



**Sampling Fish for the
Water Framework
Directive**

Lakes 2011

Carrowmore Lake



Iascach Intíre Éireann
Inland Fisheries Ireland

Water Framework Directive Fish Stock Survey of Carrowmore Lake, June 2011

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Cover photo: Lynda and Fiona gill netting © 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 falls into 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, 1997).

Algal blooms occur from time to time on the lake and in recent years the 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, and this is by far regarded as the most significant environmental threat currently facing this lake. Wind induced turbulence is 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 loughs 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 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al.*, 2009). During this survey, three-spined stickleback and brown trout were found to be the dominant species present in the lake. Sea trout and eels were also captured during the survey.



Plate 1.1. Carrowmore Lake

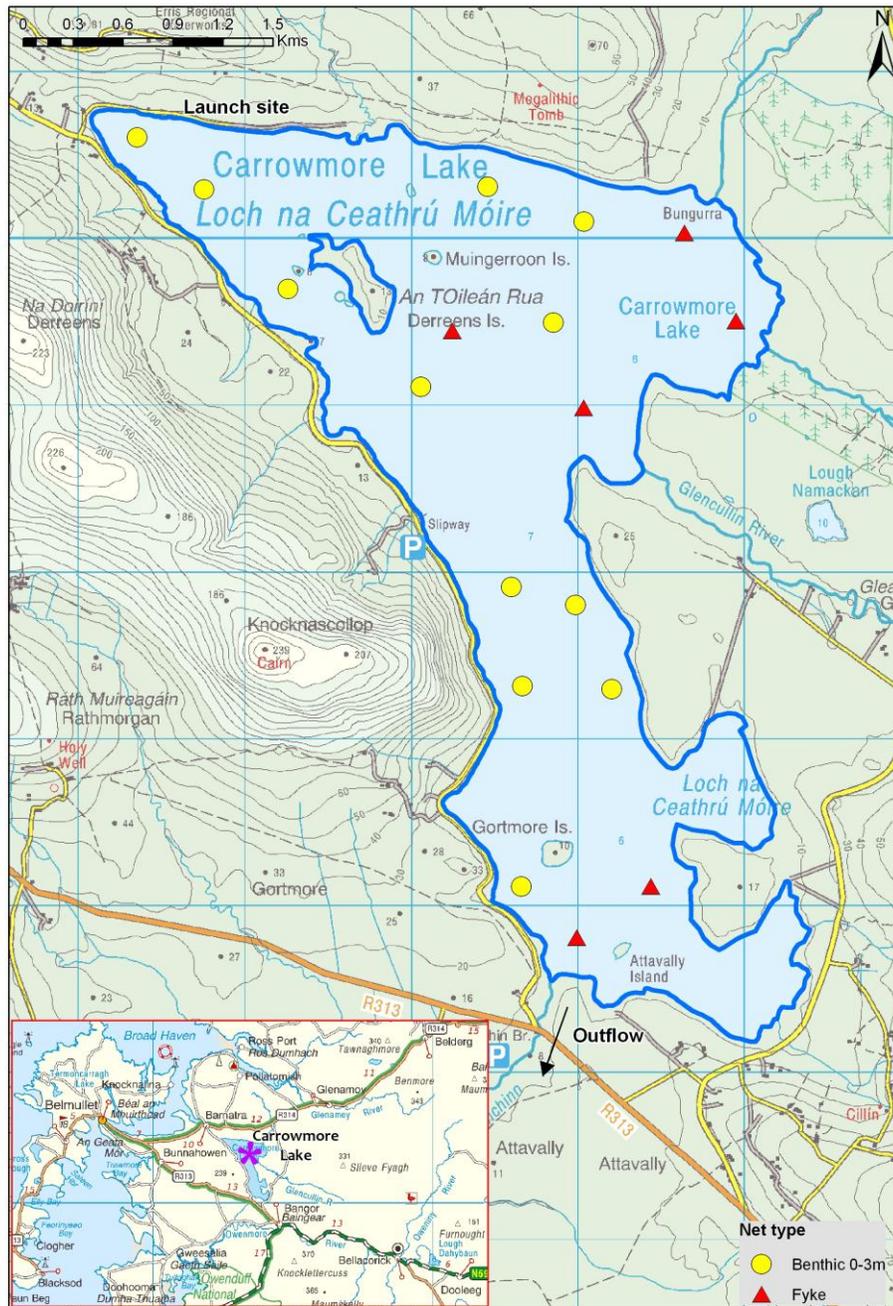


Fig. 1.1. Location map of Carrowmore Lake showing locations and depths of each net (outflow is indicated on map)

1.2 Methods

Carrowmore Lake was surveyed over two nights between the 7th and the 9th of June 2011. 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 survey in 2008. 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.

