National Research Survey Programme

Lakes 2023

Glen Lough

IFI/2024/1-4728

Iascach Intíre Éireann
Inland Fisheries Ireland

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Fish Stock Survey of Glen Lough, July 2023

National Research Survey Programme

Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

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1. Introduction

Glen Lough is located in the Lackagh catchment, approximately 5km east of Creeslough, Co. Donegal, with Glen village at the northern end of the lake (Plate 1.1, Figure 1.1). The lake is located approximately 1.5km upstream of the tidal limit of the Lackagh River and approximately 7km downstream of Lough Beagh (Glenveagh) on the Owencarrow River. The lake is situated at an altitude of 27m a.s.l., has a surface area of 168ha, a mean depth of 4.9m and a maximum depth of 21m. Glen Lough falls into 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 $CaCO_3$) (EPA, 2005). The geology of the area is predominantly granite, felsite and other intrusive rocks rich in silica.

Glen Lough is encompassed within the Cloghernagore Bog and Glenveagh National Park Special Area of Conservation (SAC). The site supports populations of Atlantic salmon and freshwater pearl-mussel (*Margaritifera margaritifera*); species that are both afforded protected status in Ireland and listed on Annex II of the EU Habitats Directive (NPWS, 2013). Several bird species listed on the Red Data Book and on Annex I of the EU Birds Directive breed within the SAC. Turf cutting and afforestation are the main threats to the SAC, with erosion, over-grazing by sheep and deer and burning also having an impact (NPWS, 2013).

Historically, Glen Lough was one of the great spring salmon lakes; however, it never really recovered from the effects of the salmon disease Ulcerative Dermal Necrosis (UDN) in the 1960s (O' Reilly, 2007). In 1970 an Inland Fisheries Trust survey revealed the presence of brown trout only in the lake (IFT, unpublished data). A conclusion of the survey was that there was limited spawning in the upper reaches of the tributaries and impassable waterfalls restricting spawning to the lower reaches of the system. The lake is now best known as a sea trout fishery, even though numbers have declined (O' Reilly, 2007).

Glen Lough has been surveyed on five occasions since 2006 (Kelly *et al.*, 2007, 2011, 2014 and 2017, 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, European eel, minnow and salmon 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 provides insight into fish stock status in the lake.

Plate 1.1. Glen Lough, July 2023, looking north along the lake.

