

National Research Survey Programme

Lakes 2018

Lough Arrow

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Iascach Intíre Éireann
Inland Fisheries Ireland



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National Research Survey Programme

**Fish Stock Survey of Lough Arrow,
August 2018**

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

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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* sp., *Potamogeton* sp. 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. A fisheries enhancement programme to increase spawning and nursery area for brown 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 previously surveyed in 1979, 1980, 1981 (O' Grady, 1986), 1994, 2002 (O' Grady and Delanty, 2003), 2006 and 2007 (O' Grady and Delanty, 2007) as part of a fish stock assessment by IFI's research section using seven-panel benthic braided survey gill nets. Up to 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.

The lake was also previously surveyed by IFI for the WFD fish monitoring programme in 2009, 2012 and 2015 (Kelly *et al.*, 2010, 2013 and 2016). During the 2015 survey, perch were found to be the dominant species present in the lake. Brown trout, roach, three-spined stickleback, roach x bream hybrids, bream, rudd, pike and eels were also captured during the survey.

This report summarises the results of the 2018 fish stock survey carried out on the lake.



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

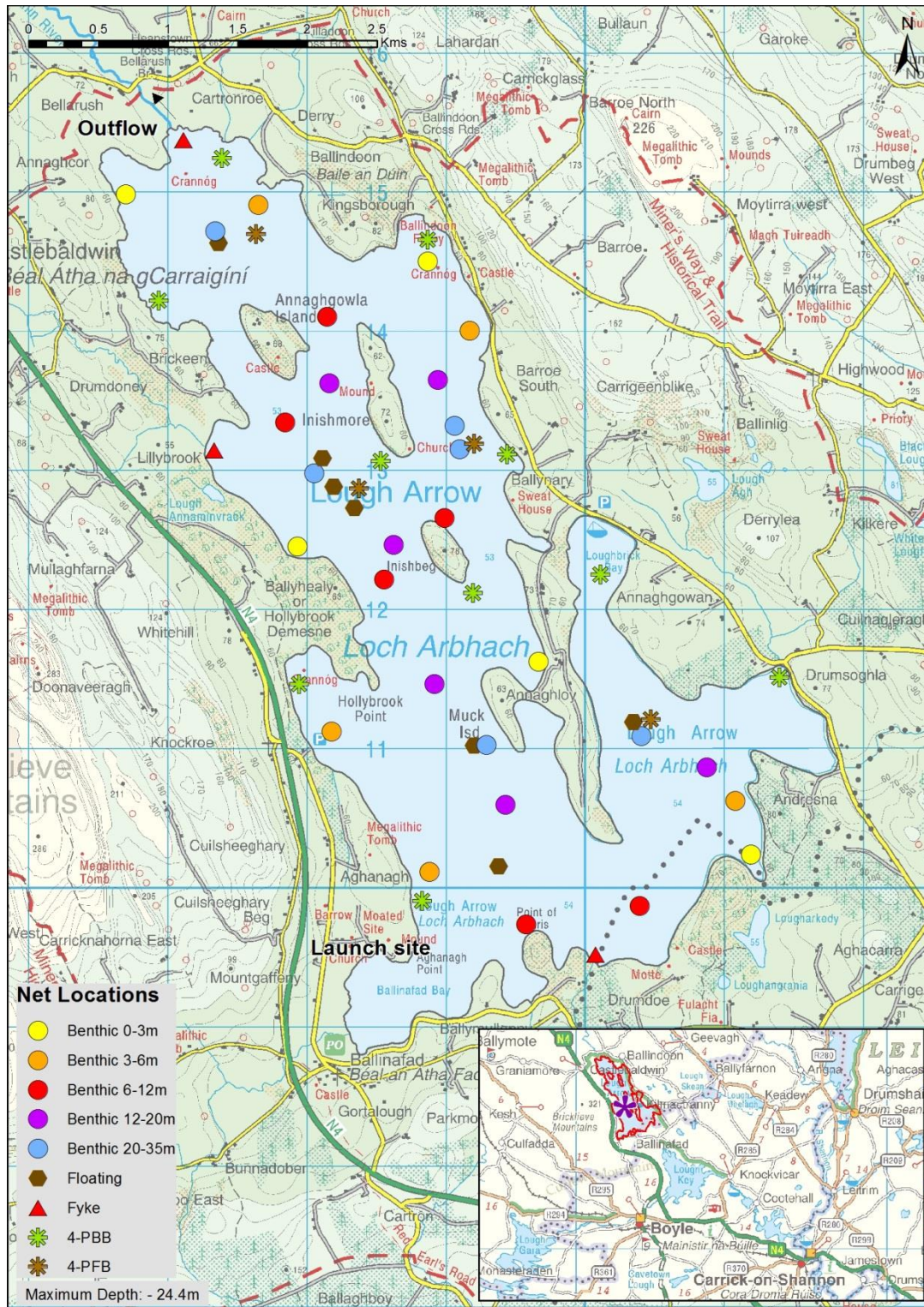


Fig. 1.1. Location map of Lough Arrow showing locations and depths of each net (outflow is indicated on map)



1.2 Methods

1.2.1 Netting methods

Lough Arrow was surveyed over four nights from the 13th to the 17th of August 2018. A total of three sets of Dutch fyke nets (Fyke), 28 benthic monofilament multi-mesh (BM CEN) (12 panel, 5-55mm mesh size) CEN standard survey gill nets (5 @ 0-2.9m, 5 @ 3.0-5.9m, 6 @ 6.0-11.9m, 6 @ 12.0-19.9m and 6 @ 20.0-34.9m) and seven floating monofilament multi-mesh (FM CEN) (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed in the lake (38 sites). The netting effort was supplemented using eleven four-panel benthic braided survey gill nets (4-PBB) and three four-panel floating braided survey gill nets (4-PFB) at 14 additional sites. The 4-panel nets are composed of four 27.5m long panels each a different mesh size (55mm, 60mm, 70mm and 90mm knot to knot) tied together randomly. 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 apart from perch were measured and weighed on site and scales were removed from all brown trout, pike, roach, hybrids and rudd. Live fish were returned to the water whenever practical or 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 six fish species and two types of hybrid were recorded on Lough Arrow in August 2018, with 1763 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. Brown trout, roach x rudd hybrids, roach x bream hybrids, rudd, pike and eels were also recorded. During the previous surveys in 2009, 2012 and 2015 the same species composition was recorded, with the exception of roach x bream hybrids, which were present during the 2012, 2015 and 2018 surveys but were not captured in 2009. No bream or three-spined stickleback were recorded in the 2018 survey (Kelly *et al.*, 2010, 2013 and 2016). The IFI surveys conducted from 1979 to 2007 captured the same species composition, with the exception of roach (O' Grady, 1986) and bream (O' Grady and Delanty, 2003 and 2007).

Table 1.1. Number of each fish species captured by each gear type during the survey on Lough Arrow, August 2018

Scientific name	Common name	Number of fish captured				
		BM CEN	FM CEN	4-Panel	Fyke	Total
<i>Perca fluviatilis</i>	Perch	1428	1	0	1	1430
<i>Rutilus rutilus</i>	Roach	265	1	2	0	268
<i>Salmo trutta</i>	Brown trout	19	5	4	0	28
<i>Scardinius erythrophthalmus</i>	Roach x rudd hybrid	20	0	4	0	24
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	8	0	0	0	8
<i>Scardinius erythrophthalmus</i>	Rudd	2	0	0	0	2
<i>Esox lucius</i>	Pike	1	0	0	0	1
<i>Anguilla anguilla</i>	European eel	0	0	0	2	2



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 2018 survey are summarised in Table 1.2.