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 2011, with 501 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 survey in 2008 the same species composition was recorded with the exception of salmon and minnow, which were recorded during the 2011 survey but were not captured in 2008.

Table 1.1. Number of each fish species captured by each gear type during the survey on Carrowmore Lake, June 2011

Scientific name	Common name	Number of fish captured		
		Benthic mono multimesh gill nets	Fyke nets	Total
<i>Salmo trutta</i>	Brown trout	176	26	202
	Sea trout	4	0	4
<i>Gasterosteus aculeatus</i>	3-spined stickleback	194	64	258
<i>Salmo salar</i>	Salmon	2	2	4
<i>Phoxinus phoxinus</i>	Minnow	1	0	1
<i>Anguilla anguilla</i>	European eel	0	32	32

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 2008 and 2011 are summarised in Table 1.2. Mean CPUE and BPUE for all fish species is illustrated in Figures 1.2 and 1.3.

The mean brown trout CPUE was significantly higher in 2011 than in 2008 (t-test, $t_{28}=2.113$, $P<0.05$). The differences in the mean brown trout CPUE between Carrowmore Lake and four other similar lakes were assessed and found to be statistically significant (Kruskal-Wallis, $P<0.05$) (Fig. 1.4). Independent-Samples Mann-Whitney U tests between each lake showed that Carrowmore Lake had a significantly higher mean brown trout CPUE than Lough Leane, Lough Gill and Lough Owel ($z = -3.536$ $P<0.05$, $z = -6.751$ $P<0.05$ and $z = -6.901$ $P<0.05$).

The mean brown trout BPUE was also significantly higher in 2011 than in 2008 (t-test, $t_{21}=3.167$, $P<0.05$). The differences in the mean brown trout BPUE between Carrowmore Lake and four other similar lakes were also assessed and found to be statistically significant (Kruskal-Wallis, $P<0.05$) (Fig. 1.5). Independent-Samples Mann-Whitney U tests between each lake showed that Carrowmore Lake had a significantly higher mean brown trout BPUE than Lough Leane, Lough Gill and Lough Owel ($z = -3.109$ $P<0.05$, $z = -6.643$ $P<0.05$ and $z = -6.920$ $P<0.05$).

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

Scientific name	Common name	2008	2011
Mean CPUE			
<i>Salmo trutta</i>	Brown trout	0.184 (0.041)	0.350 (0.666)
<i>Salmo salar</i>	Salmon	-	0.005 (0.004)
	Sea trout	0.035 (0.011)	0.007 (0.004)
<i>Gasterosteus aculeatus</i>	3-spined stickleback	0.981 (0.264)	0.418 (0.109)
<i>Phoxinus phoxinus</i>	Minnow	-	0.002 (0.002)
<i>Anguilla anguilla</i>	European eel	0.041 (0.039)	0.088 (0.040)
Mean BPUE			
<i>Salmo trutta</i>	Brown trout	12.892 (2.941)	40.926 (8.348)
<i>Salmo salar</i>	Salmon	-	0.047 (0.032)
	Sea trout	2.233 (0.716)	2.218 (1.664)
<i>Gasterosteus aculeatus</i>	3-spined stickleback	3.925 (1.069)	0.579 (0.157)
<i>Phoxinus phoxinus</i>	Minnow	-	0.013 (0.013)
<i>Anguilla anguilla</i>	European eel	5.011 (3.493)	13.023 (7.862)

