National Research Survey Programme

Lakes 2023

Garadice Lough

IFI/2024/1-4737

Iascach Intíre Éireann
Inland Fisheries Ireland

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Fish Stock Survey of Garadice Lough, September 2023

National Research Survey Programme

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Cover photo: Lough Lene, Co. Westmeath © Inland Fisheries Ireland

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1.   Introduction

Garadice Lough is situated in the Erne Catchment, in counties Leitrim and Cavan near the town of Ballinamore (Figure 1.1). It forms part of the Shannon-Erne Waterway, a navigable watercourse which links the Shannon and Erne catchments at Leitrim Village and Belturbet respectively. The navigation enters the lake at its western end, via the Ballyconnell-Ballinamore Canal. The Woodford River exits at the eastern end of the lake. The lake is situated at an altitude of 48 m.a.s.l., has a surface area of 389ha, mean depth of 4.4m and maximum depth of 22.4m. The lake is categorised as typology class 8 for the purposes of WFD (as designated by the EPA), i.e. deep (>4m), greater than 50ha and medium alkalinity (20-100mg/l CaCO3). In the 2010 to 2015 surveillance monitoring reporting period, the EPA assigned Garadice Lough an overall ecological status of Poor.

The lake is largely surrounded by agricultural pasture, and the geology of the area is predominantly limestone.

Garadice Lough is regarded as an excellent coarse fish and pike fishery and has been extensively developed as such. Access for cars to maintained angling pegs along the eastern portion of the lake (Haughton's and Church Shores), and at other locations is available. Several prestigious national and international angling competitions are held on the lake on an annual basis.

Since the mid1990s Inland Fisheries Ireland (previously the Central Fisheries Board) have undertaken relatively regular fish stock surveys on the lake, the most recent of which was conducted in 2012. Roach, perch, roach x bream hybrids, bream, brown trout, tench and pike were recorded at that time (IFI, 2013). The lake has also been surveyed in 2018 using IFIs lake monitoring protocol (McLoone *et al.,* 2018). On that occasion, perch, roach x bream hybrids and roach dominated fish stocks with respect to numbers and biomass respectively

This report summarises the results of the 2023 fish stock survey carried out on the lake using Inland Fisheries Ireland's fish in lakes monitoring protocol. The protocol is WFD compliant and provides insight into fish stock status in the lake.

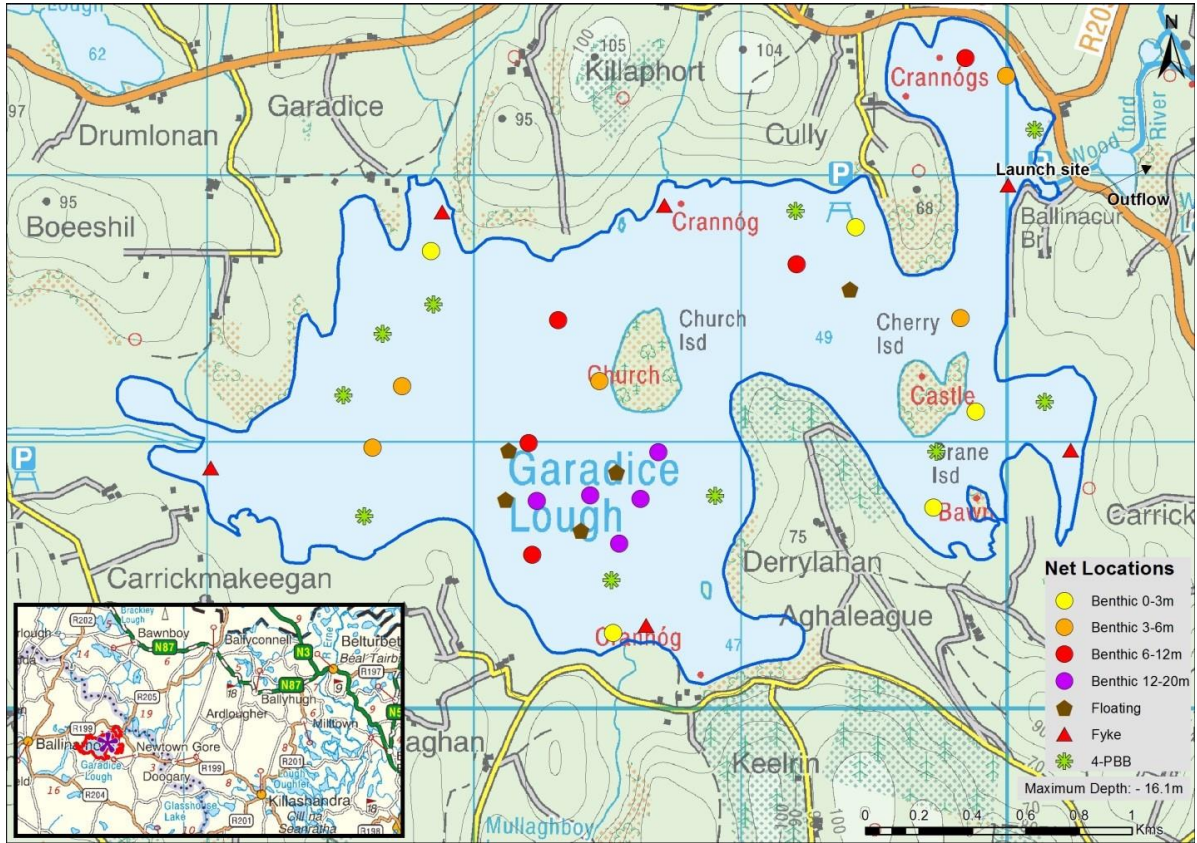**Plate 1.1. Aerial view of Garadice Lough, looking west along the lake.**

Figure 1.1. Location map of Garadice Lough showing net locations and depths of each net (outflow is indicated on map).

