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Sampling Fish for the Water Framework Directive

Summary Report 2013

Iascach Intíre Éireann
Inland Fisheries Ireland

Sampling Fish for the Water Framework Directive - Summary Report 2013

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Inland Fisheries Ireland CEO's Statement

The Water Framework Directive (WFD) was introduced in December 2000 with the broad aims of providing a standardised approach to water resource management throughout Europe and promoting the protection and enhancement of healthy aquatic ecosystems. The Directive, transposed into Irish Law in December 2003, requires Member States to protect those water bodies that are already of Good or High ecological status and to restore all water bodies that are degraded, in order that they achieve at least Good ecological status by 2015.

Inland Fisheries Ireland is responsible for monitoring fish for the Water Framework Directive. The dedicated WFD staff based at IFI Headquarters work closely with colleagues within Inland Fisheries Ireland and with staff from other national agencies, academic institutions and our parent Department, the Department of Communication, Energy and Natural Resources.

During 2013, the WFD surveillance monitoring programme was again influenced by the difficult circumstances surrounding the current economic climate. The recruitment embargo in particular has had a significant impact, with reduced staff numbers limiting the ability to complete surveys on larger sites and in many transitional water bodies; however, despite this, concerted efforts by the WFD team in IFI HQ, along with the help of many staff from the regional IFI offices, has ensured that the key objectives were still met and are summarised in this report.

I am extremely delighted to have such an experienced, dedicated and talented team of scientists working in IFI; however, it is gratefully acknowledged that without the support and commitment of the management and staff in the IFI regional offices during 2013, it would not have been possible to complete many of the key objectives reported in this document.

I would like to congratulate all who have contributed to the significant level of work which was undertaken in 2013 under the Water Framework Directive fish surveillance monitoring programme, the key elements of which are reported in this document, and wish them continued success in 2014.

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Dr Ciaran Byrne
CEO, Inland Fisheries Ireland

June 2014

Foreword

Welcome to Inland Fisheries Ireland's Sampling Fish for the Water Framework Directive – Summary Report 2013.

Inland Fisheries Ireland has been assigned the responsibility by the Environmental Protection Agency (EPA) for delivering the fish monitoring element of the WFD in Ireland. Surveillance monitoring sites are set out in the WFD Monitoring Programme published by the EPA in 2006 (EPA, 2006) and the fish monitoring requirements are extensive, with over 300 water bodies, encompassing rivers, lakes and transitional waters, being surveyed in a three year rolling programme. Although the surveillance monitoring programme for rivers and transitional waters was delayed by one year, the subsequent years have seen a huge effort by the team of scientists within IFI to achieve the three year goals (2007 – 2009 and 2010 – 2012) and I'm delighted to report a total of 70 lakes, 72 transitional waters and 137 river sites were surveyed in the first surveillance monitoring cycle and a total of 78 lakes, 30 transitional waters and 166 river sites were surveyed in the second surveillance monitoring cycle.

The first year of the third three year cycle began in 2013 with another extensive surveillance monitoring programme; 63 river sites, 24 lakes and ten transitional water bodies were successfully surveyed throughout the country. All fish have been identified, counted and a representative sub-sample has been measured, weighed and aged. A further sub-sample of fish was retained for laboratory analysis of stomach contents, sex and parasitism. Once fieldwork finished in October, IFI WFD staff spent the winter months processing this large volume of fish samples.

All water bodies surveyed have been assigned a draft ecological status class (High, Good, Moderate, Poor or Bad) and these results have been submitted to the EPA for inclusion in River Basin Management Plans (RBMP). Future information from ongoing surveillance monitoring will evaluate the effectiveness of programmes of measures set out in these RBMPs.

The data collected to date during the first seven years of surveillance monitoring for the WFD not only fulfils legislative requirements, but provides an invaluable source of information on fish species distribution and abundance for managers, legislators, angling clubs, fishery owners and other interested parties. Detailed reports for each water body surveyed in 2013 are available on the WFD fish website (www.wfdfish.ie). The huge amount of data generated has been collated and a new GIS database has been developed to store and display this information. An interactive WFD fish survey map viewer is also available on the WFD fish website, containing fish survey data collected since 2007. Data from the 2013 surveillance monitoring programme will be available on this map viewer in due course.

In addition to the above, the IFI WFD team are also providing fish samples to IFI's National Eel Monitoring Programme and the National Bass Programme whilst also collaborating with other IFI projects, e.g. the EU Habitats Directive project in relation to endangered fish species (pollan/char).

Lastly I would like to thank all those that contributed to this report, to congratulate them on the work completed and to wish them every success in the year ahead.

Dr Cathal Gallagher,
Head of Function, Research & Development

Inland Fisheries Ireland,
June 2014

Executive Summary

The Water Framework Directive (WFD) (2000/60/EC) came into force in 2000 and was subsequently transposed into Irish law in 2003 (S.I. No. 722 of 2003), with the principal aim of preserving those water bodies where the ecological status is currently 'High' or 'Good', and restoring those water bodies that are currently impaired, to achieve at least 'Good' ecological status in all water bodies by 2015 or by designated extended deadlines. A key step in this process is that each Member State must assess the current ecological status of surface water bodies (rivers, lakes and transitional waters) by monitoring a range of physical, chemical and biological quality elements including phytoplankton, macrophytes, phytobenthos, benthic invertebrates and fish. Ongoing monitoring of the ecological status of these surface waters will then aid in the development of programmes of measures designed to restore those water bodies that fail to meet the WFD requirement of Good ecological status.

Inland Fisheries Ireland has been assigned the responsibility by the EPA of delivering the fish monitoring requirements of the WFD in Ireland. Over 300 water bodies, encompassing rivers, lakes and transitional waters are required to be surveyed in a three year rolling programme. In 2013, a comprehensive fish surveillance monitoring programme was conducted, with 63 river sites, 24 lakes and ten transitional water bodies successfully surveyed throughout the country.

All surveys were conducted using a suite of European standard methods; electric-fishing is the main method used in rivers and a range of different net types are used in lakes and transitional waters. This report summarises the main findings of the 2013 surveillance monitoring programme and highlights the current status of each water body in accordance with the fish populations present.

Twenty-four lakes were surveyed during 2013, with a total of 17 fish species (sea trout are included as a separate 'variety' of trout) and one type of hybrid being recorded. Eel was the most common fish species recorded, occurring in 20 out of the 24 lakes surveyed (83.3%). This was followed by brown trout, perch, pike and roach which were present in 70.8%, 66.6%, 41.7% and 33.3% of lakes respectively. In general, salmonids were the dominant species in the north-west and west areas of the country. Sea trout were captured in four lakes in the west and north-west and Arctic char were recorded in three lakes in the west and north-west. Perch, followed by pike were the most widely distributed, non-native species recorded during the 2013 surveillance monitoring programme, with perch being present in 16 lakes and pike being present in 10 of the 24 lakes surveyed.

All lakes surveyed during 2013 have been assigned a draft ecological status using the Fish in Lakes tool (FIL2) (Kelly *et al*., 2012b) based on the fish populations present. Six lakes were classified as High, eight were classified as Good, one was classified as Moderate, six were classified as Poor and two were classified as Bad ecological status. The geographical variation in ecological status reflects the change in fish communities of upland lakes with little human disturbance, to the fish communities of lowland lakes subject to more intensive anthropogenic pressures.

A total of 63 river sites were surveyed during 2013 using boat-based electric-fishing gear for the non-wadeable sites and hand-set electric-fishing gear for the wadeable sites. A total of 16 fish species (sea trout are included as a separate 'variety' of trout) and one type of hybrid (roach x bream) were recorded. Brown trout was the most common fish species recorded, being present in 93.7% of sites surveyed, followed by European eel (69.8%), salmon (61.9%), three-spined stickleback (50.8%), stone loach (50.8%) and lamprey sp. (49.2%). Brown trout and salmon population densities were greater in wadeable streams, sampled using bank-based electric-fishing gear, when compared to the deeper rivers surveyed using boat-based gear. This is mainly due to the preference for large numbers of juvenile salmonids to inhabit shallow riffle areas.

An ecological status classification tool for fish in Irish rivers 'FSC2 Ireland' (SNIFFER, 2011) along with expert opinion, was used to classify all river sites surveyed during 2013; three river sites were classified as Poor, 28 were classified as Moderate, 26 were classified as Good and 6 were classified as High.

Ten transitional water bodies were surveyed during 2013. These included eight water bodies on the Barrow, Suir and Nore estuaries (SERBD) and two in the SWRBD, Lough Gill and Drongawn Lough). A total of 39 fish species (sea trout are included as a separate 'variety' of trout) were recorded across the ten water bodies. The highest number of species recorded in any single water body was 22, captured in the Barrow, Suir, Nore Estuary, while the lowest number, seven, was recorded in both the Upper Barrow Estuary and Lough Gill. Sand goby was the most commonly encountered species, recorded in all ten water bodies, while European eel and flounder were recorded in nine sites each. Smelt were recorded in eight water bodies. Some important angling species documented during these surveys included brown trout, cod, European seabass, salmon and sea trout.

An ecological classification tool (Transitional Fish Classification Index – TFCI) for fish in transitional waters was used to assign ecological status to each transitional water body (Coates *et al*., 2007). Four water bodies were classified as Moderate and six as Good.

In addition to the Water Framework Directive requirements of information on ecological status, the work conducted in 2013 provides more comprehensive information on fish stocks in a large number of Irish surface waters. For example, in June pollan were recorded in Lough Ree, this will be of interest to many parties and will aid in the development of appropriate fisheries management plans.

Project Personnel

This report was written and researched by Dr. Fiona Kelly, Ms. Lynda Connor, Dr. Ronan Matson, Ms. Emma Morrissey, Mr. Rory Feeney, Mr. John Coyne and Mr. Kieran Rocks, Inland Fisheries Ireland (IFI), under the direction of Dr. Cathal Gallagher, Head of Research and Development as part of the Water Framework Directive (WFD) Fish Monitoring Programme, 2013 to 2015. Mr. Johannes Bulfin, Mr. John Finn, Ms. Karen Kelly, Ms. Roisín O'Callaghan and Ms. Laura Walsh assisted with fieldwork during these surveys.

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Cooperation and assistance from the Department of Culture, Arts and Leisure (DCAL) and the Agri-Food and Biosciences Institute for Northern Ireland (AFBINI) on cross border surveys is also gratefully acknowledged.

The authors would like to thank all landowners who provided site access for surveys. The angling clubs and associations on Loughs Lene, Bane, Rea, Kylemore, Glen, Annagh/White, Lickeen and Atedaun are also gratefully acknowledged for their help and cooperation with site access and survey work.

About Inland Fisheries Ireland

Inland Fisheries Ireland is responsible for the protection, management and conservation of the inland fisheries resource across the country. Ireland has over 70,000 kilometres of rivers and streams and 144,000 hectares of lakes all of which fall under the jurisdiction of IFI. The agency is also responsible for sea angling in Ireland.

Inland Fisheries Ireland has strong regional structures responsible for each River Basin District (RBD), with the IFI headquarters in Citywest, Dublin 24 operating alongside seven regional offices; IFI, Dublin; IFI, Clonmel; IFI, Macroom; IFI, Limerick; IFI, Ballina; IFI, Galway and IFI, Ballyshannon.

TABLE OF CONTENTS

1. INTRODUCTION 10

2. STUDY AREA 12

2.1 Lakes 12
2.2 Rivers 14
2.3 Transitional waters 20

3. METHODS 22

3.1 Lakes 22
3.1.1 Survey methodology 22
3.1.2 Processing of fish 22
3.1.3 Water chemistry 22
3.2 Rivers 25
3.2.1 Survey methodology 25
3.2.2 Habitat assessment 26
3.3 Transitional waters 28
3.3.1 Survey methodology 28
3.3.2 Processing of fish 31
3.3.3 Additional information 31
3.4 Ageing of fish 32
3.5 Quality assurance 34
3.6 Biosecurity - disinfection and decontamination procedures 34
3.7 Hydroacoustic technology: new survey method development 35

4. RESULTS 37

4.1 Lakes 37
4.1.1 Fish species composition and species richness 37
4.1.2 Fish species distribution 41
4.1.3 Fish abundance and biomass 54
4.1.4 Fish Growth 66
4.1.5 Ecological status - Classification of lakes using 'FIL2' 71
4.2 Rivers 73
4.2.1 Fish species composition and species richness 73
4.2.2 Fish species distribution and abundance 79
4.2.3 Fish Growth 98
4.2.4 Ecological status – Classification of rivers using 'FCS2 Ireland' 101
4.3 Transitional waters 105
4.3.1 Fish species composition and richness 105
4.3.2 Fish species distribution 107
4.3.3 Ecological status - Classification of transitional waters using 'TFCI' 108

5. DISCUSSION 110

5.1 Species richness 110
5.2 Distribution of native species 110
5.3 Distribution of non-native fish species 111
5.4 Effects of non-native species on indigenous fish populations 112
5.5 Fish age and growth 113
5.6 Ecological status classifications 115

6. REFERENCES 117

APPENDICES 121

1. INTRODUCTION

In December 2000, the European Union introduced the Water Framework Directive (WFD) (2000/60/EC) as part of a new standardised approach for all Member States to manage their water resources and to protect aquatic ecosystems. The fundamental objectives of the WFD, which was transposed into Irish Law in December 2003 (Water Regulations S.I. No. 722 of 2003), are to protect and maintain the status of waters that are already of good or high quality, to prevent any further deterioration and to restore all waters that are impaired so that they achieve at least good ecological status by 2015 or by the respective extended deadlines (refer to the River Basin Management Plans at www wfdireland.ie).

A key step in the WFD process is for EU Member States to assess the health of their surface waters through national monitoring programmes. Monitoring is the main tool used to classify the status (high, good, moderate, poor or bad) of each water body (section of a river or other surface water). Once each country has determined the current status of their water bodies, ongoing monitoring then helps to track the effectiveness of measures needed to clean up water bodies and achieve good status. In accordance with national legislation, the Environmental Protection Agency (EPA) published a programme of monitoring to be carried out in Ireland in order to meet the legislative requirements of the WFD (EPA, 2006).

The WFD now requires that, in addition to the normal monitoring carried out by the EPA, other aquatic communities such as plants and fish populations must also be evaluated periodically in certain situations. WFD will also monitor human impacts on hydromorphology (i.e. the physical shape of river systems). These data collectively will be used to assess ecosystem quality.

The responsibility for monitoring fish has been assigned to Inland Fisheries Ireland (IFI) by the EPA (EPA, 2006). A national fish stock surveillance monitoring programme has been conducted since 2007 at specified locations over a three year rolling cycle. The monitoring programme includes over 300 sites, encompassing rivers, lakes and transitional waters (estuaries and lagoons). This programme provides information on the status of fish species present in these water bodies as well as on their abundance, growth patterns, and population demographics.

During the first three year surveillance monitoring cycle, from 2007 to 2009, a total of 70 lakes, 72 transitional waters and 137 river sites were surveyed, with over 70 fish species and 150,000 fish captured and examined. During the second three year surveillance monitoring cycle, from 2010 to 2012, a total of 78 lakes, 30 transitional waters and 166 river sites were surveyed, with over 70 fish species and over 107,000 fish captured and examined.

The WFD fish surveillance monitoring programme in 2013 has again been extensive and 63 river sites, 24 lakes and ten transitional water bodies were successfully surveyed nationwide. A team of IFI staff carried out the monitoring surveys (scientists from the Research and Development section of IFI HQ in conjunction with staff from the IFI river basin district offices). The surveys were conducted using a suite of European standard methods; electric fishing is the main survey method used in rivers, with various netting techniques being used in lakes and estuaries. Field survey work was conducted from June to October, which is the optimum time for sampling fish in Ireland.