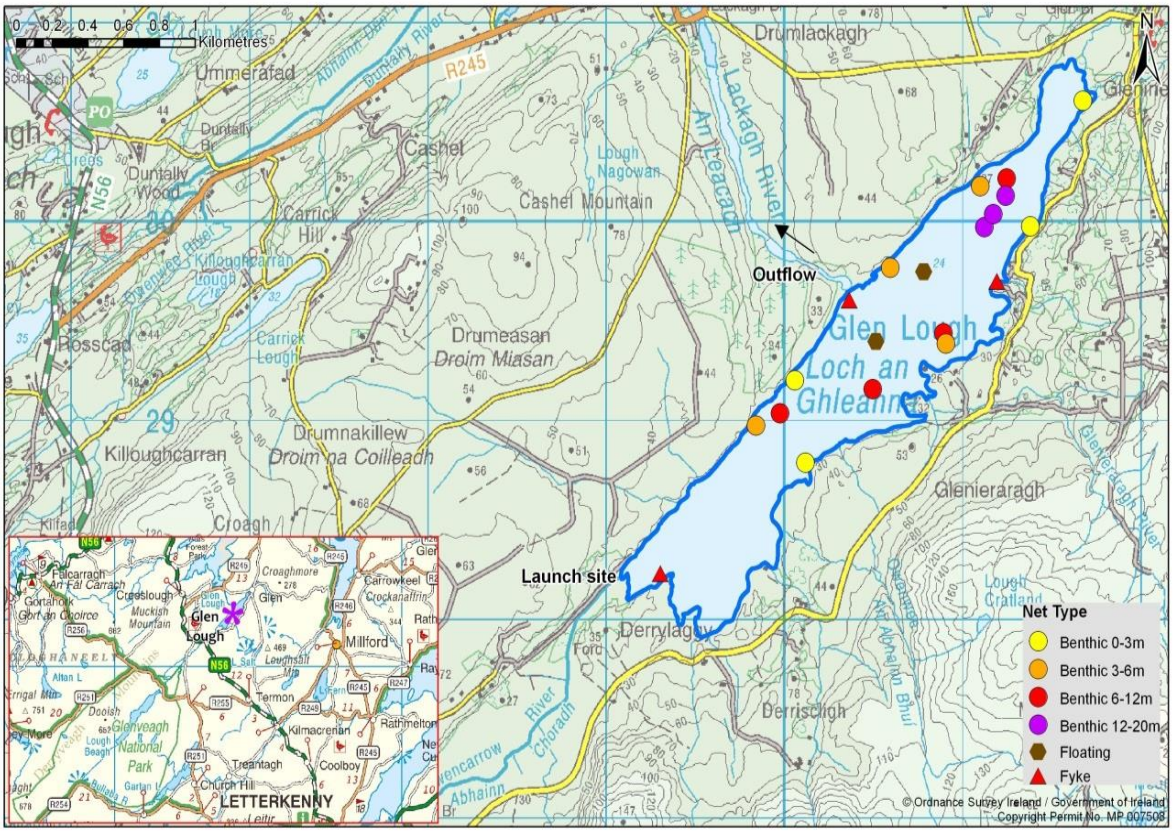

Figure 1.1. Location map of Glen Lough showing net locations and depths of each net (outflow is indicated on map).

2. Methods

2.1. Netting methods

Glen Lough was surveyed over two nights from the 5th to the 7th of July 2023. A total of three sets of Dutch fyke nets, 15 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 and 3 @ 12-19.9m) and two floating monofilament multi-mesh (FM CEN) (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed in the lake (20 sites). Nets were deployed in the same locations as were randomly selected in the previous survey. 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).

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

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

Five fish species, including two types of trout (brown trout and sea trout) were recorded in Glen Lough in July 2023. A total of 157 fish were captured (Table 3.1). Brown trout was the most numerous fish species recorded, representing *c*. 74.5% of all fish captured. Arctic char, minnow, salmon and European eels were also recorded. Similar species compositions were recorded on previous surveys of the lake (Kelly *et al.*, 2007, 2011, 2014 and 2017, Corcoran *et al.,* 2021).

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

Scientific name	Common name	Number of fish captured			
		BM CEN	FM CEN	Fyke	Total
Salmo trutta	Brown trout	106	10	1	117
	Sea trout	3	0	0	3
Salvelinus alpinus	Arctic char	16	6	0	22
Phoxinus phoxinus	Minnow	7	0	0	7
Salmo salar	Salmon	1	0	0	1
Anguilla anguilla	European eel	0	0	7	7

3.2. Fish abundance

Fish abundance (mean CPUE) and biomass (mean BPUE) were calculated as the mean number/weight of fish caught per meter 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 Glen Lough

Scientific name	Common name	Mean CPUE (± S.E)	Mean BPUE (± S.E)
Salmo trutta	Brown trout	0.194 (0.044)	21.727 (4.930)
	Sea trout	0.005 (0.004)	1.358 (1.007)
Salvelinus alpinus	Arctic char	0.037 (0.012)	2.629 (0.937)
Phoxinus phoxinus	Minnow	0.012 (0.007)	0.032 (0.021)
Salmo salar	Salmon	0.002 (0.002)	3.101 (3.101)
*Anguilla anguilla**	European eel	0.039 (0.022)	7.553 (5.320)

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 9.0cm to 36.2cm (mean 20.1cm). Brown trout captured in previous surveys had similar length ranges. While generally dominated by smaller fish, larger fish (> 35cm) were captured regularly (Figure 3.1). Brown trout were aged between 1+ and 6+ and all intervening age classes were present in the sample aged. Two to four year old fish (14cm – 28cm) dominated the population. Comparatively few 1+ fish (12-14cm) or older fish (>28cm) were captured (Figure 3.1). Mean L1 (i.e. length at the end of the 1st year) was 6.6cm (Table 3.3).

Brown trout abundance (CPUE) and biomass (BPUE) have remained relatively stable across recent surveys of the lake (Figure 3.2).