2. Methods

2.1. Netting methods

Garadice Lough was surveyed over three nights from the 4th to the 7th of September 2023. A total of six sets of Dutch fyke nets (Fyke), 20 benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (5 @ 0-2.9m, 5 @ 3-5.9m, 5 @ 6-11.9m, 5 @ 12-19.9m) and five floating monofilament multi-mesh (FM CEN) 12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed in the lake (31 sites). The netting effort was supplemented using four-panel benthic braided survey gill nets (4-PBB) at an additional 10 sites. The 4-PBB nets are composed of four 27.5m long panels each a different mesh size (55mm, 60mm, 70mm and 90mm). Nets were deployed in the same locations as were randomly selected in the previous surveys. A handheld GPS was used to mark the precise location of each net. The angle of each survey gill net in relation to the shoreline was also randomised.

All fish apart from perch were measured and weighed on site and scales were removed from a sub-sample of other species. Live fish were returned to the water whenever possible (*i.e.* when the likelihood of their survival was considered to be good). Samples of fish were retained for further analysis. Fish were frozen immediately after the survey and transported back to the IFI laboratory for later dissection.

2.2. Fish diet

Total stomach contents were inspected, and individual items were identified to the lowest taxonomic level possible. The percentage frequency occurrence (%FO) of prey items were then calculated to identify key prey items (Amundsen *et al.*, 1996).

$$\mathbf{FO}_i = \left(\frac{N_i}{N}\right) * 100$$

Where:
$\mathbf{FO}_i$ is the percentage frequency of prey item i,
N_i is the number of fish with prey i in their stomach,
N is total number of fish with stomach contents.

2.3. Biosecurity - disinfection and decontamination procedures

Procedures are required for disinfection of equipment to prevent dispersal of alien species and other organisms to uninfected waters. A standard operating procedure was compiled by Inland Fisheries

Ireland for this purpose (Caffrey, 2010) and is followed by staff in IFI when moving between water bodies.

3. Results

3.1. Species Richness

A total of eight fish species and one cyprinid hybrid were recorded on Garadice Lough in September 2023. A total of 1242 fish were captured (Table 3.1). Perch was the most numerous fish species recorded, representing *c*. 61% of all fish captured. Roach were also recorded in high numbers, and accounted for *c*. 27% of all fish captured in the survey. Roach x bream hybrids, bream, pike, tench, brown trout, gudgeon and European eel were also recorded. The same species composition was recorded on the previous survey of the lake in 2018 (McLoone *et al.,* 2018).

Table 3.1. Number of each fish species captured by each gear type during the survey on Garadice Lough, September 2023.

Scientific name	Common name	Number of fish captured				
		BM CEN	FM CEN	4-PBB	Fyke	Total
Perca fluviatilis	Perch	637	102	0	13	752
Rutilus rutilus	Roach	265	49	6	10	330
Rutilus rutilus x Abramis brama	Roach x bream hybrid	15	5	76	0	96
Abramis brama	Bream	2	4	26	0	32
Esox lucius	Pike	4	1	2	1	8
Tinca tinca	Tench	1	0	4	3	8
Salmo trutta	Brown trout	1	0	3	0	4
Gobio gobio	Gudgeon	2	0	0	0	2
Anguilla anguilla	European eel	0	0	0	10	10

3.2. Fish abundance

Fish abundance (mean CPUE) and biomass (mean BPUE) were calculated as the mean number/weight of fish caught per metre of net. For all fish species except eel, CPUE/BPUE is based on all nets, whereas eel CPUE/BPUE is based on fyke nets only. Perch were the dominant species with respect to abundance (CPUE), while roach x bream hybrids and roach were the dominant species in terms of biomass (BPUE) (Table 3.2).

Table 3.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Garadice Lough, September 2023.

Scientific name	Common name	Mean CPUE (± S.E)	Mean BPUE (± S.E)
Perca fluviatilis	Perch	0.606 (0.109)	11.290 (2.592)
Rutilus rutilus	Roach	0.261 (0.088)	18.077 (5.874)
Rutilus rutilus x Abramis brama	Roach x bream hybrid	0.033 (0.009)	23.416 (6.997)
Abramis brama	Bream	0.011 (0.004)	5.326 (1.906)
Esox lucius	Pike	0.005 (0.002)	6.648 (3.274)
Tinca tinca	Tench	0.003 (0.001)	1.599 (1.279)
Salmo trutta	Brown trout	0.001 (0.000)	2.719 (1.735)
Gobio gobio	Gudgeon	0.002 (0.001)	0.002 (0.001)
Anguilla anguilla*	European eel	0.028 (0.015)	12.104 (6.198)

Note: Where biomass data was unavailable for an individual fish, this was determined from a length/weight regression for that species (Connor et al., 2017). *Eel CPUE and BPUE based on fyke nets only.
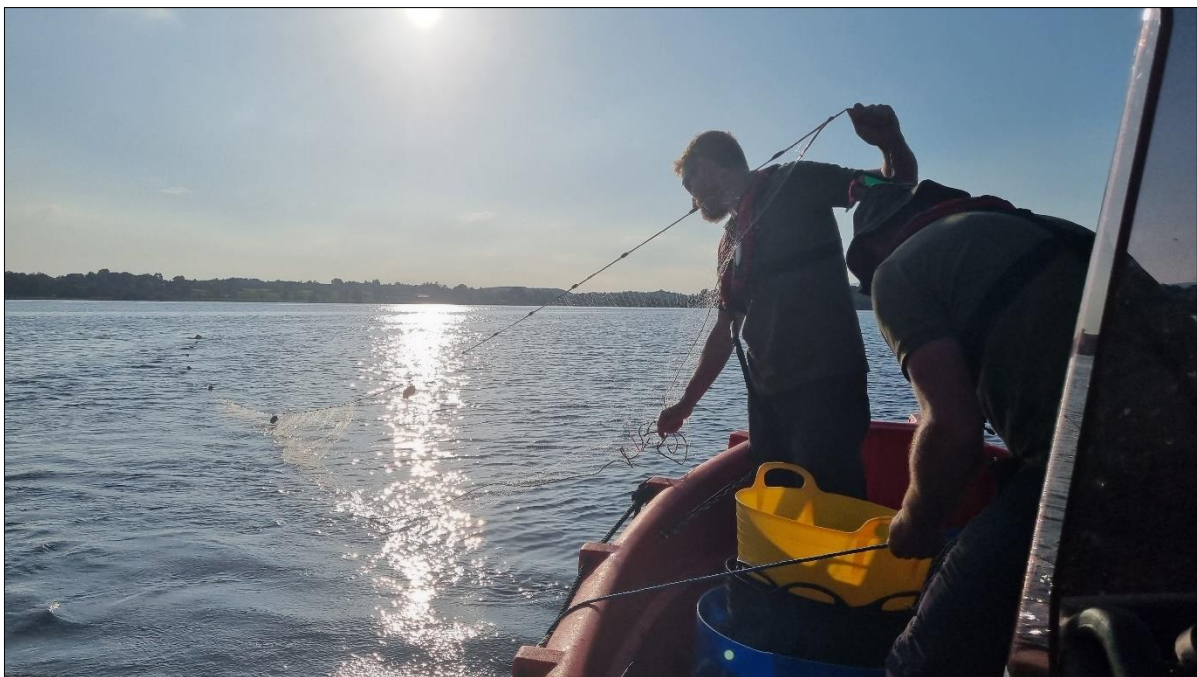