This report summarises the main findings of the fish stock surveys in all water bodies (lakes, rivers and transitional waters) surveyed during 2013 and reports the current ecological status of the fish stocks in each.

Detailed reports on all water bodies surveyed are available to download on the dedicated WFD fish website (www.wfdfish.ie).

2. STUDY AREA

2.1 Lakes

Twenty-four lake water bodies, ranging in size from 4.2ha (Lough Mushlin) to 10,500ha (Lough Ree), were surveyed between June and October 2013. The selection of lakes surveyed encompassed a range of lake types (10 WFD designated typologies) (EPA, 2005; Appendix 1) and trophic levels, and were distributed throughout four different RBDs (Table 2.1, Fig. 2.1).

Four lakes were surveyed in the Shannon International River Basin District (ShIRBD), ranging in size from 37.9ha (Lough Atedaun) to 10500ha (Lough Ree). Three lakes were surveyed in the Eastern River Basin District (ERBD) (Annagh/White Lough, Lough Bane and Lough Lene). Five lakes were surveyed in the North Western International River Basin District (NWIRBD), ranging in size from 4.3ha (Lough Mushlin) to 644ha (Lough MacNean Upper) and 12 lakes were surveyed in the Western River Basin District (WRBD), ranging in size from 10.4ha (Lough Nambrackmore) to 403ha (Beltra Lough). Summary details of all lakes surveyed in 2013 are shown in Table 2.1.

Table 2.1. Summary details of lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2013 (* indicates cross border lakes).

Lake name	Water body code	Catchment	Easting	Northing	WFD Typology	Area (ha)	Mean depth (m)	Max depth (m)
ERBD								
Annagh/White	EA_07_258	Boyne	251007	273248	11	25.1	>4.0	18.0
Bane	EA_07_270	Boyne	254631	271497	12	75.4	>4.0	16.0
Lene	EA_07_274	Boyne	251910	268363	8	416.2	>4.0	20.0
ShIRBD								
Atedaun	SH_27_108	Fergus	129714	188473	9	37.9	2.3	7.0
Lickeen	SH_28_85	Inagh	116645	190840	8	84.2	>4.0	20.0
Ree	SH_26_750a	Shannon	202947	253041	12	10500.0	6.2	36.0
Urlaur	SH_26_689	Shannon	151235	288954	10	114.9	<4.0	11.0
NWIRBD								
Glen	NW_38_22	Lackagh	210410	429362	4	167.7	4.9	14.1
Lattone*	NW_35_143	Drowes	200035	345421	7	32.8	6.9	14.7
Macnean Lower*	NW_36_445	Erne	210676	337835	6	471.0	1.5	12.7
Macnean Upper*	NW_36_673	Erne	204948	339084	8	644.0	5.2	22.7
Mushlin	NW_36_272	Erne	262457	301037	1	4.3	<4.0	2.2
WRBD								
Ardderry	WE_31_76	Coastal	96967	246051	4	81.1	>4.0	12.0
Aughrusbeg	WE_32_436	Coastal	55841	258298	7	50.2	<4.0	14.0
Beltra	WE_32_452	Newport	107191	298358	4	403.0	>4.0	26.0
Glenade	WE_35_156	Garvogue	182424	346452	6	73.6	<4.0	11.5
Glencar	WE_35_139	Drumcliff	175368	343290	12	114.6	>4.0	19.0
Kylemore	WE_32_509b	Dawros	76904	258455	4	134.1	>4.0	30.0
Lettercraffroe	WE_30_344	Corrib	105966	237374	2	82.4	2.8	17.8
Maumwee	WE_30_343	Corrib	97729	248780	1	27.6	2.1	8.8
Nambrackmore	WE_31_16	Coastal	71956	245252	1	10.4	2.1	10.0
Rea	WE_29_194	Kilcolgan	161513	215479	10	310.0	3.9	23.0
Ross	WE_30_345	Corrib	119813	236099	12	139.2	<4.0	14.0
Shindilla	WE_31_171	Coastal	95543	245916	4	65.3	>4.0	22.0

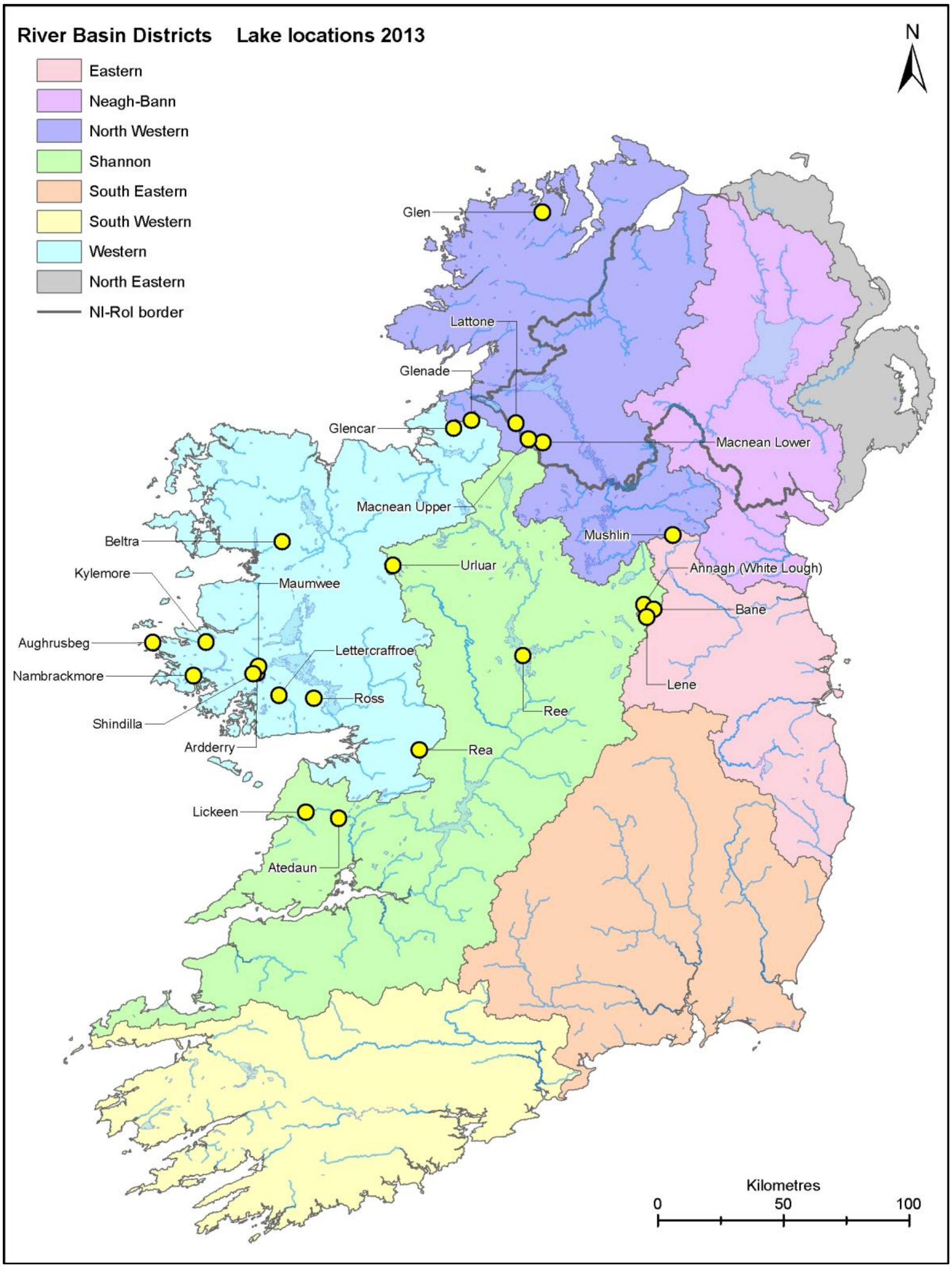

Fig. 2.1. Location of the 24 lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2013

2.2 Rivers

Sixty-three river sites, ranging in surface area from 115m^2 (Spancelhill River, ShIRBD) to 26,566m^2 (River Lee (Lee Fields), SWRBD), were surveyed between July and September 2013. Catchments encompassing each river water body were classified according to size as follows; <10km^2, <100km^2, <1000km^2 and <10000km^2. Sites were distributed throughout all seven RBDs within the Republic of Ireland (Table 2.2, Table 2.3 and Fig. 2.2).

Eight river sites were surveyed in the ERBD with surface areas ranging from 313m^2 (Avonbeg River to 8,748m^2 (River Liffey at Kilcullen). Only the River Liffey sites were deep enough to require the use of boat based electric-fishing equipment. Twelve river sites were surveyed in the SERBD, with surface areas ranging from 163m^2 (both Ballyroan sites) to 662 m^2 (Nier River). All of these sites were wadeable and fished using bank based equipment. Nineteen river sites were surveyed in the ShIRBD, ranging in size from 115m^2 (Spancelhill River) to 9,651m^2 (River Suck at Ballyforan Br.). Of these sites, 15 were wadeable and four were non-wadeable. Twelve sites were surveyed in the SWRBD, ranging in size from 255m^2 (Cummeragh River) to 26,566m^2 (River Lee at Lee Fields). Of these, six were wadeable and six were non-wadeable. Four sites were surveyed in the WRBD (all wadeable), ranging in size from 282m^2 (Screeb River) to 441m^2 (Owenboliska River). Six sites were surveyed in the NWIRBD ranging in surface area from 252m^2 (Dromore River) to 5,304m^2 (Erne River at Belturbet). Of these, two sites were wadeable and four were non-wadeable. Finally two sites were surveyed in the NBIRBD (both wadeable), with surface areas of 294m^2 (White River) and 336m^2 (Fane River). Summary details of each site's location and physical characteristics are given in Tables 2.2 and 2.3.

Table 2.2. Location and codes of river sites surveyed for the WFD fish surveillance monitoring programme, July to September 2013

River	Site name	Catchment	Site Code	Water body code
ERBD Wadeable sites				
Avonbeg River	Greenan Br._A	Avoca	10A040600A	EA_10_99
Blackwater (Kells), River	Lough Ramor_A	Boyne	07B010800A	EA_07_1035
Dodder, River	Bohernabreena_A	Liffey	09D010100A	EA_09_1656
Dodder, River	Beaver Row_B	Liffey	09D010900B	EA_09_587
Dodder, River	Mount Carmel_A	Liffey	09D010680A	EA_09_587
Vartry River	Newrath Br._A	Vartry	10V010300A	EA_10_1601
ERBD Non-Wadeable sites				
Liffey, River	Ballyward Br._A	Liffey	09L010250A	EA_09_1175
Liffey, River	Kilcullen Br._A	Liffey	09L010700A	EA_09_1870_2
NBIRBD Wadeable sites				
Fane River	Inishkeen_A	Fane	06F010650A	XB_06_8
White River (Louth)	Coneyburrow Br._B	Dee	06W010500B	NB_06_550
NWIRBD Wadeable sites				
Cullies River	Kilbrackan Br._A	Erne	36C030600A	NW_36_2032
Dromore River	Drummuck_A	Erne	36D020125A	NW_36_30
NWIRBD Non-Wadeable sites				
Annalee River	Cavan confl._A	Erne	36A021400A	NW_36_2417
Erne, River	Bellahillan Br._A	Erne	36E011100A	NW_36_1746
Erne, River	Belturbet Br._A	Erne	36E011400A	XB_36_east_4
Finn River (Monaghan)	Cumber Br._A	Erne	36F010500A	XB_36_east_3
SERBD Wadeable sites				
Ballyroan River	Ballydine Br._A	Nore	15B010150A	SE_15_1938
Ballyroan River	Gloreen Br._D	Nore	15B010200D	SE_15_1938
Banoge River	Owenavorragh confl_A	Owenavorragh	11B020300A	SE_11_257
Banoge River	M11_A	Owenavorragh	11B020230A	SE_11_257
Clody, River	Ford near Bunclody_B	Slaney	12C030200B	SE_12_2098
Douglas River (Ballon)	Sragh Br._B	Slaney	12D030200B	SE_12_789
Glory, River	Raheen_A	Nore	15G010200A	SE_15_1870
Gowran River	Goresbridge_A	Barrow	14G030300A	SE_14_1879
Gowran River	Grange Lower_A	Barrow	14G030240A	SE_14_1879
Nier, River	Ballymacarby_A	Suir	16N010100A	SE_16_1059
Nuenna River	Clomantagh_B	Nore	15N020100B	SE_15_1029
Slaney, River	Waterloo Br._A	Slaney	12S020400A	SE_12_1524

Table 2.2 ctn. Location and codes of river sites surveyed for the WFD fish surveillance monitoring programme, July to September 2013

River	Site name	Catchment	Site Code	Water body code
ShIRBD Wadeable sites				
Ballyfinboy River	Ballinderry Br._A	Shannon Lwr	25B020750A	SH_25_1853
Ballyfinboy River	Lough Derg_A	Shannon Lwr	25B020800A	SH_25_1853
Boor River	Kilbillaghan Br._B	Shannon Upr	26B071100B	SH_26_3921
Bow River	Bow Br._A	Shannon Lwr	25B100100A	SH_25_2145
Broadford River	Doon Lough_A	Bunratty	27B020800A	SH_27_287
Broadford River	Broadford (Broadford Village)_A	Bunratty	27B020700A	SH_27_287
Glenafelly River	Glenafelly Br._A	Shannon Lwr	25G210010A	SH_25_2084
Glendine River (Clare)	Knockloskeraun Br. _A	Annagh	28G020200A	SH_28_231
Gourna River	Railway Br._A	Bunratty	27G020600A	SH_27_885
Gourna River	Owenogarney confl_C	Bunratty	27G020550C	SH_27_885
Graney River	Caher Br._A	Shannon Lwr	25G040025A	SH_25_2081
Mountnugent River	Mountnugent Br._A	Inny	26M020500A	SH_26_2742
Moyree River	Fergus Br._A	Fergus	27M020700A	SH_27_1178
Newport River	Rossaguile Br._A	Shannon Lwr	25N020150A	SH_25_320
Spancelhill River	Spancelhill_A	Fergus	27S030200A	SH_27_1118
ShIRBD Non-Wadeable sites				
Fergus, River	Clonroad Br._A	Fergus	27F010700A	SH_27_1245
Fergus, River	Poplar Br._B	Fergus	27F010100B	SH_27_181
Suck, River	Ballyforan Br._A	Suck	26S071100A	SH_26_1447_4
Suck, River	Cloondacarra Br._A	Suck	26S070300A	SH_26_1447_1
SWRBD Wadeable sites				
Adrigole River	Glashduff confl_A	Adrigole	21A010150A	SW_21_8052
Araglin River	Elizabeth's Br._A	Blackwater	18A030200A	SW_18_1131
Cummeragh River	Owengarriff confl_A	Cummeragh	21C040400A	SW_21_6162
Dalua River	Liscongill_A	Blackwater	18D010200A	SW_18_394
Licky River	Glenlicky_A	Blackwater	18L010100A	SW_18_2819
Owvane River (Cork)	Piersons Br._A	Owvane	21O070400A	SW_21_8048
SWRBD Non-Wadeable sites				
Blackwater (Munster), River	Killavullen Br._A	Blackwater	18B021900A	SW_18_2292_5
Blackwater (Munster), River	Lismore Br._A	Blackwater	18B022600A	SW_18_2755
Blackwater (Munster), River	Nohaval Br._A	Blackwater	18B020200A	SW_18_450
Funshion, River	Blackwater confl_A	Blackwater	18F051100A	SW_18_1836
Lee (Cork), River	Inchinossig Br._A	Lee	19L030100A	SW_19_928
Lee (Cork), River	Lee Fields_A	Lee	19L030800A	SW_19_1663
WRBD Non-Wadeable sites				
Abbert River	Bullaun Br._A	Corrib	30A010500A	WE_30_3424
Owenboliska River	Caravan Park_A	Owenboliska	31O010180A	WE_31_2233
Owendalluleegh River	Killafeen Br._A	Kinvarra	29O011000A	WE_29_150
Screeb River	Lough Aughawoolia_A	Screeb	31S010400A	WE_31_2305

