THAMES TIDEWAY TUNNEL

Channelsea River Fisheries Survey Evidence Report, Summer 2023

Report for: Thames Water

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Thames Tideway Tunnel (TTT) Project (Tideway), a greater than £4bn construction project investment, will upgrade London's Victorian sewerage system to cope with the growing population and demands of the 21st century. The aim of TTT is to provide the next 100 years of environmental protection by intercepting, storing, and transferring sewage waste away from the Thames Tideway. The new TTT super sewer, due for completion in 2025, incorporates a combined sewer overflow design, collecting surface water in addition to sewage.

Abbey Mills Pumping Station is where the existing Lee Tunnel currently takes CSO (storm overflow) from Abbey Mills to Beckton STW. The TTT will join the Lee Tunnel and during the period when the two tunnels are joined, the Abbey Mills site will become susceptible to CSO spills into the Channelsea should a sudden storm event occur during this period. As such, the new TTT system will occasionally be susceptible to reaching capacity following high precipitation events.

The Water Framework Directive (WFD) requires all European surface waters, including transitional waters (estuaries) to meet environmental objectives set on a water body basis, with the default to achieve 'Good' status through a six-yearly cycle of planning and implementing measures to protect and enhance the water environment. While the UK has now revoked the European Union (EU) WFD, it continues to fulfil its reporting requirements under UK legislation. In England, this is the Water Environment (Water Framework Directive), (England and Wales) Regulations 2017. 'Ecological status' in transitional waters (or 'potential' within a heavily modified water body) is assessed through a combination of seasonally repeated bio-assessment biological classification tools, which includes fish community monitoring as a key biological monitoring component, with the aim of looking for any deviation from WFD reference conditions.

Ricardo Energy & Environment (Ricardo) were commissioned by TWUL to conduct Water Framework Directive (WFD 2000/60/EC; Annex V) compliant transitional water (TW) fisheries surveys within the Channelsea River, a small creek within the middle tidal Thames (GB530603911402), adjacent to the overflow system at Abbey Mills Pumping Station (Figure 1.1).

To provide the necessary data and evidence to inform the fish population baseline at locations next to Abbey Mills Pumping Station within the Channelsea River, initial autumnal tidal fisheries community monitoring was completed in November 2022, in agreeance with the EA (caveated as outside of WFD autumnal best practice timing, but acceptable to the regulatory authority). The resulting Ricardo report recommended that repeat surveys at the same location should be completed both in accordance with TW WFD fish monitoring guidance (i.e., Spring 2023), and in Summer 2023[1]. Spring data capture would accommodate an understanding of the seasonal changes in size-frequency distributions and fisheries compositions know to occur owing to the large-scale migrations of both adults and fry within the tidal Thames and its tributaries, while Summer data capture would provision an understanding of the community present during the likely operational timings of commissioning works for the Thames Tidal Tunnel (July to September) at Abbey Mills. Following consultation with the EA and TWUL, it was agreed to extend the monitoring programme to complete repeat TW fisheries surveys in Summer 2023.

The Channelsea River fish population survey creates a baseline so that if a CSO spill were to occur at Abbey Mills during the tunnel connection period, the potential impact to the fish community can be assessed. Thames Water Utilities Ltd. (TWUL) are obligated by the Environment Agency (EA) to provide baseline data for the TTT evidence base, and the fish population surveys carried out during 2022 and 2023 allow for a better understanding the current state of health of the Channelsea River.

1.2 PURPOSE OF REPORT

This report aims to provide an initial evidence base on the Summer TW fisheries community composition within the Channelsea River, in view of working toward a more complete baseline fisheries dataset, in advance of testing the overflow system at Abbey Mills Pumping Station. The report also identifies the remaining data/evidence gaps and provides future recommendations for how these should be addressed.

[1] Ricardo (2023). Channelsea River Fisheries Survey Evidence Report, Autumn 2022 Report for: Thames Water Utilities Limited.

1.3 REPORT STRUCTURE

The report is divided into the following sections:

- Section 1: Introduction
- Section 2: Methodology
- Section 3: Results and findings of survey
- Section 4: Conclusions and recommendations

The full survey evidence base has been provided in the supporting Excel workbook *(TW_Fish_Workbook_20230717.* These data were also used to inform the extent of any remaining data or evidence gaps that would result in uncertainty in the assessments of the fisheries community within the Channelsea River.

The supporting Excel workbook *(TW_Fish_Workbook_20230717)* includes the following:

- Site and survey data for TW fisheries surveys completed by Ricardo.
- Photographic evidence of site conditions, presence of INNS, and fish species present.

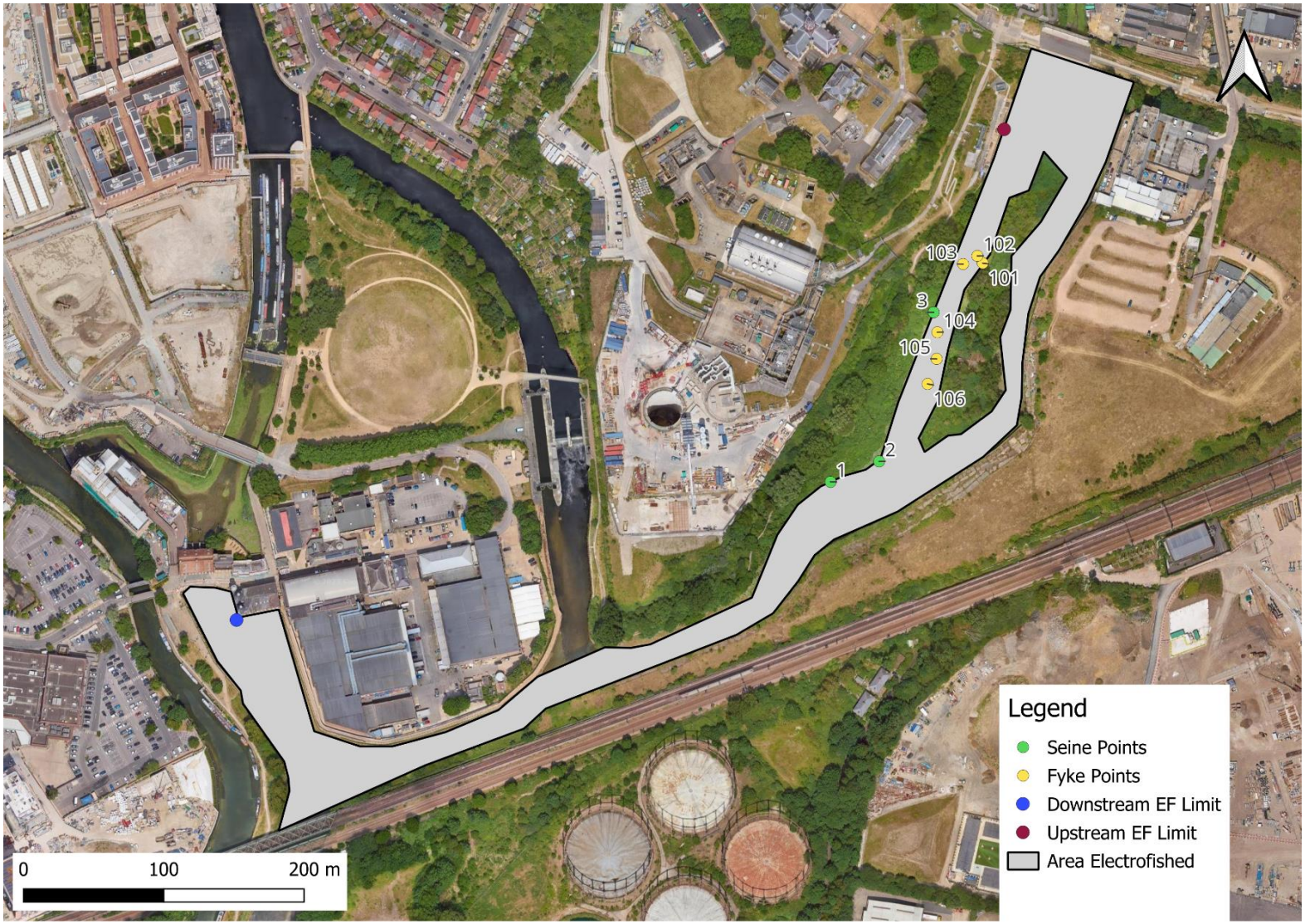


Figure 1.1: TW fisheries surveys were conducted within a reach of the Channelsea River, adjacent to TWUL Abbey Mills Pumping Station. Map indicates the area electrofished, alongside three seine netting and six fyke netting locations investigated over the four-day survey period between 17th – 20th July 2023.

2. METHODOLOGY

2.1 LANDOWNER PERMISSIONS AND ACCESS

Prior to commencement of the works, the landowners, TWUL and the Port of London Authority (PLA), granted permissions for Ricardo to access the Channelsea River to conduct works. Fully trained and competent Ricardo operatives undertook TWUL's site induction at Abbey Mills Pumping Station and operated under a Thames Water Operational Safety Authorisation (TWOSA). An Estates Licence was granted following the notice of works application process with the PLA. A Notice to Mariners was also raised via the appropriate navigational authority following a third-party works application with the Canal and River Trust (CRT).

