high average depths, impenetrable scrub), it was more feasible to undertake electro-fishing for a 5-minute CPUE. Discrepancies in fishing effort (CPUE) between sites are provided in the 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 (mixed geologies) a voltage of 250-300v, 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 quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a

lower frequency (30Hz) burst DC pulse setting which also allowed detection of European eel in sediment, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's surface, approximately 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

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

2.2 Fisheries habitat appraisal

A fisheries habitat appraisal of all riverine survey sites was undertaken in addition to electro-fishing to establish the importance of the supporting habitats as nursery, spawning and or holding habitats. The appraisal surveys focused on evaluating the spawning, nursery and or holding habitat for salmonids and lamprey species but also considered European eel and other fish species. The appraisals of salmonids and lamprey were cognisant of species-specific habitat requirements and preferences as outlined in O'Grady (2006), Hendry et al. (2003), Armstrong et al. (2003), Harvey & Cowx (2003), Maitland (2003) and Hendry & Cragg-Hine (1997). River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (Environment Agency, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata etc.). As an electro-fishing survey of the 5 no. lake and pond sites was not possible, a fisheries habitat appraisal only was undertaken. This was supported by eDNA analysis to detect fish species of high conservation value.

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. Care was given towards preventing the spread or introduction of crayfish plague (*Aphanomyces astaci*). Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=31 electro-fishing and fisheries appraisal survey sites in the vicinity of the Project

Site no.	Watercourse	EPA name (if different)	EPA code	Location	Hydrological catchment (ARUP, 2018)	X (ITM)	Y (ITM)
Riverine sites							
A1	Merlin Park Stream	Unnamed stream	n/a	Merlin Park Woods	8. Doughiska	533925	726166
B1	River Corrib		30C02	Menlough	5. Corrib catchment	528509	727739
C1	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1000 road crossing, Letteragh	4. Knocknacarra Stream	527224	726361
C2	Knocknacarra Stream	Knocknacarragh Stream	31K16	Diarmuid Road, Rahoon	4. Knocknacarra Stream	527080	725981
C3	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1016 road crossing, Rahoon	4. Knocknacarra Stream	527119	725675
C4	Knocknacarra Stream	Knocknacarragh Stream	31K16	Rahoon	4. Knocknacarra Stream	527051	725429
C5	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1013 road crossing, Rahoon	4. Knocknacarra Stream	526908	725069
C6	Unnamed channel		n/a	Rahoon	4. Knocknacarra Stream	526664	726015
C7	Unnamed stream		n/a	Rahoon	4. Knocknacarra Stream	526857	725099
C8	Knocknacarra Stream	Knocknacarragh Stream	31K16	Rahoon	4. Knocknacarra Stream	526546	724905
C9	Tonabroky Stream		31T13	Árd na Gaoithe	4. Knocknacarra Stream	525881	725754
D1	Bearna Stream		31B01	Ballynahown East	3. Bearna Stream	525105	725457
D2	Bearna Stream		31B01	Ballynahown East	3. Bearna Stream	524885	725235
D3	Bearna Stream		31B01	L5025 road crossing, Cappagh	3. Bearna Stream	524614	724671
D4	Oddacres Stream		31O05	Cappagh	3. Bearna Stream	524210	724825
D5	Loughinch Stream		31L26	Aille	3. Bearna Stream	524107	724716
D6	Bearna Stream		31B01	Cappagh Park	3. Bearna Stream	524520	724142
E1	Cloghscoltia Stream		31C36	L1321 road crossing, Trusky East	2. Trusky Stream	523113	724239
E2	Trusky Stream		31B02	Trusky West	2. Trusky Stream	522343	724022
E3	Trusky Stream		31B02	Trusky East	2. Trusky Stream	522806	723828

Site no.	Watercourse	EPA name (if different)	EPA code	Location	Hydrological catchment (ARUP, 2018)	X (ITM)	Y (ITM)
E4	Freeport Stream		31F04	L5387 road crossing, Trusky West	2. Trusky Stream	522153	723615
E5	Trusky Stream		31B02	Freeport	2. Trusky Stream	523212	722842
F1	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	L5386 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521565	723838
F2	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	Forramoyle West	1. Sruthán Na Libeirtí	521449	723337
F3	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	R336 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521064	722522
F4	Newvillage Stream		31N03	R336 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521512	722578
Lake sites							
L1*	Unnamed pond		30_507	Ballindooley	5. Corrib catchment	531246	728620
L2*†	Ballindooley Lough		30_506	Ballindooley	5. Corrib catchment	531488	728882
L3*†	Coolagh Lough (upper)		30_290	Coolagh	5. Corrib catchment	529300	727849
L4*†	Coolagh Lough (lower)		30_290	Coolagh	5. Corrib catchment	529392	727442
L5*	Unnamed pond		30_510	Menlough	5. Corrib catchment	529222	727716

*eDNA sampling for white-clawed crayfish, crayfish plague, European eel & smooth newt

† eDNA metabarcoding for all fish species

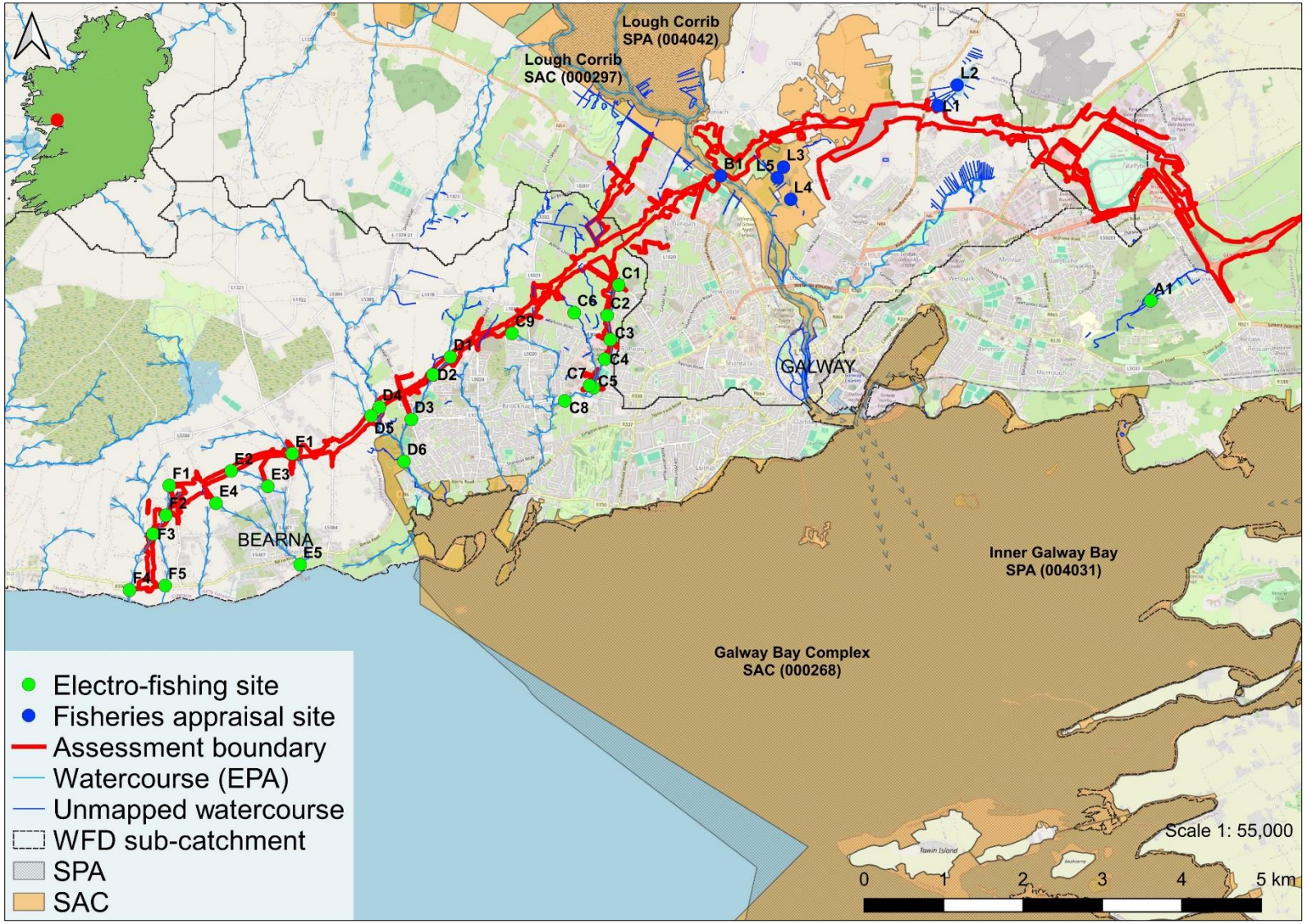


Figure 2.1 Overview of the electro-fishing & fisheries appraisal survey sites in the vicinity of the Project

3. Results

A catchment-wide fisheries survey of 31 no. sites in the vicinity of the Project was conducted on the 29th, 30th & 31st August 2023 and the 1st & 8th September 2023 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, spawning and or holding habitat for salmonids, European eel, lamprey and other fish species. Scientific names are provided at first mention only. Survey sites have been group into their respective hydrological catchments as per 2018 EIAR for the proposed N6 Galway City Ring Road.

3.1 Fisheries survey sites

Doughiska hydrological catchment

3.1.1 Site A1 – Merlin Park Stream, Merlin Park Woods

Site A1 was located on the Merlin Park Stream in Merlin Park Woods. Given the stream was dry at the time of survey, the site was not of fisheries value.

Plate 3.1 Representative image of the Merlin Park Stream at site A1, August 2023 (dry channel)

Corrib hydrological catchment

3.1.2 Site B1 – River Corrib, Menlo

Electro-fishing was not undertaken at the site B1 on the River Corrib (EPA code: 30C02) given prohibitive depths and water volumes. The typically rocky bed and slow-flowing deep glide did not offer good salmonid nursery characteristics with spawning habitat also poor given the very compacted bed. Holding habitat for adult salmonids was moderate and the site was more characteristic of a

migratory passageway for improved spawning in the tributaries of Lough Corrib rather than an important transitory resting habitat. The European eel and coarse fish value was moderate with improved habitat upstream at Lough Corrib.

Plate 3.2 Representative image of site B1 on the River Corrib at Menlo, August 2023

3.1.3 Site L1 – unnamed pond, Ballindooley

Site L1 was located at a small unnamed lake adjacent to Ballindooley Lough. A fisheries appraisal of site L1 indicated the site was of high value for coarse fish species. Pike (*Esox lucius*) were observed in the margins with abundant young-of-the-year rudd (*Scardinius erythrophthalmus*) and occasional perch (*Perca fluviatilis*). Tench (*Tinca tinca*) are also known from the lake (pers. obs.). European eel were detected via eDNA sampling (**Appendix C**).

Plate 3.3 Representative image of site L1, September 2023

3.1.4 Site L2 – Ballindooley Lough, Ballindooley

Site L2 was located at Ballindooley Lough, a 4ha irregular shaped lake in a karstic landscape. A fisheries appraisal of site L2 indicated the site was of high value for coarse fish species. As per site L1, pike were observed in the margins with abundant young-of-the-year rudd and juvenile occasional perch. The lake is also known to support tench and Red-listed European eel (Triturus, 2018). DNA metabarcoding revealed the presence of these aforementioned species (**Appendix C).**

Plate 3.4 Representative image of site L2 at Ballindooley Lough, September 2023 (northern shore)

3.1.5 Site L3 – Coolagh Lough (upper)

Site L3 was located at Coolagh Lough Upper[1], a 4ha crescent-shaped lake connected to the River Corrib. A fisheries appraisal of site L3 indicated the site was of high value for coarse fish species. Pike, perch and juvenile roach (*Rutilus rutilus*) were observed in the margins. The lake was considered a good quality coarse fish habitat (despite the high average depth) and had suitability for both European eel and brown trout given connectivity to the River Corrib (neither detected via DNA analysis but likely present in low abundances). DNA metabarcoding revealed the presence of roach, perch, pike, rudd, tench, bream (*Abramis brama*) and ten-spined stickleback (*Pungitius pungitius*) (**Appendix C**).

Plate 3.5 Representative image of site L3 at Coolagh Lough Upper, September 2023

3.1.6 Site L4 – Coolagh Lough (lower)

Site L4 was located at Coolagh Lough Lower[2], a 2.9ha elliptical lake connected to the River Corrib via a narrow, maintained channel. A fisheries appraisal of site L4 indicated the site was of high value for coarse fish species. Pike, perch and juvenile roach were observed in the margins. The lake was considered a good quality coarse fish habitat (despite the high average depth) and had suitability for both European eel and brown trout given connectivity to the River Corrib (neither detected via DNA analysis but likely present in low abundances). DNA metabarcoding revealed the presence of roach, perch, pike, rudd, tench, bream and ten-spined stickleback (**Appendix C**).

[1] At higher water levels the upper and lower lakes at Coolagh join (Triturus pers. obs.)

Plate 3.6 Representative image of site L4 at Coolagh Lough Lower, September 2023

3.1.7 Site L5 – unnamed pond, Menlo

Site L5 was located at a small 0.1ha elliptical lake adjoining Coolagh Lough Upper. A fisheries appraisal of site L5 indicated the site was of high value for coarse fish species. Pike and roach were observed in the margins. The pond was considered a good quality coarse fish habitat (good spawning & nursery) and had suitability for European eel which were detected via eDNA sampling (**Appendix C**). Suitability for brown trout was low given poor connectivity to the River Corrib although the species was detected via eDNA sampling (**Appendix C**).

Plate 3.7 Representative image of site L5 at an unnamed lake, Menlo, September 2023

Knocknacarra Stream hydrological catchment

3.1.8 Site C1 – Knocknacarragh Stream, Letteragh

No fish were recorded via electro-fishing at site C1 on the uppermost reaches of the Knocknacarragh Stream (31K16). The stream at this location was not of fisheries value given its location in the uppermost reaches of the small, modified, heavily silted near stagnant channel.

Plate 3.8 Representative image of site C1 on the Knocknacarragh Stream, August 2023

3.1.9 Site C2 – Knocknacarragh Stream, Rahoon

Site C2 was located on the Knocknacarragh Stream (31K16) at Bóthar Dhiarmada. Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.9 Representative image of site C2 on the Knocknacarragh Stream, August 2023 (culverted underground)

3.1.10 Site C3 – Knocknacarragh Stream, Rahoon

Site C3 was located on the Knocknacarragh Stream (31K16). Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.10 Representative image of site C3 on the Knocknacarragh Stream, August 2023 (culverted underground)

3.1.11 Site C4 – Knocknacarragh Stream, Rahoon

Site C4 was located on the Knocknacarragh Stream (31K16). Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.11 Representative image of site C4 on the Knocknacarragh Stream, August 2023 (culverted underground)

3.1.12 Site C5 – Knocknacarragh Stream, Rahoon

Site C5 was located on the Knocknacarragh Stream (31K16). Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.12 Representative image of site C5 on the Knocknacarragh Stream, August 2023 (culverted underground)

3.1.13 Site C6 – unnamed channel, Rahoon

No fish were recorded via electro-fishing at site C6 on the upper reaches of an unnamed Knocknacarragh Stream tributary. The small stream was not of fisheries value given its shallow (likely ephemeral) nature, historical modifications, poor hydromorphology and poor connectivity with downstream habitats.

Plate 3.13 Representative image of site C6 on an unnamed Knocknacarragh Stream tributary, August 2023

3.1.14 Site C7 – unnamed stream, Rahoon

Site C7 was located on located on an unnamed Knocknacarragh Stream tributary. Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.14 Representative image of site C7 on an unnamed stream, August 2023 (culverted underground)

3.1.15 Site C8 – Knocknacarragh Stream, Rahoon

Site C8 was located on the Knocknacarragh Stream (31K16). Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible.

Plate 3.15 Representative image of site C8 on the Knocknacarragh Stream, August 2023 (culverted underground)

3.1.16 Site C9 – Tonabroky Stream, Árd na Gaoithe

Site C9 was located on the uppermost reaches of the Tonabroky Stream (31T13). Given underground culverting and or a dry channel (L5020 road crossing), the site was not of fisheries value.

Plate 3.16 Representative image of site C9 on the Tonabroky Stream, August 2023 (culverted underground)

Bearna Stream hydrological catchment

3.1.17 Site D1 – Bearna Stream, Ballynahown East

Three-spined stickleback (*Gasterosteus aculeatus*) (*n*=18) were the only fish species recorded via electro-fishing at site D1 on the upper reaches of the Bearna Stream (31B01) (**Figure 3.1**).

Apart from moderate densities of stickleback, the stream was of poor fisheries value given extensive historical modifications (especially downstream of survey point), poor flows, siltation and poor connectivity with downstream habitats. However, there was some low suitability for European eel (although the species was not recorded).

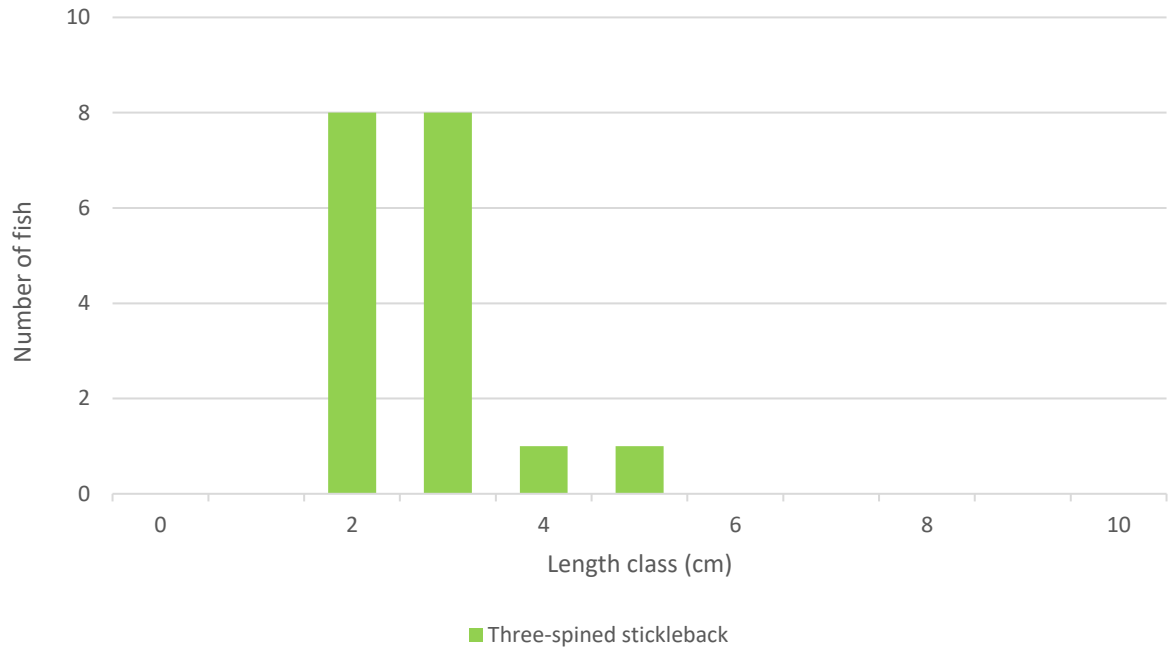


Figure 3.1 Length frequency distribution recorded via electro-fishing at site D1 on the Bearna Stream, August 2023

Plate 3.17 Representative image of site D1 on the Bearna Stream, August 2023

3.1.18 Site D2 – Bearna Stream, Ballynahown East

Brown trout (*Salmo trutta*) (*n*=13) and European eel (*Anguilla anguilla*) (*n*=3) were the only fish species recorded via electro-fishing at site D2 on the Bearna Stream (31B01) (**Figure 3.2**).

The site was evidently of value as a salmonid nursery supporting a good density of juvenile brown trout for a small stream, with cobble-dominated glide and tree roots providing refugia. These habitat

characteristics also provided some suitability for European eel which were present in low densities. The site was of poor value as a holding area given its shallow nature although good quality spawning habitat was widespread. The high energy site was unsuitable for lamprey and none were recorded.