Plate 3.1. Deploying a floating survey gill net on Garadice Lough, September 2023

3.3 Species Profiles

<u>Perch</u>

Perch captured during the 2023 survey ranged in length from 4.2cm to 27.7cm (mean = 8.3cm) (Figure 3.1). Length range and population size profiles were broadly similar in both surveys, and the population was dominated by small (i.e. < 10cm) fish. Larger perch (i.e. >15cm) were less prominent in 2023 compared to 2018. Perch were aged between 0+ and 9+ and all intervening age classes were represented in the sampled aged. Perch aged between 0+ (5cm − 6cm) and 2+ (13cm − 19cm) dominated the population, representing *c.* 66% of all the fish aged (Figure 3.1). A large cohort of 5+ (21cm to 27cm) fish was also recorded (Figure 3.1). Mean L1 (i.e. length at the end of the 1st year) was 6.0cm (Table 3.3).

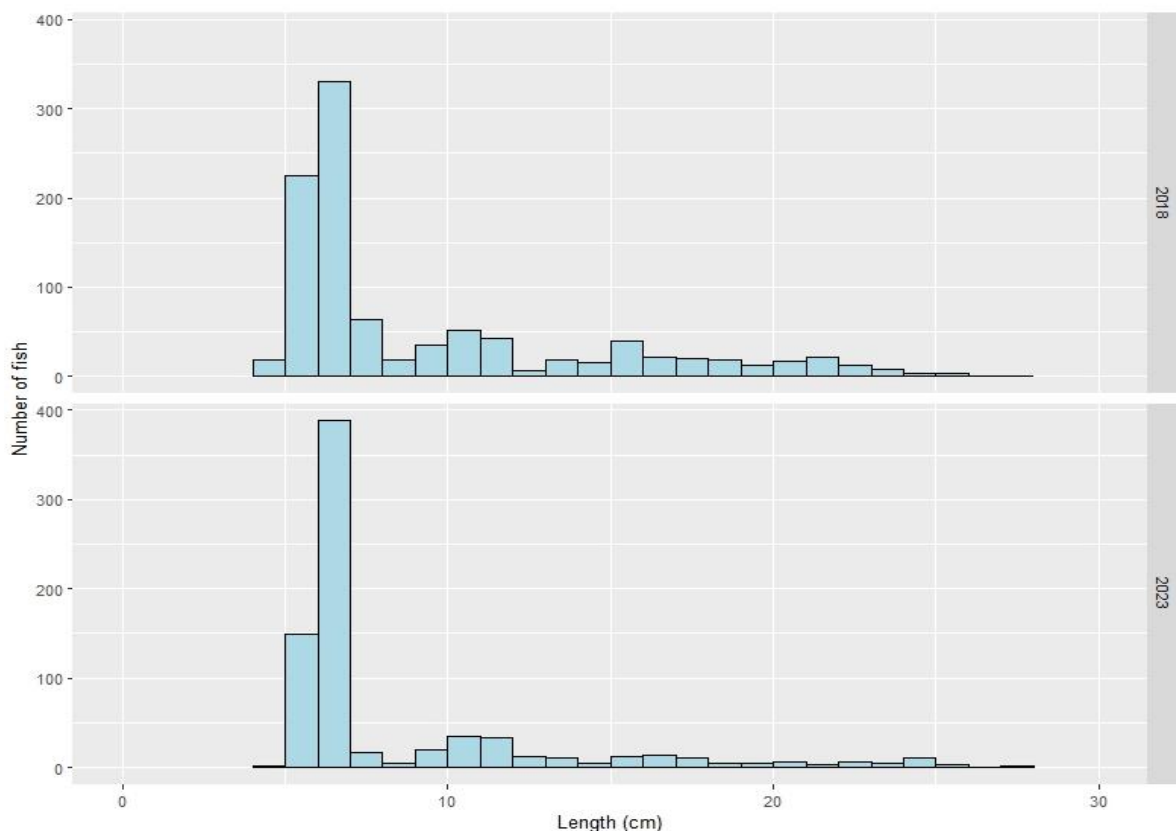Median perch abundance (CPUE) was similar in 2023 to 2018 , while biomass (BPUE) was lower in 2023 (Figure 3.2).

Figure 3.1. Length frequency of perch captured on Garadice Lough in 2018 and 2023.

