National Research Survey Programme
Lakes 2022

Lough Shindilla

Iascach Intíre Éireann
Inland Fisheries Ireland

Fish Stock Survey of Lough Shindilla, August 2022

National Research Survey Programme

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

ACKNOWLEDGEMENTS

1.   Introduction

Lough Shindilla is the uppermost lake on the Screebe system in Co. Galway, located approximately 0.75km west of Maam Cross (Plate 1.1, Figure 1.1). The lake has a surface area of 65.3ha, a mean depth >4m, a maximum depth of 22m and has been characterised 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 Shindilla is located in the Maumturk Mountains Special Area of Conservation (SAC). Most of the mountains in the SAC exceed 600m in height and the majority of the land within the site lies above an altitude of 250m. The main bedrock in the south is made up of quartzite and in the north of the SAC the bedrock is generally comprised of shales and slates (NPWS, 2013).

The site is a SAC for containing blanket bog, lowland oligotrophic lakes, alpine heath, siliceous rock and Rhynchosporion, all habitats listed on Annex I of the E.U. Habitats Directive (NPWS, 2013). The SAC is also selected for containing slender naiad (*Najas flexilis*) and Atlantic salmon (*Salmo salar*), both species listed on Annex II of the same Directive. Species listed in the Red Data Book which are located in the SAC include the Irish hare and the common frog (*Rana temporaria*). The peregrine falcon (*Falco peregrinus*), a species listed on Annex I of the EU Birds Directive also occur within the SAC (NPWS, 2013).

Damaging activities and threats to the Maumturk Mountains SAC include overgrazing, peat-cutting and afforestation. Grazing, in particular by sheep, is quite severe within the site and has resulted in the erosion of both lowland and mountain blanket bog (NPWS, 2013).

The lake has been surveyed on five occasions since 2007 (2007, 2010, 2013, 2016 and 2019) (Kelly and Connor, 2007 and Kelly *et al.,* 2011, 2014 and Corcoran *et al.*, 2020). These surveys have revealed a change in the fish community in the lake. Perch (*Perca fluviatilis*) have been the dominant species in more recent surveys, while no Arctic char (*Salvelinus alpinus*), a rare endemic species, have been recorded since 2016.

This report summarises the results of the 2022 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.
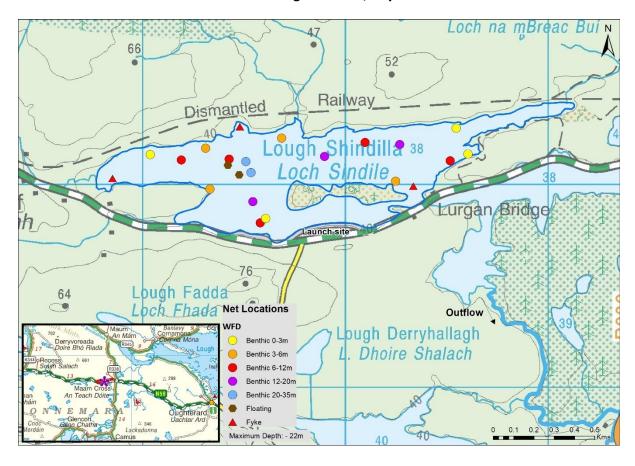
Plate 1.1. Lough Shindilla, July 2023

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

2. Methods

2.1. Netting methods

Lough Shindilla was surveyed over two nights from the 15th to 17th of August 2022. 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, 5 @ 6-11.9m, 3 @ 12-19.9m and 2 @ 20-34.9m) and two floating monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (FM CEN) were deployed in the lake (23 sites). Nets were deployed in the same locations as were randomly selected in 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 apart from perch were measured and weighed on site and scales were removed from a sub-sample of other species except eels. 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 prey 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 in order 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

Three fish species were recorded in Lough Shindilla in August 2022. A total of 125 fish were captured (Table 3.1). Perch was the most common fish species recorded. Brown trout and eels were also captured in 2022.

Table 3.1. Number of each fish species captured by each gear type during the survey on Lough Shindilla, August 2022.