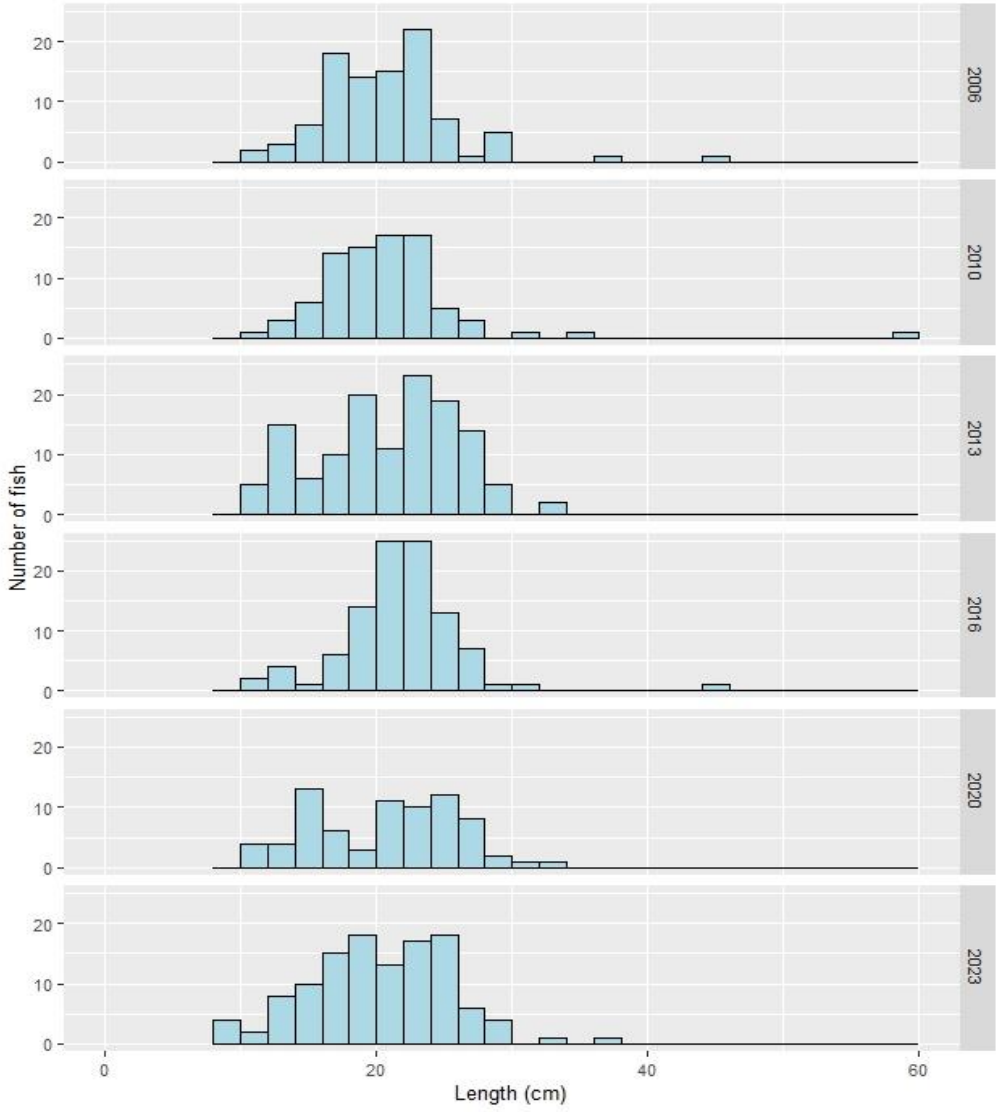

Figure 3.1. Length frequency of brown trout captured on Glen Lough between 2008 and 2023.

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

	L_1	L_2	L_3	L_4	L_5	L_6
Mean (±S.E.)	6.6 (0.07)	13.2 (0.12)	18.8 (0.15)	23.4 (0.20)	27.4 (0.63)	-
N	70	66	40	20	4	1
Range	5.2-7.8	11.2-16.5	17.0-21.3	21.9-26.1	26.2-28.8	33.7

