National Research Survey Programme
Lakes 2023

Lough Beagh

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Iascach Intíre Éireann
Inland Fisheries Ireland

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Fish Stock Survey of Lough Beagh, July 2023

National Research Survey Programme

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1.   Introduction

Lough Beagh is situated in a remote valley in the Lackagh catchment, within the Glenveagh National Park, 24 kilometres north-west of Letterkenny, Co. Donegal (Fig. 1.1). A visitor's centre is located near the northern shore of the lake and a castle is located on the eastern shore. Lough Beagh is volcanic in origin. It is a long, narrow lake, approximately 6.5 kilometres in length and 0.8 kilometres wide. The lake is surrounded by mountains on three sides (including the Derryveagh and Glendowan Mountains on the south, east and west side respectively) (Plate 1.1 and Figure 1.1).

The lake has a surface area of 261ha, a mean depth of 9.2m and a maximum depth of 46.5m. The altitude of the lake is 45.3m above sea level. The geology of the area is predominantly granite, felsite and other intrusive rocks rich in silica. The lake is classed as typology class 4 (as designated by the EPA for the Water Framework Directive), i.e. deep (>4m), greater than 50ha and low alkalinity (<20mg/l $CaCO_3$). Lough Beagh is at risk of failing to meet Water Framework Directive Standards (EPA, 2021).

The lake holds brown trout, and occasional salmon. Sea trout arrive into the lake during July (O' Reilly, 2007). Arctic char are also present in the lake. The lake was surveyed by Inland Fisheries Ireland (previously the Central Fisheries Board and Northern Regional Fisheries Board) in 1989, 1994 and 1995. In 2005, the lake was again surveyed using the current WFD lake sampling methodology as part of the cross border Interreg IIIA funded NS Share "Fish in Lakes" project by Inland Fisheries Ireland and the Agri-Food and Biosciences Institute Northern Ireland (AFBINI) (Kelly *et al*., 2007). Subsequently Lough Beagh was surveyed in 2008, 2011, 2014, 2017 and 2020 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al*., 2009, 2012a, 2015; Connor *et al.,* 2018 and Corcoran *et al.,* 2021). During the 2020 survey, brown trout were found to be the dominant species present in the lake. Arctic char, sea trout, minnow and eels were also captured during the survey (Corcoran *et al.,* 2021).

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. Lough Beagh, looking South-East along the lake, July 2023.

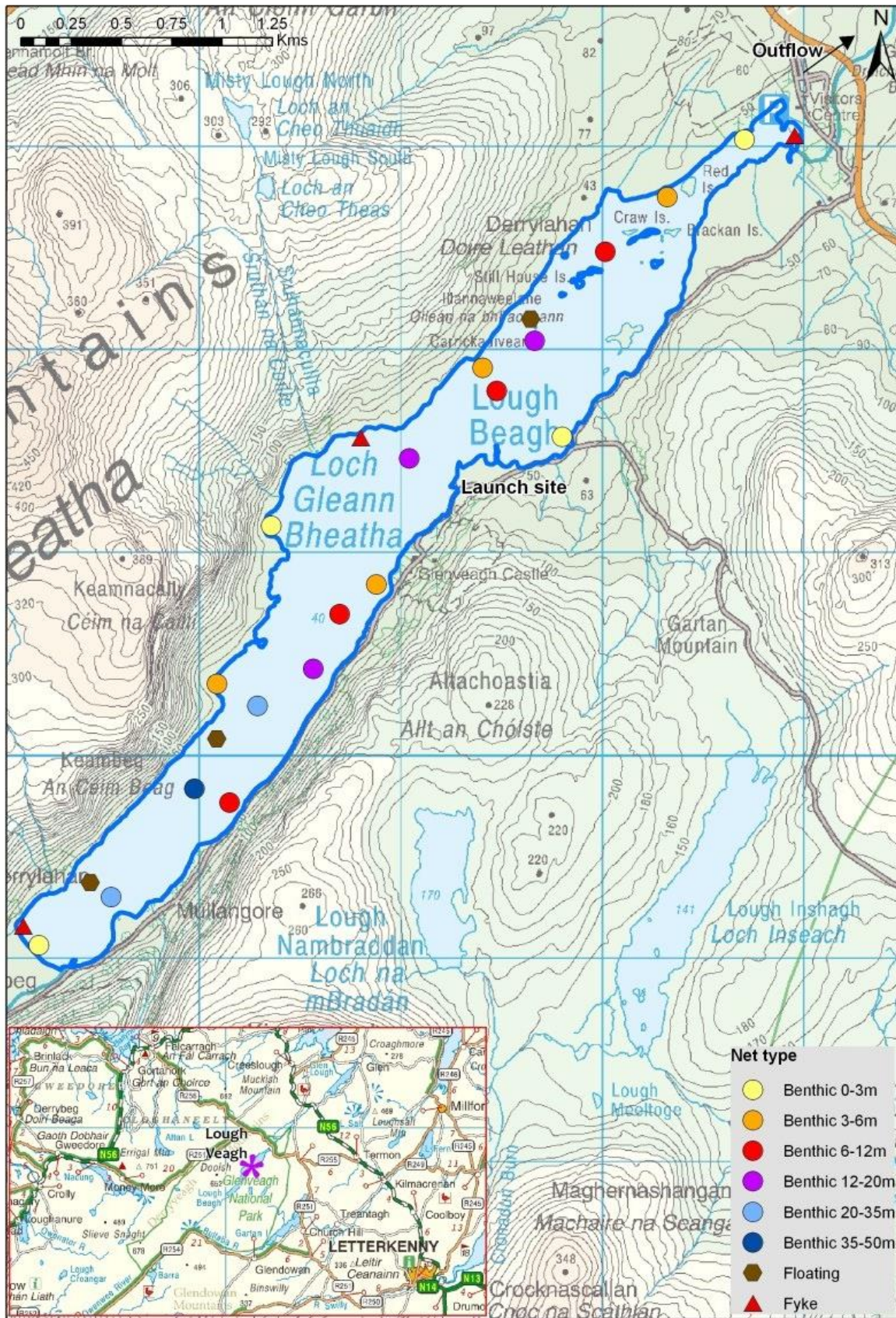**Plate 1.2. Servicing a fyke net on Lough Beagh, July 2023.**