Table 2.3. Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, July to September 2013

Site name	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ERBD Wadeable sites					
Avonbeg (Greenan Br._A)	72.13	7.82	313	0.28	0.64
Blackwater (Kells), (Lough Ramor_A)	124.12	9.77	391	0.24	0.49
Dodder (Bohernabreena_A)	31.82	7.32	315	0.19	0.59
Dodder (Beaver Row_B)	104.58	13.90	514	0.23	0.72
Dodder (Mount Carmel_A)	93.22	9.68	339	0.19	0.45
Vartry (Newrath Br._A)	102.98	7.72	347	0.22	0.48
ERBD Non-Wadeable sites					
Liffey (Ballyward Br._A)	87.70	11.60	3503	0.33	0.79
Liffey (Kilcullen Br._A)	449.86	24.17	8748	0.38	1.50
NBIRBD Wadeable sites					
Fane (Inishkeen_A)	234.30	7.82	336	0.23	0.47
White (Coneyburrow Br._B)	55.13	6.83	294	0.26	0.46
NWIRBD Wadeable sites					
Cullies (Kilbrackan Br._A)	110.44	6.50	254	0.38	0.72
Dromore (Drummuck_A)	37.14	6.30	252	0.28	0.57
NWIRBD Non-Wadeable sites					
Annalee (Cavan confl_A)	859.02	16.75	3300	0.53	1.20
Erne (Bellahillan Br._A)	336.37	13.10	2921	1.10	2.25
Erne (Belturbet Br._A)	1495.99	20.17	5304	0.72	1.00
Finn (Monaghan)(Cumber Br._A)	121.61	11.80	2372	0.80	2.50
SERBD Wadeable sites					
Ballyroan (Ballydine Br._A)	35.50	4.42	163	0.14	0.43
Ballyroan (Gloreen Br._D)	39.26	4.08	163	0.29	0.53
Banoge (Owenavorragh confl_A)	29.44	4.87	219	0.18	0.38
Banoge (M11 _A)	22.65	5.57	223	0.27	0.43
Clody (Ford near Bunclody_B)	28.38	7.50	300	0.20	0.41
Douglas (Ballon)(Sragh Br._B)	15.22	3.33	143	0.13	0.26
Glory (Raheen_A)	62.07	7.12	320	0.26	0.53
Gowran (Goresbridge_A)	42.05	3.80	171	0.20	0.37
Gowran (Grange Lower_A)	39.61	5.13	205	0.43	0.61
Nier (Ballymacarby_A)	69.00	16.55	662	0.28	0.77
Nuenna (Clomantagh_B)	22.81	4.70	207	0.17	0.35
Slaney (Waterloo Br._A)	77.66	10.60	477	0.24	0.60

Table 2.3 ctn. Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, July to September 2013

Site name	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ShIRBD Wadeable sites					
Ballyfinboy (Ballinderry Br._A)	184.86	6.28	251	0.25	0.48
Ballyfinboy (Lough Derg_A)	187.24	4.63	209	0.34	0.71
Boor (Kilbillaghan_B)	53.65	4.20	214	0.25	0.69
Bow (Bow Br._A)	10.75	4.48	202	0.13	0.25
Broadford (Doon Lough_A)	34.64	4.93	138	0.32	0.64
Broadford (Broadford Village)_A)	30.58	5.40	216	0.18	0.84
Glenafelly (Glenafelly Br._A)	4.76	3.27	147	0.12	0.34
Glendine (Knockloskeraun Br._A)	12.31	3.40	153	0.37	0.60
Gourna (Railway Br._A)	15.25	5.30	233	0.20	0.37
Gourna (Owenogarney confl_C)	15.01	4.05	182	0.17	0.37
Graney (Caher Br._A)	13.73	5.06	228	0.15	0.32
Mountnugent (Mountnugent Br._A)	91.11	6.77	298	0.27	0.55
Moyree (Fergus Br. _A)	62.56	7.72	347	0.19	0.33
Newport (Rossaguile Br._A)	65.82	9.50	380	0.31	0.67
Spancelhill (Spancelhill_A)	6.47	3.48	115	0.08	0.34
ShIRBD Non-Wadeable sites					
Fergus, (Clonroad Br._A)	60.14	19.67	5487	1.06	3.00
Fergus, (Poplar Br._B)	138.70	7.95	318	0.35	0.56
Suck, (Ballyforan Br._A)	1006.50	29.33	9651	0.65	1.40
Suck, (Cloondacarra Br._A)	153.55	9.58	2195	0.68	1.40
SWRBD Wadeable sites					
Adrigole (Glashduff confl_A)	26.28	10.02	401	0.27	0.66
Araglin (Elizabeth's Br._A)	64.24	14.00	560	0.25	0.44
Cummeragh (Owengarriff confl_A)	19.79	6.37	255	0.32	0.51
Dalua (Liscongill_A)	86.58	11.12	456	0.21	0.46
Licky (Glenlicky_A)	24.90	5.93	267	0.22	0.44
Owvane (Piersons Br._A)	71.62	15.36	614	0.32	0.81
SWRBD Non-Wadeable sites					
Blackwater (Munster), (Killavullen Br._A)	1256.72	36.80	16413	1.28	2.00
Blackwater (Munster), (Lismore Br._A)	2381.81	35.67	12947	2.00	3.00
Blackwater (Munster), (Nohaval Br._A)	89.00	11.45	2221	0.27	0.66
Funshion, (Blackwater confl_A)	380.46	14.33	2537	1.04	1.80
Lee (Cork), (Inchinossig Br._A)	31.82	9.50	428	0.21	0.44
Lee (Cork), (Lee Fields_A)	1184.03	59.83	26566	0.88	1.80
WRBD Non-Wadeable sites					
Abbert (Bullaun Br._A)	211.86	7.80	351	0.28	0.56
Owenboliska (Caravan Park_A)	88.76	11.60	441	0.25	0.51
Owendalluleegh (Killafeen Br._A)	90.48	9.67	387	0.21	0.48
Screeb (Lough Aughawoolia_A)	30.85	11.26	282	0.41	0.60

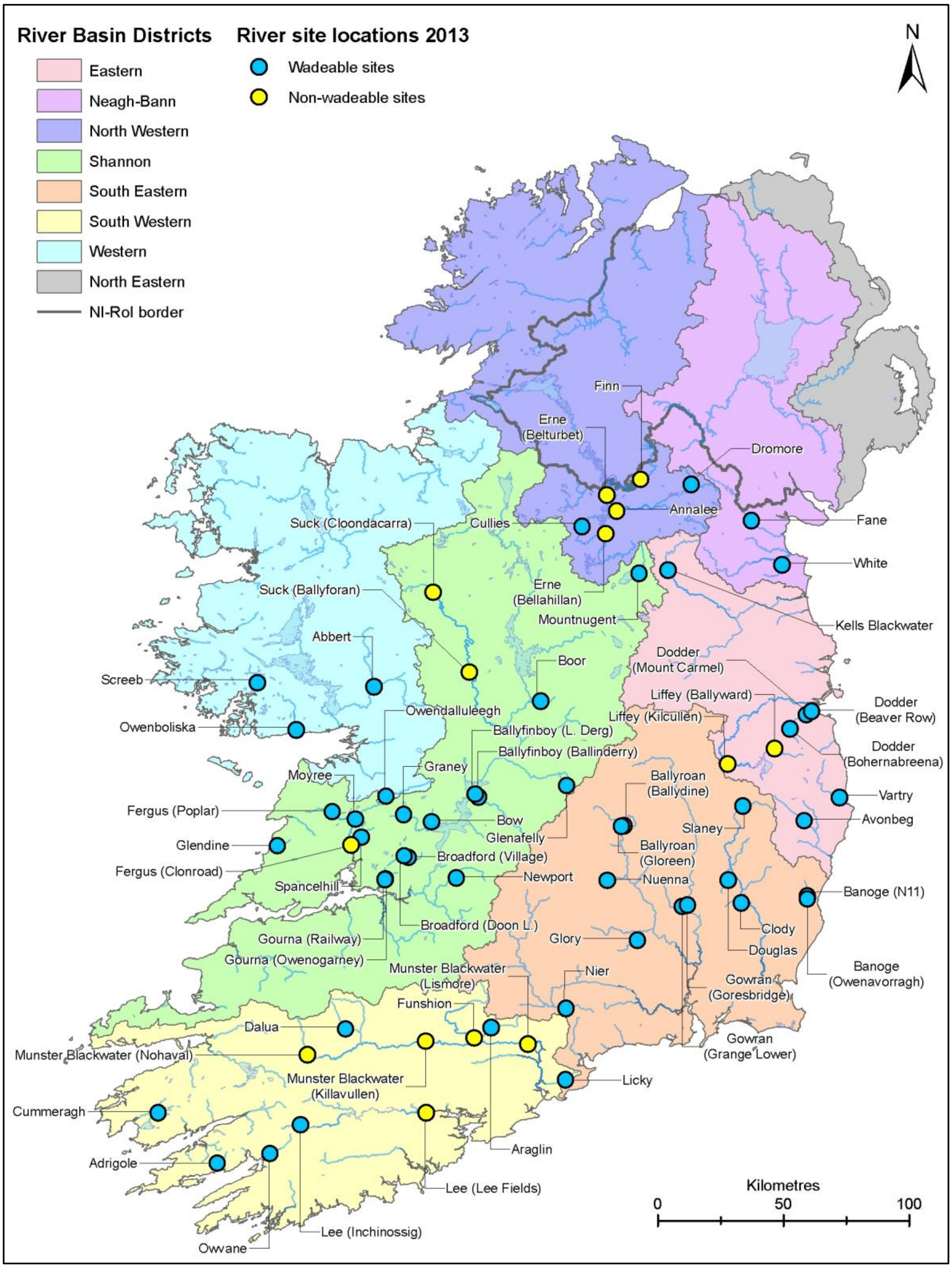

Fig. 2.2. Location of the 63 river sites surveyed for the WFD fish surveillance monitoring programme, July to September 2013

2.3 Transitional waters

Ten transitional water bodies were surveyed in 2013, eight on the Barrow, Nore, Suir system in the SERBD and two in the SWRBD, Lough Gill and Drongawn Lough (Table 2.4 and Fig. 2.3).

The largest water body surveyed was the Barrow, Suir, Nore Estuary with a surface area of 28.21 km^2, while the smallest was Drongawn Lough, a small lagoon in Co. Kerry with a surface area of only 0.12km^2.

Table 2.4.Transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2013

Water body	MS Code	Easting	Northing	Type	Area (km^2)
Barrow Suir Nore Estuary	SE_100_0100	271527	107512	Transitional water	28.21
New Ross Port	SE_100_0200	267862	117105	Transitional water	6.71
Barrow Nore Estuary Upper	SE_100_0250	272129	128644	Transitional water	0.64
Barrow Estuary, Upper	SE_100_0300	273066	137640	Transitional water	1.15
Nore Estuary	SE_100_0400	265312	135294	Transitional water	1.26
Suir Estuary, Lower	SE_100_0500	266073	112602	Transitional water	4.32
Suir Estuary, Middle	SE_100_0550	249824	114070	Transitional water	7.03
Suir Estuary, Upper	SE_100_0600	243887	121066	Freshwater Tidal	1.09
Drongawn Lough	SW_190_0500	073056	064019	Transitional water	0.12
Gill, Lough	SH_040_0100	060525	113990	Lagoon	1.40

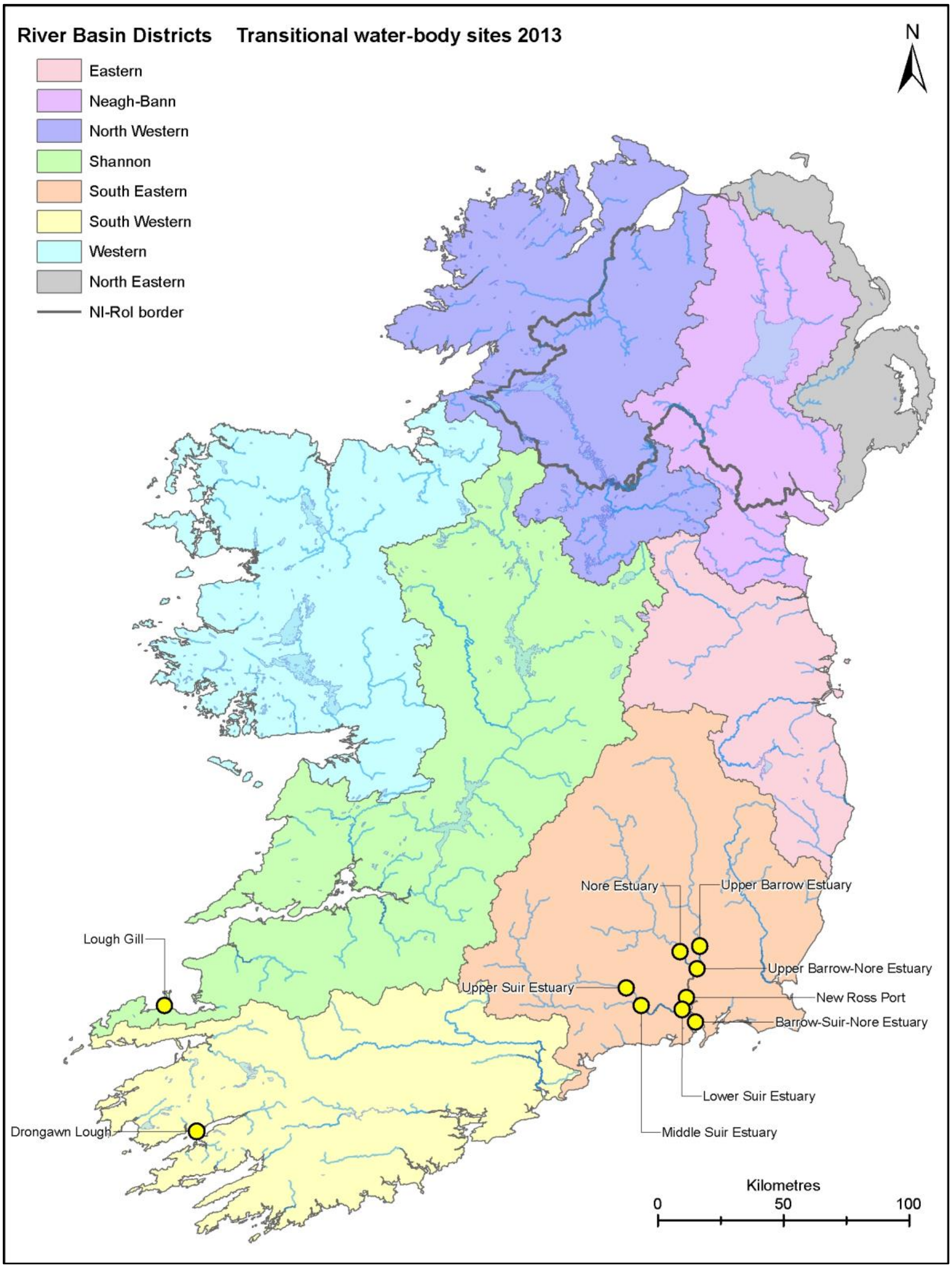

Fig. 2.3. Location of the ten transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2013

3. METHODS

All surveys were conducted using a suite of European standard methods (CEN, 2003; CEN, 2005a; CEN, 2005b). Electric fishing is the main survey method used in rivers, while a multi-method netting approach is used in both lakes and transitional waters. Details of these methods are outlined below.

