

Fish Stock Survey of Selected Lakes and River Sites in the Owenriff Catchment

2018

IFI/2019/1-4487



Iascach Intíre Éireann
Inland Fisheries Ireland





Inland Fisheries Ireland

National Research Survey Programme

Fish Stock Survey of Selected Lakes and River Sites in the Owenriff Catchment, 2018

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

CITATION: IFI (2019) Fish Stock Survey of Selected Lakes and River Sites in the Owenriff Catchment, 2018. National Research Survey Programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

Cover photo: Owenriff River and Lough Agraiffard © Inland Fisheries Ireland

© Inland Fisheries Ireland 2019



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 bathymetry data supplied by the Environmental Protection Agency.

The authors would also like to acknowledge the funding provided for the project from the Department of Communications, Climate Action and Environment for 2018.

Project team

Senior Research Officer	Dr. Fiona Kelly
Research Officer	Ms. Lynda Connor
Research Officer	Dr. Karen Delanty (<i>up to 2nd August 2019</i>)
Research Officer	Dr. Ronan Matson
Research Officer	Mr. Paul McLoone
Technician	Mr. Will Corcoran
Technician	Mr. John Coyne
Technician	Mr. Paul Gordon
Technician/Research Officer	Dr. Emma Morrissey (<i>up to 30th September 2018</i>)
Technician	Mr. Rossa O' Briain
Technical Admin	Mr. Daniel Cierpal
Fisheries Assistant	Mr. Anthony Brett (<i>June 2018 – Dec 2018</i>)
Fisheries Assistant	Ms. Aine Gavin (<i>Jul 2018 – Dec 2018</i>)
Fisheries Assistant	Mr. Elliott McCarthy (<i>June 2018 – Dec 2018</i>)

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, 2017.



Table of contents

EXECUTIVE SUMMARY	5
1. INTRODUCTION	7
1.1 OBJECTIVES OF THE SURVEY	7
2. MATERIALS AND METHODS	9
2.1 STUDY AREA	9
2.1.1 Rivers	10
2.1.2 Lakes	14
2.2 SURVEY METHODS	18
2.2.1 Rivers	18
2.2.2 Lakes	20
2.2.3 Fish age and growth	24
2.2.4 Fish diet	24
2.2.5 Data analysis	25
2.2.6 Quality Assurance	25
2.2.7 Biosecurity and decontamination procedures	25
2.2.8 Fish ecological status	25
3. RESULTS	27
3.1 RIVERS	27
3.1.1 Species richness	27
3.1.2 Fish abundance	27
3.1.3 Age and length frequency	32
3.1.4 Stomach and diet analysis	38
3.1.5 Comparison of 2018 rivers data to previous surveys (1997 and 2017)	38
3.1.6 Comparison of fish stocks in the Owenriff and Cornamona catchments	44
3.2 LAKES	46
3.2.1 Fish species richness	46
3.2.2 Fish abundance	46
3.2.3 Length and age	50
3.2.4 Stomach and diet analysis	51
3.3 FISH ECOLOGICAL STATUS ON RIVERS AND LAKES IN THE OWENRIFF CATCHMENT, 2018	54
3.3.1 Rivers	54



3.3.1 Lakes	55
4. SUMMARY AND DISCUSSION	56
5. REFERENCES	60

Executive Summary

Inland Fisheries Ireland carried out a catchment wide fish stock survey on the Owenriff River, its tributaries and lakes in summer 2018 as part of the Owenriff catchment fish population rehabilitation plan.

The aims of the surveys were to continue the catchment wide survey of the fish stocks in the Owenriff catchment that commenced in 2017 to determine the current status of the fish stocks in unmonitored rivers and lakes and continue to determine the current distribution of pike in the catchment. A total of 34 river sites and four lakes were surveyed. All fish species present were counted and identified to species level. Information on abundance, biomass, age, growth and diet are reported for certain species.

A total of six fish species were recorded across the catchment. Brown trout was the most common fish species recorded in river sites, occurring in 66.7% of sites, followed by salmon in 54.6% of sites, minnow in 39.4% and pike in 18.2% of sites. Three-spined stickleback and eel were also present in rivers surveyed. No brown trout were recorded in any of the four lakes surveyed indicating a possible failure in recruitment or survival in at least the previous few years. Salmon were dominant at all river sites where they were recorded on the Owenriff River main channel and at nine sites on tributary streams. Salmon ranged in length from 2cm to 14cm across the catchment and were aged between 0+ and 2+ with 0+ the most abundant age cohort. Brown trout were dominant at nine sites and ranged in length from 3 to 23cm. Four age classes (0+ to 3+) of brown trout were present across the catchment, but only two age cohorts were recorded on the main channel. Brown trout ranged in length from 3cm to 23cm in river sites surveyed. Pike and eel were the only fish species recorded during the fish stock surveys in the four lakes. Twelve pike were recorded during the river surveys ranging in length from 8.1cm to 31.9cm. Two pike were aged at 2+, while all other fish were 0+. Pike captured in lake surveys ranged in length from 8.3cm to 26.3cm and ages ranged from 0+ to 2+. In general the abundance of pike was higher in Lough Adrehid and Shanaghree Loughs than in Loughs Ateeann and Loughaphreaghaun; however it should be noted that only small numbers were captured.

A significantly lower total mean density for brown trout in river sites was observed in 2018 when compared to results from 1997. Results also indicate that brown trout fry recruitment in 2017 and 2018 was reduced. The overall mean minimum density for salmon in the catchment was comparable

between 1997 and 2018; however the figures were inflated by relatively high densities of fish at two sites. Six sites were surveyed in both 1997 and 2018. There appears to be a trend for decreasing population density estimates from 1997 to 2018 for brown trout at these sites. 1+ and older brown trout were absent from three of the six paired sites where they were previously recorded in 1997. A higher salmon fry density was observed in three sites, but they were also absent at three sites where they were previously recorded.

Invertebrates dominated prey items in the pike stomachs examined from the surveys. Shrimp (gammarids) were the most commonly recorded invertebrate. Approximately 17% of pike stomachs contained fish, these included minnow, pike and unidentified fish. Zooplankton was also recorded in the diet of 13% of samples.

Each river and lake surveyed during 2018 was assigned a fish ecological status. Eleven river sites achieved good fish status or higher; however the remaining 21 sites (excluding two sites for which status could not be calculated) were assigned moderate or lower. All four lakes surveyed in 2018 were assigned bad status. These failures were mainly due to the absence, lower than expected abundance or missing age classes of type specific indicator species (i.e. brown trout and salmon).

1. Introduction

A series of recommendations for on-going fisheries research work in the Owenriff catchment were listed by Inland Fisheries Ireland (IFI) in a recent fish stock survey report (IFI, 2018a). This report found that salmonid abundance in rivers and lakes across the catchment had declined. Additionally brown trout abundances were significantly lower in comparison to other lakes within the Owenriff and in neighbouring catchments (where pike are not present). The decline in salmonids was attributed to the introduction of pike to the catchment as there are currently no major pressures in the upper catchment (IFI, 2018a). In response to these findings a fish population rehabilitation plan was compiled for the catchment in early 2018 (IFI, 2018b) and approved by the then Minister responsible for Inland Fisheries. The aim of the fish population rehabilitation plan is to develop a project to promote the recovery of the salmonid (salmon and brown trout) populations across the Owenriff catchment. The principal objectives of the plan are to protect biodiversity, rebuild the salmon and brown trout populations, prevent further decline of fish stocks, improve habitat for salmonids, improve survival rates of salmonids and improve the opportunity for adult fish to reach their spawning habitats.

Effectiveness monitoring was recommended as part of the rehabilitation plan. Therefore IFI undertook a comprehensive catchment wide survey in the Owenriff during summer 2018 to establish the status of the fish populations in unmonitored sites. Thirty four sites were surveyed in the main channel and tributaries. Four lakes (Adrehid, Ateeann, Loughaphreaghaun and Shannaghree) were also surveyed.

1.1 Objectives of the survey

The 2018 surveys had two main objectives:

1. Continue the baseline catchment wide survey of the fish stocks in the Owenriff catchment (selected lakes and rivers) to determine the current status of the fish stocks present in unmonitored rivers and lakes. Repeat a selected number of sites and assess if any change has occurred since the 2017 survey.
2. Continue to determine the current distribution of pike in the catchment and assess the impact, if possible, of their introduction on the fish stocks present.

This report summarises the results of the catchment wide fish stocks assessment on 34 river sites and netting surveys on four lakes undertaken in 2018. The data obtained will provide baseline information for future management of the fish stocks in the catchment.



Plate 1.1: Owenriff River (upstream of Lough Ateeann near Rusheeny townland)

2. Materials and Methods

2.1 Study Area

The Owenriff River drains into Upper Lough Corrib downstream of Oughterard, Co. Galway (Fig. 2.1). The catchment covers an area of 6,742 hectares (67.42km²). The underlying geology of the catchment is predominantly acidic with the exception of the segment of the Owenriff River in the vicinity of Oughterard which is dominated by lower Avonian/Carboniferous rocks. The catchment is dominated by peat soils and the most common land use within the catchment is peat bogs (64%) using the CORINE Land cover GIS layer (Lydon and Smith, 2014).

There are 13 lakes in the catchment and a number of small ponds. The main lakes are Bofin, Lettercraffroe, Loughaphreaghaun, Agraffard and Adrehid. Prior to 2007 lakes such as Lough Bofin, Lough Agraffard, Lettercraffroe Lough, Shannaghree Lough, and Loughaphreaghaun were noted as having good stocks of brown trout (O' Reilly, 2007). There are ten main river sub-catchments/tributaries in the catchment (Fig. 2.1).

There are many natural waterfalls located throughout the Owenriff catchment; the more significant ones are located on the Owenriff main channel at Canrawer (Oughterard), and the Glengawbeg sub-catchment at Derryeighter (Fig. 2.1). The falls at Canrawer on the main channel is a partial barrier; small grilse and smaller trout may find it difficult to ascend. The waterfalls act as barriers to pike and coarse fish species such as roach, preventing natural colonisation of these species from Lough Corrib.

The Owenriff catchment is located within two different Special Areas of Conservation (SAC) both of which support many Annex II species of the E.U. Habitats Directive (92/43/EEC), including Atlantic salmon (*Salmo salar*) and freshwater pearl mussel (*Margaritifera margaritifera*) (NPWS, 2015a and b). The mid to lower Owenriff main channel and its associated tributaries are located within the Lough Corrib SAC (NPWS, 2015a); while the mid to upper Owenriff system, including Lettercraffroe Lough and the upper Glengawbeg system are situated within the Connemara bog complex SAC (NPWS, 2015b). Two lakes surveyed in 2018 are situated within the Connemara Bog Complex (Lough Adrehid and Loughaphreaghaun) and Lough Ateeann is located in the Lough Corrib SAC.

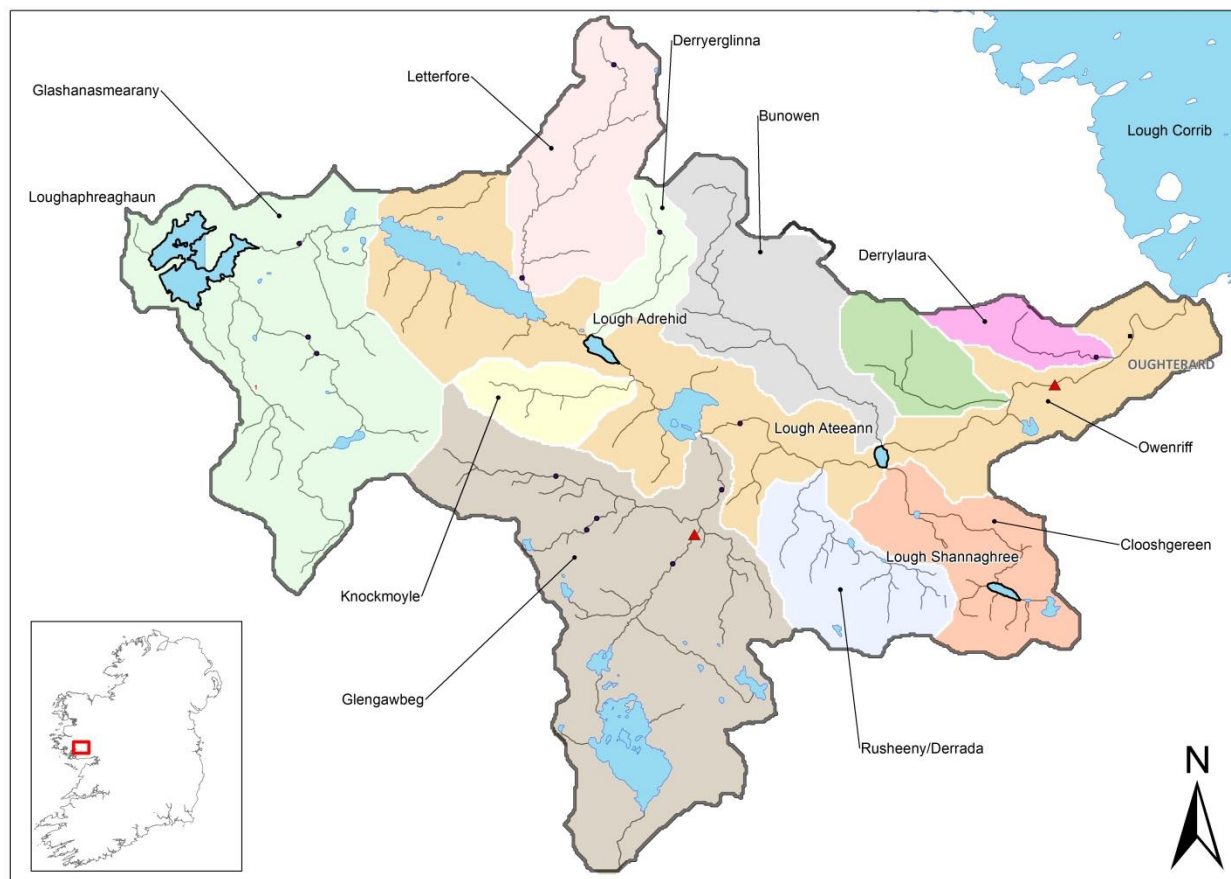


Fig. 2.1: Owenriff catchment, indicating sub-catchments. The two main waterfalls are also marked on the map

2.1.1 Rivers

Thirty-four river sites were surveyed on the Owenriff Catchment between the 17th and 31st of July 2018 (Fig. 2.2 and Table 2.1). Sites contained all habitat types, including riffle, glide and pool whenever possible. A suite of physical and chemical parameters were also recorded on each survey occasion (Table 2.2). Ten sites were surveyed on the Owenriff main channel; from downstream of Lough Bofin to upstream of Oughterard village (Table 2.1). Twenty four river sites were surveyed in the Owenriff sub-catchments (Fig. 2.1 and Table 2.1). Summary details for each site's survey date and physical characteristics are presented (Table 2.2).