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

2.   Methods

2.1. Netting methods

Lough Beagh was surveyed over two nights from the 3rd to the 5th of July 2023. A total of three sets of Dutch fyke nets, 18 benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (4 @ 0-2.9m, 4 @ 3-5.9m, 4 @ 6-11.9m, 3 @ 12-19.9m, 2 @ 20-34.9m and 1 @ 35-50m) and three floating monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (FM CEN) were deployed in the lake (24 sites). 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 gill net in relation to the shoreline was randomised.

All fish 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

Six fish species, including two types of trout (brown trout and sea trout) were recorded in Lough Beagh in July 2023. A total of 216 fish were captured (Table 3.1). Brown trout was the most numerous fish species recorded. Minnow, Arctic char, sea trout, three-spined stickleback, salmon and European eel were also captured. During the previous surveys in 2008, 2011, 2014 and 2017 the same species composition was recorded, with some exceptions related to minnow and salmon (Kelly *et al.*, 2009, 2012a, 2015, Connor *et al.,* 2018, Corcoran *et al.* 2021). Three-spined stickleback which were captured in this survey were not recorded in any of the previous surveys.

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

Scientific name	Common name	Number of fish captured			
		BM CEN	FM CEN	Fyke	Total
Salmo trutta	Brown trout	132	6	2	140
	Sea trout	3	1	0	4
Phoxinus phoxinus	Minnow	47	0	0	47
Salvelinus alpinus	Arctic char	16	0	1	17
Gasterosteus aculeatus	Three-spined stickleback	2	0	0	2
Salmo salar	Salmon	1	0	0	1
Anguilla anguilla	European eel	1	0	4	5

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. Brown trout was the dominant species with respect to both abundance (CPUE) and biomass (BPUE) (Table 3.2).

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

Scientific name	Common name	Mean CPUE (±S.E.)	Mean BPUE ((± S.E)
Salmo trutta	Brown trout	0.193 (0.048)	26.426 (5.899)
	Sea trout	0.005 (0.004)	1.722 (1.620)
Phoxinus phoxinus	Minnow	0.065 (0.038)	0.116 (0.065)
Salvelinus alpinus	Arctic char	0.022 (0.008)	0.862 (0.357)
Gasterosteus aculeatus	Three-spined stickleback	0.002 (0.002)	0.003 (0.003)
Salmo salar	Salmon	0.001 (0.001)	2.930 (2.930)
*Anguilla anguilla**	European eel	0.022 (0.005)	3.932 (2.115)

*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. Large (Ferox) trout caught and released on Lough Beagh in July 2023.