3.1 Lakes

3.1.1 Survey methodology

Lake water bodies were surveyed using a netting method developed and tested during the NSSHARE Fish in Lakes Project in 2005 and 2006 (Kelly *et al*., 2007b and 2008a). The method is based on the European CEN standard for sampling fish with multi-mesh gill nets (CEN, 2005b); however, the netting effort has been reduced (approx. 50%) for Irish lakes in order to minimise damage to fish stocks.

Monofilament multi-mesh CEN standard survey gill nets (12 panel, 5-55mm mesh size) (Plate 3.1) were used to survey the fish populations in lakes using a stratified random sampling design. Each lake was divided into depth strata (0-2.9m, 3-5.9m, 6-11.9m, 12-19.9m, 20-34.9m, 35-49.9m, 50-75m, >75m) and random sampling was then conducted within each depth stratum (CEN, 2005b). Surface floating survey gill nets (Plate 3.2), fyke nets (one unit comprised of three fyke nets; leader size 8m x 0.5m) and benthic braided single panel (62.5mm mesh knot to knot) survey gill nets were also used to supplement the CEN standard gill netting effort.

Survey locations were randomly selected using a grid placed over a map of the lake; however, when a repeat survey was undertaken, nets were deployed in the same locations as were randomly selected in the previous survey. A handheld GPS was used to mark the precise location of each net. The angle of each gill net in relation to the shoreline was randomised. Nets were set over night, and all lake surveys were completed between June and early October.

3.1.2 Processing of fish

All fish were counted, measured and weighed on site (Plate 3.3). Scales were removed from salmonids, roach, rudd, tench, pike and bream. Samples of some fish species were returned to the laboratory for further analysis, e.g. age analysis using char/eel otoliths and perch opercular bones. Stomach contents and sex were determined for any fish retained.

3.1.3 Water chemistry

Conductivity, pH, temperature and dissolved oxygen depth profiles were measured on site using a multiprobe. A Secchi disc was used to measure water clarity.

Plate 3.1. Setting a monofilament multi-mesh CEN standard survey gill net on Glencar Lough, Co. Sligo

Plate 3.2. A surface floating monofilament multi-mesh CEN standard survey gill net on Annagh/White Lough, Co. Westmeath/Meath

Plate 3.3. Processing the nets and fish on Kylemore Lough, Co. Galway

3.2 Rivers

Electric fishing is the method of choice to obtain a representative sample of the fish assemblage in river sites. A standard methodology was developed by Inland Fisheries Ireland for the WFD fish surveillance monitoring programme (CFB, 2008a), in compliance with the European CEN standard for fish stock assessment in wadeable rivers (CEN, 2003). Environmental and abiotic variables were also measured on site. A macrophyte survey was also carried out at selected wadeable sites. Surveys were conducted between July and September (to facilitate the capture of juvenile salmonids) and when stream and river flows were moderate to low.

3.2.1 Survey methodology

Each site was sampled by depletion electric fishing (where possible) using one or more anodes depending on the width of the site. Sampling areas were isolated using stop nets. On a few occasions, stop-nets were substituted with instream hydraulic or physical breakpoints, such as well-defined shallow riffles or weirs. Where possible, three electric fishing passes were conducted at each site.

In small wadeable channels (<0.5-0.7m in depth), bank-based equipment, consisting of landing nets with integrated anodes connected to control boxes and portable generators were used to sample in an upstream direction (Plate 3.4a). In larger, deeper channels (>0.5-1.5m), fishing was carried out from a flat-bottomed boat(s) in a downstream direction using a generator, control box, a pair of anodes and a cathode (Plate 3.4b). A representative sample of all habitats was sampled (i.e. riffle, glide, pool).

Plate 3.4. Electric fishing with (a) bank-based electric fishing equipment (Cummeragh River) and (b) boat-based electric fishing equipment (River Blackwater)

Fish from each pass were sorted and processed separately. Captured fish were measured and weighed, with scales removed from a subsample for age analysis (Plate 3.5). All fish were held in a large bin of oxygenated water after processing until they were fully recovered, before being returned to the river. Samples of eels were returned to the laboratory for further analysis (e.g. age, stomach contents and sex).

For various reasons, including weather, river width and the practicalities of using stop-nets, three electric fishing passes were not possible or practical at all sites. Therefore, in order to draw comparisons between sites, fish densities were calculated using data from the first electric fishing pass only.

Plate 3.5. Processing fish for length, weight and scale samples

3.2.2 Habitat assessment

An evaluation of habitat quality is critical to any assessment of ecological integrity and a habitat assessment was performed at each site surveyed. Physical characterisation of a stream includes documentation of general land use, a description of the stream origin and type, a summary of riparian vegetation and measurements of instream parameters such as width, depth, flow and substrate (Barbour *et al*., 1999).

At each site, the percentage of overhead shade, substrate type and instream cover were visually assessed. Wetted width and depth were also measured throughout the stretch. The width was recorded at six transects, with five depths at intervals along each. The percentage of riffle, glide and pool was estimated in each reach surveyed. Conductivity, temperature, salinity, pH and dissolved oxygen were also recorded at each site using a multiprobe. A summary of environmental and abiotic variables were recorded, showing the range amongst all river sites surveyed, is shown in Table 3.1.

Table 3.1. Environmental and abiotic variables recorded for all river sites surveyed for WFD fish surveillance monitoring in 2013

Environmental / abiotic variable	Min	Mean	Max	Footnote
River reach sampled				
Length fished (m)	25.00	86.89	446.00	1
Mean depth (m)	0.04	0.35	2.00	2
Max depth (m)	0.08	0.73	3.00	3
Wetted width (m)	2.57	10.1	59.83	4
Surface area (m^2)	103.00	1629.00	26566.00	5
Shade	0	-	3	6
Instream cover	0	17.30	80.00	7
Bank slippage	0	-	1	8
Bank erosion	0	-	1	8
Fencing (RHS & LHS)	0	-	1	8
Trampling (RHS & LHS)	0	-	1	8
Water level	1	-	2	9
Velocity	1	-	4	10
Conductivity @ 25^0c (µS/cm)	46.00	324.00	797.00	-
Water temperature (^{o}c)	11.00	16.30	20.90	-
pH	6.99	7.54	8.04	-
Dissolved oxygen (mg/l)	1.93	6.42	9.43	-
Dissolved oxygen (%)	19.20	65.85	99.30	-
Flow type (%)				
Riffle	0	30	75	7
Glide	10	58	100	7
Pool	0	21	50	7
Substrate type (%)				
Bedrock	0	7.17	15	7
Boulder	0	14.38	80	7
Cobble	0	46.70	85	7
Gravel	0	26.38	85	7
Sand	0	11.74	40	7
Mud/silt	0	14.61	40	7

***Footnotes*:**

1. Measured over length of site fished
2. Mean of 30 depths taken at 5 transects through the site
3. Measured at deepest point in stretch fished
4. Mean of 6 widths taken at 6 transects
5. Calculated from length and width data
6. Shade due to tree cover, estimated visually at the time of sampling (0-none, 1-light, 2-medium, 3-heavy)
7. Percentage value, estimated visually at the time of sampling
8. Bank slippage, bank erosion, fencing estimated visually at time of sampling (presence or absence recorded as 1 or 0)
9. Water level, estimated visually at time of sampling-3 grades (1-low, 2-normal & 3-flood)
10. Velocity rating, estimated visually at time of sampling-5 ratings given (1-very slow, 2-slow, 3-moderate, 4-fast, 5-torrential)

3.3 Transitional waters

Transitional waters (estuaries/lagoons) are an interface habitat, where freshwater flows from rivers and mixes with the tide and salinity of the sea. As such, they provide a challenging habitat to survey due to their constantly changing environmental conditions. In every 24 hour period, the tidal level rises and falls twice, subjecting extensive areas to inundation and exposure.

3.3.1 Survey methodology

The standard method for sampling fish in transitional waters in Ireland for the WFD monitoring programme (CFB, 2008b) is a multi-method approach using various netting techniques. Sampling methods include:

- Beach seining using a 30m fine-mesh net to capture fish in littoral areas
- Beam trawling for specified distances (200m) in open water areas adjacent to beach seining locations
- Fyke nets set overnight in selected areas

3.3.1.1 Beach Seining

Beach seining is conducted using a four-person team; two staff on shore and two in a boat. Sampling stations are selected to represent the range of habitat types within the site, based on such factors as exposure/orientation, shoreline slope and bed type. The logistics of safe access to shore and feasibility of unimpeded use of the seine net are also considered.

The standard seine net used in transitional water surveys is 30m in length and 3m deep, with 30m guide ropes attached to each end. Mesh size is 10mm. The bottom, or lead line, has lead weights attached to the net in order to keep the lead line in contact with the sea bed. This increases sediment disturbance and catch efficiency.

All beach seine nets were set from a boat with one end or guide rope held on shore, while the boat followed an arc until the net was fully deployed. In conditions with minimal influence of tide or flow, the seine nets were allowed to settle while the second guide rope was brought to shore. The net was then drawn into position before being slowly drawn shoreward (Plates 3.6 and 3.7).

Plate 3.6. Beach seining: net deployed from a boat

Plate 3.7. Beach seining: hauling the net towards shore

3.3.1.2 Fyke netting

Fyke nets, identical to those used for lake surveys (one unit comprised of 3 fyke nets; leader size 8m x 0.5m) are the standard fyke nets used to sample fish in transitional waters (Plate 3.8). Each fyke net unit is weighted by two anchors to prevent drifting and a marker buoy is attached to each end.

Nets were deployed overnight to maximise fishing time in different types of habitats, i.e. rocky, sandy and weedy shores. Tide is also a factor when deploying the fyke nets as they must be submerged at all times to fish effectively.

Plate 3.8. Fyke net being hauled onto a rigid inflatable boat (RIB)

3.3.1.3 Beam trawl

Beam trawling enables sampling of littoral and open water habitats where the bed type is suitable. The beam trawl used for IFI's WFD transitional water fish sampling measures 1.5m x 0.5m in diameter, with a 10mm mesh bag, decreasing to 5mm mesh at the cod end (Plate 3.9). A 1.5m metal beam ensures the net stays open while towing, with small floats on the top line and 3m of light chain on the bottom line. A 1m bridle is attached to a 20m tow rope and the net is towed by a boat.

Trawls were conducted over transects of 200m in length with the start and finish recorded on a handheld GPS. Trawling must be done over a substrate of sand or gravel, as trawling over soft sediments can cause the net to foul with mud and make the recovery of the trawl extremely difficult. After each trawl the net was hauled aboard and the fish were processed.

Plate 3.9. Setting a beam trawl for a transitional water surveys

3.3.2 Processing of fish

At the completion of each seine net haul, fyke net (overnight setting) and beam trawl transect, the fish were carefully removed from the nets and placed into clean water. One field team member examined each fish whilst the other recorded date set, time set, date out, transitional water name, grid reference, net information (type), number of each species and individual fish length. Once processing was complete the majority of fish were returned to the water alive. Representative sub-samples of a number of abundant fish species were measured (fork length) to the nearest millimetre. Any fish species that could not be identified on site were preserved in ethanol or frozen and taken back to the IFI laboratory for identification.

3.3.3 Additional information

Information on bed type and site slope was recorded by visual assessment at each beach seine sample station, based on the dominant bed material and slope in the wetted area sampled. Three principal bed types were identified (gravel, sand and mud). Shoreline slopes were categorized into three groups:

gentle, moderate and steep. Salinity and water temperature were also recorded at all beach seine sampling stations. A handheld GPS was used to mark the precise location of each sampling station.

3.4 Ageing of fish

A subsample of the dominant fish species from rivers and lakes were aged (five fish from each 1cm class). Fish scales were read using a microfiche reader. Perch opercular bones were prepared by boiling, cleaning and drying, before ageing them using a binocular microscope/digital camera system with Image Pro Plus software (Plate 3.10). Char otoliths were cleared in 70% ethanol and aged using a binocular microscope (Plate 3.11). Eel otoliths were prepared by the method of 'cutting and burning' and then subsequently aged using a binocular microscope/digital camera system with Image Pro Plus software (Plate 3.12). Back calculated lengths at age were determined in the laboratory.

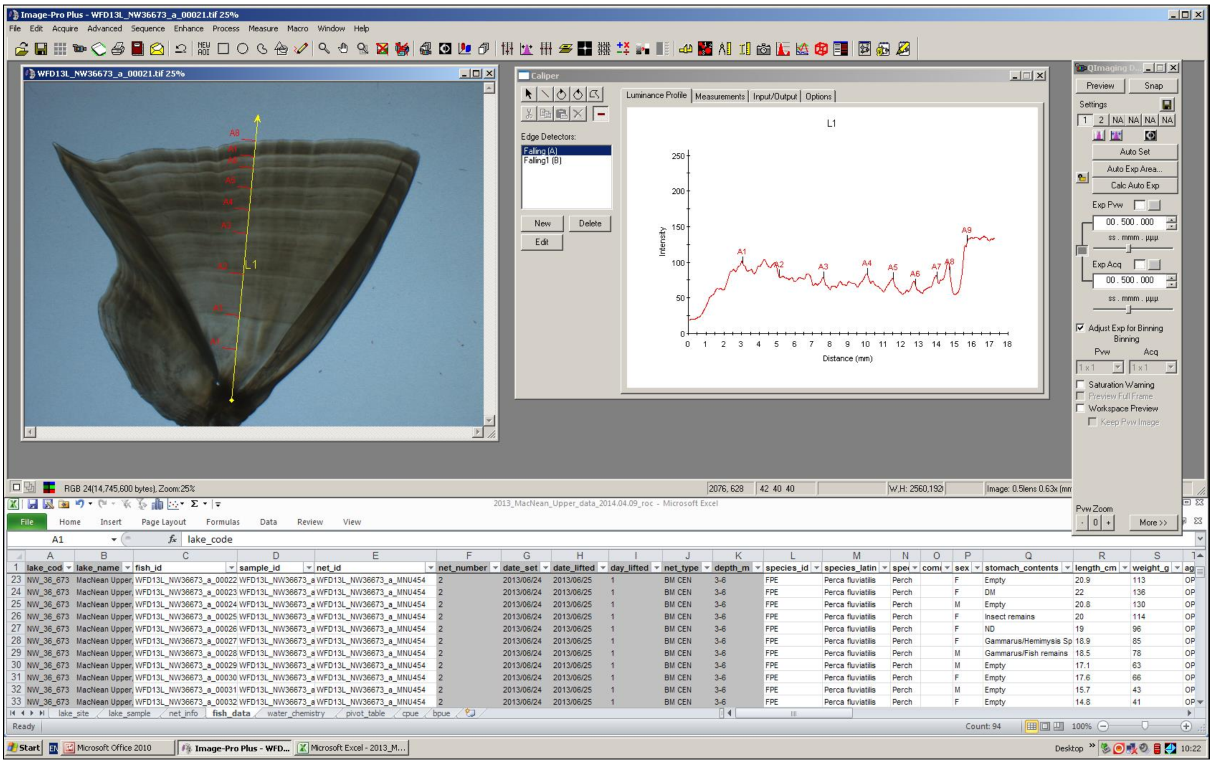

Plate 3.10. Opercular bone ageing using binocular microscope/digital camera system with Image Pro Plus software (a 8+ perch from Lough MacNean Upper)

