

National Research Survey Programme

Lakes 2023

Carrowmore Lake

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Iascach Intíre Éireann
Inland Fisheries Ireland

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Fish Stock Survey of Carrowmore Lake, June 2023



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Inland Fisheries Ireland**

National Research Survey Programme

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1. Introduction

Carrowmore Lake is situated in Co. Mayo, just over three kilometres north-west of Bangor Erris in the Owenmore catchment (Plate 1.1, Figure 1.1). The slopes of Knocknascollop Mountain rise along the western shore. The lake is over six kilometres in length and almost five kilometres at its widest point. It has a surface area of 926ha and has a maximum depth of 2.9m. The lake is categorised as typology class 6 (as designated by the EPA for the Water Framework Directive), i.e. shallow (mean depth <4m), greater than 50ha and moderate alkalinity (20-100mg/l CaCO₃).

The lake forms part of the Carrowmore Lake Complex SAC, containing many rare and important species of plants. The shoreline is dominated by Soft Rush (*Juncus effusus*), Yellow Iris (*Iris pseudacorus*), Common Club-rush (*Scirpus lacustris*) and Common Reed (*Phragmites australis*). Mediterranean Heath (*Erica erigena*), a species found frequently in parts of west Mayo, but rare in west Galway and unknown elsewhere in Ireland, is also prominent. Marsh Saxifrage (*Saxifraga hirculus*) also occurs at the site. This species is listed under Annex II of the European Habitats Directive. Most of the lake catchment is covered in a blanket of bog overlying glacial gravel deposits. The Carrowmore Lake Complex also supports various important bird species such as Greenland White-fronted Geese, Golden Plover, Merlin, Sandwich Tern and Arctic Tern (NPWS, 2013).

Algal blooms occur from time to time on the lake and in the past. Staff from IFI Ballina (formerly North Western Regional Fisheries Board) carried out a detailed study into the causes and factors relating to the eutrophication of Carrowmore Lake. The main cause of the enrichment problem was found to be land use practices, mainly agriculture and forestry. Wind induced turbulence was also an important factor in relation to phosphorous mobilisation from the sediment, due to the shallow nature of the lake (NWRFB, 2005). Carrowmore Lake is also utilised for water abstraction and a pump house is present on the lake shore.

The lake holds good stocks of salmon, brown trout and sea trout, and is regarded as one of the best salmon fishing lakes in the country, although stocks are under pressure due to the eutrophication of the lake (NWRFB, 2005).

Carrowmore Lake has been surveyed on four occasions since 2008 (2008, 2011, 2014 and 2017) as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al.*, 2009, 2012a, 2015, Connor *et al.*, 2018). During these surveys three-spined stickleback and brown trout dominated fish stocks with respect to abundance and biomass. Sea trout, salmon, minnow and eels were also captured.

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 also provides insight into fish stock status in the lake.



Plate 1.1. Carrowmore Lake, June 2023.

