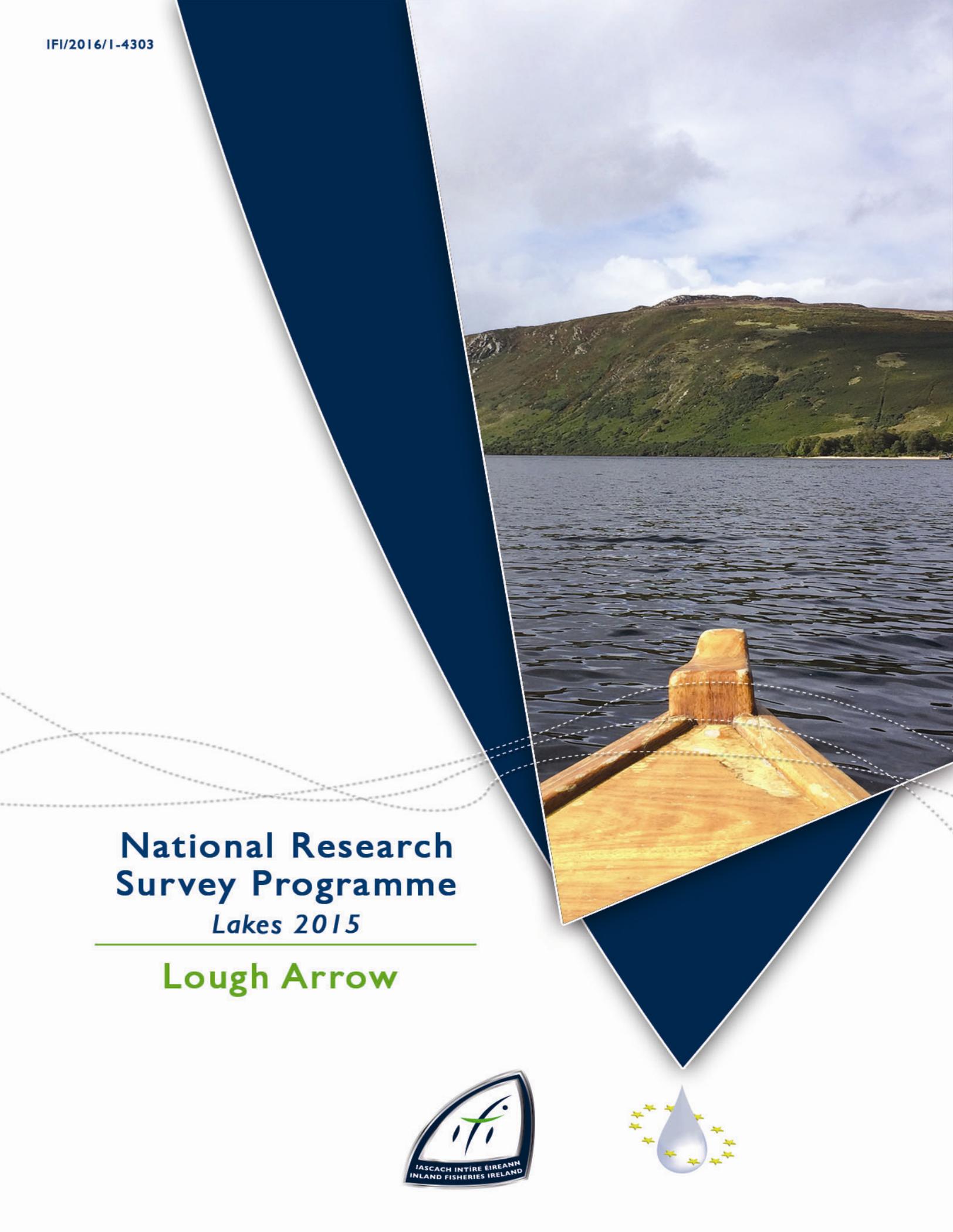


National Research Survey Programme

Lakes 2015

Lough Arrow





Inland Fisheries Ireland
National Research Survey Programme
**Fish Stock Survey of Lough Arrow,
July 2015**

Fiona L. Kelly, Lynda Connor, Karen Delanty, Paul McLoone, John Coyne, Emma Morrissey, William Corcoran, Daniel Cierpial, Ronan Matson, Paul Gordon, Rossa O' Briain, Kieran Rocks, Laura Walsh, Sinead O' Reilly, Roisin O' Callaghan, Ronan Cooney and Dave Timbs.