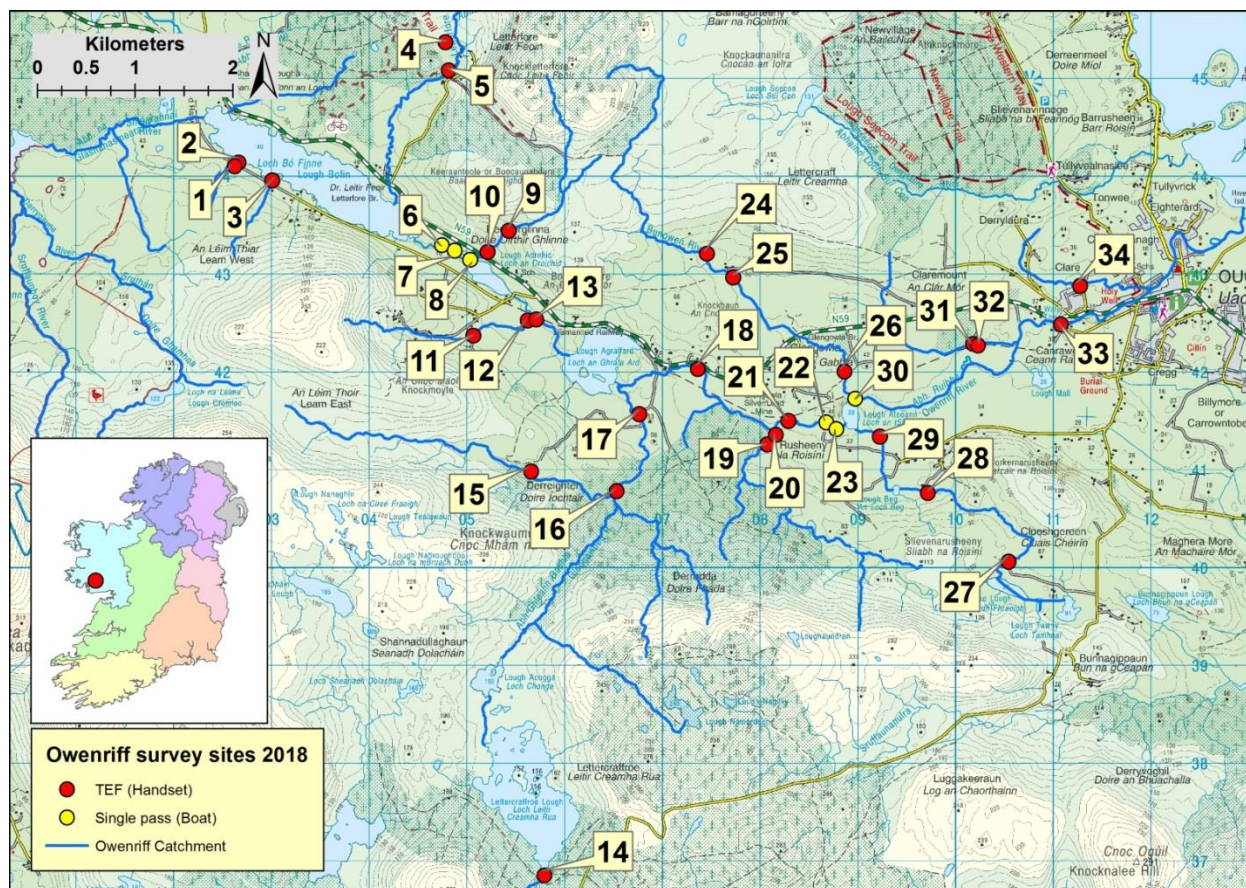


Fig 2.2. Map of Owenriff catchment indicating river survey sites, July 2018

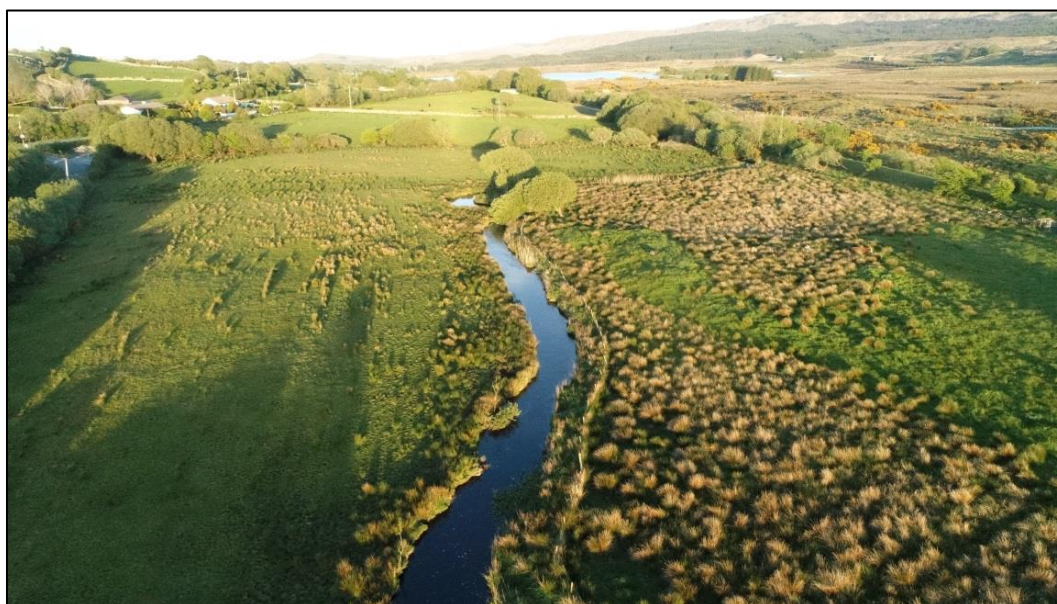


Plate 2.1 Owenriff River, downstream of Quiet Man Bridge



Table 2.1: Site survey details, Owenriff Catchment, July 2018

Site No.	River	Site name	Method	WFD	Date
MAIN CHANNEL					
6	Owenriff River	d/s L. Bofin	SP (Boat)	-	25/07/2018
7	Owenriff River	Middle Field	SP (Boat)	-	25/07/2018
8	Owenriff River	u/s L. Adrehid	SP (Boat)	-	25/07/2018
13	Owenriff River	d/s Knockmoyle Confl.	ADEF (Handset)	-	18/07/2018
18	Owenriff River	1km d/s of Lough Agraiffard	ADEF (Handset)	Y	17/07/2018
21	Owenriff River	Glengowla Mine	ADEF (Handset)	-	18/07/2018
22	Owenriff River	d/s of Glengowla Mine	SP (Boat)	-	19/07/2018
23	Owenriff River	West of L. Ateeann	SP (Boat)	-	19/07/2018
30	Owenriff River	d/s L. Ateeann	SP (Boat)	-	19/07/2018
33	Owenriff River	Water Tower	ADEF (Handset)	-	24/07/2018
SUBCATCHMENTS					
1	Leam Trib	Leam Trib West u/s	TEF (Handset)	-	31/07/2018
2	Leam Trib	Leam Trib West d/s	TEF (Handset)	-	31/07/2018
3	Leam Trib	Leam Trib East	TEF (Handset)	-	31/07/2018
4	Letterfore	Letterfore	TEF (Handset)	-	24/07/2018
5	Letterfore River	Letterfore Track	TEF (Handset)	-	23/07/2018
9	Derryerglinna River	Keerauntoole Lower	TEF (Handset)	-	26/07/2018
10	Derryerglinna River	u/s Derryerglinna Br.	TEF (Handset)	-	26/07/2018
11	Knockmoyle River	Knockmoyle Br.	TEF (Handset)	-	25/07/2018
12	Knockmoyle River	Knockmoyle Lower	TEF (Handset)	-	25/07/2018
14	Cloghermore River	Cloghermore	TEF (Handset)	-	27/07/2018
15	Derryeighter River	Upper Derryeighter	TEF (Handset)	-	17/07/2018
16	Derryeighter River	d/s Forest Confl.	ADEF (Handset)	-	17/07/2018
17	Glengawbeg River	Glengawbeg Br.	ADEF (Handset)	-	17/07/2018
19	Rusheeny River	Rusheeny Forest	TEF (Handset)	-	18/07/2018
20	Rusheeny River	u/s Confl near mines	TEF (Handset)	-	18/07/2018
24	Bunowen River	Knockbaun Upper	TEF (Handset)	-	23/07/2018
25	Bunowen River	Knockbaun	TEF (Handset)	-	23/07/2018
26	Bunowen River	North of L. Ateeann	TEF (Handset)	-	20/07/2018
27	Clooshgereen River	Clooshgereen	TEF (Handset)	-	24/07/2018
28	Clooshgereen River	Clooshgereen Track	TEF (Handset)	-	24/07/2018
29	Clooshgereen River	Rusheeny East	TEF (Handset)	-	24/07/2018
31	Canrawer River	Canrawer Lane	TEF (Handset)	-	30/07/2018
32	Canrawer River	Canrawer West	TEF (Handset)	-	30/07/2018
34	Derrylaura River	Clare	TEF (Handset)	-	24/07/2018
TEF (Ten-minute electrofishing), ADEF (Area delimited electro-fishing), SP (Single-pass boat electrofishing)					



Table 2.2 Physical characteristics for river sites surveyed on the Owenriff system, 2018

Site no.	Site name	Wetted width (m)	Wetted Area (m ²)	Mean depth (m)	Max depth (m)
MAIN CHANNEL					
6	d/s L. Bofin	6.84	850	1.39	2.8
7	Middle Field	5.83	748	1.2	1.9
8	u/s L. Adrehid	6.67	850	2.24	3.1
13	d/s Knockmoyle Confl.	5.3	204	0.1	0.14
18	1km d/s of Lough Agraftard	5.25	123	0.3	0.3
21	Glengowla Mine	8.23	263	0.18	0.4
22	d/s of Glengowla Mine	6.5	854	0.38	0.5
23	West of L. Ateeann	7.25	690	0.65	1
30	d/s L. Ateeann	7.8	1553	0.33	0.4
33	Water Tower	13.33	536	0.17	0.26
SUBCATCHMENTS					
1	Leam Trib West u/s	0.96	32.74	0.16	0.49
2	Leam Trib West d/s	2.36	43.42	0.18	0.5
3	Leam Trib East	1.13	34.25	0.22	0.87
4	Letterfore	2.63	122	0.1	0.4
5	Letterfore Track	2.54	101	0.08	0.27
9	Keerauntoole Lower	2.05	111	0.17	1
10	u/s Derryerglinna Br.	2.22	104	0.1	0.33
11	Knockmoyle Br.	1.68	41	0.18	0.41
12	Knockmoyle Lower	1.64	41.98	0.11	0.23
14	Cloghermore	0.92	30	0.19	0.8
15	Upper Derryeighther	2.93	129	0.4	0.4
16	d/s Forest Confl.	7.3	204	0.2	0.2
17	Glengawbeg Br.	7.67	270	0.3	0.3
19	Rusheeny Forest	2.8	77	0.23	0.4
20	u/s Confl near mines	1.87	55	0.07	0.13
24	Knockbaun Upper	2.22	80	0.14	0.36
25	Knockbaun	3.12	136	0.12	0.35
26	North of L. Ateeann	2.13	57	0.08	0.17
27	Clooshgereen	1.47	64	0.2	0.39
28	Clooshgereen Track	2.5	55	0.06	0.2
29	Rusheeny East	2.83	114	0.31	2.9
31	Canrawer Lane	2.64	78	0.34	0.8
32	Canrawer West	2.14	72	0.17	0.3
34	Clare	1.86	65	0.08	0.13

2.1.2 Lakes

Four lakes were surveyed in the Owenriff catchment during July 2018 to assess the status of the fish stocks present (Fig. 2.1).

2.1.2.1 Loughaphreaghaun

Loughaphreaghaun is a shallow lake located south of the N59 Oughterard Maam Cross road about 14km west of Oughterard, Co. Galway in the Glashanasmearany sub-catchment (Plate 2.2, Fig. 2.1). The Owenriff River rises upstream of the lake which was the furthest lake upstream lake surveyed in 2018. The estimated terrain elevation above sea level is 46 metres. It has a surface area of 65ha, a mean depth of <4m and a maximum depth of 8.9m. The lake is categorised as typology class 1, i.e. shallow (<4m), less than 50ha and low alkalinity (<20mg/l CaCO₃). The lake held a 'good' stock of brown trout ranging from 0.23kg to 0.34kg during the 1980's (O' Reilly, 1987).



Plate 2.2. Loughaphreaghaun, looking south along the lake

2.1.2.2 Lough Adrehid

Lough Adrehid is located between Lough Bofin and Lough Agraftard, 7km west of Oughterard, Co. Galway (Plate 2.3, Fig. 2.1). The famous 'Quiet Man Bridge' is located at the end of Lough Adrehid. The

bridge is also a well-known tourist attraction as the 1950s film 'The Quiet Man' was filmed in the area. It has a surface area of 7.5ha, a mean depth of 1.9m and a maximum depth of 8.8m. The lake is categorised as typology class 1, i.e. shallow (<4m), less than 50ha and low alkalinity (<20mg/l CaCO₃). The estimated terrain elevation above sea level is 37 metres.

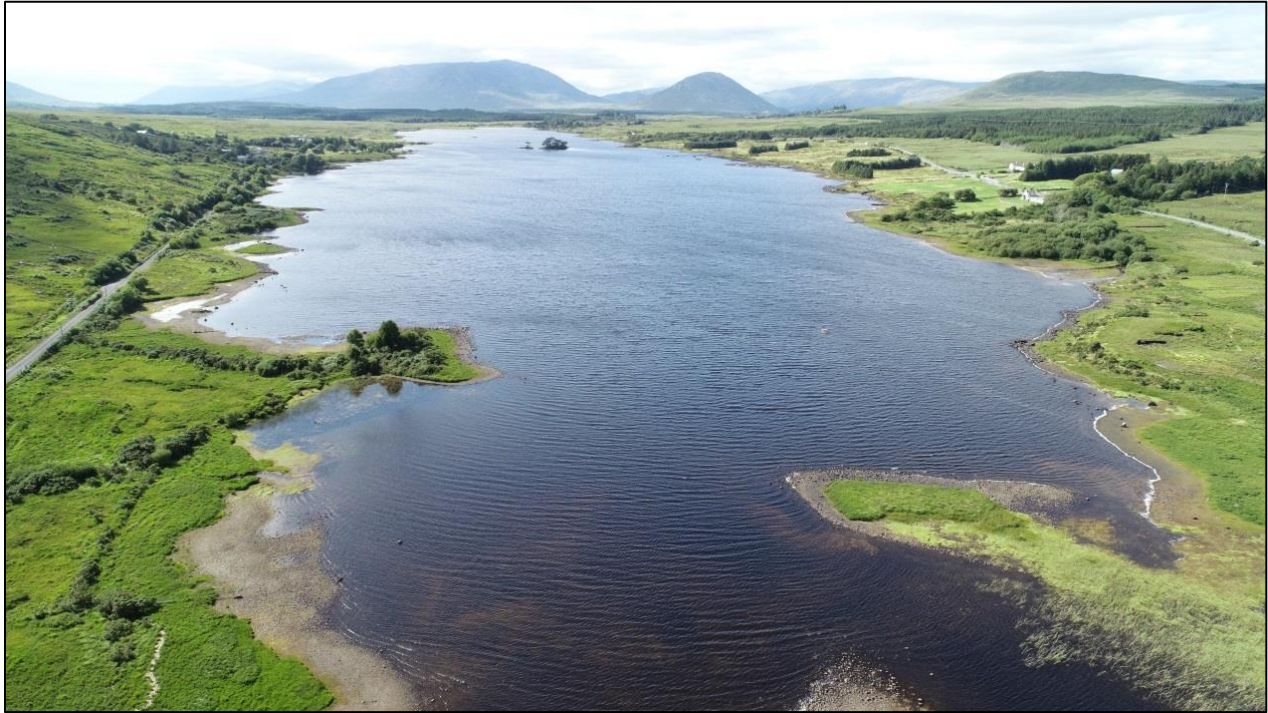


Plate 2.3. Lough Adrehid, looking west from Quiet Man Bridge

2.1.2.3 Lough Ateeann (Leadmine)

Lough Ateeann (also known as Leadmine) is a small shallow lake. It is located off the N59 Oughterard-Maam Cross road less than 1km from the Glengowla silver/lead mine (an historic 19th century silver and lead mine that was abandoned in 1865) and approximately 3.5km south-west of Oughterard, Co. Galway. It is downstream of Lough Agraiffard (Plate 2.4, Fig. 2.1). The estimated terrain elevation above sea level is 25 metres. It has a surface area of 3.8ha, a mean depth of <4m and a maximum depth of 5.0m. The lake is categorised as typology class 1, i.e. shallow (<4m), less than 50ha and low alkalinity (<20mg/l CaCO₃). The lake was known to hold a resident stock of small brown trout, but can hold salmon from Lough Corrib as soon as they run the Oughterard River in May. It was also known to get large Lough Corrib trout from July on their way up the catchment to spawn (O'Reilly, 1987).



Plate 2.4. Lough Ateeann (Leadmine). The Owenriff River main channel enters the lake at the bottom left

2.1.2.4 Shannaghree Lough

Shannaghree Lough is a small bog lake. It is located west of the Oughterard-Costello road approximately 3.5km from Oughterard, Co. Galway on a tributary in the Clooshgreen sub-catchment (Plate 2.5, Fig. 2.1). It has a surface area of 4.3ha, a mean depth of <4m and a maximum depth of 10.6m. The lake is categorised as typology class 1, i.e. shallow (<4m), less than 50ha and low alkalinity (<20mg/l CaCO_3). The estimated terrain elevation above sea level is 90 metres. Lough Shannaghree held small brown trout during the 1980's (O'Reilly, 1987).



Plate 2.5. Lough Shannaghree

2.2 Survey methods

2.2.1 Rivers

Electric-fishing is the method of choice to obtain a representative sample of the fish assemblage in rivers. It is a well-established technique used by fishery biologists globally for sampling fish in freshwaters and is generally the most non-destructive, effective and cost efficient means of sampling freshwater fish, particularly in rivers. Standard methods have been developed by IFI in compliance with the European standards for fish stock assessment in rivers (CEN, 2003 and 2005a). In wadeable rivers fish sampling is normally carried out using area-delineated (ADEF) or timed electric-fishing (TEF), while in non-wadeable rivers surveys are undertaken using boat mounted electric-fishing equipment (area delineated single or multiple pass electric-fishing or point abundance sampling). Methods used on the Owenriff catchment included TEF₁₀ and ADEF (wadeable and non-wadeable (single pass)).

2.2.1.1 TEF₁₀

The TEF₁₀ electric-fishing method involves two operators at a site and requires no stop-nets to isolate the survey stretch. The equipment consisted of one portable generator (220/240V) with an appropriate control unit (DC converter), a cathode and an anode. Electric-fishing took place by wading in a zigzag manner in an upstream direction for exactly ten minutes at a steady pace.

Fish species abundances gathered using TEF were multiplied by the conversion factors outlined in Matson *et al.* (2017), to convert them into an equivalent “Pass 1” minimum estimate for comparison with older surveys that applied depletion electrofishing methodologies. Minimum fish density estimates were then calculated by dividing the total abundance of each species by the surface area sampled.

2.2.1.2 ADEF

In wadeable waters (generally spawning and nursery areas) fish sampling was also carried out using the ADEF method. This consisted of one or more portable generators (220/240 v) with appropriate control units (DC converter), a cathode and an anode. Stop nets were used at the top and bottom of the site to prevent fish escaping from the site during the electrofishing operation and one to three fishings were carried out. Sites were sampled in an upstream direction, from the downstream end of a riffle where available. Sites were chosen to capture a range of habitat types, including riffle, glide and pool.

In deeper waters (non-wadeable) single pass ADEF electrofishing was carried out by boat (SP). This involved the use of a 220v generator with an appropriate control unit along with twin anodes and a trailing cathode, which were mounted in a flat bottomed boat crewed by three staff. Non-wadeable survey sites were surveyed in a downstream direction. No stop nets were used.

2.2.1.4 Fish processing

Fish were held in buckets of fresh cold oxygenated water after they were caught until processing. All fish were identified to species level and counted. Fish lengths and weights were taken and scales were removed from a subsample of species from each site. After processing all fish, with the exception of pike, were returned to the river as soon as possible to avoid further stress.

2.2.1.5 Habitat data

An evaluation of habitat quality is critical to any assessment of ecological integrity and an assessment of habitat was performed at each survey site, with various characteristics recorded including habitat components, substrate composition and bank vegetation structure.

General physical characteristics of the site were also recorded with particular reference being made to river typology, land use, riparian vegetation and instream features such as flow type, and substrate type. Chemical parameters recorded included water temperature and conductivity.

Wetted width and depth were also measured throughout each stretch at three transects, with five depth intervals along each. The percentage of riffle, glide and pool was also estimated in each reach surveyed.

2.2.2 Lakes

2.2.2.1 Loughaphreaghaun

Loughaphreaghaun was surveyed over two nights from the 18th to the 20th of July 2018. A total of three sets of Dutch fyke nets (Fyke), nine benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard (CEN, 2005b) survey gill nets (BM CEN) (4 @ 0-2.9m, 4 @ 3-5.9m and 1 @ 6-11.9m) and five four-panel benthic braided survey gill nets (4-PBB) were deployed in the lake (17 sites) (Fig. 2.3). The 4-PBB 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.

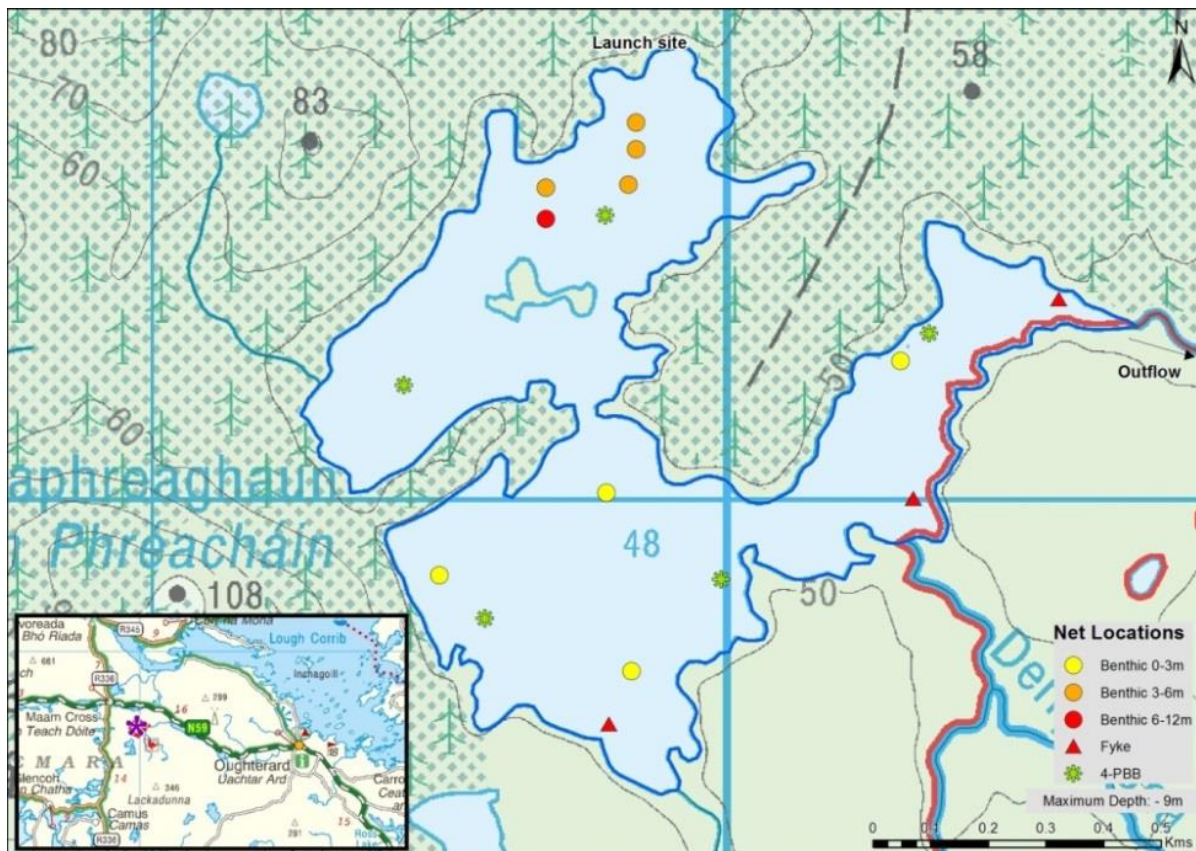


Fig. 2.3. Location map of Loughaphreaghaun showing net locations and depths of each net (outflow is indicated on map)

2.2.2.2 Lough Adrehid

Lough Adrehid was surveyed over one night from the 23rd to the 24th of July 2018. A total of three sets of Dutch fyke nets (Fyke), five benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (2 @ 0-2.9m, 2 @ 3-5.9m and 1 @ 6-11.9m) and two four-panel benthic braided survey gill nets (4-PBB) were deployed in the lake (10 sites) (Fig. 2.4).