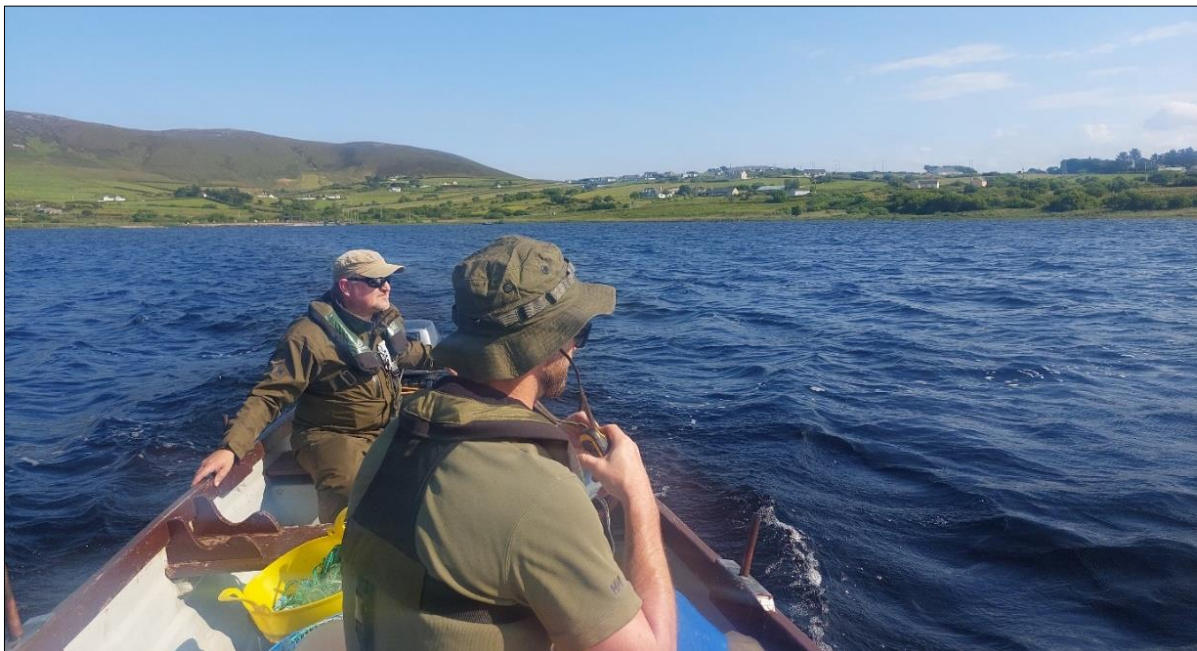


Plate 3.1. Surveying on Carrowmore Lake, June 2023

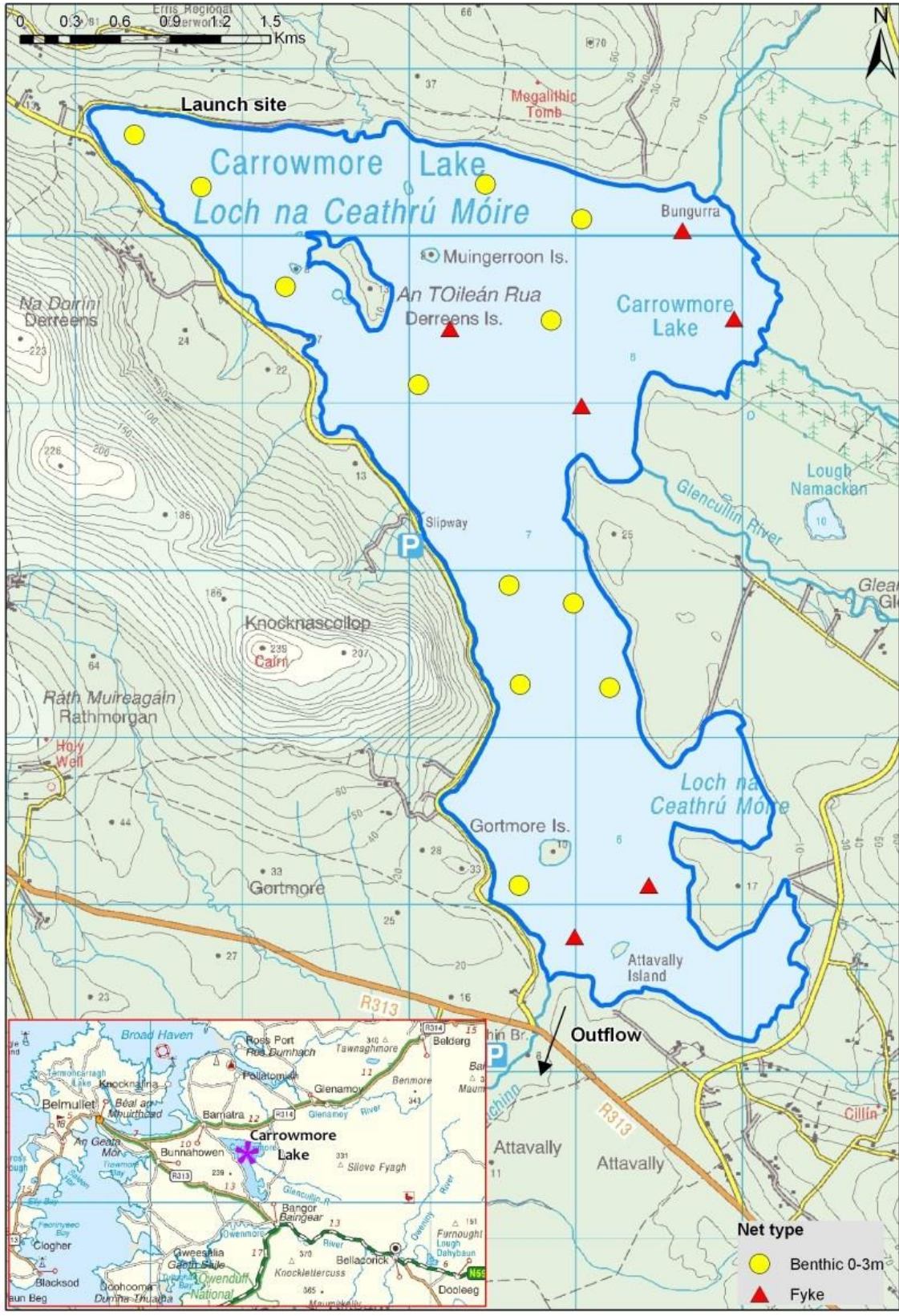


Figure 1.1. Location map of Carrowmore Lake showing net locations and depths of each net (outflow is indicated on map).

2. Methods

2.1. Netting methods

Carrowmore Lake was surveyed over two nights from the 6th to the 8th of June 2023. A total of six sets of Dutch fyke nets and 12 benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (12 @ 0-2.9m) were deployed in the lake (18 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).

$$FO_i = \left(\frac{N_i}{N} \right) * 100$$

Where:

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

Four fish species, including two types of trout (brown trout and sea trout) were recorded in Carrowmore Lake in June 2023. A total of 833 fish were captured (Table 3.1). Three-spined stickleback was the most prevalent fish species recorded, representing 70% of all fish captured in the survey. Brown trout, sea trout, minnow and European eel were also captured. During the previous surveys in 2008, 2011, 2014 and 2017 a similar species composition was recorded. Minnow, were not captured during the 2008 survey but have been captured in subsequent surveys. Salmon were not recorded in the 2008 and 2017 surveys but were captured in 2011 and 2014 (Kelly *et al.*, 2009, 2012a, 2015, Connor *et al.*, 2018).

Table 3.1. Number of each fish species captured by each gear type during the survey on Carrowmore Lake.

Scientific name	Common name	Number of fish captured		
		BM CEN	Fyke	Total