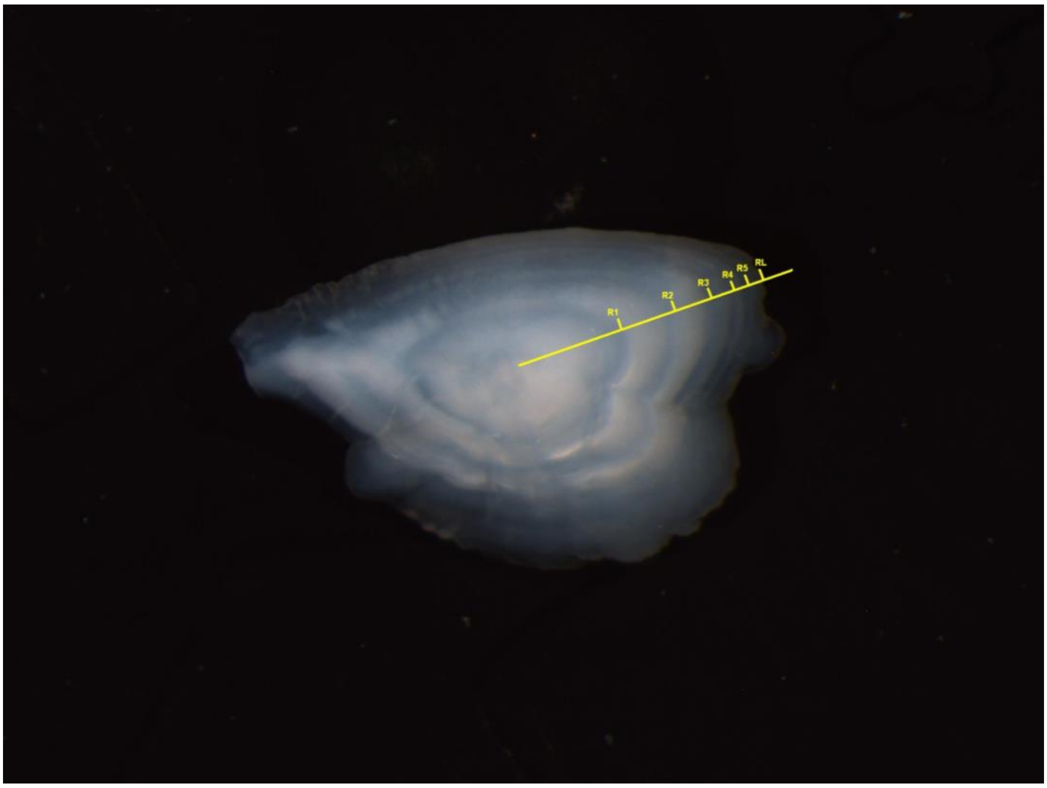

Plate 3.11. Char otolith (5+) from Lough Shindilla, Co. Donegal

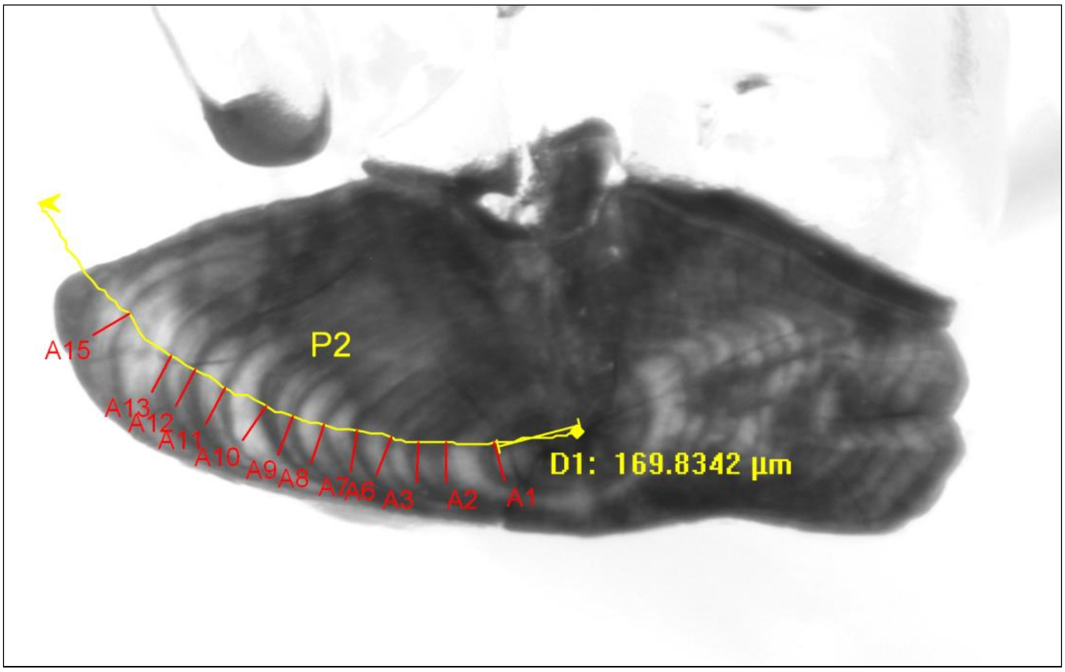

Plate 3.12. Eel otolith (11+) from Lough Ree (45.5cm, 129g)

3.5 Quality assurance

CEN (2005a) recommends that all activities undertaken during the standard fish sampling protocol (e.g. training of the lakes team, handling of equipment, handling of fish, fish identification, data analyses, and reporting) should be subjected to a quality assurance programme in order to produce consistent results of high quality. A number of quality control procedures have been implemented for the current programme. All IFI WFD staff have been trained in electric fishing techniques, fish identification, sampling methods (including gill netting, seine netting, fyke netting and beam trawling), fish ageing, data analyses, off road driving and personal survival techniques.

There is a need for quality control for fish identification by field surveyors, particularly in relation to hybrids of coarse fish. Samples of each fish species (from the three water body types) were retained when the surveyor was in any doubt in relation to the identity of the species, e.g. rudd and/or roach hybrids. There is also a need for quality control when ageing fish; therefore every tenth scale or other ageing structure from each species was checked in the laboratory by a second biologist experienced in age analysis techniques.

Further quality control measures are continually being implemented each year in relation to standardising data analyses, database structure and reporting. All classification tools for fish are continually being developed and outputs from these were intercalibrated across Europe at the end of 2011.

3.6 Biosecurity - disinfection and decontamination procedures

One of the main concerns when carrying out surveillance monitoring surveys for the WFD is to consider the changes which can occur to the biota, as a consequence of spreading unwanted non-native species, such as the zebra mussel. Procedures are required for disinfection of equipment in order to prevent dispersal of alien species and other organisms to uninfected waters. A standard operating procedure was compiled by Inland Fisheries Ireland for this purpose (Caffrey, 2010) and is followed diligently by staff on the IFI WFD team when moving between water bodies (Plate 3.13).

Plate 3.13. Disinfection procedure (steam washing) of a boat being moved between water bodies

3.7 Hydroacoustic technology: new survey method development

Hydroacoustics (or echo sounding) is the use of sound energy to remotely gather information from a water body by transmitting a pulse of sound into the water and assessing the position and strength of the returning echo. Hydroacoustic surveys have become a very useful tool in freshwater fish stock assessment, providing invaluable information on fish abundance, size distribution, spatial distribution and behaviour, whilst limiting the destructive use of gill nets.

One of the most valuable uses for hydroacoustic surveys in lakes is the targeted approach of assessing populations of indicator species or species at risk, such as Arctic char or pollan, which tend to inhabit the deeper areas of lakes. Hydroacoustics can be used very effectively to locate shoals of deep water fish and targeted ground-truth netting can then be used for species identification. Abundance estimates can subsequently be calculated from the acoustic data. Furthermore, the spatial distribution and size distribution of species of interest can also be assessed.

Further development in both hydroacoustic technology and survey methodology will see hydroacoustics play an increasing role in future WFD monitoring within IFI. Hydroacoustic technology will also continue to be used to support other important work within IFI, including assessing the population status of priority species such as pollan, Killarney shad and Arctic char. Additional experimental hydroacoustic surveys were carried out in 2013 on Lough Ree, Kylemore Lough and Glen Lough in parallel to the WFD fish stock surveys. These surveys were carried out as part of an Irish Research Council funded Ph.D. research project which aims to incorporate hydroacoustic technology into the existing standard sampling protocols used to assign ecological and conservation status for the Water Framework Directive and Habitats Directive for conservation and endangered fish species. The experimental surveys concentrated on the deeper sections of the lakes (depth >12m) and covered *circa* 112km of hydroacoustic transects. Separate reports will be available in due course. Initial results show that Lough Ree is continuing to sustain its pollan population, while results from Glen Lough and Kylemore Lough indicate that the Arctic char populations are in good condition with several size classes present. An example of an echogram showing an Arctic char shoal from Kylemore Lough is shown in Figure 3.1.

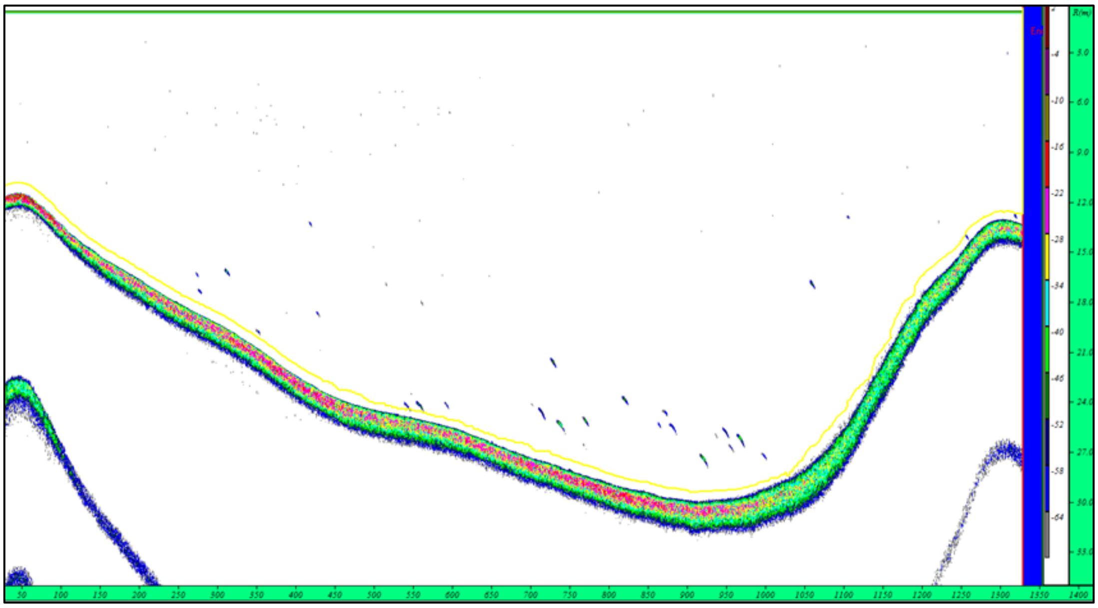

Fig. 3.1. Example of an echogram showing an Arctic char shoal from Kylemore Lough during post-processing

Ongoing cooperation with other Member States in developing the CEN standard will help to progress this work. IFI staff participated in an intercalibration exercise of echosounders for monitoring fish in deep lakes in Lake Windermere, England in November 2011 in conjunction with other Member States (Winfield *et al.*, 2012). This intercalibration exercise contributed to the endorsement of the CEN standard '*EN 15910, Water quality - Guidance on the estimation of fish abundance with mobile hydroacoustic methods'*. Work continues on this unique dataset and IFI staff will attend an International workshop dedicated to the intercalibration of hydroacoustic methods for WFD fish monitoring in Thonon-les-Bains, France in June 2014.

4. RESULTS

4.1 Lakes

4.1.1 Fish species composition and species richness

The native fish community of Irish lakes, in the absence of anthropogenic influence, is one dominated by salmonids, including at some sites the glacial relicts Arctic char (*Salvelinus alpinus*), pollan (*Coregonus autumnalis*) and Killarney shad (*Alosa fallax Killarnensis*). Three fish groups have been identified and agreed for Ecoregion 17 (Ireland) by a panel of fishery experts (Kelly *at al*., 2008b). These are Group 1 – native species, Group 2 – non-native species influencing ecology and Group 3 – non-native species generally not influencing ecology. In the absence of major human disturbance, a lake fish community is considered to be in reference state (in relation to fish) if the population is dominated by salmonids (or euryhaline species with an Arctic marine past) (i.e. Group 1 - native species are the only species present in the lake). A list of fish species recorded, along with the percentage occurrence in the 24 lakes surveyed during 2013 is shown in Table 4.1 and Figure 4.1.

Table 4.1. List of fish species recorded in the 24 lakes surveyed during 2013

	Scientific name	Common name	Number of lakes	% of lakes
	NATIVE SPECIES			
1	*Anguilla anguilla*	Eel	20	83.3
2	*Salmo trutta*	Brown trout	17	70.8
3	*Gasterosteus aculeatus*	Three-spined stickleback	4	16.7
4	*Salmo salar*	Adult salmon	2	8.3
4	*Salmo salar*	Juvenile salmon	5	20.8
5	*Salvelinus alpinus*	Char	3	12.5
6	*Salmo trutta*	Sea trout*	4	16.7
7	*Platichthys flesus*	Flounder	1	4.2
8	*Pungitius pungitius*	Nine-spined stickleback	2	8.3
	NON NATIVE SPECIES (influencing ecology)			
9	*Perca fluviatilis*	Perch	16	66.6
10	*Esox lucius*	Pike	10	41.7
11	*Rutilus rutilus*	Roach	8	33.3
12	*Abramis brama*	Bream	4	16.7
13	*Phoxinus phoxinus*	Minnow	4	16.7
14	*Oncorhynchus mykiss*	Rainbow trout	3	12.5
	NON NATIVE SPECIES (generally not influencing ecology)			
15	*Scardinius erythropthalmus*	Rudd	7	20.2
16	*Tinca tinca*	Tench	1	4.2
17	*Barbatula barbatula*	Stone loach	2	8.3
	Hybrids			
	Rutilus rutilus x Abramis brama	Roach x bream hybrid	5	20.8

*Sea trout are included as a separate "variety" of trout

A total of 17 fish species (sea trout are included as a separate "variety" of trout) and one type of hybrid were recorded across the lakes surveyed during 2014 (Table 4.1). Eel was the most common fish species recorded, occurring in 20 of the 24 lakes surveyed (83.3%). This was followed by brown trout, perch, pike and roach which were present in 70.8%, 66.6%, 41.7% and 33.3% of lakes respectively (Fig. 4.1).

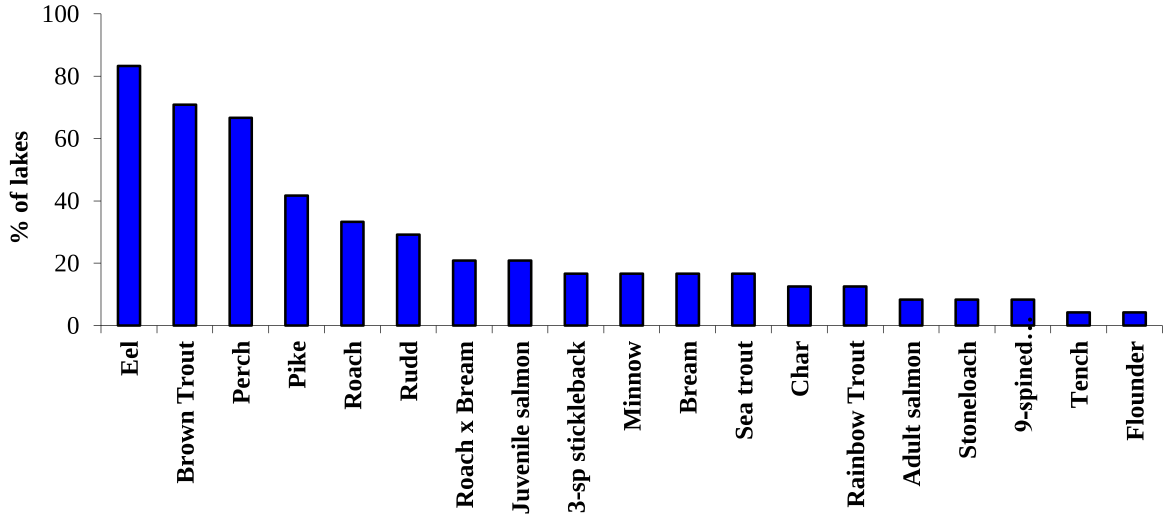

Fig. 4.1.Percentage of lakes surveyed for WFD fish surveillance monitoring during 2013 containing each fish species

Fish species richness (excluding hybrids) ranged from one species on Lough Nambrackmore, Co. Galway to a maximum of seven species on Glencar Lough, Co. Sligo and Lough MacNean Upper, Co. Fermanagh/Cavan/Leitrim (Table 4.2, Fig. 4.2). The highest number of native species (six species) was recorded in Glencar Lough, Co. Sligo. Native species (Group 1) were present in 22 out of 24 lakes surveyed, Group 2 species were present in 21 lakes and Group 3 species were present in nine lakes (Table 4.2).