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

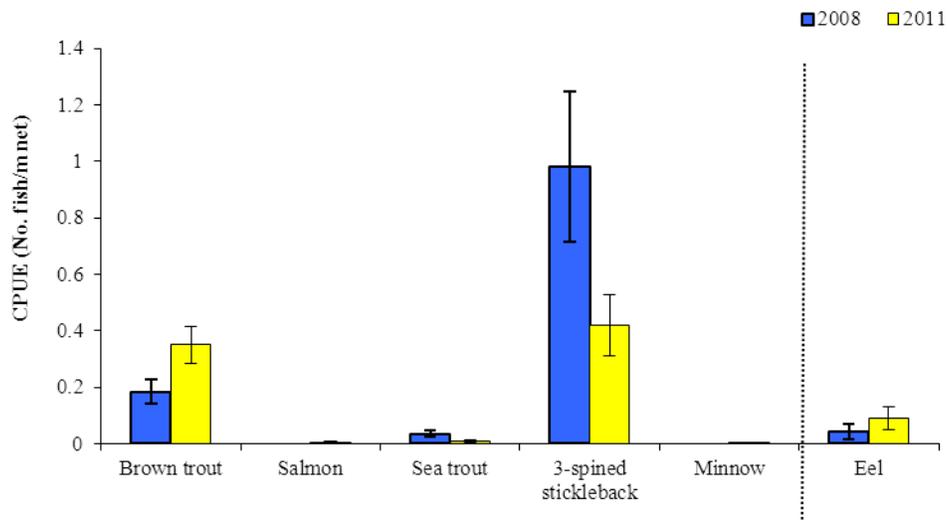


Fig. 1.2. Mean (\pm S.E.) CPUE for all fish species captured in Carrowmore Lake (Eel CPUE based on fyke nets only), 2008 and 2011

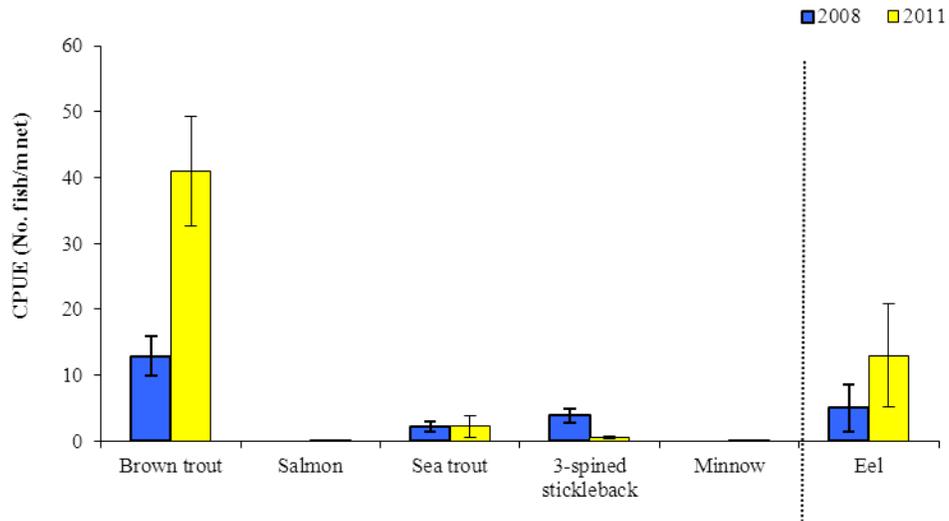


Fig. 1.3. Mean (\pm S.E.) BPUE for all fish species captured in Carrowmore Lake (Eel CPUE based on fyke nets only), 2008 and 2011

