IFI/2015/1-4262

# Sampling Fish for the Water Framework Directive

## *Lakes 2014*

## Carrowmore Lake

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INLAND FISHERIES IRELAND

# Water Framework Directive Fish Stock Survey of Carrowmore Lake, June 2014

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CITATION: Kelly, F.L., Connor, L., Morrissey, E., Coyne, J., Feeney, R., Matson, R. and Rocks, K. (2015g) Water Framework Directive Fish Stock Survey of Carrowmore Lake, June 2014. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

Cover photo: Netting survey on Lough Brin © Inland Fisheries Ireland

**ACKNOWLEDGEMENTS**

The authors wish to gratefully acknowledge the help and co-operation of the regional director Dr. John Conneely and the staff from IFI, Ballina. The authors would also like to gratefully acknowledge the help and cooperation of all their colleagues in IFI, Swords.

The authors would also like to acknowledge the funding provided for the project from the Department of Communications, Energy and Natural Resources for 2014.

## 1.1 Introduction

Carrowmore Lake is situated in Co. Mayo, just over three kilometres north-west of Bangor Erris in the Owenmore catchment (Plate 1.1 and Fig. 1.1). The slopes of Knocknascollop Mountain rise up 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 $CaCO_3$).

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, 1997).

Algal blooms occur from time to time on the lake and in past years the IFI Ballina (formerly North Western Regional Fisheries Board) have carried out a detailed study into the causes and factors relating to the eutrophication of Carrowmore Lake (NWRFB, 2005). 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 recent eutrophication of the lake (NWRFB, 2005).

Carrowmore Lake was previously surveyed in 2008 and 2011 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al*., 2009 and Kelly *et al*., 2012a). During the 2011 survey, three-spined stickleback, followed by brown trout were the dominant species present in the lake. Sea trout, salmon, minnow and eels were also captured during the survey.

**Plate 1.1. Carrowmore Lake**

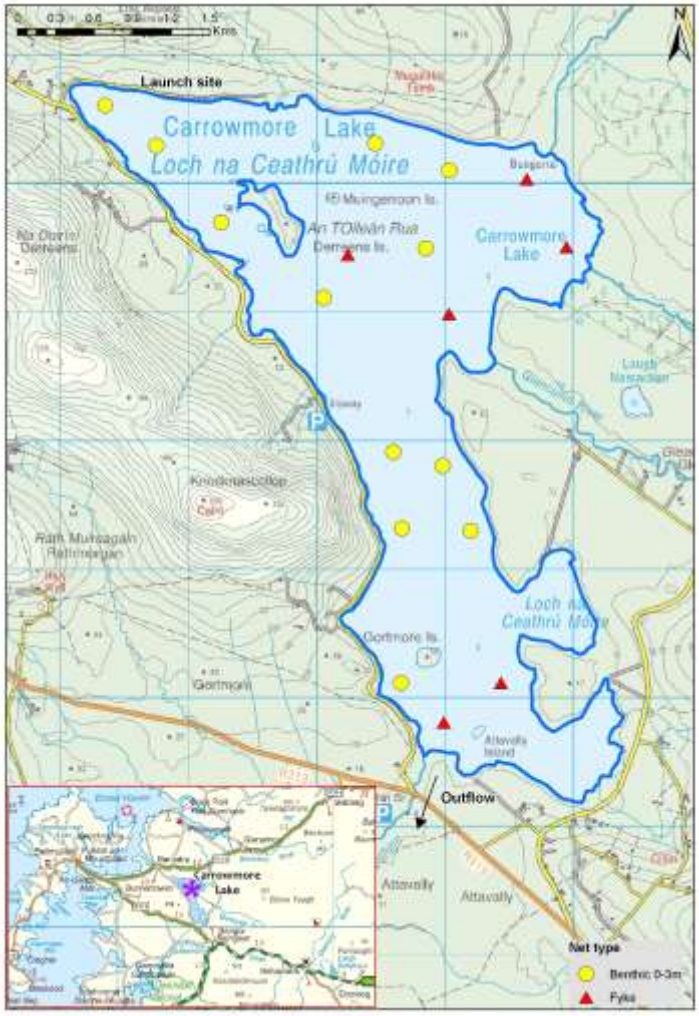


**Fig. 1.1. Location map of Carrowmore Lake showing locations and depths of each net (outflow is indicated on map)**

## 1.2 Methods

Carrowmore Lake was surveyed over two nights from the 3rd to the 5th of June 2014. 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 (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 in 2008 and 2011. 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 all brown trout, sea trout and salmon. 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.