Table 4.2. Fish species richness in the 24 lakes surveyed for WFD fish monitoring during 2013

Lake	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Glencar	7	6	1	0
Macnean Upper	7	2	4	1
Kylemore	6	5	1	0
Macnean Lower	6	1	4	1
Lene	6	2	3	1
Glen	6	5	1	0
Rea	6	3	2	1
Ree	6	2	3	1
Atedaun	5	1	2	2
Lattone	5	2	3	0
Beltra	5	4	1	0
Ross	5	1	4	0
Shindilla	5	4	1	0
Urlaur	5	2	3	0
Maumwee	4	3	1	0
Glenade	4	1	3	0
Aughrusbeg	4	3	0	1
Lickeen	4	3	0	1
Bane	4	2	2	0
Ardderry	3	2	1	0
Lettercraffroe	3	2	1	0
Annagh or White Lough	3	0	3	0
Mushlin	2	0	1	1
Nambrackmore	1	1	0	0

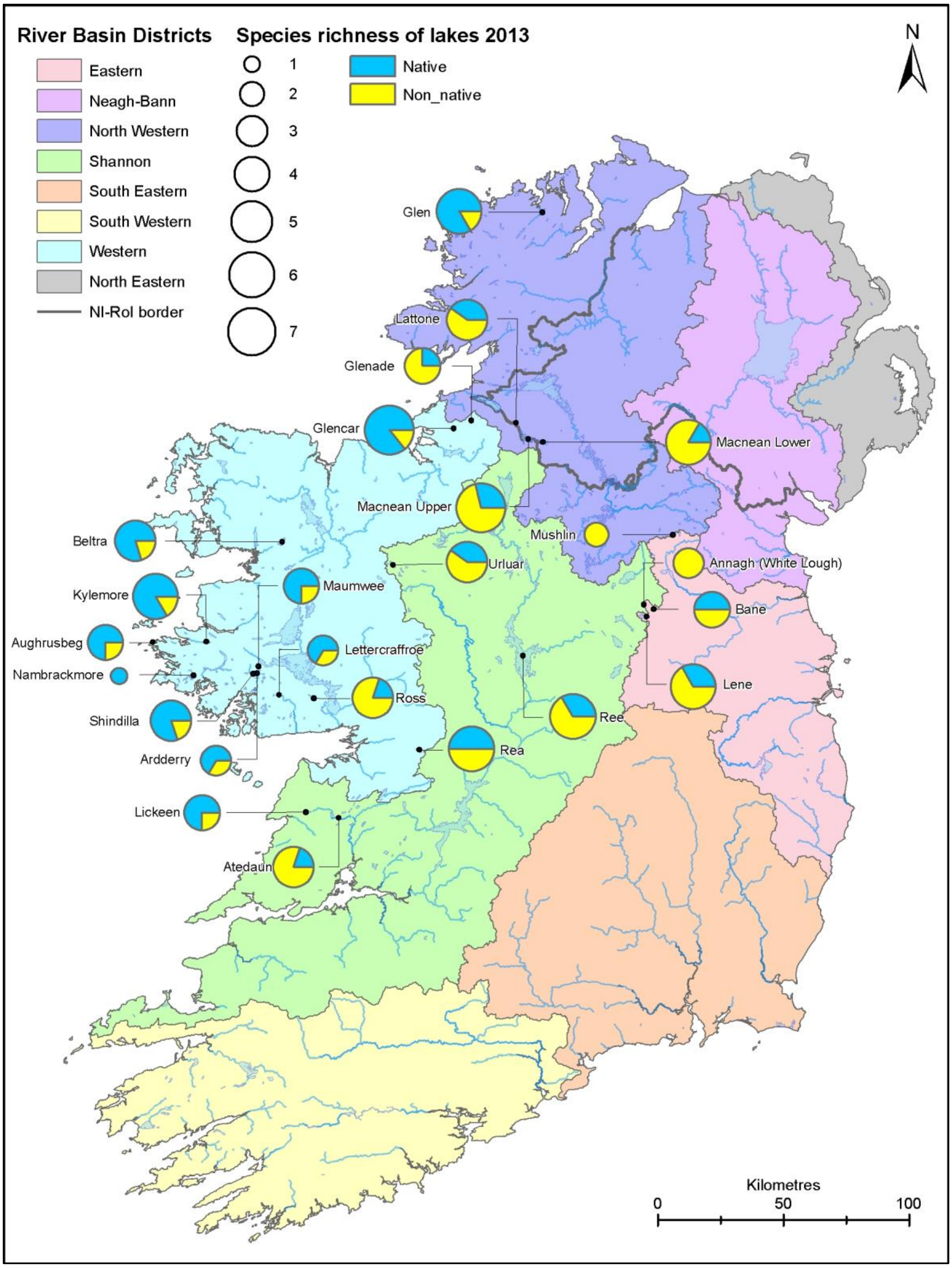

Fig. 4.2. Fish species richness in the 24 lakes surveyed for WFD fish monitoring during 2013

4.1.2 Fish species distribution

The distribution and abundance of each fish species amongst all lakes surveyed during 2013 is shown in figures 4.3 to 4.15. The size of the circles indicates mean catch per unit effort (CPUE - mean number of fish per metre of net). Details of the presence/absence of each species in each lake are also given in Appendix 2.

Eels were widely distributed, being present in 20 out of 24 lakes surveyed (Fig. 4.3). In general, salmonids were more abundant towards the north-west and western areas of the country (Figs. 4.4 to 4.7). Sea trout were present in four lakes in the west and north-west, Glen Lough, Beltra Lough, Kylemore Lough and Glencar Lough (Fig. 4.5). Juvenile salmon were recorded in five lakes (Lough Shindilla, Maumwee Lough, Glen Lough, Kylemore Lough and Beltra Lough) and adult salmon in two lakes (Beltra Lough and Glencar Lough) (Fig. 4.6). Arctic char were recorded in three lakes in the NWIRBD and WRBD (Glen Lough, Kylemore Lough and Shindilla Lough) (Fig. 4.7). Three-spined stickleback were also mainly restricted to the west and north-west of the country, being present in two lakes in the WRBD, one in the NWIRBD and one lake in the ShIRBD (Fig. 4.8).

The native Irish lake fish fauna has been augmented by the introduction of a large number of non-native species, introduced either deliberately, accidentally or through careless management, e.g. angling activities, aquaculture and the aquarium trade. Many non-native species have become established in the wild, the most widespread including pike, perch, roach, rudd and bream. The status of these species varies throughout Ireland, with much of the north-west and many areas in the west, south-west and east of Ireland still free from non-native species (Figs. 4.9 to 4.15). Perch, followed by pike were the most widely distributed non-native species recorded during the 2013 surveillance monitoring programme, with perch (Fig. 4.9) being present in 16 lakes and pike (Fig. 4.10) being present in 10 of the 24 lakes surveyed. Roach were captured in eight lakes (three in the WRBD, two in the ShIRBD and three in the NWIRBD) (Fig. 4.11). Rudd were recorded in seven lakes (two lakes within the ShIRBD, three lakes in the NWIRBD and two in the WRBD) (Fig. 4.12). Bream were recorded in four lakes, and roach x bream hybrids were recorded in five lakes (Figs. 4.14). Tench were recorded in one lake.

