



Sampling Fish for the Water Framework Directive

Lakes 2012

Lough Arrow



Iascach Intíre Éireann
Inland Fisheries Ireland

Water Framework Directive Fish Stock Survey of Lough Arrow, July 2012

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CITATION: Kelly, F.L., Connor, L., Morrissey, E., Wogerbauer, C., Matson, R., Feeney, R. and Rocks, K. (2013)
Water Framework Directive Fish Stock Survey of Lough Arrow, July 2012. Inland Fisheries Ireland, Swords
Business Campus, Swords, Co. Dublin, Ireland.

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ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the help and co-operation of the regional director Dr. John Connelly and the staff from IFI, Galway. 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 2012.

We would also like to thank Dr. Martin O' Grady (IFI) and No. 3 Operational Wing, Irish Air Corps (Aer Chór na hÉireann) for the aerial photographs.

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1.1 Introduction

Lough Arrow is a large limestone lake situated in Co. Sligo, approximately 24km south-east of Sligo town and 6.4km north-west of Boyle, Co. Roscommon (Plate 1.1, Fig. 1.1). The lake is sheltered on three sides by hills and is the source of the Unshin River. It has a small catchment fed largely by springs on the lake bed and as such is hydrologically different from most lakes in Ireland (Roscommon County Council, 2009). Lough Arrow has a surface area of 1266ha, with a mean depth of 9m and a maximum depth of 33m. The lake is categorised as typology class 12 (as designated by the EPA for the purposes of the Water Framework Directive), i.e. deep (>4m), greater than 50ha and high alkalinity (>100mg/l CaCO₃).

Lough Arrow is of major conservation significance as it conforms to a type (hard water lake) listed in Annex I of the EU Habitats Directive. It also supports a number of important bird species and a population of otter (a Red Data Book species which is legally protected under the 1976 Wildlife Act and is listed on Annex II of the EU Habitats Directive) (NPWS, 1999). The shores of the lake are, for the most part, stony, although the common club-rush (*Scirpus lacustris*) and common reed (*Phragmites australis*) occur abundantly in several bays (NPWS, 1999). Two comprehensive surveys of submerged vegetation in the lake were undertaken in 1984 and 2001, during which the open water aquatic flora was found to be dominated by species of *Chara*, *Potamogeton* and *Elodea canadensis*, whilst the shallow (<0.5m) areas commonly contained *Littorella* sp., *Potamogeton filiformis* and *Myriophyllum alterniflorum* (King, 2002).

Lough Arrow is an important game fishery, managed by Inland Fisheries Ireland (WRBD), with good stocks of brown trout and eels. The lake was once stocked with brown trout but this practice has now been discontinued (O' Reilly, 2007). Wild brown trout average 0.45kg in weight, with fish up to 2.7kg having been taken on the fly. The lake has previously been surveyed by Inland Fisheries Ireland (previously the Central Fisheries Board and the North Western Regional Fisheries Board) in 1979, 1980 (O' Grady, 1986), 1994, 2002 (O' Grady and Delanty, 2003) and 2007 (O' Grady and Delanty, 2007). In 1994, only perch, pike and brown trout were recorded, although three-spined stickleback were also recorded in the stomachs of pike. Rudd were encountered for the first time in 2002 and were captured again in the 2007 survey. Lough Arrow has been included in the IFI's long term water quality monitoring programme of lake ecosystems since 1975. A fisheries enhancement programme to increase spawning and nursery area for trout was initiated in the Lough Arrow catchment over the period 1998 to 2000 involving re-creation of pools and a natural meander pattern, fencing of streams from livestock and placing of additional spawning gravels in streams where appropriate (O' Grady, 2004).

The lake was also previously surveyed in July 2009 as part of the Water Framework Directive surveillance monitoring programme (Kelly *et al.*, 2010). During this survey, perch were found to be the dominant species present in the lake. Brown trout, roach, three-spined stickleback, bream, rudd, pike and eels were also captured during the survey.