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

CITATION: Kelly, F.L., Connor, L., Delanty, K., McLoone P., Coyne, J., Morrissey, E., Corcoran, W., Cierpial, D., Matson, R., Gordon, P., O' Briain, R., Rocks, K., Walsh, L., O' Reilly, Sinead., O' Callaghan, R., Cooney, R. and Timbs, D. (2016) Fish Stock Survey of Lough Arrow, July 2015. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

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



ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the help and co-operation of all their colleagues in Inland Fisheries Ireland.

The authors would also like to acknowledge the funding provided for the project from the Department of Communications, Energy and Natural Resources for 2015.

The report includes Ordnance Survey Ireland data reproduced under OSi Copyright Permit No. MP 007508.

*Unauthorised reproduction infringes Ordnance Survey Ireland and Government of Ireland copyright.
© Ordnance Survey Ireland, 2015.*



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. 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 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 and 2012 (Kelly *et al.*, 2010 and 2013). During both of these surveys, 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.

The survey had two objectives:

1. Assess the status of the fish stocks in the lake as part of IFIs WFD surveillance monitoring programme and also the national brown trout and coarse fish research programmes.
2. Undertake a method intercalibration exercise using the existing WFD multi method approach (benthic and floating multimesh monofilament survey gill nets, fyke nets, but adding supplementary two panel braided survey gill nets instead of one panel braided survey gill nets (WFD+)) and the method established by IFI in the late 1970s to assess the status of brown trout in lakes (seven panel braided survey gill nets), but adding an additional 88.90mm panel to these latter nets (8-PBB).

This report summarises the results of the 2015 fish stock survey (e.g. species composition, abundance and age structure) on Lough Arrow using both methods above, while the method intercalibration results will be dealt with in a separate report.



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])

