National Research Survey Programme

Lakes 2019

Lough Carra

IFI/2020/1-4494

Iascach Intíre Éireann
Inland Fisheries Ireland

Inland Fisheries Ireland

National Research Survey Programme

**Fish Stock Survey of Lough Carra,
June 2019**

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

Cover photo: Aerial view of Lough Shindilla, Co. Galway © Inland Fisheries Ireland

ACKNOWLEDGEMENTS

1.1 Introduction

Lough Carra is situated in County Mayo and forms the most northerly part of the Great Western Lakes system of Loughs Corrib, Mask and Carra (Plate 1.1, Fig. 1.1). The lake is located approximately 5km north of Ballinrobe, Co. Mayo.

Lough Carra is the largest marl lake in Ireland, with a surface area of approximately 1600ha (NPWS, 2004; Irvine *et al.,* 2003). It is a hard water lake which acquires most of its water via the feeder streams that flow in at various points around its perimeter (Huxley and Huxley, 2009). The majority of the lake is shallow with a mean depth of approximately 1.8m; however, there are sections of the lake where depths reach over 19m (Huxley and Huxley, 2009). Lough Carra is well known for its green/blue colour which is due to the formation of calcareous encrustations (NPWS, 2004).   The lake contains well developed stonewort communities with *Chara curta, C. desmacantha, C. rudis* and *C. contraria* also recorded (NPWS, 2004).

The lake is categorised as typology class 10 (as designated by the EPA for the purposes of the Water Framework Directive (WFD)), i.e. shallow (<4m), greater than 50ha and highly alkaline (>100mg/l CaCO3).

The average size of the brown trout taken from Lough Carra is greater than any of the other western lakes and the lake has previously produced a specimen of 8.2kg (O' Reilly, 2007). Lough Carra is believed to be one of the few remaining wild brown trout calcareous lakes within the EU (Irvine *et al.* 2003). During the 1990s fishery rehabilitation and enhancement works were undertaken in Lough Carra's spawning streams by Inland Fisheries Ireland (IFI) (previously the Central and Regional Fisheries Boards) and this led to increased recruitment of juvenile brown trout to the lake (O' Grady, 2009).

The lake was surveyed eight times from 1978 to 2009 as part of IFI's brown trout research programme using seven-panel benthic braided survey gill nets; brown trout, perch and pike were recorded on all sampling occasions. The most recent results (March 2009) using this survey method suggested that the lake supported an excellent and healthy stock of brown trout (IFI, 2009). More recently, the lake was surveyed by IFI for the WFD fish surveillance monitoring programme in 2009, 2012 and 2015 (Kelly *et al*., 2010, 2013 and 2016).

