National Research Survey Programme

Lakes 2017

Carrowmore Lake

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Fish Stock Survey of Carrowmore Lake, June 2017

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

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

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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 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 (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, 2011 and 2014 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al*., 2009, 2012a, 2015a and 2015b). During the

2014 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.

This report summarises the results of the 2017 fish stock survey carried out on the lake, as part of the Water Framework Directive surveillance monitoring programme.

Plate 1.1. Carrowmore Lake

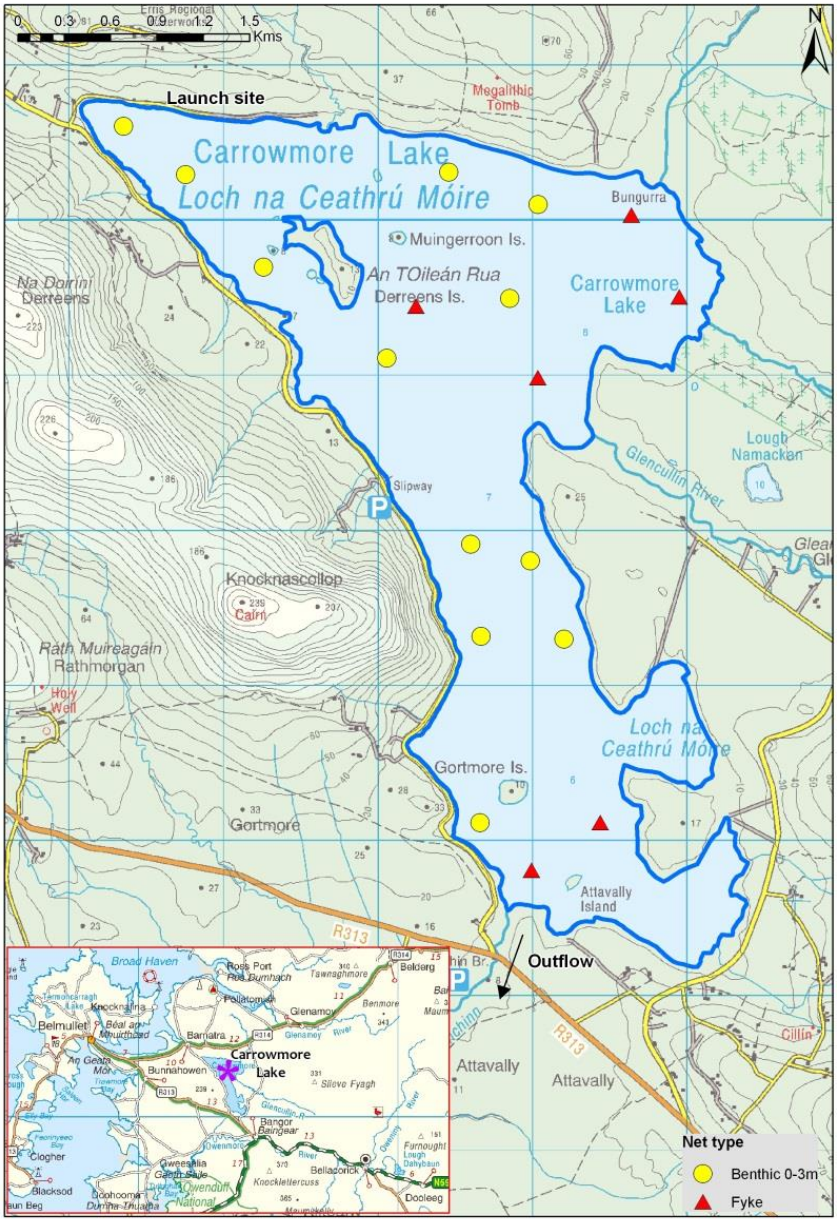

Fig. 1.1. Location map of Carrowmore Lake showing locations and depths of each net (outflow is indicated on map)

1.2 Methods

1.2.1 Netting methods

Carrowmore Lake was surveyed over two nights from the 12th to the 14th of June 2017. 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) (Fig. 1.1). 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 all brown trout and sea trout. 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

1.2.2 Fish diet

Total stomach contents were inspected and individual items were counted and 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).

$$\%FO_i = (N_i / N) \times 100$$

Where:

$\%FO_i$ is the percentage frequency of prey item i,
N_i is the number of a particular species with prey i in their stomach,
N is total number of a particular species with stomach contents.

1.2.3 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.