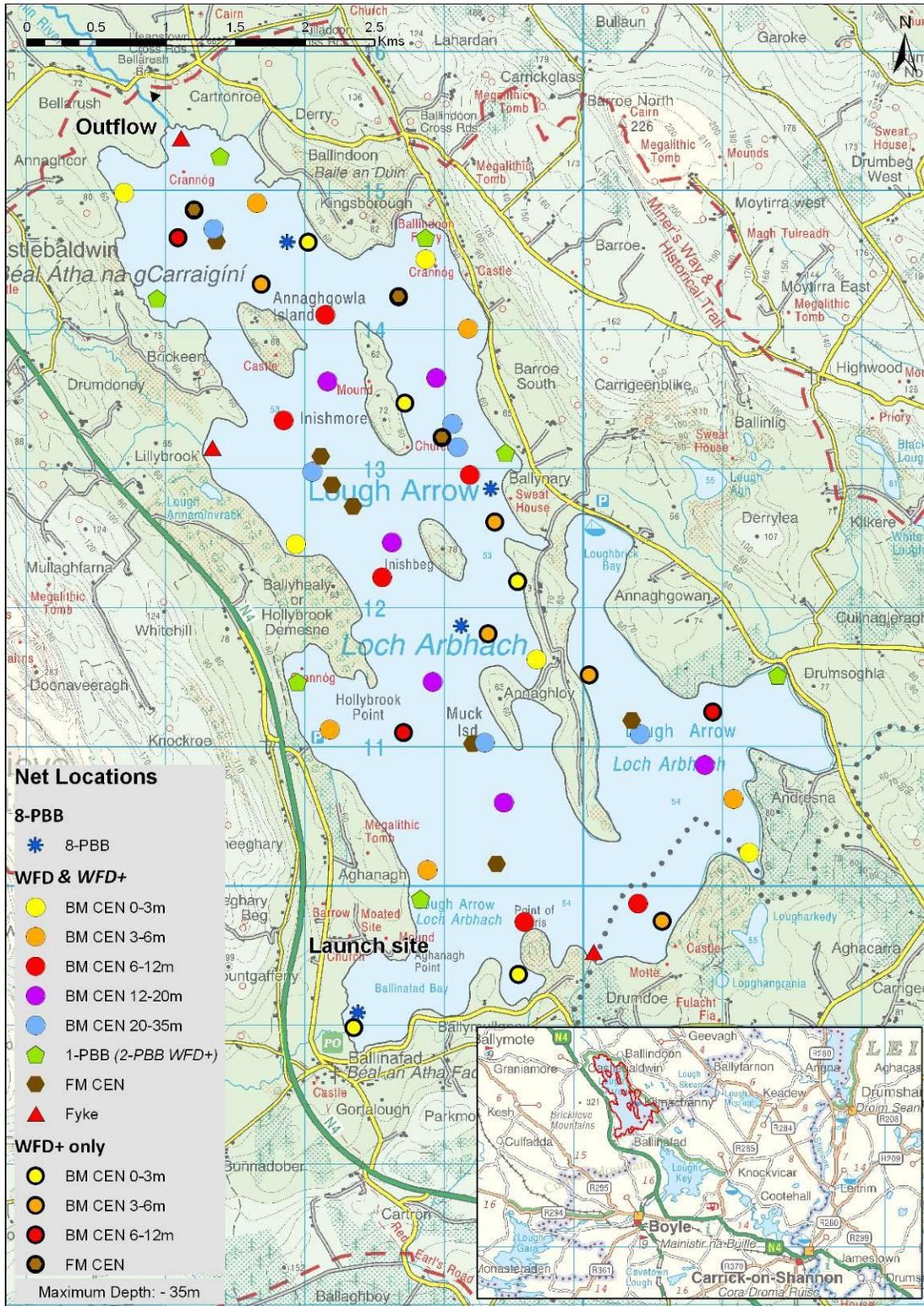


Fig. 1.1. Location map of Lough Arrow showing locations and depths of each net (outflow is indicated on map)



1.2 Methods

1.2.2 Netting methods

Lough Arrow was surveyed over four nights from the 13th and the 17th of July 2015. A total of 3 Dutch fyke nets (Fyke), 41 benthic monofilament multi-mesh (12 panel, 5-55mm mesh knot to knot) CEN standard survey gill nets (BM CEN) and 7 surface floating monofilament multi-mesh (FM CEN) (12 panel, 5-55mm mesh knot to knot) CEN standard survey gill nets were deployed in the lake. The netting effort was supplemented using two-panel benthic braided (63.5mm and 88.9mm mesh knot to knot) survey gill nets (2-PBB).

Four eight-panel benthic braided survey gill nets (8-PBB) were also deployed on the lake. They were composed of eight 27.5m long panels each a different mesh size, tied together randomly. The panels ranged from 2" (50.8mm stretched mesh, 25.4mm mesh knot to knot) to 5" (127mm stretched mesh, 63.5mm mesh knot to knot) in half inch (12.7mm) increments (O'Grady, 1981) with the addition of a 7" (177.8mm stretched mesh, 88.9mm mesh knot to knot) panel.

The nets were deployed in the same locations as randomly chosen in the previous surveys. Site locations for additional nets (WFD+) were chosen randomly within fixed depth zones. 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 also randomised.

All fish apart from perch were measured and weighed on site and scales were removed from all brown trout, pike, roach, 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 returned to the laboratory for further analysis.

1.2.2 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 on the IFI NRSP team when moving between water bodies.



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 2015, with 548 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 three-spined stickleback, roach, brown trout, eels, roach x bream hybrids, rudd, pike and bream (Table 1.1). During the previous WFD surveys in 2009 and 2012 the same species composition was recorded with the exception of roach x bream hybrids, which were present during the 2012 and 2015 surveys but were not captured in 2009 (Kelly *et al.*, 2010 and 2013). 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, July 2015

Scientific name	Common name	Number of fish captured					
		8-PBB	2-PBB	BM CEN	FM CEN	Fyke	Total
<i>Salmo trutta</i>	Brown trout	25	9	34	3	0	71
<i>Perca fluviatilis</i>	Perch	44	6	235	7	0	292
<i>Rutilus rutilus</i>	Roach	10	0	60	0	0	70
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	0	0	70	0	28	98
<i>Esox Lucius</i>	Pike	1	1	1	0	0	3
<i>Scardinius erythrophthalmus</i>	Rudd	0	0	2	0	0	2
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	0	0	3	0	0	3
<i>Abramis brama</i>	Bream	0	0	1	0	0	1
<i>Anguilla Anguilla</i>	European eel	0	0	0	0	8	8

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 are summarised in Table 1.2.

Perch was the dominant fish species in terms of abundance and biomass (Table 1.3).