Scientific name	Common name	Number of fish captured			
		BM CEN	FM CEN	Fyke	Total
Perca fluviatilis	Perch	88	2	0	90
Salmo trutta	Brown trout	31	1	1	33
Anguilla anguilla	European eel	0	2	0	2

### 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 was the dominant species in terms of abundance (mean CPUE) and biomass (mean BPUE) in the 2022 survey (Table 3.2).

For comparison purposes box plots of CPUE and BPUE for each species captured in all surveys per net type between 2007 and 2022 are presented in Figures 3.1 and 3.2 respectively and illustrates fish community change over time. Perch were first recorded in the 2010 survey. The increasing trend observed for both median CPUE and BPUE between 2010 and 2019 is no longer apparent. Arctic char have declined over the corresponding period and no specimens have been recorded in the lake since 2016. There was no obvious trend in brown trout abundance and biomass.

Table 3.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Lough Shindilla, August 2022.

Scientific name	Common name	Mean CPUE (± S.E)	Mean BPUE (± S.E)
Perca fluviatilis	Perch	0.129 (0.039)	12.730 (3.744)
Salmo trutta	Brown trout	0.047 (0.011)	4.530 (0.973)
Anguilla anguilla	European eel	0.011 (0.006)*	0.775 (0.424)*

*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.*
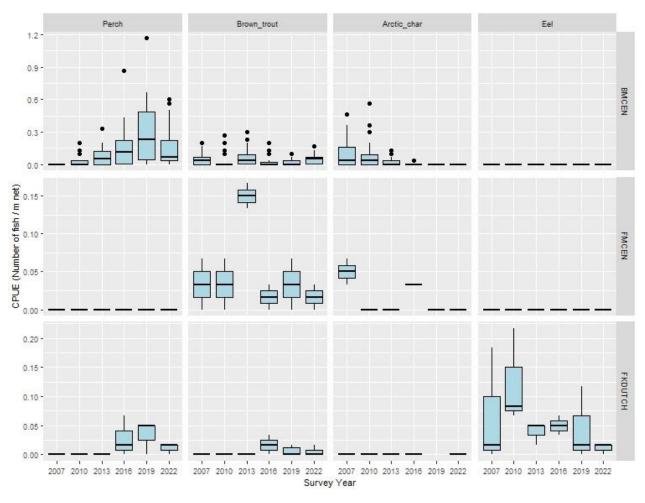
Figure 3.1. CPUE of fish species captured in each net type during surveys of Lough Shindilla between 2007 and 2022. Figures are expressed as numbers of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots. The y axis (CPUE) is unique for each net type.
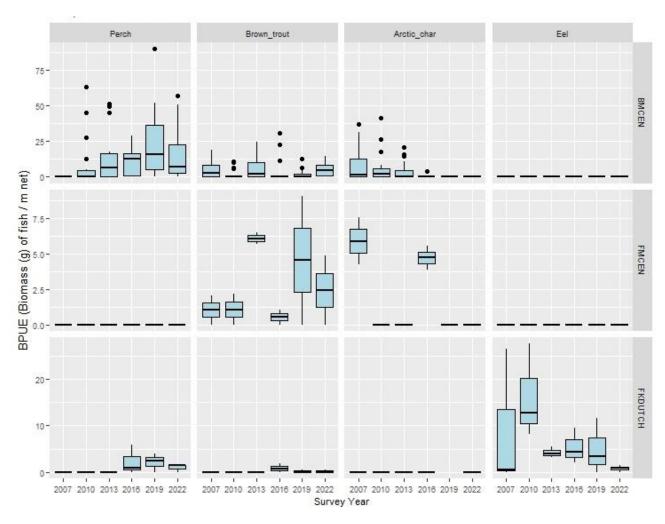
Figure 3.2. BPUE of all fish species captured in each net type during surveys of Lough Shindilla from between 2007 and 2022. Figures are expressed as biomass (g) of fish captured per linear meter of net deployed. The horizontal bars represent the median value of the sample, while the 75th and 25th percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots. The y axis (BPUE) is unique for each net type.