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	581	0	581
<i>Salmo trutta</i>	Brown trout	224	3	227
	Sea trout	3	0	3
<i>Phoxinus phoxinus</i>	Minnow	13	0	13
<i>Anguilla anguilla</i>	European eel	0	9	9

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. Three-spined stickleback was the dominant species with respect to abundance (CPUE) while brown trout had the highest biomass (BPUE) (Table 3.2).

Table 3.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Carrowmore Lake.

Scientific name	Common name	Mean CPUE (\pm S.E.)	Mean BPUE (\pm S.E)
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	1.075 (0.295)	1.501 (0.398)
<i>Salmo trutta</i>	Brown trout	0.417 (0.100)	35.412 (8.916)
	Sea trout	0.005 (0.003)	1.959 (1.086)
<i>Phoxinus phoxinus</i>	Minnow	0.024 (0.008)	0.109 (0.039)
<i>Anguilla anguilla</i> *	European eel	0.025 (0.009)	4.894 (2.832)

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.

3.3 Species Profiles

Brown trout

Brown trout captured during the 2023 survey ranged in length from 8.4cm to 39.5cm (mean 17.2cm). Brown trout captured in previous surveys had broadly similar length ranges (Figure 3.1). Brown trout were aged between 1+ and 6+ and all intervening age classes were present in the sample aged. The most abundant age class was 2+ (13cm - 21cm) and fish up to the age of 4+ (23cm - 29cm) were prominent in the population (Figure 3.1). Mean L1 (i.e. length at the end of the 1st year) was 6.2cm (Table 3.3). Brown trout abundance (CPUE) and biomass (BPUE) have fluctuated since surveys began in 2008 and no clear trends are apparent (Figure 3.2).