## 1.3 Results

### *1.3.1 Species Richness*

A total of five fish species (sea trout are included as a separate 'variety' of trout) were recorded on Carrowmore Lake in June 2014, with 745 fish being captured. The number of each species captured by each gear type is shown in Table 1.1. Three-spined stickleback was the most abundant fish species recorded, followed by brown trout. During the previous surveys in 2008 and 2011 the same species composition was recorded with the exception of minnow and salmon, which were not captured during the 2008 survey but were recorded during the 2011 and 2014 surveys.

**Table 1.1. Number of each fish species captured by each gear type during the survey on Carrowmore Lake, June 2014**

| Scientific name | Common name | Number of fish captured | | |
|---|---|---|---|---|
| | | Benthic mono multimesh gill nets | Fyke nets | Total |
| *Gasterosteus aculeatus* | 3-spined stickleback | 488 | 23 | 511 |
| *Salmo trutta* | Brown trout | 206 | 7 | 213 |
| *Salmo trutta* | Sea trout | 2 | 0 | 2 |
| *Salmo salar* | Salmon | 1 | 0 | 1 |
| *Phoxinus phoxinus* | Minnow | 9 | 0 | 9 |
| *Anguilla anguilla* | Eel | 0 | 11 | 11 |

### *1.3.2 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. Mean CPUE and BPUE for all fish species captured in the 2008, 2011 and 2014 surveys are summarised in Table 1.2. Mean CPUE and BPUE for all species is illustrated in Figure 1.2 and 1.3.

Three-spined stickleback was the dominant species in terms of abundance (CPUE) and brown trout was the dominant species in terms of biomass (BPUE). Although the mean brown trout CPUE increased slightly over the three sampling years, these differences were not statistically significant (Table 1.2; Fig 1.2 and 1.3). The mean brown trout BPUE was significantly higher in 2014 and 2011 than in 2008 (Kruskal-Wallis $H=8.4$, $P<0.05$) (Table 1.2; Fig 1.2 and 1.3).

**Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Carrowmore Lake, 2008, 2011 and 2014**

| Scientific name | Common name | 2008 | 2011 | 2014 |
|---|---|---|---|---|
| | | | **Mean CPUE** | |
| *Gasterosteus aculeatus* | Three-spined stickleback | 0.981 (0.264) | 0.418 (0.109) | 0.925 (0.269) |
| *Salmo trutta* | Brown trout | 0.184 (0.041) | 0.350 (0.666) | 0.387 (0.078) |
| *Salmo salar* | Salmon | - | 0.005 (0.004) | 0.003 (0.002) |
| *Salmo trutta* | Sea trout | 0.035 (0.011) | 0.007 (0.004) | 0.002 (0.002) |
| *Phoxinus phoxinus* | Minnow | - | 0.002 (0.002) | 0.017 (0.007) |
| *Anguilla anguilla* | European eel | 0.041 (0.039) | 0.088 (0.04) | 0.031 (0.009) |
| | | | **Mean BPUE** | |
| *Gasterosteus aculeatus* | Three-spined stickleback | 3.925 (1.069) | 0.579 (0.157) | 1.190 (0.373) |
| *Salmo trutta* | Brown trout | 12.892 (2.941) | 40.926 (8.348) | 34.533 (7.271) |
| *Salmo salar* | Salmon | - | 0.047 (0.032) | 7.607 (7.567) |
| *Salmo trutta* | Sea trout | 2.233 (0.716) | 2.218 (1.664) | 0.607 (0.607) |
| *Phoxinus phoxinus* | Minnow | - | 0.013 (0.013) | 0.051 (0.024) |
| *Anguilla anguilla* | European eel | 5.011 (3.493) | 13.023 (7.862) | 5.206 (1.711) |

Note: On the rare occasion where biomass data was unavailable for an individual fish, this was determined from a length/weight regression for that species.