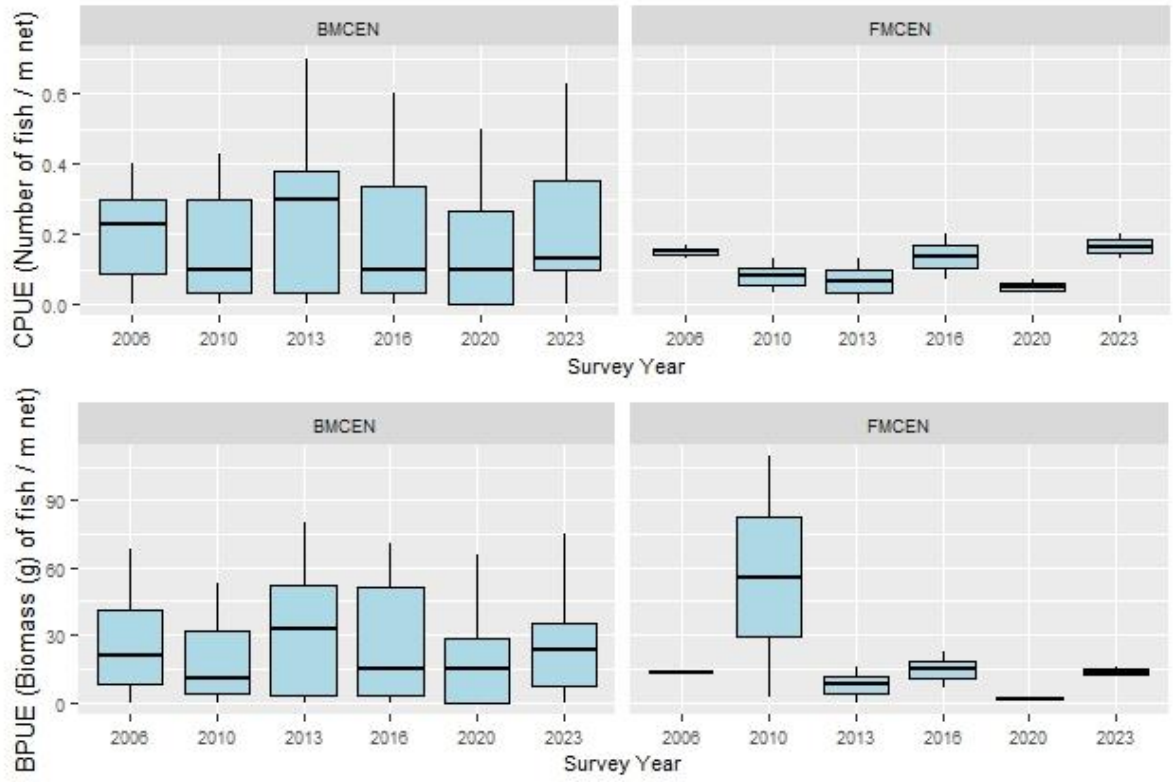

Figure 3.2. CPUE and BPUE of brown trout captured during surveys of Glen Lough between 2008 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the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

Arctic char

Arctic char captured during the 2023 survey ranged in length from 13.0cm to 22.0cm (mean 18.2cm). Small Arctic char (i.e. < 10-15cm) were captured in lesser proportions in 2023 compared to several of the other surveys since 2006 (Figure 3.3). Arctic char were aged between 1+ (13.8cm) and 4+ (18.5 - 20.5cm) (Figure 3.3 and Table 3.4) .Three and four year old char dominated the population (Table 3.4).

While no clear or obvious trend in Arctic char abundance (CPUE) was apparent, the greatest abundance of Arctic char was observed in the 2006 survey while the lowest CPUE was recorded in 2023 (Figure 3.4).