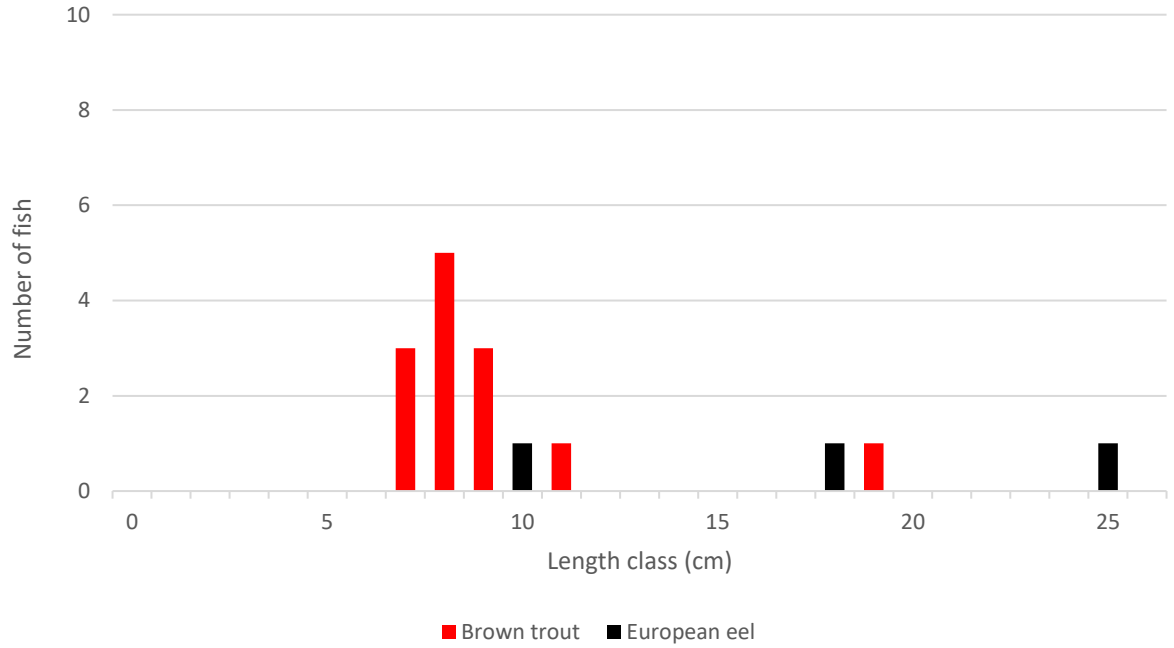


Figure 3.2 Length frequency distribution recorded via electro-fishing at site D2 on the Bearna Stream, August 2023

Plate 3.18 Juvenile brown trout recorded at site D2 on the Bearna Stream, August 2023

3.1.19 Site D3 – Bearna Stream, Cappagh

Brown trout (*n*=9) and European eel (*n*=1) were the only fish species recorded via electro-fishing at site D3 on the Bearna Stream (31B01) (**Figure 3.3**).

The site was of value as a salmonid nursery supporting a moderate density of juvenile brown trout. The site was of poor value as a salmonid holding area given its shallow nature. However, good quality spawning habitat was frequent given the presence of clean gravels. Suitability for European eel was moderate (limited refugia) with low densities recorded. The high energy site was unsuitable for lamprey and none were recorded. The Cappagh Road culvert crossing was considered to be a barrier to fish under low flows (**Plate 3.14**).

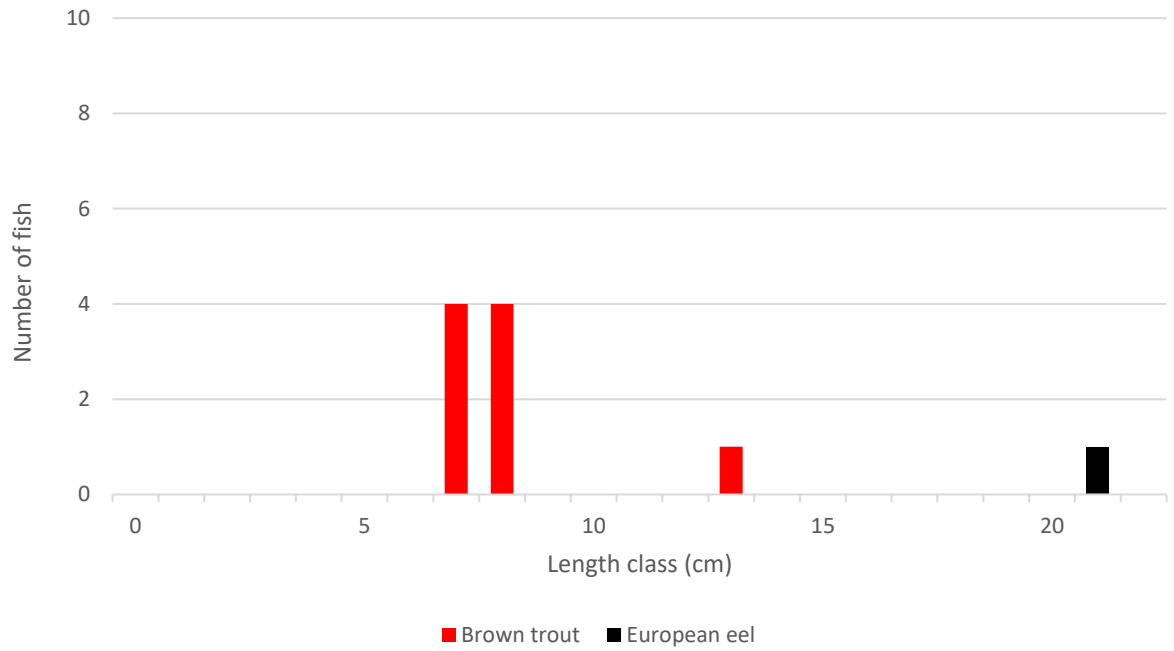


Figure 3.3 Length frequency distribution recorded via electro-fishing at site D3 on the Bearna Stream, August 2023

Plate 3.19 Instream barrier to fish passage (road culvert) at site D3 on the Bearna Stream, August 2023

3.1.20 Site D4 – Oddacres Stream, Cappagh

Brown trout (*n*=21) and European eel (*n*=4) were the only fish species recorded via electro-fishing at site D4 on the Oddacres Stream (31O05) (**Figure 3.4**).

The site was of high value for salmonids, supporting a healthy mixed-cohort population of brown trout. The stream at this location was a high quality nursery with abundant instream, bryophyte-rich refugia. Good quality spawning habitat was also present by way of clean mixed gravels (although limited in extent). Occasional deeper glide and pool, in addition to undercut banks, provided valuable thermal refugia and holding areas for adult salmonids. These areas also provided suitable refugia for European eel, which were recorded in low densities. The upland stream was unsuitable for lamprey (none recorded).

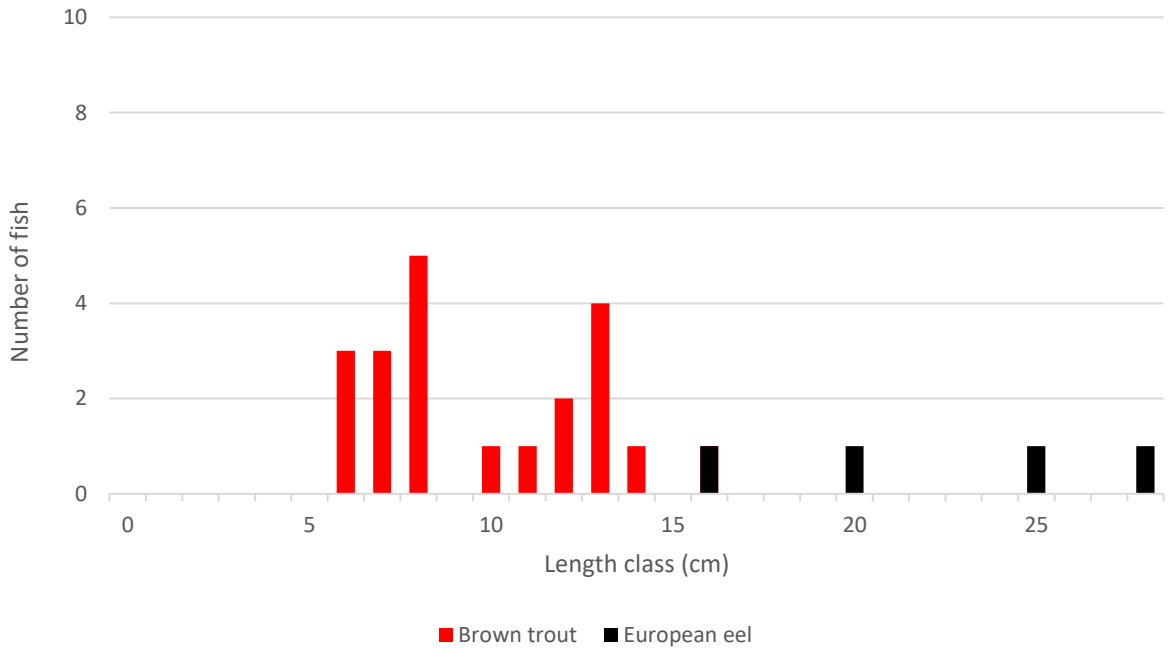


Figure 3.4 Length frequency distribution recorded via electro-fishing at site D4 on the Oddacres Stream, August 2023

Plate 3.20 Mixed cohort brown trout recorded at site D4 on the Oddacres Stream, August 2023

3.1.21 Site D5 – Loughinch Stream, Aille

No fish were recorded via electro-fishing at site D5 on the Loughinch Stream (31L26). The small stream was not of fisheries value given its shallow (likely ephemeral) nature, historical modifications, poor hydromorphology and poor connectivity with downstream habitats (supporting salmonids).

Plate 3.21 Representative image of site D5 on the Loughinch Stream, August 2023

3.1.22 Site D6 – Bearna Stream, Cappagh Park

Sea trout (*n*=2), brown trout (*n*=61) and European eel (*n*=17) were recorded via electro-fishing at site D6 on the lower reaches of the Bearna Stream (31B01) (**Figure 3.5**).

The site was of very high value for salmonids, supporting a high density healthy mixed cohort brown trout population in addition to a low density of sea trout. The site was of highest value as a salmonid nursery, with abundant instream cobble and boulder refugia. Salmonid spawning habitat was good locally but larger substrata predominated. Deep glide upstream of the bridge apron provided valuable holding habitat for adult salmonids (including sea trout). The site was also of high value for European eel given abundant instream refugia and good connectivity to the sea (0.5km downstream). The high energy site was unsuitable for lamprey with no discernible lamprey ammocoetes burial habitat.

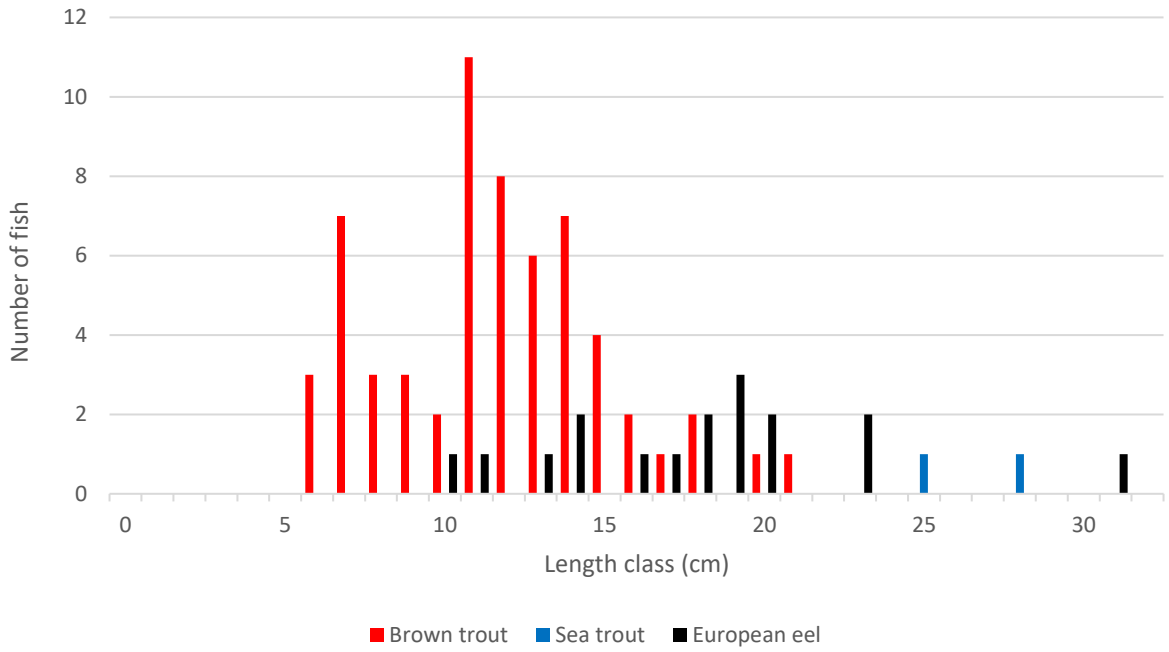


Figure 3.5 Length frequency distribution recorded via electro-fishing at site D6 on the Bearna Stream, August 2023

Plate 3.22 Sea trout recorded at site D6 on the Bearna Stream, August 2023

Trusky Stream hydrological catchment

3.1.23 Site E1 – Cloghscoltia Stream, Trusky East

Brown trout (*n*=2) was the only fish species recorded via electro-fishing at site E1 on the Cloghscoltia Stream (31C36). (**Figure 3.6**).

The site was of poor fisheries value, with only a single adult trout captured. The stream suffered from low flows and had poor spawning and nursery habitat. Localised pools associated with natural cascades and or adjoining pipe culverts were of some holding value for adult salmonids. There was also some suitability for European eel (frequent boulder refugia) although none were recorded. The upland stream was unsuitable for lamprey with no suitable spawning and or ammocoetes burial habitat.

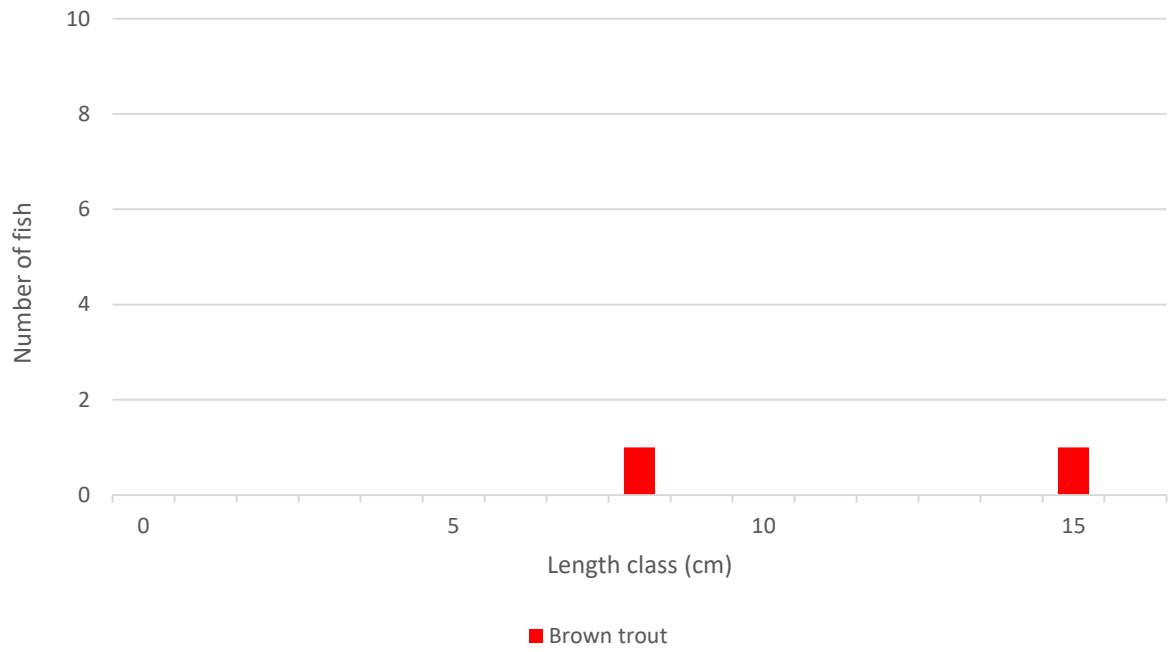


Figure 3.6 Length frequency distribution recorded via electro-fishing at site E1 on the Cloghscoltia Stream, August 2023

Plate 3.23 Adult brown trout recorded at site E1 on the Cloghscoltia Stream, August 2023

3.1.24 Site E2 – Trusky Stream, Trusky West

Site E3 was located on the upper reaches of the Trusky Stream (31B02). The small stream was not of fisheries value given its evidently ephemeral nature, historical modifications, poor hydromorphology and poor connectivity with downstream habitats.

Plate 3.24 Representative image of site E2 on the Trusky Stream, August 2023

3.1.25 Site E3 – Trusky Stream, Trusky East

Site E3 was located on the upper reaches of the Trusky Stream (31B02). Given the dry, ephemeral nature of the stream at this location, the channel was not of fisheries value. Given historical modifications, poor connectivity with downstream habitats and the location in the upper reaches, the stream was not capable of supporting resident fish.

Plate 3.25 Representative image of site E3 on the Trusky Stream, August 2023 (dry channel)

3.1.26 Site E4 – Freeport Stream, Trusky West

No fish were recorded via electro-fishing at site E4 on the upper reaches of the Freeport Stream (31F04). The small stream was not of fisheries value given historical modifications, poor flows and tenuous connectivity with downstream habitats.

Plate 3.26 Representative image of site E4 on the Freeport Stream, August 2023

3.1.27 Site E5 – Trusky Stream, Freeport

Brown trout (*n*=1), European eel (*n*=10), flounder (*Platichthys flesus*) (*n*=13) and three-spined stickleback (*n*=14) were recorded via electro-fishing at site E5 on the lowermost freshwater reaches of the Trusky Stream (31B02), (**Figure 3.7**).

The site was of moderate value only for salmonids given the shallow nature of the stream. However, there was some limited value as a nursery with localised areas providing good quality spawning substrata. The site was of highest value as a European eel and flounder nursery given abundant cobble and boulder refugia and good connectivity to marine habitats.

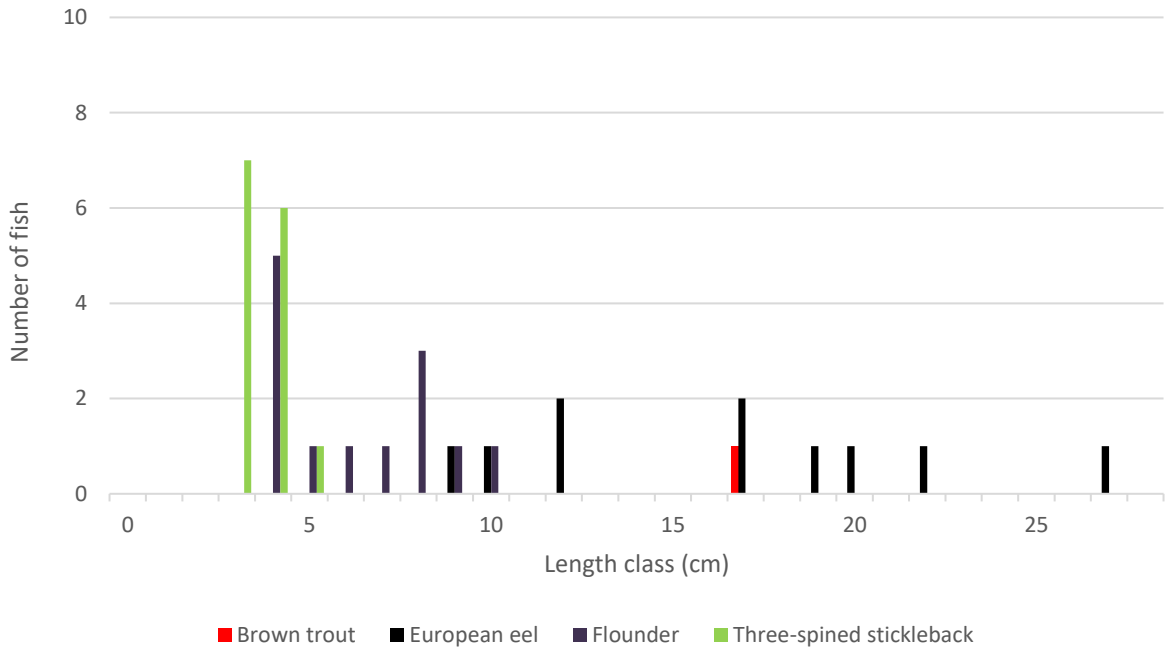


Figure 3.27 Length frequency distribution recorded via electro-fishing at site E5 on the Trusky Stream, August 2023

Plate 3.27 Three-spined stickleback and juvenile flounder recorded at site E5 on the Trusky Stream, August 2023

Sruthán Na Libeirtí Stream hydrological catchment

3.1.28 Site F1 – Sruthán Na Libeirtí Stream, Forramoyle West

Three-spined stickleback (*n*=5) were the only fish recorded via electro-fishing at site F1 on the uppermost reaches of the Sruthán Na Libeirtí Stream (34F01) (**Figure 3.8**).

Apart from low densities of stickleback, the stream was of poor fisheries value given extensive historical modifications, poor flows, siltation and poor connectivity with downstream habitats. However, there was some low suitability for European eel (although the species was not recorded).