3.3. Length frequency distributions and growth

Perch

Perch captured during the 2022 survey ranged in length from 14.0cm to 29.1cm (mean 18.9cm) (Figure 3.3). Perch captured during the 2022 survey had a broadly similar length and age range to previous surveys. However, no fish <14.0cm were captured in 2022 (Figure 3.3). Six age classes were present, ranging from 2+ to 7+. The dominant age class was 4+ and no 0+ or 1+ fish were captured. Mean L1 (i.e., age at the end of the first year) was 6.9cm (Table 3.3).
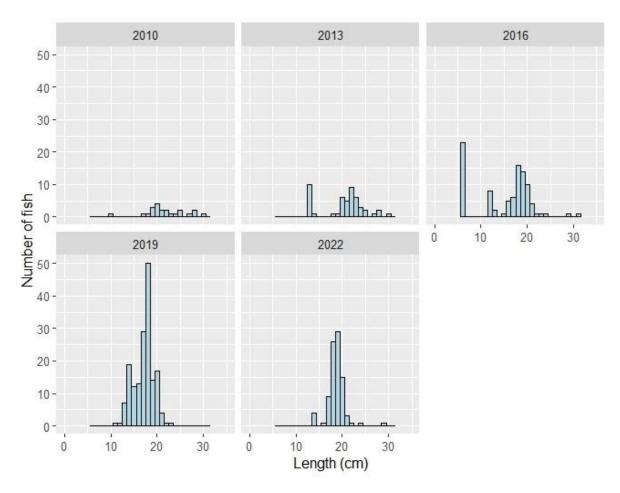

Figure 3.3. Length frequency of perch captured on Lough Shindilla, 2010, 2013, 2016, 2019 and 2022.

Table 3.3. Mean (±S.E.) perch length (cm) at age for Lough Shindilla, August 2022.

Length (cm)	L_1	L_2	L_3	L_4	L_5	L_6	L_7
Mean (±S.E.)	6.9 (0.2)	13.1 (0.3)	16.2 (0.2)	18.5 (0.3)	20.0 (0.9)	20.0 (1.9)	-
N	31	31	27	20	6	3	1
Range	5.5 - 9.2	10.9 - 16.8	14.1 - 18.7	16.2 - 20.3	17.2 - 22.5	17.7 - 23.7	25.50

Brown trout

Brown trout captured during the 2022 survey ranged in length from 13.6cm to 23.6cm (mean 19.5cm) (Figure 3.4). Brown trout captured in the 2022 had a broadly similar length range compared to previous surveys. Three age classes were present in the sample aged, ranging from 1+ to 3+. The most abundant age class was 2+ (Table 3.4). Mean L1 (i.e., length at the end of the first year) was 6.4cm (Table 3.4).
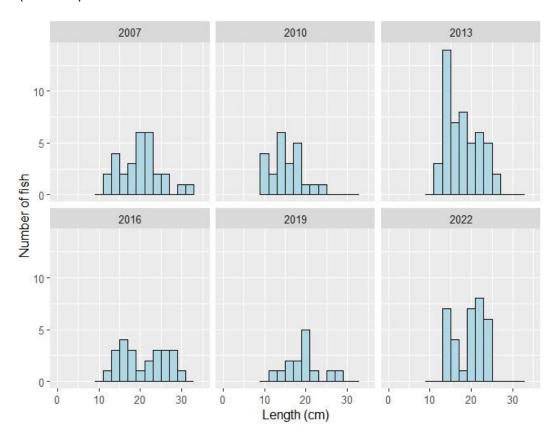

Figure 3.4. Length frequency of brown trout captured on Lough Shindilla, 2007, 2010, 2013, 2016, 2019 and 2022.

Table 3.4. Mean (±S.E.) brown trout length (cm) at age for Lough Shindilla, August 2022.

Length (cm)	L_1	L_2	L_3
Mean (±S.E.)	6.4 (0.1)	14.7 (0.3)	20.0 (0.2)
N	26	19	7
Range	5.2 - 7.8	12.6 - 16.8	19.3 - 20.7

Other fish species

Two European eels measuring 30.0cm and 36.0cm in length were also captured in the 2022 survey. Both eels were released.