Plate 1.1. Lough Arrow, looking west over the lake (Photo courtesy of CFB and No. 3 Operational Wing, Irish Air Corps [Aer Chór na hÉireann])

1.2 Methods

Lough Arrow was surveyed over four nights from the 23rd to the 27th of July 2012. A total of three sets of Dutch fyke nets, 28 benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (5 @ 0-2.9m, 5 @ 3-5.9m, 6 @ 6-11.9m, 6 @ 12-19.9m and 6 @ 20-34.9m) and seven surface floating monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed randomly in the lake (38 sites). The netting effort was supplemented using seven benthic braided survey gill nets (62.5mm mesh knot to knot) at seven additional sites. Nets were deployed in the same locations as were randomly selected in the previous survey in 2009. 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 all brown trout, roach, pike, bream, hybrids and rudd. 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 eight fish species and one type of hybrid were recorded on Lough Arrow in July 2012, with 695 fish being captured. The number of each species captured by each gear type is shown in Table 1.1. Perch was the most abundant fish species recorded, followed by roach, three-spined stickleback, brown trout, rudd, roach x bream hybrids, bream, eels and pike. During the previous survey in 2009 the same species composition was recorded with the exception of roach x bream hybrids, which were present during the 2012 survey but were not captured in 2009 (Kelly *et al.*, 2010).

Table 1.1. Number of each fish species captured by each gear type during the survey on Lough Arrow, July 2012

Scientific name	Common name	Number of fish captured				Total
		Benthic mono multimesh gill nets	Benthic braided gill nets	Surface mono multimesh gill nets	Fyke nets	
<i>Salmo trutta</i>	Brown trout	8	4	7	0	19
<i>Perca fluviatilis</i>	Perch	461	0	0	1	462
<i>Rutilus rutilus</i>	Roach	101	0	0	0	101
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	74	0	0	6	80
<i>Esox Lucius</i>	Pike	1	3	0	0	4
<i>Scardinius erythrophthalmus</i>	Rudd	4	0	0	0	4
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	2	0	0	0	2
<i>Abramis brama</i>	Bream	1	0	0	0	1
<i>Anguilla Anguilla</i>	European eel	0	0	0	22	22

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 2009 and 2012 are summarised in Table 1.2. Mean CPUE and BPUE for all fish species is illustrated in Figures 1.2 and 1.3.

Although the mean brown trout CPUE and BPUE appeared slightly lower in 2012 than in 2009, these differences were not statistically significant (Fig. 1.2 and Fig. 1.3).

The differences in the mean brown trout CPUE and BPUE between Lough Arrow and six similar lakes were assessed, with an overall significant difference being found (Kruskal-Wallis, $P < 0.05$) (Fig. 1.4 and Fig 1.5). However, Independent-Samples Mann-Whitney U tests between each lake showed that the mean brown trout CPUE and BPUE for Lough Arrow was not significantly different from the other similar lakes surveyed (Fig. 1.4 and Fig 1.5).

Although the mean perch CPUE appeared lower in 2012 than in 2009, this difference was not statistically significant (Fig. 1.2).

The differences in the mean perch CPUE and BPUE between Lough Arrow and six similar lakes were also assessed, with overall significant differences being found (Kruskal-Wallis, $P < 0.05$) (Fig. 1.6 and Fig. 1.7). Independent-Samples Mann-Whitney U tests between each lake showed that Lough Arrow had a

significantly higher mean perch CPUE and BPUE than Lough Mask (Mann-Whitney, $z = 3.277$, $P < 0.05$ and $z = 3.021$, $P < 0.05$) (Fig. 1.6 and Fig. 1.7).

Although the mean perch BPUE appeared higher in 2012 than in 2009, this difference was also not statistically significant (Fig. 1.3).

Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Lough Arrow, 2009 and 2012

Scientific name	Common name	2009	2012
Mean CPUE			
<i>Salmo trutta</i>	Brown trout	0.015 (0.005)	0.014 (0.005)
<i>Perca fluviatilis</i>	Perch	0.547 (0.168)	0.342 (0.072)
<i>Rutilus rutilus</i>	Roach	0.001 (0.001)	0.075 (0.071)
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	0.028 (0.018)	0.057 (0.024)
<i>Esox Lucius</i>	Pike	0.001 (0.001)	0.003 (0.002)
<i>Scardinius erythrophthalmus</i>	Rudd	0.015 (0.013)	0.003 (0.003)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	-	0.001 (0.001)
<i>Abramis brama</i>	Bream	0.001 (0.001)	0.001 (0.001)
<i>Anguilla Anguilla</i>	European eel	0.028 (0.020)	0.122 (0.048)
<i>Salmo trutta</i>		Mean BPUE	
<i>Salmo trutta</i>	Brown trout	11.616 (4.259)	8.501 (4.267)
<i>Perca fluviatilis</i>	Perch	16.090 (5.032)	24.680 (6.037)
<i>Rutilus rutilus</i>	Roach	0.024 (0.024)	3.637 (3.279)
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	0.026 (0.018)	0.047 (0.021)
<i>Esox Lucius</i>	Pike	2.008 (2.008)	6.051 (3.272)
<i>Scardinius erythrophthalmus</i>	Rudd	4.018 (3.090)	1.651 (1.651)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	-	0.008 (0.006)
<i>Abramis brama</i>	Bream	0.286 (0.286)	0.380 (0.380)
<i>Anguilla Anguilla</i>	European eel	6.156 (3.813)	29.228 (11.082)

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

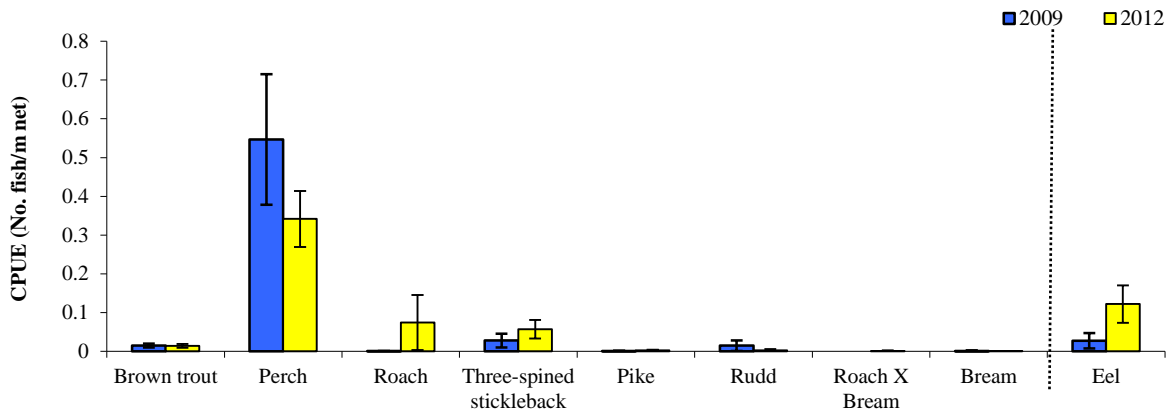


Fig. 1.2. Mean (\pm S.E.) CPUE for all fish species captured in Lough Arrow (Eel CPUE based on fyke nets only), 2009 and 2012