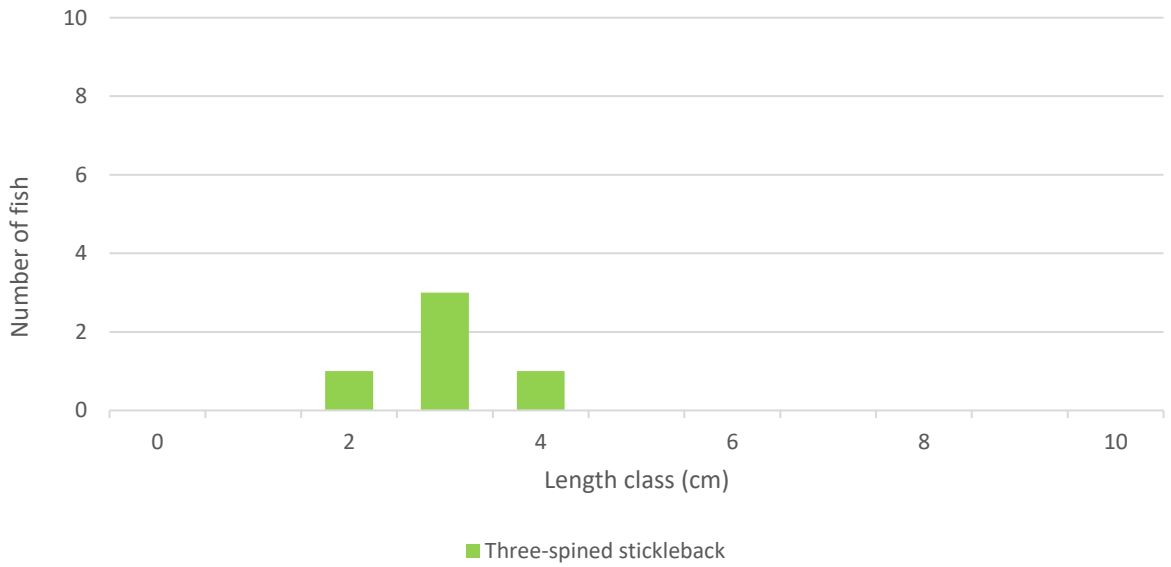


Figure 3.8 Length frequency distribution recorded via electro-fishing at site F1 on the Sruthán Na Libeirtí Stream, August 2023

Plate 3.28 Representative image of site F1 on the Sruthán Na Libeirtí Stream, August 2023

3.1.29 Site F2 – Sruthán Na Libeirtí Stream, Forramoyle West

No fish were recorded via electro-fishing at site F2 on the Sruthán Na Libeirtí Stream (34F01). The small stream was not of fisheries value given poor hydromorphology, poor flows and tenuous connectivity with downstream habitats.

Plate 3.29 Representative image of site F2 on the Sruthán Na Libeirtí Stream, August 2023

3.1.30 Site F3 – Sruthán Na Libeirtí Stream, Forramoyle West

European eel was the only fish species recorded via electro-fishing at site F4 on the lowermost reaches of the Sruthán Na Libeirtí Stream (34F01) (**Figure 3.9**).

Despite this, the site was of poor fisheries value given its shallow, narrow, modified nature and poor connectivity with downstream marine habitats. The site was not accessible for migratory salmonids.

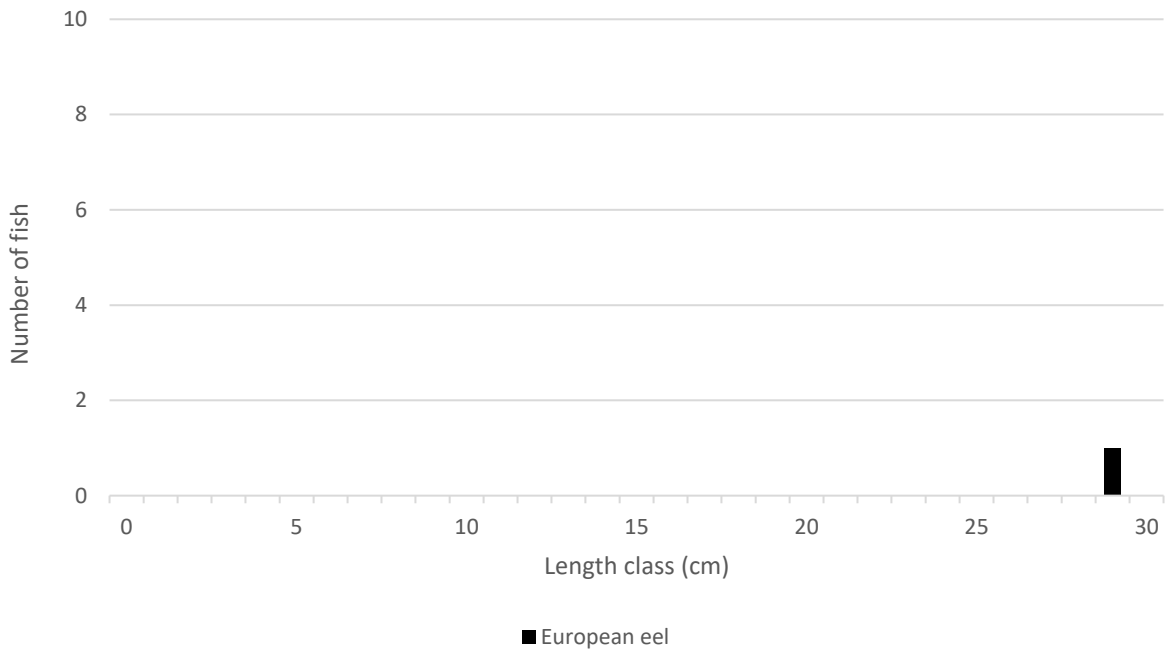


Figure 3.9 Length frequency distribution recorded via electro-fishing at site F3 on the Sruthán Na Libeirtí Stream, August 2023

Plate 3.30 Representative image of site F3 on the Sruthán Na Libeirtí Stream, August 2023, with Galway Bay in the background (not accessible to migratory salmonids)

3.1.31 Site F4 – Newvillage Stream, Forramoyle West

No fish were recorded via electro-fishing at site F4 on the lowermost reaches of the Newvillage Stream (31N03). The small stream was not of fisheries value given a paucity of water, poor hydromorphology and tenuous connectivity with downstream habitats.

Plate 3.31 Representative image of site F4 on the Newvillage Stream, August 2023 (semi-dry channel)

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of the Project via electro-fishing in August 2023 (abundances in parenthesis, **bold** indicates highest density recorded per species)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density per m^2				
				Brown trout	Sea trout	European eel	Three-spined stickleback	Flounder
A1	Merlin Park Stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a
B1	River Corrib	n/a	Too deep for electro-fishing	n/a	n/a	n/a	n/a	n/a
C1	Knocknacarra Stream	5	20	0.000	0.000	0.000	0.000	0.000
C2	Knocknacarra Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C3	Knocknacarra Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C4	Knocknacarra Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C5	Knocknacarra Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C6	Unnamed channel	5	45	0.000	0.000	0.000	0.000	0.000
C7	Unnamed stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C8	Knocknacarragh Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
C9	Tonabroky Stream	n/a	n/a - culverted underground	n/a	n/a	n/a	n/a	n/a
D1	Bearna Stream	10	125	0.000	0.000	0.000	**0.144 (*n*=18)**	0.000
D2	Bearna Stream	10	80	0.163 (*n*=21)	0.000	0.038 (*n*=3)	0.000	0.000
D3	Bearna Stream	5	75	0.120 (*n*=9)	0.000	0.013 (*n*=1)	0.000	0.000
D4	Oddacres Stream	10	160	0.131 (*n*=21)	0.000	0.025 (*n*=4)	0.000	0.000
D5	Loughinch Stream	5	20	0.000	0.000	0.000	0.000	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m²)	Fish density per m²				
				Brown trout	Sea trout	European eel	Three-spined stickleback	Flounder
D6	Bearna Stream	10	260	**0.235 (*n*=61)**	**0.008 (*n*=2)**	**0.065 (*n*=17)**	0.000	0.000
E1	Cloghscoltia Stream	5	80	0.025 (*n*=2)	0.000	0.000	0.000	0.000
E2	Trusky Stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a
E3	Trusky Stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a
E4	Freeport Stream	5	40	0.000	0.000	0.000	0.000	0.000
E5	Trusky Stream	10	180	0.006 (*n*=1)	0.000	0.056 (*n*=10)	0.078 (*n*=14)	**0.072 (*n*=13)**
F1	Sruthán Na Libeirtí Stream	5	50	0.000	0.000	0.000	0.100 (*n*=5)	0.000
F2	Sruthán Na Libeirtí Stream	5	35	0.000	0.000	0.000	0.000	0.000
F3	Sruthán Na Libeirtí Stream	5	50	0.000	0.000	0.020 (*n*=1)	0.000	0.000
F4	Newvillage Stream	5	5	0.000	0.000	0.000	0.000	0.000
L1	Unnamed pond	n/a	Fisheries appraisal only – brown trout & European eel detected via eDNA (Appendix C)					
L2	Ballindooley Lough	n/a	Fisheries appraisal only – perch, rudd, pike, tench & European eel detected via DNA metabarcoding (Appendix C)					
L3	Coolagh Lough (upper)	n/a	Fisheries appraisal only – roach, perch, rudd, pike, tench, bream & ten-spined stickleback detected via DNA metabarcoding (Appendix C)					
L4	Coolagh Lough (lower)	n/a	Fisheries appraisal only – roach, perch, rudd, pike, tench, bream & ten-spined stickleback detected via DNA metabarcoding (Appendix C)					
L5	Unnamed pond	n/a	Fisheries appraisal only – brown trout & European eel detected via eDNA (Appendix C)					

4. Discussion

The watercourses in the vicinity of the Project were typically small upland eroding channels which had been heavily modified (straightened and or deepened) historically, often resulting in poor quality fisheries habitats. Hydromorphological alterations were widespread in the peri-urban landscape and some watercourses, such as the Knocknacarra Stream, were culverted almost entirely underground with a loss of fisheries potential. Over half of the riverine sites (18 no.) supported three-spined stickleback only or (in most cases) no fish species (**Table 3.1**). However, the Bearna Stream (sites D2, D3 & D6), Oddacres Stream (D4), Cloghscoltia Stream (E1) and Trusky Stream (E5) supported salmonid populations. A low diversity of fish species – namely brown trout, sea trout, European eel, three-spined stickleback and flounder – were recorded during the electro-fishing survey (**Table 3.1**). Brown trout, European eel, pike (*Esox lucius*), perch (*Perca fluviatilis*), rudd (*Scardinius erythropthalmus*), roach (*Rutilus rutilus*), bream (*Abramis brama*), tench (*Tinca tinca*) and ten-spined stickleback (*Pungitius pungitius*) were detected from the lake sites using eDNA sampling and metabarcoding (**Appendix C**).

The highest densities of salmonids and the best quality salmonid habitat was present on the Bearna Stream and its tributary the Oddacres Stream. These watercourses retained more semi-natural characteristics than others surveyed and provided good quality salmonid spawning and nursery habitats. The lower reaches of the Bearna Stream (site D6) supported the highest brown trout densities recorded (excellent nursery habitat) and also a low number of anadromous sea trout. Despite some noted suitability in the Bearna Stream, no Atlantic salmon were recorded during the electro-fishing survey, although the River Corrib is a nationally important river for the species.

European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). Eel were widespread in the survey area, being recorded at a total of 6 no. sites on the Bearna Stream (sites D2, D3 & D6), Oddacres Stream (D4), Trusky Stream (E5) and the Sruthán Na Libeirtí Stream (F3) (**Table 3.1**). The species was also detected via eDNA sampling at lake sites L1, L2 and L5 where high quality eel habitat was present (**Appendix C**). As outlined above for salmonids, the Bearna Stream provided the highest quality riverine eel habitat, with an abundance of suitable instream refugia (Laffaille et al., 2003), a wide prey resource and good connectivity to marine environments. Recorded eel densities (electro-fishing) were highest in the lower reaches of the surveyed watercourses, a spatial distribution typically observed in this species (Degerman et al., 2019; Moriarty, 2003). The River Corrib, whilst not surveyed via electro-fishing, is part of one of Ireland's most productive eel catchments (Corrib) (IFI, 2012).

No lamprey were recorded during the survey and this reflected the poor habitat suitability in the survey area. Upland eroding channels such as the Bearna Stream typically provide conditions inimical to lamprey population persistence (as per characteristics provided in Dawson et al., 2015; Aronsuu & Virkkala, 2014; Rooney et al., 2013; Lasne et al., 2010; Goodwin et al., 2008; Gardiner, 2003). However, *Lampetra* sp. ammocoetes (likely brook lamprey) are known from the River Corrib near Quincentennial Bridge (Triturus 2022 data) and, whilst sub-optimal, may be present in low densities in the vicinity of the proposed road crossing at site B1 (backpack electro-fishing not possible due to prohibitive depths). Other survey watercourses provided little to no suitability for lamprey given hydromorphological modifications, siltation pressures and or unsuitable flows.

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Appendix K

Part 2 - Aquatic Baseline Report - 2023

K.2 Part 2 - Aquatic Baseline Report - 2023

Aquatic baseline report for the proposed N6 Galway City Ring Road (GCRR)

Prepared by Triturus Environmental Ltd. for Scott Cawley Ltd.

December 2023

Please cite as:

Triturus (2023). Aquatic baseline report for the proposed N6 Galway City Ring Road (GCRR). Report prepared by Triturus Environmental Ltd. for Scott Cawley Ltd. December 2023.

Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by Scott Cawley Ltd. to conduct baseline aquatic surveys to inform EIAR preparation for the proposed N6 Galway City Ring Road (GCRR) scheme, located in the vicinity of Galway City (**Figure 2.1**). Undertaken on a catchment-wide scale, this report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected species and habitats in the vicinity of the proposed scheme, inclusive of proposed watercourse crossings. Aquatic surveys were undertaken in August and September 2023.

1.2 Scheme description

A full description of the proposed scheme will be provided in any Environmental Impact Assessment Report (EIAR) used to support consenting applications.

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed scheme and associated infrastructure (e.g. bridges) were considered as part of the current assessment. This included riverine watercourses crossed by and in the vicinity of the proposed road layout. A number of lakes (5) adjoining the proposed layout were also surveyed. Thus, a total of *n*=31 sites were selected for detailed aquatic assessment (see **Table 2.1, Figure 2.1** below). The courses and nomenclature for the watercourses surveyed followed both ARUP (2018) and the Environmental Protection Agency (EPA).

Riverine survey sites were present on the River Corrib (EPA code: 30C02), Knocknacarra Stream (31K16), Tonabroky Stream (31T13), Bearna Stream (31B01), Oddacres Stream (31O05), Loughinch Stream (31L26), Cloghscoltia Stream (31C36), Trusky Stream (31B02), Freeport Stream (31F04), Sruthán Na Libeirtí Stream (31F01), Newvillage Stream (31N03) and several unnamed streams (**Table 2.1**). A total of 5 no. lakes were also surveyed, namely Ballindooley Lough and unnamed adjacent pond, Coolagh Lough (upper), Coolagh Lough (lower) and an unnamed lake at Menlo (**Figure 2.1**). The sites were grouped into discreet hydrological catchments as per ARUP (2018) (**Table 2.1; Figure 2.2**).

The aquatic survey sites were located in the Carrowmoneash (Oranmore)_SC_010, Corrib_SC_010 and Knock[Furbo]_SC_010 river sub-catchments within hydrometric areas 30 (Corrib) and 31 (Galway Bay North). The proposed scheme and associated infrastructure was not located within a European site although there was a proposed road crossing of the River Corrib (at Menlo) located within the Lough Corrib SAC (000297).

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

2.2 Aquatic site surveys

Aquatic surveys of the riverine watercourses within the vicinity of the proposed scheme were conducted on the 29th, 30th and 31st August 2023. Lake survey sites were undertaken on the 1st, 7th and 8th September 2023. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (**Table 2.1**). Surveys at each of these sites included a fisheries assessment (electro-fishing and or fisheries habitat appraisal), white-clawed crayfish survey, macrophyte and aquatic bryophyte survey and (where suitable) biological water quality sampling (Q-sampling) or macro-invertebrate sweep sampling (**Figure 2.1**). Environmental eDNA was also collected to support these surveys by helping detect cryptic species in addition to profiling fish assemblages at the lake sites using metabarcoding. This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed scheme and ensured that any habitats and species of high conservation value would be detected to best inform mitigation.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish

Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). This broad characterisation helped define the watercourses' conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth, channel form) including associated evidence of historical drainage
- Substrate type and relative condition, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type at riverine sites by proportion of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition and bordering land use practices

2.3 Fisheries assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed N6 GCRR in August and September 2023 following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The survey was undertaken in accordance with best practice (CEN, 2003; CFB, 2008) and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the aquatic survey sites, inclusive of 5 no. lake sites (**Figure 2.1**), was undertaken to establish their importance for salmonid, lamprey, European eel (*Anguilla anguilla*) 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. The fisheries appraisal for the lakes was accompanied by eDNA lake metabarcoding to profile the fish stocks (**Figure 2.5**). For detailed fisheries survey methodology, please refer to the 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 August-September 2023 under a National Parks and Wildlife (NPWS) open national licence (no. C24/2023), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2023), to capture and release crayfish to their site of capture. As per Inland Fisheries Ireland aquatic biosecurity recommendations, the crayfish sampling started at the uppermost site(s) of the catchment/sub-catchments in the survey area to minimise the risk of transfer invasive propagules (including crayfish plague) in an upstream direction.

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

Table 2.1 Location of *n*=31 aquatic survey sites in the vicinity of the proposed N6 GCRR

Site no.	Watercourse	EPA name (if different)	EPA code	Location	Hydrological catchment (ARUP, 2018)	X (ITM)	Y (ITM)
Riverine sites							
A1	Merlin Park Stream	Unnamed stream	n/a	Merlin Park Woods	8. Doughiska	533925	726166
B1	River Corrib		30C02	Menlough	5. Corrib catchment	528509	727739
C1	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1000 road crossing, Letteragh	4. Knocknacarra Stream	527224	726361
C2	Knocknacarra Stream	Knocknacarragh Stream	31K16	Diarmuid Road, Rahoon	4. Knocknacarra Stream	527080	725981
C3	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1016 road crossing, Rahoon	4. Knocknacarra Stream	527119	725675
C4	Knocknacarra Stream	Knocknacarragh Stream	31K16	Rahoon	4. Knocknacarra Stream	527051	725429
C5	Knocknacarra Stream	Knocknacarragh Stream	31K16	L1013 road crossing, Rahoon	4. Knocknacarra Stream	526908	725069
C6	Unnamed channel		n/a	Rahoon	4. Knocknacarra Stream	526664	726015
C7	Unnamed stream		n/a	Rahoon	4. Knocknacarra Stream	526857	725099
C8	Knocknacarra Stream	Knocknacarragh Stream	31K16	Rahoon	4. Knocknacarra Stream	526546	724905
C9	Tonabroky Stream		31T13	Árd na Gaoithe	4. Knocknacarra Stream	525881	725754
D1	Bearna Stream		31B01	Ballynahown East	3. Bearna Stream	525105	725457
D2	Bearna Stream		31B01	Ballynahown East	3. Bearna Stream	524885	725235
D3	Bearna Stream		31B01	L5025 road crossing, Cappagh	3. Bearna Stream	524614	724671
D4	Oddacres Stream		31O05	Cappagh	3. Bearna Stream	524210	724825
D5	Loughinch Stream		31L26	Aille	3. Bearna Stream	524107	724716
D6	Bearna Stream		31B01	Cappagh Park	3. Bearna Stream	524520	724142
E1	Cloghscoltia Stream		31C36	L1321 road crossing, Trusky East	2. Trusky Stream	523113	724239
E2	Trusky Stream		31B02	Trusky West	2. Trusky Stream	522343	724022

Site no.	Watercourse	EPA name (if different)	EPA code	Location	Hydrological catchment (ARUP, 2018)	X (ITM)	Y (ITM)
E3	Trusky Stream		31B02	Trusky East	2. Trusky Stream	522806	723828
E4	Freeport Stream		31F04	L5387 road crossing, Trusky West	2. Trusky Stream	522153	723615
E5	Trusky Stream		31B02	Freeport	2. Trusky Stream	523212	722842
F1	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	L5386 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521565	723838
F2	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	Forramoyle West	1. Sruthán Na Libeirtí	521449	723337
F3	Sruthán Na Libeirtí Stream	Forramoyle West Stream	31F01	R336 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521064	722522
F4	Newvillage Stream		31N03	R336 road crossing, Forramoyle West	1. Sruthán Na Libeirtí	521512	722578
Lake sites							
L1*	Unnamed pond		30_507	Ballindooley	5. Corrib catchment	531246	728620
L2*†	Ballindooley Lough		30_506	Ballindooley	5. Corrib catchment	531488	728882
L3*†	Coolagh Lough (upper)		30_290	Coolagh	5. Corrib catchment	529300	727849
L4*†	Coolagh Lough (lower)		30_290	Coolagh	5. Corrib catchment	529392	727442
L5*	Unnamed pond		30_510	Menlough	5. Corrib catchment	529222	727716

*eDNA sampling for white-clawed crayfish, crayfish plague, European eel & smooth newt

