Fisheries assessment of the River Liffey, Co. Kildare

Prepared by Triturus Environmental Ltd. for

North Kildare Trout & Salmon Anglers Association

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by North Kildare Trout & Salmon Anglers Association (NKTSAA) to undertake a baseline fisheries assessment of numerous sites on the River Liffey (EPA code: 09L01) within NKTSAA club jurisdiction throughout Co. Kildare. The project was financed through the Community Water Development Fund with support from the Local Authorities Water Programme (LAWPRO).

The surveys were completed to provide a baseline of fish stocks and associated fisheries habitat along the River Liffey, which would allow for future comparative studies, thus informing more effective management and conservation efforts by the club, in conjunction with other stakeholders.

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 electro-fishing surveys of the River Liffey at six sites in Co. Kildare (Kilcullen Bridge, Athgarvan Bridge, Newbridge, Barretstown Cemetery, Caragh Bridge and downstream of Liffey Bridge). The surveys were completed in September 2020.

1.2 River Liffey general fisheries asset

The River Liffey (EPA code: 09L01) rises near Kippure in the Wicklow mountains and has a catchment of over 1300km^2, flowing for approx. 50km in a crescent shape before entering the Irish Sea in Dublin Bay. There are a number of anthropogenic pressures affecting the Liffey throughout its course, including urbanisation, waste-water pollution, water abstraction and channel modification, in addition to hydro-regulation (from the dams at Poulaphouca (Blessington), Golden Falls and Leixlip). Despite these pressures on water quality and hydromorphology, the River Liffey is a river of county importance for fish species of high conservation value. These include anadromous Atlantic salmon (*Salmo salar*) which have heavily impacted by dam construction and are 'not self-sustaining' upstream of these impassable barriers (McGinnity et al., 2003). The river is an important recreational brown trout (*Salmo trutta*) fishery (O'Reilly, 2009), with particularly fast growth noted (Kelly et al., 2010). Additionally, the River Liffey is known to support European eel (*Anguilla anguilla*), *Lampetra* sp. lamprey, minnow (*Phoxinus phoxinus*), roach (*Rutilus rutilus*), three-spined stickleback (*Gasterosteus aculeatus*), pike (*Esox lucius*), perch (*Perca fluviatilis*) and stone loach (*Barbatula barbatula*) (Kelly et al., 2010, 2011, 2014; Macklin & Brazier, 2018; Champ, 2005). Bream (*Abramis brama*) and gudgeon (*Gobio gobio*) are also known to be present (pers. obs.). The Liffey catchment also supports Annex II white-clawed crayfish (*Austropotamobius pallipes*) and supports populations of county importance. These are also one of the main prey species of otter (*Lutra lutra*) on the River Liffey.

Recent biological water quality data was available from a number of EPA monitoring stations along the river. In 2019, water quality in the upper reaches ranged from Q4 (good status) in the upper reaches at Ballymore Eustace (station RS09L010400) to Q4-5 (high status) at Kilcullen

Bridge (RS09L010700) and at Connell Ford (RS09L010850). However, downstream of Newbridge the quality decreased to Q4 (good status) before falling to Q3-4 (moderate status) downstream of Leixlip and Q3 (poor status) closer to Dublin City. Thus, in its upper reaches, the river is achieving the 'good status' (Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC), but failing to meet this target in the lower catchment.

2. Methodology

2.1 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish a total of *n*=6 sites on the River Liffey (**Table 2.1; Figure 2.1**). Surveys were undertaken in late September 2020, following notification to Inland Fisheries Ireland and under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) license.

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

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

2.1.1 Salmonids, non-salmonids and European eel

For salmonid species and European eel, as well as other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. ≥50-100m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages.

The 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 a voltage of 250-275V, frequency of 45-50Hz and pulse duration of 3.5ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted box quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed detection of juvenile European eel in sediment, if present. Settings for lamprey followed

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

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

Table 2.2 Electro-fishing sites surveyed on the River Liffey in September 2020 (*n*=6 total, presented longitudinally along catchment)

Site no.	Watercourse	EPA code	Location	ITM (x)	ITM (y)
1	River Liffey	09L01	d/s Kilcullen Bridge, Kilcullen	684154	709830
2	River Liffey	09L01	u/s Athgarvan Bridge, Rosetown	682087	712132
3	River Liffey	09L01	Ryston Close, Newbridge	680851	714580
4	River Liffey	09L01	Barretstown Cemetery, 4.5km d/s Newbridge	682937	719131
5	River Liffey	09L01	Carragh Bridge, Gingerstown, Naas	685342	720774
6	River Liffey	09L01	0.5km d/s Liffey Bridge Sallins	687847	723103

2.2 Fisheries habitat

2.2.1 Salmonids

Fisheries habitat quality for salmonids was assessed using the Life Cycle Unit method (Kennedy, 1984; O'Connor & Kennedy, 2002) to map the *n*=6 riverine sites as nursery, spawning and holding habitat, by assigning quality scores to each type of habitat. Those habitats with poor quality substrata, shallow depth and a poorly defined river profile receive a higher score. Higher scores in the Life Cycle Unit method of fisheries quantification are representative of poorer value, with lower scores being more optimal despite this appearing counter-intuitive.

Table 2.1 Life Cycle Unit scoring system for salmonid nursery, spawning and holding habitat value (as per Kennedy, 1984 & O'Connor & Kennedy, 2002)

Habitat quality	Habitat score	Total score (three components)
Poor	4	12
Moderate	3	9-11
Good	2	6-8
Excellent	1	3-5

2.2.2 Lamprey

Lamprey habitat evaluation for each survey site was undertaken using the Lamprey Habitat Quality Index (LHQI) scoring system, as devised by Macklin et al. (2018). The LHQI broadly follows a similar rationale as the Life Cycle Unit score for salmonids. Those habitats with a lack of soft, largely organic sediment areas for ammocoete burrowing, shallow sediment depth (<10cm) or compacted sediment nature receive a higher score. Higher scores in this index are thus of poorer value (in a similar fashion to the salmonid Life Cycle Unit Index), with lower scores being more optimal. Overall scores are calculated as a simple function of the sum of individual habitat scores.

Larval lamprey habitat quality as well as the suitability of adult spawning habitat is assessed based on the information provided in Maitland (2003) and other relevant literature (e.g. Gardiner, 2003). Unlike the salmonid Life Cycle Unit index, holding habitat for adult lamprey is not assessed owing to their different migratory and life history strategies, and that electro-fishing surveys routinely only sample larval lamprey.

The LHQI scoring system provides additional information compared to the habitat classification based on the observations of Applegate (1950) and Slade et al. (2003), which deals specifically with larval (sea) lamprey settlement habitat. Under this scheme, habitat is classified into three different types: preferred (Type 1), acceptable (Type 2), and not acceptable for larvae (Type 3) (Slade et al. 2003). Type 1 habitat is characterized by soft substrate materials usually consisting of a mixture of sand and fine organic matter, often with some cover over the top such as detritus or twigs in areas of deposition. Type 2 habitat is characterized by substrates consisting of shifting sand with little if any organic matter and may also contain some gravel and cobble (lamprey may be present but at much lower densities than Type 1). Type 3 habitat consists of materials too hard for larvae to burrow including bedrock and highly compacted sediment. This classification can also be broadly applied to other lamprey species ammocoetes, including *Lampetra* species.

Table 2.2 Lamprey Habitat Quality Index (LHQI) scoring system for lamprey spawning and nursery habitat value (Macklin et al., 2018).

Habitat quality	Habitat score	Total score (two components)
Poor	4	8
Moderate	3	6-7
Good	2	3-5
Excellent	1	2

2.2.3 General fisheries habitat

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

2.3 Biosecurity

A strict biosecurity protocol following the Check-Clean-Dry approach was employed during the crayfish surveys. Equipment and PPE used was disinfected with Virkon® between survey sites to prevent the transfer of pathogens and/or invasive species between survey areas. Equipment was also thoroughly dried (through UV exposure) between the sampling of different watercourses. Particular cognisance was given to preventing the introduction or spread of crayfish plague (*Aphanomyces astaci*) given the known presence of a healthy white-clawed crayfish population in the River Liffey catchment. Surveys were undertaken at sites in a downstream order (i.e. uppermost site on each watercourse surveyed first) to prevent the upstream mobilisation of invasive propagules and pathogens, including crayfish plague.