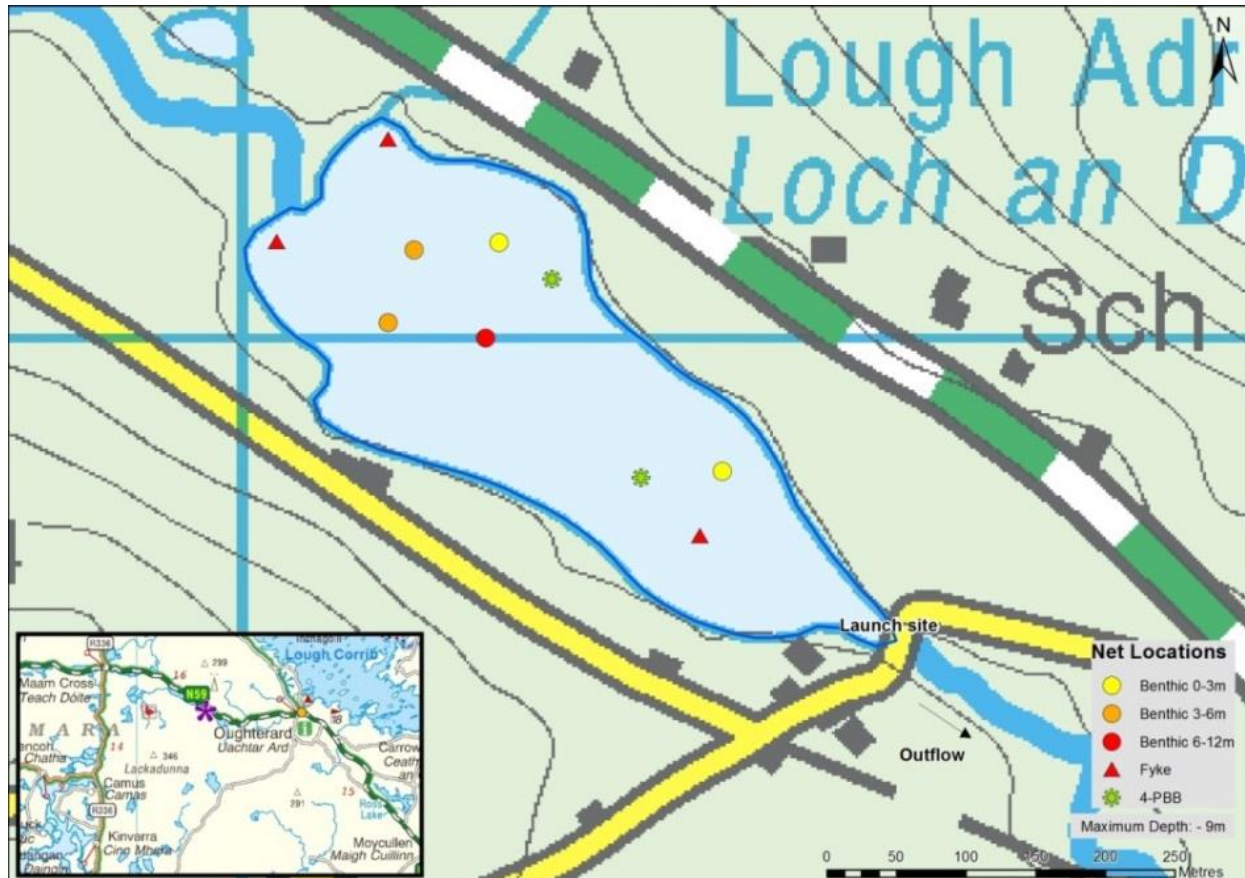


Fig. 2.4. Location map of Lough Adrehid showing net locations and depths of each net (outflow is indicated on map)

2.2.2.3 Lough Ateeann (Leadmine)

Lough Ateeann was surveyed over one night from the 16th to the 17th of July 2018. A total of two sets of Dutch fyke nets (Fyke), four benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (2 @ 0-2.9m and 2 @ 3-5.9m) and one four-panel benthic braided survey gill nets (4-PBB) were deployed in the lake (7 sites) (Fig. 2.5).

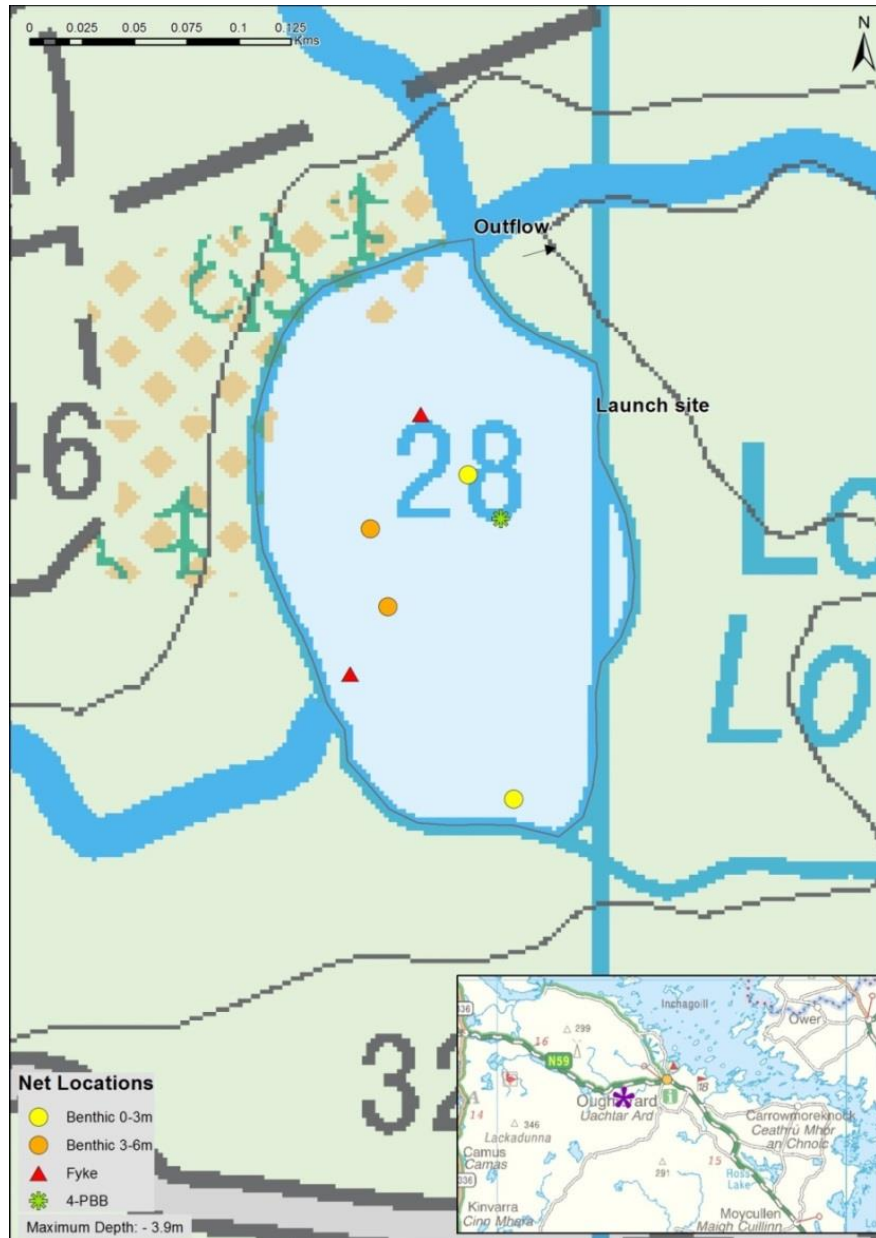


Fig. 2.5. Location map of Lough Ateeann (Leadmine) showing net locations and depths of each net (outflow is indicated on map)

2.2.2.4 Lough Shannaghree

Lough Shannaghree was surveyed over one night from the 24th to the 25th of July 2018. A total of two sets of Dutch fyke nets (Fyke), six benthic monofilament multi-mesh (12 panel, 5-55mm mesh size) CEN standard survey gill nets (BM CEN) (2 @ 0-2.9m, 2 @ 3-5.9m and 2 @ 6-11.9m) and one four-panel benthic braided survey gill nets (4-PBB) were deployed in the lake (9 sites) (Fig. 2.6).

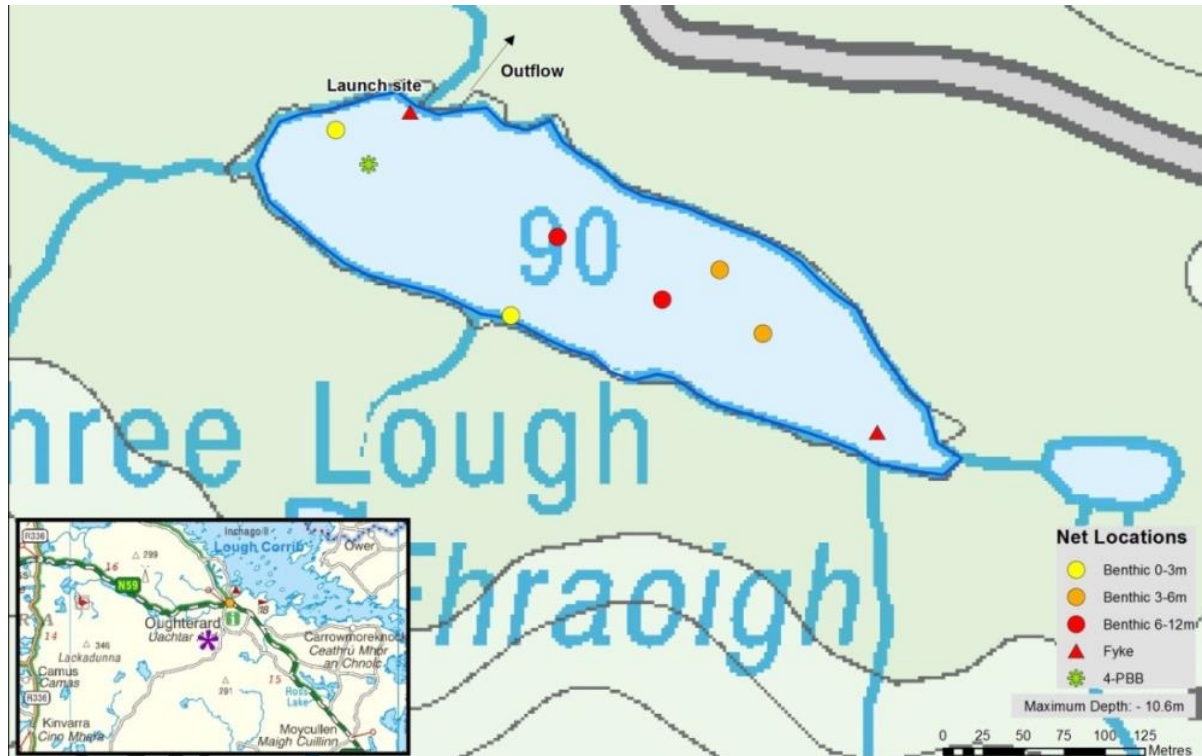


Fig. 2.6. Location map of Lough Shannaghree showing net locations and depths of each net (outflow is indicated on map)

2.2.2.5 Site locations

The site locations for the benthic monofilament multi-mesh gill nets (BM CEN) and the four-panel benthic braided survey gill nets (4-PBB) were chosen randomly within fixed depth zones (0-2.9m, 3-5.9m and 6-11.9m) using available bathymetry data. 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 were measured and weighed on site and scales were removed from all pike. Samples of fish were retained for further analysis.

2.2.3 Fish age and growth

A sub-sample of all fish was aged. All pike were aged. Fish scales were read using a microfiche reader. Growth was determined by back-calculating lengths at the end of each winter using the following formula:

$$Ln = \left(\frac{Sn}{S} \right) * L$$

Where:

Ln= length of fish when annulus “n” was formed
L= length of fish when scale sample was taken
Sn = radius of annulus “n” (at fish length Ln)
S = total scale radius

2.2.4 Fish diet

Fish samples from the river and lake surveys were either dissected in the field and their entire stomach contents preserved in 97% ethanol or the fish were frozen immediately after the survey and transported back to the IFI laboratory for later dissection. The stomach contents of dissected fish were identified to the lowest taxonomic level, i.e. species of fish and family for invertebrates.

The percentage frequency occurrence (%FO) of prey items were then calculated to identify key prey items (Amundsen *et al.*, 1996).

$$\%FO_i = \left(\frac{N_i}{N} \right) * 100$$

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.

For pike stomach content analysis, fish-prey were identified, enumerated and each individual prey item weighed to the nearest 0.001g. Invertebrate prey were enumerated and assigned to an appropriate taxonomic level and the combined weight of all prey within each group was determined for each stomach. Prey species, numbers of prey and prey weight were thus available for each stomach examined.

2.2.5 Data analysis

Electric-fishing results from the different methods employed were standardized to provide minimum densities of captured fish per m² (Matson *et al.*, 2017). Fish abundance (mean CPUE) and biomass (mean BPUE) from lakes 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.

2.2.6 Quality Assurance

CEN (2005) recommends that all activities undertaken during the standard fish sampling protocol (e.g. training, handling of equipment, fish handling, fish identification, etc.) should be subjected to a quality assurance programme in order to produce consistent results of high quality. A number of quality control procedures were implemented for the current programme, for example; every tenth fish scale was checked in the laboratory by a second biologist experienced in age analysis techniques.

2.2.7 Biosecurity 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 was followed by staff undertaking the survey on the Owenriff catchment.

2.2.8 Fish ecological status

2.2.8.1 Rivers

An ecological classification tool for fish in rivers (Fisheries Classification Scheme 2 (FCS2-Ireland)) was developed in 2011 to assign ecological status to fish in rivers for the Republic of Ireland and Northern Ireland along with a separate version for Scotland (SNIFFER, 2011). FCS2-Ireland is a geostatistical model based on Bayesian probabilities and works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) condition. The resulting output is an Ecological Quality Rating (EQR) between 1 and 0 for each site, corresponding to the five different ecological status classes of High, Good, Moderate, Poor and Bad

(SNIFFER, 2011). Confidence levels are then assigned to each class and represented as probabilities. The tool has been successfully inter-calibrated in a cross-Europe exercise (EC, 2013).

All outputs of the tool are sense-checked annually by experienced users. Using this tool and expert opinion, each river site surveyed on the Owenriff River system was assigned a draft fish classification status.

2.2.8.1 Lakes

A multimetric fish in lakes 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 Interreg funded 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). FIL2 was also successfully intercalibrated in a cross-Europe Exercise (EC, 2013). Using this tool and expert opinion, each lake surveyed in the catchment was assigned a draft fish classification status.

3. Results

3.1 Rivers

3.1.1 Species richness

Six fish species were recorded at thirty four sites surveyed on the Owenriff River Catchment in 2018 (Table 3.1). Brown trout and salmon were the two most frequently encountered fish species, recorded in 22 and 18 sites respectively. These results are consistent with the 2017 survey (IFI, 2018). Minnow, pike, three-spined stickleback and eel were also recorded during the survey (Table 3.1).

Table 3.1. List of fish species recorded in the 34 survey sites, Owenriff catchment, July 2018. Number of sites and overall percentage at which each fish species was recorded is also included

Common name & age cohort	Species name	Number of river sites	% of river sites
Brown trout	<i>Salmo trutta</i>	22	66.7
0+ brown trout		16	48.5
1+ & older brown trout		18	54.6
Salmon	<i>Salmo salar</i>	18	54.6
0+ salmon		17	51.5
1+ & older salmon		16	48.5
Minnow	<i>Phoxinus phoxinus</i>	13	39.4
Pike	<i>Esox lucius</i>	6	18.2
Three-spined stickleback	<i>Gasterosteus aculeatus</i>	2	6.1
European eel	<i>Anguilla anguilla</i>	1	3.0

3.1.2 Fish abundance

3.1.2.1 Owenriff River (main channel)

Ten sites were surveyed on the Owenriff main channel in 2018 (Fig. 2.2). Salmon were recorded at six main channel sites (Table 3.2) and were dominant at sites where they were present with the exception of sites 22 and 23. The highest densities of salmon on the main channel were recorded at site 18 (1km d/s of Lough Agraftard) (0+ = 0.895fish/m²; 1+ & older = 0.326 fish /m²), followed by sites 21 and 33 (Glengowla Mine and West of Lough Ateeann). Salmon ranged in length from 3cm to 14cm and were aged between 0+ and 1+. In general 0+ salmon were more abundant than 1+ and older fish.

Brown trout were recorded at four sites on the Owenriff main channel during the 2018 fish stock survey. Brown trout densities were generally low or absent across sites surveyed on the main Owenriff channel. The highest 0+ brown trout density (0.057 fish/m²) was recorded at site 18 (1 km d/s of Lough Agraiffard (Table 3.2 and Fig. 3.1). 1+ and older trout were recorded at three main channel sites (13, 21 and 33) in 2018 (Table 3.2 and Fig. 3.1).

Pike were recorded at six sites (18.2%), and the only fish species recorded at sites 6 and 7 at relatively low densities (mean = 0.05 fish/m²) (Table 3.2).

Minnow were recorded in 29% of sites surveyed. The highest density (0.258/m²) was encountered at Site 21 (Glengowla Mine). Three-spined stickleback were recorded at two sites and a single European eel was recorded at site 22 (d/s of Glengowla Mine) (Table 3.2).