† eDNA metabarcoding for all fish species

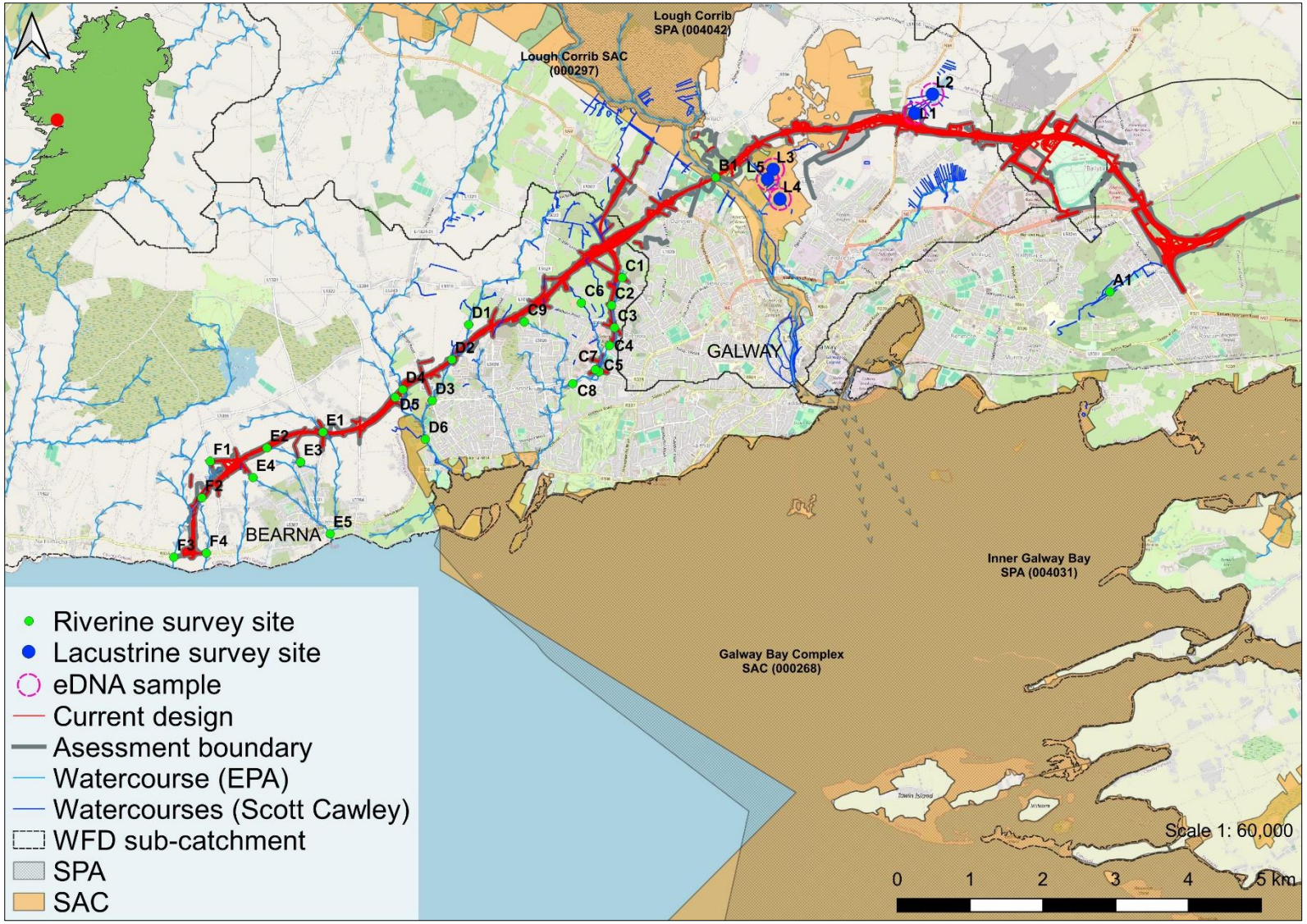

Figure 2.1 Overview of the aquatic survey sites in the vicinity of the proposed N6 GCRR

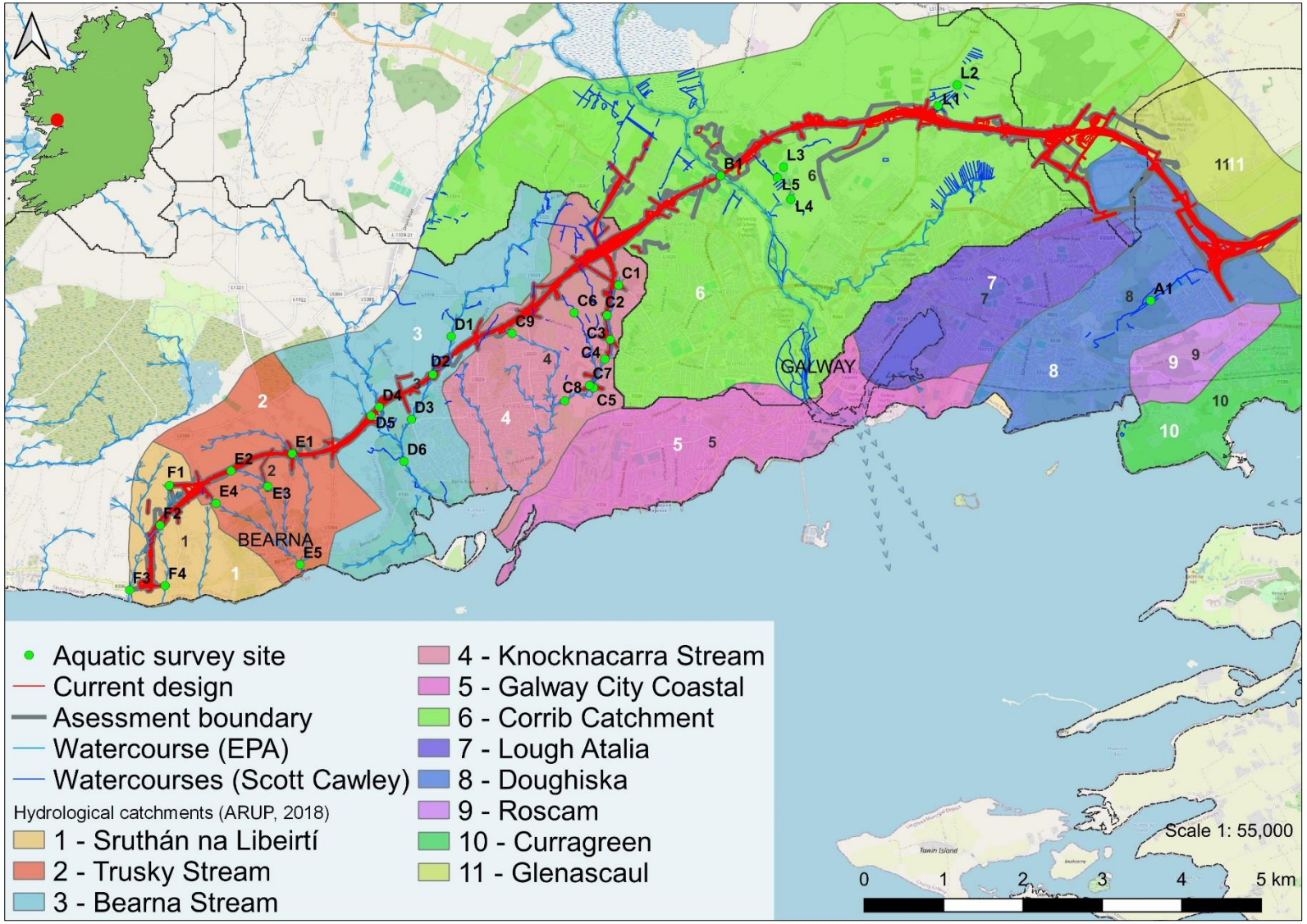

Figure 2.2 Overview of the aquatic survey sites and respective hydrological catchments (as per ARUP, 2018)

2.5 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of high conservation value species within the study area, composite water samples were collected from lake sites L1, L2, L3, L4 and L5 and analysed for white-clawed crayfish, crayfish plague (*Aphanomyces astaci*), European eel and smooth newt (*Lissotriton vulgaris*) environmental DNA (eDNA) (**Figure 2.1**).

Given the paucity of fisheries data, composite eDNA metabarcoding[1] samples were also collected from Ballindooley Lough (L1), Coolagh Lough (upper) (L2) and Coolagh Lough (lower) (L3) to provide a complete list of all fish species present at each site. This metabarcoding approach utilises fish environmental DNA to establish the full spectrum of fish species present that can be missed by other sampling methods.

In accordance with best practice, a composite (4000ml) water sample was collected by walking the entire perimeter of each lake site, thus maximising the geographic spread at the site and increasing the chance of detecting the target species' DNA. The composite sample was then filtered and fixed (preserved) on site using a sterile proprietary eDNA sampling kit, with the filter volume recorded for each site (1000ml). The fixed sample was stored, in the dark, at room temperature and sent to the laboratory for analysis within 48 hours of collection. DNA from each filter was extracted in the lab using a commercial DNA extraction kit with a protocol modified to increase DNA yields. DNA was purified to remove inhibitors using a commercial purification kit. Purified DNAs were amplified with polymerase chain reaction (PCR) for a hypervariable region of the 12S rRNA gene to target fish within each sample. A total of *n*=12 PCR replicates were analysed for each lake site. Please refer to **Appendix C** for full eDNA laboratory analysis methodology.

2.6 Biological water quality (Q-sampling)

The 27 no. riverine survey sites were assessed for biological water quality through Q-sampling in August to September 2023 (**Table 2.1**). All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, as per Environmental Protection Authority (EPA) methodology (Feeley et al., 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley et al., 2020). Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification to species level. Samples were converted to Q-ratings as per Toner et al. (2005) and assigned to WFD status classes (**Table 2.2**). 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).

[1] Metabarcoding entails using high throughput sequencing (HTS) to determine the sequence information from a pool of genetic material, which can then be linked to a DNA barcode database, hence the name metabarcoding (Deiner et al., 2017). In contrast to eDNA sampling (maximum of 4 specified species per sample), metabarcoding analyses entire taxonomic groups (e.g. fish) and provides a complete list of all species detected within a sample

Table 2.2 Reference categories for EPA Q-ratings (Q1 to Q5) (Toner et al., 2005)

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

2.7 Lake macro-invertebrate communities

The 5 no. lake sites were sampled for macro-invertebrates via sweep netting in September 2023. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes and submerged vegetation to capture macro-invertebrates. The net was also moved along the lake bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats.

2.8 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the survey sites, with specimens collected (by hand or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species listed under the Flora (Protection) Order, 2022 and or Irish Red list for vascular plants (Wyse-Jackson et al., 2016) or habitats corresponding to the Annex I habitats, e.g., 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses [3260]' (more commonly referred to as 'floating river vegetation').

2.9 Otter signs

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

2.10 Aquatic ecological evaluation

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

2.11 Biosecurity

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

3. Desktop review

3.1 Fisheries asset of the survey area

The River Corrib is a nationally important Atlantic salmon habitat and is ranked 8th in Ireland with regards to fluvial accessible habitat to salmon (McGinnity et al., 2003). The River Corrib was not surveyed during catchment wide surveys carried out during 2020 as part of the National Research Survey Programme that informs WFD assessment (Gordon et al., 2021), and thus limited data exists for the river between Lough Corrib and the Galway Weir based on recent fisheries survey data. However, coarse fish species including pike (*Esox lucius*), perch (*Perca fluviatilis*) and invasive roach (*Rutilus rutilus*) are known from the lower River Corrib (pers. obs.). Both sea lamprey (*Petromyzon marinus*) and brook lamprey (*Lampetra planeri*) are known to occur in the River Corrib catchment (hydrometric area 30) with sea lamprey being known to spawn below the Galway weir (Igoe et al., 2004). Low densities of *Lampetra* sp. (likely brook lamprey given downstream barriers) were recorded by Triturus during September 2022 at Terryland on the east bank of the River Corrib downstream of Quincentennial Bridge. This was considered the first evidence of larval *Lampetra* sp. in the River Corrib downstream of Lough Corrib.

The Knocknacarra Stream is typically of poor fisheries value but is known to support European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) in its lower reaches (Triturus, 2018). The Trusky Stream is known to support these species in addition to brown trout (*Salmo trutta*) and flounder (*Platichthys flesus*) (Triturus, 2018). The Bearna Stream and Tonabrocky Streams are known to support brown trout, with European eel also present in the Bearna Stream (Triturus, 2018). The Sruthán na Libeirtí Stream near Bearna is known to support European eel (Triturus, 2018).

Ballindooley Lough is known to support a range of coarse fish species including tench (*Tinca tinca*), rudd (*Scardinius erythropthalmus*), pike (*Esox lucius*) and perch (*Perca fluviatilis*) (Triturus, 2018). The Coolagh Loughs support perch, roach (*Rutilus rutilus*) and European eel (Triturus, 2018).

Fisheries data for the other survey watercourse/waterbodies was not available prior to this survey.

3.2 Protected aquatic species

A comprehensive desktop review of available data from the National Parks and Wildlife Service (NPWS), National Biodiversity Data Centre (NBDC), Inland Fisheries Ireland (IFI), Botanical Society of Britain and Ireland (BSBI), National Crayfish Plague Surveillance Programme (NCPSP), Environmental Protection Agency (EPA) and Triturus databases for the 10km grid squares containing and adjoining the scheme (i.e. M22 & M32) identified only a low number of records for rare and or protected aquatic (freshwater) species within the vicinity of the proposed scheme.

A number of contemporary Annex II otter (*Lutra lutra*) records were available in the vicinity of the proposed scheme (2005-2021 period). Most records were concentrated on the River Corrib and coastal areas (NPWS, EPA & NBDC data; **Figure 3.1**).

A number of contemporary records (2021) were available for smooth newt (*Lissotriton vulgaris*) in grid squares M22 & M32 (**Figure 3.1**).

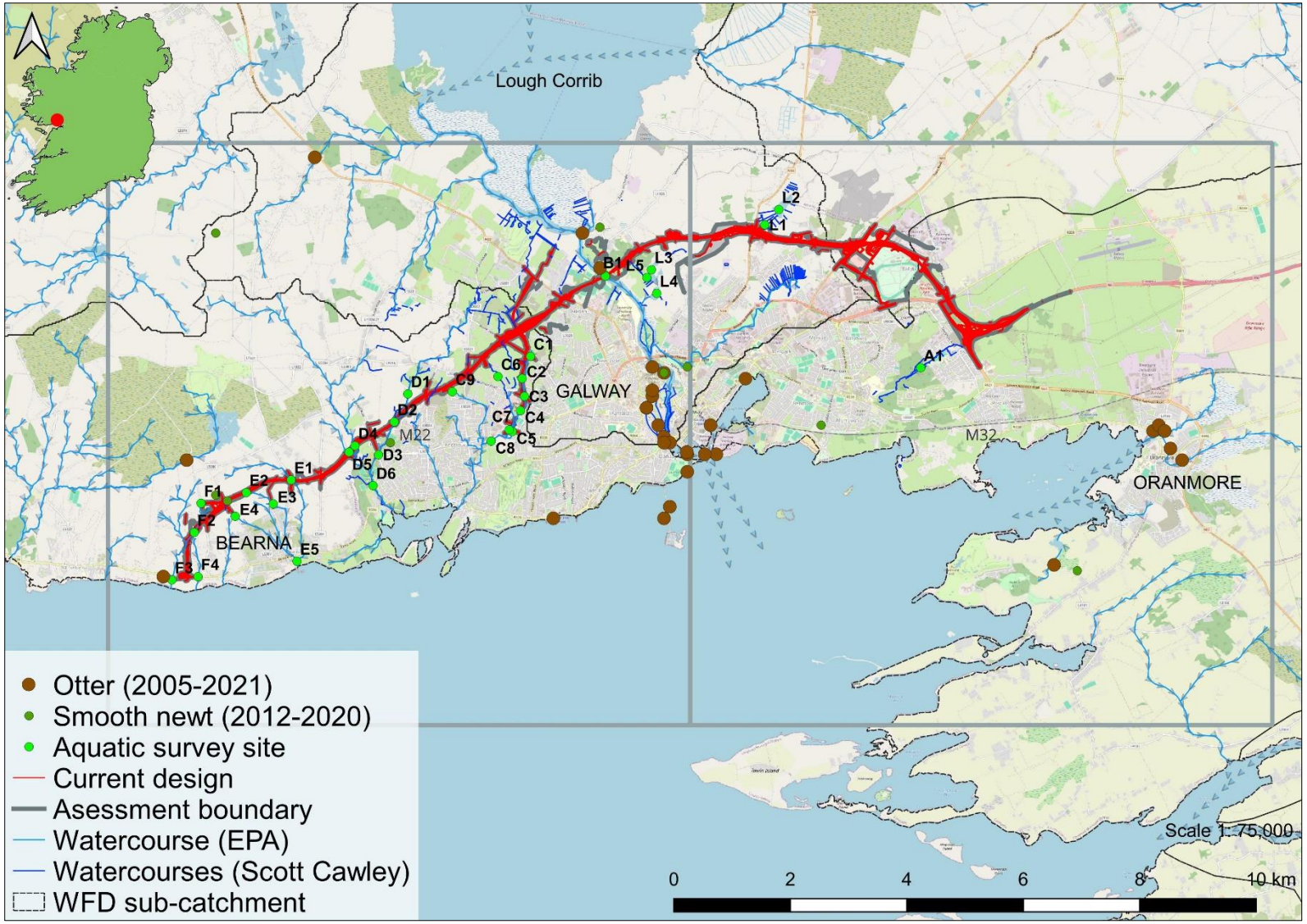

Figure 3.1 Selected protected aquatic species records in the vicinity of the proposed scheme (source: NPWS, NBDC, EPA & Triturus data, 2005-2021)

4. Results of aquatic surveys

The following section summarises each of the *n*=31 survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, white-clawed crayfish and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each riverine sampling site and in **Appendix A**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in August and September 2023. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. A summary of the fish species recorded at each survey site is provided in **Table 4.3**. A summary of the aquatic species and habitats of high conservation concern recorded during the surveys is provided in **Table 4.4**. Aquatic sites have been group into their respective hydrological catchments as per ARUP (2018).

4.1 Aquatic survey sites

Doughiska hydrological catchment

4.1.1 Site A1 – Merlin Park Stream, Merlin Park Woods

Site A1 was located on the Merlin park Stream (no EPA code) in Merlin Park Woods. The channel had been historically straightened and deepened, resulting in a mostly U-shaped channel of up to 3m wide and bank heights of up to 2m locally. The former stream had been dry for some years although supports standing water during wetter periods (pers. obs.). No water was identified during the current survey.

Given the stream was dry at the time of survey, the site was not of fisheries value and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.1 Representative image of the Merlin Park Stream at site A1, August 2023 (dry channel)

Corrib hydrological catchment

4.1.2 Site B1 – River Corrib, Menlo

Site B1 was located on the River Corrib (EPA code: 30C02) at a proposed road crossing near Menlo Castle. The very large lowland river (FW2: Fossitt, 2000) had been heavily modified historically and was 90m wide and between 1-5m deep with deep with slow-flowing glide habitat dominating. The channel sloped gently on the eastern bank with a steeper drop off on the western bank. The substrata along the margins comprised compacted large boulder, cobble and mixed gravels. The coarse substrata offered limited capacity for prolific macrophyte settlement given the absence of any significant deposition of fines. However, over the wider channel width a moderate diversity community was recorded in fragmented patches. The west bank supported scattered emergent common clubrush (*Schoenoplectus lacustris*) with patches of occasional rigid hornwort (*Ceratophyllum demersum*), spiked water milfoil (*Myriophyllum spicatum*), perfoliate pondweed (*Potamogeton perfoliatus*) and fennel pondweed (*Stuckenia pectinata*). Deeper water supported occasional shining pondweed (*Potamogeton lucens*) that became more abundant adjoining the marginal stands of reed swamp vegetation c.250m downstream of the proposed crossing. Given the presence of several indicator species (EC, 2013), the pondweed-dominated community was considered representative of the Annex I qualifying interest habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]'. However, while the habitat was fragmented near the proposed crossing it was more extensive downstream. The stoneworts *Chara virgata* and *Chara vulgaris* were also recorded occasionally, sprawling on the littoral shelf zone in addition to the invasive Canadian pondweed (*Elodea canadensis*). The east bank supported occasional emergent spike rush (*Eleocharis palustris*) on the rocky shoreline with shoreweed (*Littorella uniflora*) submerged in gaps between rocks along the very shallow sloping shoreline. Alternate water milfoil (*Myriophyllum alterniflorum*) was locally frequent on the drop off zone of this shelf area. Water starwort (*Callitriche* spp.) and bladderwort (*Utricularia* sp.) were recorded as rare.