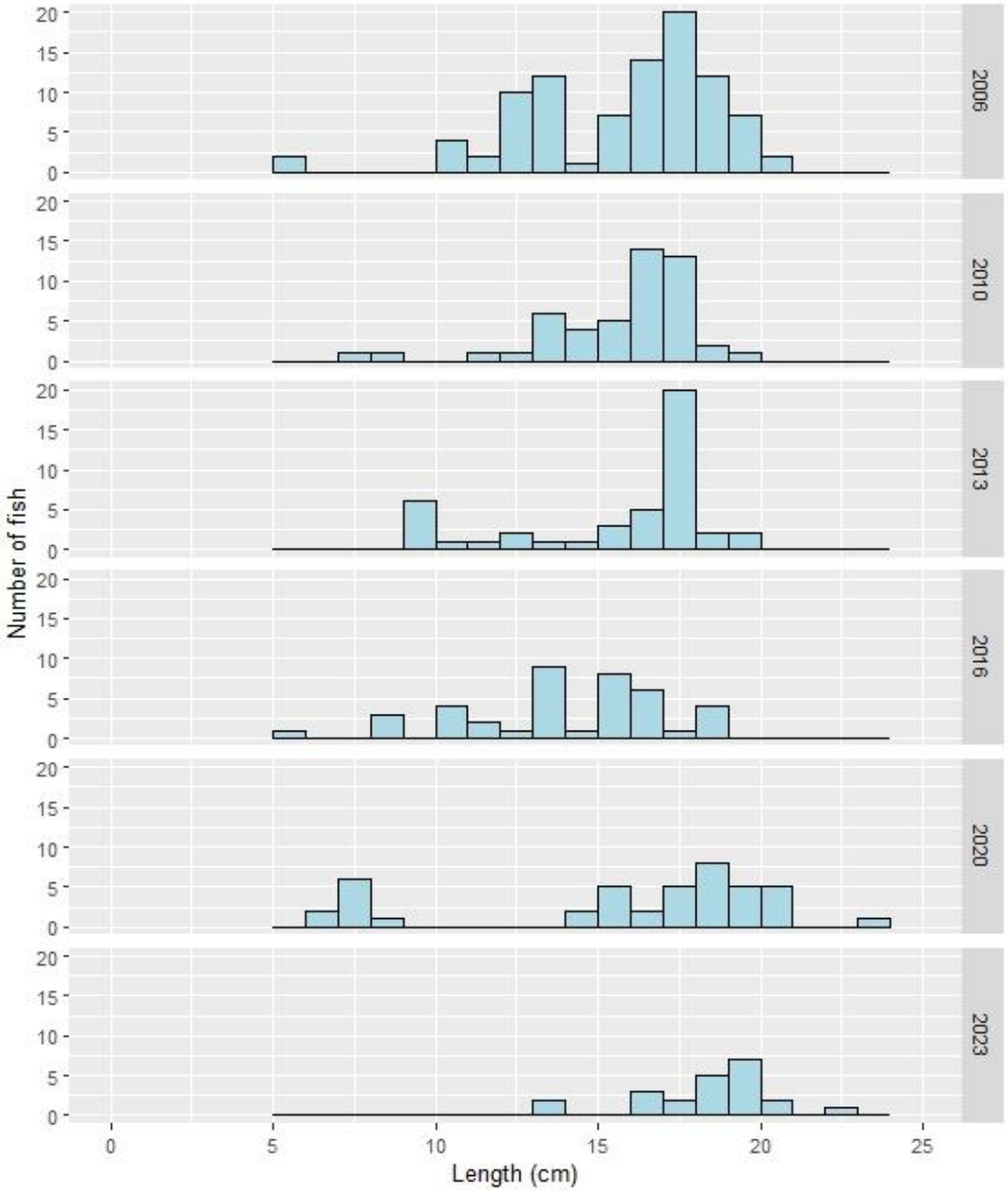

Figure 3.3. Length frequency of Arctic char captured on Glen Lough between 2008 and 2023

Table 3.4. Summary age data from Arctic char captured on Glen Lough, 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+	4+
N	-	1	1	6	7
Mean	-	13.8	16.8	18.3	19.6
Min	-	13.8	16.8	17.2	18.5
Max	-	13.8	16.8	19.4	20.5

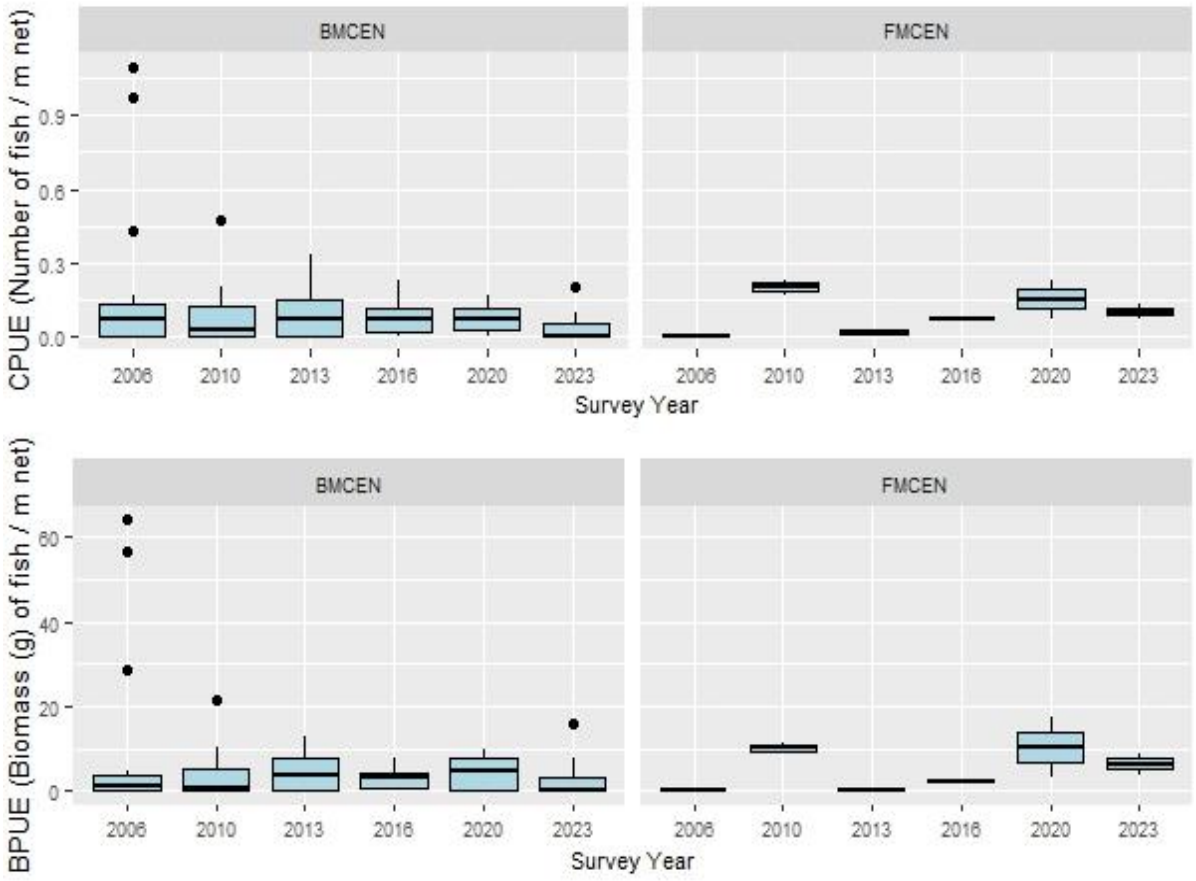

Figure 3.4. CPUE and BPUE of Arctic char captured during surveys of Glen Lough between 2008 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the 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 36.1cm to 61.2cm (mean 45.9cm) (Figure 3.5). Both abundance (CPUE) and biomass ((BPUE) of eel have declined since 2006 (Figure 3.6).