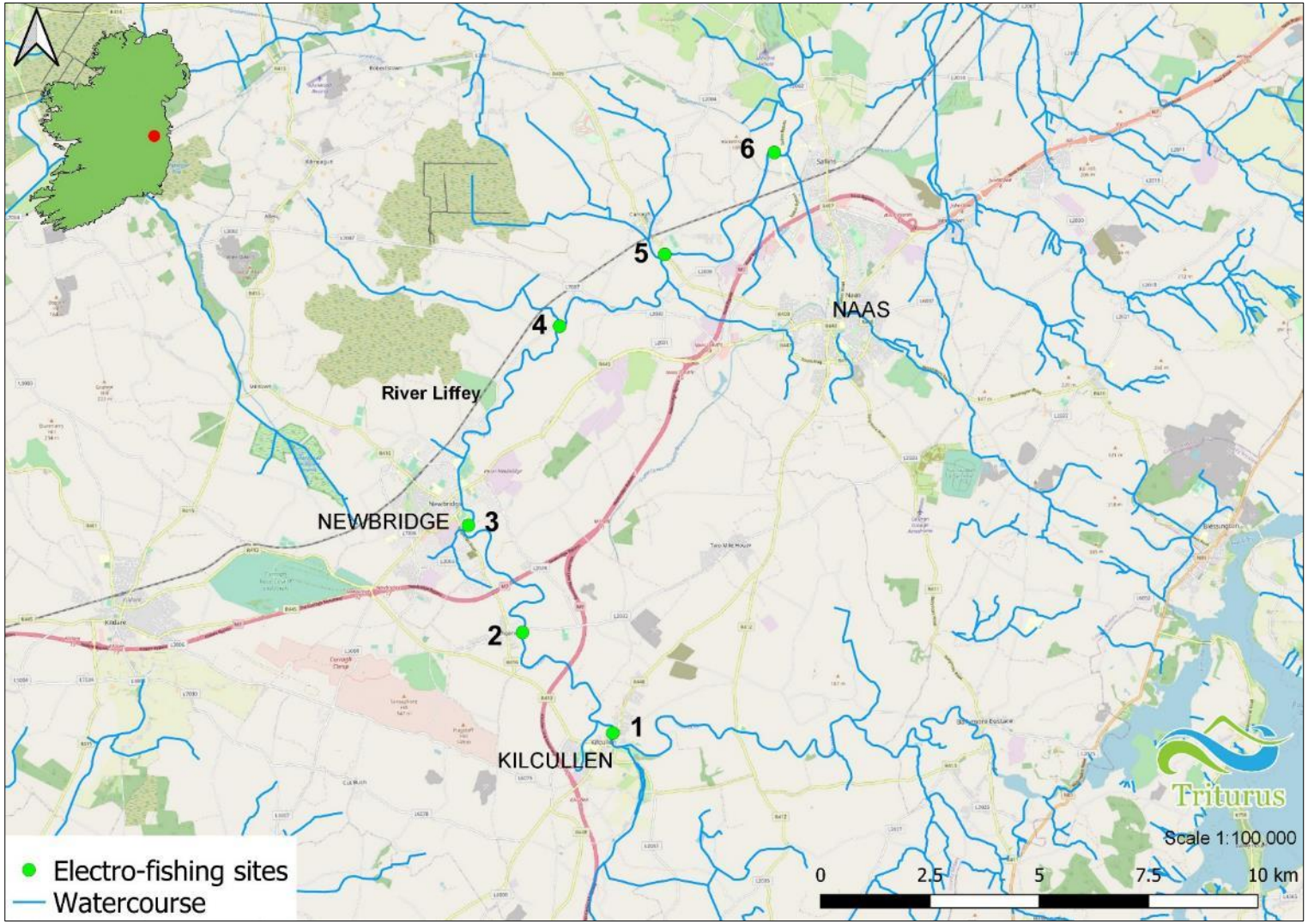

Figure 2.1 Location overview of the *n*=6 electro-fishing sites surveyed on the River Liffey, September 2020

3. Site descriptions

3.1 Site 1 – River Liffey, d/s Kilcullen Bridge

The River Liffey downstream of Kilcullen Bridge was a large, semi-natural lowland depositing watercourse (FW2). The river averaged 20m in width and 0.3-0.6m in depth, with both extensive shallower areas (<0.3m) and deeper pool areas to >2m. The moderate-energy site was typified by fast shallow glide habitat (60%) with occasional riffle zones at the tail of a large deep holding pool in the vicinity of the bridge. The substrata were dominated by cobble (40%) with occasional boulder (20%) and medium to coarse gravels (20%) in interstitial spaces and at the tailing of pool and glide habitat. Marginal slacks and creases supported fine gravels and sand, particularly along the eastern bank. The concrete bridge apron (3 arches) supported some gravel deposits but overall offered little fisheries value (<0.1m deep mostly). Instream macrophytes were dominated by spiked water milfoil (*Myriophyllum spicatum*) with frequent small water crowfoot beds (*Ranunculus* subgenus *Batrichion* agg.). Common clubrush (*Schoenoplectus lacustris*) and the emergent & submerged form of pink water speedwell (*Veronica catenata*) were both present but rare. Lesser water parsnip (*Berula erecta*) was present (both submerged and emergent forms). Canadian pondweed (*Elodea canadensis*) was present but rare (marginal slacks). The river moss *Fontinalis antipyretica* was occasional on larger instream boulder and cobble. *Hygroamblystegium tenax* was present on the weir face. Filamentous algae (*Cladophora* sp.) was abundant and the site had a high (excessive) coverage (30-40% surface area) (**Plate 3.2**). Siltation was moderate overall, which was higher than expected for the river type.

The riparian zone supported mosaics of tall herb and reed swamp vegetation, with fool's watercress (*Apium nodiflorum*) and abundant reed canary grass (*Phalaris arundinacea*) along the east bank. This area also supported frequent great willowherb (*Epilobium hirsutum*), nettle (*Urtica dioica*), hedge bindweed (*Calystegia sepium*), creeping buttercup (*Ranunculus repens*) and the invasive Himalayan balsam (*Impatiens glandulifera*). Common valerian (*Valeriana officinalis*) grew on the bridge structure and abutments. On the west bank, the river was bordered by a mature treeline (WL2; Fossitt, 2000) of crack willow (*Salix fragilis*), sycamore (*Acer psuedoplatanus*), alder (*Alnus* sp.) grey willow (*Salix cinerea*) and ash (*Fraxinus excelsior*) with wild angelica (*Angelica sylvestris*), nettle and Himalayan balsam.

Plate 3.1 Representative image of site 1 on the River Liffey at Killcullen Bridge

Plate 3.2 Representative image of filamentous algal cover and siltation of substrata at site 1

3.2 Site 2 – River Liffey, u/s Athgarvan Bridge

The River Liffey upstream of Athgarvan Bridge was a high-energy, lowland depositing watercourse. The site averaged 20m wide and 0.3-0.6m deep with locally deeper glides and pools to 1.5m (some pools >2m near the weir). Downstream of the weir structure, the site was typified by fast shallow glide (50%) and frequent riffle (30%) with localised pool, often small in area (20%). The substrata were dominated by cobble (50%) with locally frequent smaller boulder (20%) and frequent well-sorted medium to coarse gravels. Sand was present locally in slacks and in association with macrophyte beds. Spiked water milfoil was the dominant macrophyte (10% cover), with lesser amounts of water crowfoot. Pink water speedwell, lesser water parsnip and water starwort (*Callitriche* sp.) were present locally in slacker areas. Common clubrush was rare. *Fontinalis antipyretica* was occasional on larger instream boulders. Red algae (*Batrachospermum* sp.) had colonised boulders and aquatic mosses. Filamentous algae cover was excessively high (50% of substrata). This was higher than upstream at Kilcullen and reduced the overall fisheries value of the site.

The riparian zone supported abundant willow vegetation (crack and grey) with sycamore and horse chestnut (*Aesculus hippocastanum*). Reed canary grass was abundant along the river margins and colonised instream gravel islands/shoals downstream of the weir. The invasive Himalayan balsam was scattered throughout the riparian zone, along with nettle, wild angelica, and hedge bindweed.