Table 3.3. Mean (±S.E.) perch length (cm) at age for Garadice Lough, September 2023

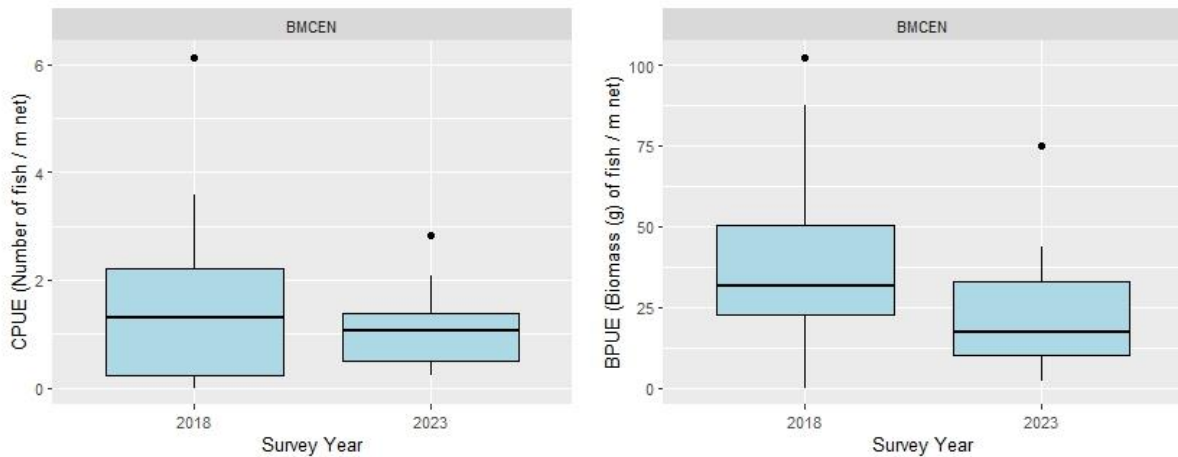|	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9
Mean (±S.E.)	6.0 (0.12)	10.5 (0.21)	15.2 (0.29)	18.5 (0.36)	20.6 (0.55)	20.3 (0.65)	20.9 (0.78)	22.2 (1.28)	21.8 (1.12)
N	78	50	32	27	21	10	6	4	3
Range	4.1-8.8	8.5-14.9	12.3-18.9	14.6-22.4	15.9-26.9	17.1-23.8	18.2-23.6	19.2-25.2	19.8-23.7

Figure 3.2. CPUE and BPUE of perch captured during surveys of Garadice Lough in 2018 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Roach

Roach captured during the 2023 survey ranged in length from 3.8cm to 34.3cm (mean = 13.2cm) (Figure 3.3). Length range was broadly similar in both surveys. However, large roach (i.e. > 20cm) were less prominent in 2023. Roach in the population were aged between 1+ and 15+ (Table 3.4). All intervening age classes were present (Table 3.4). Three year old (7cm - 13cm) and 4+ (11cm – 17cm) fish were the most abundant year classes in the sample aged. 8+ fish were also well represented (Figure 3.3 and Table 3.4).

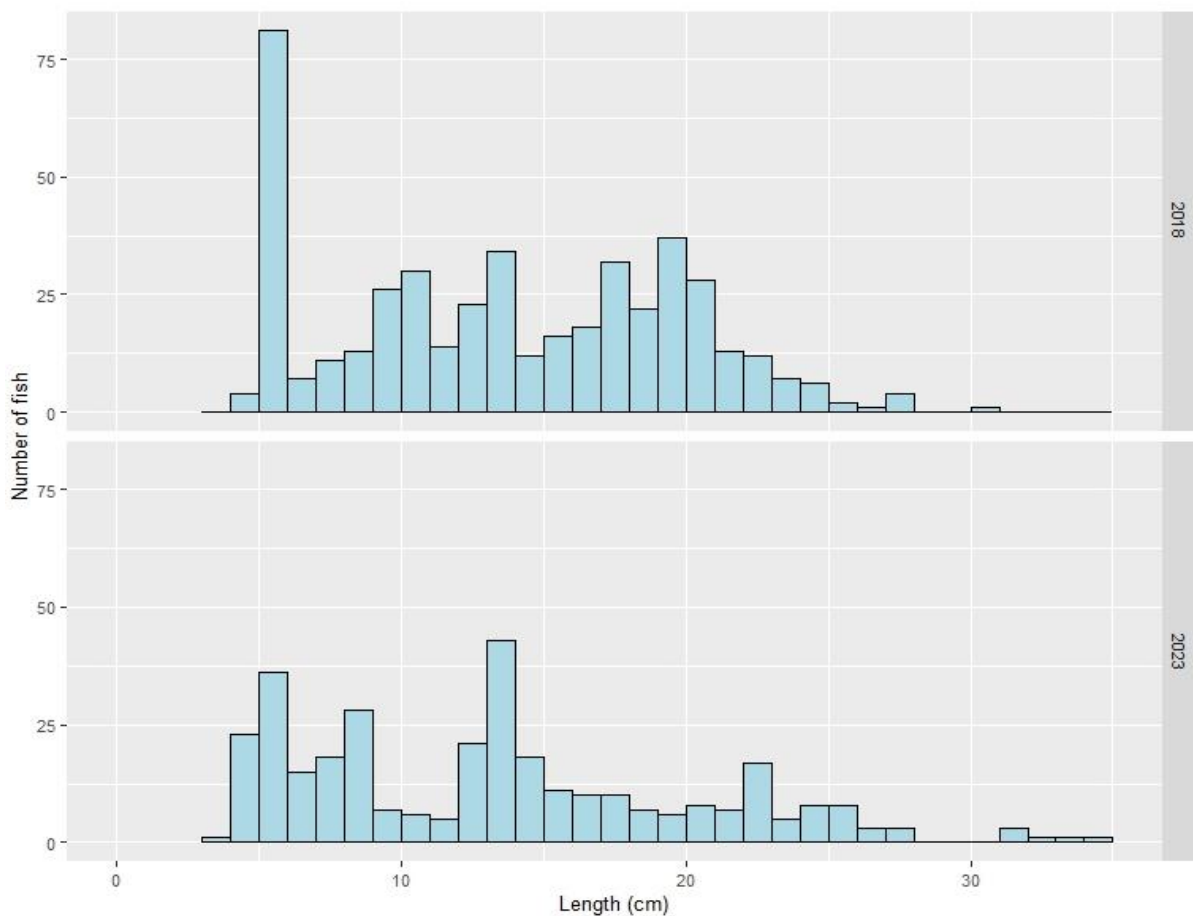Roach abundance (CPUE) and biomass (BPUE) appear to have remained relatively stable (Figure3.4).

Figure 3.3. Length frequency of roach captured on Garadice Lough in 2018 and 2023

Table 3.4. Summary age data from roach captured on Garadice Lough, September 2023. Number of fish and length ranges of all fish aged in the sample is presented.