*Eel CPUE and BPUE based on fyke nets only

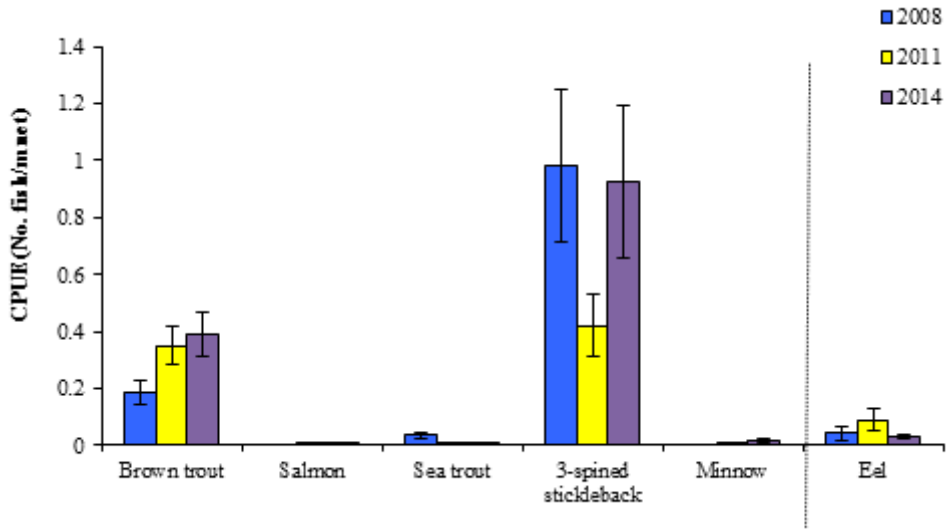


**Fig. 1.2. Mean (±S.E.) CPUE for all fish species captured in Carrowmore Lake (Eel CPUE based on fyke nets only), 2008, 2011 and 2014**

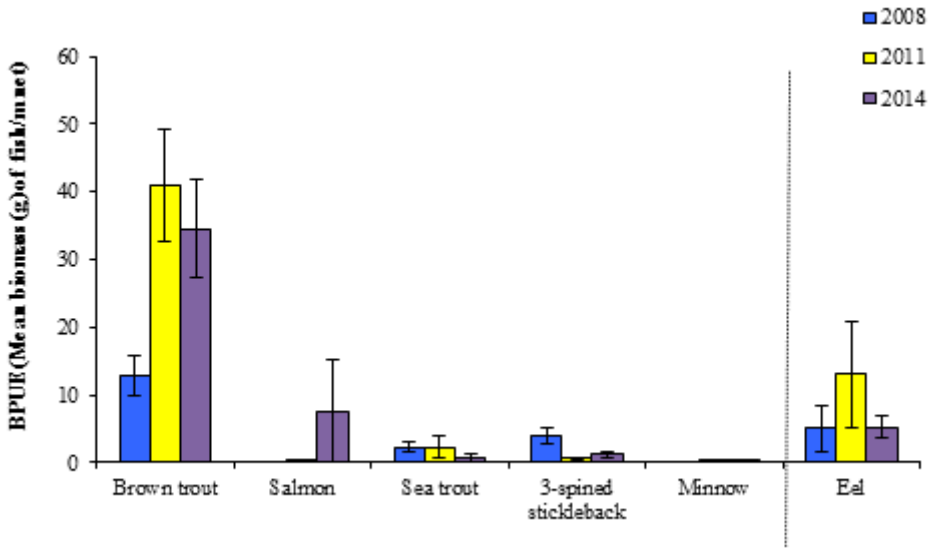


**Fig. 1.3. Mean (±S.E.) BPUE for all fish species captured in Carrowmore Lake (Eel BPUE based on fyke nets only), 2008, 2011 and 2014**

### *1.3.3 Length frequency distributions and growth*

Three-spined stickleback captured during the 2014 survey ranged in length from 2.5cm to 6.8cm (mean = 5.2cm) (Fig.1.4). Three-spined stickleback captured during the 2008 and 2011 surveys had similar lengths (Fig.1.4). The dominant age class in all years corresponded with the 4-5cm class (Fig.1.4).