Plate 3.3 Representative image of site 2 on the River Liffey at Athgarvan Bridge (facing upstream towards weir)

3.3 Site 3 – River Liffey, d/s The Gables, Newbridge

The River Liffey downstream of the Gables, Newbridge was a swift-flowing lowland depositing watercourse (FW2), which averaged 20m wide and 0.3-0.5m deep, with locally deeper pools and glides to 1.2m. Deeper pool habitat was present upstream at the large meander (by car park) and downstream of riffle zone survey area. The river flowed in a shallow U-shaped channel alongside a parkland and residential area (Ryston Close). The site featured mostly riffle (40%) and shallow glide (40%) with localised pool, mostly along the path-side bank (south). Deeper glide predominated upstream and downstream. The substrata comprised mostly compacted cobble (30%) with occasional boulder (20%). However, well-mixed gravels were frequent and accounted for the majority of the substrata (40%) with localised coarse sand (5%) and silt (5%). Overall, levels of siltation were moderate despite high flow rates. Exposed clay was also present in some areas along the north bank. Generally, the substrata were less compacted along the south bank and upstream of the riffle zone (i.e. better spawning habitat, see **section 4.1.3**). Filamentous algal cover was excessively high, as per upstream (approx. 50% cover) and significantly reduced the value of the site. Instream macrophytes were dominated by curled pondweed (*Potamogeton crispus*) and spiked water milfoil, with occasional pink water speedwell, hemlock water dropwort (*Oenanthe aquatica*), lesser water parsnip and water mint (*Mentha aquatica*). In terms of aquatic mosses, *Fontinalis antipyretica* was frequent on larger cobble and boulder, with occasional *Cinclidotus fontinaloides*. The substrata were invariably covered by filamentous algae (such as *Cladophora* sp.) and or red algae (*Batrachospermum* sp.) (**Plate 3.5**).

The riparian zone featured a mature treeline of alder, grey willow and hawthorn (*Crataegus monogyna*) along the north bank, with bramble scrub (*Rubus fruticosus* agg.). The south bank was dominated by reed canary grass with nettle, bindweed, water mint, great willowherb and occasional crack willow and grey willow. Invasive Himalayan balsam was scattered throughout the site.

Plate 3.4 Representative image of site 3 on the River Liffey at Newbridge (facing upstream from riffle zone)

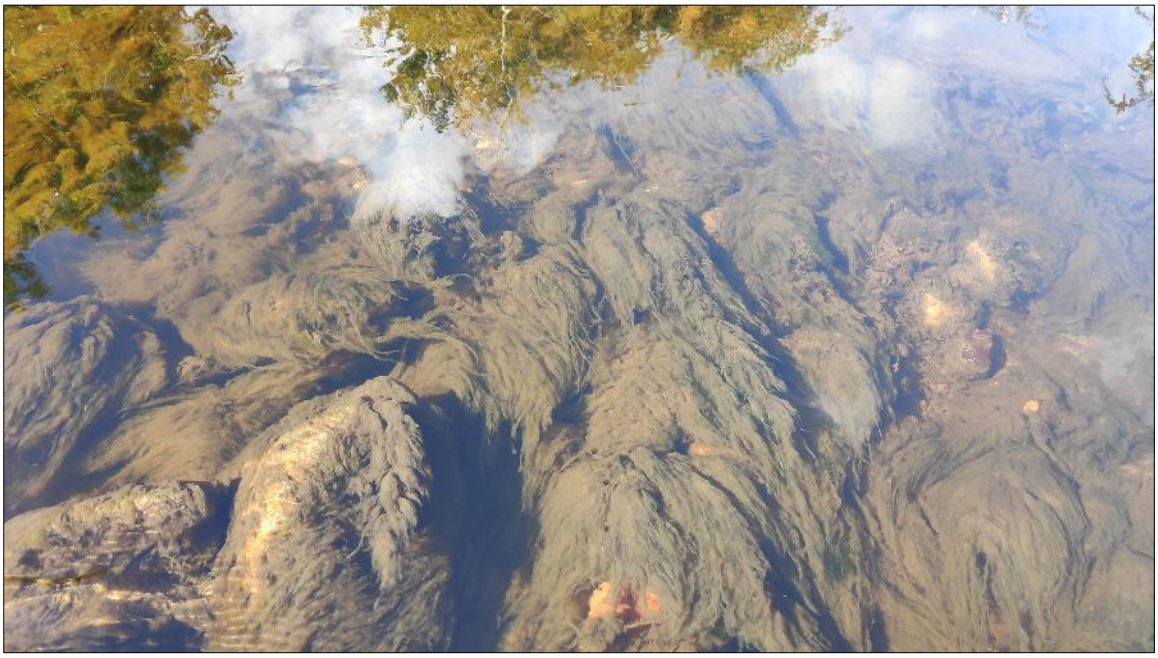

Plate 3.5 Representative image of high filamentous algal cover of cobble substrata at site 3

3.4 Site 4 – River Liffey, Barretstown Cemetery

The River Liffey at site 4 was of higher energy than upstream sites. The river averaged 25m in width and 0.2-0.4m in depth (shallower and significantly faster than upstream sites), with frequent, scattered pool areas to 1.6m. Very fast glide predominated (60%) with occasional riffle (30%) and localised pool (mostly along the western bank). However, even pool areas featured very fast flows. As a result, the substrata were largely clean and free from the filamentous algal cover so prominent upstream. The substrata were dominated by unbedded cobble (40%) with high fractions of well-mixed gravels (30%), particularly along the east bank (lower flows). Exposed clay was present in some areas, locally. Boulder was also occasional (10%). Instream macrophytes were dominated by spiked water milfoil (abundant) and frequent lesser water parsnip (submerged form), with occasional water crowfoot and curled pondweed. Pink water speedwell (submerged form) was occasional. The coverage of *Fontinalis antipyretica* was relatively high (10%) with the liverwort species *Chiloscyphus polyanthos* occasional. The river margins supported frequent reed canary grass (some stands of which were undercut and provided fish refugia). Water mint and water pepper (*Persicaria hydropiper*) were also occasional.

The river was bordered by a mature beech-dominated broad-leaved woodland (WD1) with scattered alder, sycamore, ash, grey willow and crack willow and bramble along the riparian zone. Reed canary grass, hedge bindweed, great willowherb, creeping buttercup, nettle and the non-native snowberry (*Symphoricarpos albus*) were also present.

Plate 3.6 Representative image of site 4 on the River Liffey at Barretstown Cemetery (facing downstream)

Plate 3.7 The substrata were cleaner than upstream sites given higher flow rates (filamentous algae still present, however)

3.5 Site 5 – River Liffey, Caragh Bridge

The River Liffey at site 5 averaged 30m in width and 0.1-0.4m in depth, with locally deeper fast glide along the west bank upstream and deeper pool habitat present downstream of the bridge. The site was dominated by fast shallow glide (70%) with occasional riffle (20%) and localised pool (10%). Given high flow rates, the substrata were clean, unbedded and free from siltation. Filamentous algae cover was low (unlike sites 1, 2, & 3 upstream). The substrata were dominated by cobble (40%) and well-sorted medium to coarse gravels (40%), with only localised boulder (possibly historically installed) and sand. Sediment accumulations were only present in vicinity of mid-channel islands downstream of the bridge and, even here, these were shallow and mostly sand-dominated (i.e. poor lamprey habitat, see **section 4.1.5**). The site featured a high coverage (50%) of macrophytes, particularly upstream of the bridge. Here, abundant spiked water milfoil and frequent water crowfoot were present, with occasional lesser water parsnip (submerged) and rare common club rush. The bryophyte coverage was high also, with abundant *Fontinalis antipyretica* and occasional *Hygroamblystegium tenax*. Filamentous algal coverage was low.

The site was bordered by crop fields (BC3) and improved agricultural grassland (GA1). The riparian zone featured mature treelines (WL2) comprising plentiful crack willow, grey willow, alder, sycamore, ash and hawthorn with abundant Himalayan balsam. Nettle, butterbur (*Petasites hybridus*), reed canary grass, great willowherb, hedge bindweed, creeping buttercup and broad-leaved dock (*Rumex obtusifolius*) were also common.

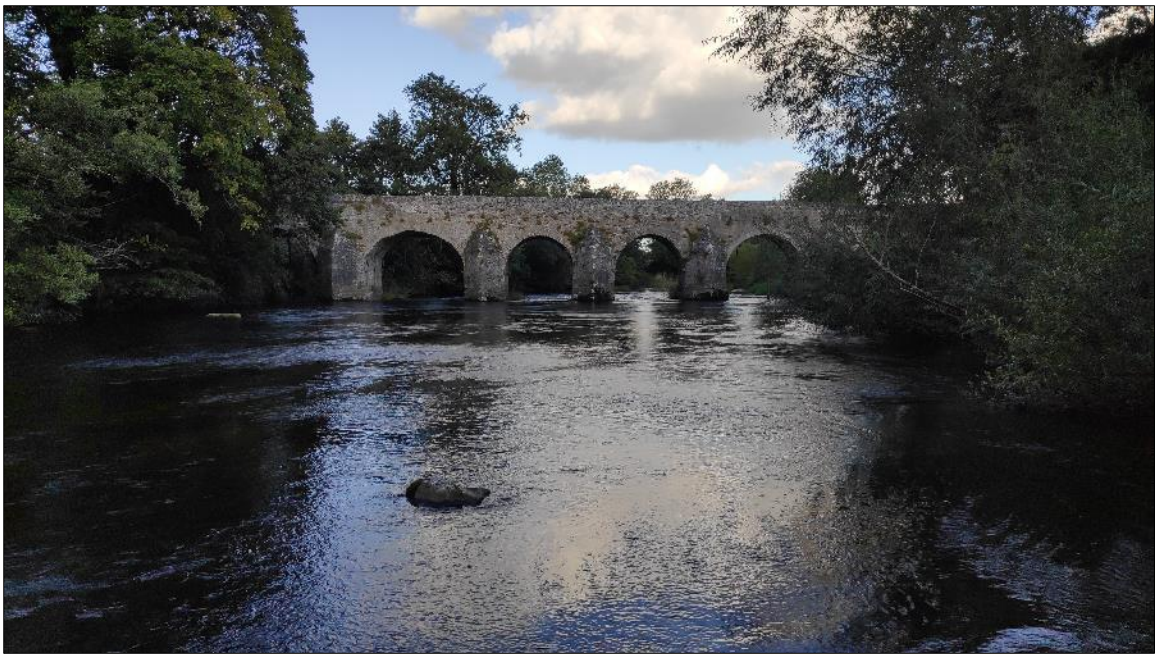

Plate 3.8 Representative image of site 5 on the River Liffey at Caragh Bridge (facing downstream towards bridge)