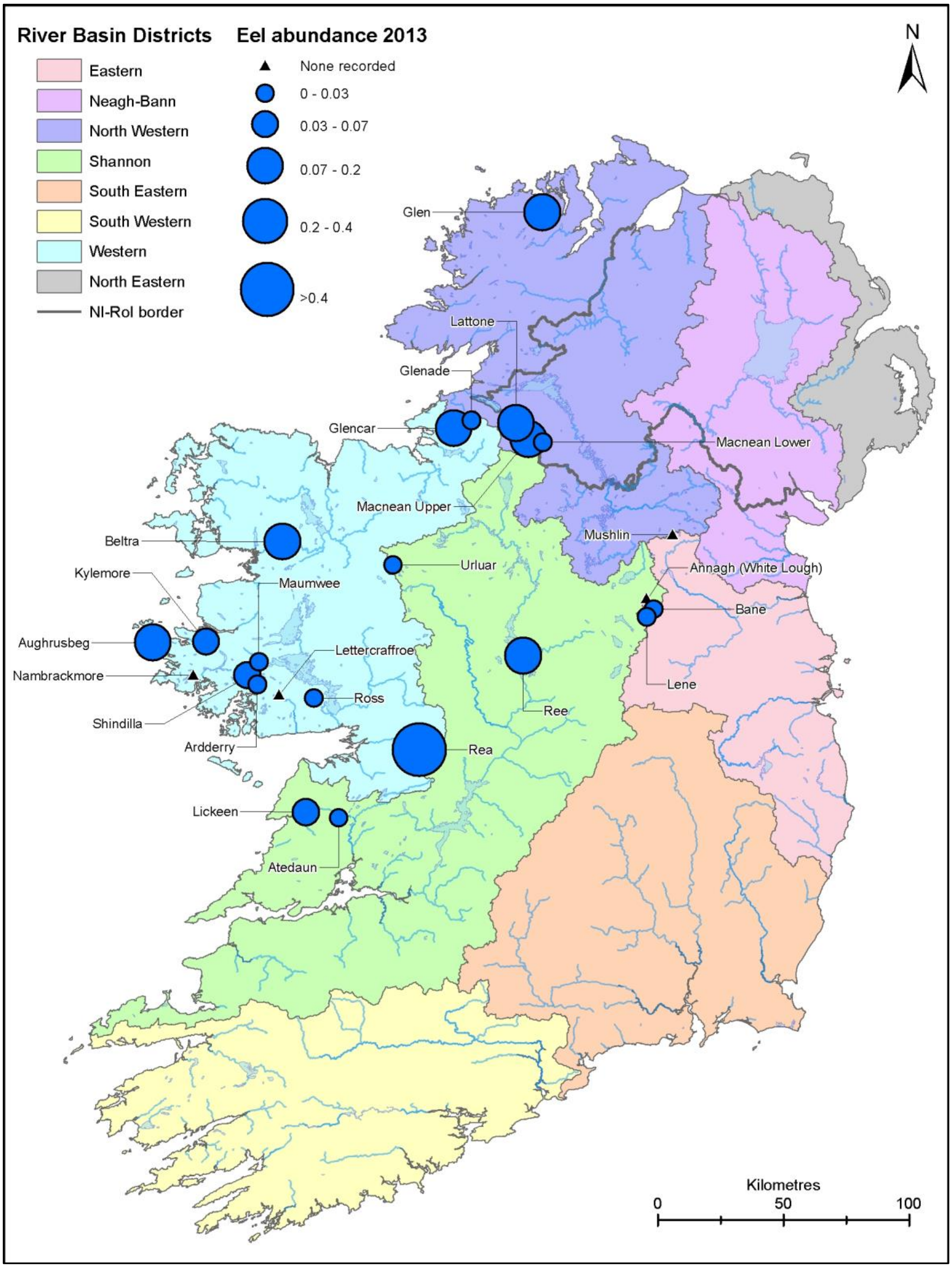

Fig. 4.3. Eel distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

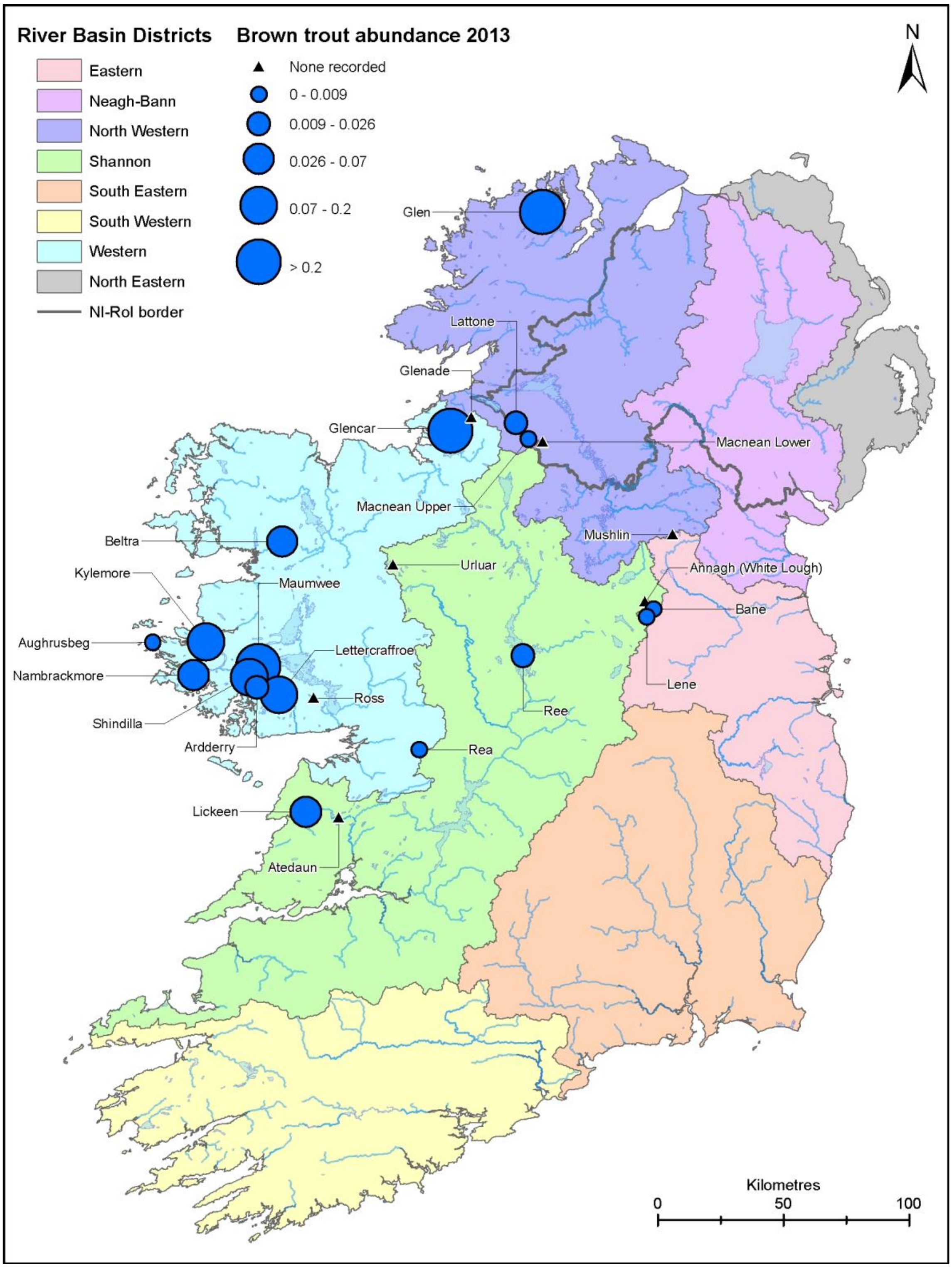

Fig. 4.4. Brown trout distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

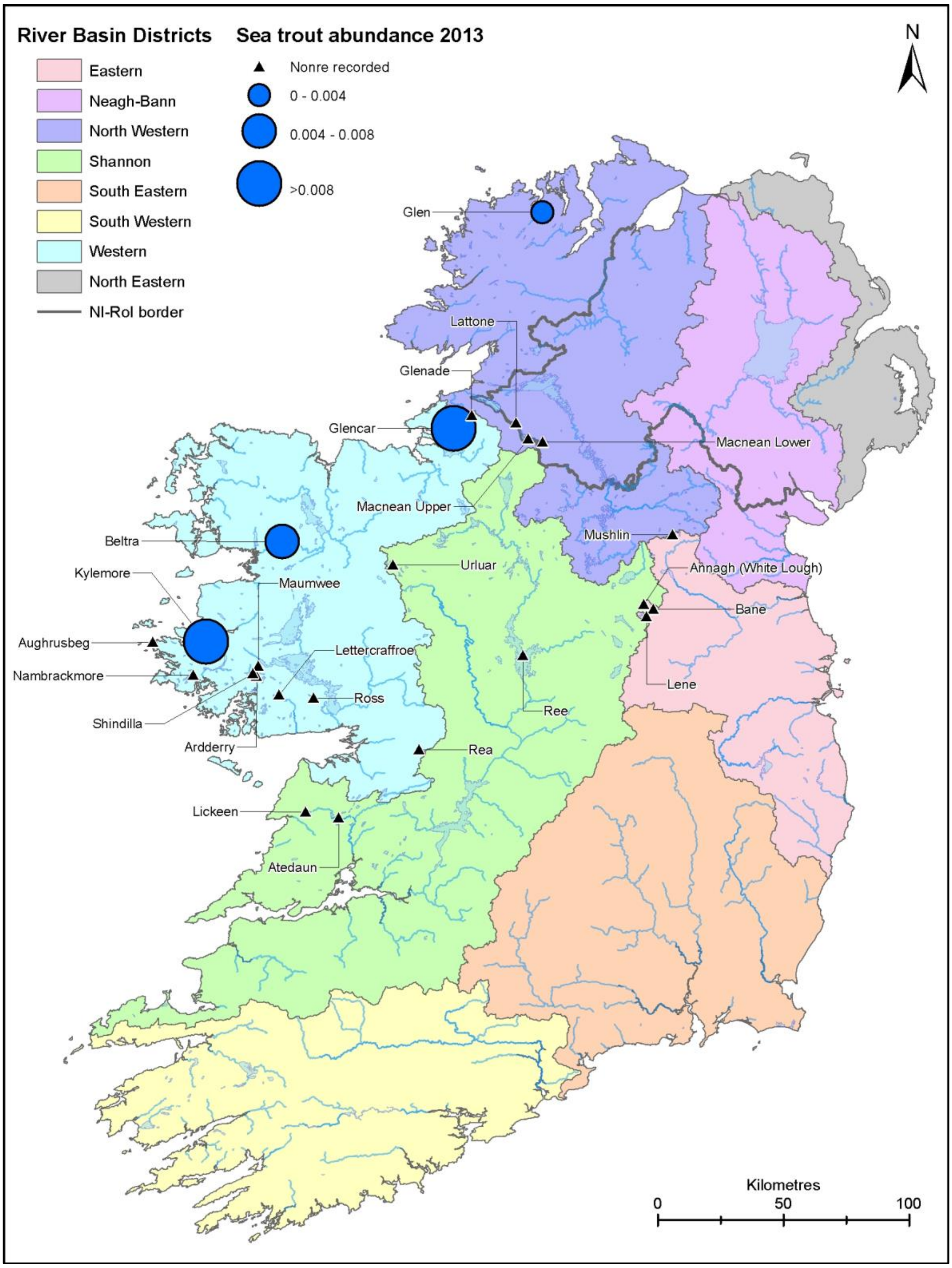

Fig. 4.5. Sea trout distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

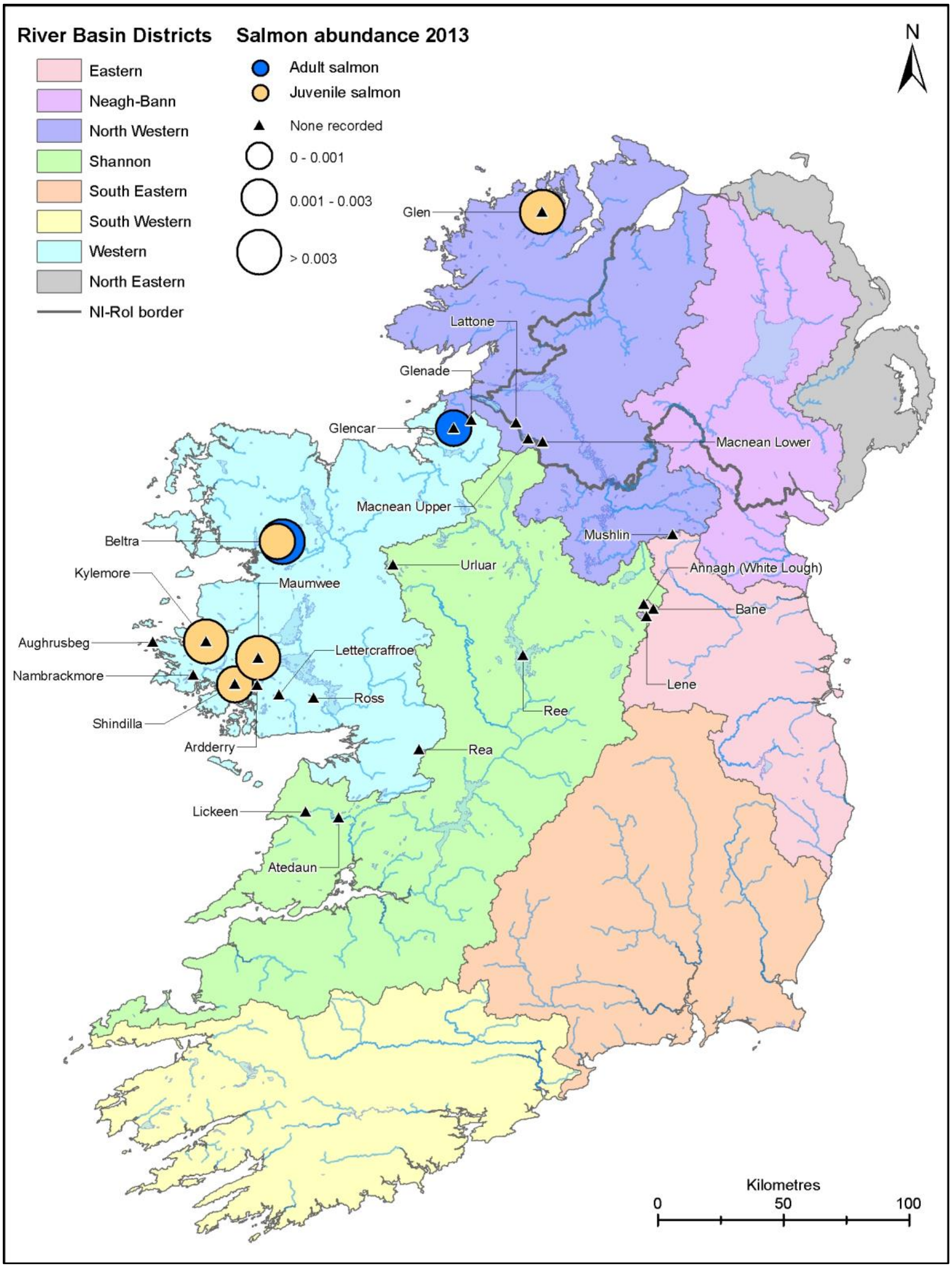

Fig. 4.6. Salmon distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

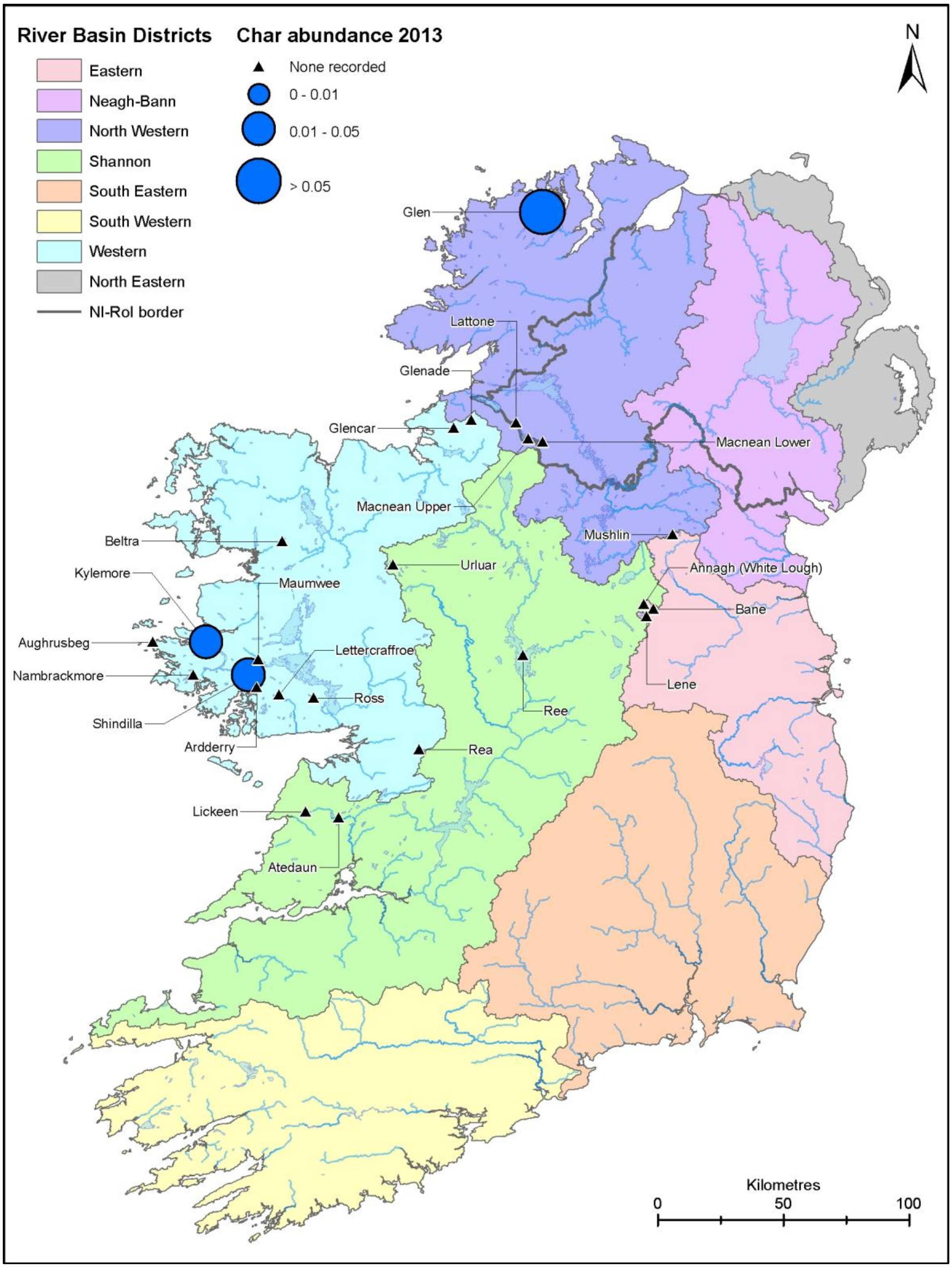

Fig. 4.7. Char distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

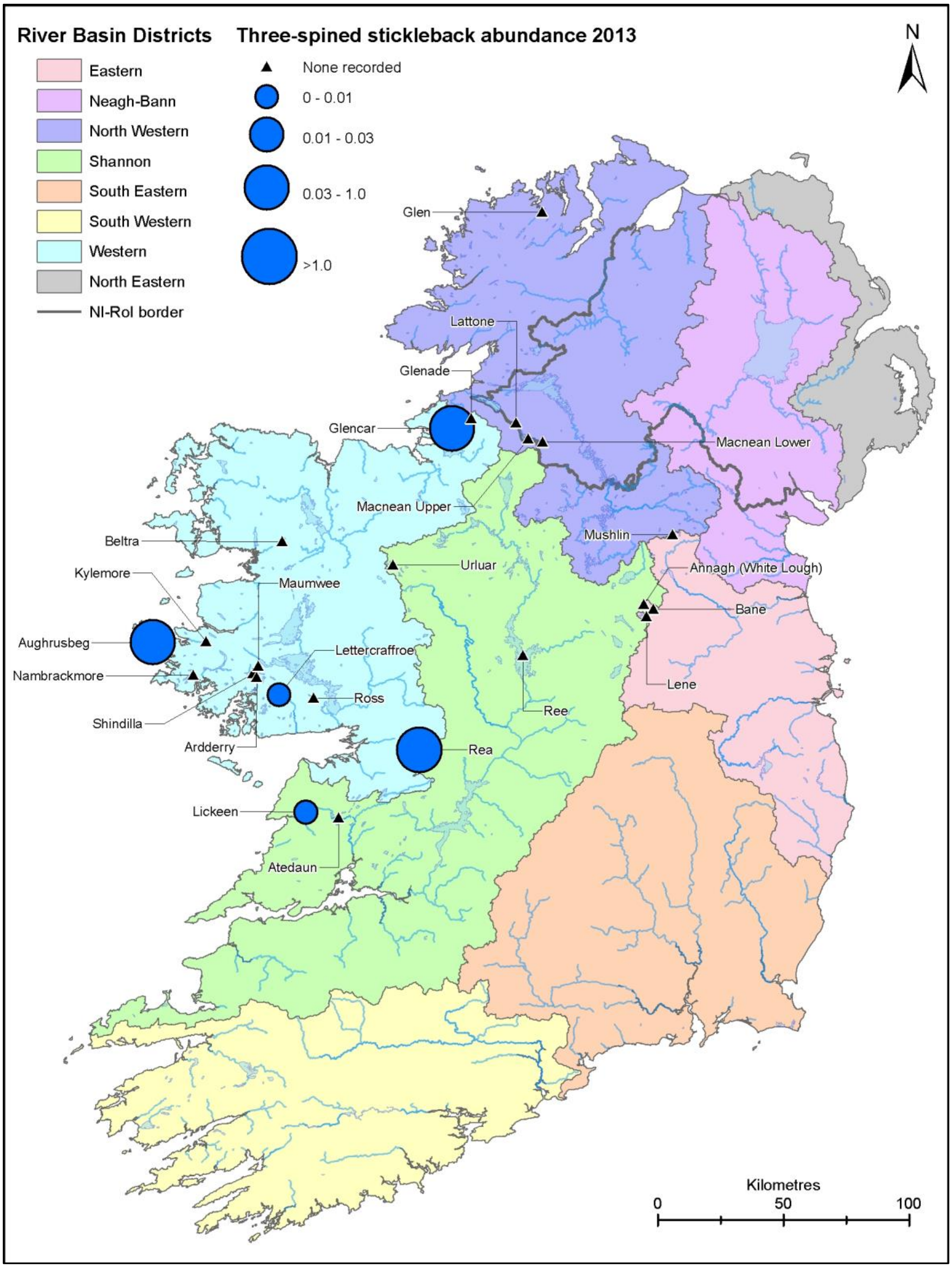

Fig. 4.8. Three-spined stickleback distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