2.2 CONSENT AND PERMITTING

Ricardo were given authorisation to undertake fyke netting (< 1 m fyke opening and with fitted otter guards), seine netting, and electric fishing capture techniques by the Environment Agency (EA Permit Reference: EP/EW112-F-949/26046/01). Fish capture was consented under a Section 27a Authorisation under the Salmon and Freshwater Fisheries Act, 1975 (as amended)[2].

2.3 SITE DESCRIPTION

The Channelsea River is a small tidal creek which is connected to the tidal River Lea (Bow Creek) at Three Mills, Bromley-by-Bow in E. London. The Channelsea River and tidal River Lee are within the 'Thames Middle' transitional WFD water body (GB530603911402; **Figure 1.1**; **Figure 2.1**) and is defined as a Heavily Modified water body under the WFD. It therefore must meet 'Good Ecological Potential'[3], whereby hydromorphological mitigation measures relevant to different water uses must be in place to prevent deterioration.

The Channelsea River is tidally influenced (usually diurnal with a mean tidal range of circa 4 m) and is a remnant of the Bow Back Rivers that flow into the Bow Creek, part of the River Lea. At low tide, a combination of amphibious and aquatic macrophyte assemblages are exposed along the mudflat banks and bordered by a thin strip of deciduous woodland along the true right-hand bank. The western channel (Abbey Creek) surrounds Channelsea Island, a former works site reclaimed by nature, providing shaded areas and surrounded by submersed and emergent aquatic macrophytes on the North and South sides. The remainder of the island banks are reinforced by large sheet piles. The island is positioned adjacent to Abbey Mills Pumping Station overflow pipes, with the route of the Northern outfall sewer pipes now paving the course of the Greenway footpath.

Figure 2.1: Channelsea River and A) Channelsea Island at high water; and B) the river channel was overgrown by heavy macrophyte assemblages in the tidal river margins.

[2] HM Government of Great Britain and Northern Ireland. (1975). *Salmon and Freshwater Fisheries Act 1975*. United Kingdom.

[3] WFD UK TAG. (2008). *Guidance on the classification of ecological potential for heavily modified water bodies and artificial water bodies*. UKTAG Guidance. Final Report. 31/03/2008.

2.4 FISH CAPTURE METHOD SELECTION

To allow for adequate sampling of different habitats within the tidal estuarine environment and target a range of fish species and size classes, the EA Thames Tideway developed 'European Best Practice'[4] multi-method approach was deployed[5,6]. For the Channelsea River survey, three techniques with differing gear selectivities (i.e., differing in the type of fish species they target) were utilised:

I. Seine netting: A method used to sample intertidal and shallow subtidal marginal habitats, with target organisms including littoral, demersal and smaller shoaling pelagic fishes, including young and adult individuals.

II. Fyke netting: An intertidal and shallow subtidal habitat methodology which, depending on design (i.e., use of paired fykes attached to one leader), allows for fishing on both the flood and ebb tide when placed parallel to shore. Fyke nets target a wide array of marine and estuarine organisms including pelagic, benthic, and demersal species of fish that swim in close proximity to the shore.

III. Electric fishing: Appropriate across a wide range of habitats. An effective method for capturing moderate to large-sized fish across a range of species in freshwater and at low salinities.

Site locations were chosen mainly on their survey suitability substrate regime and ease of access, allowing Ricardo staff to safely and effectively operate the differing fishing gear.

2.5 SEINE NETTING

Seine nets are encircling nets that surround assemblages of fish on the riverbed or water column. The net consists of a wall of knotless mesh netting (consisting of wings, and a finer meshed central panel, or 'bag' region), weighted at the bottom (lead-line: 85 g leads at 61 cm spacing in wings; 46 cm in bag) and buoyant at the top (float-line: expanded PVC CN3: 46 cm spacing in wings; 30.5 cm in bag; 12.7 cm middle-marker float). The net is shot from shore in a semi-circular shape using a small boat, and the other end returned to shore. The two ends are then hauled in toward the shore, with the fish gradually collected in the micromesh central bag region before final retrieval.

A total of three replicate samples (two per survey sample, per survey location; **Figure 1.1**) were conducted using a 43 m x 4 m estuary survey seine net (14 mm wing mesh; 6.5 mm central panel mesh: Collins Nets, Bridport, UK) at three locations, over two days of the Channelsea River Fisheries survey (18th and 20th July 2023). Owing to estuary system conditions, nets were deployed from shore over the high-water slack period. The net was shot from shore and set into its semi-circular shape off the front of a 3.8 m Northern Diver DS380 (Wigan, UK) survey vessel (6 hp 4-stroke outboard motor: Mercury Marine, Fond du Lac, WI, USA).

The three seine net GPS sampling locations (3 m resolution) were recorded. Dates and times at which nets were deployed were also recorded.

2.6 FYKE NETTING

Fyke nets consist of a series of interconnecting nets with a one-way entrance to trap fish and limit escape opportunities. They are conical in shape, with a D-shape ("Dutch type") or circular opening, held in place by metallic rings. A series of inscales move the fish from the opening of the net into the 'cod-end' of the fyke, from which fish are later retrieved. The opening of the fyke net (mouth) is attached to a leader, a length of net which is set to corral the fish into the mouth of the fyke.

A total of six fyke nets were operated over three days as part of the Channelsea River Fisheries survey (18th – 20th July 2023; **Figure 1.1**). EA tagged nets were deployed on foot (at low water), placed parallel to the shore (**Figure 2.2A**), and retrieved from a survey vessel after fishing over the majority of a tidal cycle. In compliance with EA Operational Instruction 25_07[7], two 2.75 m double-ended knotless fyke nets (53 cm diameter; 6 m leader; 10 mm mesh: Collins Nets, Bridport, UK) and four 5.3 m double-ended Dutch Type, knotless fyke nets

[4] European Commission Fair Programme. (2000). Commercial fish and European estuaries: Priorities for Management and Research. Available at: https://cordis.europa.eu/project/id/FAIR961634

[5] Coates, S., Waugh, A., Anwar, A., and Robson, M. (2007). Efficacy of a multi-metric fish index as an analysis tool for the transitional fish component of the WFD. *Marine Pollution Bulletin*. 55, 225-240.

[6] Coates, S.A., Colclough, S.R., Robson, M., and Harrison, T.D. (2004). Development of an estuarine classification scheme for the Water Framework Directive. Phases 1 & 2 – transitional fish component. R&D Technical Report E1-131/TR. Bristol: Environment Agency.

[7] Environment Agency. (2013). *Fyke netting for monitoring fish*. Operational Instruction 25_07. Issued 06/08/2013.

(100 cm height; 10 m leader; 10 mm mesh: Collins Nets, Bridport, UK) were set with otter guards (85 mm x 85 mm, and 127.5 mm x 127.5 mm, respectively) fitted to the entrance inscale. Small kettle bells were used as mud weights to secure both ends of each individual fyke net, which in turn were attached to fluorescent buoys acting as markers and aiding retrieval (**Figure 2.2 B**). Buoy rope length was determined according to water depth, calculated from available charted tide data for Bow Creek/ River Lea (upper) from the PLA Hydrographic Service[8].

Figure 2.2: A) Fyke nets positioned parallel to shore at low water; and **B)** buoys marking submerged fykes at high water.

Once in position, GPS locations (3 m resolution) were recorded. Dates and times at which nets were set and retrieved were recorded. A full 12-hour soak time was not possible within the reach owing to water depths (near dry) at low tide within the Channelsea River. Nets were therefore left for a total of 8 to 9 hours on the 18th, 19th, and 20th July, respectively, prior to retrieval and fish collection.

2.7 ELECTRIC FISHING

Electric fishing is a freshwater fisheries survey technique that has been adapted and used by the EA for use in low salinities within a tidal creek environment (usually at low water).

Boat-based catch per unit effort (CPUE) electric fishing was conducted near high water by suitably trained and experienced operatives from a 3.8 m inflatable boat on both 17th and 19th July 2023. Electric fishing operations complied with British Standards Institution (BSI) Standards BS EN 14011:2003, BS 6068-5.32:2003[9] and BS EN 60335-2-86:2003[10], and EA Operational Instruction Standards 993_08[11] and 144_03[12].

Two anodes (ø400 mm) and a cathode (2 m) were connected to a pulsed direct current (PDC) control box (Electrafish, Wolverhampton, UK) to target a range of species, with output (50 Hz; 50 V; 7.5-8A) selected in accordance with conductivity measurements recorded using a hand-held Aqua TROLL 400 Multiparameter probe (In-Situ, Fort Collins, CO, USA). In total, an area covering 2.79 ha was electrofished over a period of 1.75 hours and 2.5 hours on separate days (**Figure 1.1**), focussing upon the margins of both banks and circumnavigating the entirety of the Channelsea Island.

[8] Port of London Authority. (2017). PLA 378C MS (Sheet 3 of 3). *River Thames. Bow Creek/ River Lea (Upper), (including Bow Locks) Depths in metres.* Surveyed by the Port of London Authority Hydrographic Service June 2017. H.O. Ref. No. 113-378-020C. 21/08/2017.