Plate 3.9 Small clubrush stands and mid-channel islands downstream of Caragh Bridge

3.6 Site 6 – River Liffey, 0.5km d/s Liffey Bridge, Sallins

The River Liffey at site 6 averaged 30-35m in width and 0.3-0.6m in depth. The site was typified by fast glide (50%) with a riffle zone (30%) and localised pool to 1.5m. The substrata were dominated by cobble (50%) with occasional boulder (20%) and interstitial gravels (20%) with finer gravels and sand in marginal slacks. Sediment accumulations were rare and limited to extreme marginal areas. However, the substrata were relatively compacted in comparison to upstream areas and this reduced the overall fisheries value of the site, particularly in terms of spawning (see **section 4.1.6**). The site featured a heavy coverage of thick beds of water crowfoot and spiked water milfoil (30% coverage combined). Submerged lesser water parsnip and pink water speedwell was occasional. Common club rush stands were rare but present in marginal areas along both north and south banks. Branched bur-reed (*Sparganium erectum*) was intermixed with reed sweet grass (*Glyceria maxima*) reed canary grass along both margins. Bryophytes were rare and restricted to occasional *Fontinalis antipyretica* on larger instream boulder. Invasive Himalayan balsam was scattered throughout.

The riparian zones were characterised by abundant reed canary grass and reed sweet grass with nettle, hedge bindweed, broad-leaved dock, creeping buttercup and water pepper. Mature crack willow, grey willow, ash, alder and hawthorn treelines lined both banks.

Plate 3.10 Representative image of site 6 on the River Liffey 0.5km downstream of Liffey Bridge, Sallins

4. Results

An electro-fishing survey of *n*=6 sites on the River Liffey was undertaken in September 2020 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only. Additional survey images are provided in **Appendix A**.

4.1 Fish stock assessment (electro-fishing)

4.1.1 Site 1 – River Liffey, d/s Kilcullen Bridge

A total of five fish species were recorded from site 1, located downstream of Kilcullen Bridge (**Figure 4.1**). Brown trout were the most numerous (*n*=22), with juvenile size classes dominating. A single Atlantic salmon parr (16.3cm FL) was recorded. Moderate numbers of minnow and stone loach were present, typically in association with macrophyte beds. A single European eel was also captured.

The site was an excellent salmonid habitat overall, offering combinations of good spawning and good nursery habitat (**Table 4.1**). Excellent holding habitat was present in the large deep pool immediately downstream of the bridge, in addition to installed salmon groynes/boulders downstream of main pool. However, spawning substrata were impacted by excessive cover of filamentous algae (but otherwise good and unbedded). Nursery habitat quality was good in areas adjoining beds of spiked water milfoil and water crowfoot, with moderate numbers of juvenile salmonids present. Whilst some good spawning substrata for lamprey was present locally (finer gravels), suitable ammocoete habitat was sparse and typically sand-dominated. European eel habitat was good overall given the presence of abundant larger cobble, occasional large boulder and deep pool habitat. Incidentally, white-clawed crayfish were observed present at low densities, mostly along the muddy margins of the west bank. Fresh otter spraint containing fresh crayfish remains was recorded on a marginal boulder (salmon groyne) located c.50m downstream of the bridge (ITM 684148, 709774).

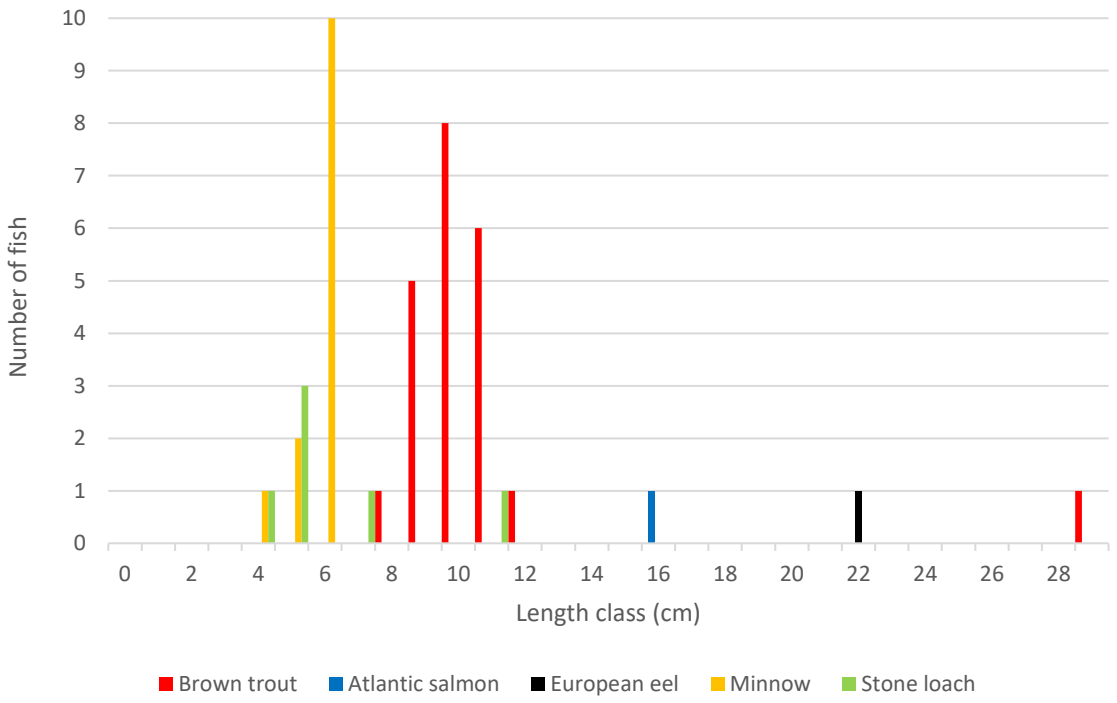

Figure 4.1 Fish stock length distribution recorded via electro-fishing at site 1 on the River Liffey at Kilcullen Bridge, September 2020

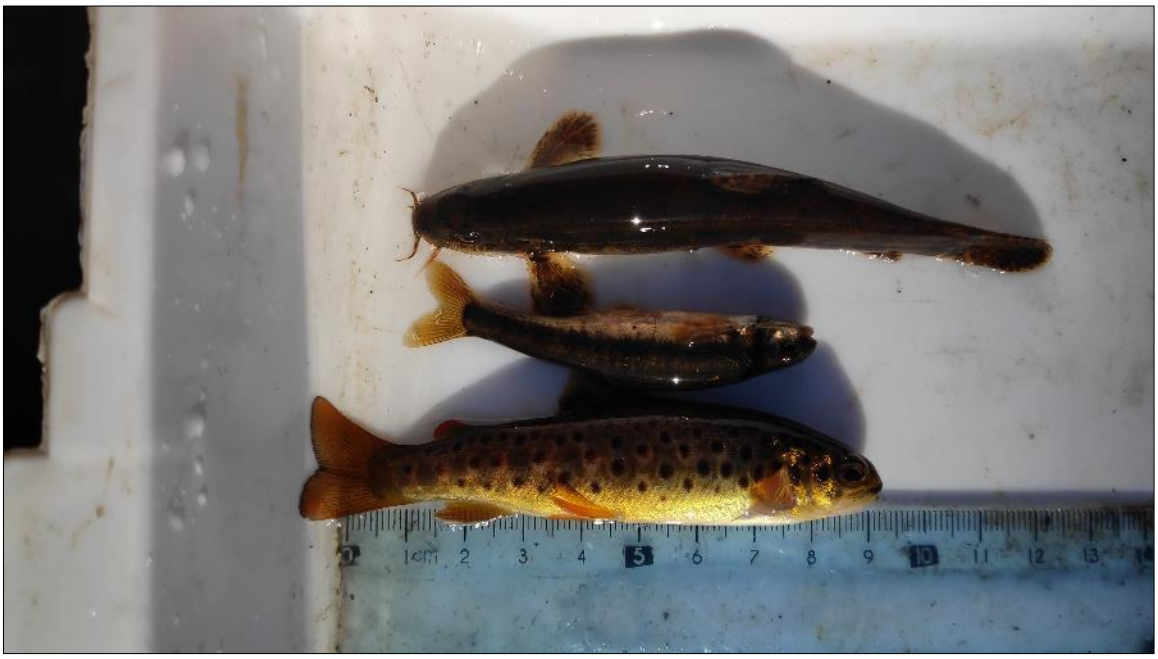

Plate 4.1 Stone loach (top), minnow (centre) and juvenile brown trout (bottom) recorded from site 1