Perch was the dominant fish species in terms of abundance (CPUE) and biomass (BPUE) captured during the 2018 survey (Table 1.2).

The mean CPUE and BPUE (excluding the 55mm, 70mm and 90mm mesh panels of each 4-PBB survey net) for all species captured in the 2009, 2012, 2015 and 2018 surveys are illustrated in Figures 1.2 and 1.3. Mean perch, roach and brown trout CPUE and BPUE fluctuated slightly over the four sampling occasions. These differences were most apparent in 2018 where perch and roach had the highest CPUE and BPUE of all the sampling years (Table 1.2; Fig 1.2 and 1.3).

Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Lough Arrow, 2018

Scientific name	Common name	Mean CPUE (\pm S.E) **
<i>Perca fluviatilis</i>	Perch	0.914 (0.280)
<i>Rutilus rutilus</i>	Roach	0.174 (0.049)
<i>Salmo trutta</i>	Brown trout	0.016 (0.004)
<i>Scardinius erythrophthalmus</i>	Roach x rudd hybrid	0.014 (0.004)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	0.005 (0.003)
<i>Scardinius erythrophthalmus</i>	Rudd	0.001 (0.001)
<i>Esox lucius</i>	Pike	0.001 (0.001)
<i>Anguilla anguilla</i> *	European eel*	0.011 (0.011)*
		Mean BPUE (\pm S.E) **
<i>Perca fluviatilis</i>	Perch	36.495 (9.525)
<i>Rutilus rutilus</i>	Roach	13.639 (3.561)
<i>Salmo trutta</i>	Brown trout	7.317 (2.218)
<i>Scardinius erythrophthalmus</i>	Roach x rudd hybrid	5.516 (1.779)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	1.179 (0.588)
<i>Scardinius erythrophthalmus</i>	Rudd	0.415 (0.415)
<i>Esox lucius</i>	Pike	0.017 (0.017)
<i>Anguilla anguilla</i> *	European eel*	3.400 (3.400)*

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

**CPUE and BPUE data above for all fish species except eels are not comparable to earlier surveys as extra panels were added to the 1-PBB to provide additional information on large fish.

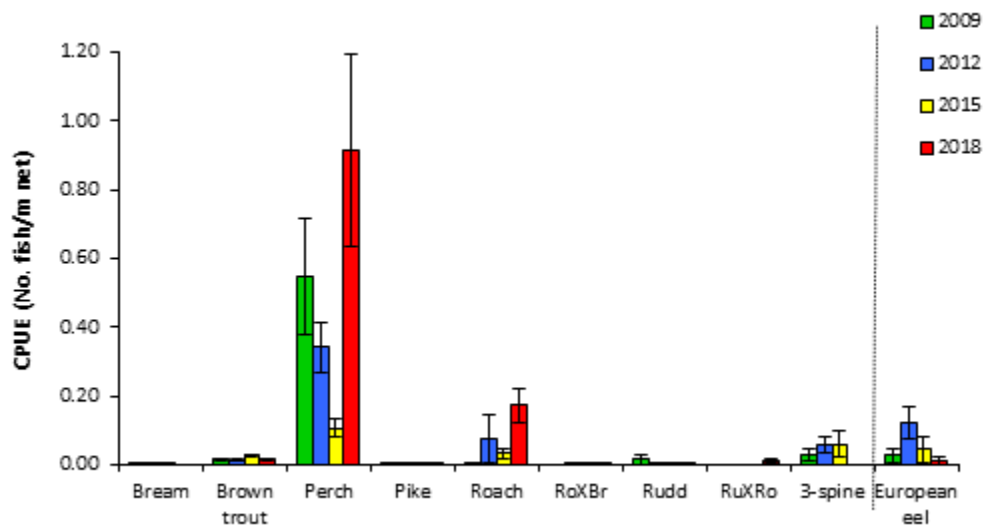


Fig. 1.2. Mean (\pm S.E.) CPUE for all fish species captured in Lough Arrow (Eel CPUE based on fyke nets only), 2009, 2012, 2015 and 2018