Brown trout captured during the 2014 survey ranged in length from 9.3cm to 45.0cm (mean = 17.9cm) (Fig. 1.5) with seven age classes present, ranging from 1+ to 7+, with a mean L1 of 6.5cm (Table 1.3). The dominant age class was 1+ (Fig. 1.5). Mean brown trout L4 in 2014 was 23.5cm indicating a very slow rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971). Brown trout captured during the 2008 and 2011surveys had similar length ranges with some smaller fish recorded in 2011 and some larger fish in the 2008 and 2014 surveys (Fig. 1.5). The age ranges and growth rates were similar over the three year sampling period (Fig. 1.5).

Minnow captured during the 2014 survey ranged in length from 4.5cm to 8.8cm and eels ranged from 31.5cm to 57.0cm. Two salmon captured were aged 2+ and 1.2+ and had lengths of 15.2cm to 74.0cm. One sea trout measuring 31.2cm was also recorded and aged at 2.1+.

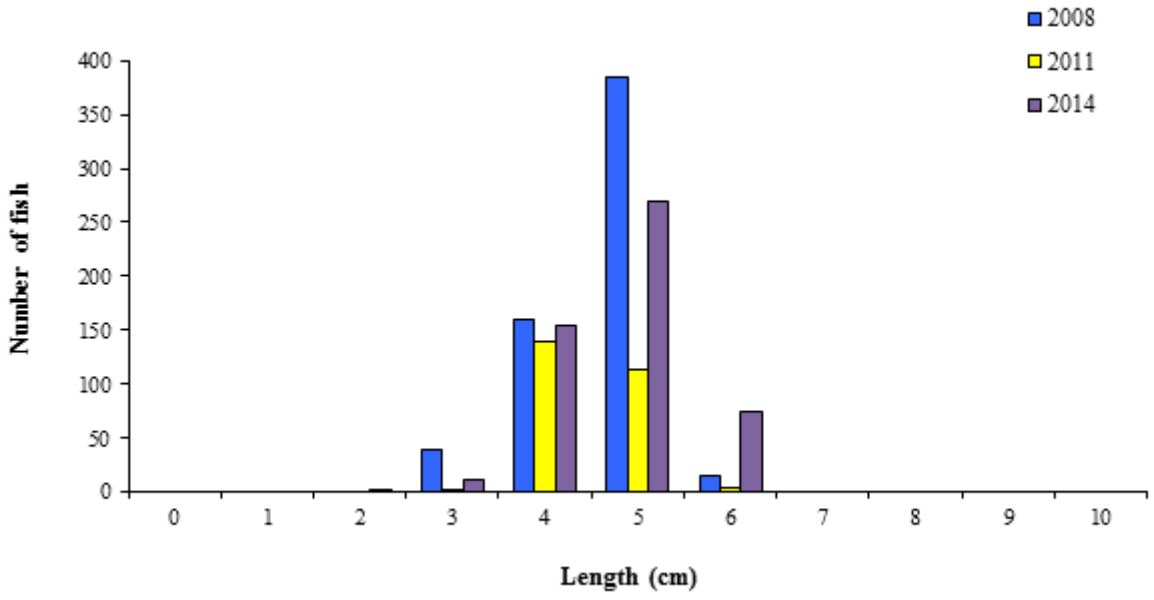


**Fig. 1.4. Length frequency of three-spined stickleback captured on Carrowmore Lake, 2008, 2011 and 2014**

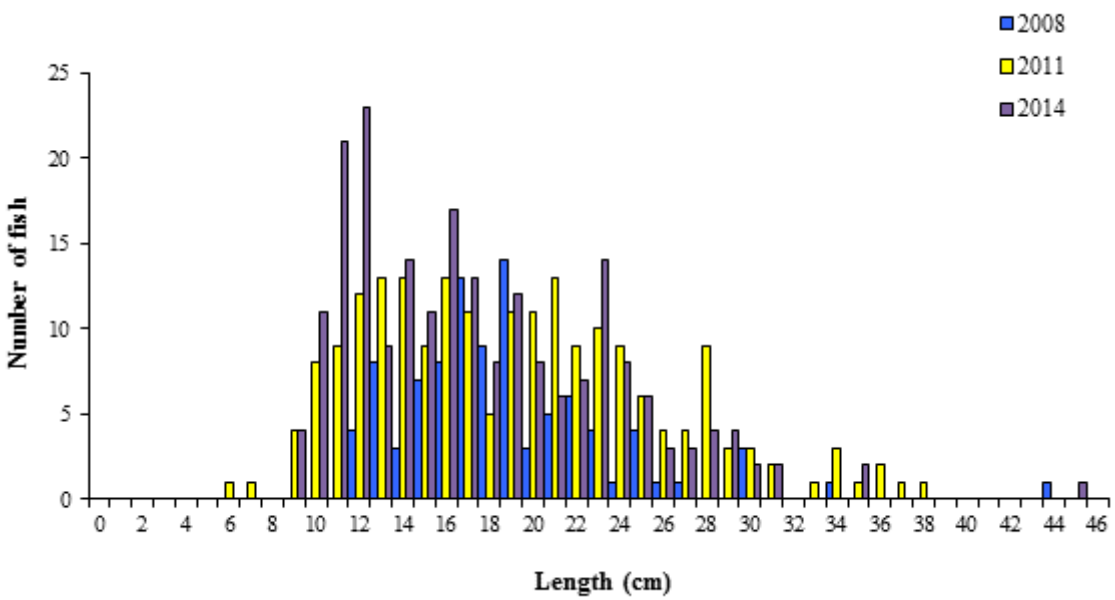


**Fig. 1.5. Length frequency of brown trout captured on Carrowmore Lake, 2008, 2011 and 2014**

**Table 1.3. Mean (±SE) brown trout length (cm) at age for Carrowmore Lake, June 2014**

| | $L_1$ | $L_2$ | $L_3$ | $L_4$ | $L_5$ | $L_6$ | Growth Category |
|---|---|---|---|---|---|---|---|
| Mean | 6.5 (0.2) | 13.9 (0.3) | 19.2 (0.4) | 23.5 (0.5) | 27.1 (0.9) | 30.2 (1.5) | Very slow |
| N | 74 | 57 | 43 | 30 | 13 | 7 | |
| Range | 3.1-10.8 | 9.4-19.5 | 14.1-24.7 | 18.8-27.8 | 22.9-33.0 | 26.6-36.4 | |

### 1.4 Summary

Three-spined stickleback was the dominant species in terms of abundance (CPUE) and brown trout was the dominant species in terms of biomass (BPUE) captured in the survey gill nets during the 2014 survey.