[9] British Standards Institution. (2003). *BS EN 14011:2033, BS 6068-5.32:2003: Water quality. Sampling of fish with electricity*, London BSI.

[10] British Standards Institution. (2003). *BS EN 60335-2-86:2003: Household and similar electrical appliances – Safety – Part 2-86: Particular requirements for electric fishing machines*, London, BSI.

[11] Environment Agency. (2011). *Electric fishing operations: equipment and working practices*. Operational Instruction 993_08. Issued 06/10/2011.

[12] Environment Agency. (2010). *Electric fishing in rivers*. Operational Instruction 144_03. Issued 23/04/2010.

2.8 WATER QUALITY

Water quality parameters (temperature, °C; conductivity, C, µScm^{-1}; salinity, ppt; dissolved oxygen, mgl^{-1} and %; and pH) were measured and recorded from a single representative sampling location during each survey, using a calibrated hand-held Aqua TROLL 400 Multiparameter probe.

2.9 FISH DATA

Ricardo fish surveys were designed to be fully Water Framework Directive (WFD 2000/60/EC; Annex V) compliant and were undertaken to EA Operational Instruction Standard 328_07[13]. It should, however, be noted that in agreeance with the EA, data was gathered outside of the WFD recommended survey window (i.e., 1st April to 30th June), instead taking place over the Summer to provide an indication of the fish community present during the likely operational timings of commissioning works for the Thames Tidal Tunnel (May to July) at Abbey Mills, and this would be deemed acceptable by the regulatory authority[14].

To meet the WFD requirement that the transitional fish quality element is assessed from the composition and abundance of the fish fauna, and that of disturbance sensitive taxa[5], captured fish were identified to species level[15], counted, measured (mm), (dependent on species morphology: fork length [FL]: freshwater and migratory fishes; total length [TL]: marine fishes) and returned live at each site. Where species numbers were high, a sub-sample of a minimum of 50 individual fish were measured from each net, after which the remainder of individuals were counted as a tally.

Standard EA length-weight relationships used in the EA National Fish Population Database (NFPD) and CEFAS length-weight relationships of marine fish[16] have been used to estimate weights of individual fishes from recorded length measurements. When a sub-sample of a fish species has been recorded, while total abundance from count data is available, the length frequency histograms and estimated wet weights (g) presented are only available for the sub-sampled set of data. Representative individuals of each species size class were photographed. Note that total abundances calculated do not account for double counting of individual fish across surveys.

2.10 DATA VISUALISATION

Data visualisation and descriptive statistics were performed using freeware programme RStudio (v 4.2.2: https://rstudio.com/).

2.11 BIOSECURITY AND INNS

Given the presence of invasive non-native species (INNS) within the Thames Middle Catchment, strict biosecurity protocols were followed in accordance with Ricardo policy[17]. Personal protective equipment and fish capture equipment, including all fyke and seine nets, fish measuring boards and holding buckets, were only used within the Channelsea River for the duration of monitoring. Following completion of TW fisheries surveys, all equipment was returned to Ricardo's base, where it was thoroughly checked, disinfected, and cleaned, rechecked, dried, and stored separately.

A note of any INNS positively identified on site were recorded by fully trained and competent aquatic ecologists.

2.12 LIMITATIONS

A number of limitations were noted:

- **Survey timing:** As aforementioned (**Section 2.9**), surveys were scheduled to commence outside of WFD spring/autumn best practice monitoring season. As such, although the EA as the regulatory

[13] Environment Agency. (2011). *Data requirements for WFD transitional fish surveillance monitoring.* Operational Instruction 328_07. Issued 22/12/2011.

[14] Tom Cousins, EA Fisheries Tech Specialist, Pers.Comm.

[15] Maitland, P.S. & Herdson, D. ed Steve Coates (2009). Key to the Marine and Freshwater Fishes of Britain and Ireland. A guide to the identification of more than 370 species. ISBN 978-1-84911-049-5. https://www.nmbaqcs.org/scheme-components/fish/literature-and-taxonomic-keys/

[16] Silva, J.F., Ellis, J.R., and Ayers, R.A. (2013). Length-weight relationships of marine fish collected from around the British Isles. *Sci. Ser. Tech. Rep.,* CEFAS Lowestoft, 150: 109pp.

[17] Ricardo Energy & Environment. (2022). Biosecurity procedure. Document no: REE_PRO_304. V3.0, 03/08/2022.

authority directed the timing of the survey and have agreed that data gathered will be accepted, it is done so under the caveat that the data is not considered WFD compliant.

- **Macrophyte coverage:** Dense marginal mats of Floating Pennywort (*Hydrocotyle ranunculoides*) at the North end of the Channelsea River constrained electric fishing methods, providing fish with dense areas of coverage and limiting areas that could be effectively sampled during the electric fishing run. Catch efficiency at these points was therefore reduced, with catch abundance and even total community composition likely to be an under-estimate.
- **Water depth:** Electric fishing methodology efficiencies were also constrained owing to deep water levels at high water, allowing fish to dive to a point within the water column that enabled avoidance of the electric field and subsequent capture. For instance, one or two large grey mullets (Mugilidae family) were visually observed by operatives at the downstream fishing limit, but evaded capture.
- F**yke net soak time:** As earlier noted (**Section 2.6**), fyke nets could not be left to fish for a full 12-hour period as water depths during low tide within the Channelsea River reach were at times running dry. This would have been a welfare concern for any fish catch owing to the risk of mortality. To account for this problem, fykes were instead left in the channel for up to 9 hours as an appropriate workaround.
- **Tide:** The surveys were undertaken during high ‘spring tides’ (moving toward ‘neap tides’ later in the week) which meant that the tidal height at high water was in excess of 7.4 m above chart datum. As such, tidal height at high-water limited the number of seine net locations that were available to survey within the Channelsea River.

3. RESULTS

3.1 TOTAL CATCH DATA

A total of 920 individuals from fourteen different species were captured between 17th and 20th July 2023, using the three different fish capture techniques (seine netting, fyke netting, and electric fishing: **Figure 3.1**; **Table 3.1**). Deployment of a multi-method approach using three different fish capture techniques allowed for a breath of species, across a range of size classes to be captured and recorded.

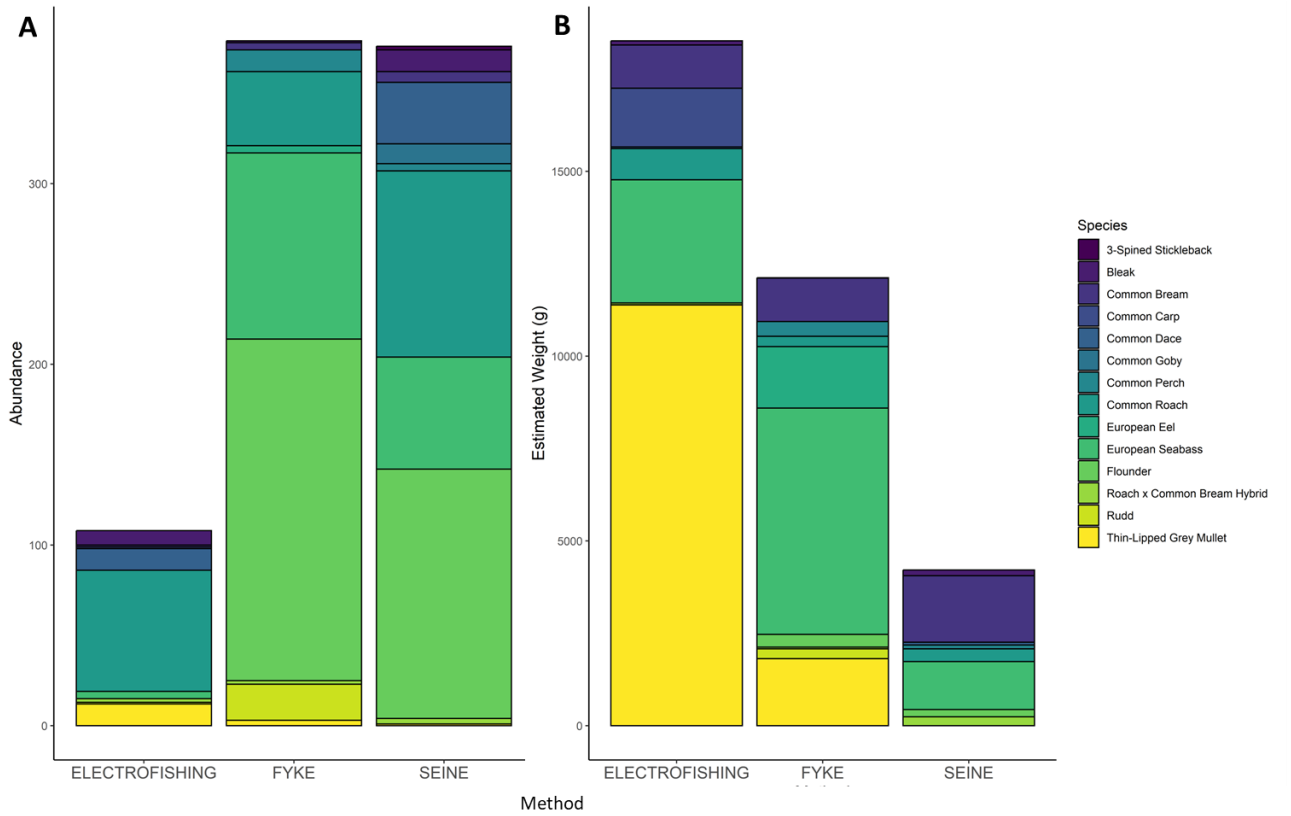


Figure 3.1: A) Species abundance, **B)** estimated wet weight (g) and fish community composition within the Channelsea River in Summer 2023, using three different fish capture methodologies.