Table 1.2. Mean (S.E.) CPUE and BPUE (per metre of net) for all fish species captured on Lough Arrow, 2015

Scientific name	Common name	8-PBB	WFD+**
Mean CPUE (±S.E.)			
<i>Salmo trutta</i>	Brown trout	0.028 (0.008)	0.023 (0.004)
<i>Perca fluviatilis</i>	Perch	0.050 (0.023)	0.136 (0.024)
<i>Rutilus rutilus</i>	Roach	0.011 (0.006)	0.033 (0.011)
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	-	0.046 (0.029)
<i>Esox Lucius</i>	Pike	0.001 (0.001)	0.001 (0.001)
<i>Scardinius erythrophthalmus</i>	Rudd	-	0.001 (0.001)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	-	0.002 (0.001)
<i>Abramis brama</i>	Bream	-	0.001 (0.001)
<i>Anguilla Anguilla</i>	European eel	-	0.033 (0.016)*
Mean BPUE (±S.E.)			
<i>Salmo trutta</i>	Brown trout	-	11.127 (2.636)
<i>Perca fluviatilis</i>	Perch	-	13.271 (2.369)
<i>Rutilus rutilus</i>	Roach	-	6.719 (2.794)
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	-	0.036 (0.023)
<i>Esox Lucius</i>	Pike	-	0.878 (0.749)
<i>Scardinius erythrophthalmus</i>	Rudd	-	0.874 (0.874)
<i>Rutilus rutilus x Abramis brama</i>	Roach x bream hybrid	-	0.669 (0.532)
<i>Abramis brama</i>	Bream	-	0.546 (0.546)
<i>Anguilla Anguilla</i>	European eel	-	7.428 (6.966)*

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

**CPUE and BPUE data above for all fish species except eels are not comparable to earlier surveys as an extra panel was added to the supplementary nets (now 2-PBB) to provide additional information on large coarse fish.



1.3.3 Length frequency distributions and growth

Brown trout

Brown trout captured during the 2015 survey ranged in length from 14.8cm to 56.0cm (mean = 30.8cm) (Fig. 1.2). Seven age classes were present, ranging from 1+ to 7+, with a mean L1 of 7.5cm (Table 1.3). The dominant age class was 4+ (Fig. 1.2). Mean brown trout L4 in 2015 was 36.4cm indicating a very fast rate of growth for brown trout in this lake according to the classification scheme of Kennedy and Fitzmaurice (1971) (Table 1.3).

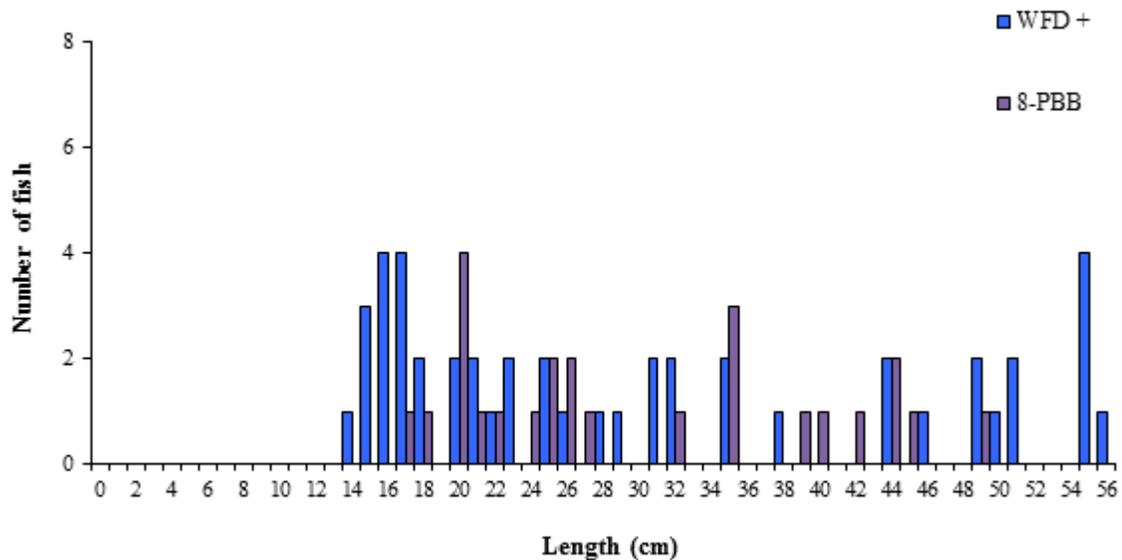


Fig. 1.2. Length frequency of brown trout captured on Lough Arrow, 2015

Table 1.3. Mean (\pm S.E.) brown trout length (cm) at age for Lough Arrow, July 2015