This report summarises the results of the 2019 fish stock survey carried out on the lake.
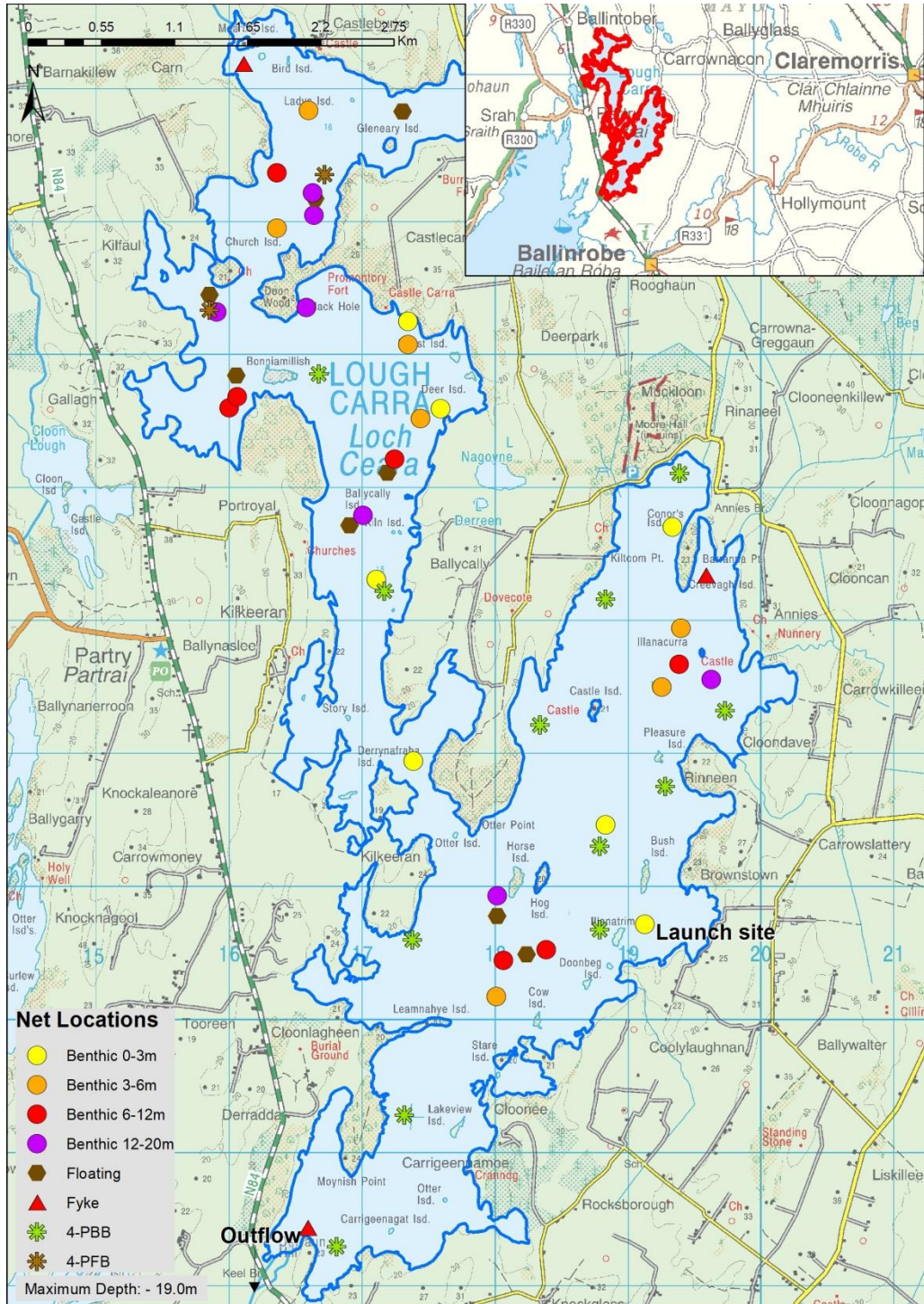
Plate 1.1. Lough Carra

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

1.2 Methods

1.2.1 Netting methods

Lough Carra was surveyed over three nights from the 24th to the 27th of June 2019. 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 (7 @ 0-2.9m, 7 @ 3-5.9m, 7 @ 6-11.9m and 7 @ 12-19.9m) and eight surface floating monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets were deployed randomly in the lake (39 sites). The netting effort was supplemented using four-panel benthic braided survey gill nets (4-PBB) and four-panel floating braided survey gill nets (4-PFB) at 14 additional sites. The four-panel survey gill nets are composed of four 27.5m long panels each a different mesh size (55mm, 60mm, 70mm and 90mm knot to knot). 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 and pike. 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).

$$\%FO_i = (N_i/ N)\times100$$

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 five fish species were recorded in Lough Carra in June 2019, with 578 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 brown trout, pike, eels and three-spined stickleback. During the previous surveys in 2009, 2012 and 2015 the same species composition was recorded, apart from a single roach that was recorded during the 2015 survey (Kelly *et al.*, 2010, 2013 and 2016).