The dominant species captured were flounder (*Platichthys flesus*; *n* = 416; **Figure 3.1A**; **Figure 3.2**; **Table 3.2**). These were all juveniles, within the size range 22 – 116 mm (total length: TL: **Figure 3.5**). Common roach (*Rutilus rutilus*; *n* = 202: **Figure 3.1A**; **Figure 3.2**; **Table 3.2**) were the next most prevalent species, and were predominantly juveniles within the size range 32 – 133 mm (fork length: FL; **Figure 3.3**). Primarily juvenile European seabass (*Dicentrarchus labrax*: *n* = 168: **Figure 3.1A**; **Figure 3.4**;**Table 3.1**) followed as the third most abundant species, within the size range 30 – 68 mm (TL; **Figure 3.5**), with a range of larger juveniles within the size range 119 – 179 mm captured, alongside three smaller adults (339 – 404 mm), and two large adults (i.e., > landing size of 420 mm), measuring in at 434 mm (estimated weight: 1858.87 kg) and 533 mm (estimated weight: 3667.54 kg). Predominantly juvenile, and a small number of adult common dace (*Leuciscus leuciscus; n* = 44), ranging 34 – 111 mm (FL; **Figure 3.3**) were also highly prevalent. **Table 3.1** provides an overview of total species composition, abundance, and species tolerance relative to changes in the surrounding environment. **Table 3.2** provides a ranking overview of captured species abundance, alongside functional and feeding guilds, and an indication of conservation status. Further to all species captured, a single adult Northern pike, *Esox lucius* (FL: ~500 mm) was also observed, but evaded capture, taking the total confirmed species recorded during surveys, to fifteen.

Table 3.1: Channelsea River TW fisheries survey catch data summary, including survey sites and methodologies deployed between 17th – 20th July 2023[18].

						Medium tolerance	Medium tolerance	Medium tolerance	Medium tolerance	Medium tolerance	Medium tolerance	High tolerance	High tolerance	High tolerance	High tolerance	High tolerance	High tolerance	High tolerance	Unclassified tolerance		
						Species															
E_ID	SURVEY_ID	EVENT_DATE	SURVEY_METHOD	SURVEY_STRATEGY	TOTAL_NETS/RUNS/COD_ENDS	Common Dace	Common Bleak	3 Spined stickleback	European eel	Common bream	Roach x Bream	Common [wild] carp	Common roach	Common Rudd	Common perch	Flounder	Thin-lipped grey mullet	Common goby	European Seabass	TOTAL_ABUNDANCE	N_SPECIES
EF_201	201_1	17/07/2023	Electric fishing (CPUE boat)	Single Catch Sample	1	5	3	-	-	-	2	1	20	-	-	-	10	-	2	43	7
FYKE_101	101_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	-	-	-	16	-	-	3	19	2
FYKE_102	102_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	-	-	-	17	-	-	1	4	2
FYKE_103	103_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	1	-	-	2	1	-	3	-	-	5	12	5
FYKE_104	104_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	-	-	-	8	-	-	1	9	2
FYKE_105	105_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	-	1	-	1	-	-	1	3	3
FYKE_106	106_1	18/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	-	-	1	5	-	-	4	10	3
SEINE_001	001_1	18/07/2023	Seine Netting	Single Catch Sample	1	13	-	2	-	1	-	-	36	-	-	3	-	-	5	60	6
SEINE_001	001_2	18/07/2023	Seine Netting	Single Catch Sample	1	7	-	-	-	2	2	-	39	-	1	17	-	-	4	72	7
EF_201	201_2	19/07/2023	Electric fishing (CPUE boat)	Single Catch Sample	1	6	4	-	-	1	-		42	-	-	-	2	-	-	55	5
FYKE_101	101_2	19/07/2023	Fyke netting	Single Catch Sample	2		-	-	-	1	-	-	1	-	-	22	2	-	20	46	5
FYKE_102	102_2	19/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-		-	-	5	-	-	19	-	-	15	39	3
FYKE_103	103_2	19/07/2023	Fyke netting	Single Catch Sample	2	-	1	-	-	1	-	-	-	2	3	13	-	-	3	23	6
FYKE_104	104_2	19/07/2023	Fyke netting	Single Catch Sample	2	-	1	-	-	1	-	-	-	2		13	1	-	3	21	6
FYKE_105	105_2	19/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	3	2	2	13	-	-	-	20	4
FYKE_106	106_2	19/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	2	-	-	-	-	2	1	1	-	-	3	9	5
FYKE_101	101_3	20/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	1	-		-	6	1	-	20	-	-	36	64	5
FYKE_102	102_3	20/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	14	-	-	24	-	-	11	49	3
FYKE_104	104_3	20/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	-	-	1	4	-	4	-	-	-	9	3
FYKE_105	105_3	20/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	-	-	2	-	2	1	1	10	-	-	-	16	5
FYKE_106	106_3	20/07/2023	Fyke netting	Single Catch Sample	2	-	-	-	1	1	-	-	5	3	4	6	-	-	1	21	7
SEINE_002	002_1	20/07/2023	Seine Netting	Single Catch Sample	1	3	5	-	-	-	1	-	12	-	-	61	-	4	20	106	7
SEINE_002	002_2	20/07/2023	Seine Netting	Single Catch Sample	1	9	4	-	-	-	-	-	8	-	2	125	-	6	20	174	7
SEINE_003	003_1	20/07/2023	Seine Netting	Single Catch Sample	1	-	1	-	-	1	-	-	3	-	-	10	-	-	6	21	5
SEINE_003	003_2	20/07/2023	Seine Netting	Single Catch Sample	1	1	-	-	-	2	-	-	3	-	-	5	-	-	4	15	5
					TOTALS_ACROSS_SURVEYS**	44	19	2	4	12	7	1	202	19	15	416	15	10	168	920	14

[18] *Note*: a single adult Northern pike of approximately 500 mm in fork length was observed while electric fishing on 17th July 2023, however, evaded capture.

Table 3.2: Fisheries community composition, including functional and feeding guilds detected within the Channelsea River (Summer 2023) and differing fishing gear capture success by species (F: fyke net; S: seine net; E: electric fishing).

Species	Functional guild	Rare/ threatened	Feeding guild	Presence within samples (n)	Catch %	Total abundance	Fishing gear		
							F	S	E
Flounder *Platichthys flesus*	Estuarine resident[19]	-	Benthic invertebrates	23	45.2	416	x	x	
Roach *Rutilus rutilus*	Freshwater species[20]	-	Zooplankton	17	21.9	202	x	x	x
Sea Bass *Dicentrarchus labrax*	Marine juvenile species[21]	-	Piscivorous	21	18.2	168	x	x	x
Dace *Leuciscus leuciscus*	Freshwater species	-	Zooplankton	7	4.8	44		x	x
Common Bleak *Alburnus alburnus*	Freshwater species	-	Zooplankton	7	2.1	19	x	x	x
Rudd *Scardinius erythrophthalmus*	Freshwater species	-	Zooplankton	10	2.1	19	x		
Perch *Perca fluviatilis*	Freshwater species	-	Piscivorous	8	1.6	15	x	x	
Thin-lipped grey mullet *Liza ramada*	Diadromous species	-	Detritus	4	1.6	15	x		x
Bream *Abramis brama*	Freshwater species	-	Benthic invertebrates	10	1.3	12	x	x	x
Common goby *Pomatoschistus microps*	Estuarine resident	-	Benthic invertebrates	2	1.1	10		x	
Roach X Bream *hybrid*	Freshwater species	-	Zooplankton/ Benthic invertebrates	4	0.8	7	x	x	x
European eel *Anguilla anguilla*	Diadromous species	Y	Piscivorous	3	0.4	4	x		

[19] Estuarine resident: fishes that spend their entire life in estuaries.
[20] Freshwater species: fishes that are present mainly or exclusively at low salinity values.
[21] Marine juvenile species: fishes that use estuaries as nursery grounds or during juvenile phases of their life cycle.

Species	Functional guild	Rare/ threatened	Feeding guild	Presence within samples (n)	Catch %	Total abundance	Fishing gear		
							F	S	E
3-spined stickleback *Gasterostreus aculeatus*	Diadromous species[22]	-	Zooplankton	1	0.2	2		x	
Carp *Cyprinus carpio*	Freshwater species	-	Benthic invertebrates	1	0.1	1			x
Pike *Esox lucius*	Freshwater species	-	Piscivorous	1	0.1	1			

[22] Diadromous species: species that migrate between fresh and salt water during different life stages.