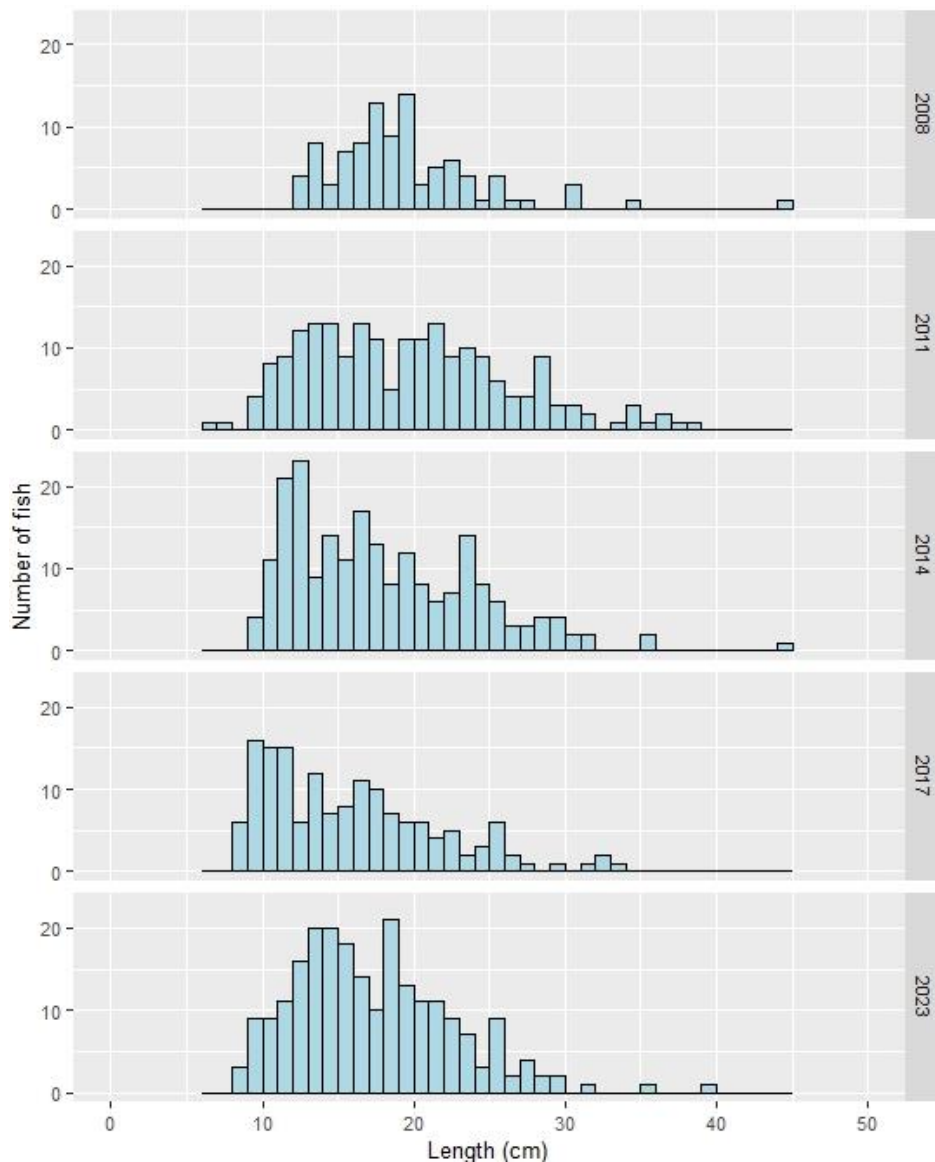


Figure 3.1. Length frequency of brown trout captured on Carrowmore Lake between 2008 and 2023.

Table 3.3. Mean (\pm S.E.) brown trout length (cm) at age for Carrowmore Lake, June 2023

Length (cm)	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆
Mean (\pm S.E.)	6.2 (0.06)	12.5 (0.16)	18.5 (0.22)	23.6 (0.35)	29.1 (1.88)	-
N	73	59	24	14	3	1
Range	4.2-7.7	9.1-15.7	16.0-20.1	21.4-26.4	25.4-31.3	36.7