Table 1.1. Number of each fish species captured by each gear type during the survey on Lough Carra, June 2019

Scientific name	Common name	Number of fish captured				
		BM CEN	FM CEN	4-PBB	Fyke	Total
Perca fluviatilis	Perch	497	0	13	5	525
Salmo trutta	Brown trout	17	1	23	0	31
Esox lucius	Pike	13	0	1	3	17
Gasterosteus aculeatus	Three-spined stickleback	1	0	0	0	1
Anguilla anguilla	European eel	0	0	0	4	4

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 2009, 2012, 2015 and 2019 WFD fish surveillance surveys are summarised in Table 1.2 and illustrated in Figures 1.2 and 1.3. For comparison purposes the 2019 CPUE/BPUE uses only the 60mm mesh panel of 4-PBB.

Perch

Perch was the dominant species in terms of abundance (CPUE) and biomass (BPUE). The mean perch CPUE increased steadily over the four sampling occasions (Table 1.2; Fig. 1.2). Although the mean BPUE

fluctuated slightly across the four sampling periods, the overall trend was for an increasing BPUE for perch in Lough Carra (Fig 1.3).

Brown trout

The mean brown trout CPUE decreased slightly across the four sampling occasions (Table 1.2; Fig.1.2). Mean BPUE fluctuated across the four sampling periods, however the trend is downward (Table 1.2; Fig. 1.3).

Table 1.2. Mean (S.E.) CPUE and BPUE for all fish species captured on Lough Carra, 2009, 2012, 2015 and 2019

Scientific name	Common name	2009	2012	2015	2019**
			Mean CPUE		
Perca fluviatilis	Perch	0.109 (0.030)	0.169 (0.042)	0.234 (0.053)	0.321 (0.072)
Salmo trutta	Brown trout	0.026 (0.007)	0.023 (0.006)	0.017 (0.005)	0.013 (0.004)
Esox lucius	Pike	0.002 (0.001)	0.003 (0.001)	0.006 (0.002)	0.009 (0.004)
Gasterosteus aculeatus	Three-spined stickleback	0.013 (0.008)	0.027 (0.012)	0.014 (0.0007)	0.001 (0.001)
Anguilla anguilla	European eel*	0.067 (0.029)*	0.056 (0.047)*	0.022 (0.022)*	0.022 (0.015)*
			Mean BPUE		
Perca fluviatilis	Perch	18.160 (6.131)	15.012 (3.662)	18.304 (4.652)	28.752 (5.830)
Salmo trutta	Brown trout	17.105 (6.153)	10.316 (3.005)	11.794 (3.509)	8.420 (2.470)
Esox lucius	Pike	0.495 (0.294)	0.797 (0.395)	1.234 (0.386)	2.633 (1.454)
Gasterosteus aculeatus	Three-spined stickleback	0.013 (0.008)	0.023 (0.010)	0.012 (0.007)	0.001 (0.001)
Anguilla anguilla	European eel*	19.207 (6.079)*	20.778 (17.249)*	8.589 (8.589)*	16.792 (12.413)*