4.1.2 Site 2 – River Liffey, u/s Athgarvan Bridge

A total of four fish species were recorded from site 2, located upstream of Athgarvan Bridge (**Figure 4.1**). Brown trout dominated the site (*n*=48), with high numbers of juveniles and lower numbers of adults present. A particularly large adult (45.8cm FL and approx. 1.2kg) was recorded (**Plate 4.2**). Moderate numbers of minnow were present. Single examples of perch and pike were also recorded. No European eel, salmon or lamprey were recorded.

The site was an excellent salmonid habitat overall, with a high number of brown trout recorded. The high-energy site was more suited to adult fish although frequent macrophyte beds and shallower glides offered some very good nursery habitat. The overall value of the site (as per site 1 upstream) was reduced given very high coverage of filamentous algae (50% bed cover) and associated sedimentation. Holding habitat was excellent for adult salmonids in slacks adjoining the main flow downstream of the weir, notably along the west bank (underneath overhanging trees). Filamentous algae cover aside, salmonid spawning habitat was of good quality, with frequent areas of cobble and clean, unbedded gravels. Whilst these areas offered good lamprey spawning potential, ammocoete habitat was largely absent given high flow rates - sediment deposits were either sand-dominated or very shallow and flocculent in nature. European eel were not recorded despite some good suitability locally in boulder-dominated areas and undercut banks/pools. White-clawed crayfish were present and recorded in fresh otter spraint on mature crack willow immediately downstream of the bridge (ITM 682088, 712192).

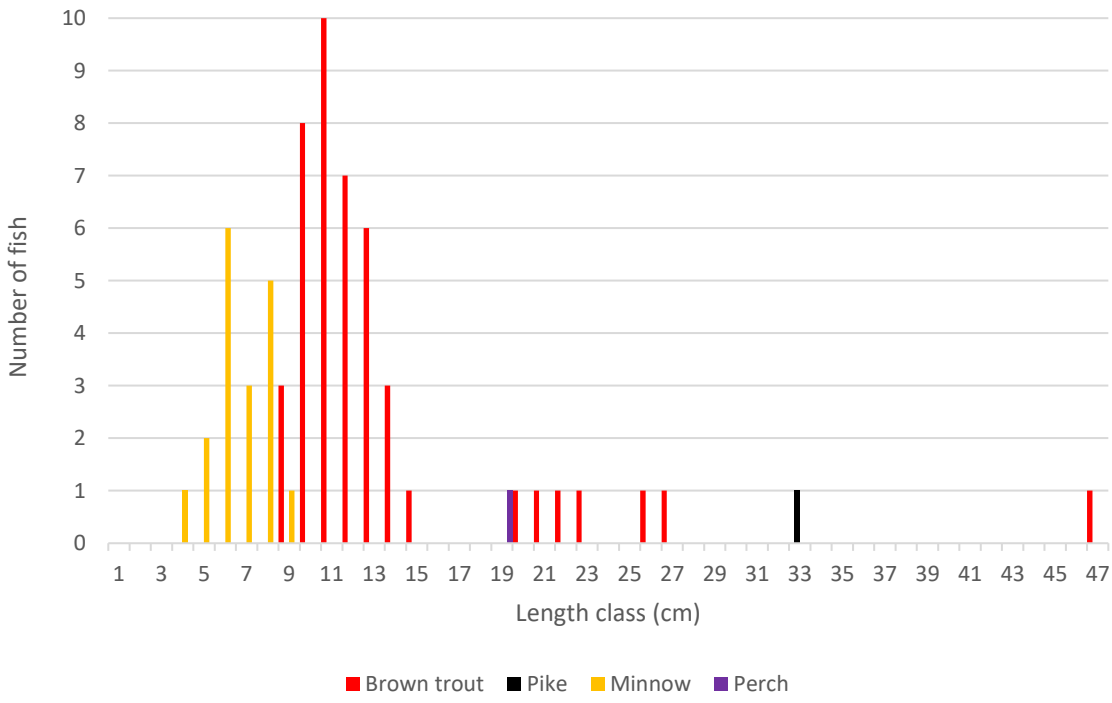

Figure 4.2 Fish stock length distribution recorded via electro-fishing at site 2 on the River Liffey at Athgarvan Bridge, September 2020

Plate 4.2 Large adult brown trout of 45.8cm recorded from site 2

4.1.3 Site 3 – River Liffey, d/s The Gables, Newbridge

A total of four fish species were recorded from site 3, located downstream of the Gables Leisure Centre car park, Newbridge (**Figure 4.3**). Minnow were the most numerous species (*n*=31), captured mainly in slacker areas of flow along the north bank. Moderate numbers of brown trout were recorded, with both juveniles and lower amounts of adults present (*n*=19 total). A low density of *Lampetra* sp. ammocoetes was recorded (*n*=6) from soft sediment accumulations associated with a mid-channel island. Three of these were 'transformers' (i.e. maturing into adults). Stone loach were also present in low numbers.

The site was a good overall salmonid habitat (**Table 4.1**) although the value of the site was reduced by excessive filamentous algal cover (indicating enrichment) and moderate siltation. The site supported a moderate density of juvenile and adult brown trout, but no Atlantic salmon were recorded. Holding habitat was largely absent at the site (but present both upstream and downstream). European eel habitat was moderate at best (lack of instream suitable refugia). Lamprey spawning habitat was good overall (**Table 4.2**) (more so upstream of riffle zone) and there was some localised ammocoete habitat supporting a low density of ammocoetes in the lee of the small reed canary grass island. White-clawed crayfish were present at low densities (flow rate too high to be optimal habitat).

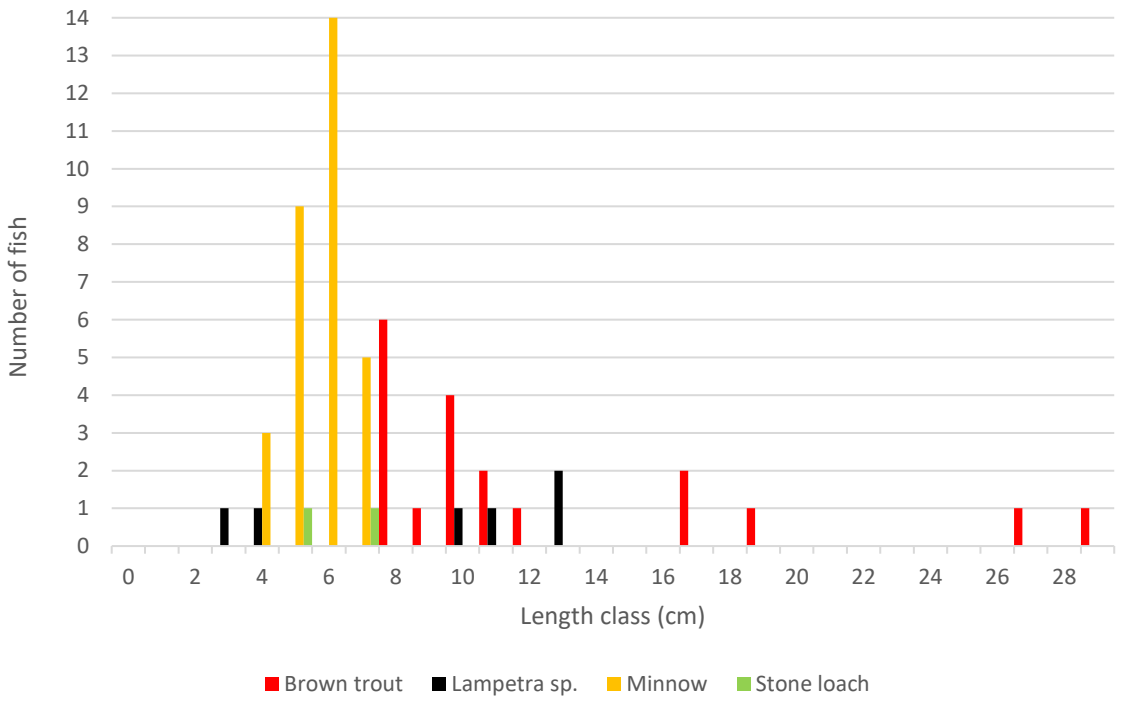

Figure 4.3 Fish stock length distribution recorded via electro-fishing at site 3 on the River Liffey at Newbridge, September 2020