1.3 Results

1.3.1 Species Richness

A total of four fish species (sea trout are included as a separate 'variety' of trout) were recorded on Carrowmore Lake in June 2017, with 950 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 common fish species recorded, followed by brown trout. During the previous surveys in 2008, 2011 and 2014 a similar species composition was recorded. However, minnow, were not captured during the 2008 survey but were recorded during the later surveys and salmon were not recorded in the 2008 and 2017 surveys but were present in 2011 and 2014 (Kelly *et al*., 2009, 2012a, 2015a and 2015b) (Table 1.1).

Table 1.1. Number of each fish species captured by each gear type during the survey on Carrowmore Lake, June 2017

Scientific name	Common name	Number of fish captured		
		BM CEN	Fyke	Total
Gasterosteus aculeatus	3-spined stickleback	760	0	760
Salmo trutta	Brown trout	147	6	153
	Sea trout	5	0	5
Phoxinus phoxinus	Minnow	18	1	19
Anguilla anguilla	Eel	0	13	13

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, 2014 and 2017 surveys are summarised in Table 1.2 and illustrated in Figures 1.2 and 1.3.

Three-spined stickleback

Three-spined stickleback was the dominant species in terms of abundance (CPUE). The mean three-spined stickleback CPUE fluctuated slightly over the four sampling occasions; however, these differences were not statistically significant (Table 1.2; Fig 1.2 and 1.3). There was a significant difference in mean BPUE across the four sampling years, where BPUE was significantly higher in 2008 than 2011, 2014 and 2017 (Kruskal-Wallis $H=15.57$, $P<0.001$).

Brown trout

Brown trout was the dominant species in terms of biomass (BPUE). Although the mean brown trout CPUE fluctuated slightly over the four sampling occasions, these differences were not statistically significant (Table 1.2; Fig 1.2 and 1.3). There was a significant difference in mean BPUE across the four sampling years; BPUE was significantly lower in 2008 than 2011 and 2014 and significantly lower in 2017 compared to 2011 (Kruskal-Wallis H=9.948, P<0.05).

Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Carrowmore Lake, 2008 to 2017

Scientific name	Common name	2008	2011	2014	2017
			Mean CPUE (±S.E.)		
Gasterosteus aculeatus	Three-spined stickleback	0.981 (0.264)	0.418 (0.109)	0.925 (0.269)	1.407 (0.423)
Salmo trutta	Brown trout	0.184 (0.041)	0.350 (0.666)	0.387 (0.078)	0.278 (0.068)
Salmo trutta	Sea trout	0.035 (0.011)	0.007 (0.004)	0.002 (0.002)	0.009 (0.004)
Salmo salar	Salmon	-	0.005 (0.004)	0.003 (0.002)	-
Phoxinus phoxinus	Minnow	-	0.002 (0.002)	0.017 (0.007)	0.034 (0.014)
Anguilla anguilla	European eel	0.041 (0.039)	0.088 (0.04)	0.031 (0.009)	0.036 (0.012)
			Mean BPUE (±S.E.)		
Gasterosteus aculeatus	Three-spined stickleback	3.925 (1.069)	0.579 (0.157)	1.190 (0.373)	2.720 (0.843)
Salmo trutta	Brown trout	12.892 (2.941)	40.926 (8.348)	34.533 (7.271)	17.998 (5.457)
Salmo trutta	Sea trout	2.233 (0.716)	2.218 (1.664)	0.607 (0.607)	3.416 (1.432)
Salmo salar	Salmon	-	0.047 (0.032)	7.607 (7.567)	-
Phoxinus phoxinus	Minnow	-	0.013 (0.013)	0.051 (0.024)	0.116(0.046)
Anguilla anguilla	European eel	5.011 (3.493)	13.023 (7.862)	5.206 (1.711)	4.417 (1.203)

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 (Connor *et. al.,* 2017).