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, is calculated using only the 60mm panel from the 4-PBB nets
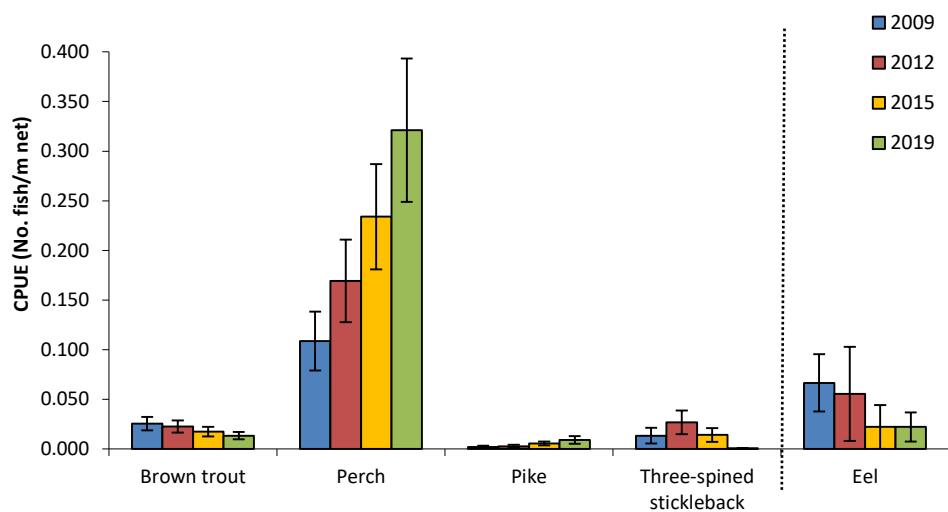
Fig. 1.2. Mean (±S.E.) CPUE for all fish species captured in Lough Carra (Eel CPUE based on fyke nets only), 2009, 2012, 2015 and 2019
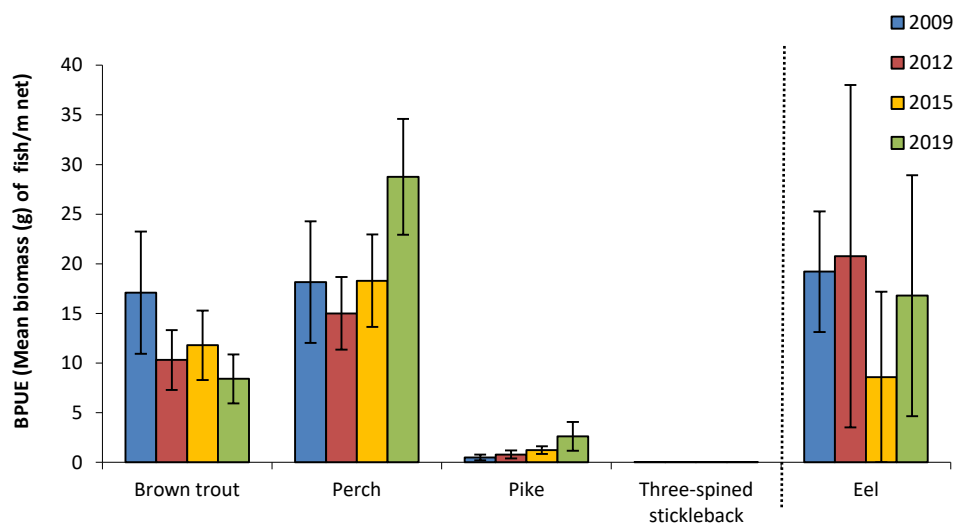

Fig. 1.3. Mean (±S.E.) BPUE for all fish species captured in Lough Carra (Eel BPUE based on fyke nets only), 2009, 2012, 2015 and 2019

1.3.3 Length frequency distributions and growth

Perch

Perch captured during the 2019 survey ranged in length from 5.5cm to 35.8cm (mean = 15.6cm) (Fig.1.5) with nine age classes present, ranging from 0+ to 8+ (Table1.3). The dominant age class was 1+, with a mean L1 of 6.4cm (Table1.3). Perch captured in 2019 had a similar length and age range to the 2009, 2012 and 2015 surveys, although larger numbers of small fish were captured in 2012 compared to other years (Fig.1.4).
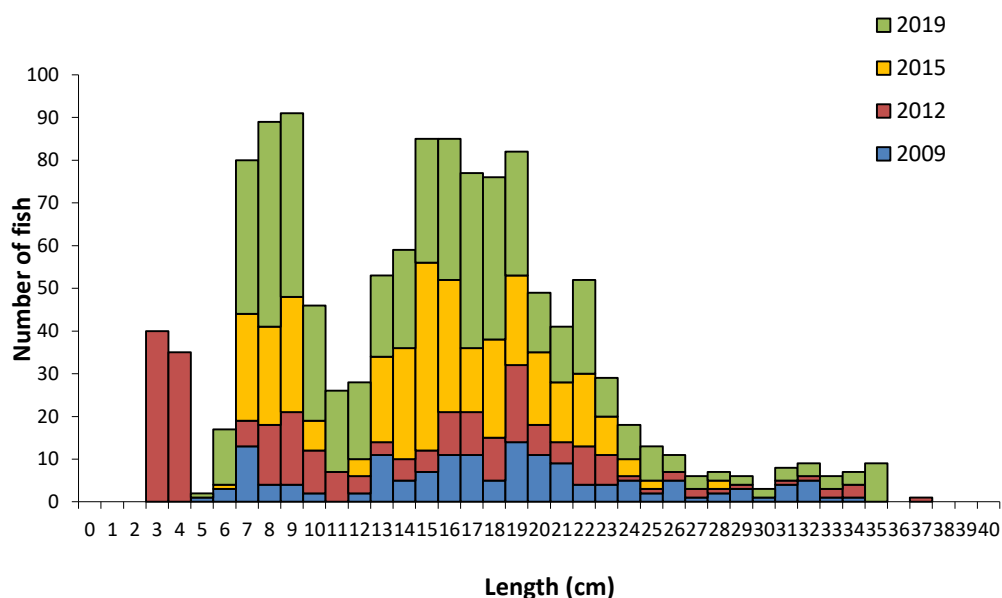