Length (cm)	Age class										
	0+	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+
N	-	1	4	20	21	9	5	3	11	8	4
Mean	-	4.9	7.1	10.9	15.2	18.0	19.9	20.7	22.1	22.6	25.9
Min	-	4.9	6.4	7.5	11.6	16.7	19.3	20.1	21.1	11.5	25.1
Max	-	4.9	7.8	13.5	17.7	18.9	20.3	21.8	23.1	25.8	26.7

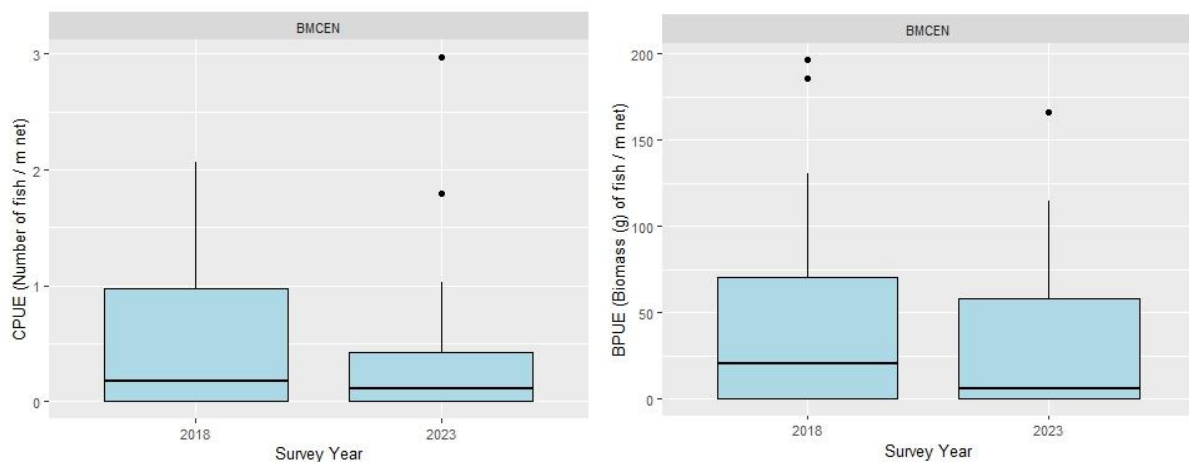| Length (cm)	Age class				
	11+	12+	13+	14+	15+
N	4	1	2	2	1
Mean	23.475	27.8	32.05	31.75	34.3
Min	13.5	27.8	31.3	31.6	34.3
Max	27.6	27.8	32.8	31.9	34.3

Figure 3.4. CPUE and BPUE of roach captured during surveys of Garadice Lough in 2018 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Roach x bream hybrids

Roach x bream hybrids captured during the 2023 survey ranged in length from 19.2cm to 43.6cm (mean = 33.4cm) (Figure 3.5). Roach x bream hybrids were dominated by large individuals on both sampling occasions. However, in 2023, fish measuring <30cm in length were less prominent and the overall range has shifted slightly toward larger fish. Roach x bream hybrids were aged between 5+ and 19+ (Table 3.5). Fish older than 10+ (28cm – 31cm) dominated the population (Figure 3.5).

There is some evidence to suggest a decline in abundance (CPUE) and biomass (BPUE) of roach x bream hybrids. This is particularly so in the case of fish captured in benthic (BMCEN) survey nets (Figure 3.6). These survey nets capture fish of all sizes while the 4-PBB nets typically only catch the larger fish.
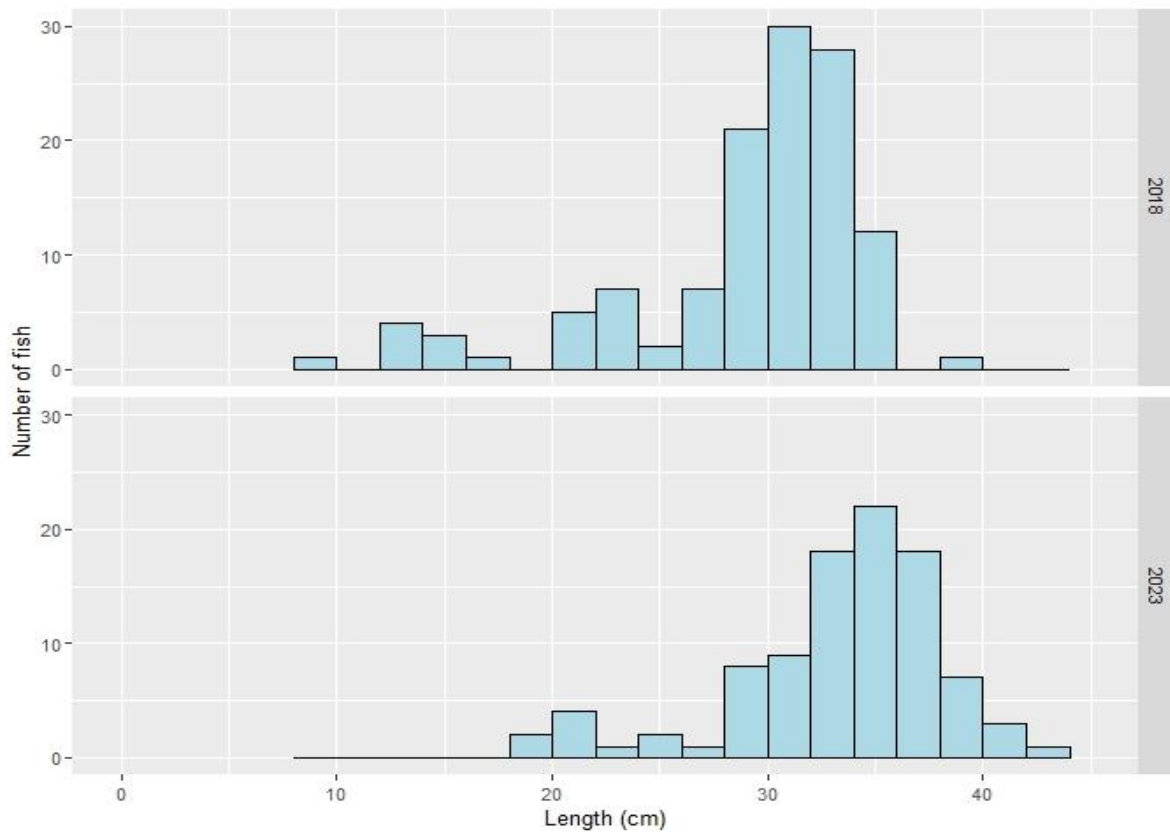

Figure 3.5. Length frequency of roach x bream hybrids captured on Garadice Lough in 2018 and 2023.