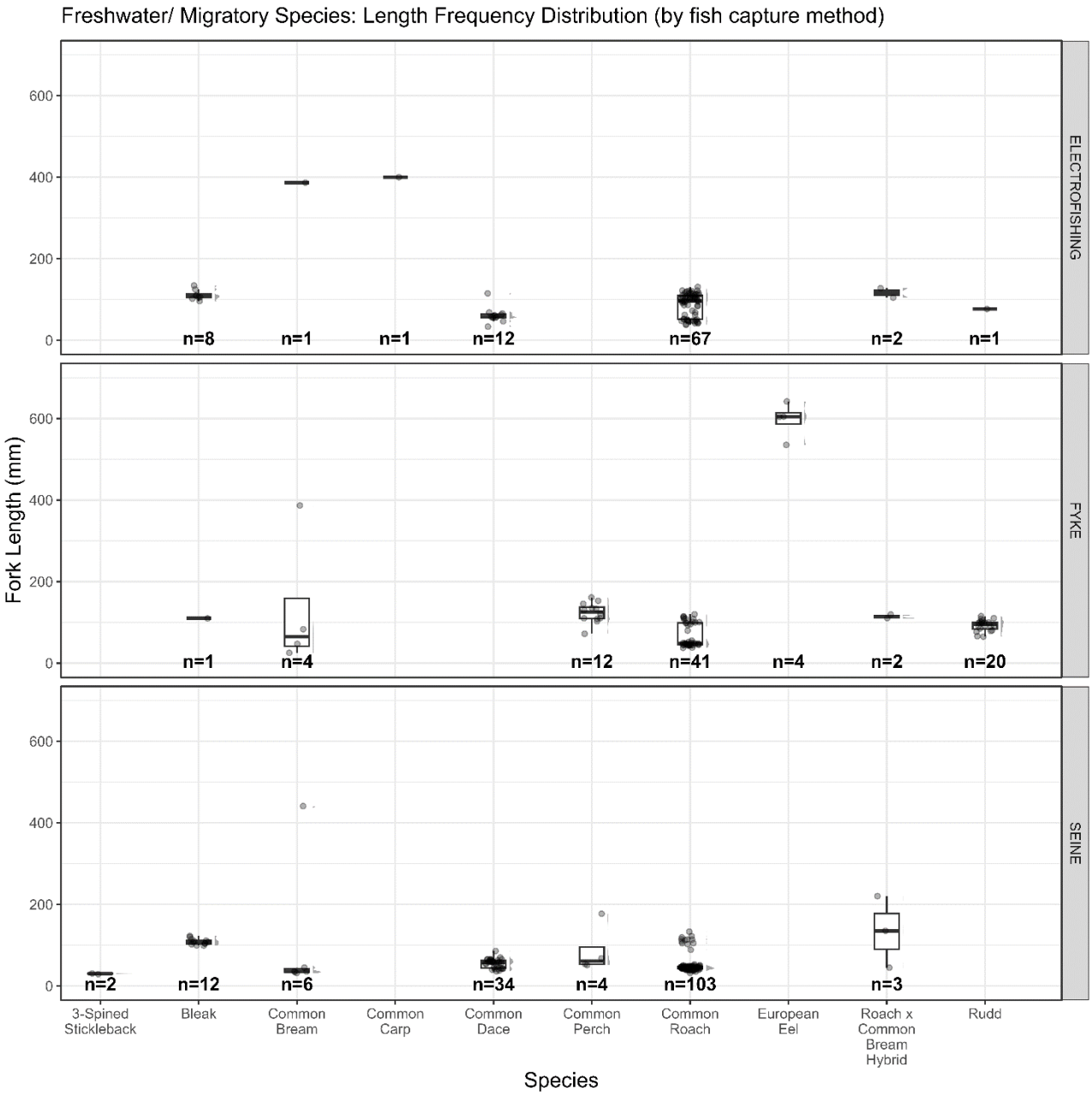


Figure 3.2: Size class distribution of all freshwater and migratory fishes captured across differing fish capture methods deployed within the Channelsea River (17th – 20th July 2023)[23].

[23] Note: Length measurement for European eel is the total length owing to species morphology.

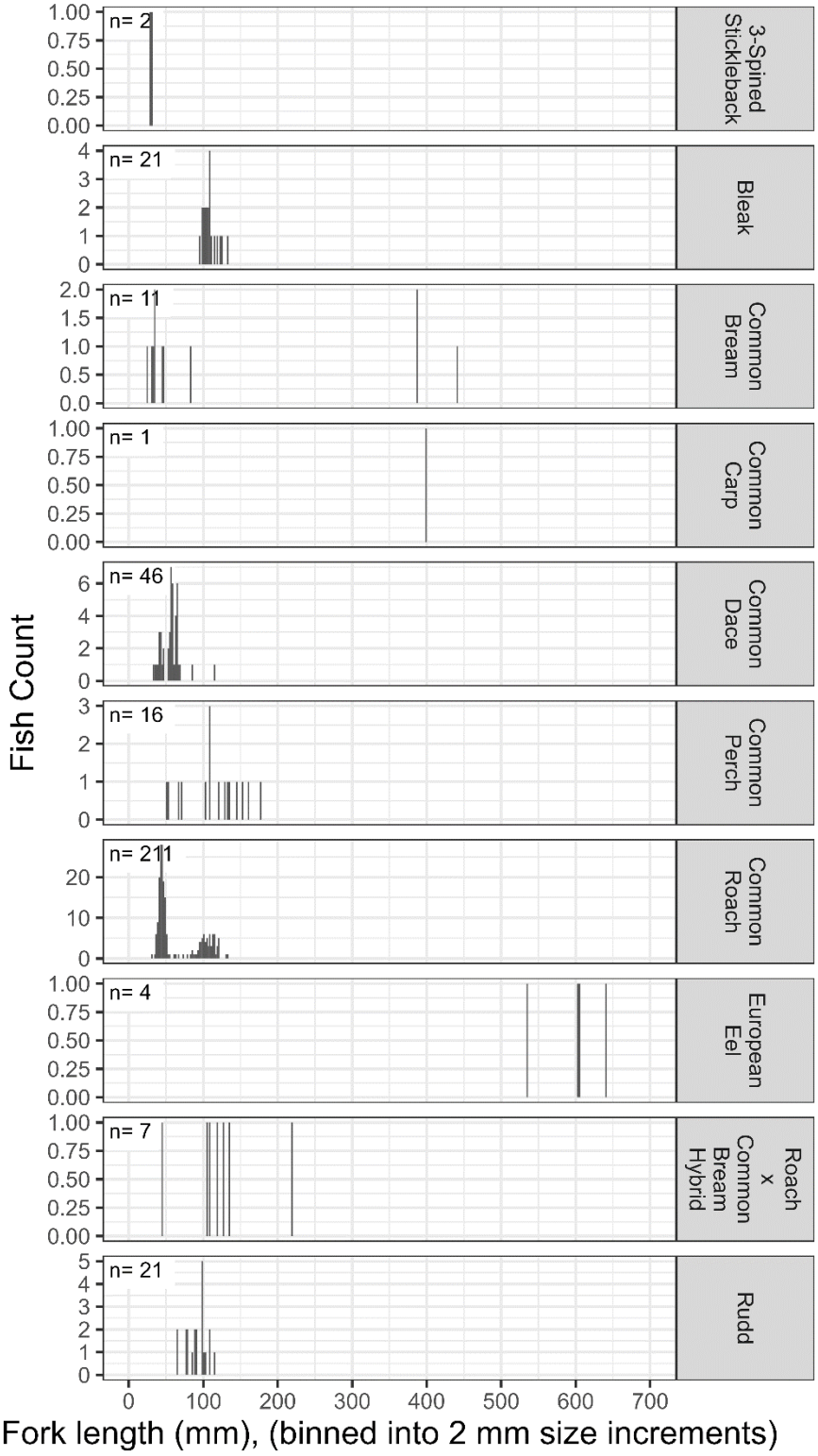


Figure 3.3: Frequency distribution of all freshwater and migratory fishes captured across all surveys conducted within the Channelsea River between 17th – 20th July 2023[23].