Electro-fishing was not undertaken at the site given prohibitive depths and water volumes. However, a fisheries appraisal was completed. The typically rocky bed and slow-flowing deep glide did not offer good salmonid nursery characteristics with spawning habitat also poor given the very compacted bed. Holding habitat for adult salmonids was moderate and the site was more characteristic of a migratory passageway for improved spawning in the tributaries of Lough Corrib (e.g. Owenriff River etc.) rather than an important transitory resting habitat. The European eel and coarse fish value was moderate with improved habitat upstream at Lough Corrib. No white-clawed crayfish were recorded via sweep netting and hand searching of instream refugia. Despite good foraging suitability, no otter signs were recorded in vicinity of the site.

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

Plate 4.2 Representative image of site B1 on the River Corrib at Menlo, August 2023

4.1.3 Site L1 – unnamed pond, Ballindooley

Site L1 was a small unnamed pond adjacent to Ballindooley Lough. The small 0.35ha elliptical pond was connected to Ballindooley Lough via several drainage channels. The pond had a high average depth, ranging from 1.5m in the margins to 4m in the central basin. The pond featured peat stained water with dense reed fringed littorals and steep marginal slopes. The margins supported abundant common reed (*Phragmites australis*) with occasional common clubrush. The littorals also supported occasional *Chara globularis* along the south eastern shoreline. Bladderwort (*Utricularia* sp.) was recorded locally in the margins along with lesser marshwort (*Apium inundatum*). Invasive Canadian pondweed was locally frequent along the shelf zone with yellow water lily (*Nuphar lutea*) being locally frequent. Water plantain and lesser water plantain (*Baldellia ranunculoides*) were present but rare. The pond was bordered by lowland blanket bog (PB3).

A fisheries appraisal of the pond indicated the site was of high value for coarse fish species. Pike (*Esox lucius*) were observed in the margins with abundant young-of-the-year rudd (*Scardinius erythrophthalmus*) and occasional perch (*Perca fluviatilis*). Tench (*Tinca tinca*) are also known from the lake (pers. obs.). European eel were detected via eDNA sampling (**Table 4.1**). The lake had limited suitability for white-clawed crayfish given the peaty nature of the lake basin and none were recorded during the survey. No otter signs were recorded in vicinity of the site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep sampling.

Plate 4.3 Representative image of site L1, September 2023

4.1.4 Site L2 – Ballindooley Lough, Ballindooley

Site L2 was located at Ballindooley Lough, a 4ha irregular shaped lake in a karstic landscape. The margins shelved steeply from 1.5m to >8m in the central basin. The bed comprised soft sediment with a high clay fraction. The clear water lake was fringed with dense reed swamp habitat (FS1) dominated by common reed with locally frequent great-fen sedge (*Cladium mariscus*). The steep littorals supported abundant *Chara rudis* with frequent *Chara hispida*. The stonewort *Chara globularis* was present but rare. Invasive Canadian pondweed was occasional along the shelf zone with occasional bladderwort (*Utricularia* sp.) in the margins. Common duckweed was rare. Eutrophication pressures were not evident with floating duckweeds and algae largely absent. Given the abundance of stonewort species, the lake was considered an example of the Annex I habitat 'Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]'. The lake was bordered by fen habitat supporting typical species such as black bog rush (*Schoenus nigricans*), marsh cinquefoil (*Comarum palustre*), common sedge (*Carex nigra*), great-fen sedge, purple loosestrife, tormentil (*Potentilla erecta*), Devil's bit scabious (*Succisa pratensis*), water mint and grass-of-Parnassus (*Parnassia palustris*).

A fisheries appraisal of site L2 indicated the site was of high value for coarse fish species. As per site L1, pike were observed in the margins with abundant young-of-the-year rudd and juvenile occasional perch. The lake is also known to support tench and Red-listed European eel (Triturus, 2018). DNA metabarcoding supported the presence of these species (**Table 4.2).** Whilst the lake had some suitability for white-clawed crayfish, none were recorded via hand searching of refugia or eDNA sampling (**Table 4.1**). Despite high suitability, no otter signs were recorded in vicinity of the site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep sampling.

Plate 4.4 Representative image of site L2 at Ballindooley Lough, September 2023 (northern shore)

4.1.5 Site L3 – Coolagh Lough (upper)

Site L3 was located at Coolagh Lough Upper[2], a 4ha crescent-shaped lake connected to the River Corrib. The lake had a high average depth with steeply shelving margins, ranging from 1.5-3m depth in the margins to a maximum depth of c.14m in the central basin. The clear water lake was fringed with dense reed swamp habitat (FS1) dominated by common reed with occasional common clubrush and occasional bulrush. The narrow marginal shelf supported yellow water lily with the stonewort species *Chara rudis* being locally abundant. The invasive Canadian pondweed was occasional. Mare's-tail (*Hippuris vulgaris*) was present in the shallow bay at the northern end of the lake. Eutrophication pressures were evident with abundant filamentous algae on submerged marginal vegetation and abundant ivy-leaved duckweed (*Lemna trisulca*). Great-fen sedge was present in the channel connecting the upper and lower lakes. This channel also supported shining pondweed and perfoliate pondweed locally in addition to frequent fool's watercress. *Chara aculeolata* was present but rare within this connecting channel. Given the abundance of stonewort species, the lake was considered an example of the Annex I habitat 'Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]'. The lake was bordered by reed swamp (FS1) and willow-dominated scrub (WS1).

A fisheries appraisal of site L3 indicated the site was of high value for coarse fish species. Pike, perch and juvenile roach (*Rutilus rutilus*) were observed in the margins. The lake was considered a good quality coarse fish habitat (despite the high average depth) and had suitability for both European eel and brown trout given connectivity to the River Corrib (neither detected via DNA analysis but likely present in low abundances). DNA metabarcoding revealed the presence of roach, perch, pike, rudd, tench, bream (*Abramis brama*) and ten-spined stickleback (*Pungitius pungitius*) (**Table 4.2).** Whilst the lake had some low suitability for white-clawed crayfish, none were recorded via hand searching of

[2] At higher water levels the upper and lower lakes at Coolagh join (Triturus pers. obs.)

refugia or eDNA sampling (**Table 4.1**). No otter signs were recorded in vicinity of the site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep sampling. The invasive zebra mussel was locally frequent at the site (**Appendix B**).

Plate 4.5 Representative image of site L3 at Coolagh Lough Upper, September 2023

4.1.6 Site L4 – Coolagh Lough (lower)

Site L4 was located at Coolagh Lough Lower[2], a 2.9ha elliptical lake connected to the River Corrib via a narrow, maintained channel. As per the upper lake, the lake had a high average depth with steeply shelving margins, ranging from 2-6m depth in the margins to a maximum depth of c.16m in the central basin. The clear water lake was fringed with dense reed swamp habitat (FS1) dominated by common reed with occasional common clubrush and occasional bulrush. The narrow marginal shelf supported yellow water lily and abundant ivy-leaved duckweed with occasional *Chara rudis* and rare *Chara hispida.* Shining pondweed and Canadian pondweed were also occasional. The outflowing channel (to the River Corrib) also supported shining pondweed in addition to perfoliate pondweed, water mint, bog bean (*Menyanthes trifoliata*), fool's watercress and lesser water parsnip (*Berula erecta*). Given the abundance of stonewort species (albeit less than site L3), the lake was considered an example of the Annex I habitat 'Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]'. The lake was bordered by reed swamp (FS1) and willow-dominated scrub (WS1).

A fisheries appraisal of site L4 indicated the site was of high value for coarse fish species. Pike, perch and juvenile roach were observed in the margins. The lake was considered a good quality coarse fish habitat (despite the high average depth) and had suitability for both European eel and brown trout given connectivity to the River Corrib (neither detected via DNA analysis but likely present in low abundances). DNA metabarcoding revealed the presence of roach, perch, pike, rudd, tench, bream and ten-spined stickleback (**Table 4.2).** Whilst the lake had some low suitability for white-clawed

crayfish, none were recorded via hand searching of refugia or eDNA sampling (**Table 4.1**). A well-worn otter slide (with tunnel) through reed swamp vegetation was present in the outflowing channel to the River Corrib (ITM 529257, 727391).

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep sampling. The invasive zebra mussel was locally frequent at the site (**Appendix B**).

Plate 4.6 Representative image of site L4 at Coolagh Lough Lower, September 2023

4.1.7 Site L5 – unnamed pond, Menlo

Site L5 was a small 0.1ha elliptical pond adjoining Coolagh Lough Upper. The pond was shallower than the nearby Coolagh Lakes, ranging from 1m in the margins to 2.5m in the centre. The substrata comprised primarily silt and peat. The clear water pond was fringed by dense reed swamp vegetation dominated by common reed with occasional great-fen sedge and scattered bulrush. The margins were heavily vegetated with abundant yellow water lily and broad-leaved pondweed. Invasive Canadian pondweed was frequent in shallower areas with occasional intermediate water starwort (*Callitriche hamulata*). Whorled water-milfoil (*Myriophyllum verticillatum*) was abundant in the open water and along the shelf zone. *Chara vulgaris* and bog bean were present but rare. The duckweed species *Lemna trisulca* and *Lemna minor* were abundant indicating enrichment pressures. The lake surface featured c.40% cover of green filamentous algae, further indicating strong eutrophication pressures. The lake was bordered by reed swamp (FS1), wet grassland (GS4) and birch woodland.

A fisheries appraisal of site indicated the site was of high value for coarse fish species. Pike and roach were observed in the margins. The pond was considered a good quality coarse fish habitat (good spawning & nursery) and had suitability for European eel which were detected via eDNA sampling (**Table 4.1; Appendix C**). Suitability for brown trout was low given poor connectivity to the River Corrib although the species was detected via eDNA sampling (**Table 4.1**). Whilst the lake had some low

suitability for white-clawed crayfish, none were recorded via hand searching of refugia or eDNA sampling (**Table 4.1**). No otter signs were recorded in vicinity of the site.

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep sampling.

Plate 4.7 Representative image of site L5 at an unnamed pond, Menlo, September 2023

Knocknacarra Stream hydrological catchment

4.1.8 Site C1 – Knocknacarra Stream, Letteragh

Site C1 was located on the uppermost reaches of the Knocknacarra Stream (31K16) at the L1000 road crossing. The small lowland stream (FW2) had been straightened and modified historically with retaining walls present along the west bank and a culvert underneath the local road (leading to a deepened V-shaped channel tunnelled by bramble scrub). The small stream was near stagnant at the time of survey and averaged 1.5m wide and <0.01m deep. The substrata were comprised of deep anoxic silt with scattered boulder originating from an adjoining dry stone wall. The stream was very heavily vegetated with near total cover of watercress (*Nasturtium officinale*) and fool's watercress (*Apium nodiflorum*) with occasional brooklime (*Veronica beccabunga*), water mint (*Mentha aquatica*) and redshank (*Persicaria maculosa*). Common duckweed (*Lemna minor*) was present but rare. Aquatic bryophytes were not present. The riparian zone supported abundant bramble (*Rubus fruticosus* agg.) with scattered hawthorn (*Crataegus monogyna*) and ash (*Fraxinus excelsior*). The small stream emanated from an area of wet grassland (GS4) dominated by rushes (*Juncus* spp.).

No fish were recorded via electro-fishing at site C1 and the stream at this location was not of fisheries value. This was considered given its location in the uppermost reaches of the small, modified, heavily silted and near stagnant channel.

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

Plate 4.8 Representative image of site C1 on the Knocknacarra Stream, August 2023

4.1.9 Site C2 – Knocknacarra Stream, Rahoon

Site C2 was located on the Knocknacarra Stream (31K16) at Bóthar Dhiarmada. The stream had been culverted underground and was not accessible for survey. A small area of wet grassland (seepage) was present in the vicinity of an old track crossing/pipe culvert and this supported fool's watercress, purple loosestrife (*Lythrum salicaria*), willowherbs (*Epilobium* spp.) and rushes. An old dry channel extended southwards from the site (see 4.1.5 below). Invasive Japanese knotweed (*Reynoutria japonica*) and buddleja (*Buddleja davidii*) were locally abundant at the survey site in scrub (WS1) and recolonising waste ground (ED2).

Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible and it was not possible to collect a biological water quality sample.

Plate 4.9 Representative image of site C2 on the Knocknacarra Stream, August 2023 (culverted underground)

4.1.10 Site C3 – Knocknacarra Stream, Rahoon

Site C3 was located on the Knocknacarra Stream (31K16) at the L1016 (Rahoon Road) crossing, approximately 300m downstream of site C2. The stream had been culverted underground and the remnants of an old, intermittent channel were evident in pasture adjacent to the road but this did not contain any water at the time of survey. The stream's course passed under the L1016 road and through an area of dense scrub dominated by gorse (*Ulex europaeus*), buddleja and willow (*Salix* sp.) but no surface water was identified.

Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.10 Representative image of site C3 on the Knocknacarra Stream, August 2023 (culverted underground)

4.1.11 Site C4 – Knocknacarra Stream, Rahoon

Site C4 was located on the Knocknacarra Stream (31K16) at the Miller's Lane road crossing, approximately 300m downstream of site C3. The stream had been culverted underground and was not accessible for survey. The stream's course was through an area of waste ground/scrub dominated by hedge bindweed (*Calystegia sepia*), gorse, willow (*Salix* spp.), bramble and hawthorn.

Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.11 Representative image of site C4 on the Knocknacarra Stream, August 2023 (culverted underground)

4.1.12 Site C5 – Knocknacarra Stream, Rahoon

Site C5 was located on the Knocknacarra Stream (31K16) at the Western Distributor Road (L1013) road crossing adjacent to the An Lógan residential area, approximately 400m downstream of site C4. The stream had been culverted underground and was not accessible for survey. The stream's course was through an area of rough pasture (GS2)/scrub (WS1) upstream of the road crossing and amenity grassland (GA2) downstream.

Given the stream was culverted underground at this location, a fisheries assessment or appraisal was not possible and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.12 Representative image of site C5 on the Knocknacarra Stream, August 2023 (culverted underground)

4.1.13 Site C6 – unnamed channel, Rahoon

Site C6 was located on the upper reaches of an unnamed Knocknacarra Stream tributary. The small upland eroding stream (FW1) had been straightened and deepened historically and flowed under a local access track via a perched pipe culvert. The U-shaped stream was 1.5m wide and 0.1m with banks of up to 2m in height. The profile comprised near stagnant glide with very localised riffle. The substrata were dominated by soft sediment with scattered bedded boulder and cobble near the culvert. The site was very heavily vegetated with abundant watercress and less frequent fool's watercress. Water mint and brooklime were also present locally. The liverwort *Chiloscyphus polyanthos* was occasional on instream boulders. Terrestrial encroachment of the narrow channel was evident. The banks had been historically cleared and supported low lying scrub vegetation with scattered grey willow, ash, hawthorn and sycamore (*Acer psuedoplatanus*). The site was bordered by semi-improved pasture (GA1) and scrub (WS1).

No fish were recorded via electro-fishing at site C6 (**Appendix A**). The small stream was not of fisheries value given its shallow nature and poor flows given inherent poor hydromorphology with tenuous connectivity downstream. There was no suitability for white-clawed crayfish and the species was not recorded. No otter signs were recorded in vicinity of the site.

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

Plate 4.13 Representative image of site C6 on an unnamed Knocknacarra Stream tributary, August 2023

4.1.14 Site C7 – unnamed stream, Rahoon

Site C7 was located on located on an unnamed Knocknacarra Stream tributary at the Western Distributor Road (L1013) road crossing, approximately 1km downstream of site C6. The stream had been culverted underground beneath the Gateway Shopping Park and Gaelscoil Mhic Amhlaigh. Given the stream was culverted underground at this location, a fisheries assessment was not possible and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.14 Representative image of site C7 on an unnamed stream, August 2023 (culverted underground)

4.1.15 Site C8 – Knocknacarra Stream, Rahoon

Site C8 was located on the Knocknacarra Stream (31K16) at a local road crossing adjacent to the Gort Siar residential area, approximately 500m downstream of site C5. The stream had been culverted underground and was not accessible for survey. The stream's course was through an area of rough pasture (GS2)/scrub (WS1).

Given the stream was culverted underground at this location, a fisheries assessment was not possible and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.15 Representative image of site C8 on the Knocknacarra Stream, August 2023 (culverted underground)

4.1.16 Site C9 – Tonabroky Stream, Árd na Gaoithe

Site C9 was located on the uppermost reaches of the Tonabroky Stream (31T13). The channel had been culverted underground adjacent to the Árd na Gaoithe residential area. Whist the channel briefly appeared above ground at the L5020 road crossing (pipe culvert) approximately 250m downstream, the stream was dry at the time of survey with no trace of water or aquatic species. The channel was again culverted underground through numerous residential areas downstream of this point.

Given underground culverting the site was not of fisheries value and it was not possible to collect a biological water quality sample. No otter signs were recorded in vicinity of the site.

Plate 4.16 Representative image of site C9 on the Tonabroky Stream, August 2023 (culverted underground)

Bearna Stream hydrological catchment

4.1.17 Site D1 – Bearna Stream, Ballynahown East

Site D1 was located on the upper reaches of the Bearna Stream (31B01) approximately 0.2km upstream of the proposed road crossing (proposed crossing inaccessible due to dense scrub). The lowland stream (FW2) had been extensively straightened and deepened resulting in a canalised, often trapezoidal channel with very poor flows and poor hydromorphology. The stream was a homogenous 2.5m wide and between 0.4-0.6m deep. The profile was of near stagnant glide with no riffle and no pool. The bed was comprised exclusively of deep silt underlain by clay. Some slumping of mixed gravels and cobble from the steep banks was present locally. The site was heavily vegetated with abundant fennel pondweed (*Potamogeton pusillus*), branched bur-reed (*Sparganium erectum*) and water starwort (*Callitriche* sp.). Water mint, fool's watercress, watercress, broad-leaved pondweed (*Potamogeton natans*), common duckweed, water forget-me-not (*Myosotis scorpioides*) and water plantain (*Alisma plantago-aquatica*) were also present locally. Bent grass (*Agrostis* sp.) encroachment of the surface was locally abundant (often up to 50% of channel width). Aquatic bryophytes were not recorded. The low lying banks supported abundant herbaceous vegetation with abundant purple loosestrife, wild angelica (*Angelica sylvestris*), meadowsweet (*Filipendula ulmaria*) and abundant rushes (*Juncus* spp.). The site was bordered by wet grassland (GS4) and dense scrub (WS1) dominated by bracken (*Pteridium aquilinum*) and gorse.

Three-spined stickleback (*Gasterosteus aculeatus*) were the only fish species recorded via electro-fishing at site D1 (**Appendix A**). With the exception of moderate densities of stickleback, the stream was of poor fisheries value given extensive historical modifications (especially downstream of survey point), poor flows, siltation and poor connectivity with downstream habitats. However, there was

some low suitability for European eel (although the species was not recorded). There was no suitability for white-clawed crayfish and the species was not recorded. No otter sign were recorded in vicinity of the site and suitability was very poor given a poor prey resource.

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

Plate 4.17 Representative image of site D1 on the Bearna Stream, August 2023

4.1.18 Site D2 – Bearna Stream, Ballynahown East

Site D2 was located on the Bearna Stream (31B01) approximately 0.6km downstream of site D1 at a proposed road crossing. The upland eroding stream (FW1) meandered along a natural, unmodified course was 2m wide and between 0.1-0.2m deep. The profile comprised shallow swift glide and riffle with only very localised shallow pool. The substrata were dominated by fine and medium gravels with frequent cobble and scattered small boulder. Sands were present locally and siltation was low overall. The site was heavily tunnelled by scrub and thus macrophyte growth was limited to very occasional fool's watercress. Much of the instream vegetation comprised the roots of grey willow. Aquatic bryophyte coverage was also low with occasional *Chiloscyphus polyanthos* and rare *Fontinalis antipyretica* on larger substrata. The semi-aquatic liverwort *Pellia epiphylla* was frequent on the banks. The stream was heavily tunnelled by abundant grey willow, sycamore, blackthorn (*Prunus spinosa*), bog myrtle (*Myrica gale*), gorse, bramble and bracken. The site and adjoining stream valley was bordered by heath and bracken scrub.

Brown trout (*Salmo trutta*) and European eel (*Anguilla anguilla*) were the only fish species recorded via electro-fishing at site D2 (**Appendix A**). The site was evidently of value as a salmonid nursery supporting a high density of juvenile brown trout, with cobble-dominated glide and tree roots

providing suitable refugia. These areas also provided some suitability for European eel which were present in low densities. The site was of poor value as a holding area given its shallow nature although good quality spawning habitat was widespread. The high energy site was unsuitable for lamprey and none were recorded. There was no suitability for white-clawed crayfish and the species was not recorded. No otter signs were recorded in vicinity of the site although marking opportunities were poor.