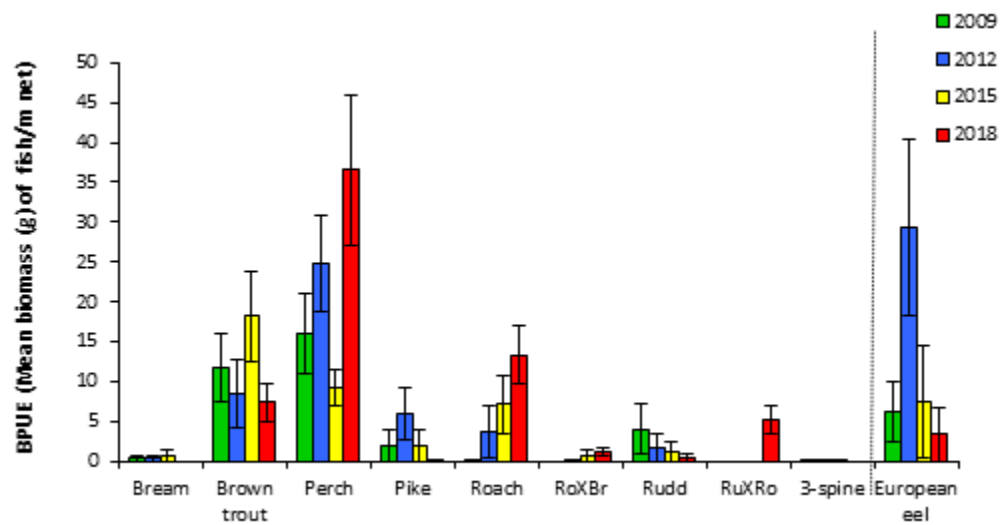


Fig. 1.3. Mean (\pm S.E.) BPUE for all fish species captured in Lough Arrow (Eel BPUE based on fyke nets only), 2009, 2012, 2015 and 2018

1.3.3 Length frequency distributions and growth

Perch

Perch captured during the 2018 survey ranged in length from 3.5cm to 35.6cm (mean = 9.8cm) (Fig.1.4) with nine age classes present, ranging from 0+ to 8+ with a mean L1 of 6.3cm (Table 1.3). The dominant age class was 1+ (Fig. 1.4). Perch captured during the 2009, 2012 and 2015 surveys had a similar length and age range with some smaller fish recorded in 2009 and 2012 (Fig.1.4).