Table 3.5. Summary age data from roach x bream hybrids captured on Garadice Lough, September 2023. Number of fish and length ranges of all fish aged in the sample is presented.

Length (cm)	Age class										
	0+	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+
N	-	-	-	-	-	1	3	4	1	1	7
Mean	-	-	-	-	-	21.8	20.9	23.0	26.4	28.1	29.5
Min	-	-	-	-	-	21.8	19.8	19.2	26.4	28.1	28.4
Max	-	-	-	-	-	21.8	21.7	25	26.4	28.1	31.7

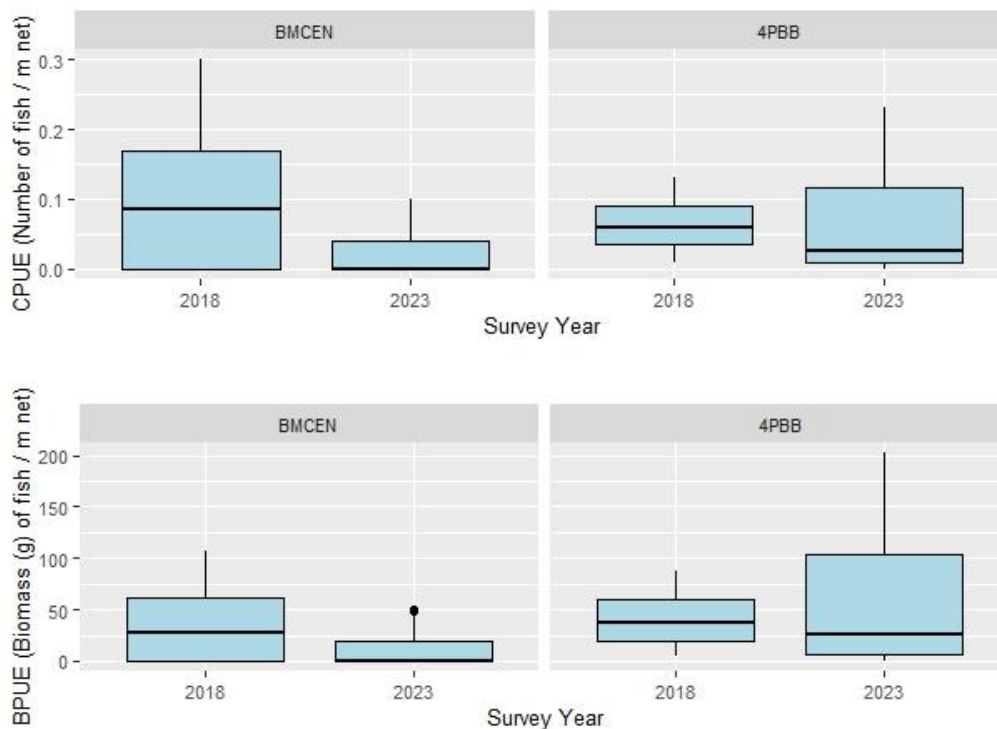| Length (cm)	Age class								
	11+	12+	13+	14+	15+	16+	17+	18+	19+
N	5	-	8	8	2	7	5	4	2
Mean	30.74	-	32.8625	34.925	36.15	37.04286	38.92	39.925	42.1
Min	30.2	-	32.1	33.5	36.1	36	38	39	40.6
Max	31.6	-	34	35.6	36.2	37.9	41.1	41.8	43.6

Figure 3.6. CPUE and BPUE of roach x bream hybrids captured during surveys of Garadice Lough in 2018 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Bream

Bream captured during the 2023 survey ranged in length from 3.6cm to 43.8cm (mean = 29.9cm) (Figure 3.7). Bream were aged between 2+ and 11+ (Table 3.6). The population was dominated by 7+ and 8+ fish (27cm – 35cm) (Table 3.6 and Figure 3.7). Scales were not available from one small (3.6 cm) bream. It is probable that this fish was a 1+ juvenile.

Bream abundance (CPUE) and biomass (BPUE) were relatively similar in recent surveys (Figure 3.8).
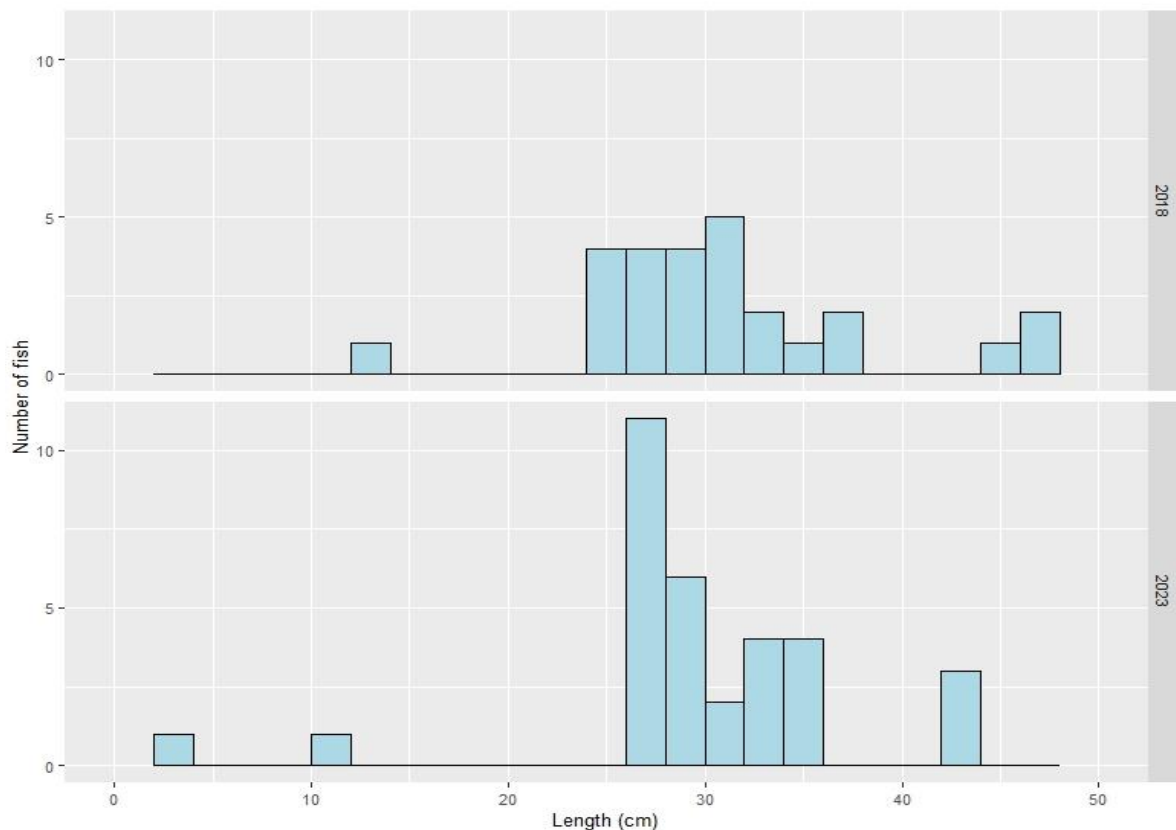