Plate 3.1. Owenriff main channel downstream of Glengowla Mine (site 22), 2018

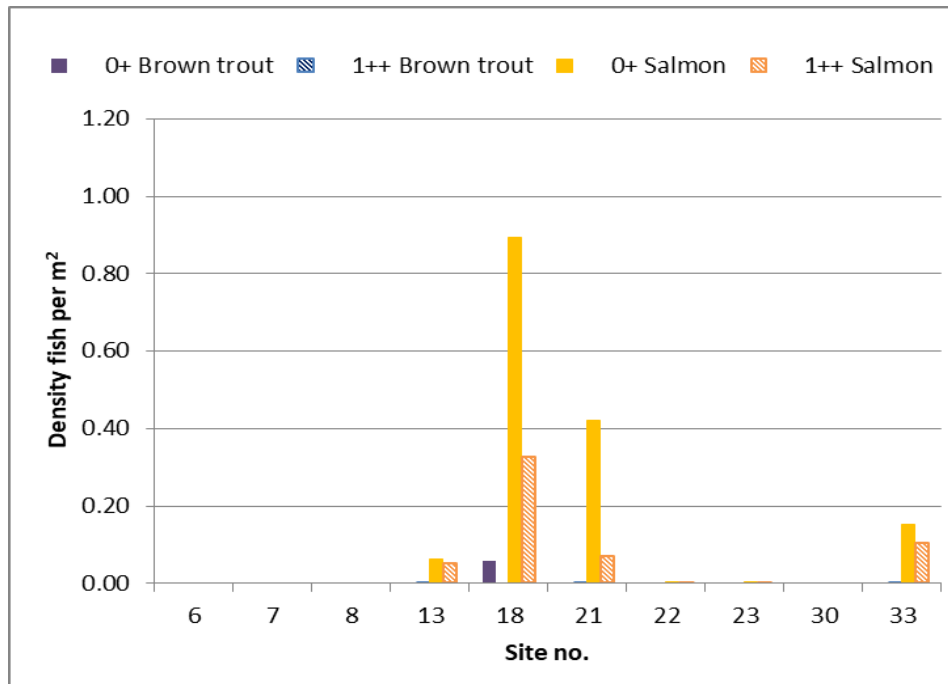


Fig. 3.1. Minimum densities of brown trout and salmon on the Owenriff main channel, 2018

Table 3.2: Minimum density estimate (no. fish per m²) of fish species captured on the Owenriff main channel, July 2018

Species	Site no.									
	6	7	8	13	18	21	22	23	30	33
Brown trout	-	-	-	0.005	0.057	0.008	-	-	-	0.007
0+ brown trout	-	-	-	-	0.057	-	-	-	-	-
1+& older brown trout	-	-	-	0.005	-	0.008	-	-	-	0.007
European eel	-	-	-	-	-	-	0.001	-	-	-
Pike	0.001	0.001	-	0.025	-	-	-	0.003	0.001	0.002
Minnow	-	-	-	0.010	0.122	0.258	0.014	0.014	0.012	0.013
Three-spined stickleback	-	-	-	-	-	-	-	-	-	-
Salmon	-	-	-	0.113	1.221	0.490	0.006	0.007	-	0.256
0+ salmon	-	-	-	0.064	0.895	0.421	0.002	0.003	-	0.153
1+ & older salmon	-	-	-	0.049	0.326	0.068	0.004	0.004	-	0.103
All fish	0.001	0.001	0.000	0.152	1.400	0.755	0.021	0.025	0.013	0.278

3.1.2.2 - Owenriff tributaries

Brown trout were recorded at 18 of the 24 tributary sites surveyed in 2018 (more details are available in Appendix 1). Brown trout fry (0+) and older brown trout (1+ and older) were present at 15 sites each (Fig. 3.2 and Table 3.3). The highest densities recorded for 0+ (0.51 fish/m²) and 1+ and older brown trout (0.423 fish/m²) were recorded at Site 24 (Knockbaun Upper – Bunowen sub-catchment).

Salmon were encountered at 12 of the tributary sites surveyed, with the highest total density (1.213 fish/m²) recorded at Site 28 (Clooshgereen Track) (Fig. 3.2 and Table 3.3). Salmon fry (0+) were present at 11 sites while salmon 1+ and older were recorded at four sites (Fig. 3.2 and Table 3.3). The highest densities recorded for 0+ salmon (1.065 fish/m² and 0.959) were noted at site 12 (Knockmoyle Lower) and site 28 (Clooshgereen Track) respectively while the highest density of 1+ and older salmon (0.253 fish/m²) was also recorded at site 28 (Table 3.3).

Minnow were recorded at six tributary sites with their greatest density (2.477 fish/m²) recorded at site 12 (Knockmoyle Lower). Pike were not recorded in any tributary sites.

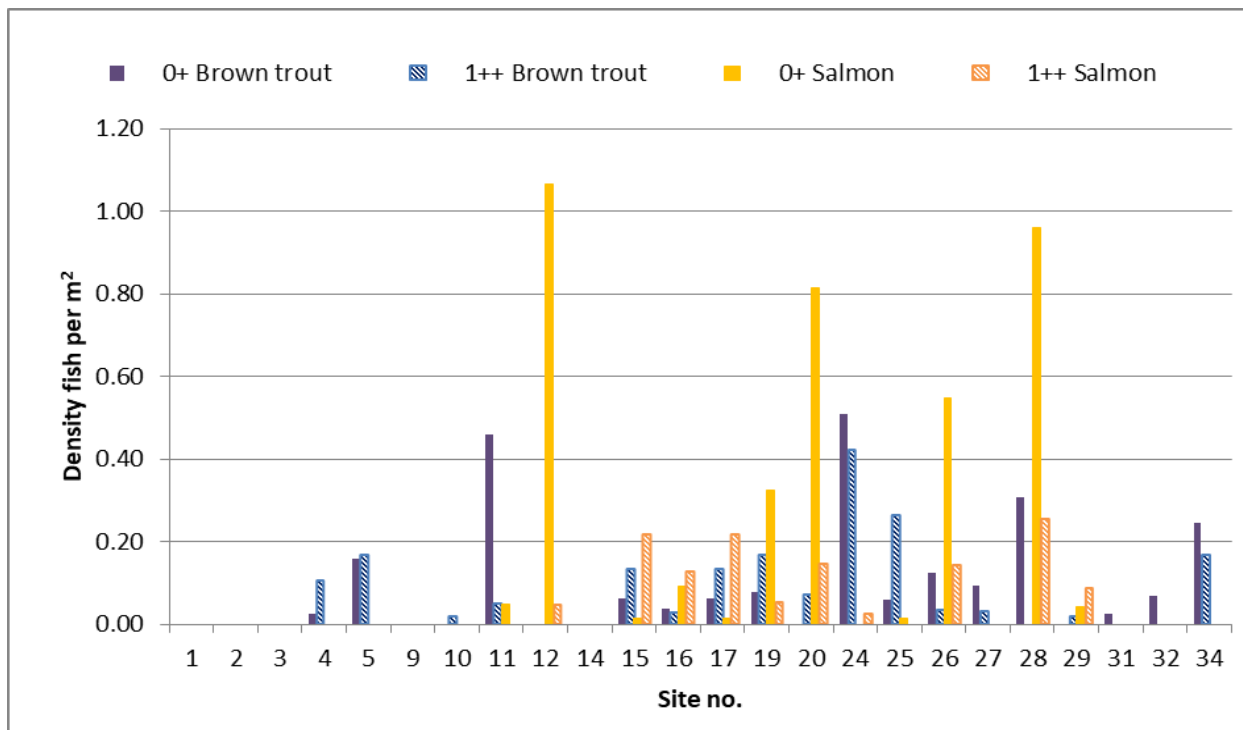


Fig. 3.2. Minimum densities of brown trout and salmon on the Owenriff tributaries, 2018

3.1.3 Age and length frequency

3.1.3.1 Brown trout

A total of 205 brown trout were captured during the catchment wide electrofishing survey on the Owenriff catchment in July 2018. Brown trout ranged in length from 3.4cm to 23cm and ranged in age from 0+ to 3+ (Figs. 3.3 and 3.4). Most brown trout were within the 0+ (57%) and 1+ age classes (35%) (Fig. 3.4). Only two age classes were recorded on the main channel (0+ and 1+), while four age classes were recorded on the tributary streams (Table 3.4). Fish aged 2+ ranged in length from 11.79cm to 16.4cm. The largest (23cm) and oldest (3+) fish was captured on the Derrylaura stream at Clare townland (Site 34).

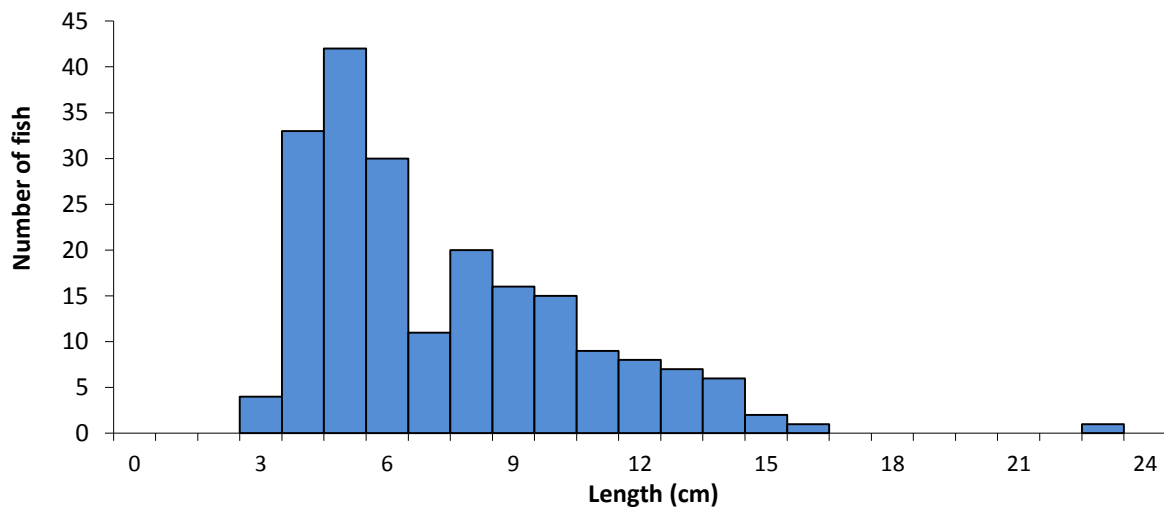


Fig. 3.3. Length frequency distribution of brown trout on the Owenriff river survey sites (all sites combined), 2018 (n= 205)

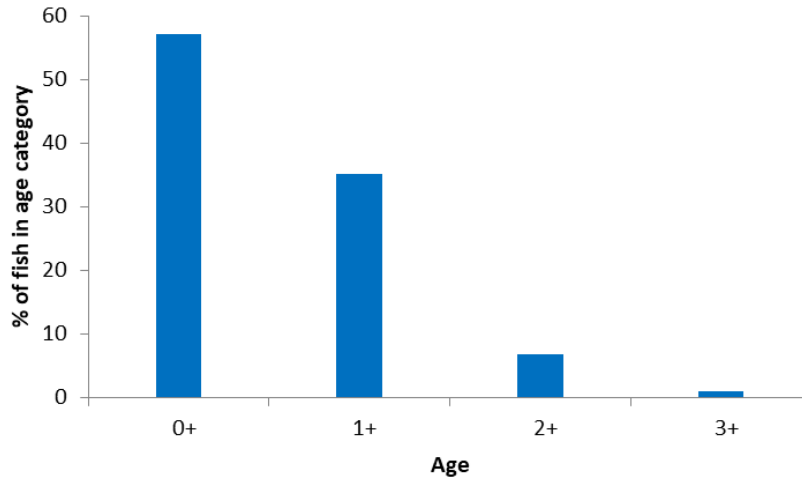


Fig. 3.4. Brown trout age class structure (n=205), Owenriff river survey sites 2018 (all sites combined)

Table 3.4. Brown trout age class structure (%) site at each survey site (n=205), Owenriff Catchment 2018

Site No.	% of catch				Site No.	% of catch			
	0+	1+	2+	3+		0+	1+	2+	3+
Main channel									
6	-	-	-	-	21	-	100	-	-
7	-	-	-	-	22	-	-	-	-
8	-	-	-	-	23	-	-	-	-
13	-	100	-	-	30	-	-	-	-
18	100	-	-	-	33	-	100	-	-
Sub-catchments									
1	-	-	-	-	17	100	-	-	-
2	-	-	-	-	19	40	60	-	-
3	-	-	-	-	20	-	100	-	-
4	-	88	13	-	24	62	26	12	-
5	53	29	18	-	25	23	64	9	5
9	-	-	-	-	26	80	20	-	-
10	-	-	100	-	27	80	20	-	-
11	92	8	-	-	28	100	-	-	-
12	-	-	-	-	29	-	100	-	-
14	-	-	-	-	31	100	-	-	-
15	38	54	8	-	32	100	-	-	-
16	57	43	-	-	34	67	20	7	7

3.1.3.2 Salmon

A total of 682 salmon were captured during the catchment wide electrofishing survey on the Owenriff catchment in 2018. Salmon ranged in length from 2cm to 14cm across all the sites surveyed in 2018 (Fig. 3.5). Three age classes of salmon were recorded, with 0+ the most abundant cohort (Fig. 3.6). Salmon aged 2+ were recorded at one site only on the Bunowen river at Knockbaun upper (site 24) (Table 3.5).

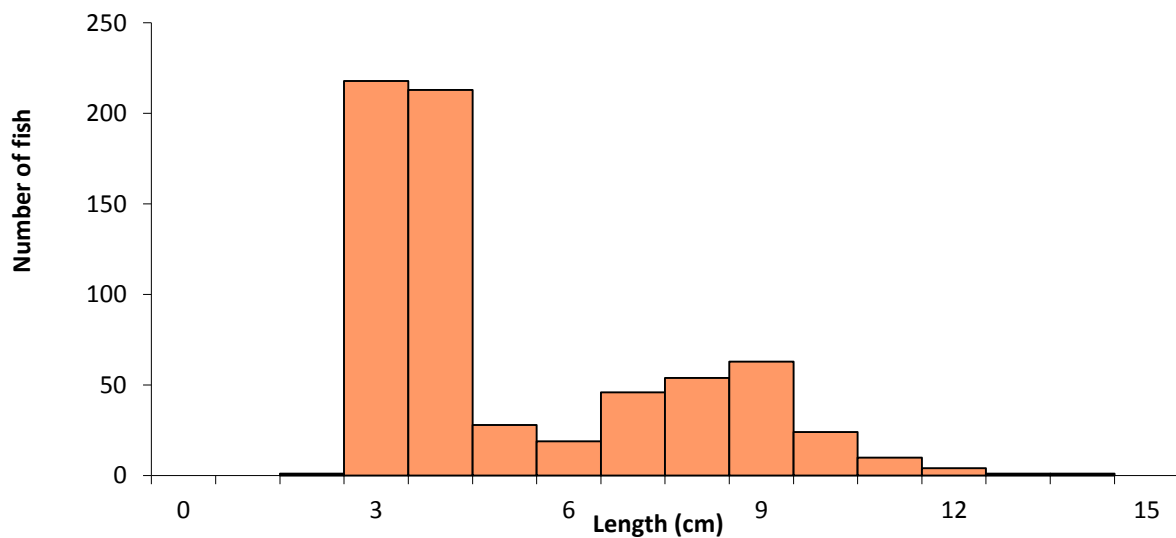


Fig. 3.5. Length frequency distribution of Atlantic salmon in the Owenriff river survey sites (all sites combined), 2018 (n=682)

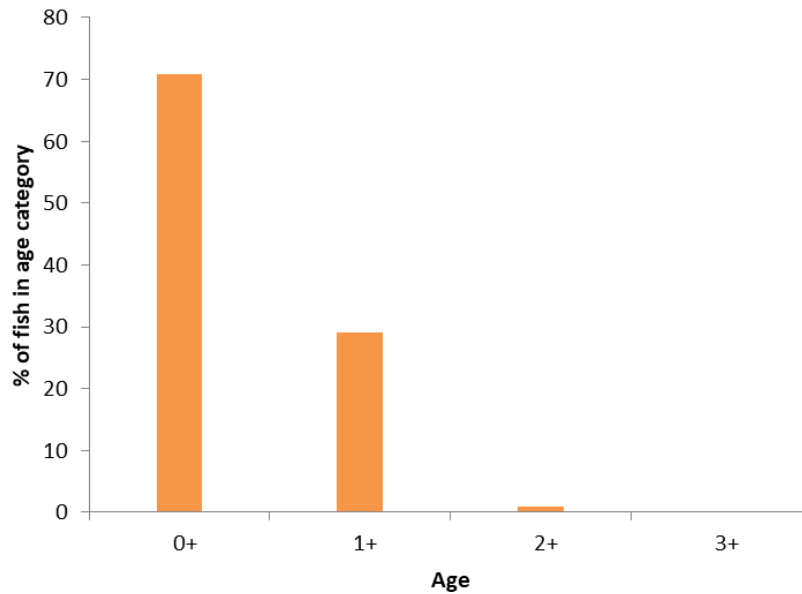


Fig. 3.6. Salmon age class structure (n=682), Owenriff river survey sites 2018 (all sites combined)

Table 3.5. Salmon age class structure (%) at each survey site (n=682), Owenriff catchment 2018

Site No.	% of catch				Site No.	% of catch			
	0+	1+	2+	3+		0+	1+	2+	3+
Main channel									
6	-	-	-	-	21	86	14	-	-
7	-	-	-	-	22	40	60	-	-
8	-	-	-	-	23	40	60	-	-
13	57	43	-	-	30	-	-	-	-
18	73	27	-	-	33	60	40	-	-
Sub-catchments									
1	-	-	-	-	17	71	29	-	-
2	-	-	-	-	19	89	11	-	-
3	-	-	-	-	20	88	13	-	-
4	-	-	-	-	24	-	-	100	-
5	-	-	-	-	25	100	-	-	-
9	-	-	-	-	26	83	17	-	-
10	-	-	-	-	27	-	-	-	-
11	100	-	-	-	28	83	17	-	-
12	96	4	-	-	29	38	63	-	-
14	-	-	-	-	31	-	-	-	-
15	7	93	-	-	32	-	-	-	-
16	42	58	-	-	34	-	-	-	-

3.1.3.3 Pike

Twelve pike were recorded during the 2018 river survey and ranged in length from 8 to 31.9cm (Fig. 3.7). Ten of these pike were aged 0+, with the remaining aged 2+ (Fig. 3.8 and Table 3.6). The two largest pike captured measured 29.9 and 31.9cm and were aged at 2+.