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

Plate 4.18 Representative image of site D2 on the Bearna Stream, August 2023

4.1.19 Site D3 – Bearna Stream, Cappagh

Site D3 was located on the Bearna Stream (31B01) at the L5025 road crossing approximately 0.6km downstream of site D2. The upland eroding stream (FW1) flowed in a semi-natural incised valley under the road via twin pipe culverts (barrier to salmonids at low flows). The stream had been straightened and deepened throughout resulting in a deep trapezoidal channel with mostly unstable banks of up to 6m in height locally. The stream was 2.5m wide and 0.1m deep with a paucity of deeper areas. The profile comprised shallow glide and riffle. The substrata were dominated by mixed gravels and cobble with scattered small boulder. Sands were also present locally. Soft sediment accumulations were not present and siltation was low overall. Due to very high riparian shading (tunnelling), macrophytes were limited to fool's watercress and watercress (both localised) in the limited open areas of channel. Coverage of aquatic bryophytes was also low with occasional *Chiloscyphus polyanthos*, *Hygroamblystegium* sp., *Rhynchostegium riparioides* and *Pellia epiphylla*. The stream was tunnelled by dense scrub dominated by blackthorn, hawthorn and bramble with mature elder (*Sambucus nigra*), ash, grey willow and gorse. Invasive Japanese knotweed was scattered along the sloping banks.

Fuchsia (*Fuchsia magellanica*) dominated downstream of the bridge (tunnelling). The site was bordered by amenity grassland (GA2), scrub (WS1) and semi-improved pasture (GA1).

Brown trout and European eel were the only fish species recorded via electro-fishing at site D3 (**Appendix A**). The site was of moderate value as a salmonid nursery (given broken flow patterns and stoney hard bed providing refugia and oxygenated water. The site supported a moderate density of juvenile brown trout. The site was however, of poor value as a salmonid holding area given its shallow nature although good quality spawning habitat was frequent due to the presence of clean gravels. Suitability for European eel was moderate (limited coarse bed refugia and deeper pool) with low densities recorded. The high energy site was unsuitable for lamprey (given limited ammocoete habitat) and none were recorded. No otter signs were recorded in vicinity of the site.

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

Plate 4.19 Representative image of site D3 on the Bearna Stream, August 2023

4.1.20 Site D4 – Oddacres Stream, Cappagh

Site D4 was located on the Oddacres Stream (31O05), approximately 0.6km upstream of the Bearna Stream confluence. The medium-sized, swift flowing upland eroding stream (FW1) flowed over a low gradient in a largely natural channel with exception of localised bank modifications such as revetments. The stream was 2.5-3m wide and between 0.1-0.3m deep with only localised deeper areas associated with natural cascades. The profile comprised of swift glide, riffle and pools associated with cascades and meanders. Bank scours and undercuts were frequent. The substrata were dominated by boulder and cobble (bedded) with locally abundant mixed gravels. Coarse sand accumulations were present along the channel margins. Siltation was however low overall and silt accumulations were not present. Given high flow rates, macrophytes were limited to occasional fool's

watercress and alternate water milfoil (*Myriophyllum alterniflorum*) with occasional marginal stands of iris (*Iris psuedacorus*) and hemlock water dropwort (*Oenanthe crocata*) that was recorded as rare. Coverage of aquatic bryophytes was high with abundant *Rhynchostegium riparioides* and frequent *Chiloscyphus polyanthos*. *Racomitrium aciculare* and *Pellia epiphylla* were occasional on the tops of larger boulders, with *Marchantia polymorpha* on the wet lower river banks. Filamentous algae was present but coverage was low (<1%). The banks were heavily scrubbed with abundant blackthorn, grey willow, gorse, bracken, bramble and royal fern (*Osmunda regalis*).

Brown trout and European eel were the only fish species recorded via electro-fishing at site D4 (**Appendix A**). The site was of high value for salmonids, supporting a healthy mixed-cohort population of brown trout. The stream at site D4 was also a high quality nursery with abundant instream, bryophyte-rich refugia. Good quality spawning habitat was also present by way of clean mixed gravels (although limited in extent). Occasional deeper glide and pool, in addition to undercut banks, provided valuable thermal refugia and holding areas for adult salmonids. These areas also provided suitable refugia for European eel, which were recorded in low densities. The upland stream was unsuitable for lamprey and white-clawed crayfish and neither species were recorded. No otter signs were recorded in vicinity of the site, despite some good foraging suitability.

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

Plate 4.20 Representative image of site D4 on the Oddacres Stream, August 2023

4.1.21 Site D5 – Loughinch Stream, Aille

Site D5 was located on the Loughinch Stream (31L26) approximately 100m upstream of the Oddacres Stream confluence. The narrow channel was 1-1.5m wide and 0.1m deep, with no flows present at the time of survey. The stream had been historically drained (straightened) and was heavily vegetated

with abundant fool's watercress and occasional water mint. The substrata comprised of soft sediment with scattered boulder. Livestock poaching was widespread contributing to the siltation pressures observed. No aquatic bryophytes were recorded. The site was bordered by wet grassland (GS4).

No fish were recorded via electro-fishing at site D5 (**Appendix A**). The small stream was not of fisheries value given its shallow nature and poor flows in addition to poor connectivity with downstream habitats (supporting salmonids). There was no suitability for white-clawed crayfish and the species was not recorded present. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.21 Representative image of site D5 on the Loughinch Stream, August 2023

4.1.22 Site D6 – Bearna Stream, Cappagh Park

Site D6 was located on the lower reaches of the Bearna Stream (31B01) in Cappagh Park approximately 0.5km downstream of site D3. The upland eroding stream (FW1) had natural character apart from a small weir at the survey site and an online pond upstream. The swift flowing stream was 3-4m wide and between 0.2-0.4m deep, with localised deeper areas to 0.7m. The profile comprised swift glide and short cascades over boulder, with localised riffle. Small pools were present but localised. Deeper glide was present upstream of the bridge apron. The substrata were dominated by angular cobble and boulder (partially bedded) with frequent areas of mixed gravels. Sands were locally frequent. Siltation was low and soft sediment accumulations were not present. Macrophytes were not present at the swift flowing site. However, the aquatic bryophytes *Chiloscyphus polyanthos*, *Hygroamblystegium* sp. and *Racomtrium aciculare* were locally frequent. The site flowed through mature mixed broadleaved

woodland (WD1) supporting alder (*Alnus glutinosa*), holly (*Ilex aquifolium*), hawthorn, blackthorn and ash with abundant bramble-dominated scrub.

Sea trout, brown trout and European eel were recorded via electro-fishing at site D6 (**Appendix A**). The site was of very high value for salmonids, supporting a healthy mixed cohort brown trout population in addition to a low density of sea trout. The site was of highest value as a salmonid nursery, with abundant instream cobble and boulder refugia. Salmonid spawning habitat was present but localised (larger substrata predominated). Deep glide upstream of the bridge apron provided valuable holding habitat for adult salmonids (including sea trout). The site was also of high value for European eel given abundant instream refugia and good connectivity to the sea (0.5km downstream). The high energy site was unsuitable for lamprey. Despite good suitability for otter, no signs were recorded in vicinity of the site.

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

Plate 4.22 Representative image of site D6 on the lower reaches of the Bearna Stream, August 2023

Trusky Stream hydrological catchment

4.1.23 Site E1 – Cloghscoltia Stream, Trusky East

Site E1 was located on the Cloghscoltia Stream (31C36). The small upland stream had been deepened and locally straightened historically but retained some semi-natural characteristics. The stream suffered from low flows at the time of survey (much of the bed was exposed) and was 1-1.5m wide and 0.1m deep. The profile comprised slow-flowing glide and small cascades, with very localised pool. The substrata were dominated by angular boulder and cobble with interstitial gravels. Siltation was moderate given low flow rates (some flocculent peat). The site was heavily vegetated with abundant

fool's watercress often covering the full channel width. The moss *Fontinalis antipyretica* was present locally on larger boulder with more occasional *Leptodictyum riparium*. Filamentous algae was present, indicating enrichment. The narrow channel was very heavily tunnelled by dense scrub vegetation supporting abundant great willowherb, bramble, meadowsweet, water figwort and bindweed with scattered bramble, grey willow and blackthorn. The site was bordered by scrub (WS1).

Brown trout was the only fish species recorded via electro-fishing at site E1 (**Appendix A**). The site was of poor fisheries value, with only a single adult trout captured. The stream suffered from low flows and provided poor spawning and nursery habitat. Localised pools associated with natural cascades and adjoining pipe culverts were of some holding value for adult salmonids. There was also some suitability for European eel (frequent boulder refugia) although none were recorded. The upland stream was unsuitable for lamprey or white-clawed crayfish and neither species was recorded present. No otter signs were recorded in vicinity of the site.

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

Plate 4.23 Representative image of site E1 on the Cloghscoltia Stream, August 2023

4.1.24 Site E2 – Trusky Stream, Trusky West

Site E2 was located on the uppermost reaches of the Trusky Stream (31B02) at a proposed road crossing. The small stream had been locally straightened and realigned resulting in an intermittent channel with no observable flows and a poorly defined profile. Macrophytes were limited to localised fool's watercress and water pepper (*Persicaria hydropiper*). Aquatic bryophytes were not recorded. The channel flowed through improved pasture (GA1) and areas of wet grassland (GS4) dominated by rushes (*Juncus* sp.).

The small stream was not of fisheries value given the presence of isolated pockets of water only, poor hydromorphology and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish and the species was not recorded present. No otter signs were recorded in vicinity of the site.

Due to the absence of flowing water, it was not possible too collected a biological water quality sample at the time of survey.

Plate 4.24 Representative image of site E2 on the Trusky Stream, August 2023

4.1.25 Site E3 – Trusky Stream, Trusky East

Site E3 was located on the upper reaches of the Trusky Stream (31B02) at a local road crossing and proposed road upgrade location. The small stream emanated from an area of wet grassland (GS4) upstream of the road (near site E2) and crossed under the road via a perched pipe culvert. The channel was 1.5m wide and was dry at the time of survey. The dry base comprised of mud and scattered cobble. The historically straightened and deepened seasonal channel did not support aquatic vegetation and was heavily tunnelled by ornamental cherry laurel (*Prunus laurocerasus*) hedging in a residential garden (GA2).

Given the dry, ephemeral nature of the stream at this location, the channel was not of fisheries value. There was no suitability for white-clawed crayfish and the species was not recorded present. No otter signs were recorded in vicinity of the site. As the channel was dry it was not possible to collect a biological water quality sample.

Plate 4.25 Representative image of site E3 on the Trusky Stream, August 2023 (dry channel)

4.1.26 Site E4 – Freeport Stream, Trusky West

Site E4 was located on the upper reaches of the Freeport Stream (31F04) at the L5387 road crossing. The small stream had been extensively modified historically (straightened and deepened), resulting in a channel with very poor flows and poor hydromorphology. The stream crossed under the local road via a perched pipe culvert before flowing through an area of wet grassland. The channel was 2.5m wide and less than 0.1m deep with no observable flows. The channel was very heavily vegetated with near total coverage of fool's watercress. No aquatic bryophytes were recorded. The site was bordered by semi-improved pasture (GA1) with frequent dense scrub (WS1) supporting hawthorn, blackthorn, gorse, bramble and bracken.

No fish were recorded via electro-fishing at site E4 (**Appendix A**). The small stream was not of fisheries value given historical modifications, poor hydromorphology and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.26 Representative image of site E4 on the Freeport Stream, August 2023

4.1.27 Site E5 – Trusky Stream, Freeport

Site E5 was located on the lowermost freshwater reaches of the Trusky Stream (31B02), upstream of the outfall to Bearna Harbour. The small upland eroding stream (FW1) had been straightened and deepened historically with retaining walls/revetment in the tidal reaches, although the stream retained some semi-natural characteristics upstream. The stream was 2m wide and less than 0.15m deep (at low tide) with deeper glide to 0.6m downstream. The substrata comprised abundant mixed gravels, sands, angular boulder and localised cobble. Compacted and heavily silted cobble predominated in the tidal reaches. Siltation was low in the freshwater reaches but present nonetheless. Macrophyte growth was sparse with only occasional fool's watercress along the channel margins. The moss *Fontinalis antipyretica* and *Leptodictyum riparium* were occasional. Filamentous algae were present indicating enrichment (abundant in tidal reaches). *Ulva intestinalis* was frequent in tidal glide. The channel was open downstream of an old (disused) masonry arch bridge with scattered bramble scrub, willow species and invasive Himalayan balsam (*Impatiens glandulifera*). Upstream of the bridge, the stream was heavily tunnelled by fuchsia. The site was bordered by low intensity pasture (GA1) and residential properties (GA2/BL3).

Brown trout, European eel, flounder (*Platichthys flesus*) and three-spined stickleback were recorded via electro-fishing at site E5 (**Appendix A**). The site was of moderate value only for salmonids given the shallow nature of the stream. However, there was some limited value as a nursery with localised areas providing good quality spawning substrata. The site was of highest value as a European eel and flounder nursery given abundant coarse substrata refugia and good connectivity to marine habitats. Two regular otter spraint sites were recorded; on a mid-stream boulder (ITM 523214, 722838) and one under the masonry bridge arch (ITM 523211, 722845).

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

Plate 4.27 Representative image of site E5 on the Trusky Stream, August 2023

Sruthán Na Libeirtí Stream hydrological catchment

4.1.28 Site F1 – Sruthán Na Libeirtí Stream, Forramoyle West

Site F1 was located on the uppermost reaches of the Sruthán Na Libeirtí Stream (34F01) at the L5386 road crossing. The small upland stream (FW1) had been straightened and deepened historically resulting in a shallow U-shaped channel with poor hydromorphology. The stream was 1.5m wide and 0.3m deep in vicinity of the road crossing, with no observable flows at the time of survey (i.e. stagnant glide and pool). The substrata were dominated by heavily silted cobble and boulder. The site was very heavily vegetated with near total cover of fool's watercress with frequent watercress. Terrestrial encroachment was high with wild angelica, purple loosestrife, marsh woundwort (*Stachys palustris*), meadowsweet and cleavers (*Galium aparine*). The site was bordered by wet grassland (GS4) and bracken-dominated scrub (WS1).

Three-spined stickleback were the only fish recorded via electro-fishing at site F1 (**Appendix A**). With the exception of low densities of stickleback, the stream was of poor fisheries value given extensive historical modifications, poor flows, siltation and poor connectivity with downstream habitats. However, there was some low suitability for European eel (although the species was not recorded). There was no suitability for white-clawed crayfish and no crayfish were recorded present. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given an absence of suitable riffle areas

for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.28 Representative image of site F1 on the Sruthán Na Libeirtí Stream, August 2023

4.1.29 Site F2 – Sruthán Na Libeirtí Stream, Forramoyle West

Site F2 was located on the Sruthán Na Libeirtí Stream (34F01) at a local road crossing approximately 0.5km downstream of site F1. As per upstream, the stream had been historically straightened and deepened throughout resulting in a channel with very poor hydromorphology. Upstream of the road crossing, the stream had been modified and realigned through a series of small ornamental garden ponds. These were largely dry at the time of survey. The stream was 1.5m wide and less than 0.1m deep in a V-shaped channel with poor flows at the time of survey (shallow glide). The substrata comprised compacted cobble with mixed gravels. Siltation was moderate given poor flows. The stream was very heavily tunnelled by herbaceous and scrub vegetation and did not support macrophytes or aquatic bryophytes. The stream flowed through an area of dense scrub (WS1) dominated by great willowherb, bramble, bracken, hedge bindweed, gorse and grey willow. The site was bordered by residential properties (BL3/GA2).

No fish were recorded via electro-fishing at site F2 (**Appendix A**) and the small stream was not of fisheries value given poor hydromorphology, poor flows and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish and the species was not recorded. No otter signs were recorded in vicinity of the site.

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

Plate 4.29 Representative image of site F2 on the Sruthán Na Libeirtí Stream, August 2023

4.1.30 Site F3 – Sruthán Na Libeirtí Stream, Forramoyle West

Site F3 was located on the lowermost reaches of the Sruthán Na Libeirtí Stream (34F01), immediately downstream of the R336 road crossing. The small upland eroding stream (FW1) had been straightened and deepened historically, resulting in a trapezoidal channel (near vertical banks). The stream suffered from low flows at the time of survey and this, coupled with bank slumping and terrestrial encroachment, resulted in an intermittent connectivity (i.e. frequent impediments to flow). The stream was 1m wide and between 0.1-0.2m deep. The profile comprised of near stagnant glide with localised riffle cascading areas. The substrata were dominated by angular boulder and cobble although localised areas of fine to medium gravels were also present. These were moderately silted. Soft sediment accumulations were abundant in association with macrophyte beds and instream bank slumping. Stands of fool's watercress were locally frequent with occasional water mint, brooklime (*Veronica beccabunga*), localised watercress and common duckweed. Coverage of aquatic bryophytes was locally high with *Fontinalis antipyretica* and *Hygroamblystegium* sp. Filamentous algae was also present (2% cover). The narrow, steep-sided channel was heavily shaded by dense scrub vegetation including grey willow, bracken and bramble. The site was bordered by low-intensity pasture (GA1).

European eel was the only fish species recorded via electro-fishing at site F3 (**Appendix A**). Despite this, the site was of poor fisheries value given its shallow, narrow, modified nature and poor connectivity with downstream marine habitats. The site was not accessible for migratory salmonids. No otter signs were recorded in vicinity of the site.

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

Plate 4.30 Representative image of site F3 on the Sruthán Na Libeirtí Stream, August 2023

4.1.31 Site F4 – Newvillage Stream, Forramoyle West

Site F4 was located on the lowermost reaches of the Newvillage Stream (31N03) downstream of the R336 road crossing. The small upland stream (FW1) had been historically straightened and deepened in vicinity of the road crossing (masonry box culvert). Whilst a pool of standing water (0.2m deep) was present under the road culvert, the stream was largely dry elsewhere and representative of a seepage area through an area of wet grassland. There was no observable flow at the time of survey. The intermittent channel was colonised by terrestrial and wetland species including fool's watercress, brooklime, purple loosestrife, water mint, iris and bulrush (*Typha latifolia*). The site was bordered by scrub (WS1) and semi-improved pasture (GA1).

No fish were recorded via electro-fishing at site F4 (**Appendix A**). The small stream was not of fisheries value given a paucity of water, historical modifications, poor hydromorphology and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish and the species was not recorded present. No otter signs were recorded in vicinity of the site.

Biological water quality was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this was a tentative rating given an absence of suitable riffle areas for sampling (Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Plate 4.31 Representative image of site F4 on the Newvillage Stream, August 2023

4.2 White-clawed crayfish

No white-clawed crayfish were recorded via hand-searching or sweep netting of instream refugia during the survey of 31 no. survey sites. Furthermore, environmental DNA sampling did not detect the presence of crayfish from the 5 no. survey lakes (see section 4.3 below).

4.3 eDNA & metabarcoding analysis

Brown trout and Red-listed European eel were detected in composite water samples collected from all 5 no. lacustrine survey sites via eDNA (sites L1 & L5) and metabarcoding (sites L2 & L3/L4) (**Tables 4.1, 4.2**).

Smooth newt (*Lissotriton vulgaris*) were detected via eDNA sampling at Ballindooley Lake (L2) and an unnamed pond at Coolagh (L5) (4 & 9 positive qPCR replicates out of 12, respectively) but not at sites L1, L3 or L4 (**Table 4.1; Appendix C**).

Despite some habitat suitability, no white-clawed crayfish eDNA was detected in the water samples from lacustrine sites L1, L2, L3, L4 or L5 (**Table 4.1**). These results were considered as evidence of the species' absence at the sampling locations.

Whilst known from the Corrib catchment (NCPSP[3] & Triturus data), the invasive pathogen crayfish plague (*Aphanomyces astaci*) was not detected via eDNA sampling at lake sites L2, L3 or L4 (**Table 4.1; Appendix C**).

[3] National Crayfish Plague Surveillance Programme

Lake metabarcoding revealed the presence of similar fish populations within Ballindooley Lough (L2) and the Coolagh lakes (L3 & L4) (**Table 4.2; Appendix C**). In order of DNA read counts (the number of DNA sequences assigned to a species; a proxy for abundance) Ballindooley Lough supported a fish population dominated by perch (*Perca fluviatilis*), rudd (*Scardinius erythropthalmus*) and pike (*Esox lucius*), with lower numbers of tench (*Tinca tinca*) and European eel (**Table 4.2**). The Coolagh Loughs sample indicated a population dominated by roach (*Rutilus rutilus*) and perch with low numbers of pike, rudd, tench, bream (*Abramis brama*) and ten-spined stickleback (*Pungitius pungitius*) (**Table 4.2**). Whilst European eel were not detected via metabarcoding[4] in the Coolagh Loughs sample, the species was detected via eDNA sampling (**Appendix C**).

4.4 Invasive aquatic species

The invasive macrophyte Canadian pondweed (*Elodea canadensis*) was recorded at site B1 on the River Corrib as well as all 5 no. survey lakes. The species is relatively widespread in Ireland and is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). It is considered a high-risk invasive species in Irish waters (O' Flynn et al., 2014).

The invasive bivalve mollusc zebra mussel (*Dreissena polymorpha*) was recorded at both Coolagh Loughs (sites L3 & L4) and the River Corrib (B1) (**Appendix B**). The species is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and is considered a high-risk impact species in Ireland (O' Flynn et al., 2014). Zebra mussels have been present in Ireland since the early 1990s (Minchin et al., 2005) and the Corrib system since the early 2000s.