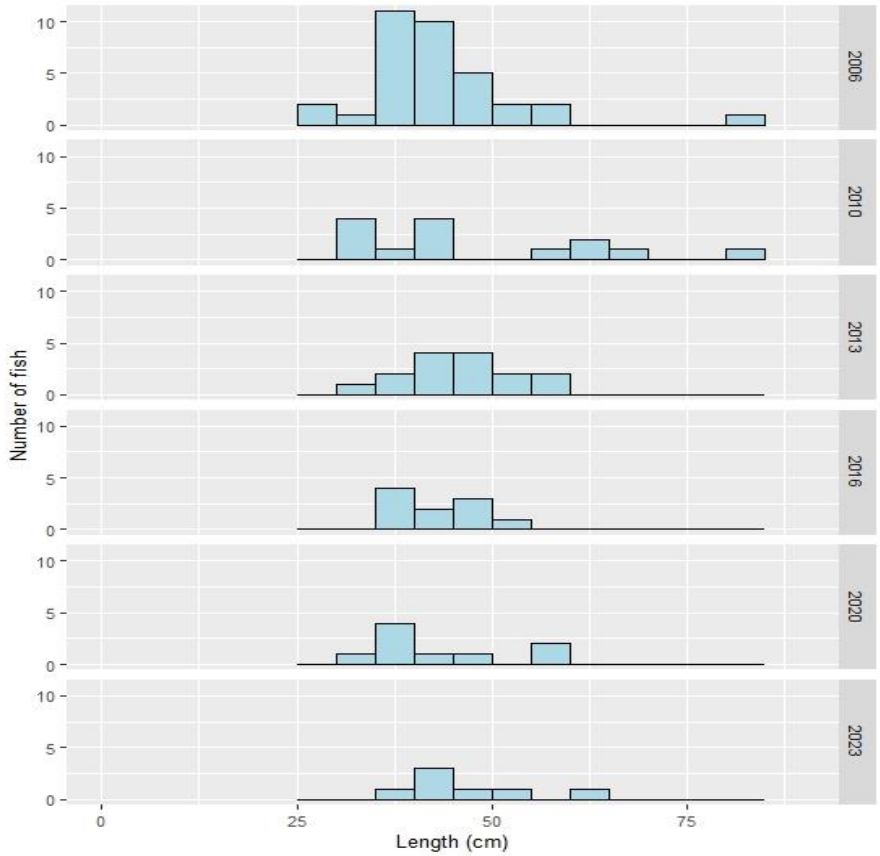

Figure 3.5. Length frequency of European eel captured on Glen Lough between 2008 and 2023

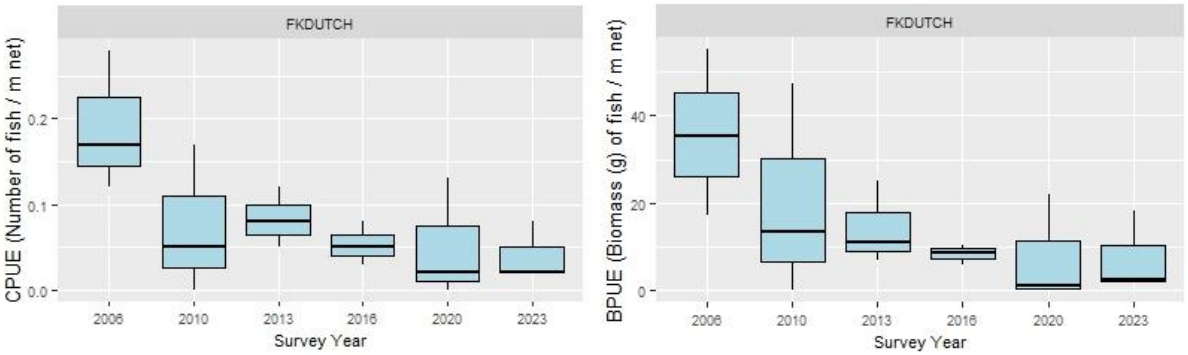

Figure 3.6. CPUE and BPUE of European eel captured during surveys of Glen Lough between 2008 and 2023. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the 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 ranged from 26.8cm to 28.6cm (mean = 27.5cm). One adult salmon captured measured 56.3cm. Minnow caught ranged in length from 5.2cm to 7.3cm (mean = 6.1cm).