Fig. 1.4. Length frequency of perch captured Lough Carra, 2009, 2012, 2015 and 2019

Table 1.3. Mean (±S.E.) perch length (cm) at age for Lough Carra, June 2019

	L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8
Mean (±S.E.)	6.4 (0.1)	11.6 (0.2)	17.9 (0.3)	22.1 (0.4)	25.6 (0.7)	28.5 (1.0)	31.9 (1.3)	34.7
N	104	75	57	36	25	13	8	1
Range	4.4-9.8	8.7-18.1	13.3-22.6	15.8-27.7	18.8-31.7	22.7-33.6	25.8-35.0	34.7-34.7

Brown trout

Brown trout captured during the 2019 survey ranged in length from 14.7cm to 50.5cm (mean = 35.2cm) (Fig. 1.5). Six age classes were present, ranging from 1+ to 6+, with a mean L1 of 6.9cm (Table 1.4). Mean brown trout L4 in 2019 was 33.2cm indicating a fast 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 2009, 2012 and 2015 surveys had similar length and age ranges with some larger fish recorded in 2009, 2012 and 2015 (Fig.1.4).
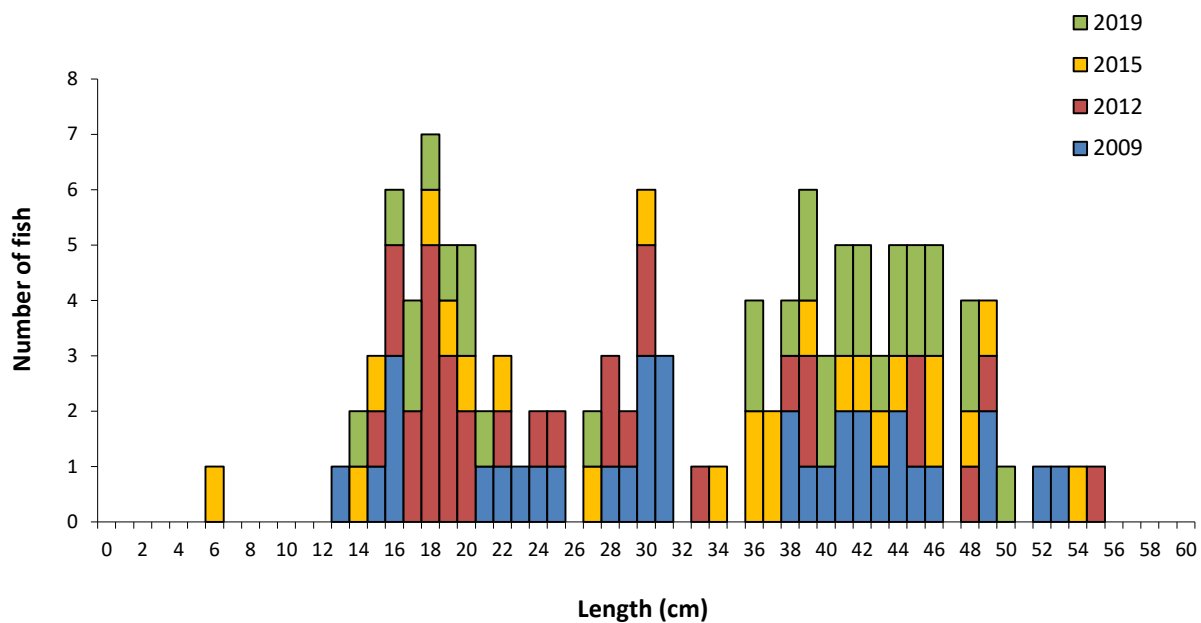