*Eel CPUE and BPUE based on fyke nets only

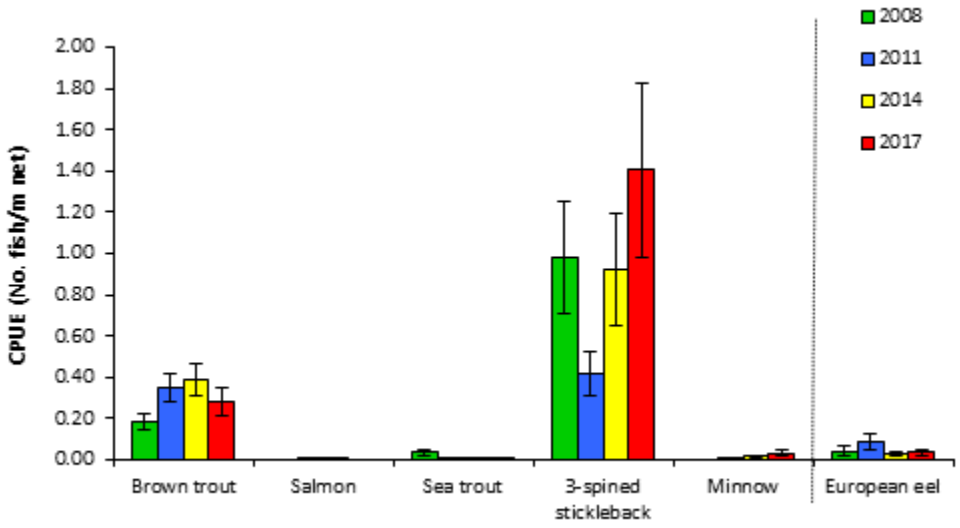

Fig. 1.2. Mean (±S.E.) CPUE for all fish species captured in Carrowmore Lake (Eel CPUE based on fyke nets only), 2011, 2014 and 2017

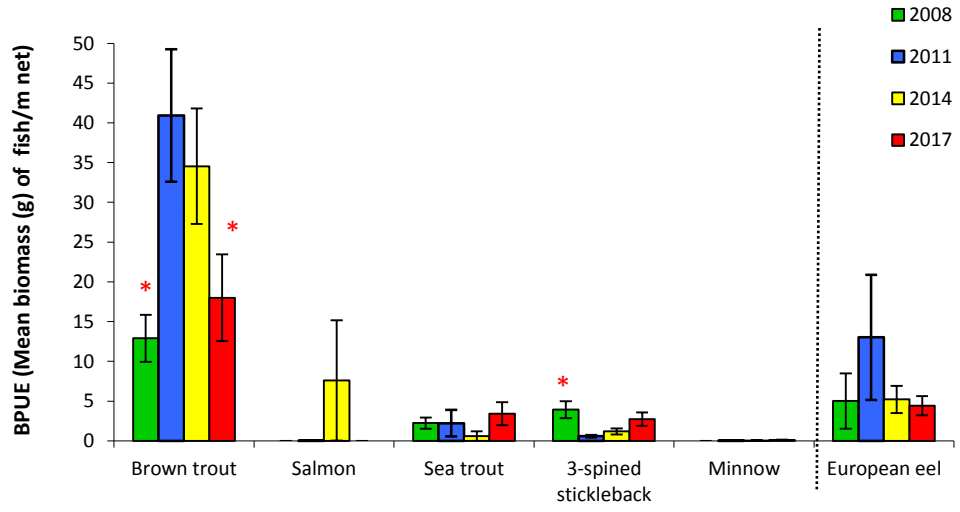

Fig. 1.3. Mean (±S.E.) BPUE for all fish species captured in Carrowmore Lake (Eel BPUE based on fyke nets only), 2011, 2014 and 2017. * indicates a significant difference

1.3.3 Length frequency distributions and growth

Brown trout

Brown trout captured during the 2017 survey ranged in length from 8.0cm to 33.4cm (mean = 16.4cm) (Fig. 1.4). Five age classes were present, ranging from 1+ to 5+, with a mean L1 of 6.8cm (Table 1.3). The dominant age class was 2+ (Fig. 1.4). Mean brown trout L4 in 2017 was 24.9cm indicating a very slow rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971) (Table 1.3). Brown trout captured during the 2008, 2011 and 2014 surveys had similar length and age ranges, with some smaller and larger fish recorded in the 2011 survey (Fig.1.4).