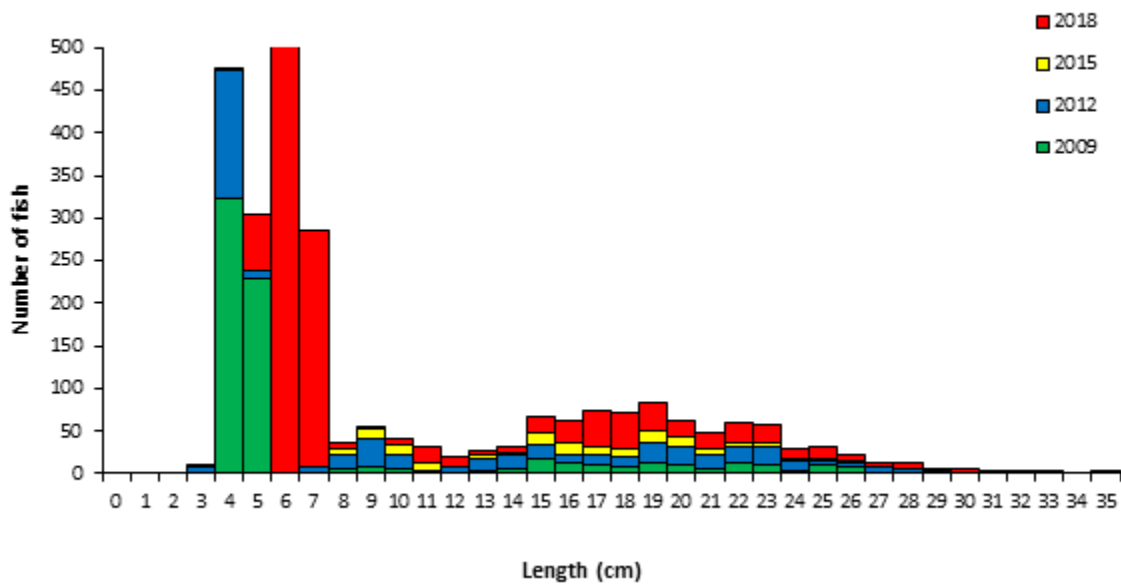


Fig. 1.4. Length frequency of perch captured on Lough Arrow, 2009, 2012, 2015 and 2018

Table 1.3. Mean (\pm S.E.) perch length (cm) at age for Lough Arrow, August 2018

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈
Mean (\pm S.E.)	6.3 (0.1)	11.8 (0.2)	17.4 (0.2)	21.2 (0.3)	23.8 (0.4)	25.4 (0.6)	29.1 (1.3)	33.2
N	104	76	54	49	32	21	5	1
Range	4.1-11.5	9.1-15.1	12.9-21.3	16.0-25.5	18.2-27.1	19.2-29.2	24.1-31.2	33.2-33.2



Roach

Roach captured during the 2018 survey ranged in length from 4.0cm to 33.2cm (mean = 13.2cm) (Fig.1.5) with twelve age classes present, ranging from 0+ to 11+ (Table 1.4). Roach captured during the 2009, 2012 and 2015 surveys had a similar length and age range with 2018 exhibiting the largest range (Fig.1.5).

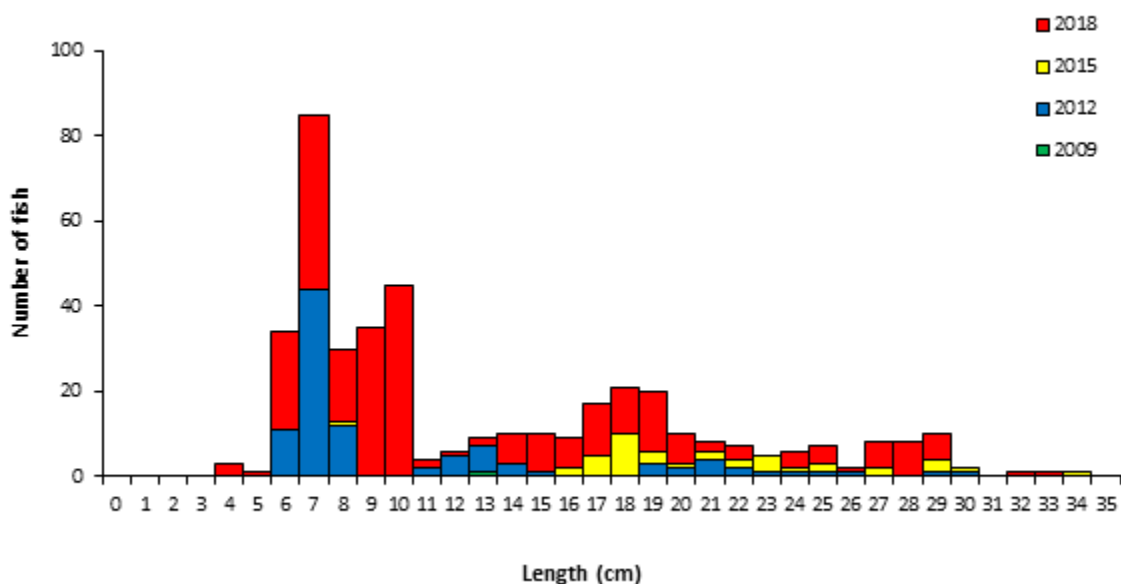


Fig. 1.5. Length frequency of roach captured on Lough Arrow, 2009, 2012, 2015 and 2018