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

Perch

A total of 15 perch stomachs were examined. Of these six (40%) were found to contain no prey items. Of the nine remaining stomachs, five (56%) contained invertebrates/zooplankton and three stomachs (33%) contained zooplankton. Fish remains were recorded in one stomach (11%) (Figure 3.5).
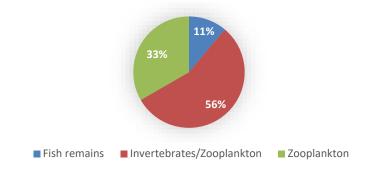

Figure 3.5. Diet of perch (N = 9) captured on Lough Shindilla, 2022 (% FO)

Brown trout

A total of 14 brown trout stomachs were examined. Of these five (36%) were found to contain no prey items. Of the nine stomachs containing food, invertebrates were the sole prey recorded in four (44%) stomachs. Invertebrates occurred together with fish and with zooplankton in two separate stomachs and zooplankton was the sole prey identified in three (33%) stomachs (Figure 3.6).
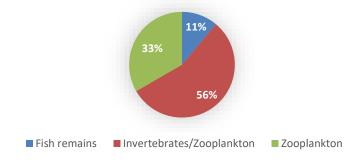

Figure 3.6. Diet of brown trout (N = 9) captured on Lough Shindilla, 2022 (% FO).

4.   Summary and fish ecological status

Three fish species were recorded on Lough Shindilla in August 2022.

Perch was the dominant species in terms of both abundance (CPUE) and biomass (BPUE) captured in the survey gill nets during the 2022 survey. Samples of perch were first recorded in Lough Shindilla in 2010. The increasing trend in both abundance and biomass evident between 2010 and 2019 has not continued in the 2022 survey, when no 0 + or 1+ perch were captured. This indicates that recruitment to this population, which has recently colonised the lake, may have been limited in recent years.

Arctic char is a rare species nationally and are endemic to the lake. However, there has been a clear decline in both abundance and biomass on Lough Shindilla. This decline was first evident in 2013 and no Arctic char have been recorded in surveys since 2016. It is now likely that this species is no longer present in the lake or that their numbers are so low that their capture in surveys is unlikely.

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). Surveys of the adjacent Lough Ardderry have indicated a similar decrease and subsequent disappearance of Arctic char following the colonisation of perch (McLoone *et al*., 2023).

Brown trout abundance and biomass have remained relatively steady across all survey periods.

Classification and assigning lakes with an ecological status is a critical part of the WFD monitoring programme. It allows River Basin District managers to identify and prioritise 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) 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, Lough Shindilla has been assigned an ecological status of High for 2022 based on the fish populations present. In previous years the lake was also assigned a fish status of High (Figure 4.1).

In the 2016 to 2021 surveillance monitoring reporting period, the EPA assigned Lough Shindilla an overall ecological status of High, based on all monitored physico-chemical and biological elements, including fish (EPA 2021).
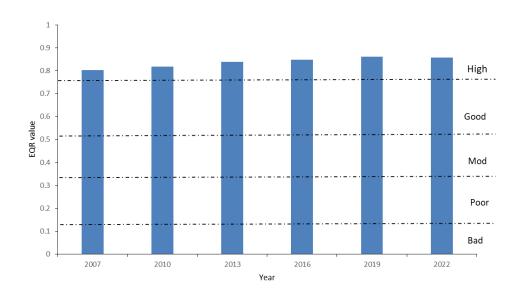
Figure 4.1. Fish ecological status, Shindilla Lough, 2007, 2010, 2013, 2016, 2019 and 2022 (dashed line indicates EQR status boundaries).

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., Bateman, A., Coyne, J., Cierpial, D., Lopez, S., McLoone, P., Rocks, K., Twomey, C., Gordon, P., O' Briain, R., Matson, and Kelly, F.L. (2020). *Fish Stock Survey of Lough Shindilla, August 2019*. 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 - Catchments.ie. Accessed in May/June 2023.

Kelly, F. and Connor, L. (2007) *WFD Surveillance Monitoring - Fish in Lakes 2007*. Central Fisheries Board report.

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, NSSHARE 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 Lough Shindilla, September 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 Lough Shindilla, 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 Lough Shindilla, September 2016*. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

McLoone, P., Corcoran, W., Bateman, A., Cierpial, D., Gavin, A., Gordon, P., McCarthy, E., Heagney, B., Hyland, J., Matson, R., Robson, S., Kelly, K., and Kelly, F.L. (2023) *Fish Stock Survey of Ardderry Lough, August 2022*. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

NPWS (2013). Site *synopsis: Maumturk Mountains. Site code: 002008*. Available at https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002008.pdf

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