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 48 brown trout stomachs were examined. Ten (20.8%) were empty. Thirty-eight stomachs contained food. Invertebrates were the sole prey type recorded in 17 (45%) stomachs and were found together with zooplankton in 10 (26%) stomachs. Zooplankton was the sole prey type recorded in nine (24%) stomachs. Fish were found in one (3%) stomach. Unidentified digested material was recorded in one (3%) other brown trout stomach (Figure 3.7).

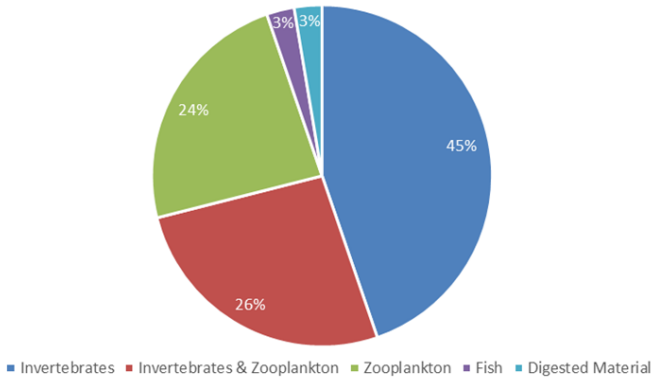

Figure 3.7. Diet of brown trout (N = 38) captured on Glen Lough, 2023 (% FO).

Arctic char

A total of 16 Arctic char stomachs were examined. Of these, seven (43.8%) were empty. Zooplankton was found to be the sole food item found in the remaining nine stomachs.

Sea trout

Two sea trout stomachs were examined, both of which were empty.

4. Summary and fish ecological status

A total of five fish species, including two varieties of trout (brown and sea trout) were recorded in Glen Lough 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. While the population was largely dominated by younger and smaller individuals brown trout were relatively long lived, with older and larger cohorts recorded in small numbers.

Arctic char is a rare species nationally and is endemic to the lake. No clear trend in Arctic char numbers was apparent. However, fewer smaller Arctic char were recorded in 2023 compared to earlier surveys. Furthermore, the CPUE of Arctic char recorded was the smallest on any survey of 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).

Both abundance and biomass of eel has declined since the lake was first surveyed in 2006.

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*., 2012).

Using the FIL2 classification tool, Glen Lough has been assigned an ecological status of Good for 2023 based on the fish populations present. Glen Lough was assigned a status of High following all precious surveys on the lake (Figure 4.1).