Table 1.4. Summary age data for a sub-sample of roach captured on Lough Arrow, August 2018.
Number of fish and length ranges of all fish aged in the sample is presented (N=105)

	Age class											
	0+	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+
Mean (cm)	5.0	7.3	9.5	15.7	17.8	19.8	22.7	24.9	26.8	28.5	29.9	33.2
N	3	6	24	17	14	8	5	4	7	12	4	1
Range (cm)	4.9-5.3	6.2-10.3	7.3-16.0	12.5-19.2	14.2-20.2	18.5-21.1	21.0-24.4	24.1-25.5	25.0-28.8	27.0-29	29.0-32.3	33.2-33.2

Brown trout

Brown trout captured during the 2018 survey ranged in length from 15.5cm to 54.5cm (mean = 31.5cm) (Fig.1.5) with six age classes present, ranging from 1+ to 6+ (Table 1.5). Brown trout captured during the 2009, 2012 and 2015 surveys had a similar length and age range (Fig.1.5).

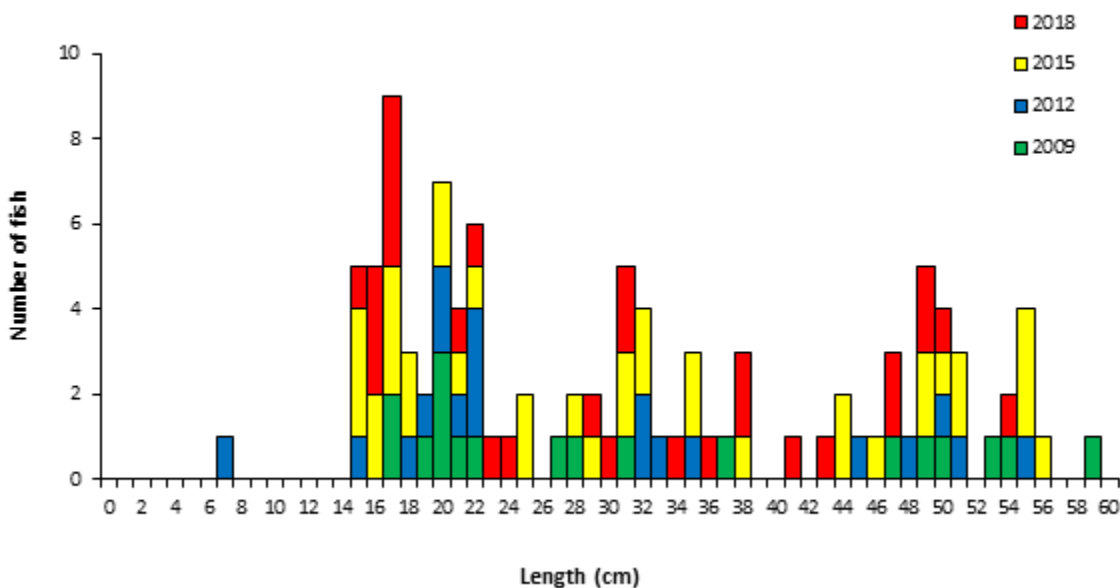


Fig. 1.6. Length frequency of brown trout captured on Lough Arrow, 2009, 2012, 2015 and 2018

Table 1.5. Summary age data from a sub-sample of brown trout captured on Lough Arrow, August 2018. Number of fish and length ranges of all fish aged in the sample is presented