Fig. 1.5. Length frequency of brown trout captured on Lough Carra, 2009, 2012, 2015 and 2019

Table 1.4. Mean (±S.E.) brown trout length (cm) at age for Lough Carra, June 2019

	L_1	L_2	L_3	L_4	L_5	L_6	Growth Category
Mean (±S.E.)	6.9 (0.1)	15.2 (0.4)	24.5 (0.7)	33.2 (0.7)	38.8 (1.3)	42.0 (1.1)	Fast
N	31	28	22	18	9	3	
Range	4.8-9.0	12.2-19.9	20.3-32.5	28.3-41.2	34.0-48.1	40.1-43.8	

Other fish species

Pike ranged in length from 11.9cm to 69.6cm. Four eels ranging from 59.0cm to 83.0cm were captured in the survey. One three-spined stickleback measuring 2.7 cm was also recorded.

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, brown trout and pike 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 103 stomachs were examined, of these 52 were found to contain no prey items. Of the 51 remaining stomachs 68% contained invertebrates, 18% fish, 6% unidentified digested material, 4% zooplankton and 4% contain fish/invertebrates (Fig. 1.6).
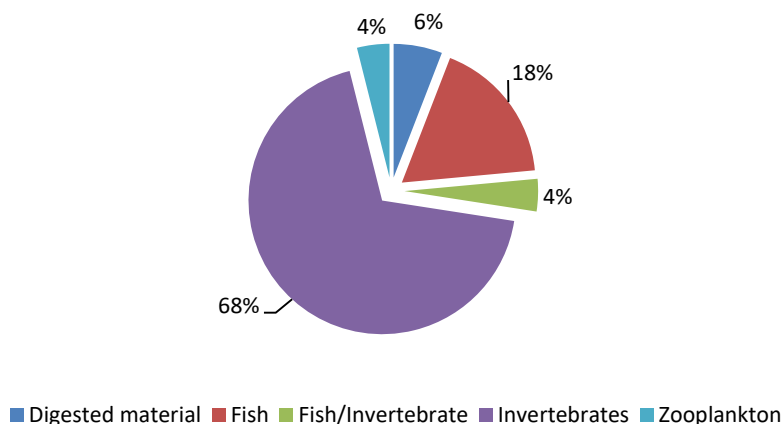

■ Digested material ■ Fish ■ Fish/Invertebrate ■ Invertebrates ■ Zooplankton

Fig 1.6. Diet of perch (n=51) captured on Lough Carra, 2019 (% FO)

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 15 stomachs were examined. Of these seven were found to contain no prey items. Of the remaining eight stomachs containing food, 100% contained invertebrates.

Pike

Fifteen pike, ranging in length from 15.0 to 69.6cm were available for stomach analysis. Of these, eight pike (20.4cm – 69.6cm) contained prey. The pike examined had been feeding principally upon fish. Three stomachs (37.5%) contained perch. One pike (12.5%) contained pike fry; one contained three-spined stickleback and one stomach contained both invertebrates and unidentified fry. The remaining two stomachs (25%) contained invertebrates only.

1.4 Summary and ecological status

A total of five fish were recorded in Lough Carra in June 2019. Perch was the dominant species in terms of abundance (CPUE) and biomass (BPUE) captured in the survey gill nets during the 2019 survey.

The mean perch CPUE increased progressively over the four sampling occasions. Perch ranged in length from 5.5cm to 35.8cm and ranged in age from 0+ to 8+, indicating reproductive success in each of the previous nine years.