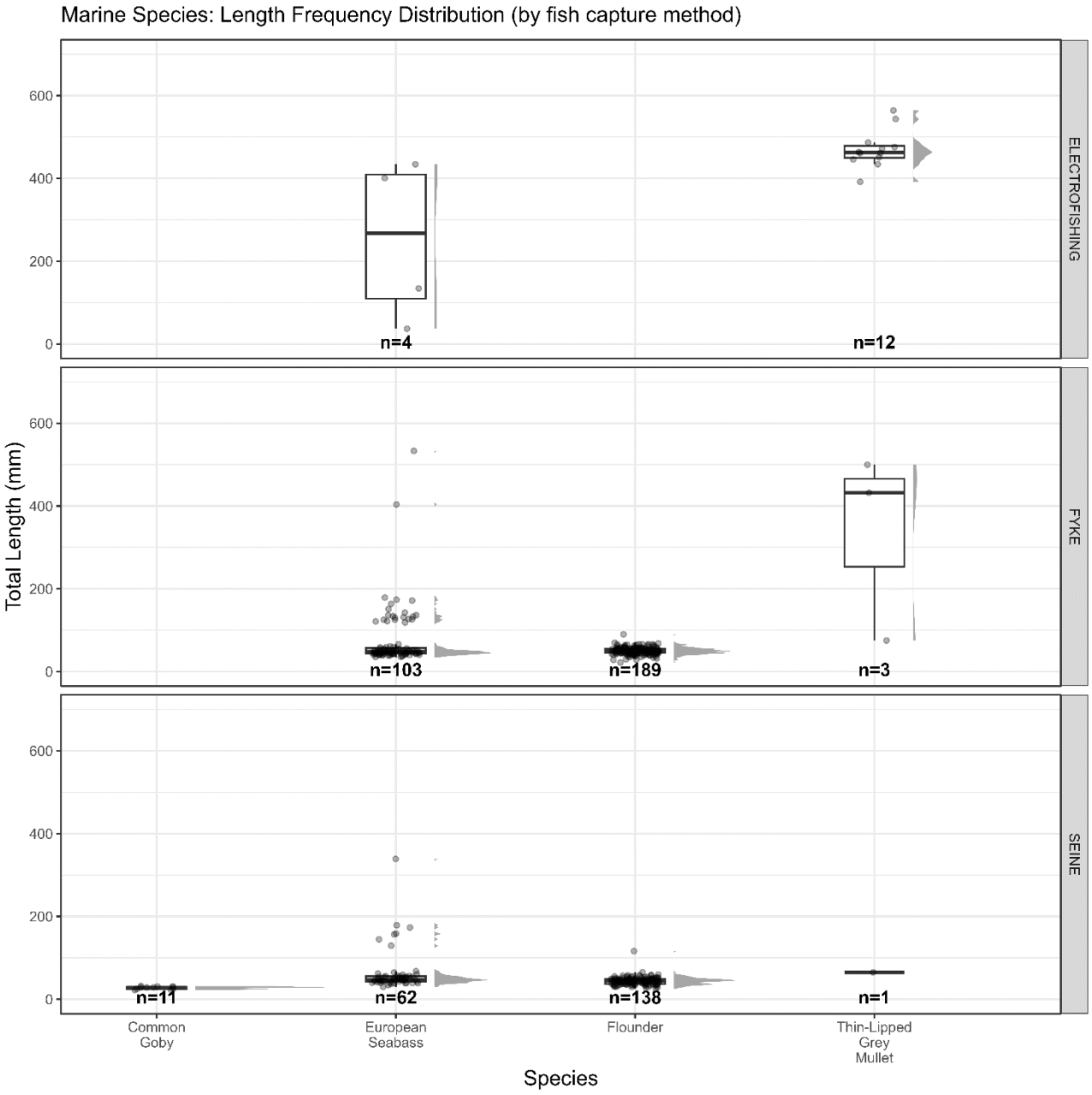


Figure 3.4: Size class distribution of all marine fish species captured across differing fish capture methods deployed within the Channelsea River (17th – 20th July 2023).

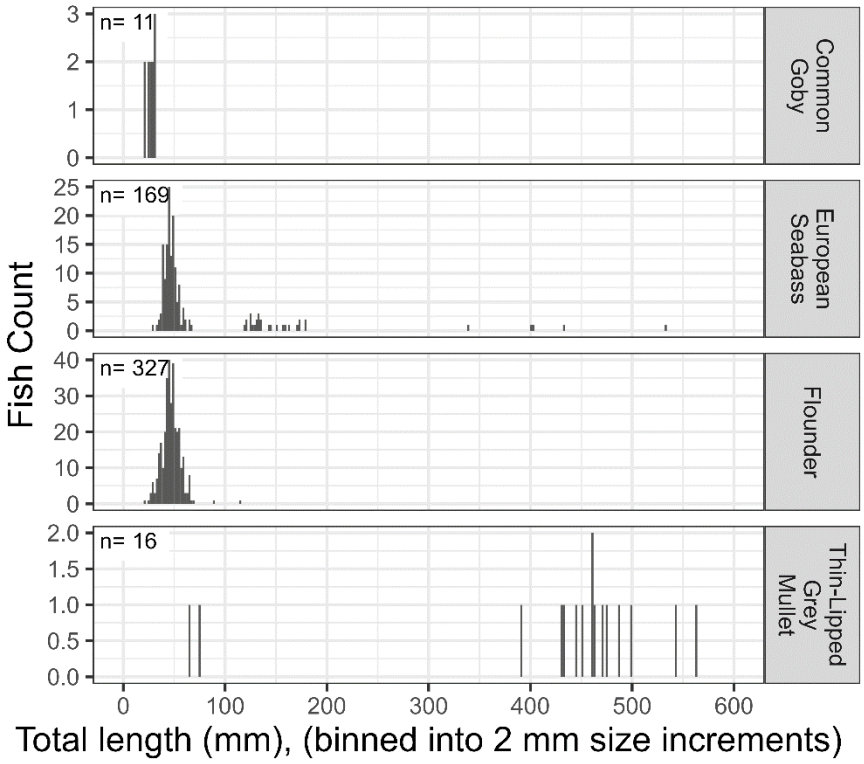


Figure 3.5: Total length (mm) frequency distribution of all marine fish species captured across all surveys conducted within the Channelsea River between 17th – 20th July 2023.

Figure 3.6: The TW fisheries survey indicated the presence of 12 fish species from across four different functional and feeding guilds, with differing age classes identified among some taxa. Photographic examples presented include **A)** common bream; **B)** common perch; **C)** adult European seabass; **D)** European eel; **E)** adult thin-lipped grey mullet; **F)** common bleak; **G)** adult common carp; and H) common goby[24].

3.2 WATER QUALITY

Water quality was measured from representative sampling locations during each day of surveying (n = 3)[25] on the Channelsea River using an Aqua TROLL 400 Multiparameter probe. All parameters were observed to remain relatively constant throughout the four-day survey period (**Table 3.3**).

Table 3.3: Water quality readings taken at survey representative sampling locations during TW fisheries surveys conducted between 17th – 20th July 2023 on the Channelsea River.

WQ Parameter	Unit	Sample size	Mean	± SE	Range
Salinity	ppt	3	0.50	0.03	0.44 – 0.50
Specific Conductance (SPC)	µS cm^{-1}	3	897.3	56	795.7 – 989
Conductivity (C)	µS cm^{-1}	3	921	75.9	784–2 - 1046
Temperature	°C	3	22.8	1.82	19.3 – 23.9
pH	logarithmic units	3	8.09	0.04	8.03– 8.16
Dissolved oxygen	%	3	92.75	2.15	89.4 – 96.76
Dissolved oxygen	mg l^{-1}	3	8.23	0.20	7.85 – 8.55

3.3 INNS

Four invasive non-native species were confirmed on site within the Channelsea River: Asian clams (*Corbicula fluminea*), Floating Marshpennywort, Himalayan balsam (*Impatiens glandulifera*; **Figure 3.7**), and giant hogweed (*Heracleum mantegazzianum*).

Figure 3.7: A large volume of Himalayan balsam was identified as present on-site within the Channelsea River.

[24] Note: further photographs of species captured are available within the supporting Excel workbook (TW_Fish_Workbook_20230717).
[25] Note: no water quality data was collected on 18th July 2023

3.4 SEASONAL FISH ASSEMBLAGES

The Bray-Curtis similarity index[26] was applied to quantify similarity in fish community composition between the two seasonal datasets within the Channelsea River. This index takes into account fish species and abundance, and is calculated as:

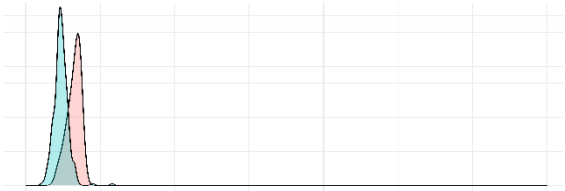
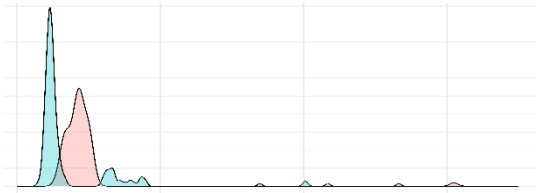
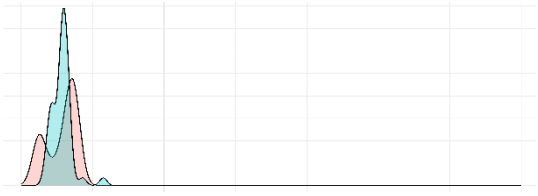
$$BC_s = 1 - \left(\frac{\sum |xi - xj|}{\sum (xi - xj)}\right)$$

Where *xi* is the abundance of a species during one season, and *xj*, the abundance at the other. Expressed as a percentage, 100% would reflect an identical fish species composition.