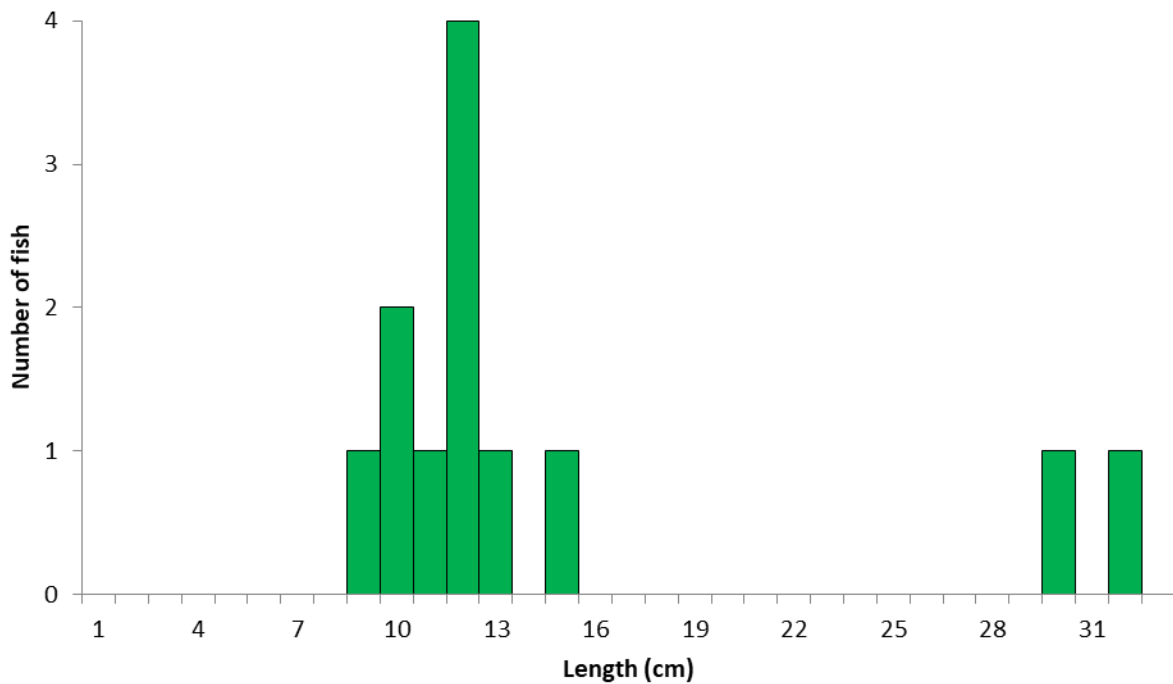


Fig. 3.7 Length frequency distribution of Pike in the Owenriff river survey sites (all sites combined), 2018 (n=12)

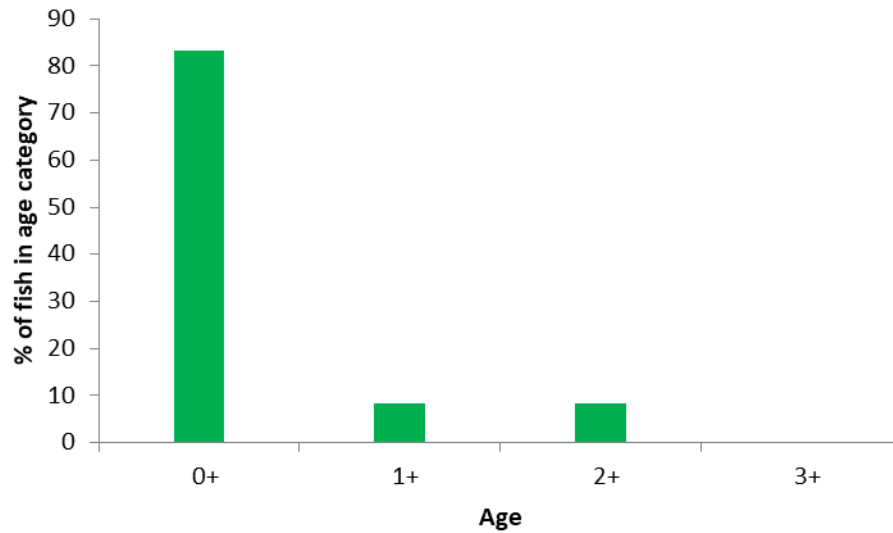


Figure 3.8. Pike age class structure (n=12), Owenriff river survey sites 2018 (all sites combined)

Table 3.6. Pike age class structure (%) (n=12), Owenriff Catchment 2018 (all sites)

Site No.	% of catch				Site No.	% of catch			
	0+	1+	2+	3+		0+	1+	2+	3+
Main channel									
6	-	-	100	-	21	-	-	-	-
7	-	-	100	-	22	-	-	-	-
8	-	-	-	-	23	100	-	-	-
13	100	-	-	-	30	100	-	-	-
18	-	-	-	-	33	100	-	-	-
Sub-catchments									
1	-	-	-	-	17	-	-	-	-
2	-	-	-	-	19	-	-	-	-
3	-	-	-	-	20	-	-	-	-
4	-	-	-	-	24	-	-	-	-
5	-	-	-	-	25	-	-	-	-
9	-	-	-	-	26	-	-	-	-
10	-	-	-	-	27	-	-	-	-
11	-	-	-	-	28	-	-	-	-
12	-	-	-	-	29	-	-	-	-
14	-	-	-	-	31	-	-	-	-
15	-	-	-	-	32	-	-	-	-
16	-	-	-	-	34	-	-	-	-

3.1.4 Stomach and diet analysis

A total of 11 pike were available for diet analysis from river surveys, ranging in length from 7.9cm to 31.9cm. Four stomachs (36.4%) were empty. Of those stomachs which contained food, three (42.9%) contained invertebrates and four (57.1%) contained fish (3 minnow and 1 unidentified fish). While those feeding on invertebrates spanned the full length range of pike sampled (7.9cm - 31.9cm), the four pike which contained fish were all small, Young of Year (YOY) individuals, ranging in length from 9.1cm - 10.2cm.

3.1.5 Comparison of 2018 rivers data to previous surveys (1997 and 2017)

Catchment wide electrofishing surveys were carried out within the Owenriff catchment in 1997, as part of the National Development Plan (NDP) funded Tourism Angling Measure (TAM) (IFI unpublished data, 1997) prior to the first official record of pike in the catchment. A second catchment wide survey funded by the Western River Basin District, for Water Framework Directive purposes, was undertaken in the catchment in 2007, primarily focussing on salmon (WRBD, 2008). Three and six of the 1997 sites were re-surveyed in 2017 and 2018 (Table 3.7), respectively, as part of the Owenriff fish stock assessment programme. While the sampling methods employed during the 1997 survey differed slightly (i.e. TEF₁₀ was not employed during the 1997 survey) and sampling locations are not always the same as those in the 2017-2018 surveys, the information collected does allow for comparison of minimum densities (fish/m²) and distribution of fish species between years at a catchment level. Where survey sites overlap, a direct comparison is made.

Species richness (1997 vs. 2017/18)

Five fish species were recorded in 1997, while four and six species were recorded in the 2007, 2017 and 2018, respectively (Table 3.7). The most significant difference in species composition between the three eras is the presence of pike, which were not captured in the 1997 and 2007 surveys (Table 3.7). Pike were first recorded in an electrofishing survey on the Owenriff in 2015 at site 18 on the main channel. This site is a Water Framework Directive surveillance monitoring site that is subject to regular monitoring by IFI (Kelly *et al.*, 2011 and 2017) and the Environmental Protection Agency.

Table 3.7. Fish species recorded in the Owenriff in 1997, 2017 and 2018 catchment wide surveys

Fish Species	Survey Year			
	1997	2007	2017	2018
Brown trout	✓	✓	✓	✓
Salmon	✓	✓	✓	✓
Minnow	✓	✓	✓	✓
Pike	-	-	✓	✓
Three-spined stickleback	✓	-	-	✓
European eel	✓	✓	-	✓

Fish abundance (1997 vs. 2017/2018)

A comparison of the overall electrofishing results between eras indicates a reduction in total mean minimum density for brown trout between the 1997 and 2017/2018 surveys (Figure 3.9).

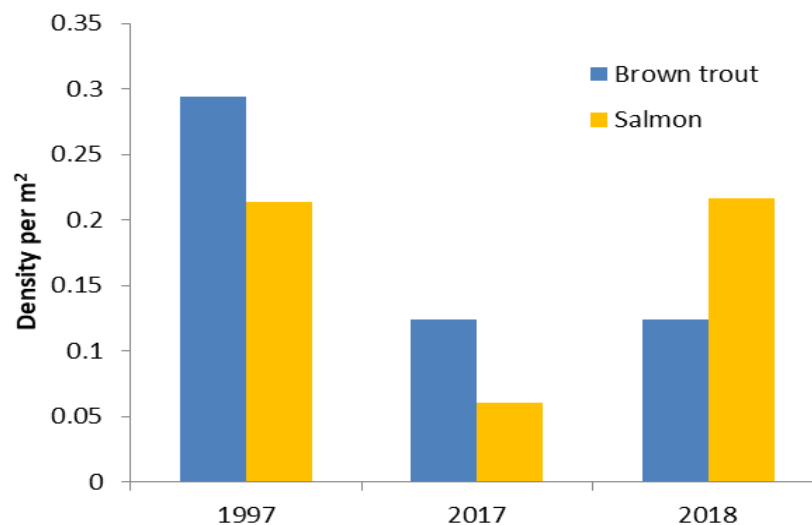


Figure 3.9. Mean minimum densities for brown trout and salmon in 1997, 2017 and 2018 surveys

Results also indicate that brown trout fry (0+) recruitment in 2017 and 2018 was reduced with lower median and quartile range catch values across sites between survey years (Figure 3.10). The overall proportion of 1+ and older brown trout recorded in the 2017 and 2018 surveys was slightly higher than in the 1997 survey (Figs. 3.10); however, overall densities for 1+ and older brown trout were relatively low in all survey years. Total brown trout mean minimum density was significantly lower in 2018 compared to 1997 (two-tailed (Wilcoxon) Mann-Whitney U test, $z = -0.196$, $P = 0.050$). Total brown trout

densities (all year classes) were not significantly different between the 2017 and 2018 surveys (two-tailed (Wilcoxon) Mann-Whitney U test, $z=-0.617$, $P=0.0453$).

The overall mean minimum density for salmon in the Owenriff catchment between the 1997 and 2018 was comparable (0.213 vs. 0.216 fish/m² respectively) (Fig. 3.11). Overall mean salmon density was lower in 2017 (0.06 fish/m²). Notably, overall salmon densities in 2018 were inflated by high numbers of 0+ fish recorded at sites 12 (Knockmoyle Lower) and 28 (Clooshgreen track).

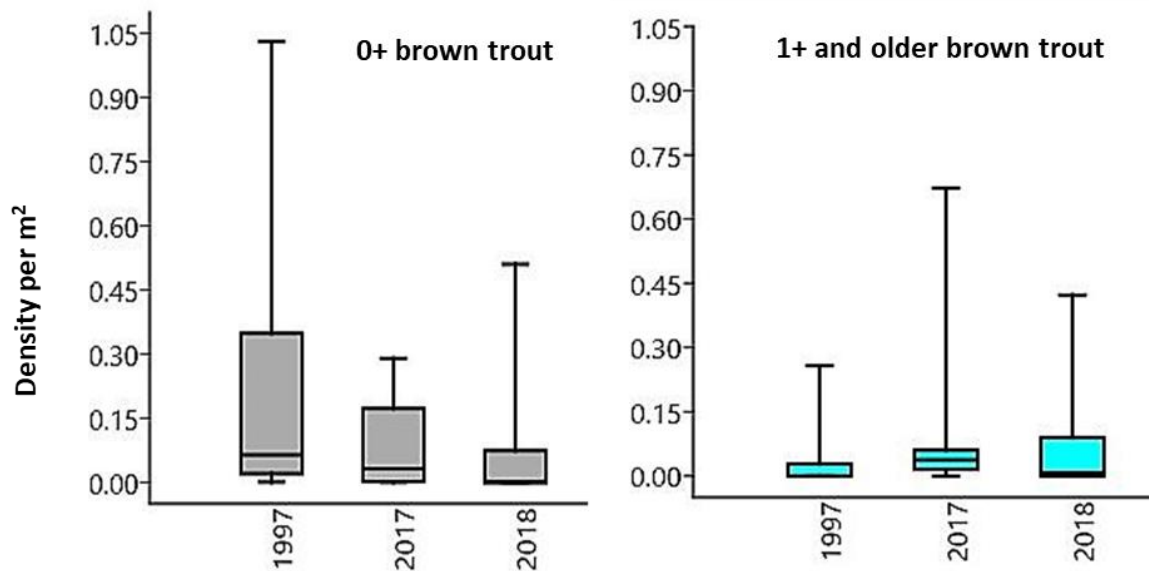


Figure 3.10. Box plot showing 0+ (left) and 1+ and older (right) brown trout minimum densities (number of fish per m²) recorded in the Owenriff 1997, 2017 and 2018 surveys. For each year sample, the 25 and 75 per cent quartiles are marked by the upper and lower boundaries of each box. The median is shown as a horizontal line inside the box. The minimal and maximal values are shown as short horizontal lines ("whiskers")

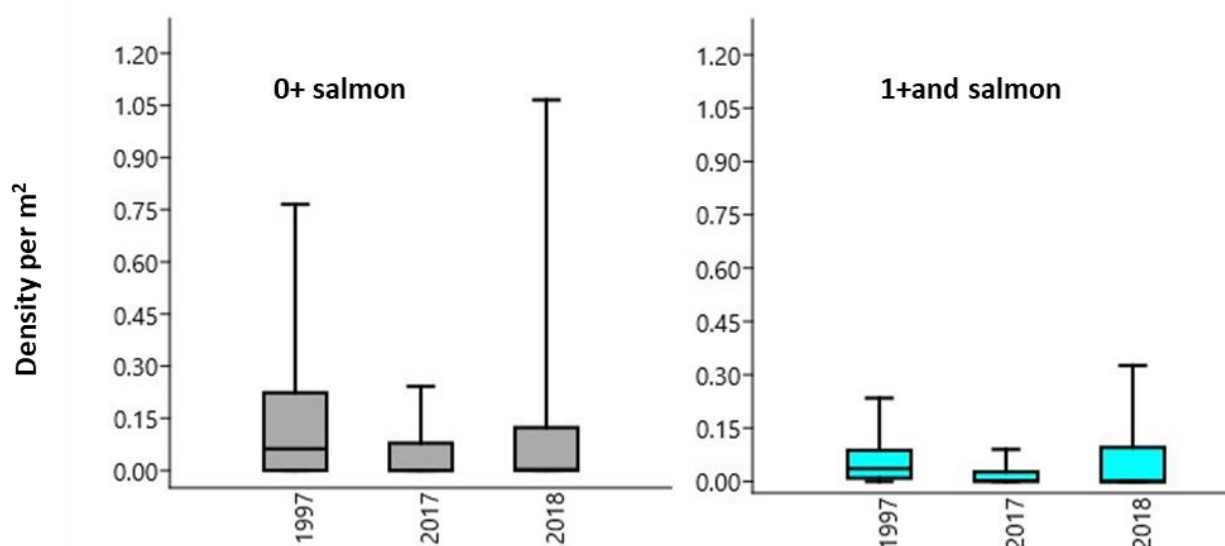


Figure 3.11. Box plot showing 0+ (left) and 1++ (right) salmon minimum densities (number of fish per m²) recorded in the Owenriff 1997, 2017 and 2018 surveys. For each year sample, the 25 and 75 percent quartiles are marked by the upper and lower boundaries of each box. The median is shown as a horizontal line inside the box. The minimal and maximal values are shown as short horizontal lines ("whiskers")

Fish abundance - paired sites - 1997 vs. 2018

Six sites were surveyed in both 1997 and 2018 which allows for a direct comparison between sites (Table 3.8 and Fig. 3.12). Three sites from the 2017 survey are also referred to as they overlap with the 1997 survey. Two of these sites, 29 (Rusheeney East) and 34 (Clare), were surveyed in all years (1997-2017-2018). Generally, there appears to be a trend for decreasing population density estimates from 1997 to 2018 for brown trout (Table 3.8 and Fig. 3.12). 1+ and older brown trout were absent from three of the six paired sites where they were previously recorded in 1997 (Fig. 3.12). Total brown trout densities were slightly higher in 2017 than 1997 at Site 29, but were reduced in 2018. Brown trout densities were also showing a downward trend at Site 34 from 1997 to 2018 (Table 3.8). A higher salmon fry (0+) density was observed in 2018 compared to 1997 at three sites (12, 19 and 28 in the Knockmoyle, Rusheeney and Clooshghereeen sub-catchments respectively), but salmon fry were also absent at three sites where they were previously recorded (Fig. 3.12).



Table 3.8: Total minimum densities (no. fish/m²) for trout and salmon from sites surveyed in 1997, 2017 and 2018

River	Site name	Site no.	1997		2017		2018	
			Trout	Salmon	Trout	Salmon	Trout	Salmon
Main channel								
Owenriff River	1 km d/s of Lough Agraiffard	18	-	-	0.008	0.277	0.057	1.221
Sub-catchments								
Letterfore River	Letterfore	4	-	-	0.026	0.012	0.131	0.000
Knockmoyle R.	Knockmoyle Br.	11	1.293	0.131	0.300	0.000	-	-
Knockmoyle R.	Knockmoyle Lower	12	0.213	0.806	-	-	0.000	1.113
Rusheeny R.	Rusheeny Forest	19	0.103	0.155	-	-	0.247	0.377
Bunowen R.	North of L. Ateeann	26	-	-	0.196	0.000	0.159	0.690
Clooshgereen R.	Clooshgereen Track	28	0.554	0.862	-	-	0.308	1.212
Clooshgereen R.	Rusheeny East	29	0.042	0.049	0.054	0.031	0.018	0.132
Canrawer R.	Canrawer West	32	0.256	0.784	-	-	0.069	0.000
Derrylaura River	- Clare	34	0.765	0.000	0.549	0.000	0.415	0.000

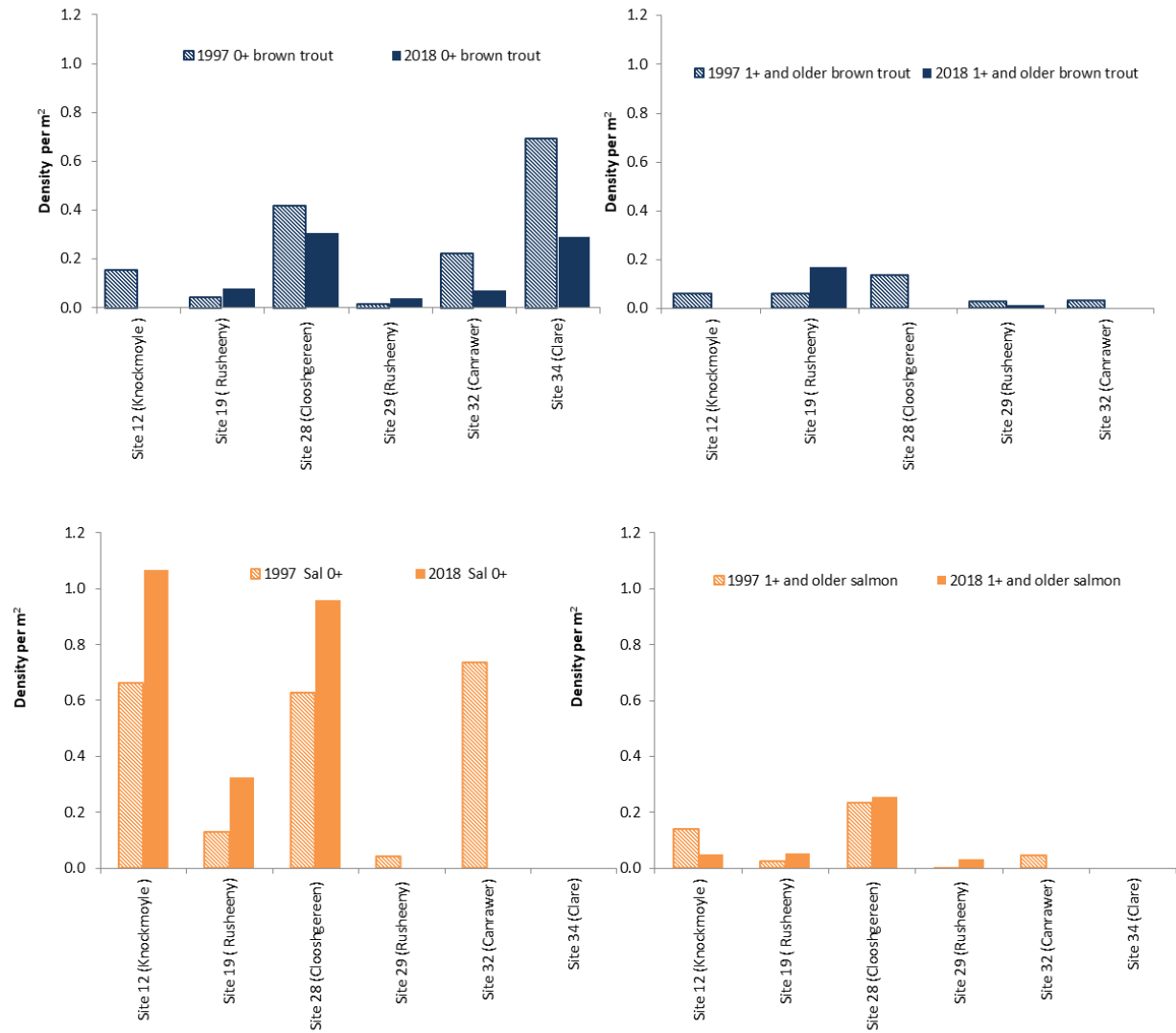


Figure 3.12. Comparison of minimum fish density estimates for paired sites on the Owenriff catchment, 1997 and 2018

3.1.6 Comparison of fish stocks in the Owenriff and Cornamona catchments

For comparison purposes a second catchment, Cornamona, on the western side of the Corrib catchment was also surveyed in 2018. The Cornamona catchment was also surveyed in 1996 as part of the Tourism Angling Programme (TAM – IFI unpublished data, 1996). 36 and 16 sites were surveyed in 1996 and 2018, respectively and six of these were surveyed in both years allowing for a comparison of minimum densities (fish per m^2) and distribution of fish species between years at a catchment and site level.