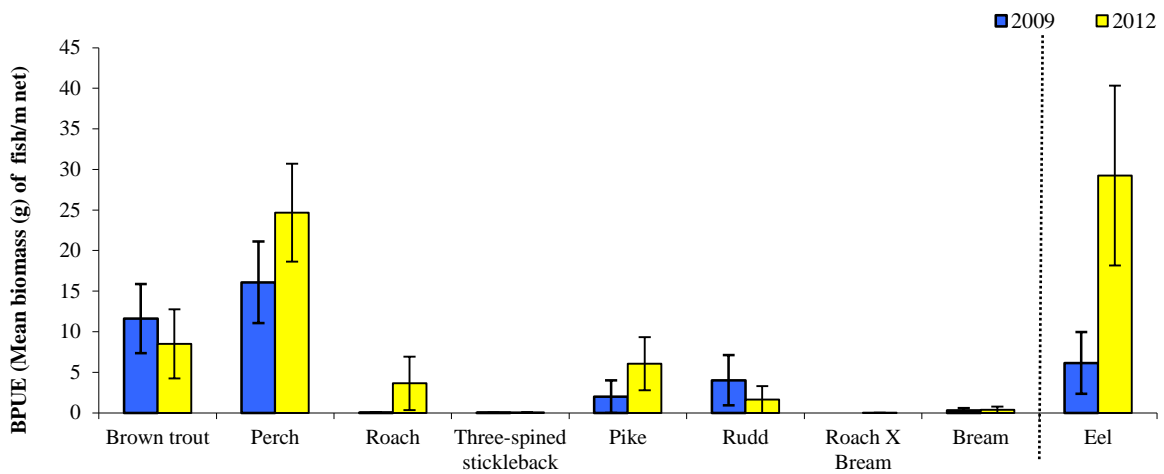


Fig. 1.3. Mean (\pm S.E.) BPUE for all fish species captured in Lough Arrow (Eel BPUE based on fyke nets only), 2009 and 2012