	Age class					
	1+	2+	3+	4+	5+	6+
Mean (cm)	16.6	20.8	26.9	36.2	42.3	49.5
N	5	5	5	2	8	3
Range (cm)	15.5-17.4	17.5-24.9	16.5-34.5	31.4-41.0	31.8-54.5	49.0-50.1

Other fish species

Two eels were captured during the 2018 survey and were measured at 48.0cm and 63.0cm. One pike at 26.5cm was recorded, aged 1+ and two rudd ranged in length from 25.0cm to 26.0cm (5+ and 6+ respectively). Roach x bream hybrids ranged in length from 16.5cm to 30.1cm (five age classes ranging



from 3+ to 11+) and roach x rudd hybrids ranged in length from 20.1cm to 32.6cm, with seven age classes present ranging from 6+ to 12+.

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 perch captured during the survey were examined and are presented below.

Perch

Perch initially start to feed on pelagic zooplankton. Once they reach an intermediate size they start feeding on benthic resources eventually moving on to feed on fish once they are large enough (Hjelm *et al.*, 2000). A total of 116 stomachs were examined. Sixty two were empty and of the remaining 54 stomachs containing food, 55% contained unidentified digested material, 24% fish, 17% zooplankton and 4% invertebrates (Fig. 1.7).

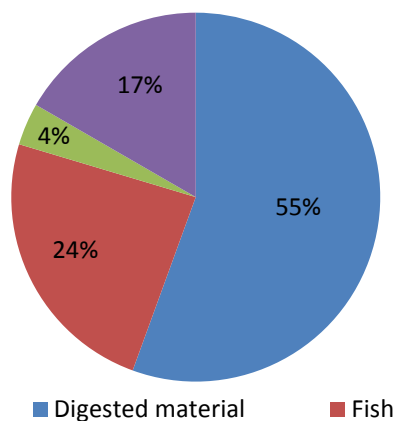


Fig 1.7. Diet of perch (n=54) captured on Lough Arrow, 2018 (% frequency occurrence)

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). Lough Arrow had total of 16 stomachs were examined. Of these nine were found to contain no prey items. Of the remaining seven stomachs containing food, 43% contained fish, 43% unidentified digested material and 14% zooplankton (Fig. 1.8).

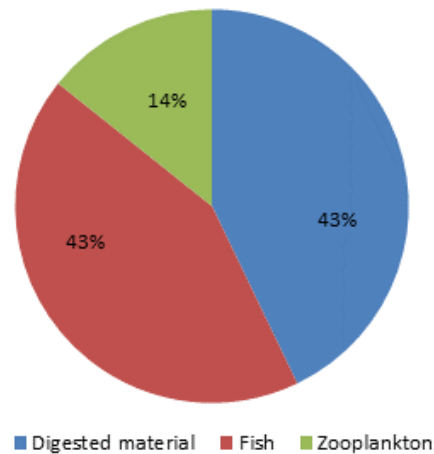


Fig 1.8. Diet of brown trout (n=7) captured on Lough Arrow, 2018 (% frequency occurrence)



1.4 Summary and ecological status

A total of six fish species and two types of hybrid were recorded on Lough Arrow in August 2018. Perch was the dominant fish species in terms of abundance and biomass captured during the 2018 survey.

Perch captured during the 2018 survey ranged in length from 3.5cm to 35.6cm, with nine age classes present, ranging from 0+ to 8+, indicating reproductive success in each of the previous nine years. The dominant age class was 1+.

Roach captured during the 2018 survey ranged in length from 4.0cm to 33.2cm, with twelve age classes present, ranging from 0+ to 11+, indicating reproductive success in all of the previous twelve years.

Brown trout ranged in length from 15.5cm to 54.5cm and ranged in age from 1+ to 6+, indicating reproductive success in six of the previous seven 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 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 for 2018 based on the fish populations present. In previous years the lake was assigned a similar status based on the fish populations present.

In the 2010 to 2015 surveillance monitoring reporting period, the EPA assigned Lough Arrow an overall ecological status of Good.



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