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	Growth Category
Mean (\pm S.E.)	7.5 (0.1)	17.1 (0.4)	27.4 (0.6)	36.4 (0.9)	42.6 (1.0)	48.3 (1.8)	51.6	Very fast
N	59	49	35	24	17	7	1	
Range	5.7-9.9	12.1-24.3	20.1-35.0	28.1-43.9	36.2-49.4	41.9-52.9	51.6-51.6	

Perch

Perch captured during the 2015 survey ranged in length from 3.5cm to 31.6cm (mean = 17.4cm) (Fig.1.3) with seven age classes present, ranging from 0+ to 8+ with a mean L1 of 6.6cm (Table 1.4). The dominant age class was 3+ (Fig.1.3).

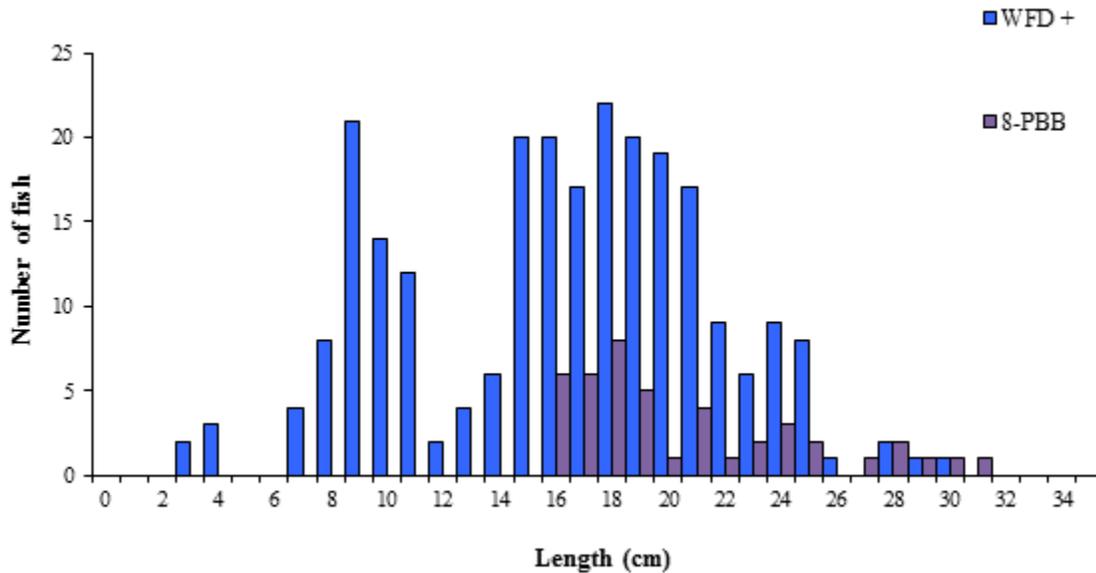


Fig. 1.3. Length frequency of perch captured on Lough Arrow, 2015

Table 1.4. Mean (\pm S.E.) perch length (cm) at age for Lough Arrow, July 2015

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈
Mean (\pm S.E.)	6.6 (0.2)	12.0 (0.3)	17.7 (0.3)	22.2 (0.4)	24.8 (0.8)	26.8	28.9	30.2
N	60	44	33	17	10	1	1	1
Range	4.9-10.3	8.3-16.1	13.3-21.4	19.9-24.9	21.6-28.5	26.8-26.8	28.9-28.9	30.2-30.2

Roach

Roach captured during the 2015 survey ranged in length from 7.4cm to 34.9cm (mean = 21.0cm) (Fig.1.4) with eight age classes present, ranging from 1+ to 8+ with a mean L1 of 3.3cm (Table 1.5). The dominant age class was 3+ (Fig.1.4).