The invasive fish species roach (*Rutilus rutilus*) were detected from the Coolagh Loughs via eDNA metabarcoding (**Appendix C**). Roach have been present in the River Corrib catchment since the mid-1970s (Brazier, 2018) and the species is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and is considered a high-risk impact species in Ireland (O' Flynn et al., 2014).

The non-native amphipod crustacean *Crangonyx* sp. was recorded in low numbers at Ballindooley Lough (L2), an unnamed lake (L5) and the River Corrib (B1). Whilst *Crangonyx pseudogracilis* has been known in Ireland since 1969 (Phoenix Park, Dublin; Holmes, 1975) its Irish range has expanded in recent years (Minchin et al., 2013) and it is now well established, including in Lough Corrib (Baars et al., 2021). Furthermore, *Crangonyx floridanus* has recently been confirmed in the Liffey and Barrow catchments (Baars et al., 2021). Speciation within the *Crangonyx* genus has proven difficult (Mauvisseau et al. 2018). The ecological impacts of either *Crangonyx* species in Ireland remains uncertain (Baars et al., 2021).

[4] The failure to detect European eel DNA at sites L3 and L4 (Coolagh Loughs) likely reflects the species' demersal characteristics and decreased likelihood of DNA detection (sampling near the lake surface) in deep water lake habitats rather than an absence of the species from these sites

Table 4.1 eDNA results in the vicinity of the proposed N6 GCRR (positive qPCR replicates out of 12 in parentheses)

Site	Watercourse	Brown trout	White-clawed crayfish	Crayfish plague	European eel	Smooth newt
L1	Unnamed lake	**Positive (3/12)**	Negative (0/12)	n/a	**Positive (5/12)**	Negative (0/12)
L2	Ballindooley Lough	n/a	Negative (0/12)	Negative (0/12)	n/a – but present, see Table 4.2	**Positive (4/12)**
L3	Coolagh Lough (upper)	n/a	Negative (0/12)	Negative (0/12)	n/a	Negative (0/12)
L4	Coolagh Lough (lower)	n/a	Negative (0/12)	Negative (0/12)	n/a	Negative (0/12)
L5	Unnamed lake	**Positive (12/12)**	Negative (0/12)	n/a	**Positive (12/12)**	**Positive (9/12)**

Table 4.2 DNA metabarcoding results for Ballindooley and Coolagh Loughs

Species	% of DNA reads	
	Ballindooley Lough	Coolagh Loughs
Perch (*Perca fluviatilis*)	59.19%	20.63%
Rudd (*Scardinius erythropthalmus*)	20.78%	0.69%
Pike (*Esox lucius*)	17.64%	0.71%
Tench (*Tinca tinca*)	1.93%	0.21%
European eel (*Anguilla anguilla*)	0.47%	Not detected (but detected via eDNA)
Roach (*Rutilus rutilus*)	Not detected	77.36%
Bream (*Abramis brama*)	Not detected	0.26%
Ten-spined stickleback (*Pungitius pungitius*)	Not detected	0.15%

4.5 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from a total of 15 no. riverine sites[5] in August 2023 (**Appendix B**).

Sites D2 and D3 on the Bearna River achieved **Q4 (good status)** water quality based on the presence of the EPA group A (most pollution sensitive) mayfly species *Ephemera danica* in numbers ≥5% of the total sample abundance (**Appendix B**). These were the only two survey sites to meet the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**).

Site D6 on the Bearna Stream achieved **Q3-4 (moderate status)** given the presence of low numbers (<5%) of group A species, namely *Ephemera danica*.

The remaining 12 no. sites on the River Corrib (B1), Knocknacarra Stream (C1), unnamed channel (C6), Bearna Stream (D1), Oddacres Stream (D4), Loughinch Stream (D5), Cloghscoltia Stream (E1), Freeport Stream (E4), Trusky Stream (E5) and the Forramoyle Stream (F1, F2 & F3) achieved **Q2-3 or Q3 (poor status)** given an absence of group A species, a paucity or absence of group B species and a dominance of pollution tolerant group C and D species, such as the New Zealand mud snail (*Potamopyrgus antipodarum*), freshwater shrimp (*Gammarus duebeni*), and hoglouse (*Asellus aquaticus*) (**Appendix B**).

It should be noted that the ratings for sites B1, C1, D1, D5, E1, E4, F1, F2 and F4 was tentative due to poor flows and or an absence of riffle areas for sampling at the time of survey (as per Toner et al., 2005).

4.6 Lake macro-invertebrate communities

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the composite sweep samples collected from 5 no. lake sites in August 2023. The samples were dominated by common lacustrine species such as *Asellus aquaticus*, damselfly (Coenagrionidae larvae), non-biting midge larvae (*Chironomus* spp.) and common bithynia (*Bithynia tentaculata*) (**Appendix B**).

[5] The remaining riverine survey sites were either culverted underground or dry at the time of survey

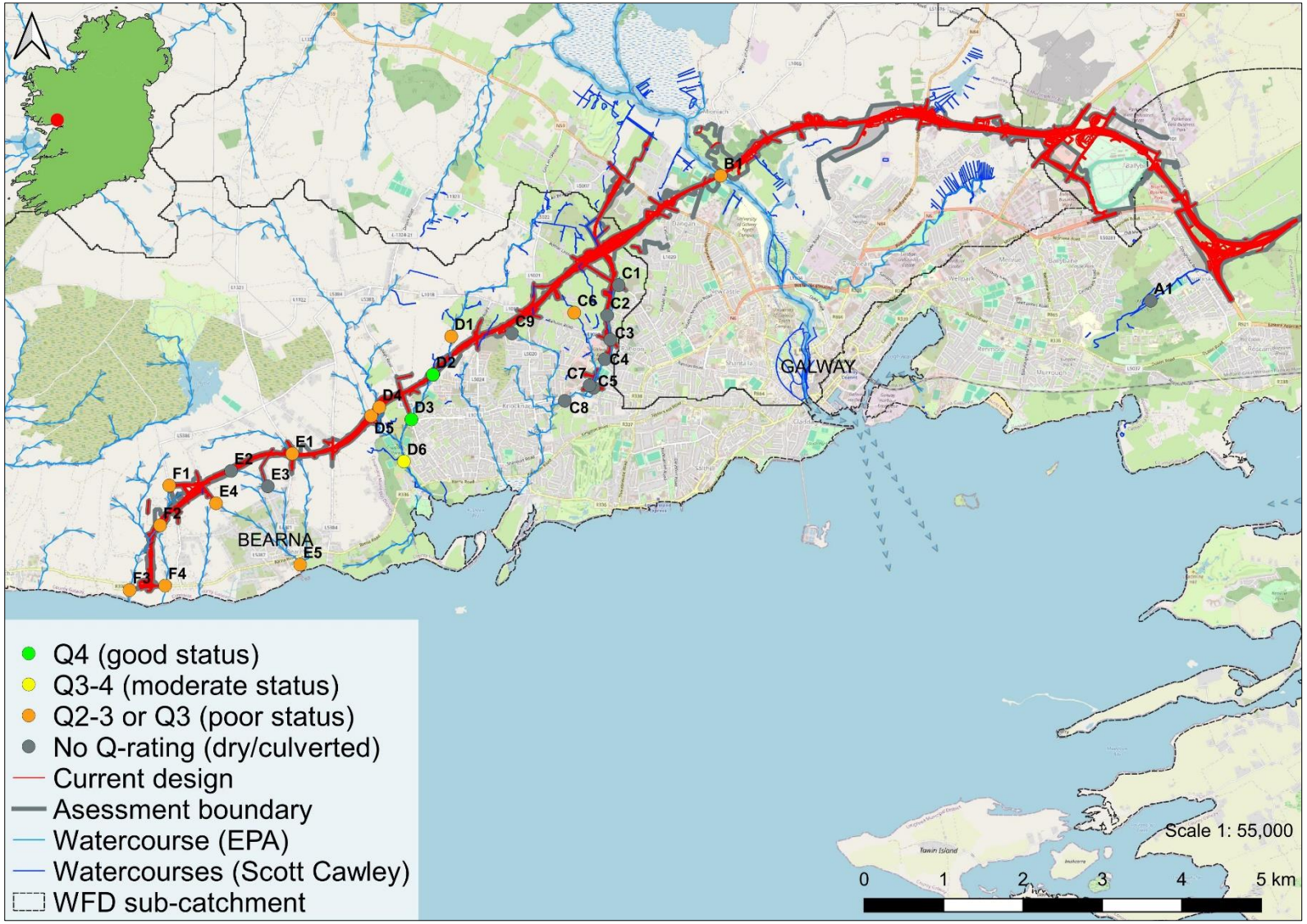

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed N6 GCRR scheme, August 2023

Table 4.3 Relative abundance of fish species of higher conservation value recorded via **electro-fishing** in the vicinity of the proposed N6 GCRR, August 2023

Site	Watercourse	Brown trout	Sea trout	European eel	Other species
A1	Merlin Park Stream	No fish recorded – dry channel			
B1	River Corrib	n/a – too deep for backpack electro-fishing			
C1	Knocknacarra Stream				
C2	Knocknacarra Stream	n/a - culverted underground			
C3	Knocknacarra Stream	n/a - culverted underground			
C4	Knocknacarra Stream	n/a - culverted underground			
C5	Knocknacarra Stream	n/a - culverted underground			
C6	Unnamed channel				
C7	Unnamed stream	n/a - culverted underground			
C8	Knocknacarra Stream	n/a - culverted underground			
C9	Tonabroky Stream	n/a - culverted underground/dry channel			
D1	Bearna Stream				Three-spined stickleback
D2	Bearna Stream	Medium		Low	
D3	Bearna Stream	Medium		Low	
D4	Oddacres Stream	High		Medium	
D5	Loughinch Stream				
D6	Bearna Stream	**Very high**	Low	High	
E1	Cloghscoltia Stream	Low			
E2	Trusky Stream	No fish recorded – dry channel			
E3	Trusky Stream	No fish recorded – dry channel			
E4	Freeport Stream				
E5	Trusky Stream	Low		High	Three-spined stickleback, flounder
F1	Sruthán Na Libeirtí Stream				Three-spined stickleback
F2	Sruthán Na Libeirtí Stream				
F3	Sruthán Na Libeirtí Stream			Low	
F4	Newvillage Stream				

Table 4.4 Summary of aquatic species and habitats of higher conservation value recorded in the vicinity of the proposed N6 GCRR, August 2023

Site	Watercourse	White-clawed crayfish	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
Riverine sites							
A1	Merlin Park Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
B1	River Corrib	None recorded	No signs	**Floating river vegetation [3260]**	None recorded	None recorded	None recorded
C1	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C2	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C3	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C4	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C5	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C6	Unnamed channel	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C7	Unnamed stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C8	Knocknacarra Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C9	Tonabroky Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
D1	Bearna Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
D2	Bearna Stream	None recorded	No signs	Not present	None recorded	None recorded	**European eel**
D3	Bearna Stream	None recorded	No signs	Not present	None recorded	None recorded	**European eel**
D4	Oddacres Stream	None recorded	No signs	Not present	None recorded	None recorded	**European eel**
D5	Loughinch Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
D6	Bearna Stream	None recorded	No signs	Not present	None recorded	None recorded	**Sea trout, European eel**
E1	Cloghscoltia Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded

Site	Watercourse	White-clawed crayfish	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
E2	Trusky Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
E3	Trusky Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
E4	Freeport Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
E5	Trusky Stream	None recorded	**2 no. spraint sites**	Not present	None recorded	None recorded	**European eel**
F1	Sruthán Na Libeirtí Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
F2	Sruthán Na Libeirtí Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
F3	Sruthán Na Libeirtí Stream	None recorded	No signs	Not present	None recorded	None recorded	**European eel**
F4	Newvillage Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
Lake sites							
L1	Unnamed pond	None recorded; negative eDNA result at site	No signs	Not present	None recorded	None recorded	**European eel (eDNA)**
L2	Ballindooley Lough	None recorded; negative eDNA result at site	No signs	**Hard-water lake [3140]**	None recorded	None recorded	**European eel, smooth newt (eDNA)**
L3	Coolagh Lough (upper)	None recorded; negative eDNA result at site	No signs	**Hard-water lake [3140]**		None recorded	
L4	Coolagh Lough (lower)	None recorded; negative eDNA result at site	No signs	**Hard-water lake [3140]**	None recorded	None recorded	
L5	Unnamed pond	None recorded; negative eDNA result at site	No signs	Not present	None recorded	None recorded	**European eel, smooth newt (eDNA)**

Conservation value: White-clawed crayfish (*Austropotamobius pallipes*) and Eurasian otter (*Lutra lutra*) are listed under Annex II of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and are protected under the Irish Wildlife Acts 1976-2023. White-clawed crayfish (Füreder et al., 2010) are also listed as 'Endangered' according to the IUCN Red List. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). Smooth newt (*Lissotriton vulgaris*) are protected under the Irish Wildlife Acts 1976-2023. [4] Otter signs within 150m of the survey site.

5. Discussion

The watercourses in the vicinity of the proposed N6 GCRR scheme were typically small upland eroding channels which had been heavily modified (straightened and or deepened) historically, often resulting in poor quality fisheries and aquatic habitats. Hydromorphological alterations were widespread in the peri-urban landscape and some watercourses, such as the Knocknacarra Stream, were culverted almost entirely underground with a subsequent loss of aquatic habitats.

However, almost half of the riverine sites, in addition to pond site L2 were supported fish and or amphibian[6] species of high conservation value, Q4 (good status) water quality and or were utilised by otter (**Table 4.4**). Ballindooley Lough was of particularly high aquatic ecological importance given that it supported European eel and smooth newt (recorded via eDNA sampling), an important coarse fish population and a good example of the Annex I habitat 'Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]'. This Annex I habitat was also present at the Coolagh Lake sites (L3 & L4). Site B1 on the River Corrib featured Annex I floating river vegetation habitat [3260][7] and is known to support aquatic species of high conservation value (e.g. Atlantic salmon and otter). Overall, the Corrib hydrological catchment (**Figure 2.2**) was of highest aquatic value.

5.1 Fisheries

Whilst most riverine sites (18 no.) supported three-spined stickleback only or (in most cases) no fish species (**Table 4.3**), a low number of sites with higher quality aquatic habitats on the Bearna Stream (sites D2, D3 & D6), Oddacres Stream (D4), Cloghscoltia Stream (E1) and Trusky Stream (E5) supported salmonid and or Red-listed European eel populations. Site B6 on the Bearna Stream supported anadromous sea trout, an unusual component of peri-urban fish populations. No Atlantic salmon were recorded during the electro-fishing survey although the species is known from the River Corrib. No lamprey were recorded during the survey and this reflected the poor habitat suitability in the survey area (**Appendix A**). However, the River Corrib is known to support sea lamprey and *Lampetra* sp. downstream of the proposed road crossing (**section 3.1**). DNA metabarcoding and eDNA sampling revealed the presence of a low species diversity in the lake sites, including brown trout (L1 & L5) and European eel (L1, L2 & L5) (**Appendix C**).

5.2 Macro-invertebrates

No white-clawed crayfish were recorded during the surveys (inclusive of eDNA sampling), thus supporting the known absence of crayfish in the survey area (based on NPWS & EPA data). Suitability for crayfish was poor if not absent entirely given historical modifications, heavy siltation, poor hydromorphology and or the low alkalinity nature of the survey watercourses which results in conditions inimical to the species (Demers et al., 2005; Lucy & McGarrigle, 1987).

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the samples taken from 15 no. riverine or 5 no. lake sites (**Appendix B**). In terms of biological water quality, with the exception of sites D2 and D3 on the Bearna Stream (**Q4 (good status)**), all sites failed to meet the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface

[6] smooth newt were detected via eDNA sampling at pond L2
[7] given the presence of several indicator species (EC, 2013)

Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**). Significant hydromorphological modifications and eutrophication pressures (including urban run-off) were noted during the surveys and are known to be the primary threats to water quality in the wider survey area (EPA, 2019).

5.3 Macrophytes & Annex I aquatic habitats

No rare or protected macrophytes or aquatic bryophytes were recorded at the *n*=31 survey sites in August 2023. However, the Annex I habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]' (aka. floating river vegetation) was recorded at site B1 on the River Corrib. This was based on the presence of numerous pondweed indicator species (EC, 2013). However, the habitat was fragmented near the survey site (proposed road crossing) but was more extensive >200m downstream.

Given the abundance of charophytes such as *Chara rudis* and *C. hispida*, Ballindooley Lough (site L1), Coolagh Lough Upper (L3) and Coolagh Lough Lower (L4) were representative of the Annex I habitat 'Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]'. Based on diagnostic characteristics provided in Roden et al. (2020), Ballindooley Lough supported the best example of this Annex I habitat (and was thus considered of county importance). Both floating river vegetation and hard-water lake habitats are listed as qualifying interests of the Lough Corrib SAC (000297) (NPWS, 2017).

5.4 Otter

Despite habitat suitability at numerous survey sites (e.g. lake sites, River Corrib, Bearna Stream), otter signs (spraints) were only recorded at a single site on the Trusky Stream (site D5). The paucity of signs was considered to mainly reflect the poor quality of the fisheries and aquatic habitats within many of the survey watercourses, leading to sub-optimal foraging opportunities for otter. Furthermore, the close proximity of the survey area to more extensive habitats and more profitable foraging areas such as Lough Corrib (to the north) and Galway Bay (to the south) reduced the likelihood of regular otter utilisation of many of the survey sites. No breeding (holt) or couch (resting) areas were identified in the vicinity of the survey sites in August and September 2023.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

8. Appendix B – Macro-invertebrates (biological water quality) & lake macro-invertebrate communities

Table 8.1 Macro-invertebrate Q-sampling results for riverine sites B1, C1, C6 & D1-D6, August 2023

Group	Family	Species	B1	C1	C6	D1	D2	D3	D4	D5	D6	EPA class
Ephemeroptera	Ephemeridae	*Ephemera danica*					10	4			1	**A**
Ephemeroptera	Baetidae	*Alainites muticus*					6	4	8			**B**
Ephemeroptera	Baetidae	*Cloeon* sp.	1									**B**
Plecoptera	Leuctridae	*Leuctra fusca*					1		10		2	**B**
Trichoptera	Glossosomatidae	*Agapetus fuscipes*					6	4	1		10	**B**
Trichoptera	Leptoceridae	*Athripsodes aterrimus*	3			3						**B**
Trichoptera	Leptoceridae	*Leptocerus tineiformis*	8									**B**
Trichoptera	Limnephilidae	*Halesus radiatus*					1		1			**B**
Trichoptera	Sericostomatidae	*Sericostoma personatum*			7		2	3	8			**B**
Trichoptera	Odontoceridae	*Odontocerum albicorne*			1				3		1	**B**
Odonata	Coenagrionidae	sp. indet.	5	2		59						**B**
Ephemeroptera	Baetidae	*Baetis rhodani*			36	1		31	36		21	**C**
Ephemeroptera	Ephemerellidae	*Serratella ignita*			4				3			**C**
Ephemeroptera	Caenidae	*Caenis luctuosa*	4									**C**
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*					5	1	1			**C**
Trichoptera	Philopotamidae	*Wormaldia occipitalis*					14	21				**C**
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*	3									**C**
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*					1	6	2		5	**C**
Crustacea	Gammaridae	*Gammarus duebeni*	1		28		19	10	15	2	11	**C**
Coleoptera	Dytiscidae	*Dytiscus marginalis*				1						**C**
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*							6	2	1	**C**
Coleoptera	Elmidae	*Elmis aenea*					1		4		3	**C**
Coleoptera	Elmidae	*Limnius volckmari*					1		10		5	**C**
Coleoptera	Halipliidae	Haliplidae larva	2									**C**
Coleoptera	Halipliidae	*Haliplus ruficollis* group				14						**C**

Group	Family	Species	B1	C1	C6	D1	D2	D3	D4	D5	D6	EPA class
Diptera	Chironomidae	Non-*Chironomus* spp.	1	4	2	13	1		2	1		**C**
Diptera	Culicidae	sp. indet.	1		2		6					**C**
Diptera	Simuliidae	sp. indet.					10		1			**C**
Diptera	Tipuliidae	sp. indet.		3						5		**C**
Hemiptera	Gerridae	*Gerris* sp.		4	4	1				1		**C**
Gastropoda	Bithnyiidae	*Bithynia tentaculata*	24									**C**
Gastropoda	Planorbidae	*Gyraulus albus*				11	7					**C**
Gastropoda	Neritidae	*Theodoxus fluviatilis*	2						5			**C**
Gastropoda	Planorbidae	*Bathyomphalus contortus*	1									**C**
Gastropoda	Planorbidae	*Gyraulus albus*	2									**C**
Gastropoda	Planorbidae	*Hippeutis complanatus*	4									**C**
Gastropoda	Planorbidae	*Planorbis planorbis*	14									**C**
Gastropoda	Planorbidae	*Lymnaea stagnalis*				1						**C**
Gastropoda	Tateidae	*Potamopyrgus antipodarum*	1	86		136			28	5	7	**C**
Arachnida	Hydrachnidiae	sp. indet.		2	5	4						**C**
Crustacea	Asellidae	*Asellus aquaticus*	11	24	9	15	7	6		16		**D**
Crustacea	Crangonyctidae	*Crangonyx* sp.	3			7						**D**
Gastropoda	Physidae	*Physa fontinalis*	2									**D**
Gastropoda	Lymnaeidae	*Ampullacaena balthica*	1			53						**D**
Hirudinidae	Glossiphoniidae	sp. indet.	1		2						2	**D**
Diptera	Chironomidae	*Chironomus* spp.	1	2						2		**E**
Annelidae	Oligochaeta	sp. indet.	1				3					**n/a**
Bivalvia	Dreissenidae	*Dreissena polymorpha*	1									**n/a**
Abundance			**98**	**127**	**100**	**319**	**101**	**90**	**144**	**34**	**69**	
Q-rating			*Q3	*Q3	Q3	*Q3	Q4	Q4	Q3	*Q2-3	Q3-4	
WFD status			Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Mod	