Figure 3.7. Length frequency of bream captured on Garadice Lough in 2018 and 2023#

Table 3.6. Summary age data from bream captured on Garadice Lough, September 2023. Number of fish and length ranges of all fish aged in the sample is presented

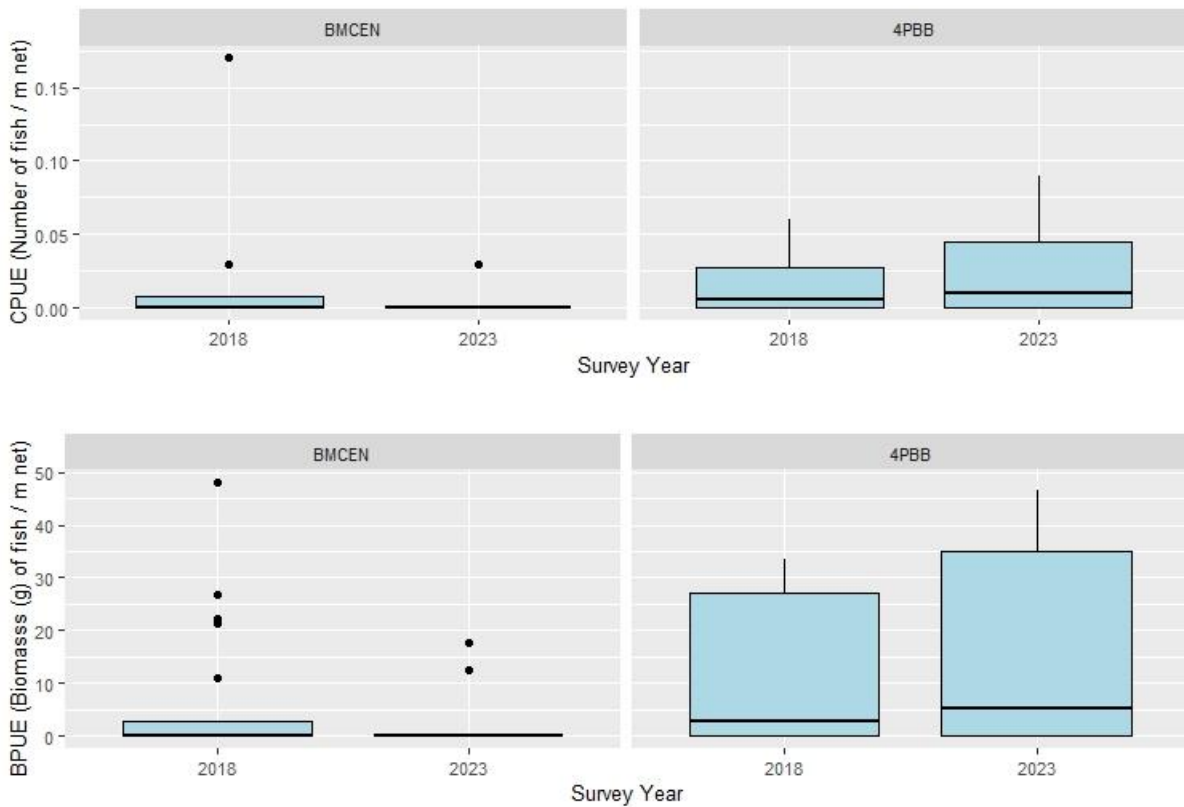| Length (cm)	Age class											
	0+	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+
N	-	-	1	-	-	-	3	13	8	1	1	2
Mean	-	-	11.8	-	-	-	27.0	28.2	33.8	35.8	42.9	43.7
Min	-	-	11.8	-	-	-	26.8	27	31.5	35.8	42.9	43.5
Max	-	-	11.8	-	-	-	27.3	30.5	35.3	35.8	42.9	43.8

Figure 3.8. CPUE and BPUE of bream captured during surveys of Garadice Lough in 2018 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Other fish species

Tench captured, ranged in length from 6.4cm to 45.0cm (mean = 30.5cm). Tench were aged between 2+ and 7+.

Pike ranged from 12.0cm to 83.7cm (mean = 83.7cm). Pike were aged from 1+ to 6+ and all age classes were represented.

Brown trout ranged from 47.5cm to 53.0cm (mean = 50.9cm). Brown trout were aged 6+ and 7+.

Two gudgeon were captured. They measured 4.4cm and 5.0cm.