Plate 4.3 Example of a *Lampetra* sp. transformer (centre) and ammocoetes recorded from site 3

4.1.4 Site 4 – River Liffey, Barretstown Cemetery

A total of four fish species were recorded from site 4, located approx. 4.5km downstream of site 3 at Barretstown Cemetery (**Figure 4.4**). Minnow were the most numerous species encountered (*n*=38), captured mainly in slacker areas of flow along the east bank. Moderate numbers of brown trout were recorded (*n*=23), with juveniles and adults present in roughly equal numbers. A single Atlantic salmon parr (15.8cm FL) was recorded. A moderate number of stone loach (juveniles and adults) was also present. No European eel or lamprey were recorded.

The site was an excellent overall salmonid habitat (**Table 4.1**) with excellent quality spawning habitat throughout (clean, unbedded, unsilted cobble and gravels). The substrata were better suited to better suited to Atlantic salmon spawning than trout (i.e. larger average particle sizes). Nursery and holding habitat were good although the value was reduced by the very fast flows present at the site (much higher than upstream). The coverage of macrophytes offered valuable juvenile salmonid refugia although a greater coverage of water crowfoot would be preferable. The site was typically of too high energy to be of value to lamprey ammocoetes (little or no fine sediment accumulations), despite some good spawning gravels for adults. European eel habitat was moderate but none were recorded.

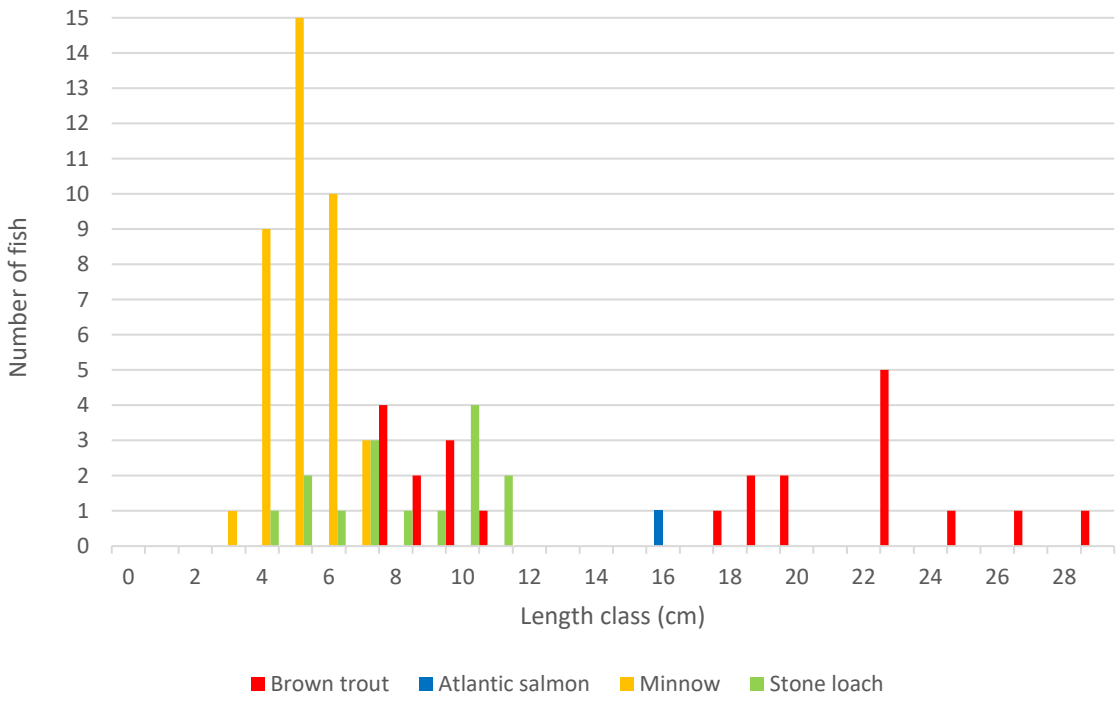

Figure 4.4 Fish stock length distribution recorded via electro-fishing at site 4 on the River Liffey at Barretstown Cemetery, September 2020

Plate 4.4 Atlantic salmon parr recorded from site 4

4.1.5 Site 5 – River Liffey, Caragh Bridge

A total of five fish species were recorded from site 5, located at Caragh Bridge (**Figure 4.5**). Minnow were the most numerous species encountered (*n*=52), followed by stone loach (n=38). Brown trout were present in relatively high numbers (*n*=29), with roughly equal numbers of juveniles and adults captured, including a particularly large 38.7cm individual. Two Atlantic salmon parr were recorded (8.2cm & 10.1cm FL). A low density of *Lampetra* sp. ammocoetes were recorded from localised sediment accumulations associated with macrophyte beds. No European eel were recorded.

The site was an excellent overall salmonid habitat with excellent quality spawning habitat throughout (clean, unbedded, unsilted cobble and gravels). The substrata particle size was more suited to Atlantic salmon spawning than brown trout. Nursery habitat was excellent upstream of the bridge and supported high numbers of trout, stone loach and minnow. Downstream of the bridge, excellent holding habitat for adult salmonids was present, in addition to valuable macrophyte refugia for smaller fish. European eel habitat was moderate given a general lack of boulder-dominated areas although deeper pool habitat provided some good suitability (although none recorded). Whilst good spawning habitat existed for lamprey in slower-flowing areas, ammocoete habitat was limited, although present. These areas were mostly located downstream, in association with mid-channel islands and supported low densities of *Lampetra* sp. transformers and ammocoetes. White-clawed crayfish were observed at low densities.

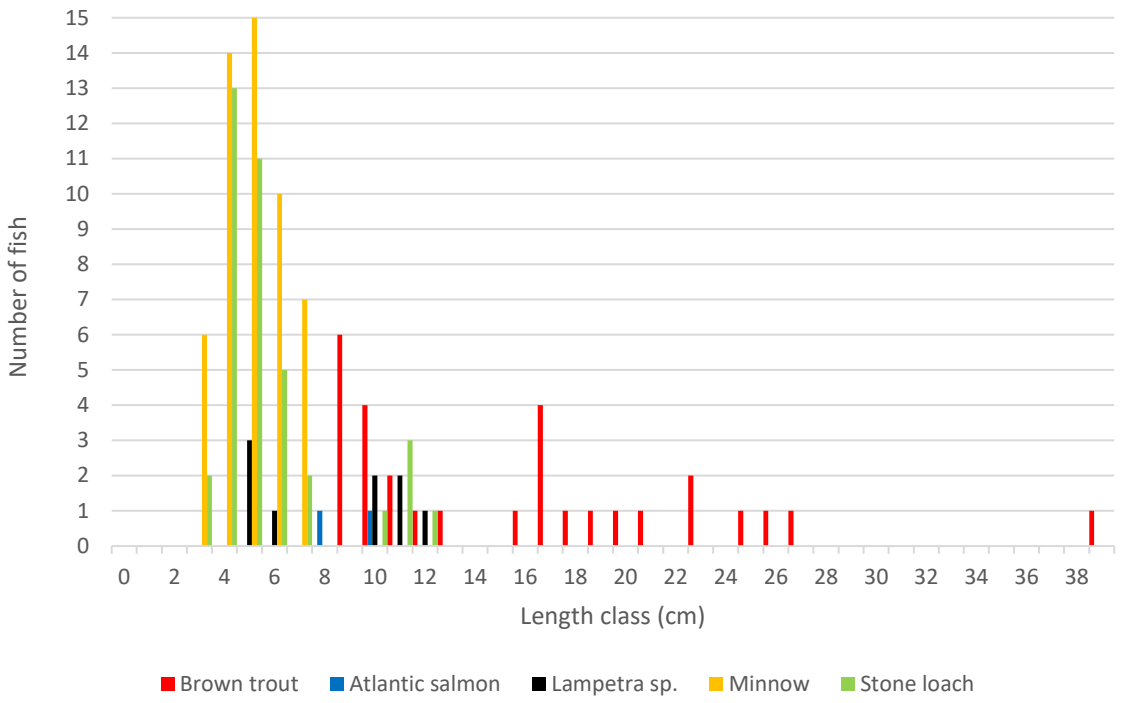

Figure 4.5 Fish stock length distribution recorded via electro-fishing at site 5 on the River Liffey at Caragh Bridge, September 2020

Plate 4.5 Large adult brown trout recorded from site 5

4.1.6 Site 6 – River Liffey, 0.5km d/s Liffey Bridge, Sallins

A total of six fish species were recorded from site 6, located approx. 0.5km downstream of Liffey Bridge (**Figure 3.6**). Minnow dominated the site (*n*=47), accounting for over half of the fish captured. Brown trout were present in moderate densities, with a mixed range of juvenile and adult cohorts present (*n*=25). Low numbers of stone loach were captured, along with single examples of European eel and gudgeon (*Gobio gobio*). Two juvenile pike were also captured. No lamprey or Atlantic salmon were recorded.