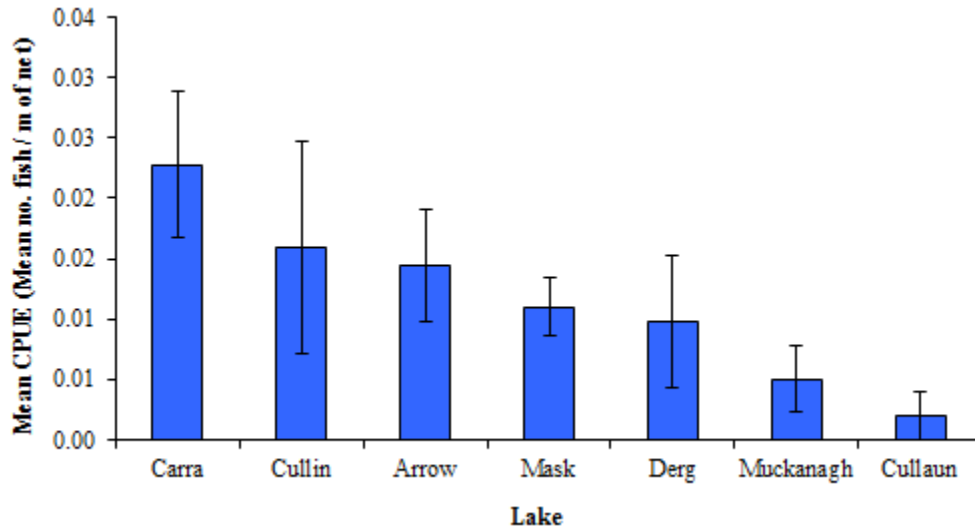


Fig. 1.4. Mean (\pm S.E.) brown trout CPUE in seven lakes surveyed during 2012

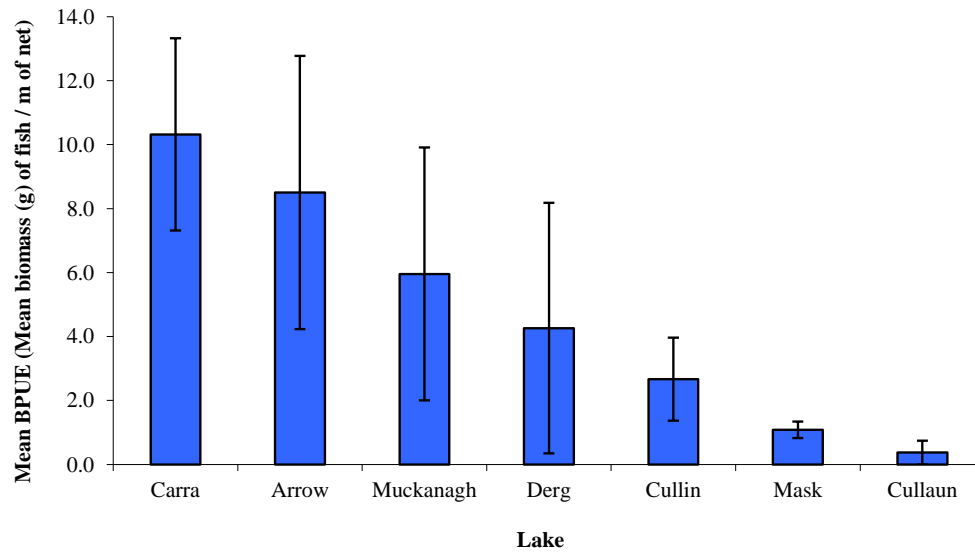


Fig. 1.5. Mean (\pm S.E.) brown trout BPUE in seven lakes surveyed during 2012

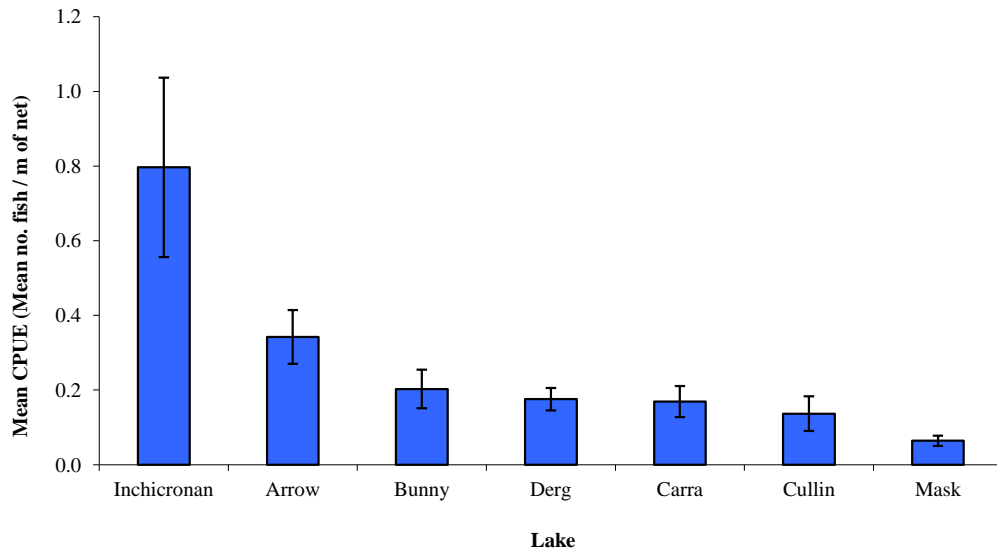


Fig. 1.6. Mean (\pm S.E.) perch CPUE in seven lakes surveyed during 2012

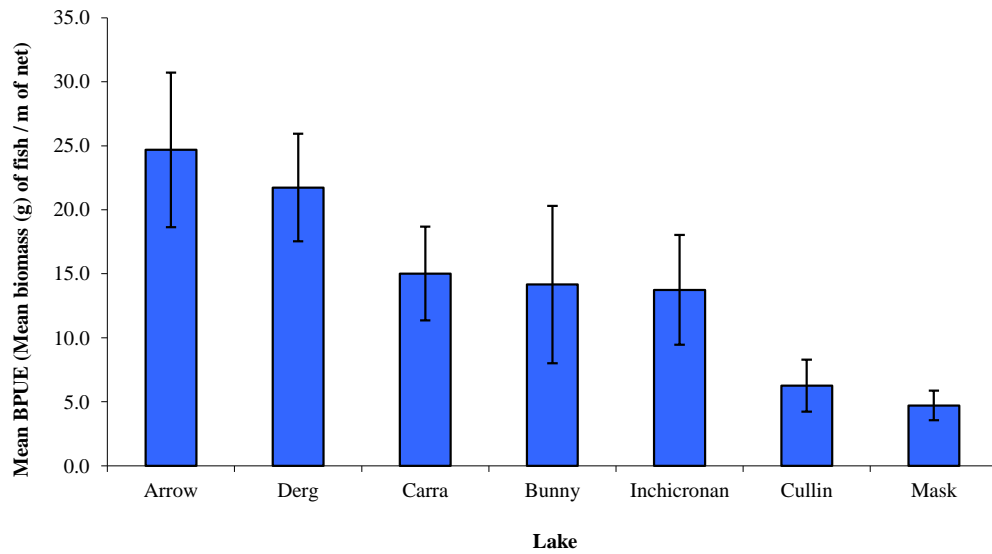


Fig. 1.7. Mean (\pm S.E.) perch BPUE in seven lakes surveyed during 2012

1.3.3 Length frequency distributions

Brown trout captured during the 2012 survey ranged in length from 7.2cm to 55.0cm (mean = 30.3cm) (Fig. 1.6). Brown trout captured during the 2009 survey ranged in length from 17.5cm to 59.0cm (Fig. 1.6).