Results from the Cornamona catchment between years shows average minimum densities of 0.524 fish/ m^2 to 0.444 fish/ m^2 for total brown trout (all age classes) in 1996 and 2018, respectively (Fig. 3.13). Overall, total brown trout density was not significantly lower in 2018 compared to 1996 (two-tailed (Wilcoxon) Mann-Whitney U test, $z=-0.1080$, $P=0.23$). This differs with the Owenriff catchment where average total brown trout densities have decreased between the 1997 and 2017/2018 surveys (Figure 3.13). In contrast the average density for total salmon (all year classes) in the Cornamona catchment was lower in the 2018 survey compared to 1996 with average total minimum densities ranging from 0.261 to 0.419 fish per m^2 , respectively; however there was no significant difference between years. Salmon fry recruitment was generally higher at a site level in 2018 indicated by the higher median value (Fig. 3.13).

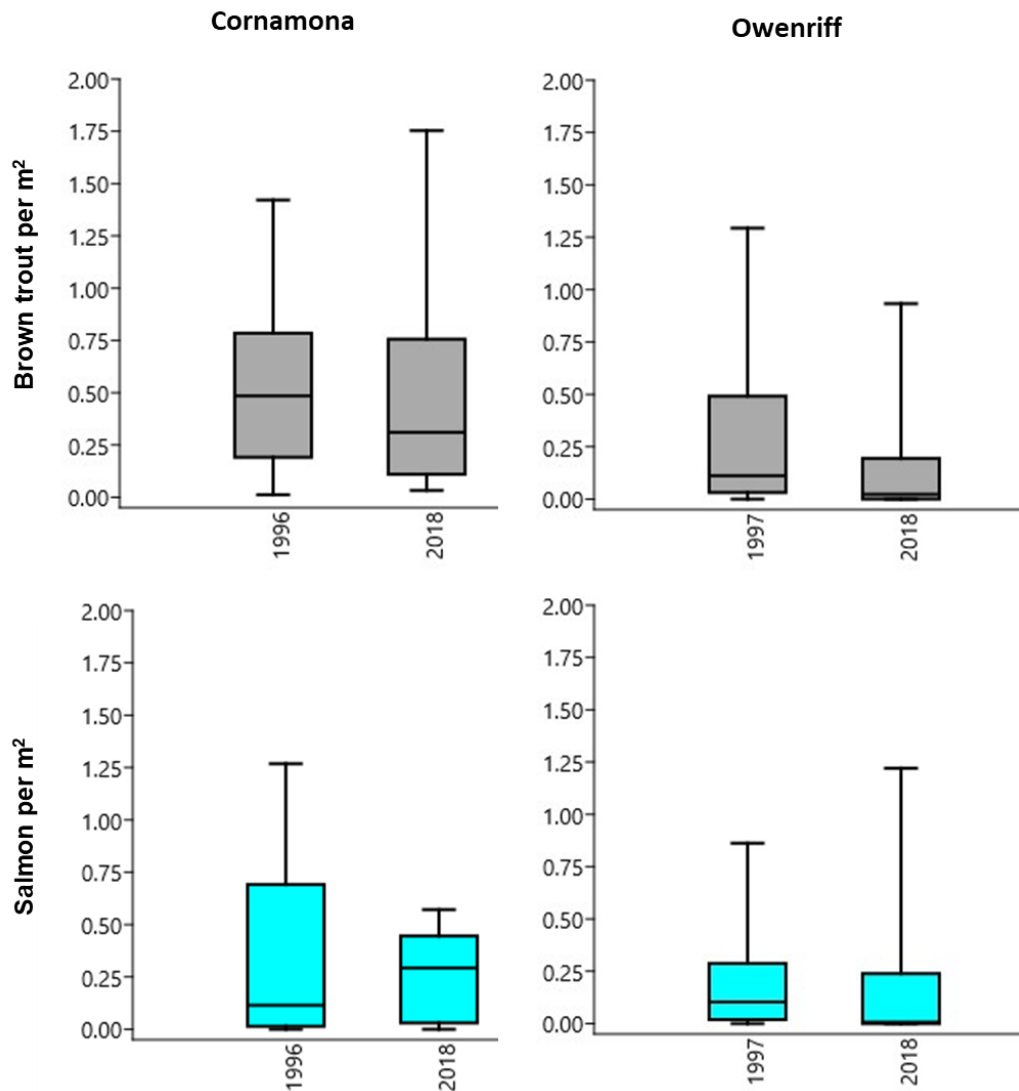


Figure 3.13. Box plot showing brown trout (top) and salmon (bottom) minimum densities (no. fish/m²) recorded in the Cornamona (left) and Owenriff (right) catchments, 1996/97 and 2018 surveys. For each year sample, the 25 and 75 percent quartiles are marked by the upper and lower boundaries of each box. The median is shown as a horizontal line inside the box. The minimal and maximal values are shown as short horizontal lines ("whiskers")

3.2 Lakes

3.2.1 Fish species richness

Two fish species were recorded in both Loughaphreaghaun and Lough Adrehid in July 2018, with only four and six fish being captured respectively (Table 3.8). Only pike were recorded in Lough Ateeann (2 fish) and Shannaghree Lough (4 fish). Pike was the most common fish species recorded in all lakes, followed by eel. No brown trout were recorded (Table 3.8).

Table 3.8. Number of each fish species captured by each gear type during fish stock surveys on four lakes in the Owenriff catchment, July 2018

Lake	Scientific name	Common name	Number of fish captured			
			BM CEN	4-PBB	Fyke	Total
Loughaphreaghaun	<i>Esox lucius</i>	Pike	1	0	2	3
	<i>Anguilla anguilla</i>	European eel	0	0	1	1
Adrehid, Lough	<i>Esox lucius</i>	Pike	2	0	2	4
	<i>Anguilla anguilla</i>	European eel	0	0	2	2
Ateeann, Lough	<i>Esox lucius</i>	Pike	1	0	1	2
Shannaghree Lough	<i>Esox lucius</i>	Pike	1	0	3	4

3.2.2 Fish abundance

Mean CPUE and BPUE for all fish species captured in the four lakes during the 2018 surveys are summarised in Table 3.9 and illustrated in Figures 1.5 and 1.6. Pike was the dominant fish species in terms of abundance (CPUE) and biomass (BPUE) captured in the survey gill nets in all four lakes (Table 3.9, Figs. 3.14 and 3.15). No brown trout were recorded in the four lakes surveyed. In general the abundance of pike was higher in Lough Adrehid and Shannaghree Lough than in Loughs Ateeann and Loughaphreaghaun; however it should be noted that only small numbers of each species were captured during the surveys. Eels were only recorded in Loughaphreaghaun and Lough Adrehid (Table 3.9).

Table 3.9. Mean (S.E.) CPUE and BPUE for all fish species captured on Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough, July 2018

Lake	Scientific name	Common name	Mean CPUE 2018	Mean BPUE 2018
Loughaphreaghaun	<i>Esox lucius</i>	Pike	0.004 (0.002)	0.159 (0.098)
	<i>Anguilla anguilla</i>	*European eel	0.006 (0.006)	1.778 (1.778)
Lough Adrehid	<i>Esox lucius</i>	Pike	0.010 (0.004)	0.457 (0.225)
	<i>Anguilla anguilla</i>	*European eel	0.011 (0.006)	5.178 (2.790)
Lough Ateeann	<i>Esox lucius</i>	Pike	0.007 (0.005)	0.633 (0.415)
Lough Shannaghree	<i>Esox lucius</i>	Pike	0.009 (0.005)	0.254 (0.136)

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; therefore not directly comparable to other fish species.

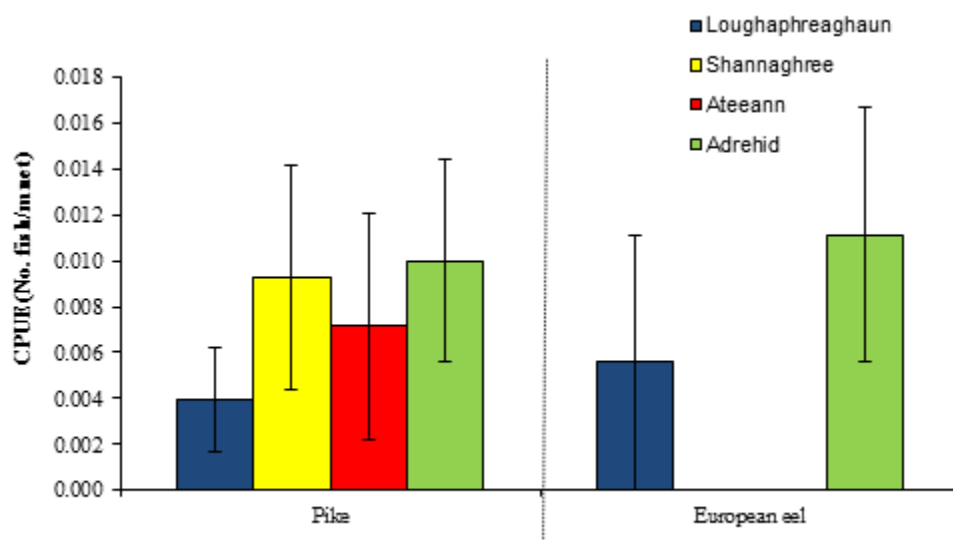


Fig. 3.14. Mean (±S.E.) CPUE for all fish species captured in Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough (Eel CPUE based on fyke nets only), July 2018

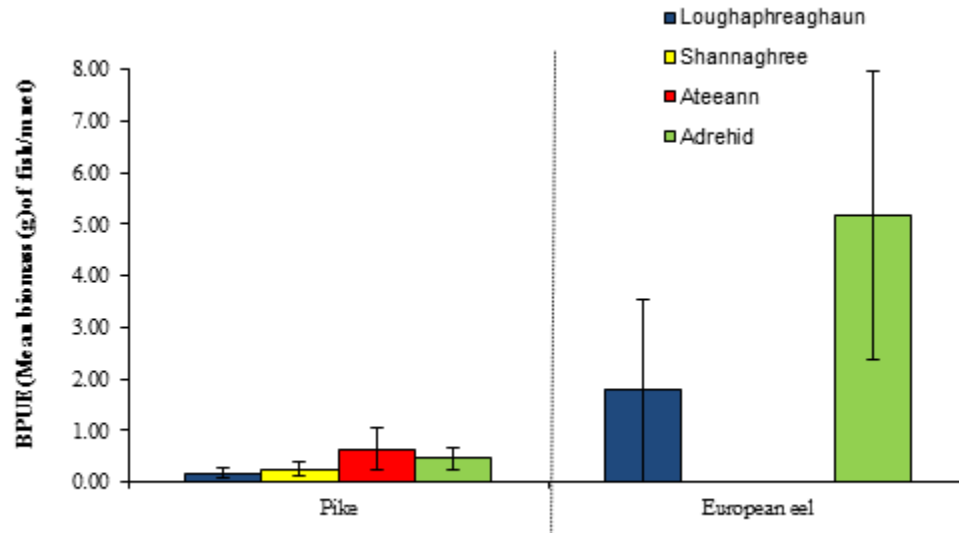


Fig. 3.15. Mean (\pm S.E.) BPUE for all fish species captured in Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough (Eel BPUE based on fyke nets only), July 2018

For comparative purposes the relative abundance of brown trout and pike captured in Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough was compared to other lakes in the Owenriff catchment surveyed in 2017 and 2016 (Lough Agraffard, Lough Bofin and Lettercraffroe Lough) (no pike are present in Lettercraffroe Lough)) and to other similar low alkalinity lakes surveyed by IFI in Counties Galway and Mayo (Fig. 3.16). In this context, the very small numbers of trout recorded in the Owenriff lakes in 2017, and 2018 where none were recorded in the surveys, is apparent.

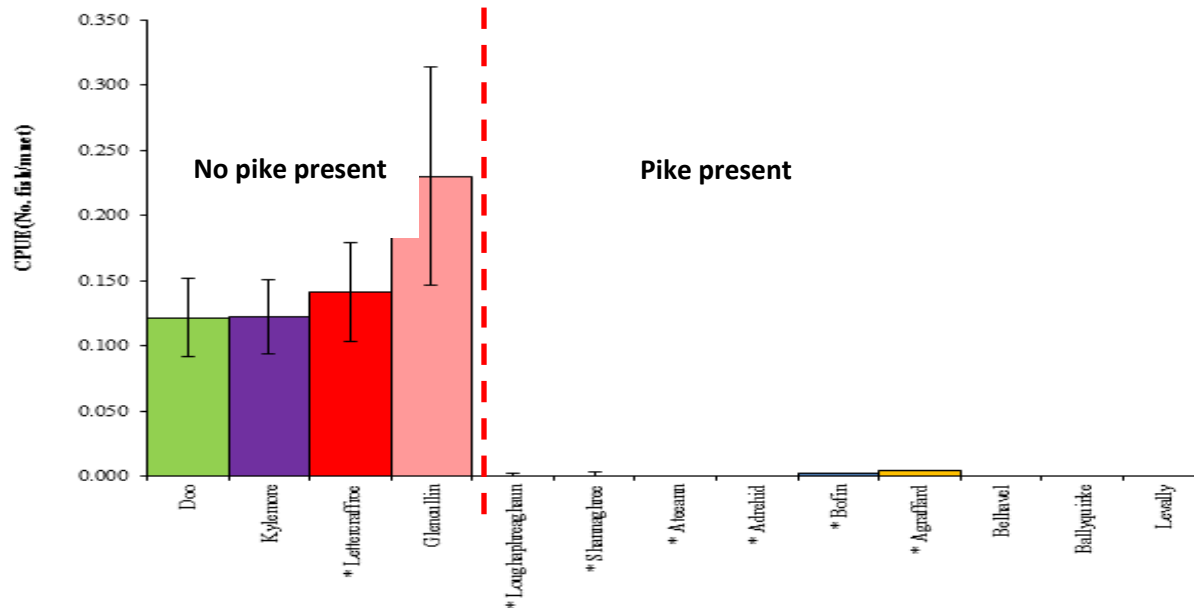


Fig. 3.16. Comparison of mean (\pm S.E.) CPUE for brown trout captured in seven lakes on the Owenriff catchment 2016 to 2018 (*Lettercraffoe Lough, *Loughaphreaghann, *Lough Adrehid, *Lough Agraiffard, *Lough Ateeann, *Lough Bofin and *Shannaghree Lough) with other lakes of similar alkalinity

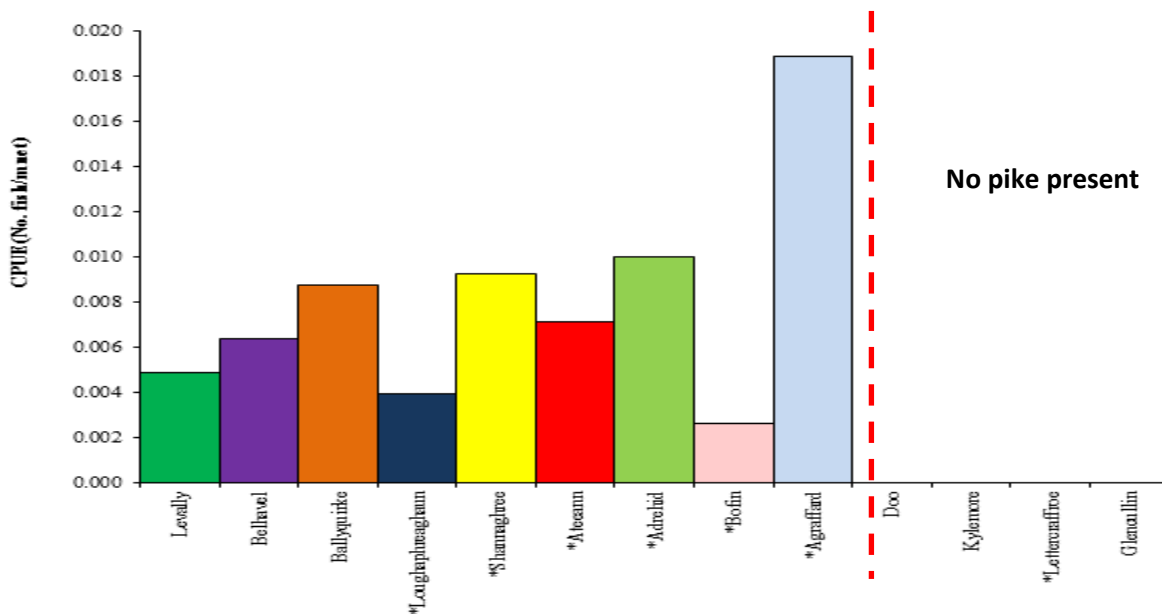


Fig. 3.17. Comparison of mean (\pm S.E.) CPUE for pike captured in seven lakes on the Owenriff catchment 2016 to 2018 (*Lettercraffoe Lough, *Loughaphreaghann, *Lough Adrehid, *Lough Agraiffard, *Lough Ateeann, *Lough Bofin and *Shannaghree Lough) to other lakes of similar alkalinity

3.2.3 Length and age

Pike

During the 2018 surveys, pike captured on Loughaphreaghaun ranged in length from 10.1cm to 22.6cm (Fig. 3.18). Two age classes were present at 1+ and 2+, with a mean L1 of 7.8cm. Pike on Lough Adrehid ranged in length from 10.7cm to 25.3cm (Fig. 3.18), with three age classes present ranging from 0+ to 2+, and a mean L1 of 8.4cm. Two pike captured on Lough Ateeann were measured at 22.3cm and 26.3cm and were aged 1+ and 2+ respectively. Four pike were captured on Shannaghree Lough ranging in length from 8.3cm to 18.6cm (Fig. 3.18). Two age classes were present at 0+ and 1+, with a mean L1 of 8.2cm.