3.3. Species profiles

Brown trout

Brown trout captured during the 2023 survey ranged in length from 5.0cm to 53.3cm (mean 21.2cm). Brown trout captured in previous surveys had similar length and age ranges. While generally dominated by smaller fish, larger fish (> 50cm) have been captured regularly (Figure 3.2). Brown trout were aged between 1+ and 8+. All intervening age classes (except 7+) were present in the sample aged. Fish aged between 1+ and 3+ represented *c.* 78% of all the fish aged (13cm - 25cm) (Figure 3.2). The most abundant year class was 2+ and older cohorts (≥ 4+) were recorded in smaller numbers. Mean L1 (i.e. length at the end of the 1st year) was 6.6cm (Table 3.3).

Brown trout populations have remained relatively stable across all surveys of the lake, with no obvious trends in population abundance (CPUE) or biomass (BPUE) apparent (Figure 3.1).
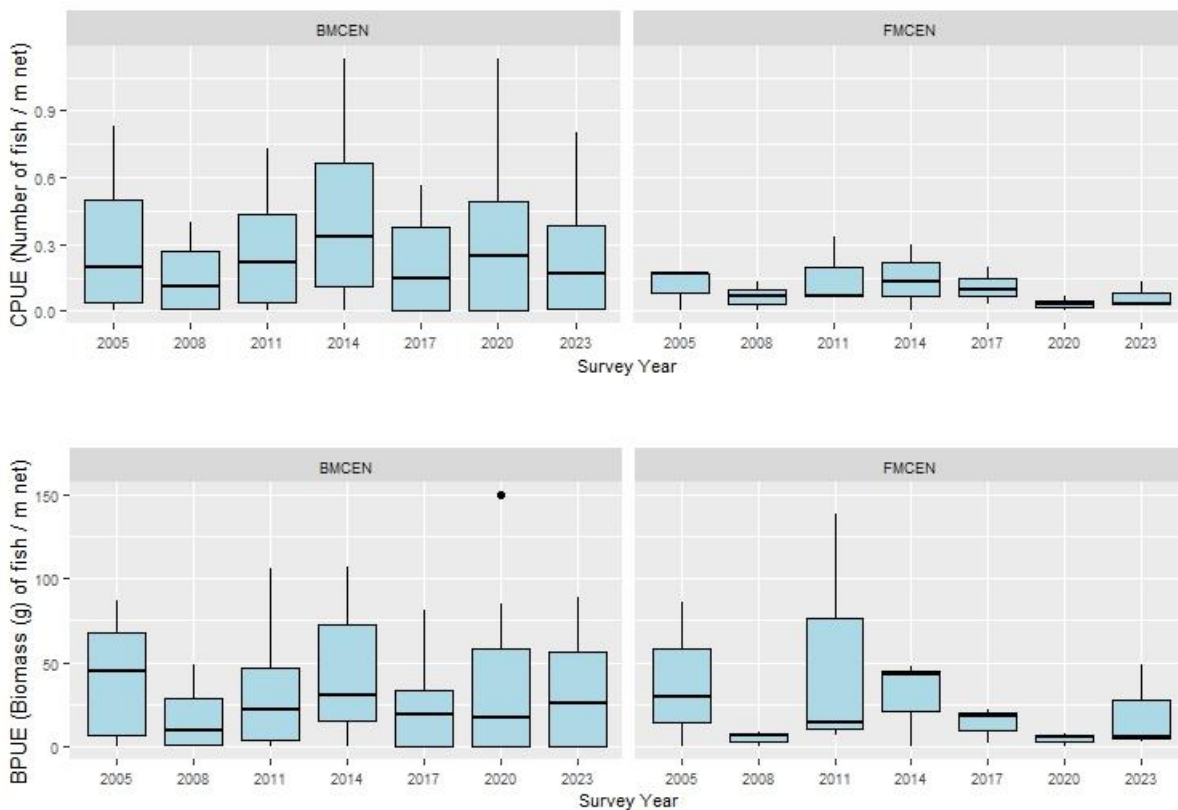
Figure 3.1. CPUE and BPUE of brown trout captured during surveys of Lough Beagh between 2005 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.
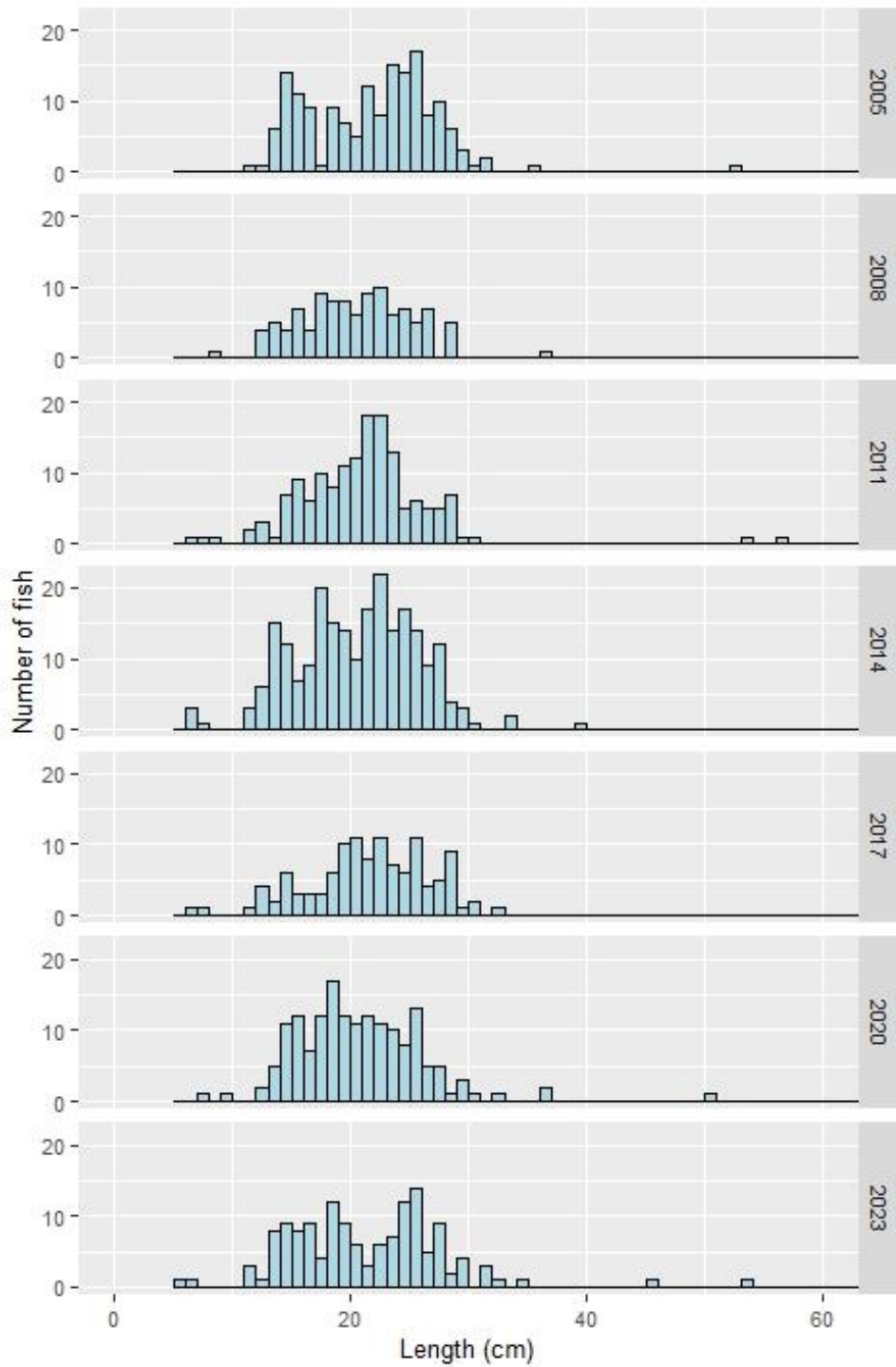
Figure 3.2. Length frequency of brown trout captured on Lough Beagh between 2005 and 2023.