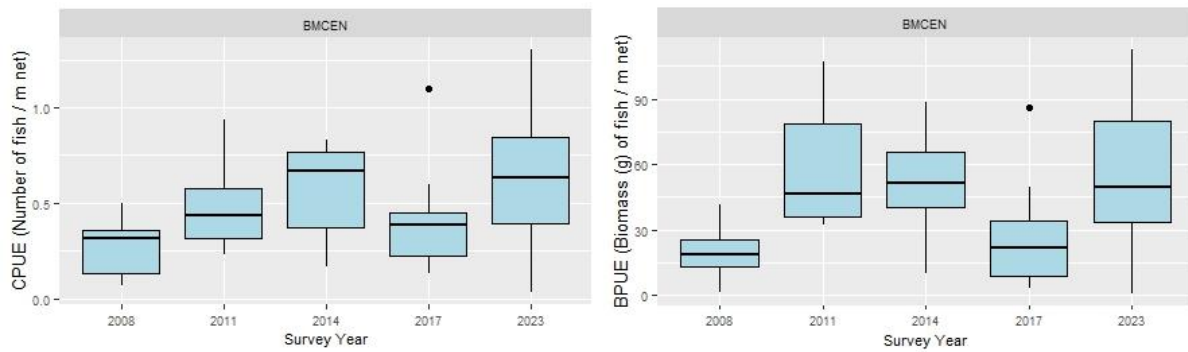


Figure 3.2. CPUE and BPUE of brown trout captured during surveys of Carrowmore Lake between 2008 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

European eel

European eel captured during the 2023 survey ranged in length from 31.0cm to 80.0cm (mean 43.1cm) (Figure 3.3). There was an apparent decline in median abundance and biomass of eel since 2011 (Figure 3.4).