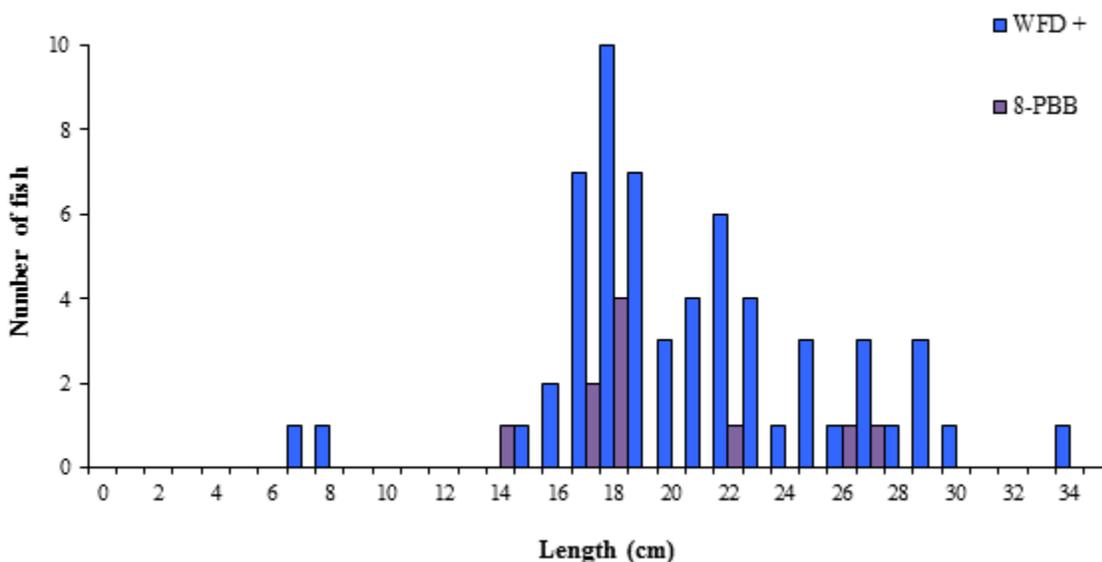


Fig. 1.4. Length frequency of roach captured on Lough Arrow, 2015

Table 1.5. Mean (\pm S.E.) roach length (cm) at age for Lough Arrow, July 2015

	L ₁	L ₂	L ₃	L ₄	L ₅	L ₆	L ₇	L ₈
Mean (\pm S.E.)	3.3 (0.1)	7.8 (0.2)	12.7 (0.4)	16.6 (0.4)	20.6 (0.5)	24.0 (0.6)	26.5 (1.0)	30.9 (3.1)
N	39	38	37	28	21	14	8	2
Range	2.2-4.2	6.0-11.1	9.3-18.7	13.7-21.3	17.1-26.7	20.6-28.2	23.2-32.0	27.7-34.0

Other fish

Eels captured during the 2015 survey ranged in length from 37.5cm to 56.0cm, three-spined stickleback ranged in length from 2.9cm to 4.8cm, pike ranged from 31.4cm to 73.0cm, roach x bream hybrids ranged 25.0cm to 31.7cm and one bream was 41.4cm. Two rudd were measured at 33.9cm.

1.3.4 Stomach and diet analysis

Feeding 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.

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). The food items recorded in perch stomachs during the survey were dominated by *Gammarus* sp. (Fig 1.5).