The site was a good salmonid habitat overall, with a moderate density of adult and juvenile trout. Nursery habitat was good although the numbers of juvenile salmonids was lower than expected given the high coverage of water crowfoot beds (offering very good refugia). Marginal slacks and undercuts (especially along the north bank) provided excellent adult salmonid holding habitat, (although this was much improved upstream of the site, near Liffey Bridge). The site was sub-optimal for lamprey with a paucity of finer gravel fractions (for spawning) and soft sediment accumulations (for larvae). European eel habitat was good overall, with ample refugia, but none were recorded.

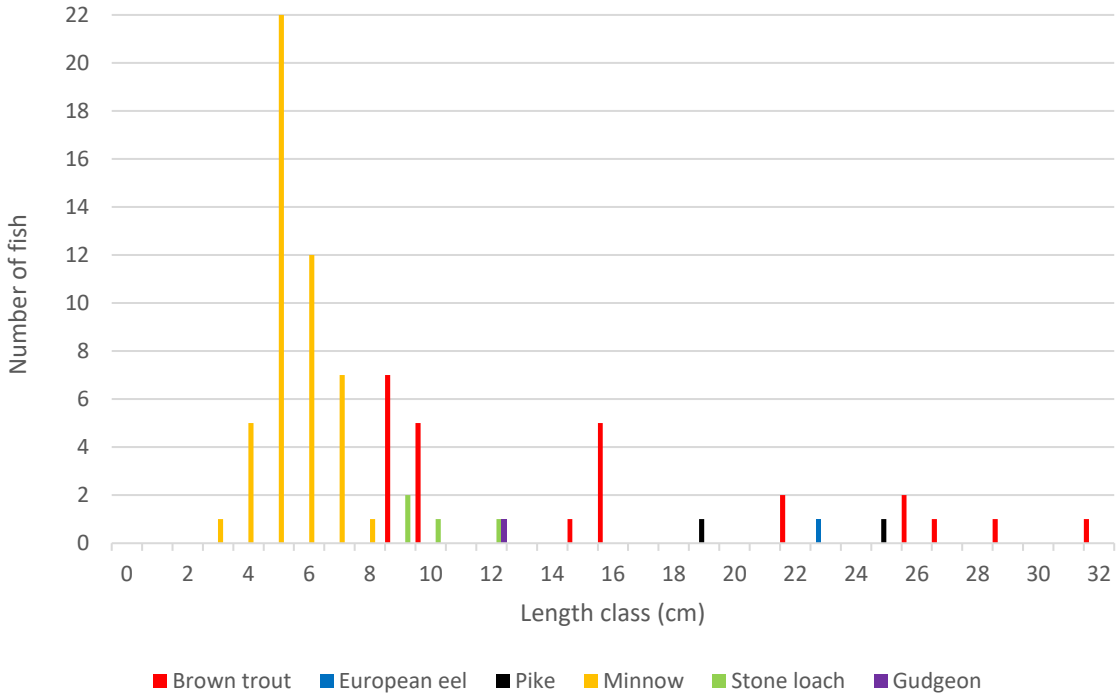

Figure 4.6 Fish stock length distribution recorded via electro-fishing at site 6 on the River Liffey at 0.5km downstream of Liffey Bridge, September 2020

Plate 4.5 (top to bottom) Juvenile brown trout, gudgeon, juvenile pike and adult brown trout recorded from site 6

4.2 Fisheries habitat

4.2.1 Salmonid habitat

Brown trout were recorded from all six survey sites, with low numbers of Atlantic salmon parr recorded at sites 1 (Kilcullen Bridge), 4 (Barretstown Cemetery) and 5 (Caragh Bridge). The quality of salmonid habitat, according to Life Cycle Unit scores, ranged from good to excellent across the survey sites (**Table 4.1**). Sites 1, 2 (Athgarvan Bridge), 4 (Barretstown Cemetery) and 5 offered excellent quality salmonid habitat, given the presence of excellent quality nursery, spawning and holding conditions. The value of sites 3 (Newbridge) and 6 (0.5km downstream of Liffey Bridge) was reduced due to pressures such as siltation of spawning substrata and filamentous algal growth but both sites, nevertheless, provided good salmonid habitat overall.

Table 4.1 Life Cycle Unit scores for salmonid habitat on the River Liffey, September 2020.

Site no.	Salmonid habitat value	Spawning	Nursery	Holding	Total score	Salmonids recorded
1	Excellent	2	2	1	**5**	**Yes**
2	Excellent	2	2	1	**5**	**Yes**
3	Good	2	2	3	**7**	**Yes**
4	Excellent	1	2	2	**5**	**Yes**
5	Excellent	1	1	1	**3**	**Yes**
6	Good	2	2	2	**6**	**Yes**

4.2.2 Lamprey habitat

Lamprey ammocoetes (*Lampetra* sp.) were recorded from sites 3 (Newbridge) and 5 (Caragh Bridge), where low densities were supported in localised areas of soft sediment. However, all six survey sites offered good quality lamprey habitat, according to Lamprey Habitat Quality Index scores (**Table 4.2**). Generally, the high flow rates of the Liffey discouraged fine sediment deposition required by larval lamprey and, therefore, the survey sites were more suitable as lamprey spawning areas than nurseries.

Table 4.2 Lamprey Habitat Quality Index (LHQI) scores for lamprey habitat on the River Liffey, September 2020.

Site no.	Lamprey habitat value	Spawning	Nursery	Total score	Ammocoetes recorded
1	Good	2	3	**5**	No
2	Good	2	3	**5**	No
3	Good	2	2	**4**	**Yes**
4	Good	2	2	**4**	No
5	Good	2	2	**4**	**Yes**
6	Good	2	3	**5**	No

4.2.3 European eel habitat

Despite good suitability at all survey sites, European eel were only recorded from sites 1 (Kilcullen Bridge) and 6 (0.5km downstream of Liffey Bridge). Numbers captured via electro-fishing were low, with single fish recorded at each site, respectively. Overall, habitat was considered good (though sub-optimal) across all sites, with the best eel habitat present at those sites with higher frequency of instream refugia and a greater proportion of deeper pools, e.g. sites 1,2, 6.

Table 4.3 Fish species densities per m^2 recorded at the survey sites, September 2020. Values in **bold** represent the highest densities recorded for each species, respectively. *values for *Lampetra* sp. are presented in no. fish per $1m^2$ quadrat area targeted for lamprey.

Site	CPUE	Fish density (number fish per m^2)									
		Approx. area fished (m^2)	Brown trout	Atlantic salmon	*Lampetra* sp.	European eel	Stone loach	Minnow	Perch	Pike	Gudgeon
1 – d/s Kilcullen Bridge	10-minute	800	0.031	0.001	0.000	0.001	0.008	0.016	0.000	0.000	0.000
2 – u/s Athgarvan Bridge	10-minute	880	**0.055**	0.000	0.000	0.000	0.000	0.020	**0.001**	0.001	0.000
3 - Newbridge	10-minute	580	0.033	0.000	**6***	0.000	0.003	0.053	0.000	0.000	0.000
4 – Barretstown Cemetery	10-minute	550	0.042	0.002	0.000	0.000	0.027	**0.069**	0.000	0.000	0.000
5 – Caragh Bridge	10-minute	900	0.032	**0.002**	4.5*	0.000	**0.042**	0.058	0.000	0.000	0.000
6 - 0.5km d/s Liffey Bridge	10-minute	860	0.029	0.000	0.000	0.001	0.005	0.055	0.000	**0.002**	**0.001**

5. Discussion & recommendations

5.1 Most valuable sites

Brown trout were recorded via electro-fishing from all six survey sites in September 2020, with low numbers of Atlantic salmon parr recorded at Kilcullen Bridge (1 fish), Barretstown Cemetery (1 fish) and Caragh Bridge (2 fish), respectively. Salmonid habitat was evaluated as being of at least 'good quality' at all sites, with the best overall habitat present at sites 1, 2, 4 and 5. Sites 4 and 5 provided particularly good spawning habitat (i.e. unbedded cobble/gravel largely free from siltation). Site 1 (Kilcullen Bridge) and site 2 (upstream of Athgarvan Bridge) featured some excellent quality holding habitat (deep pools) for adult salmonids. The best quality nursery habitat was present at Caragh Bridge (site 5), although the highest numbers of juvenile trout were recorded from site 2 at Athgarvan Bridge.