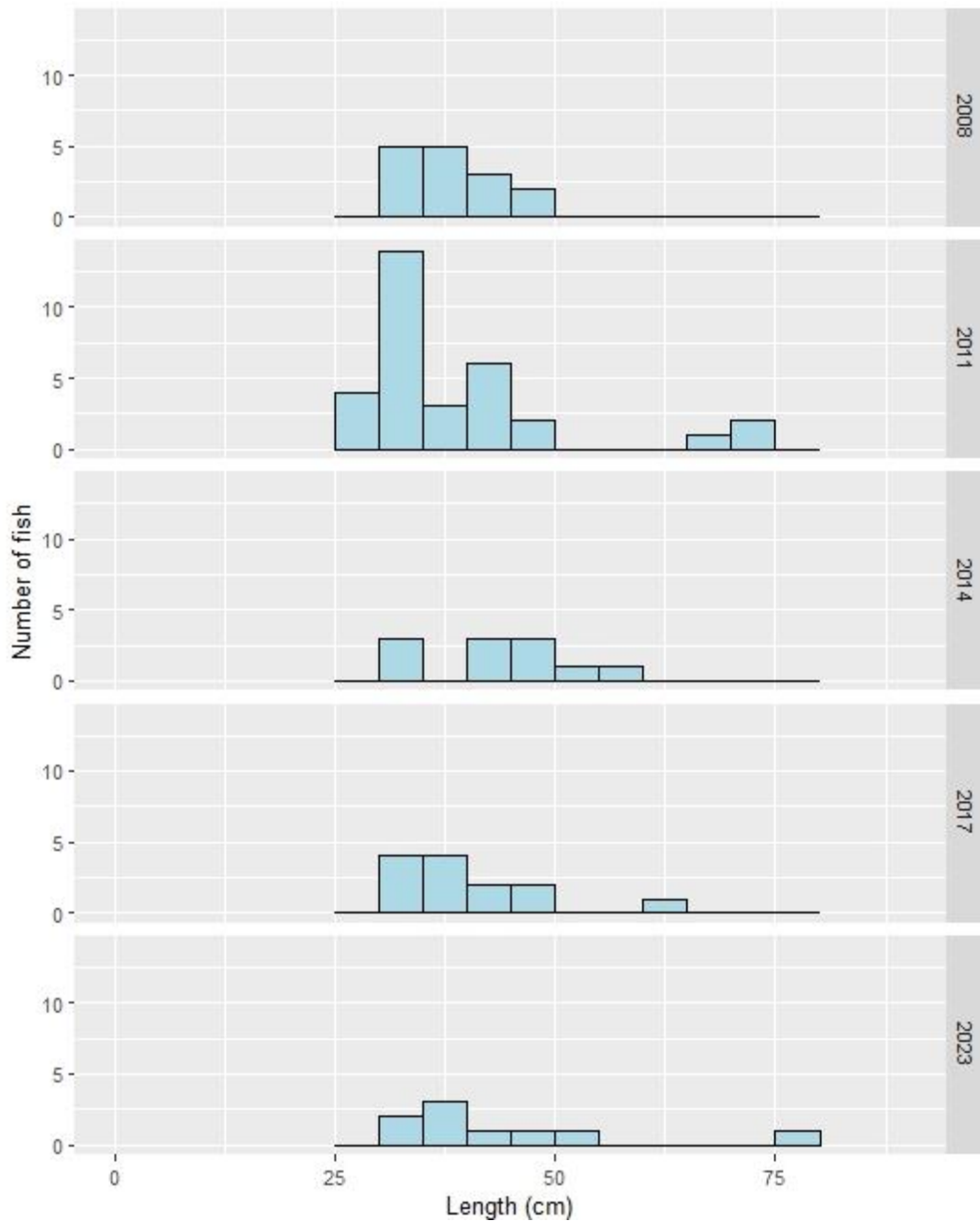


Figure 3.3. Length frequency of European eel captured on Carrowmore Lake between 2008 and 2023.

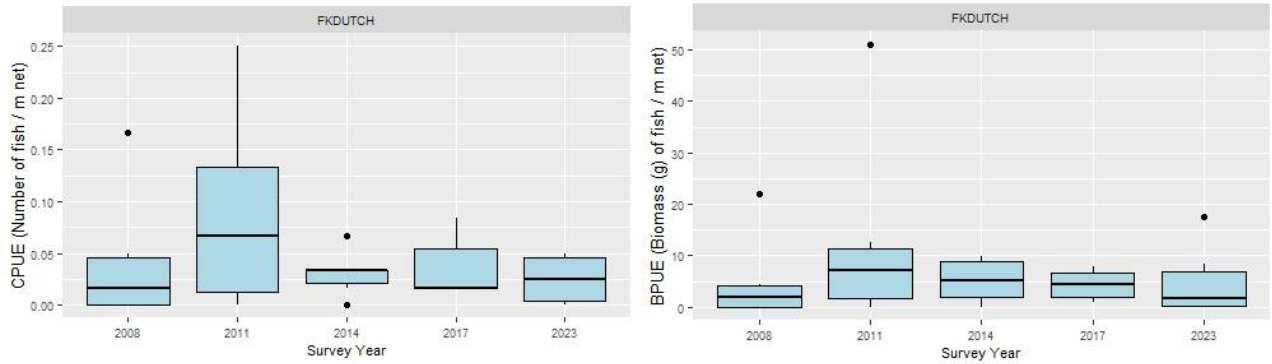


Figure 3.4. CPUE and BPUE of European eel captured during surveys of Carrowmore Lake between 2008 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots.

Other fish species

Sea trout captured in the 2023 survey ranged in length from 28.0cm to 34.1cm (mean = 31.2cm). Three-spined stickleback captured ranged from 3.0cm to 6.8cm (mean = 4.8cm). Minnow captured ranged from 5.2cm to 8.2cm (mean = 6.9cm).

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 and sea trout captured during the survey were examined and are presented below.

Brown trout

A total of 40 stomachs were examined. Eleven (27.5%) were empty. Twenty-nine stomachs contained food. Invertebrates were the sole prey type recorded in 24 (83%) stomachs. Fish was the sole prey type recorded in two (7%) stomachs, while one (3%) stomach contained fish eggs. Unidentified digested material was recorded in two (7%) fish (Figure 3.5).

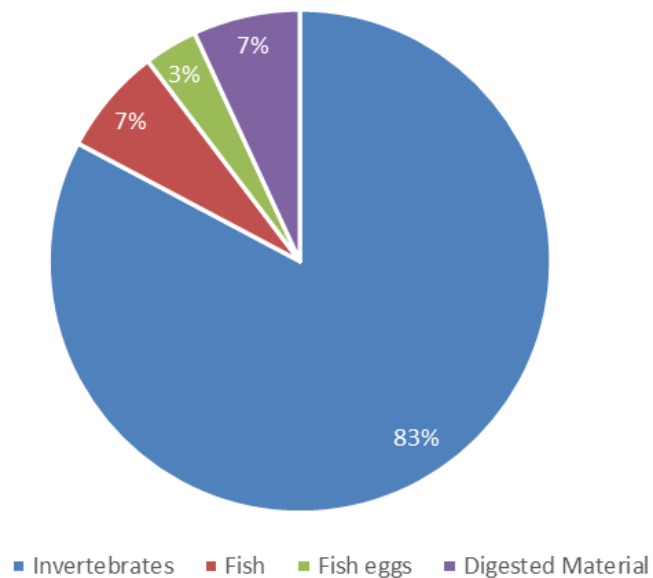


Figure 3.5. Diet of brown trout (N = 29) captured on Carrowmore Lake, 2023 (% FO).