**Table 3.3. Mean (±S.E.) brown trout length (cm) at age for Lough Beagh, July 2023.**

Length (cm)	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8
Mean (±S.E)	6.6 (0.06)	13.2 (0.15)	20.2 (0.19)	25.4 (0.30)	30.9 (1.0)	38.7 (0.88)	-	-
N	83	76	41	18	6	2	1	1
Range	5.3-8.0	11.3-21.1	18.0-22.9	23.7-27.4	27.9-33.9	37.9-39.6	43.4	43.4

Arctic char

Arctic char captured during the 2023 survey ranged in length from 8.4cm to 19.0cm (mean 14.1cm) (Figure 3.4). The length range was similar to other surveys of the lake since 2005. Otoliths from 11 Arctic char were examined for age analysis. Arctic char were aged between 0+ (8.1cm) and 3+ (15.4cm – 18.7cm) (Figure 3.4 and Table 3.4). The largest age group was 2+ fish. These measured 11cm -15.3cm in length. It was not possible to obtained otoliths from one larger fish, which was estimated to be 19cm in length.

While no discernible population trend was apparent, the median CPUE was lower than previous years and the median biomass (BPUE) was similar to 2008, which was amongst the lowest recorded across all sampling occasions (Figure 3.3).
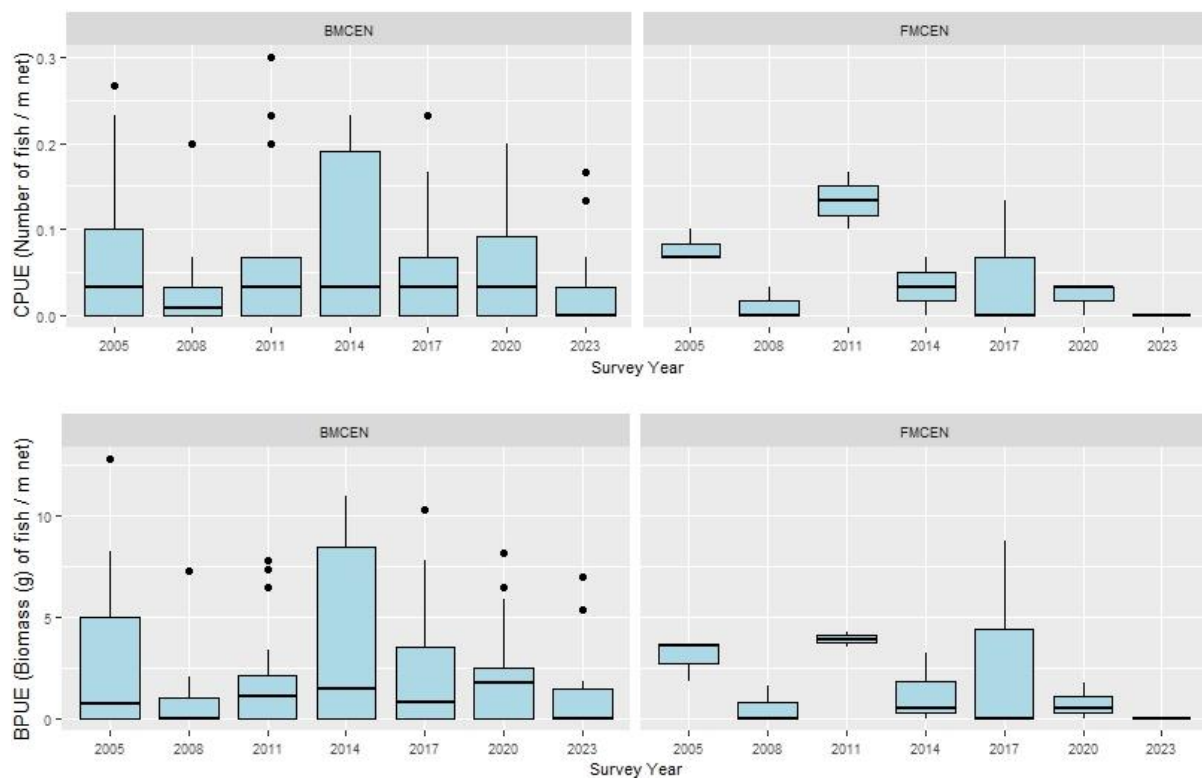
Figure 3.3. CPUE and BPUE of arctic char captured during surveys of Lough Beagh between 2005 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.
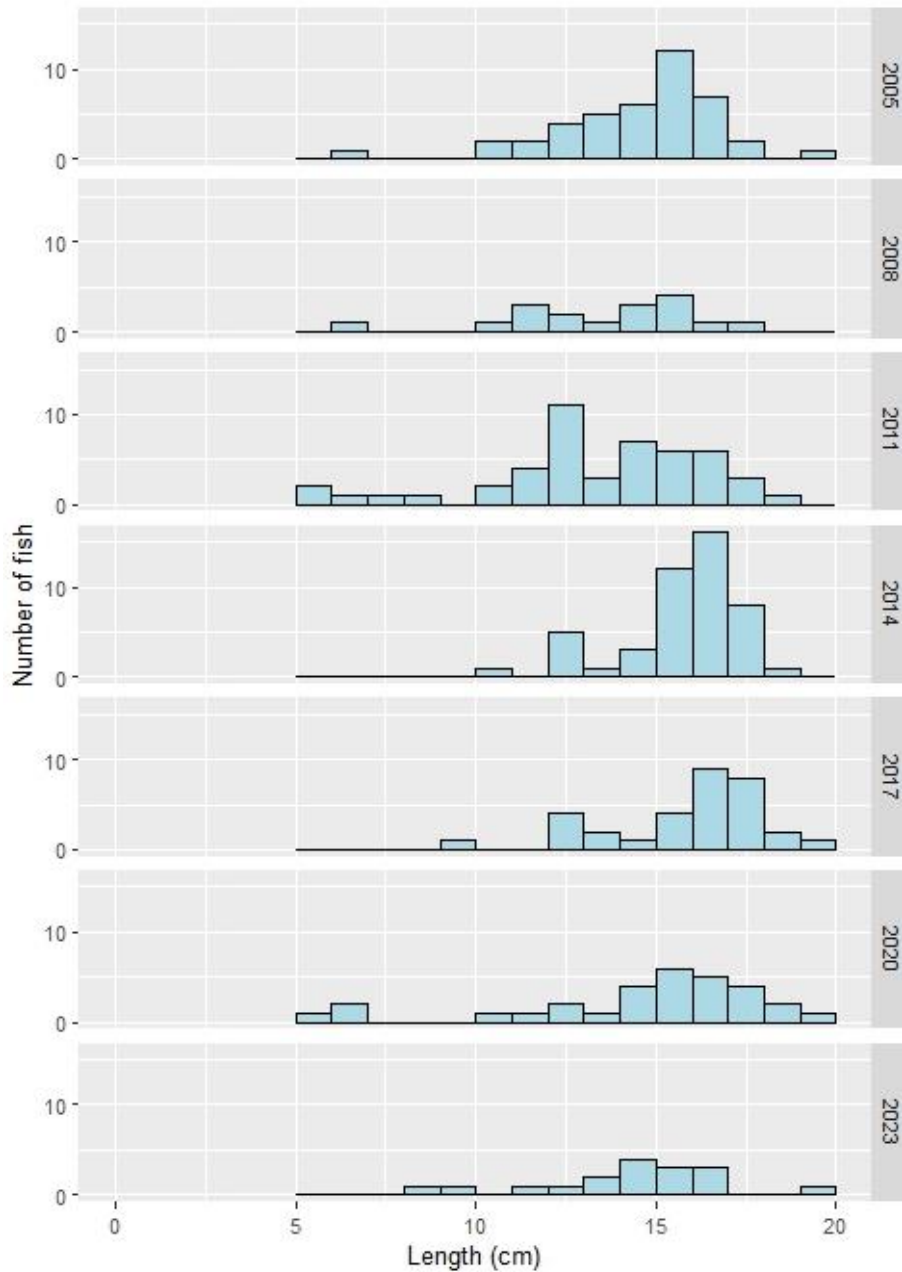
Figure 3.4. Length frequency of Arctic char captured on Lough Beagh between 2005 and 2023.