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

Table 8.2 Macro-invertebrate Q-sampling results for riverine sites E1, E4, E5 & F1-F4, August 2023

Group	Family	Species	E1	E4	E5	F1	F2	F3	F4	EPA class
Trichoptera	Glossosomatidae	*Agapetus fuscipes*	21		67			45		**B**
Trichoptera	Limnephilidae	*Potamophylax latipennis*			14					**B**
Trichoptera	Sericostomatidae	*Sericostoma personatum*					2			**B**
Trichoptera	Odontoceridae	*Odontocerum albicorne*	2							**B**
Odonata	Coenagrionidae	sp. indet.				1				**B**
Ephemeroptera	Baetidae	*Baetis rhodani*	7					4		**C**
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*			4					**C**
Trichoptera	Rhyacophilidae	*Rhyacophila munda*			1					**C**
Crustacea	Gammaridae	*Gammarus duebeni*	8			6	29			**C**
Coleoptera	Dytiscidae	*Dytiscus marginalis*		1						**C**
Coleoptera	Dytiscidae	*Ilybius fuliginosus*			1					**C**
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*					1			**C**
Coleoptera	Elmidae	*Elmis aenea*	4		3					**C**
Coleoptera	Elmidae	*Limnius volckmari*					2			**C**
Coleoptera	Hydraenidae	*Hydraena gracilis*			1		6			**C**
Diptera	Chironomidae	Non-*Chironomus* spp.	2		1	1				**C**
Diptera	Culicidae	sp. indet.	5			4			2	**C**
Diptera	Simuliidae	sp. indet.	12		2			10		**C**
Diptera	Tipuliidae	sp. indet.			1		1			**C**
Hemiptera	Gerridae	*Gerris* sp.				2		3	2	**C**
Gastropoda	Planorbidae	*Gyraulus albus*				2				**C**
Gastropoda	Neritidae	*Theodoxus fluviatilis*						4		**C**
Gastropoda	Planorbidae	*Gyraulus albus*		6						**C**
Gastropoda	Planorbidae	*Lymnaea stagnalis*				1		14		**C**
Gastropoda	Tateidae	*Potamopyrgus antipodarum*		13	61	19	1	51	5	**C**

Group	Family	Species	E1	E4	E5	F1	F2	F3	F4	EPA class
Arachnida	Hydrachnidiae	sp. indet.		8	9	1			4	**C**
Crustacea	Asellidae	*Asellus aquaticus*	25	16	21	8	1	26	9	**D**
Crustacea	Crangonyctidae	*Crangonyx* sp.			1			21		**D**
Gastropoda	Lymnaeidae	*Ampullacaena balthica*		5		1	2		1	**D**
Hirudinidae	Glossiphoniidae	sp. indet.		1		1	1			**D**
Hirudinidae	Erpobdellidae	sp. indet.	1		1					**D**
Diptera	Chironomidae	*Chironomus* spp.		5	1	4			6	**E**
Annelidae	Oligochaeta	sp. indet.	2	5		8	2		3	**n/a**
Abundance			**89**	**60**	**189**	**59**	**48**	**178**	**30**	**178**
Q-rating			*Q3	*Q2-3	Q3	*Q3	*Q3	Q3	*Q3	
WFD status			Poor	Poor	Poor	Poor	Poor	Poor	Poor	

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

Table 8.3 Macro-invertebrate Q-sampling results for lake sites L1, L2, L3, L4 & L5, September 2023

Group	Family	Species	L1	L2 (Ballindooley Lough)	L3 (Coolagh Lough Upper)	L4 (Coolagh Lough Lower)	L5
Ephemeroptera	Caenidae	*Caenis luctuosa*		1			
Trichoptera	Leptoceridae	*Athripsodes aterrimus*				2	
Trichoptera	Leptoceridae	*Mystacides longicornis*		2			
Trichoptera	Phryganeidae	*Agrypnia obsoleta*	1			11	
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*			1		
Trichoptera	Polycentropodidae	*Plectrocnemia geniculata*				2	
Odonata	Coenagrionidae	sp. indet.	5	23	12	8	5
Crustacea	Gammaridae	*Gammarus duebeni*			1		
Coleoptera	Gyrinidae	*Gyrinus substriatus*	1	1		2	
Coleoptera	Halipliidae	*Haliplus ruficollis* group		1	1		
Coleoptera	Noteridae	*Noterus clavicornis*				1	
Diptera	Chironomidae	*Chironomus* spp.			7	10	12
Diptera	Chironomidae	Non-*Chironomus* spp.			1		
Diptera	Culicidae	sp. indet.			1		
Diptera	Simuliidae	sp. indet.				1	
Hemiptera	Corixidae	Corixidae nymph		1			3
Hemiptera	Corixidae	*Corixa panzeri*		4	1		1
Hemiptera	Corixidae	*Hesperocorixa linnaei*					2
Hemiptera	Gerridae	Gerridae nymph			5		
Hemiptera	Gerridae	*Gerris* sp.					1
Hemiptera	Nepidae	*Nepa cinerea*					1
Crustacea	Asellidae	*Asellus aquaticus*	5	17	5	5	29
Megaloptera	Sialidae	*Sialis lutaria*			1		
Gastropoda	Bithnyiidae	*Bithynia tentaculata*		3	27	9	3

Group	Family	Species	L1	L2 (Ballindooley Lough)	L3 (Coolagh Lough Upper)	L4 (Coolagh Lough Lower)	L5
Bivalvia	Dreissenidae	*Dreissena polymorpha*			2	3	
Gastropoda	Lymnaeidae	*Ampullacaena balthica*	1	2			2
Gastropoda	Lymnaeidae	*Lymnaea stagnalis*			1	2	
Gastropoda	Physidae	*Physa fontinalis*					2
Gastropoda	Planorbidae	*Gyraulus albus*	1				
Gastropoda	Planorbidae	*Planorbarius corneus*					5
Gastropoda	Planorbidae	*Planorbis planorbis*			1	2	6
Gastropoda	Sphaeriidae	sp. indet.			3		5
Crustacea	Crangonyctidae	*Crangonyx* sp.		1			13
Arachnida	Hydrachnidiae	sp. indet.	1		2	1	
Hirudinidae	Glossiphoniidae	sp. indet.			2	2	
Hirudinidae	Piscicolidae	*Piscicola sp.*		1			
Ichthyostraca	Argulidae	*Argulus* sp.			1		
Abundance			**15**	**57**	**75**	**61**	**90**

9. Appendix C – eDNA analysis lab reports

Triturus

SureScreen Scientifics

Folio No: E19212
Report No: 1
Client: Triturus Environmental Limited
Contact: Ross Macklin

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

SUMMARY

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

RESULTS

Date sample received in laboratory: 14/09/2023
Date results reported: 25/09/2023
Matters affecting result: None

TARGET SPECIES: Brown (Sea) Trout *(Salmo trutta)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK1610	L5 GCRR Coolagh Pond	-	Pass	Pass	Pass	Positive	12/12
FK1616	L1 Ballindooley Pond	-	Pass	Pass	Pass	Positive	3/12

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SureScreen Scientifics

Crayfish plague
(Aphanomyces astaci)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK1609	L4 Coolagh Lake - Lower	-	Pass	Pass	Pass	Negative	0/12
FK1612	L2 Ballindooley Lake	-	Pass	Pass	Pass	Negative	0/12
FK1619	L3 Coolagh Lake - Upper	-	Pass	Pass	Pass	Negative	0/12

European eel
(Anguilla anguilla)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK1610	L5 GCRR Coolagh Pond	-	Pass	Pass	Pass	Positive	12/12
FK1616	L1 Ballindooley Pond	-	Pass	Pass	Pass	Positive	5/12

Smooth Newt
(Lissotriton vulgaris)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK1609	L4 Coolagh Lake - Lower	-	Pass	Pass	Pass	Negative	0/12
FK1610	L5 GCRR Coolagh Pond	-	Pass	Pass	Pass	Positive	9/12
FK1612	L2 Ballindooley Lake	-	Pass	Pass	Pass	Positive	4/12
FK1616	L1 Ballindooley Pond	-	Pass	Pass	Pass	Negative	0/12
FK1619	L3 Coolagh Lake - Upper	-	Pass	Pass	Pass	Negative	0/12

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White-clawed crayfish
(Austropotamobius pallipes)

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK1609	L4 Coolagh Lake - Lower	-	Pass	Pass	Pass	Negative	0/12
FK1610	L5 GCRR Coolagh Pond	-	Pass	Pass	Pass	Negative	0/12
FK1612	L2 Ballindooley Lake	-	Pass	Pass	Pass	Negative	0/12
FK1616	L1 Ballindooley Pond	-	Pass	Pass	Pass	Negative	0/12
FK1619	L3 Coolagh Lake - Upper	-	Pass	Pass	Pass	Negative	0/12

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

Reported by: **Jennifer Higginbottom** Approved by: **Chelsea Warner**

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SureScreen Scientifics

METHODOLOGY

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

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

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

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

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

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INTERPRETATION OF RESULTS

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

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

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

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

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

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

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

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

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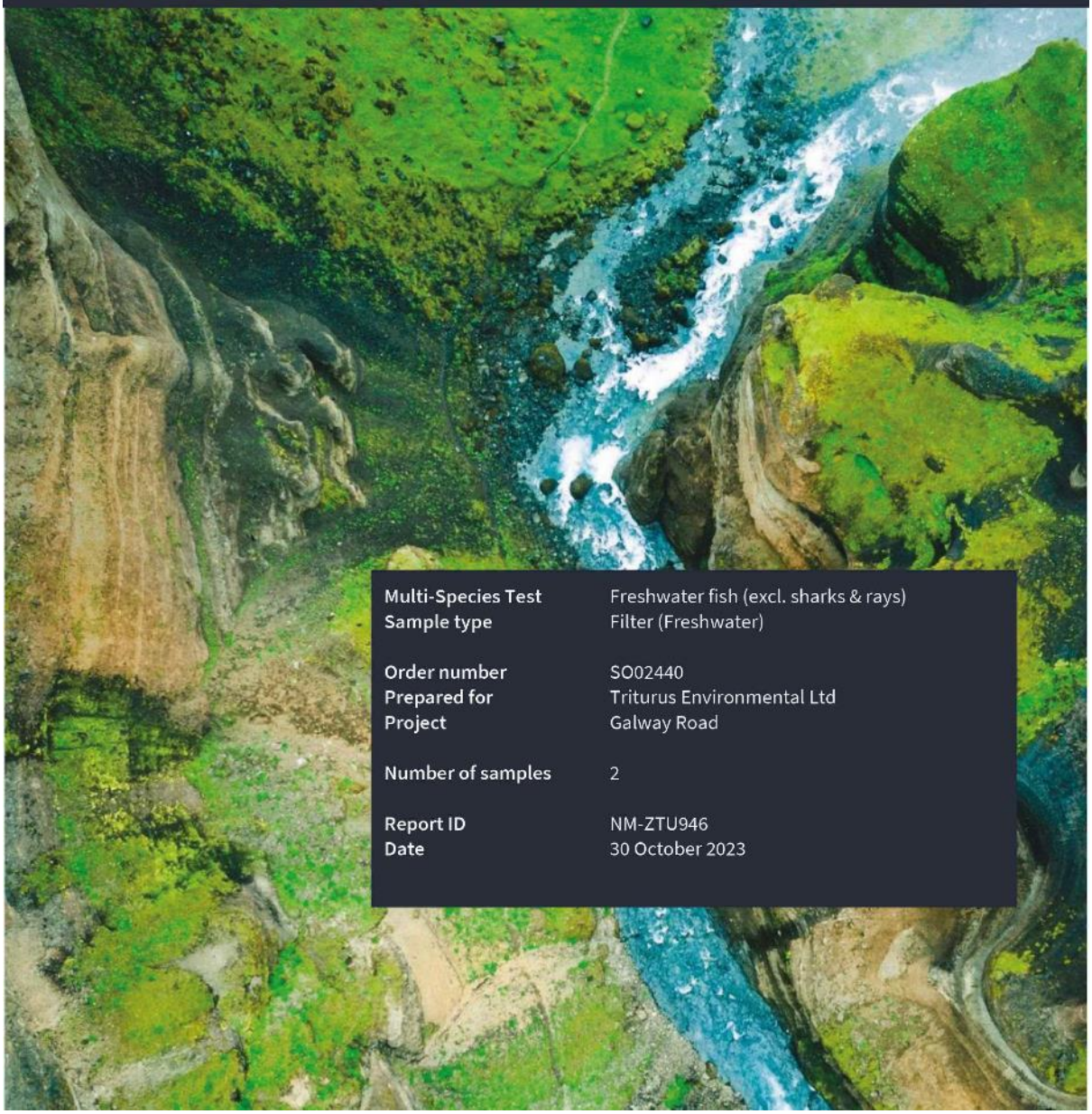
NATURE METRICS
DNA-BASED MONITORING

Environmental DNA Report
Freshwater fish (excl. sharks & rays)



Multi-Species Test	Freshwater fish (excl. sharks & rays)
Sample type	Filter (Freshwater)
Order number	SO02440
Prepared for	Triturus Environmental Ltd
Project	Galway Road
Number of samples	2
Report ID	NM-ZTU946
Date	30 October 2023

Triturus

NATURE METRICS
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Data Tables: Accompanying spreadsheet with results at the individual sample level: species detected, metrics and quality control: NM-ZTU946.SO02440.Fish.Results.xlsx

- Data Description
- Species Data Table: Percentages
- Species Data Table: Read Counts
- Metrics by Sample Table
- Quality Control Table

Throughout the report you'll see reference to 'OTU'. This stands for Operational Taxonomic Unit; an OTU is broadly equivalent to a species in most cases.

Executive Summary

Field Samples submitted:	2
Field Samples reported:	2
Field Blanks submitted:	0
Species Richness:	8
Average Species Richness per sample:	6
Total number of IUCN Red List Species:	1
Total number of Invasive Species:	0

Reported samples are those that passed Quality Control and are included in the Species Data Table

Please be careful when sharing this report, it contains biodiversity information that may be sensitive, particularly with respect to endangered or protected species. Please share responsibly. If the report is shared, we kindly ask that the report is shared in its entirety - to limit the possibility of any information being taken out of context.

New to our reports? Our Report Interpretation Guide is here to help:
www.naturemetrics.co.uk/report-interpretation-guide

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Triturus

NATURE METRICS
DNA-BASED MONITORING

REPORT

Taxonomic Composition

This chart provides a view of the species detected in your samples and their taxonomic relationship, (names on the same branch are more similar than those on different branches). The chart is structured with the highest taxonomic rank at the centre (e.g., kingdom, phylum, class), moving through the ranks of order, family, genus, species as you move to the outer edge. Note that the centre and outer ranks will change depending on the test applied and the number of species detected. The legend in the bottom right of the chart indicates how to relate the colour in the branches to the number of species. The colour scale goes from grey - indicating very few species, to blue - indicating a lot of species.

This chart is not shown for this dataset as there were fewer than 10 target OTUs detected that had unique taxonomic lineages.

Taxonomic Resolution

This table provides the number of OTUs detected and the percentage of OTUs identified to each taxonomic level.

Depending on completeness of reference databases for the region where you sampled, some OTUs may not match to a reference at species level. Global DNA reference databases contain millions of barcodes, but gaps remain, particularly in regions and taxonomic groups that are more diverse and less studied. Coverage is expected to improve over time and data tables can be updated to include new information at a future date.

Number of OTUs	Phylum	Class	Order	Family	Genus	Species
8	100%	100%	100%	100%	100%	87.50%

Want to increase the number of species named to species level? If you have specimens of species you have identified, we can sequence the DNA and add the species to our reference databases. We will then be able to enhance the reference library and report if the species is detected. Please contact us about this service and we can send you our barcoding kits, but note that we only offer these kits for fish and amphibians.

IUCN Red List Species

These are the IUCN (International Union for Conservation of Nature) Red List species detected in your samples. These are detected species that are designated as one of the IUCN Red List Threatened Categories (Vulnerable, Endangered and Critically Endangered). An increase in the number of threatened species is generally associated with a positive trend in biodiversity or habitat condition.

Species	Common name	Threat Status
Anguilla anguilla	European Eel	Critically Endangered
Number of species		1

The Data Tables contain further information for all species, including their designations as Least Concern or Near Threatened status.

Invasive Species

These are the Invasive species detected in your samples. These species are invasive according to the Global Register of Introduced and Invasive Species (GRIIS) in the country where sampling occurred. GRIIS is an IUCN Invasive Species Specialist Group initiative. The Convention on Biological Diversity defines an invasive species as one whose introduction and/or spread threatens biological diversity. An increase in the number of invasive species is generally associated with enhanced pressures at your site and reduced resilience of the native community. Please note: this label is only available for animals; and GRIIS lists marine species as invasive for a country, even if the species is known to be invasive in only one marine area bordering the country.

No invasive species were detected in the samples.

NATURE METRICS
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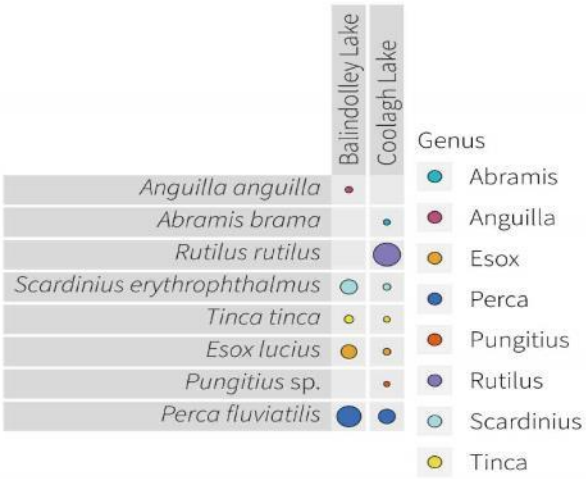
Community Composition

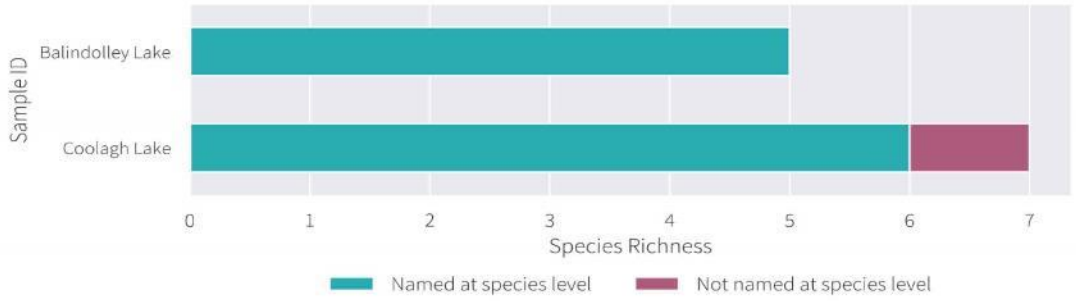
This chart lists the species found in each sample. The presence of a bubble means a species was detected in that sample. The chart displays at species level, unless the number of species detected is too great to display clearly in the document. In these cases, the chart displays at a higher taxonomic level. The full species level chart is provided as an appendix.

The size of the bubbles represents the proportion of DNA sequences within a sample. A larger bubble size can indicate a stronger eDNA signal. This signal may be linked to abundance of species in the environment but should be interpreted only as a coarse measure because the signal is also impacted by biological (e.g., biomass, life stage, activity, body condition), environmental (e.g., temperature, pH, salinity, conductivity), and technical factors (e.g., primer bias, PCR stochasticity).



Species Richness

This is the total count of OTUs detected in each sample. The blue portion of each bar indicates the number of OTUs identified to a species.



High Species Richness generally indicates a healthier and functioning ecosystem and is the simplest biodiversity metric that is consistently reported in biodiversity monitoring.

Evolutionary Diversity

Evolutionary Diversity calculated for each sample. This is a measure of the variety of species types that occurred in your samples.

Evolutionary Diversity is a strong complementary indicator of biodiversity progress alongside Species Richness. Increasing Evolutionary Diversity can indicate an increasing resilience of the community.

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