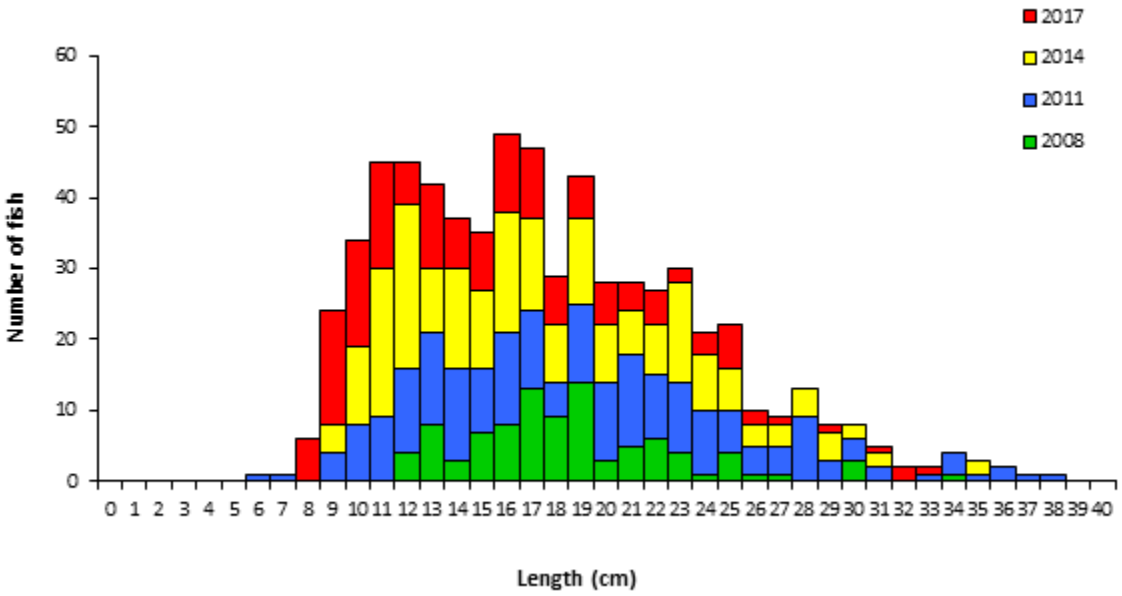

Fig. 1.4. Length frequency of brown trout captured on Carrowmore Lake, 2008, 2011, 2014 and 2017

Table 1.3. Mean (±S.E.) brown trout length (cm) at age for Carrowmore Lake, June 2017

	L_1	L_2	L_3	L_4	L_5	Growth Category
Mean (±S.E.)	6.8 (0.2)	13.6 (0.3)	20.2 (0.4)	24.9 (0.6)	28.3 (0.7)	Very slow
N	61	46	28	9	5	
Range	3.3-11.6	9.3-19.4	15.2-25.7	22.5-28.0	26.7-30.7	

Other fish species

Eels captured during the 2017 survey ranged in length from 30.3cm to 60.5cm. Three-spined stickleback captured measured 3.3cm to 8.1cm. Sea trout ranged in length from 27.8cm to 37.8cm and ages ranged from 2.1.1sm+ to 3.1+. Minnow ranged in length from 4.5cm to 10.0cm.

1.3.4 Stomach and diet analysis

Dietary analysis studies provide a good indication of the availability of food items and the angling methods that are likely to be successful. However, the value of stomach content analysis is limited unless undertaken over a long period as diet may change on a daily basis depending on the availability of food items. The stomach contents of a subsample of brown trout captured during the survey were examined and are presented below.

Brown trout

Adult trout usually feed principally on crustaceans (*Asellus* sp. and *Gammarus* sp.), insects (principally chironomid larvae and pupae) and molluscs (snails) (Kennedy and Fitzmaurice, 1971, O'Grady, 1981). A total of 49 stomachs were examined. Of these six were found to contain no prey items. Of the remaining 43 stomachs containing food, 91% contained invertebrates, 5% zooplankton, 2% unidentified digested material and 2% fish/invertebrates (Fig. 1.5).

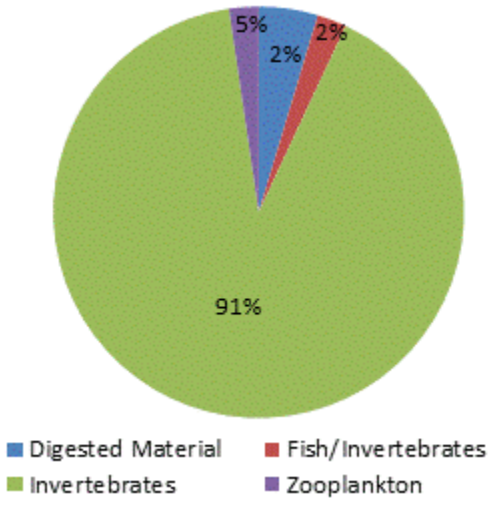

Fig 1.5. Diet of brown trout (n=43) captured on Carrowmore Lake, 2017 (% FO)

1.4 Summary and ecological status

A total of four fish species (sea trout are included as a separate 'variety' of trout) were recorded in Carrowmore Lake in June 2017. 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 2017 survey.

The mean brown trout CPUE fluctuated slightly over the four sampling occasions; however these differences were not statistically significant. There was a significant difference in mean BPUE across the four sampling years, where BPUE was significantly lower in 2008 than 2011 and 2014 and was significantly lower in 2017 compared to 2011. Brown trout ranged in age from 1+ to 5+, indicating reproductive success in the previous five out of six years. The dominant age class was 2+. 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 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 2017 based on the fish populations present. In previous years the lake was assigned a fish status of Good in 2008/2014 and High in 2011.

In the 2010 to 2015 surveillance monitoring reporting period, the EPA assigned Carrowmore Lake an overall ecological status of Moderate.

1.5 References

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