European eel captured during the 2023 survey ranged in length from 44.5cm to 86.0cm (mean = 61.3cm). Abundance (CPUE) and biomass (BPUE) of eel were lower in 2023 compared to 2018 (Figure 3.9).
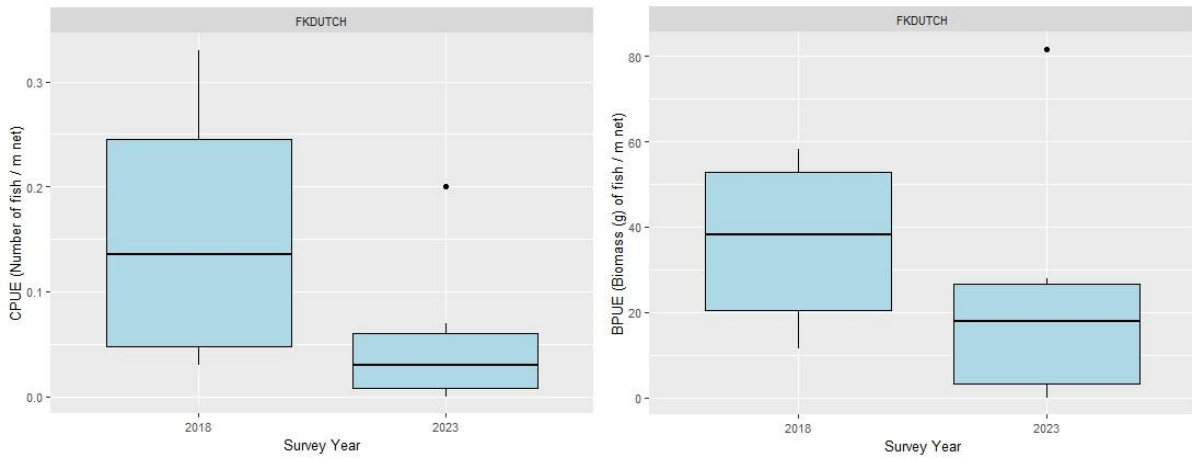
Figure 3.9. CPUE and BPUE of European eel captured during surveys of Garadice Lough in 2018 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

3.4. Stomach and diet analysis

The dietary analysis conducted provides insight to the prey of examined fish immediately prior to capture. Longer term and seasonal studies provide a more robust assessment of fish diet. The stomach contents of a subsample of perch and pike captured during the survey were examined and are presented below.

Perch

A total of 97 perch stomachs were examined. Sixty-eight (70%) were empty. Twenty-nine stomachs contained food. Invertebrates were the sole prey type recorded in 16 (55%) stomachs and were found together with plant material in two (7%) stomachs. Fish was the sole prey type recorded in four (14%) stomachs and was found together with invertebrates in two (7%) stomachs. Unidentified digested material was recorded in the stomachs of five (17%) fish (Figure 3.10).
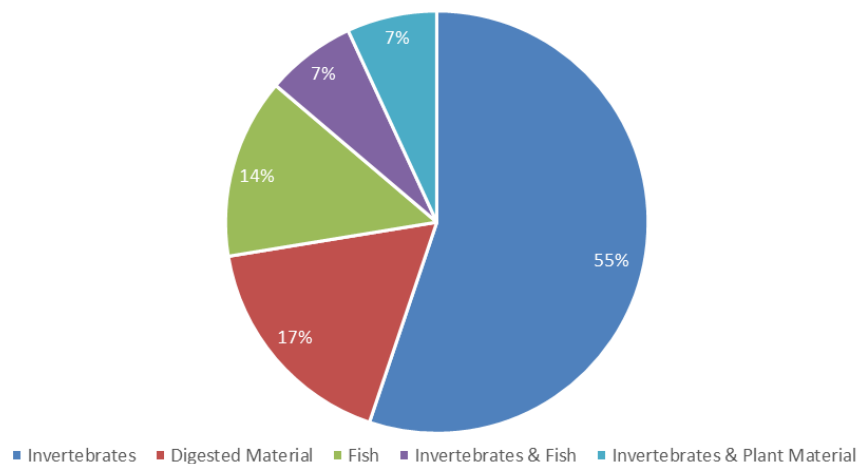

Figure 3.10. Diet of perch (N = 29) captured on Garadice Lough, 2023 (% FO).

Pike

Three pike stomachs were available for analysis; two of which were empty. The remaining pike had fed on perch.

4. Summary and fish ecological status

A total of eight fish species and one cyprinid hybrid were recorded in Garadice Lough in September 2023. Perch was the dominant species in terms of abundance (CPUE) while roach x bream hybrids and roach had the highest biomass (BPUE) captured during the 2023 survey.

The two most abundant species (i.e. perch and roach) are recruiting regularly in the lake. The perch population was dominated by younger and smaller cohorts. Roach are relatively long lived in the lake, with all year classes from 1+ to 15+ recorded. Older and larger roach were less prominent in 2023 compared to 2018.

The roach x bream hybrid population is characterised by a dominance of large and old fish. There is limited evidence of successful recruitment (which requires spawning populations of both parent species (Hayden *et al*., 2010) in this variety in recent years. An apparent reduction in abundance and biomass since 2018 is driven by a reduction in the proportion of smaller and younger hybrids in particular.

Bream abundance and biomass remain stable and the capture of some small (<15cm) bream in 2023 indicates that some recruitment, while limited in recent years, is continuing in the lake.

Classification and assigning lakes with an ecological status is a critical part of the WFD monitoring programme. It allows for the identification and prioritisation of lakes that currently fall short of the minimum "Good Ecological Status" that is required if Ireland is not to incur penalties. A multimetric fish ecological classification tool (Fish in Lakes – 'FIL') was developed for the island of Ireland (Ecoregion 17) using IFI and Agri-Food and Biosciences Institute Northern Ireland (AFBINI) data generated during the NSSHARE Fish in Lakes project (Kelly *et al.*, 2008). This tool was further developed during 2010 (FIL2) in order to make it fully WFD compliant, including producing EQR (Ecological Quality Ratio) values for each lake and associated confidence in classification (Kelly *et al*., 2012).

Using the FIL2 classification tool, Garadice Lough has been assigned an ecological status of Good for 2023 based on the fish populations present. Garadice Lough was assigned a status of Moderate (based on expert opinion) in 2018.

In the 2016 to 2021 surveillance monitoring reporting period, the EPA assigned Garadice Lough an overall ecological status of Moderate, based on all monitored physico-chemical and biological elements, including fish (EPA 2021).

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5. References

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