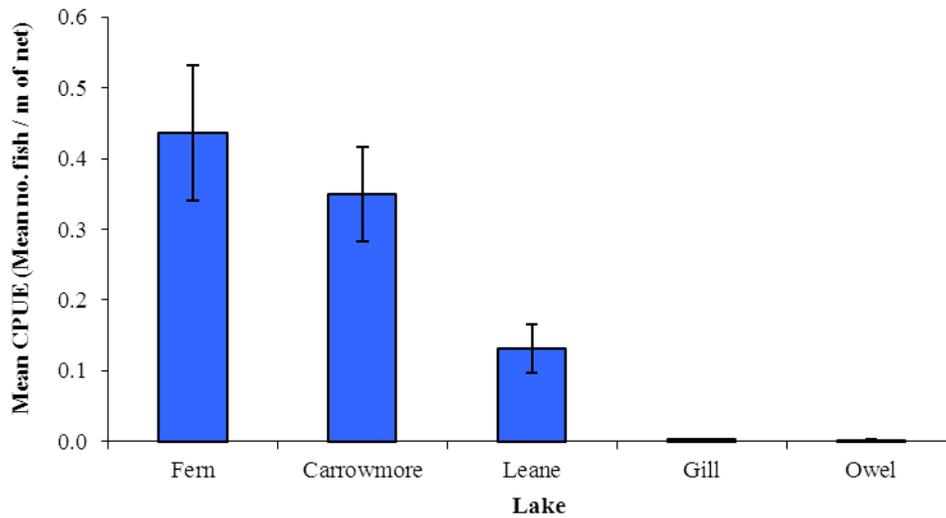


Fig. 1.4. Mean (\pm S.E.) brown trout CPUE in five lakes surveyed during 2011

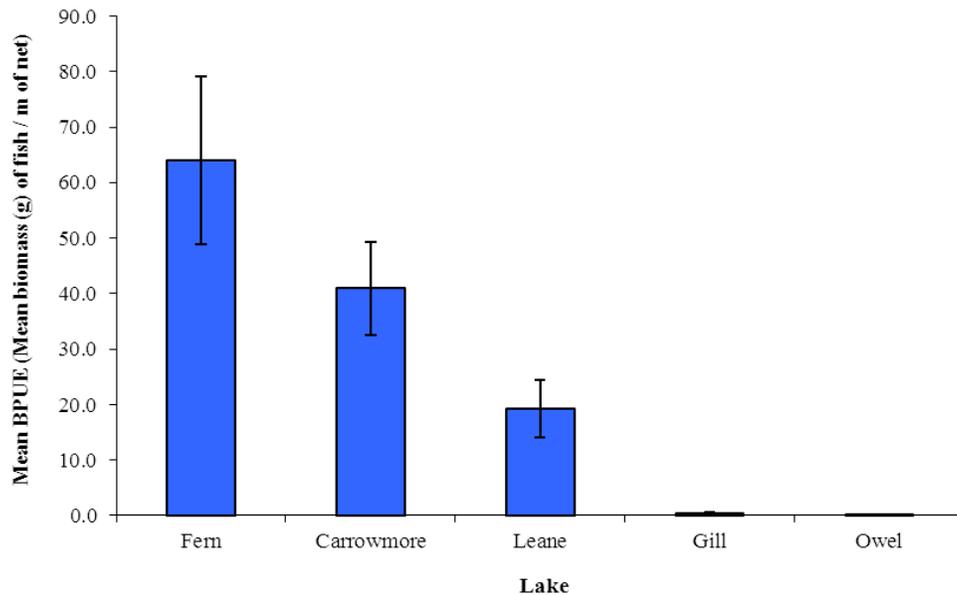


Fig. 1.5. Mean (\pm S.E.) brown trout BPUE in five lakes surveyed during 2011

1.3.3 Length frequency distributions

Brown trout captured during the 2011 survey ranged in length from 6.0cm to 38.0cm (mean = 19.4cm) (Fig. 1.6). Brown trout captured during the 2008 survey ranged in length from 12.3cm to 44.0cm (Fig. 1.6).

Three-spined stickleback captured during the 2011 survey ranged in length from 3.3cm to 6.4cm (mean = 4.7cm) (Fig.1.7). Three-spined stickleback captured during the 2008 survey had similar lengths ranging from 3.0cm to 6.0cm (Fig.1.7).

Salmon captured during the 2011 survey ranged in length from 8.8cm to 10.2cm and eels ranged in length from 25.2cm to 71.3cm. Sea trout ranged in length from 24.5cm to 32.2cm and one minnow was recorded at 8.2cm.

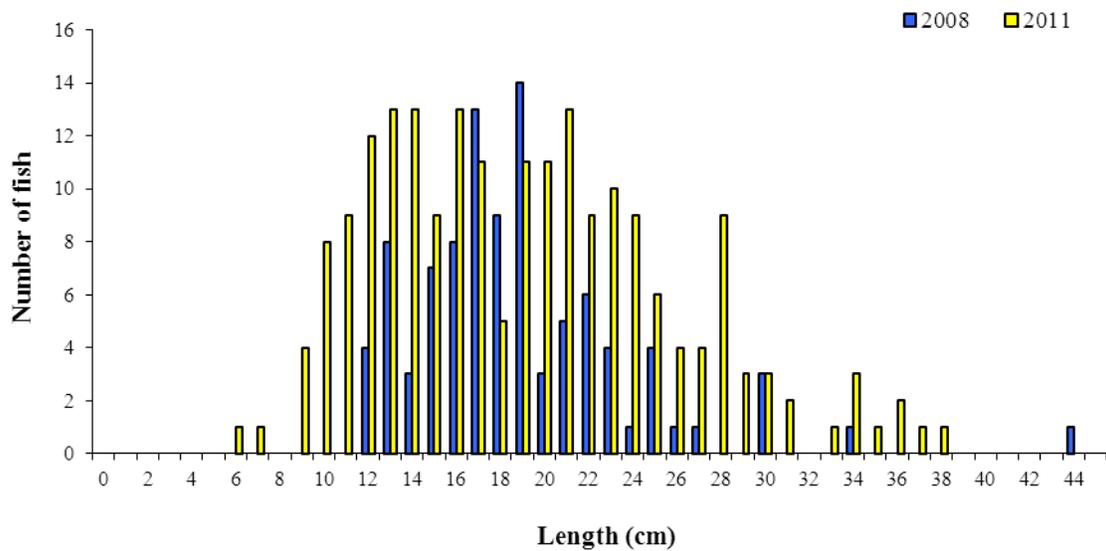


Fig. 1.6. Length frequency of brown trout captured on Carrowmore Lake, 2008 and 2011