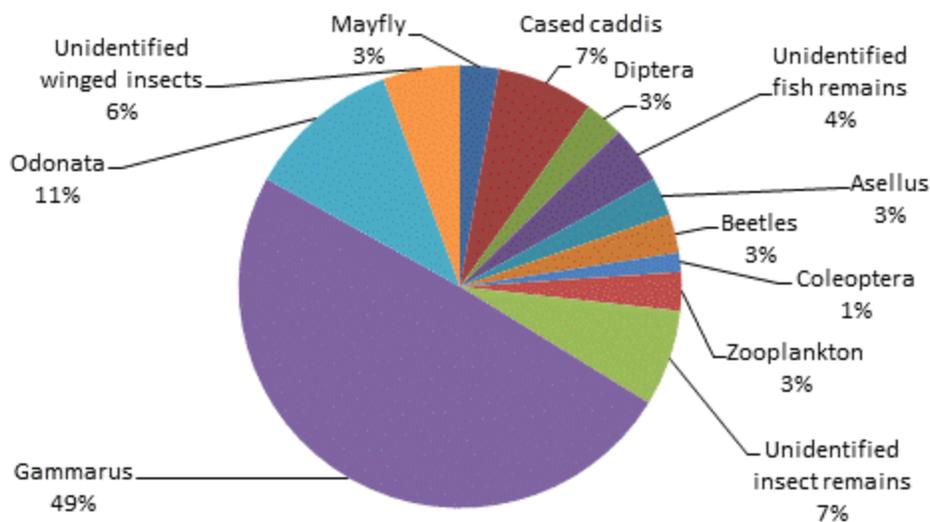


Fig. 1.5. Diet of perch captured on Lough Arrow 2015 (% occurrence) n=52

1.4 Summary and ecological status

Perch was the dominant species in terms of abundance (CPUE) captured in the survey gill nets during the 2015 survey.

Perch ranged in length from 3.5cm to 39.1cm and ranged in age from 0+ to 8+, indicating reproductive success in each of the previous nine years. The dominant age class was 3+.



Roach ranged in length from 7.4cm to 34.9cm ranging in age from 1+ to 8+ indicating reproductive success in eight of the previous nine years. The dominant age class was 3+.

Brown trout captured ranged in length from 14.8cm to 56.0cm and ranged in age from 1+ to 7+, indicating reproductive success in seven of the previous eight years. The dominant age class was 4+. 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).

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 Lough Arrow has been assigned an ecological status of Good for 2009, 2012 and 2015 based on the fish populations present.

In the 2010 to 2012 surveillance monitoring reporting period, the EPA assigned Lough Arrow an overall draft ecological status of Good, based on all monitored physico-chemical and biological elements, including fish. This status classification will be revised during 2016.



1.5 References

- Caffrey, J. (2010) *IFI Biosecurity Protocol for Field Survey Work*. Inland Fisheries Ireland.
- Hjelm, J., Persson, L., and Christensen, B. (2000) Growth, morphological variation and ontogenetic niche shifts in perch (*Perca fluviatilis*) in relation to resource availability. *Oecologia*, **122**, (2), 190-199.
- 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., Harrison A., Connor, L., Matson, R., Morrissey, E., O'Callaghan, R., Wogerbauer, C., Feeney, R., Hanna, G. and Rocks, K. (2010) *Sampling Fish for the Water Framework Directive – Summary Report 2009*. The Central and Regional Fisheries Boards.
- Kelly, F.L., Harrison, A.J., Allen, M., Connor, L. and Rosell, R. (2012) Development and application of an ecological classification tool for fish in lakes in Ireland. *Ecological Indicators*, **18**, 608-619.
- Kelly, F., Connor, L., Matson, R., Feeney, R., Morrissey, E., Wogerbauer, C. and Rocks, K. (2013) *Sampling Fish for the Water Framework Directive – Summary Report 2012*. Inland Fisheries Ireland.
- 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.
- King, J.J. (2002) *Investigations on aquatic plants in Lough Arrow: Findings from a study undertaken in July 2001 and comparison with a study of 1984*. Central Fisheries Board, unpublished report.
- NPWS (1999) *Site synopsis: Lough Arrow. Site code: 001673*. Site Synopsis report, National Parks and Wildlife Service.
- O' Grady, M. F. (1986) *A Summary of Stock Survey Data Compiled for Lough Arrow (1979 to 1981) and Management Recommendations for this Resource*. Central Fisheries Board, unpublished report.
- O' Grady, M.F. and Delanty, K. (2003) *A Fish Stock Assessment of Lough Arrow, 2002. Recommendations and Management for this resource*. Central Fisheries Board, unpublished report.
- O' Grady, M.F. and Delanty, K. (2007) *A Fish Stock Assessment of Lough Arrow, 2007*. Central Fisheries Board, unpublished report.



O' Grady, M.F. (2004) *Enhancement of the Lough Arrow Catchment*. Central Fisheries Board, unpublished report.

O' Reilly, P. (2007) *Loughs of Ireland - A Flyfisher's Guide*. 4th Edition. Merlin Unwin Books.

Roscommon County Council (2009) www.roscommoncoco.ie

A large, dark blue, irregularly shaped graphic element on the left side of the page. It has a white dashed line that curves across its bottom edge, extending towards the right side of the page. The background is white.

**IFI Dublin,
3044 Lake Drive,
Citywest Business Campus,
Dublin 24,
Ireland**

**www.fisheriesireland.ie
dublin@fisheriesireland.ie
+353 1 8842 600**