This is similar to the pike that were captured during the 2017 surveys on Lough Bofin (19.5cm and 23.3cm, 1+) and Lough Agraftard (8.5cm to 36.2cm, 0+ to 3+). However, it is important to note, that pike captured during stock management operations and via angling span a greater length range.

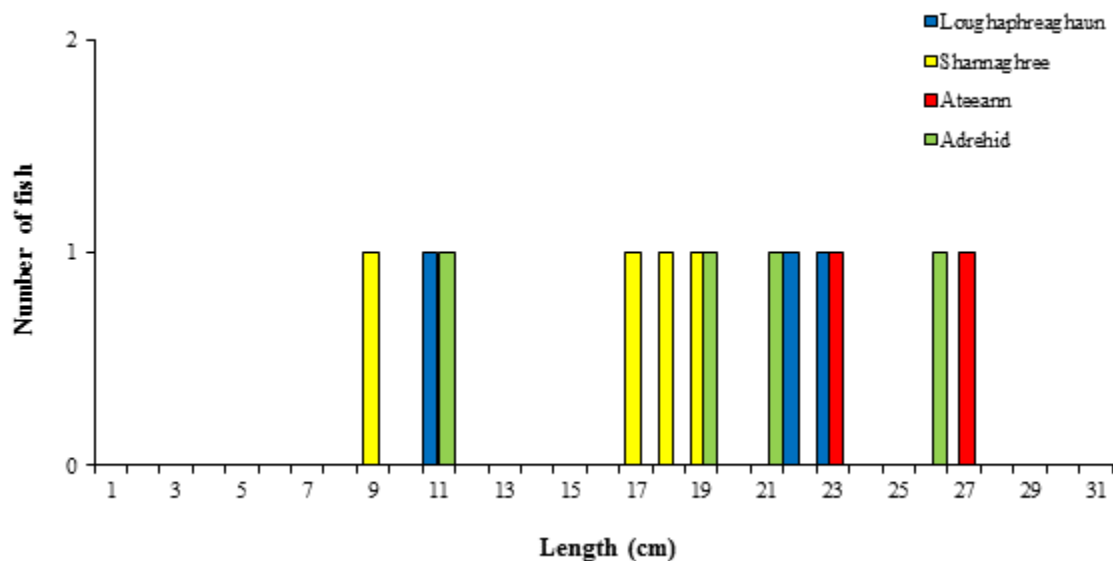


Fig. 3.18. Length frequency of pike captured on Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough, 2018

Other fish species

Eels captured during the 2018 survey ranged in length from 57.0cm to 70.2cm on Lough Adrehid and one eel captured on Loughaphreaghaun measured 62.0cm.

3.2.4 Stomach and diet analysis

The stomach contents of all pike captured during the surveys on Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough were examined. The sample was supplemented by a small number of fish captured during pike management operations conducted on Lough Ateeann (n = 4) during 2018, and from samples captured by electrofishing on Lough Adrehid (n = 17) at the time that the surveys were conducted on those respective lakes. A total of 34 pike stomachs were available for analysis of diet. These pike ranged in length from 8.0 to 40.2 cm (Figure 3.19). For analysis purposes, prey types have been amalgamated into four categories (Figure 3.20). Thirty pike stomachs contained food. Of these, 20 (66.7%) stomachs contained only invertebrates (Figure 3.20). Invertivorous pike ranged in length from 8.0cm to 26.3 cm (Figure 3.21). Shrimp (gammarids) were the most commonly recorded invertebrate, occurring in nine stomachs. Five pike stomachs (16.7%) contained only fish (Figure 3.20). Fish species recorded in pike stomachs included minnow, pike and unidentified fish. These piscivorous fish ranged in length from 8.2 to 40.2cm (Figure 3.20). Zooplankton (not identified) were the only food item recorded in the stomachs of four (13.3%) pike, ranging in length from 8.4 to 10.1cm (Figure 3.20 and 3.21). One pike stomach (L = 18.4 cm) contained both zooplankton and invertebrates (Figure 3.20 and 3.21). Summary dietary information for each lake is presented in Table 3.10.

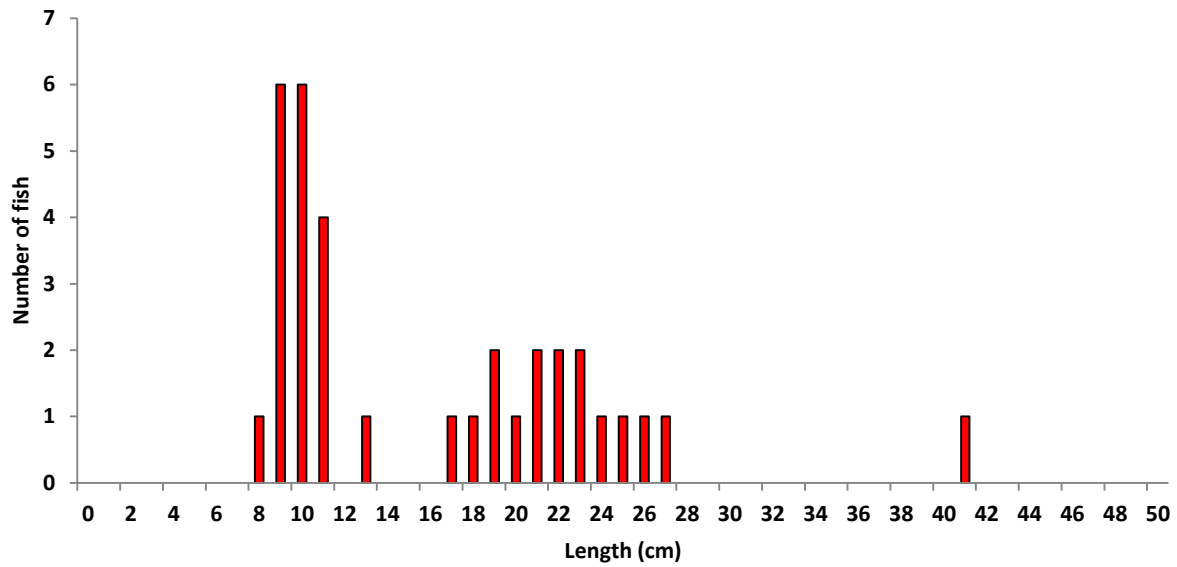


Fig. 3.19. Length frequency of pike available for stomach content analysis on Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Shannaghree Lough, 2018

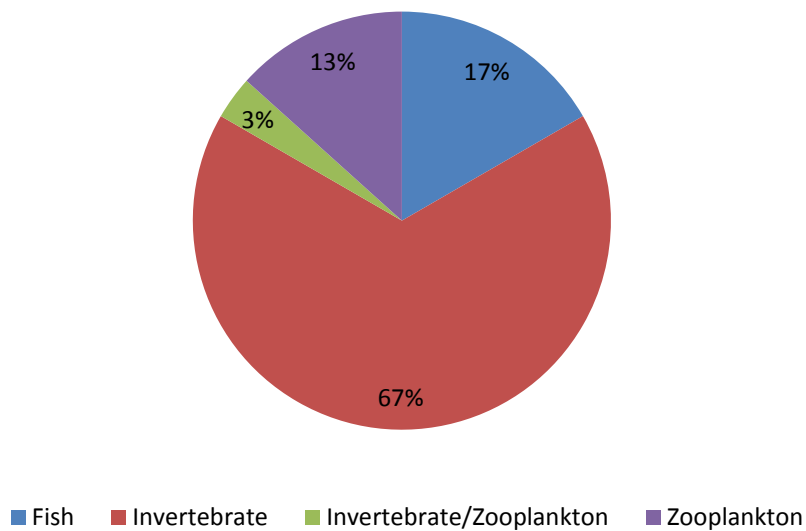


Figure 3.20. Diet of pike (n =30) captured on Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Lough Shannaghree, 2018

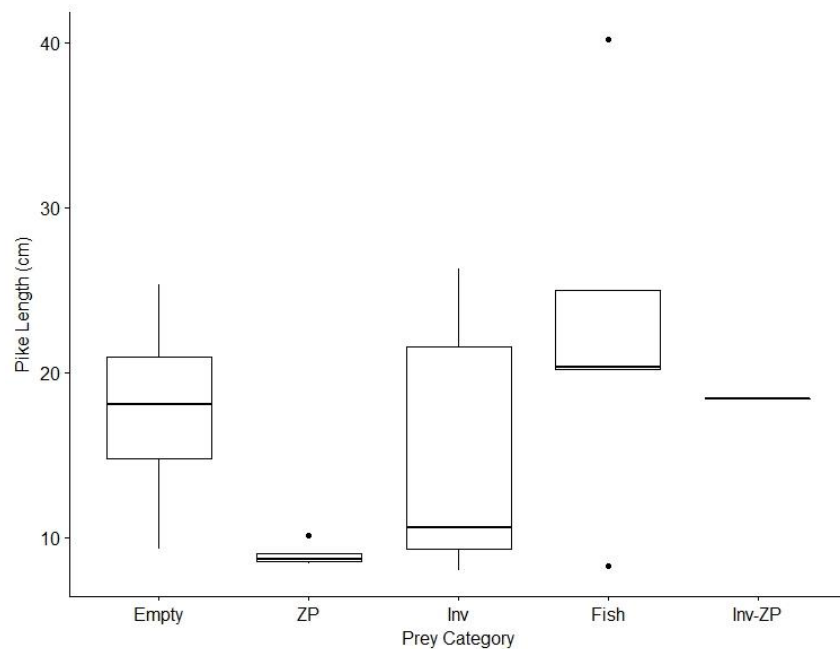


Figure 3.21. Boxplot illustrating ontogenetic differences in diet of pike captured on Loughaphreaghau, Lough Adrehid, Lough Ateeann and Lough Shannaghree, 2018. The horizontal bars represent the median value of the sample, while the 75% and 25% percentiles are marked by the upper and lower boundary of each box. The vertical 'whiskers' show the data range. Outliers are marked by dots. (Empty = no food; ZP = Zooplankton; Inv = Invertebrate Fish = Fish; Inv-Zp = Invertebrate & Zooplankton)

Table 3.10. Summary dietary analysis of 34 pike captured during a survey of Loughaphreaghau, (Figure 1.11) Lough Adrehid, Lough Ateeann and Lough Shannaghree, July 2018

Lake	Diet Category (no of pike)				
	Empty	Invertebrate	Fish	Zooplankton	Invertebrate / Zooplankton
Adrehid	3	11	2	4	1
Ateeann	-	4	2	-	-
Loughaphreaghau	-	3	-	-	-
Shannaghree	1	2	1	-	-
Total	4	20	5	4	1

3.3 Fish ecological status on rivers and lakes in the Owenriff Catchment, 2018

3.3.1 Rivers

Each river site surveyed in 2018 was assigned a fish ecological status using the FCS2-Ireland tool and expert opinion (Table 3.11). Eleven river sites achieved good fish status or higher; however the remaining 21 sites (excluding sites 8 and 9 for which ecological status could not be calculated) were assigned moderate or lower fish status (11 Moderate, eight Poor and two Bad) (Table 3.11). These failures were mainly due to the absence, lower than expected abundance or missing age classes of type specific indicator species (i.e. brown trout and salmon). The majority of sites surveyed in both 2017 and 2018 showed no change in status with exception of sites 17 and 18. Site 17 (Glengawbeg Br.) declined in status from moderate to poor. Site 18 (1km d/s of Lough Agraftard) is a designated WFD surveillance monitoring site for fish and was assigned a fish ecological status of Good in 2010 and 2015; moderate in 2017 (IFI, 2018), but returned to good ecological fish status in 2018 (Table 3.11) following an increase in salmon across age classes.

Table 3.11. Fish ecological status classification at surveyed river sites, Owenriff catchment

Site No.	2010	2015	2017	2018	Site No.	2010	2015	2017	2018
Main channel									
6				Poor	21			Mod	Mod
7				Bad	22				Poor
8				N/A	23				Poor
13				Mod	30				Bad
18	Good	Good	Mod	Good	33				Mod
Sub-catchments									
1				Mod	17			Mod	Poor
2				Mod	19				High
3				Mod	20				Good
4			Mod	Mod	24				High
5				Good	25			Mod	Mod
9				N/A	26				High
10				Poor	27			Mod	Mod
11				Good	28				Good
12				Mod	29			Mod	Mod
14				Poor	31				Poor
15				High	32				Poor
16				Good	34			Good	Good

3.3.1 Lakes

Using the FIL2 classification tool, Loughaphreaghau, Lough Adrehid, Lough Ateeann and Lough Shannaghree were all assigned a fish ecological status of Bad for 2018 based on the fish populations present (Table 3.12). Reasons for the failures were mainly due to the absence, lower than expected abundance or missing age classes of type specific indicator species (i.e. brown trout).

In 2017 Lough Bofin and Lough Agraffard were assigned a status of Poor and Bad respectively. In contrast, Lettercraffroe Lough (also located within the Owenriff catchment but no pike are present in the lake) was assigned a fish ecological status of Good in 2016 (IFI, 2018) (Table 3.12).

Table 3.12: Fish ecological status classification at surveyed lake sites, Owenriff catchment (2016-2018)

Lake	Pike present	Year of survey	Fish ecological status
Lettercraffroe Lough	No	2016	Good
Bofin, Lough	Yes	2017	Poor
Agraffard, Lough	Yes	2017	Bad
Loughaphreaghau	Yes	2018	Bad
Ateeann, Lough	Yes	2018	Bad
Shannaghree Lough	Yes	2018	Bad
Adrehid, Lough	Yes	2018	Bad

4. Summary and Discussion

Brown trout and salmon were the dominant fish species at 67% and 55% respectively of sites surveyed in the Owenriff catchment during 2018. This contrasts with the Cornamona catchment where brown trout and salmon prevalence was higher, i.e. 100% and 75% respectively (Matson *et al.*, 2019). Salmonid prevalence figures on the Owenriff are also low compared to other rivers across the country (e.g. Kelly *et al.*, 2015).

Salmon were not recorded from four sites on the Owenriff main channel and were the dominant salmonid species in the remaining sites. Brown trout were only present at four of the ten sites surveyed on the main channel. Fish stock surveys in the early 80's indicated that the Owenriff main channel was a productive salmon river, but brown trout densities were low (Browne and Gallagher, 1982). Pike were recorded in six sites on the main channel in 2018. Pike were not captured in earlier surveys (Browne and Gallagher, 1982; WRBD, 2008).

No salmon were present in the two Letterfore River sites and relatively low densities of brown trout were also recorded. Historically this river was considered a productive juvenile salmon river (Browne and Gallagher, 1980; IFI unpublished data 1997; WRBD, 2008). Indeed, the Letterfore River had the highest density of 0+ salmon for any river in the Corrib catchment surveyed during 1980 and was one of the top three sites for salmon fry (0+) surveyed in 1997 (WRBD, 2008). A large woody debris blockage was observed in the lower section of this channel in 2018 which may have been preventing salmon and brown trout migrating upstream to spawn. Brown trout were more prevalent at two sites on the upper Bunowen River, but salmon were dominant at the lower site during 2018. These results contrast with earlier surveys when salmon were the dominant species at all sites surveyed on this river (Browne and Gallagher, 1980; WRBD, 2008).

Fish were not recorded at five sites (1, 2, 3, 9 and 14) during the survey. The reason for the complete absence of fish is not apparent. In a previous survey in 2007 fish were also not recorded in site 14 and the absence may be explained by excessive forest canopy and low flows (WRBD, 2008). Trout fry were previously recorded on the Derryerglinna stream (Lough Adrehid inflow) (WRBD, 2008), but during the 2018 survey no fry were present at the two sites (9 and 10) surveyed, indicating a recruitment failure in this river. Site 9 is located upstream of an impassable natural waterfall which may explain the absence of fish.

Salmon were the dominant species across the catchment in terms of abundance. Total salmon densities ranged from 0.006 to 1.213 fish/m². Total brown trout densities ranged from 0.005 to 0.933 fish/m². Salmon and brown trout were mainly absent or present in relatively low densities in sites close to Loughs Bofin, Adrehid and Lough Ateeann (tributary streams or main channel). Minimum densities of brown trout fry (0+) were relatively poor at many sites. Minnow were recorded at six tributary sites with their greatest density (2.477 fish/m²) recorded at site 12 (Knockmoyle Lower). This high abundance of minnow may be indicative of poor to moderate water quality (Kelly *et al.*, 2007). Pike were not recorded in any tributary sites. Three-spined stickleback and eel were also present during the 2018 survey.

Only two age classes of brown trout were present on the main channel (0+ and 1+); no adult fish were recorded, this is unexpected as larger adult fish are normally captured in the main channel of most rivers. Four age classes of brown trout were recorded on the tributary streams; however 0+ were absent from four sites (4, 10, 20 and 29) where older brown trout were present. Salmon fry (0+) was the dominant age class at many sites where they were present, but parr (1+ and older) were dominant at five sites. The absence of salmonids or age class cohorts (e.g. 0+) at sites where suitable habitat is present is an indicator of a problem with recruitment or survival in the catchment.

Brown trout appeared to have a significantly lower mean minimum density across the Owenriff catchment in the 2018 survey compared to 1997. Results also indicate that brown trout recruitment is also lower in 2018 than 1997. Salmon densities were comparable between 1997 and 2018; however the 2018 figures were inflated by high density figures at sites 12 and 28. Mean salmon density was lower in 2017 (0.06 fish/m²), demonstrating that salmon recruitment can show substantial variation between years.

Fish stock survey results from different survey eras on the Cornamona catchment (1996 and 2018) indicate no significant reduction in brown trout abundance (Matson *et al.*, 2019), suggesting that the decline in brown trout density in the Owenriff is not consistent with nearby catchments. Mean total salmon abundance was lower in the Cornamona catchment during 2018 than 1997, but salmon fry recruitment was generally higher at a site level in 2018. Salmon fry densities can fluctuate substantially between years as noted previously.

A total of two fish species were recorded in both Loughaphreaghun and Lough Adrehid in July 2018 with only pike recorded in Lough Ateeann and Shannaghree Lough. Pike was the most common fish species recorded in all lakes, followed by eel. Pike and eel were also captured in the fyke nets in both lakes where the two species were recorded. No brown trout were recorded in any of the lakes indicating a possible failure in recruitment or survival in at least the previous few years. In contrast the brown trout captured in Lettercraffroe Lough (also located in the Owenriff catchment, but no pike are present in the lake) during the 2016 survey ranged in age from 0+ to 4+ indicating recruitment success in the previous five years (Kelly *et al.*, 2017). Brown trout in Lough Bofin and Lough Agraiffard from the 2017 survey were aged at 2+ (IFI, 2018a). Definitive conclusions are difficult to determine for all four lakes surveyed due to the limited number of fish recorded. However, brown trout were not recorded in each lake, but they are still present in Lettercraffroe (a lake within the Owenriff with no pike present) and in neighbouring catchments (Loughs Doo, Glencullin, Kylemore and Lettercraffroe) where pike are also not present.