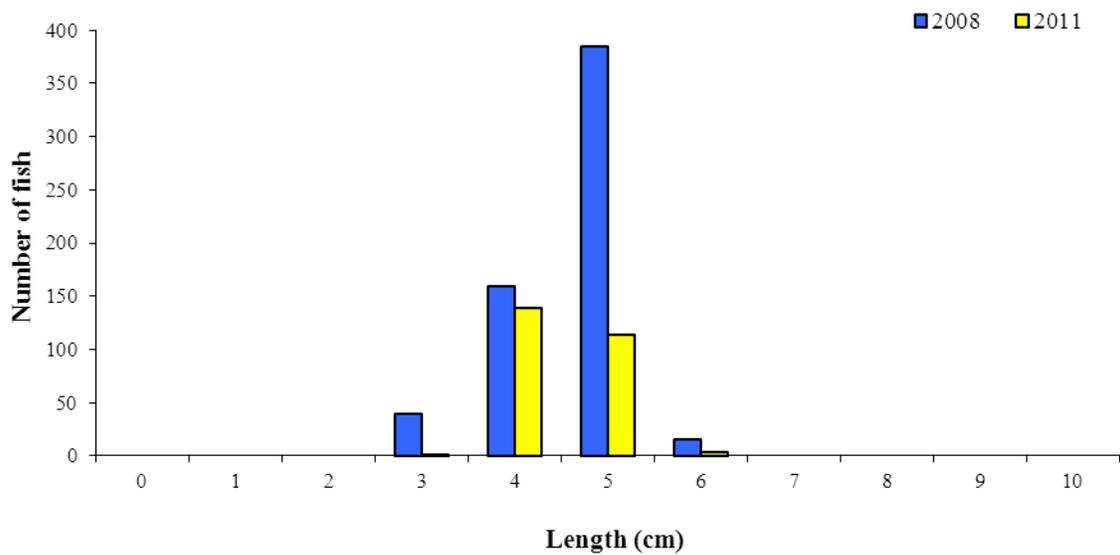


Fig. 1.7. Length frequency of three-spined stickleback captured on Carrowmore Lake, 2008 and 2011

1.3.4 Fish age and growth

Seven age classes of brown trout were present, ranging from 1+ to 7+, with a mean L1 of 5.8cm (Table 1.3). In the 2008 survey, brown trout ranged from 1+ to 6+ with a mean L1 of 6.3cm. Mean brown trout L4 in 2011 was 21.5cm indicating a very slow rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971). The dominant age class of brown trout was 4+, with ages ranging from 1+ to 7+ indicating reproductive success in each of the previous seven years.

Sea trout captured ranged in age from 1.2+ to 2.3+ and salmon captured were aged from 1+ to 2+.

Table 1.3. Mean (\pm SE) brown trout length (cm) at age for Carrowmore Lake, June 2011

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇
Mean	5.8 (0.1)	12.1 (0.2)	17.4 (0.3)	21.5 (0.4)	26.0 (0.7)	28.7 (1.2)	32.4 (0.2)
N	114	98	76	55	28	11	2
Range	2.8-9.8	6.5-21.3	12.3-29.5	15.9-33.8	20.3-33.5	23.5-36.3	32.3-32.6

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.

The mean brown trout CPUE and BPUE was significantly higher in 2011 than in 2008.

The mean brown trout CPUE and BPUE in Carrowmore Lake was significantly higher than two other moderate alkalinity lakes surveyed in 2011; Lough Leane, Co. Kerry, Lough Gill, Co. Sligo and Lough Owel, Co. Westmeath. Brown trout ranged in age from 1+ to 7+, indicating reproductive success in each of the previous seven years. 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.*, 2012). Using the FIL2 classification tool, Carrowmore Lake has been assigned an ecological status of High based on the fish populations present in 2011. The ecological status assigned to the lake based on the 2008 survey data was Good.

In the 2007 to 2009 surveillance monitoring reporting period, the EPA assigned Carrowmore Lake an overall ecological status of Good, based on all monitored physico-chemical and biological elements, including fish. This status classification will be revised at the end of 2012.

1.5 References

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