Perch captured during the 2012 survey ranged in length from 3.5cm to 29.8cm (mean = 12.6cm) (Fig. 1.7). Perch captured during the 2009 survey ranged in length from 3.5cm to 30.9cm (Fig. 1.7).

Roach captured during the 2012 survey ranged in length from 6.0cm to 30.0cm, eels had lengths ranging from 34.5cm to 65.8cm, pike ranged in length from 36.5cm to 70.1cm, rudd ranged in length from 26.7cm to 31.9cm and three-spined stickleback ranged in length from 3.4cm to 5.0cm. Two roach x bream hybrids were recorded at 7.5cm and one bream was recorded at 29.8cm.

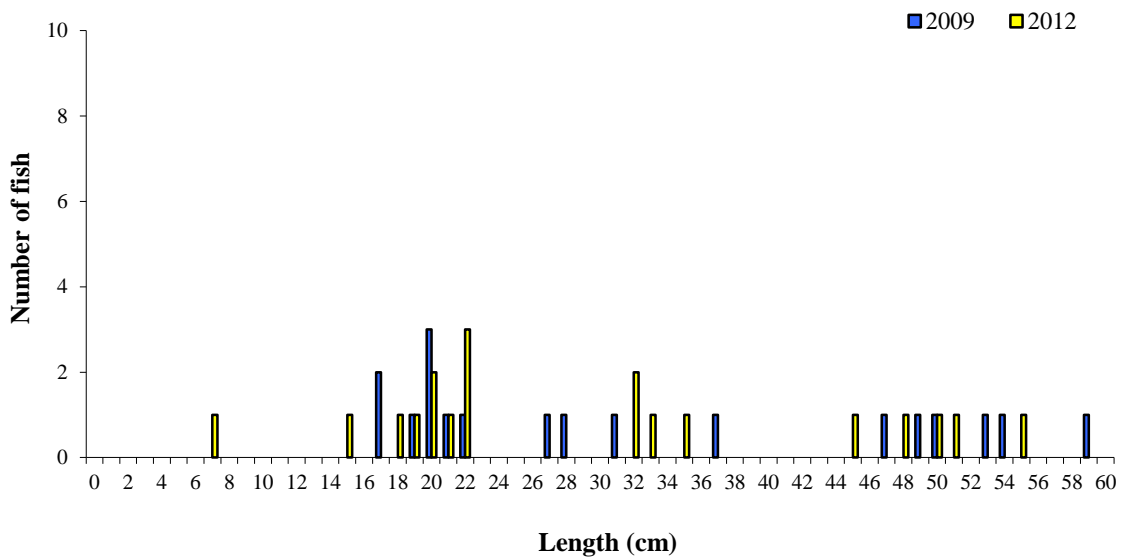


Fig. 1.6. Length frequency of brown trout captured on Lough Arrow, 2009 and 2012

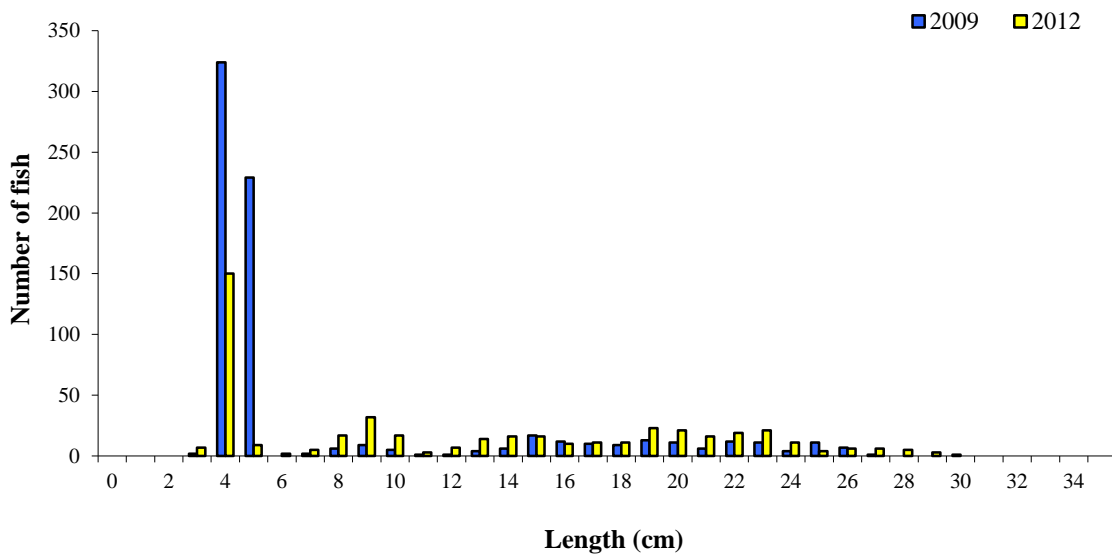


Fig. 1.7. Length frequency of perch captured on Lough Arrow, 2009 and 2012

1.3.4 Fish age and growth

Seven age classes of brown trout were present, ranging from 0+ to 6+, with a mean L1 of 7.8cm (Table 1.3). In the 2009 survey, brown trout ranged from 0+ to 5+ with a mean L1 of 8.0cm. Mean brown trout L4 in 2012 was 38.4cm indicating a very fast rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971).

Ten age classes of perch were present, ranging from 0+ to 9+, with a mean L1 of 5.9cm (Table 1.4). The dominant age class was 0+ (Fig 1.7). In the 2009 survey, perch also ranged from 0+ to 9+ with a mean L1 of 5.9cm.

The roach captured ranged in age from 1+ to 8+.

Table 1.3. Mean (\pm SE) brown trout length (cm) at age for Lough Arrow, July 2012

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆
Mean	7.8 (0.4)	19.0 (1.4)	30.7 (1.9)	38.4 (2.8)	45.5 (0.4)	50.6 (0)
N	17	13	8	8	4	1
Range	5.7-10.7	11.6-27.9	20.5-39.2	24.6-51.8	44.7-46.4	50.6-50.6

Table 1.4. Mean (\pm SE) perch length (cm) at age for Lough Arrow, July 2012

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈	L ₉
Mean	5.9 (0.1)	10.9 (0.1)	16.8 (0.3)	21.1 (0.3)	24.2 (0.4)	24.7 (0.7)	25.4 (0.4)	26.5 (0.7)	27.0 (1.1)
N	149	120	82	43	27	7	5	4	2