Invertebrates dominated prey items in the pike stomachs examined in all lakes during the 2018 survey, occurring in c. 67% of all stomachs sampled which contained food, with invertivorous individuals ranging in length from 8.0 to 26.3 cm. While based on a comparatively smaller sample, invertivory was less apparent in the river pike diet, occurring in 3 of 7 stomachs (42.9%). Invertivory is common in small Irish pike (Pedreschi *et al.*, 2014; Healy, 1956). Pike are also known to feed on invertebrates in the absence of alternative fish prey (Venturelli and Tonn, 2006) or when fish prey populations have become reduced (Haught and Von Hippel, 2011).

Piscivorous pike ranged in length from 7.9cm to 40.2cm and spanned almost the full length range of pike in the samples in both rivers and lakes. In fact, all the piscivorous pike recorded in river samples were YOY fish, ranging in length from 9.1cm - 10.2cm. Early piscivory is common in pike (Mittelbach and Persson, 1998) and increases with length (Skov *et al.*, 2003) and had also been recently described in Irish populations (McLoone *et al.*, 2019). In the lakes surveyed, YOY pike and minnow were the only fish prey found in the pike stomachs examined. This is perhaps unsurprising in the context of the small numbers of the other fish species recorded. While no minnow were captured in the lake surveys, they were recorded in the river sections surveyed in 2018 (where they dominated diet of the piscivorous pike sampled). Minnow have also been recorded in surveys of other similar Irish lakes such as Lough Shindilla (Kelly *et al.*, 2014). Intra-specific predation is an important factor regulating survival of juvenile

pike cohorts (Grimm and Klinge, 1996). No brown trout were recorded in the lake surveys on the Owenriff catchment conducted in 2018, and their absence from the diet is therefore unsurprising, possibly reflecting the already depleted populations following longer-term predation by pike in those habitats (Persson *et al.*, 2018). Dietary analysis studies provide a good indication of the availability of food items at the time of sampling, and longer term studies may provide a more thorough understanding of pike predation within the catchment, where stocks of prey fish can fluctuate as a consequence seasonal migrations of salmonids, for example.

Eleven river sites achieved good fish ecological status or higher; however the remaining 21 sites (excluding sites 8 and 9 for which ecological status could not be calculated) were assigned moderate or lower fish status (11 Moderate status, eight Poor status and two Bad status). These failures were mainly due to the absence, lower than expected abundance or missing age classes of type specific indicator species (i.e. brown trout and salmon). In contrast the EPA assigned good and high status to their monitoring sites in the catchment for the 2010 to 2015 period; however fish status was only included in one of these status assignments (EPA, 2017; IFI, 2018). This contrasts with the Cornamona catchment where 14 of the 16 sites were assigned Good status or higher. Habitat and water quality in both catchments is generally good for salmonids, suggesting that another factor, such as predation pressure is having an impact in the Owenriff catchment.

Using the FIL2 classification tool, Loughaphreaghaun, Lough Adrehid, Lough Ateeann and Lough Shannaghree Lough were assigned a fish ecological status of Bad for 2018 based on the fish populations present. Reasons for the failures were mainly due to the absence, lower than expected abundance or missing age classes of type specific indicator species (i.e. brown trout). In contrast lakes in neighbouring catchments where there are no pike present, such as Glencullin Lough, Doo Lough, Kylemore Lough and Lough Shindilla, were assigned a fish status of High and Ardderry Lough was assigned a fish status of Good (see www.wfdfish.ie). The EPA has also assigned high status to Lough Bofin; however this status assignment does not incorporate fish status (EPA, 2017).

5. References

- Amundsen P.A., Gabler, H.M., 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.
- Browne, J. and Gallagher, P. (1982) *Population Estimates of Juvenile Salmonids in the Corrib System 1981*. Fishery Leaflet No. 115. Department of Fisheries and Forestry, Dublin.
- 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.
- CEN (2003) *Water Quality – Sampling of Fish with Electricity*. CEN EN 14011:2000.
- CEN (2005a) *Water Quality - Guidance on the Scope and Selection of Fish Sampling Methods*. CEN EN 14962
- CEN (2005b) *Water Quality – Sampling of Fish with Multi-Mesh Gill Nets*. CEN EN 14757.
- CORINE (2012) *CORINE Landcover 2012 Ireland*. Final Report.
- EC (2013) Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC. Official Journal of the European Union L266/1.
- EPA (2017) WFD Status Assessment 2010 to 2015. <https://gis.epa.ie/EPAMaps/>
- Grimm, M. P. and Klinge, M. (1996) Pike and some aspects of its dependence on vegetation. In: *Pike Biology and Exploitation* (pp. 125-156). Springer Netherlands.
- Haught, S. and Von Hippel, F.A. (2011) Invasive pike establishment in Cook Inlet Basin lakes, Alaska; diet, native fish abundance and lake environment. *Biological Invasions*, **13**, 2103-2114.



Healy, A. (1956) Pike (*Esox lucius* L.) in three Irish lakes. Royal Dublin Society.

IFI (2018a) *Fish Stock Survey of Selected lakes and River Sites in the Owenriff Catchment, 2017*. National Research Survey programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

IFI (2018b) *Owenriff Fish Population Rehabilitation Plan*. National Research Survey programme, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

Kelly, F.L., Champ, W.S.T., McDonnell, N., Kelly-Quinn, M., Harrison, S., Arbuthnott, A., Giller, P., Joy, M., McCarthy, K., Cullen, P., Harrod, C., Jordan, P., Griffiths, D. and Rosell, R. (2007) Investigation of the Relationship between Fish Stocks, Ecological Quality Ratings (Q-values), Environmental Factors and Degree of Eutrophication. EPA Environmental RTDI Programme 2000-2006.

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.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, NSSHARE project.

Kelly, F.L., Connor, L., Matson, R., Feeney, R., Morrissey, E., Coyne, J. and Rocks, K. (2015) *Sampling Fish for the water Framework Directive – Summary Report 2014*. Inland Fisheries Ireland, Citywest Business Campus, Dublin 24, Ireland.

Kelly, F.L., Connor, L., Morrissey, E., Coyne, J., Matson, R., Feeney, R. and Rocks, K. (2014) *Water Framework Directive Fish Stock Survey of Lough Shindilla, August 2013*. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24.

Kelly, F.L., Connor, L., Coyne, J., Morrissey, E., Corcoran, W., Cierpal, D., Delanty, K., McLoone, P., Matson, R., Gordon, P., O' Briain, R., Rocks, K., O' Reilly, S., Kelly, K., Puttharee, D., McWeeney, D., Robson, S. and Buckley, S. (2017) Fish Stock Survey of Lettercraffroe Lough, September 2016. Inland Fisheries Ireland.

Kelly, F.L., Matson, R., Delanty, K., Connor, L., O' Briain, R., Gordon, P., Corcoran, W., Feeney, R., Coyne, J., Morrissey, E., Cierpal, D. and Rocks, K. (2017) Sampling Fish for the Water Framework Directive,

- Rivers 2015. Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24, Ireland.
- Lydon, K. and Smith, G. (2014) *CORINE Landcover 2012 Ireland*. Final Report. Environmental Protection Agency.
- Matson, R., Delanty, K., Shephard, S., Coghlan, B. and Kelly, F. (2017) Moving from multiple pass depletion to single pass timed electrofishing for fish community assessment in wadeable streams. *Fisheries Research*, **198**, 99-108.
- Matson, R., Delanty, K., Gordon, P., O'Briain, R., McCarthy, E., Cierpal, D., Connor, L., Corcoran, W., Coyne, J., McLoone, P., Morrissey-McCaffrey, E., Brett, T., Gavin, A and Kelly, F.L., (2019) *Sampling Fish in Rivers 2018 - Cornamona, Factsheet No. 12*. National Research Survey Programme. Inland Fisheries Ireland.
- McLoone, P., Shephard, S., O' Reilly, S. and Kelly, F. (2019) Shifts in diet of an apex predator following the colonisation of an invasive fish. *Hydrobiologia*, <https://doi.org/10.1007/s10750-019-03972-w>(0123456789)
- Mittelbach, G. G. and Persson, L. (1998) The ontogeny of piscivory and its ecological consequences. *Canadian Journal of Fisheries and Aquatic Sciences*, **55 (6)**, 1454-1465.
- NPWS (2015a) *Lough Corrib SAC 000297*. . Conservation Objectives Series. National Parks and Wildlife Services. 58pp.
- NPWS (2015b) *Connemara Bog Complex SAC 002034*. Conservation Objectives Series. National Parks and Wildlife Services. 42pp.
- O' Reilly, P. (1987) *Trout and Salmon Loughs of Ireland - A Fisherman's Guide*. 4th Edition. Merlin Unwin Books.
- O' Reilly, P. (2007) *Loughs of Ireland – A Flyfisher's Guide*. 4th edition. Merlin Unwin Books.
- Persson, A., Nilsson, P.A. and Brönmark, C. (2018) Trophic Interactions. In C. Skov & Nilsson, P. A. (eds.), *Biology and Ecology of Pike* CRC Press: 185-214.



- Pedreschi, D., Mariani, S., Coughlan, J., Voigt, C.C., O'Grady, M., Caffrey, J. and Kelly-Quinn, M. (2015) Trophic flexibility and opportunism in pike *Esox lucius*. *Journal of Fish Biology*, **87**, 876-894.
- Skov, C., Lousdal, O., Johansen, P. H. & Berg, S. (2003) Piscivory of 0+ pike (*Esox lucius* L.) in a small eutrophic lake and its implication for biomanipulation. *Hydrobiologia*, **506 (1-3)**, 481-487.
- SNIFFER (2011) *River Fish Classification Tool: Science Work*. WFD68c. Phase 3, Final Report. Scotland and Northern Ireland Forum for Environmental Research.
- Venturelli, P. A. and Tonn, W. M. (2006) Diet and growth of northern pike in the absence of prey fishes: initial consequences for persisting in disturbance-prone lakes. *Transactions of the American Fisheries Society*, **135 (6)**, 1512-1522.
- WRBD (2008) *Catchment Wide Fish Survey for the Owenriff River*. The Western Regional Fisheries Board. A Western River Basin District Project.



APPENDIX 1

Detailed description of Owenriff tributaries surveyed during 2018

A1. Leam Tributaries

Three sites (1, 2 and 3) were surveyed on the Leam tributaries during the 2018 survey (Fig. 2.2 and Table 2.1). The Leam tributaries comprise two small channels that flow into Lough Bofin on its south-western side (Fig 2.2 and Plate A1). The underlying bedrock geology is mostly granite. The primary land cover is blanket bog. The majority of this catchment falls within the Connemara Bog Complex SAC. No fish were recorded at the three sites during the 2018 electrofishing survey (Table 3.3).



Plate A1. Leam tributary sub-catchment at Leam Trib East (Site 3), 2018

A2 Letterfore sub-catchment

Two sites (4 and 5) were surveyed on the Letterfore River in 2018 (Fig. 2.2 and Plate A2). The area of the Letterfore sub-catchment is approximately 5km². The Letterfore stream flows in a southerly direction draining into Lough Bofin below Letterfore Bridge (Fig 1.1). The underlying geology is mixed, comprising of granite on the western side of the catchment and schist to the east. Land use consists of forestry, blanket bog and pasture. A portion of this catchment falls within the Connemara Bog Complex SAC, towards the lower end of the channel and down to its confluence with Lough Bofin.

The Letterfore sites were located in the middle reaches of the river. Brown trout were captured at both sites, but no salmon were recorded (Table 3.3). Trout ranged in length from 4 cm to 14 cm and ranged in age from 0+ to 2+.



Plate A2. Letterfore sub-catchment at Letterfore Track (Site5), 2018

A3 Derryerglinna sub-catchment

Two sites (9 and 10) were surveyed on the Derryerglinna River on the 26th of July 2018 (Fig. 2.2 and Plate A3). The area of sub-catchment is approximately 1.4km². The Derryerglinna stream flows in a southerly direction draining into Lough Adrehid (Fig 2.2). The underlying geology is varied, comprising of granite in its lower reaches with mixed geology above. The dominant land type is blanket bog. A small portion of the lower catchment falls within the Connemara Bog Complex SAC.

The Derryerglinna sites were located in the lower reaches of the river. A single adult brown trout was captured at site 10, but none were recorded at site 9 (Table 3.3). No salmon were recorded. The upper site (site 9) is located upstream of an impassable waterfall.



Plate A3. Derrerglinna sub-catchment at Keerauntoole Lower (Site 9), 2018

A4. Knockmoyle sub-catchment

Two sites (11 and 12) were surveyed on the Knockmoyle River on the 25th of July 2018 (Fig. 2.2 and Plate A4). The area of the sub-catchment is approximately 1.75km². This small tributary joins the Owenriff main channel between Lough Adrehid and Lough Agraftard close to where the old dismantled railway crossed the river (Fig 2.2). The underlying geology of this sub-catchment is mostly schist. The main land use for this catchment is peat bog/scrub land and pasture.

Brown trout, salmon and minnow were recorded at site 11, but no brown trout were recorded at site 12 (Table 3.3). Minnow were the most abundant fish at site 12. Both the brown trout and salmon population were dominated by fry (0+) with a single 1+ trout and salmon recorded across sites. Salmon ranged in length from 4-11cm and brown trout from 5-12cm.



Plate A4. Knockmoyle sub-catchment at Knockmoyle Br. (Site 11), 2018

A5. Glengawbeg sub-catchment

Sites were surveyed on the Glengawbeg River and two of its tributaries, the Derryeighter and Cloghermore. The area of the Glengawbeg sub-catchment is approximately 15km². The Glengawbeg River flows in a northerly direction draining two lakes, Lettercraffroe Lough and Lough Acogga before joining the Owenriff River just downstream of Lough Agraiffard (Fig 2.2). The underlying geology is mixed between granite, gneiss and schist. Coniferous forestry and peat bog covers most of this catchment.

There are a number of small and one large natural waterfalls within this sub-catchment (e.g. Plate A5). Salmon are present in the Derryeighter tributary which is located above these falls. However, salmon are not known to travel further upstream of this tributary (pers. comm, WRBD staff). The upper and western reaches of this catchment fall within the Connemara Bog Complex SAC.



Plate A5. Natural waterfall on the Glengawbeg, downstream of Derryighter

One site (14) was surveyed on the Cloghermore River, located on the northern side of Lettercraffroe Lough. No fish were captured at the site (Table 3.3). Two sites (15 and 16) were surveyed on the Derryighter River. The channel has been subject to some fisheries enhancement work in the past (e.g. - Plate A6). Brown trout and salmon were recorded at the two survey sites while brown trout, salmon, 3-spined stickleback and pike were recorded on the Glengawbeg River at site 17 (Table 3.3). Salmon ranged in length from 3-12 cm and trout from 3-14cm. The oldest trout was 14.6cm and aged 2+.



Plate A6. Vortex weir structure at site 16 (d/s Forest Confl.) in the Derryighter sub-catchment

A6. Rusheeny sub-catchment

Two sites (19 and 20) were surveyed in the Rusheeny sub catchment (Fig. 2.2 and Plate A7). The catchment area is approximately 3.56km². This tributary joins the Owenriff main channel between Lough Agraiffard Lough and Lough Ateeann (Fig 2.2). The underlying geology of this sub-catchment is mostly schist, marble and amphibolite. The main land type in this sub-catchment is peat bog, but there is also a significant coniferous plantation on its western side.

Brown trout, salmon and minnow were recorded at both sites surveyed (Table 3.3). Salmon were the most abundant fish at both sites (Table 3.3 and Fig 3.2). These largely consisted of 0+ fish.



Plate A7. Rusheeny sub-catchment Rusheeny Forest (Site 19), 2018

A7. Bunowen sub-catchment

Three sites were surveyed on the Bunowen River in 2018 (Fig. 2.2 and Plate A8). The area of the Bunowen sub-catchment is approximately 5.4km². This river flows in a south-easterly direction towards Glengowla, joining the main Owenriff system at Lough Ateeann (Fig 2.2). The underlying geology is typically granite and schist. The land use is mainly composed of blanket bog, with forestry towards the uppermost reaches. Pockets of scrub and rough pasture also exist within the mid-reaches. A large portion of this channel's lower section and banks are located within the Lough Corrib SAC (NPWS, 2005).

Trout and salmon were recorded at each site (Table 3.3). Brown trout were the most abundant species at sites 24 and 25, while salmon were the most abundant species at site 26. Salmon ranged in length from 3-11cm and included fish aged from 0+ to 2+, while trout ranged in length from 3-16cm, the largest being 16.4cm and aged 2+.



Plate A8. Bunowen sub-catchment at Knockbaun (Site 25), 2018

A8. Clooshgereen sub-catchment

Three sites (27, 28 and 29) were surveyed in the Clooshgereen sub-catchment in 2018 (Fig. 2.2 and Plate A9). The area of the Clooshgereen sub-catchment is approximately 4.12km². This river flows in a north-westerly direction joining the main Owenriff system at Lough Ateeann (Fig 1.1). The underlying geology is typically schist, marble and amphibolite. The land use is mainly composed of blanket bog, with some pasture. This channel's lower section and banks are located within the Lough Corrib SAC (NPWS, 2005). A number of small lakes are present in the sub-catchment.

Brown trout were recorded at two sites (27 and 29), whereas salmon were recorded at sites 27 and 28. Pike, minnow and 3-spined stickleback were also recorded on the river. Salmon were the most

abundant species with relatively good densities of fry (0+) at site 28 (Table 3.3). Salmon ranged in length from 2-11cm and trout ranged from 4-13cm.



Plate A9. Clooshgereen sub-catchment at Clooshgereen (Site 27), 2018

A9. Canrawer sub-catchment

Two sites (31 and 32) were surveyed on the Canrawer River in 2018 (Fig. 2.2 and Plate A10). The area of the Canrawer catchment is approximately 2.1km². This small tributary joins the Owenriff main channel upstream of Oughterard village (Fig 2.2). The underlying geology of this sub-catchment is granite in the upper reaches and schist in its downstream section. The main land use for this catchment is peat bog and pasture.

Brown trout, three-spined stickleback and minnow were recorded. Three-spined stickleback was the most abundant fish species at both sites (Table 3.3). Only trout fry (0+) were recorded.



Plate A10. Canrawer sub-catchment at Canrawer West (Site 32), 2018

A10. Derrylaura (Byrnes) sub-catchment

One site (34) was surveyed on the Derrylaura stream (Byrne's stream) in 2018 (Fig. 2.2 and Plate A11). The area of the Derrylaura sub-catchment is approximately 1.3km². This small river flows eastwards towards the main Owenriff channel joining it in Oughterard. It flows underground for approximately 300m (Fig 2.2). The underlying geology of this catchment differs from the greater Owenriff catchment, being comprised of calcareous rock types including shale, limestone and sandstone. The land use here is predominantly farmland and pasture, with significant portions also used for urban developments and housing estates.

Only brown trout were recorded at the site (Table 3.3). Brown trout ranged in length from 4.1cm to 23cm and included four age classes, 0+, 1+, 2+ and 3+.



Plate A11. Derrylaura sub-catchment at Clare (Site 34), 2018

**Inland Fisheries Ireland
3044 Lake Drive,
Citywest Business Campus,
Dublin 24,
Ireland.
D24 Y265**

**www.fisheriesireland.ie
info@fisheriesireland.ie**

+353 1 8842 600