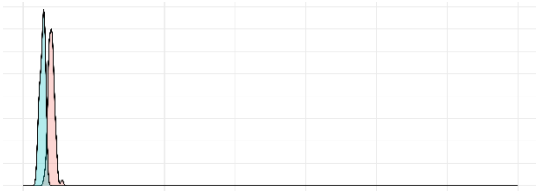
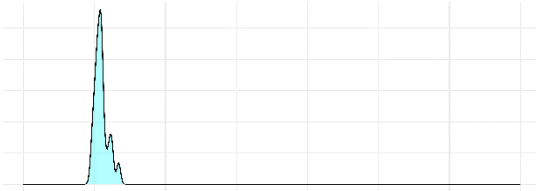
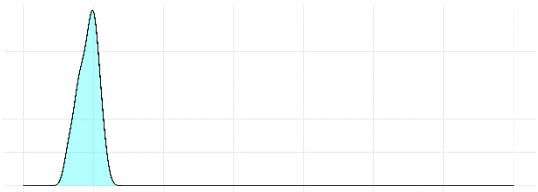
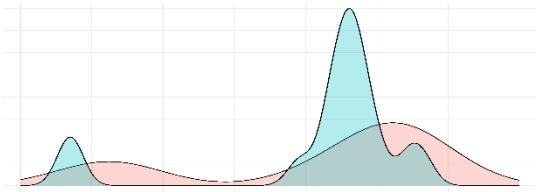
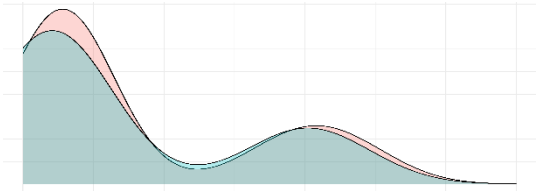
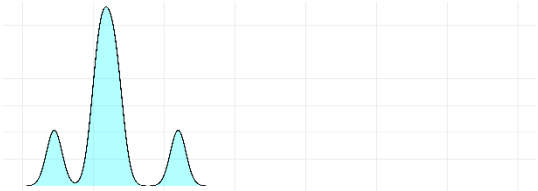
The Bray-Curtis similarity index between the two seasonal fish assemblages within the Channelsea River was calculated as 47%. This formula has been applied to statistically clarify seasonal differences in fish populations. As expected, seasonal variations existed between fish assemblages between autumn 2022 and summer 2023. Bleak, rudd, European eel, and roach x bream hybrids were only recorded in Summer 2023, while feral goldfish and minnow were only recorded in autumn 2022.

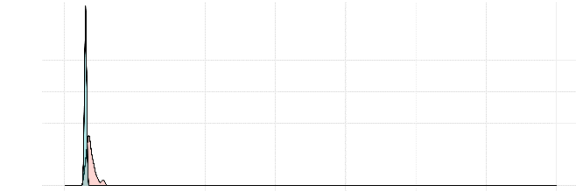
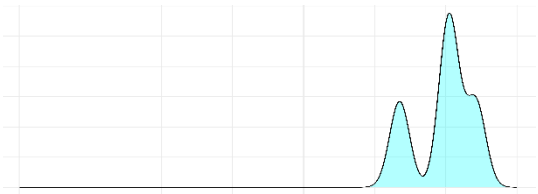
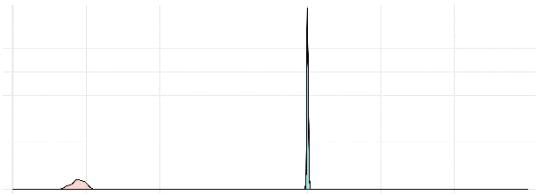
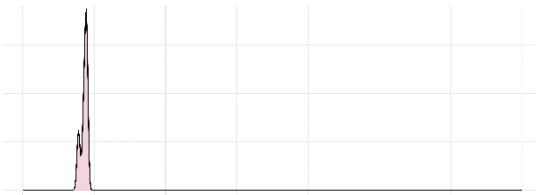
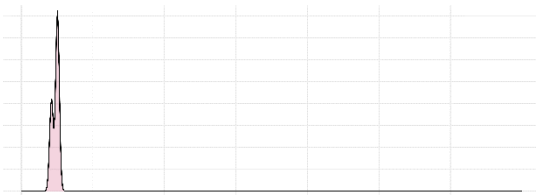
There were also differences in age classes among species between the seasons (**Table 3.4**), with flounder, sea bass, roach, dace and goby all noted to be within a smaller juvenile size class during the Summer 2023 survey in comparison to autumn 2022.

Table 3.4: Differences in seasonal size frequency distribution and abundance of species captured across all surveys conducted within the Channelsea River during autumn 2022 (7th to 10th November) and Summer 2023 (17th to 20th July) sampling periods.

Species	Differences in seasonal size frequency distribution (Wilcoxon ranked sum test) 2022 2023		Abundance (*n*)	
			Autumn 2022	Summer 2023
Flounder		*W* = 5052; ***p* < 0.01**	17	416
Roach		*W* = 44844; ***p* < 0.01**	401	202
Sea Bass		*W* = 10059; ***p* < 0.01**	73	168
Dace		*W* = 1337.5; ***p* = 0.12**	49	44

[26] The Bray-Curtis similarity index is used in the WFD Transitional Fish Classification Index (TFCI) to assess species composition and abundance data against a WFD reference fish assemblage. See: http://www.wfduk.org/resources/transitional-waters-fish.

Species	Differences in seasonal size frequency distribution (Wilcoxon ranked sum test) 2022 2023		Abundance (*n*) Autumn 2022	Summer 2023
Goby		*W* = 733.5; ***p* < 0.01**	67	10
Bleak		***n.a.***	-	19
Rudd		***n.a.***	-	19
Thin-lipped grey mullet		*W* = 156; ***p* = 0.29**	16	15
Perch		*W* = 86; ***p* < 0.05**	20	15
Bream		*W* = 295.5; ***p* = 0.16**	42	12
Roach x bream *hybrid*		***n.a.***	-	7

Species	Differences in seasonal size frequency distribution (Wilcoxon ranked sum test) 2022 2023		Abundance (*n*) Autumn 2022	Abundance (*n*) Summer 2023
3-spined stickleback		*W* = 31.5; ***p* = 0.06**	17	2[27]
European eel		***n.a.***	-	4
Carp		***NC***	5	1[27]
Feral goldfish		***n.a.***	5	-
Minnow		***n.a.***	3	-

[27] *Note*: small sample size should be considered with respect to statistical analysis, with some data too few to run Wilcoxon ranked sum test, or not calculated ('*NC*').

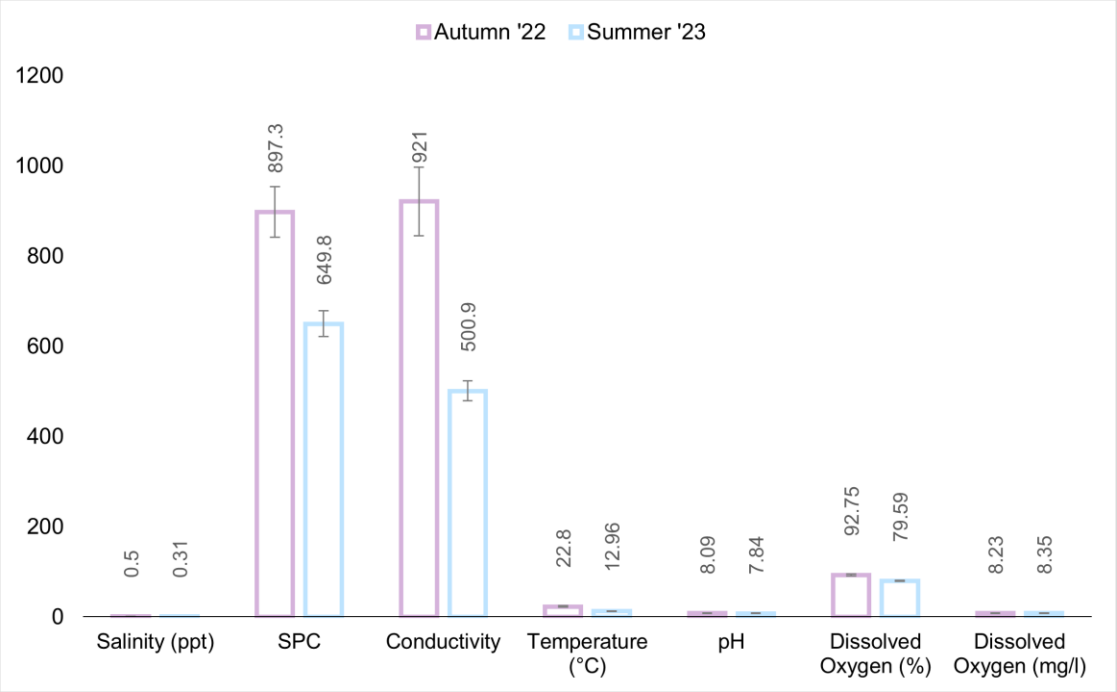


Figure 3.8: Differences in water quality parameters between surveys conducted within the Channelsea River during autumn 2022 (7th to 10th November) and Summer 2023 (17th to 20th July) sampling periods.

4. CONCLUSIONS & RECOMMENDATIONS

4.1 FISH COMMUNITY COMPOSITION

4.1.1 Summary of baseline data

The multiple-method fish surveys carried out are considered sub-optimal from a WFD monitoring perspective (spring WFD TW fish monitoring is completed from April to the end of June). However, following consultation with the EA and TWUL, summer data was required in order to provide an understanding of the fish community present during the likely operational timings of commissioning works for TTT (July to September) at Abbey Mills. The data gathered within the Channelsea River is considered to be representative of the fish community present within the Channelsea River during summer 2023.