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

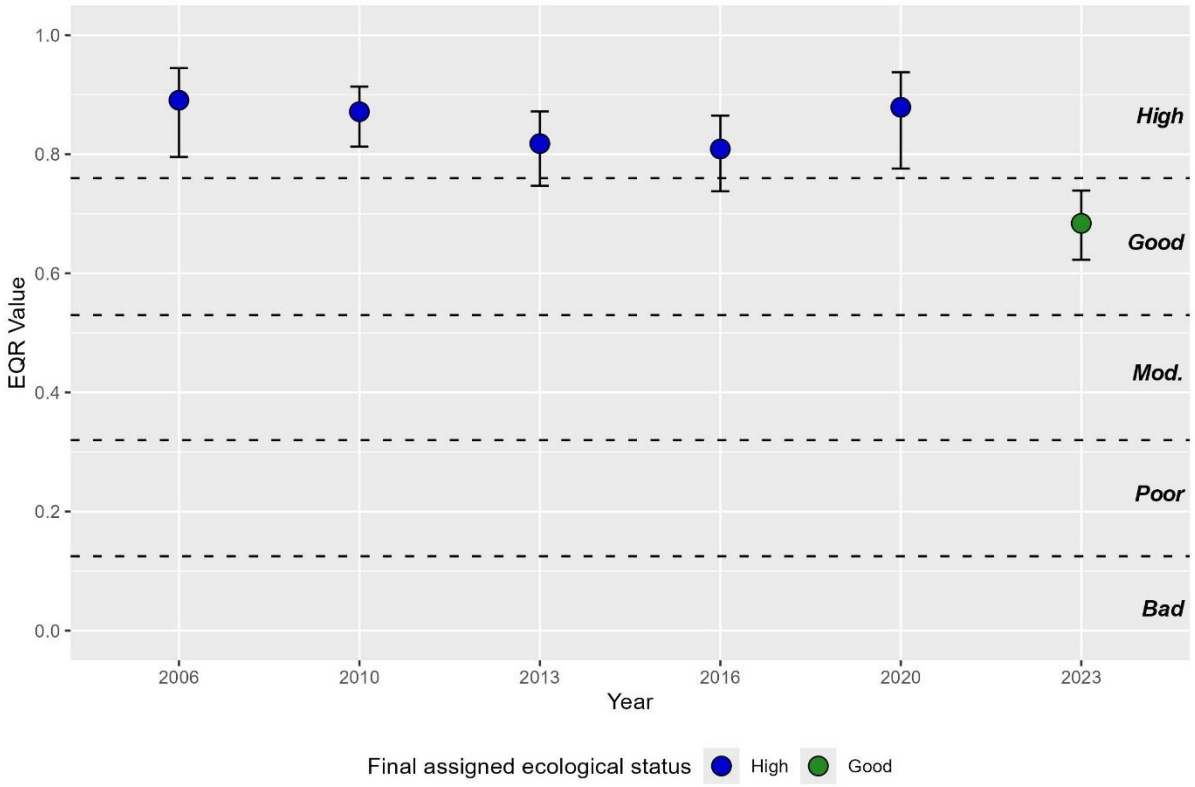

Figure 4.1. Fish ecological status, Glen Lough, between 2006 and 2023 (dashed line indicates EQR status boundaries).

5. References

Amundsen, P.A., Gabler, H.M. and Staldvik, F.J. (1996) A new approach to graphical analysis of feeding strategy from stomach contents data—modification of the Costello (1990) method. *Journal of Fish Biology,* **48,** 607–614.

Caffrey, J. (2010) *IFI Biosecurity Protocol for Field Survey Work*. Inland Fisheries Ireland.

Connor, L., Matson, R. and Kelly, F.L. (2017) Length-weight relationships for common freshwater fish species in Irish lakes and rivers. *Biology and Environment: Proceedings of the Royal Irish Academy*, **117** (2), 65-75.

Connor, L., Shephard, S., Rocks, K. and Kelly, F. L. (2019) Potential climate change impacts on Arctic char *Salvelinus alpinus* L. in Ireland. *Fisheries Management and Ecology*, **26**, 527-539.

Corcoran, W., Connor, L., McLoone, P., Bateman, A., Cierpial, D., Gavin, A., Gordon, P., McCarthy, E., Putthaaree, D., Twomey, C., Matson, R., Robson, S., Duffy, P., Rocks, K., Donovan, R., Crowley, D., and Kelly, F.L. (2021) *Fish Stock Survey of Glen Lough, August 2020.* National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

EPA (2021) https://gis.epa.ie/EPAMaps/ Data - Catchments.ie. Accessed in May 2024

Kelly, F.L. Connor, L. and Champ, W.S.T. (2007) *A Survey of the Fish Populations in 46 lakes in the Northern Regional Fisheries Board, June to September 2005 and 2006*. North South Shared Aquatic Resource (NS Share) Lakes Project.

Kelly, F.L., Harrison, A., Connor, L., Allen, M., Rosell, R. and Champ, T. (2008) *FISH IN LAKES Task 6.9: Classification tool for Fish in Lakes. FINAL REPORT*. Central Fisheries Board, NS Share project.

Kelly, F.L., Harrison A., Connor, L., Morrissey, E., Wogerbauer, C., Matson, R., Feeney, R., O'Callaghan, R. and Rocks, K. (2011) *Water Framework Directive Fish Stock Survey of Glen Lough, August 2010*. Inland Fisheries Ireland.

Kelly, F.L., Harrison, A.J., Allen, M., Connor, L. and Rosell, R. (2012) Development and application of an ecological classification tool for fish in lakes in Ireland. *Ecological Indicators*, **18**, 608-619.

Kelly, F.L., Connor, L., Morrissey, E., Coyne, J., Matson, R., Feeney, R. and Rocks, K. (2014) *Water Framework Directive Fish Stock Survey of Glen Lough, August 2013*. Inland Fisheries Ireland.

Kelly, F.L., Connor, L., Coyne, J., Morrissey, E., Corcoran, W., Cierpial, D., Delanty, K., McLoone, P., Matson, R., Gordon, P., O' Briain, R., Rocks, K.., O' Reilly, S., Kelly K., Puttharee, D., McWeeney,

D., Robson S. and Buckley, S. (2017) *Fish Stock Survey of Glen Lough, August 2016*. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

NPWS (2013) Site *synopsis: Cloghernagore Bog and Glenveagh National Park. Site code: 002047*. Site Synopsis report, National Parks and Wildlife Service.

O' Reilly, P. (2007) *Loughs of Ireland*. A Flyfisher's Guide. 4th edition. Merlin Unwin Books.

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