It is important to provide context, where possible, for the current survey results. However, directly comparable electro-fishing data was only available for one survey site, namely Kilcullen Bridge. A boat-based survey was completed in 2008 with brown trout, Atlantic salmon, European eel and stone loach recorded but notably no minnow (Kelly et al., 2010). A repeat survey in 2013 (Kelly et al., 2014) recorded the same species assemblage in addition to perch and minnow. Whilst the density of trout (per m^2) recorded in 2008 and 2013 was similar to this survey (slightly higher in 2020, see **Table 5.1**), the density of salmon parr was much greater in 2008 and 2013 (only a single parr recorded in September 2020). This indicates a decline in salmon parr at Kilcullen Bridge although the trout population continues to be dominated by juveniles (see section 4.1.1). Comparable data was not available for the other sites surveyed in this study although anecdotal evidence suggests a widespread decline in all salmonids in the middle reaches of the Liffey in recent years.

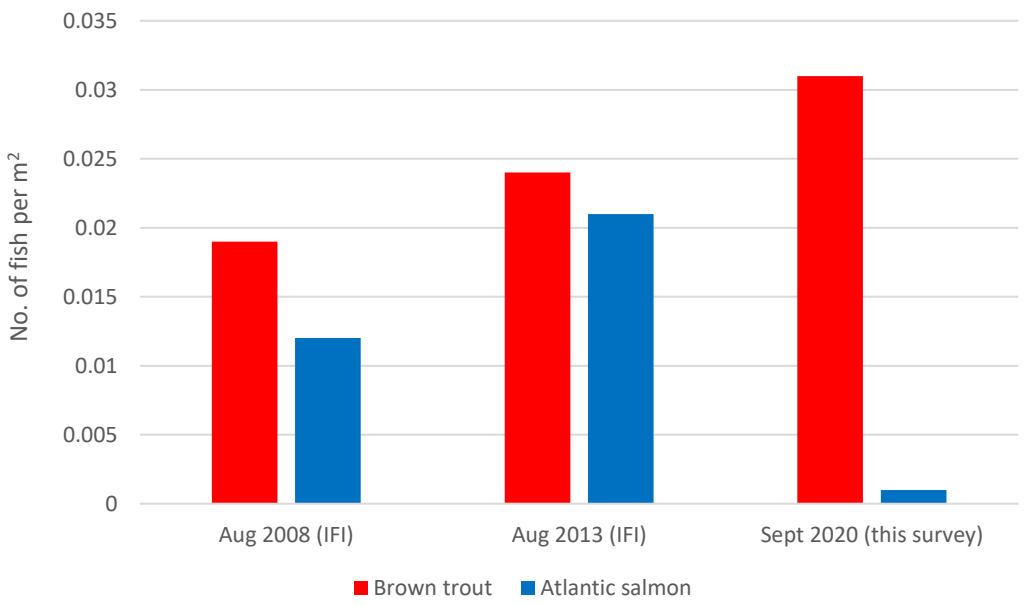

Table 5.1 Comparison of brown trout and Atlantic salmon densities (fish per m^2) recorded at Kilcullen Bridge in 2008, 2013 and 2020

In spite of the overall good quality of salmonid habitat throughout the survey sites, there were several issues noted. High levels of eutrophication (enrichment) were evident throughout much of the survey area, especially at sites 1, 2 and 3. At these sites, filamentous algal cover was often excessive (up to 50% of riverbed covered at site 3), greatly reducing the overall value of the sites in terms of spawning and, to a lesser extent, nursery habitat. This would also be considered an issue for *Lampetra* sp. lamprey, which require finer gravel substrata for spawning compared to salmonids (Aronsuu & Virkkala, 2014). The presence of more nutrient-tolerant species like minnow and stone loach in high abundances is also indicative of enrichment and declining water quality status (Kelly et al., 2007).

Growth of macrophytes such as spiked water milfoil and curled pondweed, whilst natural, was considered to be higher than expected for the river type at these sites (i.e. classic sign of nutrient enrichment). Whilst this high filamentous algal coverage is clearly an issue in the warmer (growth) months, its impact during the salmonid spawning and incubation season is likely lessened due to reduced algal growth (i.e. less likely to cover eggs). Eutrophication in considered a primary threat to the health of Irish rivers (Trodd & O'Boyle, 2020).

Given that the flow is managed by three hydroelectric dams, the Liffey has higher flow rates and more irregular flows than normal for a river of this size. This has both positive and negative implications for Liffey fish communities. Atlantic salmon, given their larger sizes and different life histories, are better suited to faster flows with larger substrata that brown trout (Hendry & Cragg-Hine, 2003; Armstrong et al., 2003). Indeed, despite the predominance of recruiting trout populations, all of the survey sites were considered better suited to salmon given inherent flow rates. A recent survey on the River Liffey at Ballymore Eustace in 2018 made similar observations although, in that instance, salmon outnumbered trout almost 5:1 (Macklin & Brazier, 2018). This also indicates the importance of the upper Liffey for salmon given the species passage is restricted further upstream. As with other dammed river systems, salmon densities are often elevated in reaches below dam structures where salmon are bottlenecked (e.g. River Lee).

Lamprey ammocoetes were sparse across the survey area, only recorded in low densities from sites 3 and 5. Early stage *Lampetra* sp. transformers were recorded from site 3 (**Plate 4.3**). Given known distributions patterns and migration barriers in the upper Liffey catchment, these were likely all brook lamprey (*Lampetra planeri*), although *Lampetra* sp. are not distinguishable until later life stages (Gardiner, 2003). Typically, *Lampetra* sp. are not present at sites with average water velocities of >0.5m/s (Taverney et al., 2012). Generally, the high flow rates of the Liffey discourage the deposition of fine sediment required by ammocoetes (Goodwin et al., 2008), resulting in highly localised populations with very patchy distributions (as seen in other regulated Irish rivers, e.g. River Lee, pers. obs.).

The paucity of European eel (only 2 individuals recorded), despite widespread high suitability in the survey area, is a catchment-wide issue for the Liffey and primarily driven by significant instream barriers within the catchment (e.g. weirs, dams and fast flow rates).

5.2 Recommendations

This report represents an essential fisheries baseline to compare with future studies. Given the large coverage of NKTSAA jurisdiction along the River Liffey, the general irregularity of catchment-wide fisheries surveys on the river (e.g. Water Framework Directive surveys) and the evident decline in water quality (eutrophication) along the river (EPA data), it is recommended that repeat electro-fishing surveys and fisheries habitat appraisals are undertaken on a routine basis (i.e. every 3-5 years). This should be undertaken in combination with more regular biological water quality monitoring (i.e. seasonal or annual), which can be broadly undertaken by club members, following training by a qualified riverine ecologist. This approach will ensure the most up-to-date data is available for club management and key stakeholders alike, thereby more efficiently identifying any ecological trends and enabling more holistic management and conservation of the River Liffey fisheries asset. Biological water quality could be assessed by the adoption of the recently developed Citizens Science Stream Index (CCSI) by the NKTSAA. This would provide a cost-effective way of monitoring biological water quality annually by club members themselves. Such an initiative could work hand in hand with more detailed scientific data collation over longer time intervals (e.g. every 3 years) to fill data lacunae with higher level expertise by an independent expert. Ultimately interannual trends in fish status and riverine health can only be accurately assessed by data collection initiatives to allow for clear determination of patterns of change interannually. By documenting changes in riverine health (i.e. fisheries and biological water quality status) stakeholders can influence management decisions to improve river health through an evidence based approach.

6. Acknowledgements

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8. Appendix A – additional survey images

Plate C.1 European eel recorded from site 1

Plate C.2 White-clawed crayfish captured incidentally from site 1

Plate C.3 Atlantic salmon parr recorded from site 1

Plate C.4 Juvenile pike recorded from site 2

Plate C.5 Perch recorded from site 2

Plate C.6 *Lampetra* sp. transformer recorded from site 3

Plate C.5 Fresh otter spraint containing crayfish remains recorded at site 1

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