Although the mean brown trout CPUE increased slightly over the three sampling years, these differences were not statistically significant. However, the mean brown trout BPUE was significantly higher in 2014 than in 2008. Brown trout ranged in age from 1+ to 7+, indicating reproductive success in the previous seven years. The dominant age class was 1+. Length at age analyses revealed that brown trout in the lake exhibit a very slow rate of growth according to the classification scheme of Kennedy and Fitzmaurice (1971).

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 by 2015 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, Carrowmore Lake has been assigned an ecological status of Good for both 2008 and 2014 and High in 2011 based on the fish populations present.

In the 2010 to 2012 surveillance monitoring reporting period, the EPA assigned Carrowmore Lake an overall draft ecological status of Good, based on all monitored physico-chemical and biological elements, including fish.

### 1.5 References


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., Connor, L., Wightman, G., Matson, R. Morrissey, E., O'Callaghan, R., Feeney, R., Hanna, G. and Rocks, K. (2009) *Sampling fish for the Water Framework Directive – Summary Report 2008*. Central and Regional Fisheries Boards report.

Kelly, F., Harrison A., Connor, L., Matson, R., Morrissey, E., Wogerbauer, C., Feeney, R., O'Callaghan, R. and Rocks, K. (2012a) *Sampling Fish for the Water Framework Directive – Summary Report 2011*. Inland Fisheries Ireland.

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

Kennedy, M. and Fitzmaurice, P. (1971) Growth and food of brown trout *Salmo trutta* (L.) in Irish waters. *Proceedings of the Royal Irish Academy*, **71 (B) (18)**, 269-352.

NPWS (1997) *Site synopsis: Carrowmore Lake complex SAC. Site code: 000476*. Site Synopsis report, National Parks and Wildlife Service.

NWRFB (2005) *An examination of the causes and factors related to the eutrophication of Carrowmore Lake*. North Western Regional Fisheries Board report.

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