The mean brown trout CPUE decreased slightly across the four sampling occasions. Brown trout ranged in length from 14.7cm to 50.5cm and out of the fish that were aged, they ranged from 1+ to 6+. Length at age analyses revealed that brown trout in the lake exhibit a 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 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 Carra has been assigned an ecological status of Good for 2019 based on the fish populations present. In previous years the lake was also assigned a fish status of Good in 2009, and High in 2012 and 2015 (Fig.1.7).

In the 2013 to 2018 surveillance monitoring reporting period, the EPA assigned Lough Carra an overall draft ecological status of Good, based on all monitored physico-chemical and biological elements, including fish.
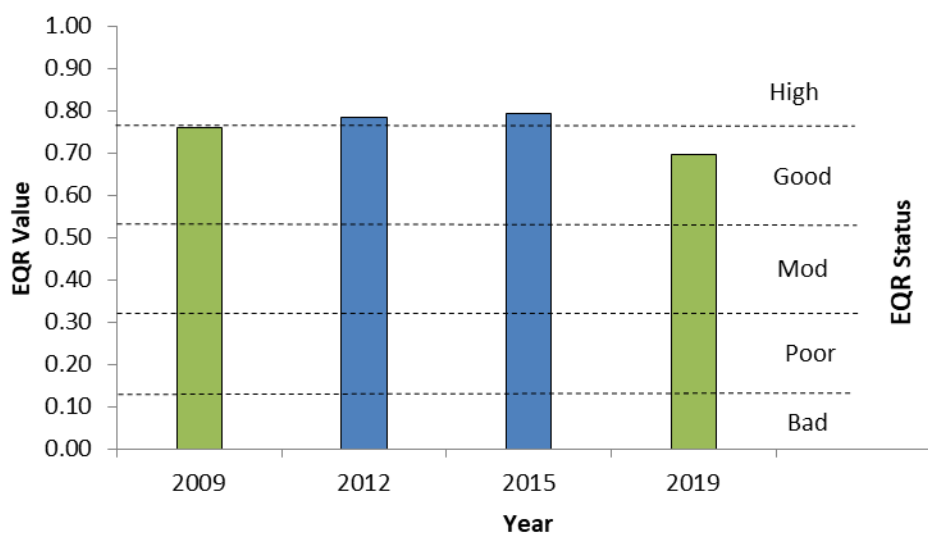

Fig. 1.7. Fish ecological status of Lough Carra, 2009, 2012, 2015 and 2019

1.5 References

Amundsen, P.A., Gabler H.M. and Staldvik F.J. (1996) A new approach to graphical analysis of feeding strategy from stomach contents data—modification of the Costello (1990) method. *Journal of Fish Biology,* **48,** 607–614.

Caffrey, J. (2010) *IFI Biosecurity Protocol for Field Survey Work*. Inland Fisheries Ireland.

Connor, L., Matson R. and Kelly F.L. (2017) Length-weight relationships for common freshwater fish species in Irish lakes and rivers. *Biology and Environment: Proceedings of the Royal Irish Academy*, **117** (2), 65-75.

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.

Huxley C. and Huxley L. (2009) http://www.loughcarra.org

IFI (2009) *A Fish Stock Survey of Lough Carra and a Review of the Current Ecological Status of this Fishery*. Inland Fisheries Ireland management report.

Irvine, K., Donoghue, I., Wemaere, A., Styles, D. and Hobbs, W. (2003) Connecting land-use with water quality: sources, sinks and time-bombs. In: M. Bruen, Editor, *Diffuse Pollution and Basin Management: Proceedings of the 7th IWA International Conference, Dublin, Ireland* (2003) 1:56–60.

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.

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 Carra, July 2015. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

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.

NPWS (2004) *Site synopsis: Lough Carra/Mask Complex. Site code: 001774*. Site Synopsis report, National Parks and Wildlife Service.

O' Grady (2009) Press Release: http://www.cfb.ie/pr/2009/carrasurvey.htm

O' Grady, M.F. (1981). *A Study of Brown Trout (Salmo trutta L.) Populations in Selected Irish Lakes*. Ph.D. Thesis, National University of Ireland.

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