Sea trout

One sea trout stomach was examined. Invertebrates were the sole prey item.

4. Summary and fish ecological status

A total of four fish species, including two varieties of trout (brown and sea trout) were recorded in Carrowmore Lake in June 2023. Three-spined stickleback was the dominant species in terms of abundance (CPUE) while brown trout had the highest biomass (BPUE) captured in the survey gill nets during the 2023 survey.

Brown trout abundance (CPUE) and biomass (BPUE) have fluctuated since surveys began in 2008. Recruitment appears to be stable and regular in the population. Brown trout were relatively long lived. Fish were aged between 1+ and 6+ and fish up to 4+ were prominent in the sample.

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.*, 2012b).

Using the FIL2 classification tool, Carrowmore Lake has been assigned an ecological status of Good for 2023 based on the fish populations present. The lake was assigned a status of Good on all previous occasions with the exception of 2011 when it was assigned a status of High (Figure 4.1).

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

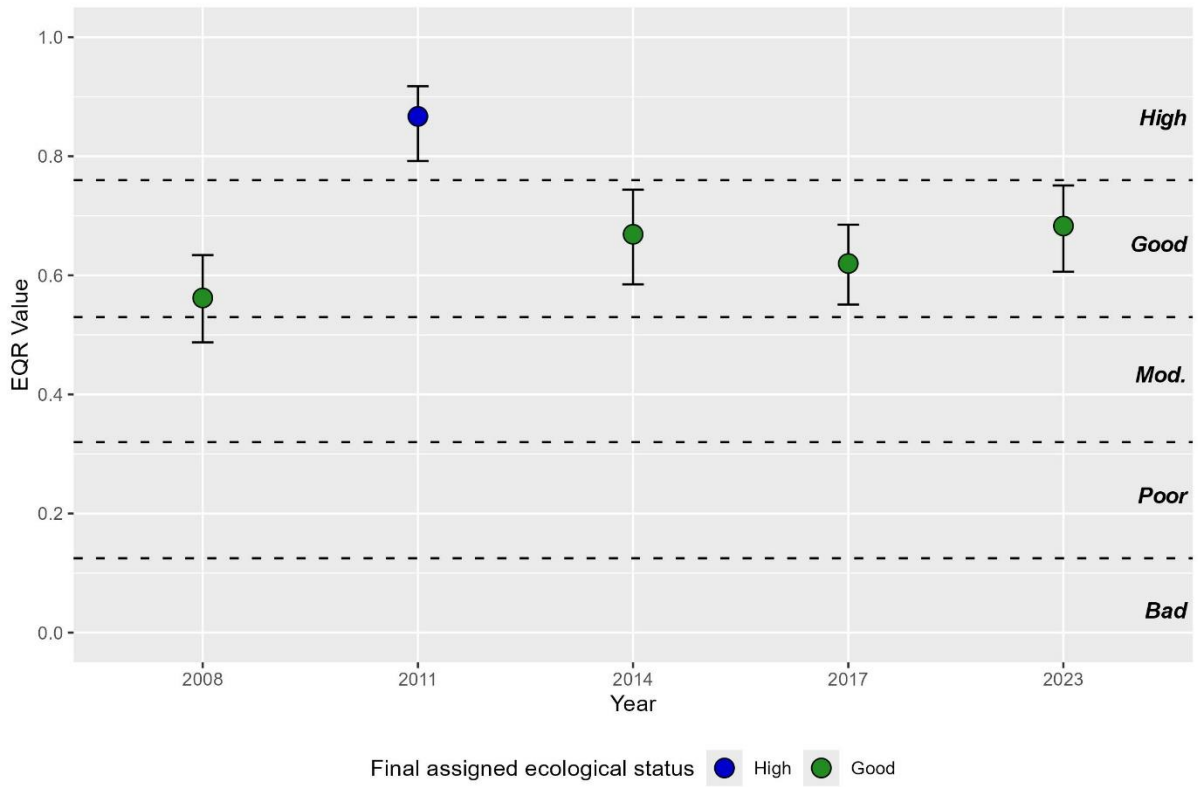


Figure 4.1. Fish ecological status, Carrowmore Lake, between 2008 and 2023 (dashed line indicates EQR status boundaries).

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