Table 3.4. Summary age data from Arctic char captured on Lough Beagh, July 2023. Number of fish and length ranges of all fish aged in the sample is presented.

Length (cm)	Age class			
	0+	1+	2+	3+
N	1	1	6	3
Mean	-	-	14.2	16.1
Min	8.4	9.1	11	15.4
Max	8.4	9.1	15.3	16.8

European eel

Five European eels captured in the 2023 survey ranged in length from 41cm to 59.8cm (mean = 48.9cm). Abundance (CPUE) has fluctuated across all surveys while biomass (BPUE) appears to have declined between 2005 and 2023 (Figure 3.5).
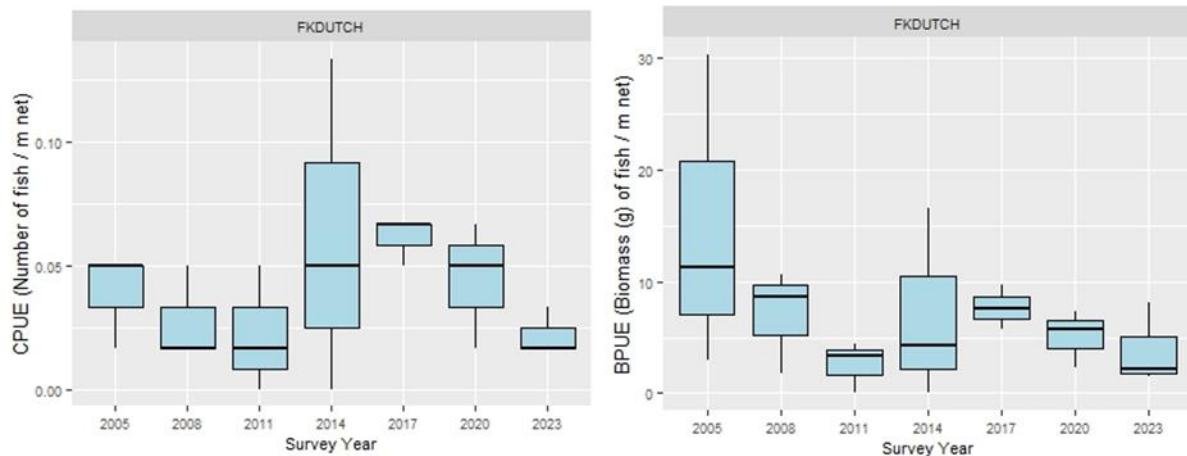
Figure 3.5. CPUE and BPUE of eel captured during surveys of Lough Beagh between 2005 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Other fish species

Four sea trout ranged in length from 18.9 to 35.6cm (mean = 27.1cm) and were aged between 2 and 3 years old. One adult 2 sea winter salmon (60cm) was captured. Forty-seven minnow ranged in length from 4.3cm to 7.4cm (mean 5.4cm). Two three-spined sticklebacks measured 4.3cm and 5cm.

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 brown trout, Arctic char and sea trout captured during the survey were examined and are presented below.

Brown trout

A total of 40 brown trout stomachs were examined. Eleven (27.5%) were empty. Twenty-nine stomachs contained food. Invertebrates were the sole prey type recorded in 18 (62 %) stomachs and were found together with zooplankton in one (3%) stomach, and plant matter in one other stomach. Zooplankton was the sole prey type recorded in five (17%) stomachs. Fish was recorded in two (7%) stomachs. Unidentified digested material was recorded in two (7%) fish (Figure 3.6).
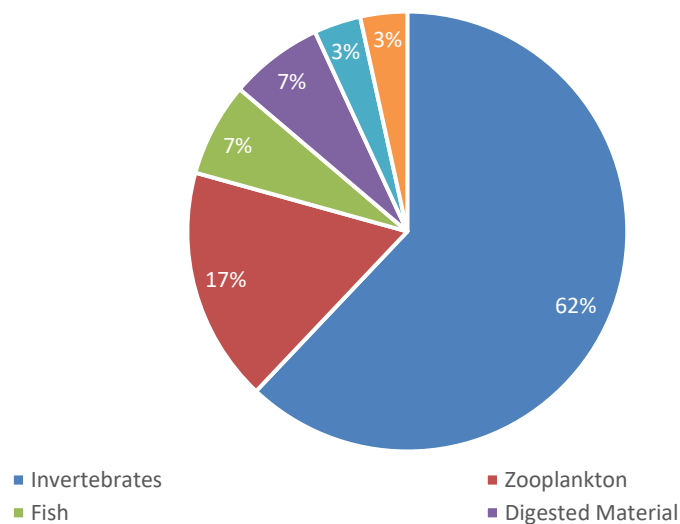
Figure 3.6. Diet of brown trout (N = 29) captured on Lough Beagh, 2023 (% FO).

Arctic char

A total of eleven Arctic char stomachs were examined. Of these, one (9.1%) was empty. Of the ten stomachs that contained food, zooplankton was the sole prey item found in each.