Range	3.9-7.8	7.7-14.9	10.5-21.3	16.2-25.3	19.8-28.5	22.0-27.4	24.3-26.3	25.1-28.4	25.9-28.1

1.4 Summary

Perch was the dominant species in terms of abundance (CPUE) and biomass (BPUE) captured in the survey gill nets.

Although the mean brown trout CPUE and BPUE in Lough Arrow appeared slightly different in 2012 than in the 2009 survey, these differences were not statistically significant. The mean brown trout CPUE and BPUE in Lough Arrow was similar to the other lakes assessed during 2012, with no statistically significant differences being found between lakes. Brown trout ranged in age from 0+ to 6+, indicating reproductive success in the previous seven years. Length at age analyses revealed that brown trout in the lake exhibit a very fast rate of growth according to the classification scheme of Kennedy and Fitzmaurice (1971).

Although the mean perch CPUE and BPUE in Lough Arrow appeared slightly different in 2012 than in the 2009 survey, these differences were not statistically significant. The mean perch CPUE and BPUE in Lough Arrow was significantly higher than Lough Mask, another similar lake surveyed. Perch ranged in age from 0+ to 9+, indicating reproductive success in the previous ten years.

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, Lough Arrow has been assigned an ecological status of Good based on the fish populations present in 2012. The ecological status assigned to the lake based on the 2009 survey data was High.

In the 2007 to 2009 surveillance monitoring reporting period, the EPA assigned Lough Arrow 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.

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A dark blue abstract shape, resembling a stylized wave or a folded piece of paper, occupies the lower-left portion of the page. It features several white dashed lines that curve across its surface and extend into the white background to the right.

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