The European Best Practice[28] multi-method approach combining fyke netting, seine netting, and electric fishing techniques, identified a total of 920 specimens of varying size classes that were comprised of 14 different species, including one hybrid, across seven different taxonomic orders. On-site visual confirmation of a further species that evaded physical capture was also recorded, taking the total number of different species confirmed to 15 during completion of the surveys. Orders identified included predominantly Cypriniformes (6 species belonging to 2 families, plus hybrid individuals), Perciformes (2 species from 2 families), Gobiformes (1 species, 1 family), Pleuronectiformes (1 species, 1 family), Scorpaeniformes (1 species, 1 family), Mugiliformes (1 species, 1 family) and Anguilliformes (1 species, 1 family).

These included species from a total of four functional guilds, including predominantly freshwater species (*n* = 9), and diadromous (*n* = 3), marine juvenile (*n* = 1), and estuarine resident (*n* = 2) species. The fish community belonged to four feeding guilds: zooplankton feeders (*n* = 5), benthic invertebrate feeders (*n* = 4), piscivorous (*n* = 4), and detritus feeders (*n* = 1) and zooplankton/benthic invertebrate feeders (n = 1).

Just under half of the total catch (*n* = 416; 45%) was comprised of a single species, flounder, an estuarine fish which can travel far into freshwater territories. The flounder recorded during this survey were all of juvenile size, with no adult fish being recorded. Juvenile flounder return to shallow freshwater areas as larvae in early May where they live and feed within estuarine nursery areas for approximately 18 to 20 months until they reach maturity and migrate to outer estuaries or coastal waters to spawn.

The second most abundant species was common roach (*n* = 202; 22%), a shoaling freshwater cyprinid species that is highly tolerant to organic pollution and brackish water and is commonly among the most numerous fish under sparsely vegetated or highly turbid aquatic environments. Indeed, this species was the dominant species captured during the autumn 2022 seasonal survey. The average size of roach during the summer 2023 surveys was 66.1 mm, compared to a larger average size of 73.9 mm recorded in autumn 2022. During the 2022 survey, it emerged that there were two predominant roach size classes, however in summer 2023, there was only one predominant roach size class, this change is best described by the large proportion of young roach. Again, similar to the autumnal surveys, following on from roach, were juvenile seabass (*n* = 168), however, in over double the abundance.

Comparatively, the average size of sea bass recorded in autumn 2022 was 91.3 mm, compared to 72.97 mm in summer 2023. The seabass is a demersal marine juvenile species that typically spends the first 4 to 6 years inshore (penetrating in large numbers as far as Richmond on the Thames[29]), before migrating between inshore spawning grounds and offshore feeding grounds. Spawning typically takes place between March to mid-June when adults move closer inshore into warmer waters. This is apparent with results from the summer 2023 surveys, with a greater amount of small juvenile sea bass being recorded in comparison to the autumn 2022 surveys.

The Thames Estuary and its tributaries provide significant nursery functions for a variety of species, including seabass, making it one of the primary fish production areas for the southern North Sea[30]. While a few larger adult sea bass were captured during surveys, only two were above the legal minimum landing size (i.e., > 420 mm) that is applied to protect immature fish, thereby assisting with fisheries management and conservation. As expected, the use of a range of fish capture techniques with varying gear selectivities proved beneficial in providing a more complete picture of functionality within the transitional water body. For instance, four European eels were only

[28] European Commission Fair Programme. (2000). Commercial fish and European estuaries: Priorities for Management and Research. Available at: https://cordis.europa.eu/project/id/FAIR961634

[29] Colclough, S.R., Gray, G., Bark, A., and Knights, B. (2002). Fish and fisheries of the tidal Thames: management of the modern resource, research aims and future pressures. *J. Fish. Biol. 61*, 64-73.

[30] Walmsley S.A. and Pawson, M.G., (2007). The coastal fisheries of England and Wales, Part V: a review of their status 2005–6. Sci. Ser. Tech Rep., Cefas Lowestoft, 140: 83pp.

captured within the fyke nets in Summer 2023, while none were recorded during the autumn 2022 surveys. Similarly, although perch were captured during fyke and seine netting in summer 2022, comparatively, in autumn 2022 individuals were only captured in fyke nets.

Sub-dominant species within the reach included key species known to the Thames tidal estuary: adult common gobies, juvenile common dace, adult and juvenile common bream, and common perch. Further species of interest captured included thin-lipped grey mullet, as well as individuals that were identified as roach x bream hybrids. It should be noted that in contrast to autumn 2022, no minnow, or feral goldfish were recorded in summer 2023.

Disturbance-sensitive species, or WFD 'indicator taxa' are determined from the conservation and protection status[31], and sensitivity of individuals to changes in their surrounding environment (e.g., oxygen levels[32]) of certain species. Sensitivity may be defined as tolerance (low, medium, or high) as displayed by the various elements of the local ichthyofauna to physico-chemical and environmental pressures.

One WFD 'indicator taxa' species, European eel and four eel individuals being collected within the fyke nets and optimal eel habitat was available throughout the surveyed reach (particularly surrounding Channelsea Island), including refuges and ambush points available from aquatic plant coverage, submerged root systems, woody debris, undercut banks, physical structures and varying substrates. No European eels were collected during the autumn 2022 sampling. Presence of eels may be indicative of increased feeding activity of the individuals that were captured during the summer conditions, in comparison to non-feeding silver individuals in the autumn that store fat before migrating to the sea without feeding [33]. But it must be noted that lack of eels during the autumn sampling may not be due to lack of presence within the survey area, it may be due to environmental limitations that prevented their capture such as deep water, macrophyte assemblages and blanket algae.

Other WFD transitional fish indicator species include for example, European smelt (*Osmerus eperlanus*). It is pertinent to note that the absence of any species from the survey catch data that is known to occur within the Thames catchment, does not directly indicate its absence within the surveyed reach. Varying limitations, as discussed earlier may have prevented capture of other indicator species.

4.1.2 Uncertainty, data gaps and recommendations.

This report provides an evidence base on the Summer tidal fisheries community composition within the Channelsea River. Fish communities (species composition and abundance) within the Thames Tideway change each season of the year[34, 35] and the inclusion of summer data provides a seasonal indication of the fish community present within the Channelsea River.

In accordance with TW WFD fish monitoring guidance (spring and autumn), WFD compliant **repeat surveys should be completed in autumn 2023** at the same locations next to Abbey Mills Pumping Station, within the Channelsea River. This will allow for data capture of the annual (and seasonal) changes in size-frequency distributions and fisheries composition known to occur owing to interannual variations in environmental conditions, fish populations are often subjected to wide fluctuations in abundance, a pattern primarily attributed to annual variability in year-class strength and recruitment success[31] and the large-scale migrations of both adults and fry within the tidal Thames and its tributaries.

Repeat surveys would add to our overall understanding of fish species composition and abundance across a greater temporal scale and would also enable the future application of the Transitional Fish Classification Index (TFCI) to derive a WFD classification for the Channelsea River. The TFCI provides an assessment of WFD status when compared to an ideal or 'reference' community, thereby allowing for an assessment of the transitional fish status within a transitional water body.

Application of the TFCI requires a minimal number of 30 samples to be repeated for inclusion in the analysis, of which samples collected through autumn and summer surveys completed to date, do not yet meet the minimum

[31] European Council Directive (1992) on the conservation of natural habitats and of wild fauna and flora.

[32] Turnpenny, A.W.H., Clough, S.C., Holden, S.D.J., Bridges, M., Bird, H., O'Keeffe, N.J., Johnson, D., Edmonds, M., and Hinks, C. (2004). *Thames tideway strategy: experimental studies on the dissolved oxygen requirements on fish*. Baptie Aquatic Report, Thames Water Utilities.

[33] Arjan P. Palstra and Guido E. E. J. M. van den Thillart., 2010 Swimming physiology of European silver eels (Anguilla anguilla L.): energetic costs and effects on sexual maturation and reproduction.

[33] Turnpenny, A.W.H., Clough, S.C., Holden, S.D.J., Bridges, M., Bird, H., O'Keeffe, N.J., Johnson, D., Edmonds, M., and Hinks, C. (2004). *Thames tideway strategy: experimental studies on the dissolved oxygen requirements on fish*. Baptie Aquatic Report, Thames Water Utilities.

[34] Colclough, S.R., Dutton, C., Coates, S.A., 1992. Tidal Thames Quarterly Fisheries Survey. National Rivers Authority, Thames Region.

[35] Colclough, S.R., Dutton, C., Coates, S.A., 1993. Tidal Thames Quarterly, Fisheries Survey. National Rivers Authority, Thames Region.

threshold for analysis[36]. As such, **it is also recommended that a fully WFD compliant monitoring programme is developed** in conjunction with the TTT Project going online to mitigate for any risk to fish communities in response to any potential changes in the associated Channelsea River and connected water body ecological health status.

[36] Davey, A., Clist, S. & Glennie, E. (2013). Quantifying uncertainty in the Transitional Fish Classification Index tool. Environment Agency, Bristol.

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