Sea trout

Four sea trout stomachs were examined, one (25%) of which was empty. Invertebrates were the sole prey type recorded in the other two stomachs while they were recorded together with zooplankton in the remaining stomach.
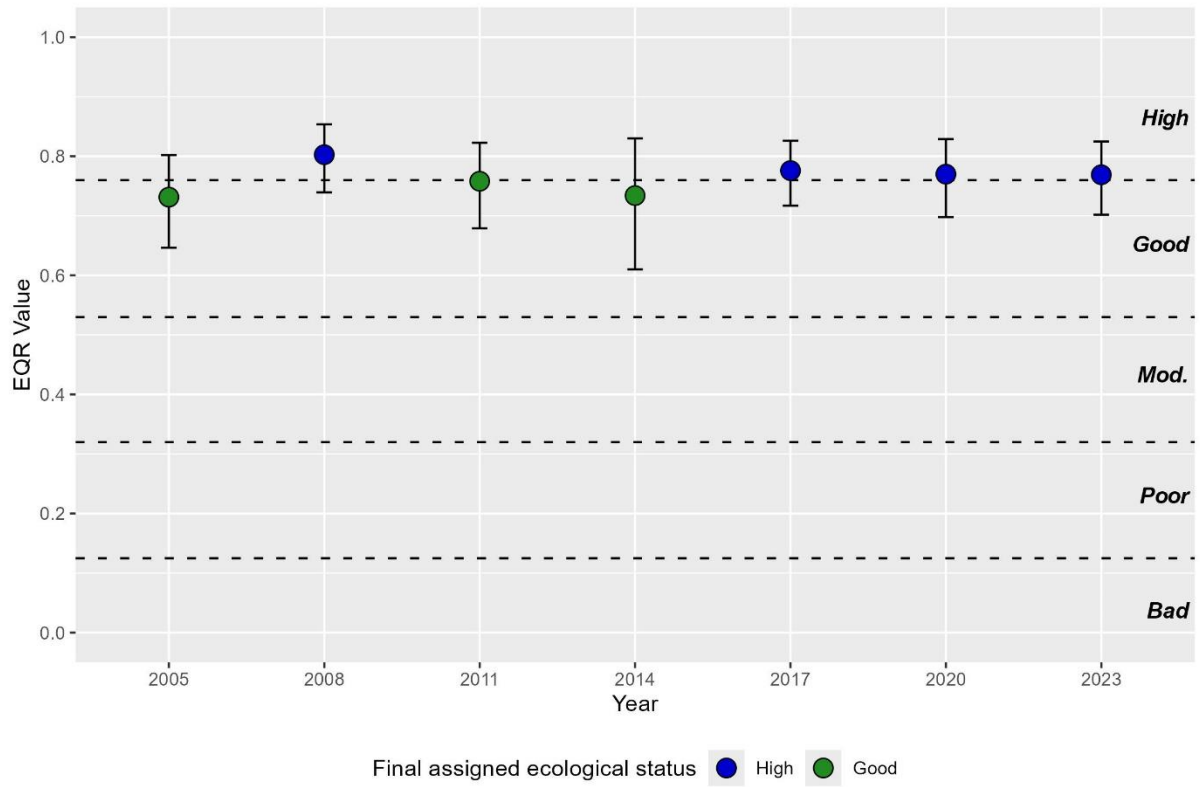
4.   Summary and fish ecological status

A total of six fish species, including two varieties of trout (brown and sea trout) were recorded in Lough Beagh in July 2023. Brown trout was the dominant species in terms of abundance (CPUE) and biomass (BPUE) captured in the survey gill nets during the 2023 survey. Recruitment appears to be regular and the population, in common with previous surveys was dominated by younger and smaller individuals but with older and larger cohorts persisting in the population.

Arctic char is a rare species nationally and is endemic to the lake. CPUE and BPUE has fluctuated across all surveys of the lake since 2005. While no discernible trend in population status is apparent, the abundance (CPUE) and biomass (BPUE) of Arctic char captured in 2023 was relatively low compared to other surveys of the lake with the exception of 2008. The continued presence of smaller and younger individuals (including young of year fish < 10cm) indicates that some recruitment is continuing in the lake. In Ireland, Arctic char populations are threatened by the combined impact of several pressures including climate change and non-native species competition (Connor *et al*., 2019).

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 values for each lake and associated confidence in classification (Kelly *et al*., 2012b).

Using the FIL2 classification tool, Lough Beagh has been assigned an ecological status of High for 2023 based on the fish populations present. The fish ecological status of Lough Beagh following fish stock surveys of the lake between 2005 and 2023 is presented in Figure 4.1.

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

Figure 4.1. Fish ecological status, Lough Beagh, between 2005 and 2023 (dashed line indicates EQR status boundaries).

5. References

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