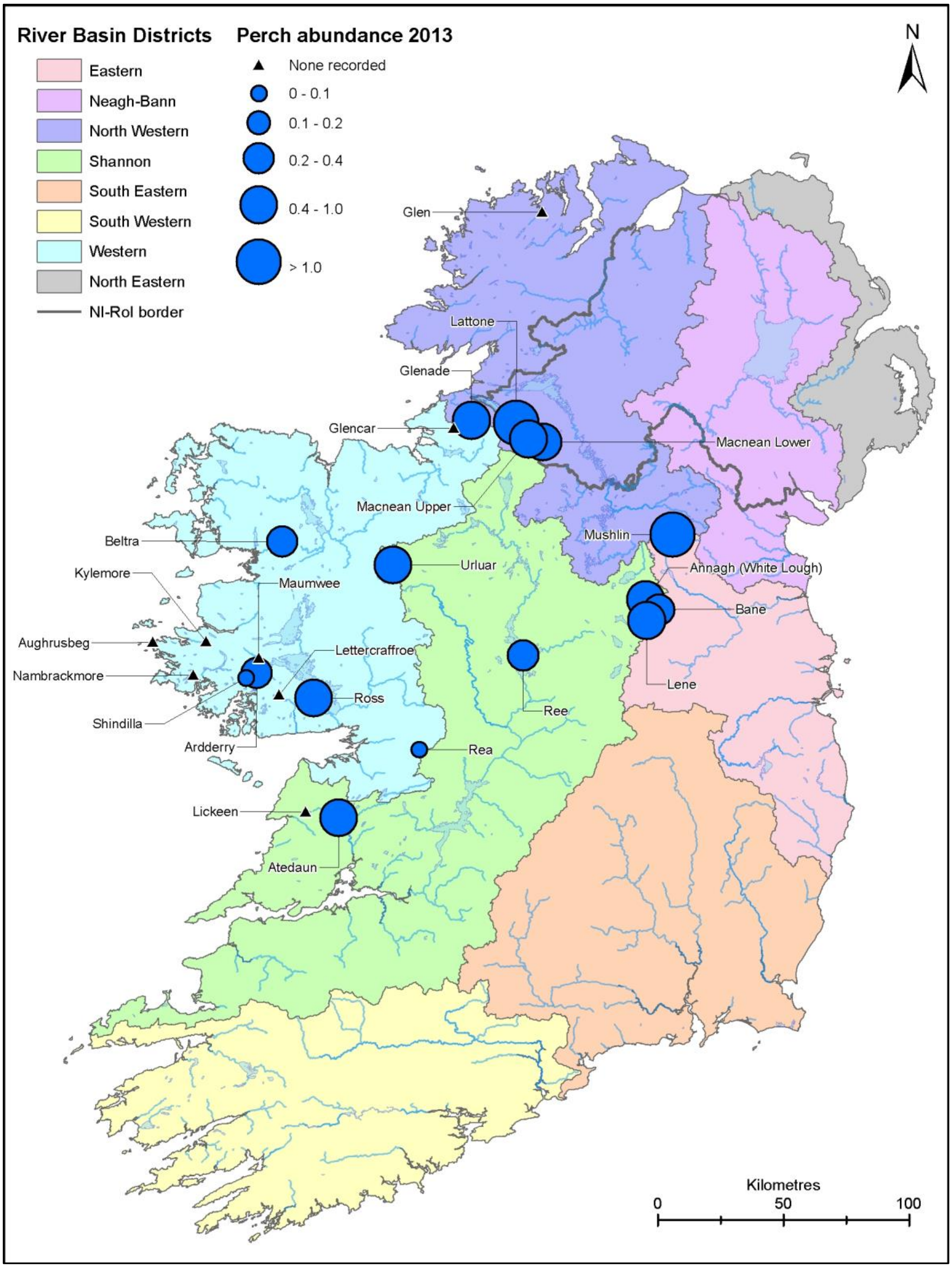

Fig. 4.9. Perch distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

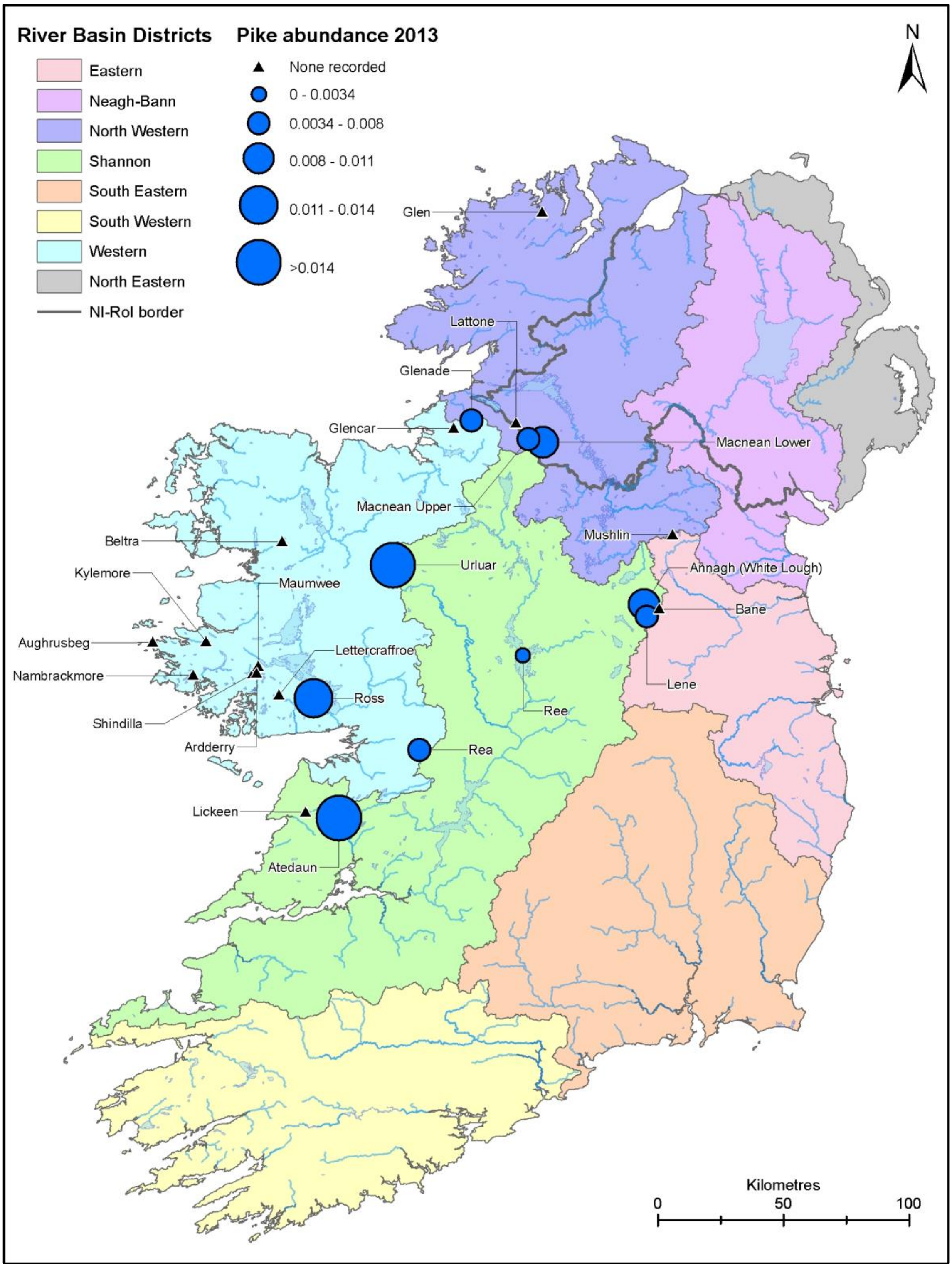

Fig. 4.10. Pike distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

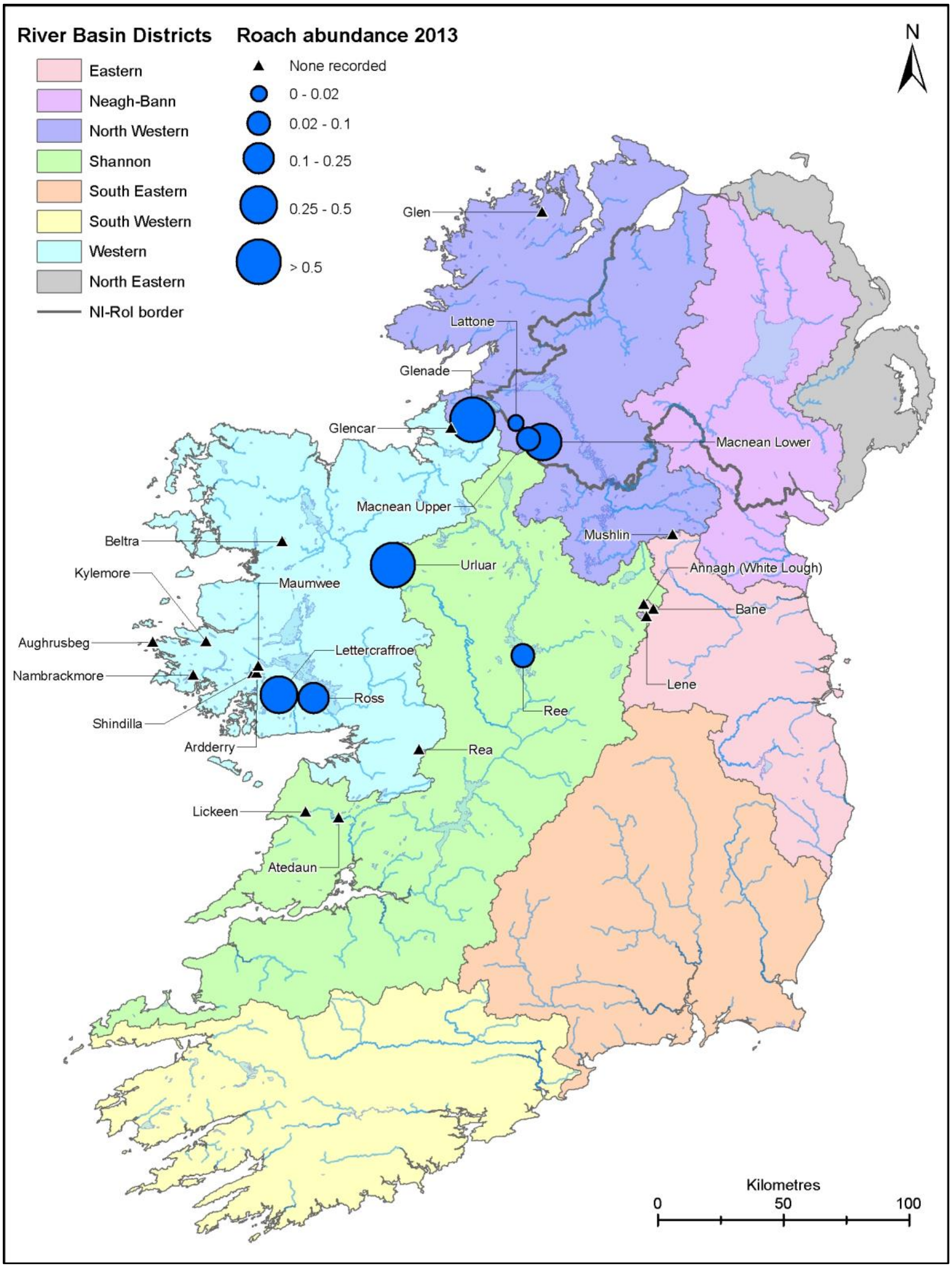

Fig. 4.11. Roach distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

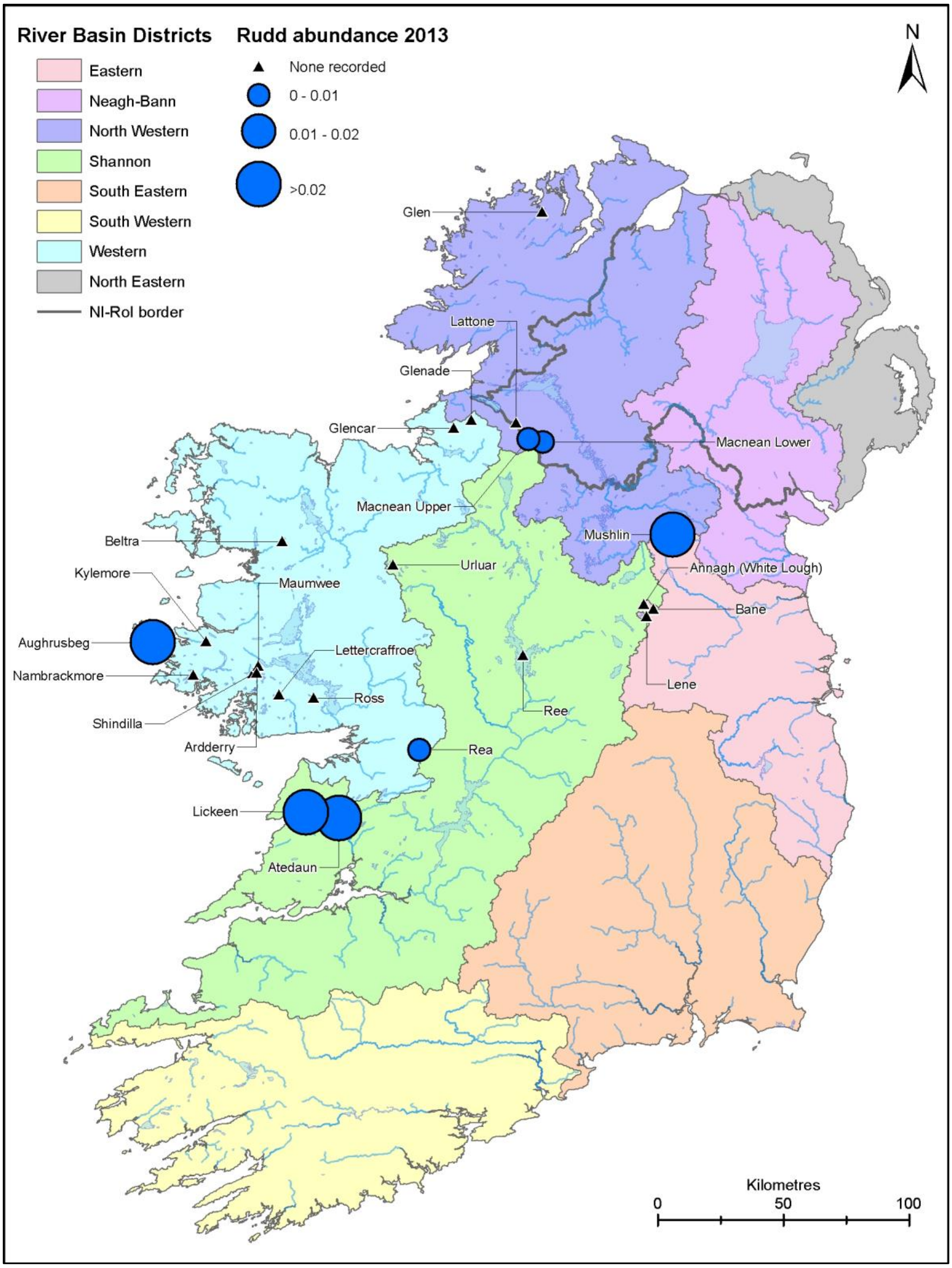

Fig. 4.12. Rudd distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

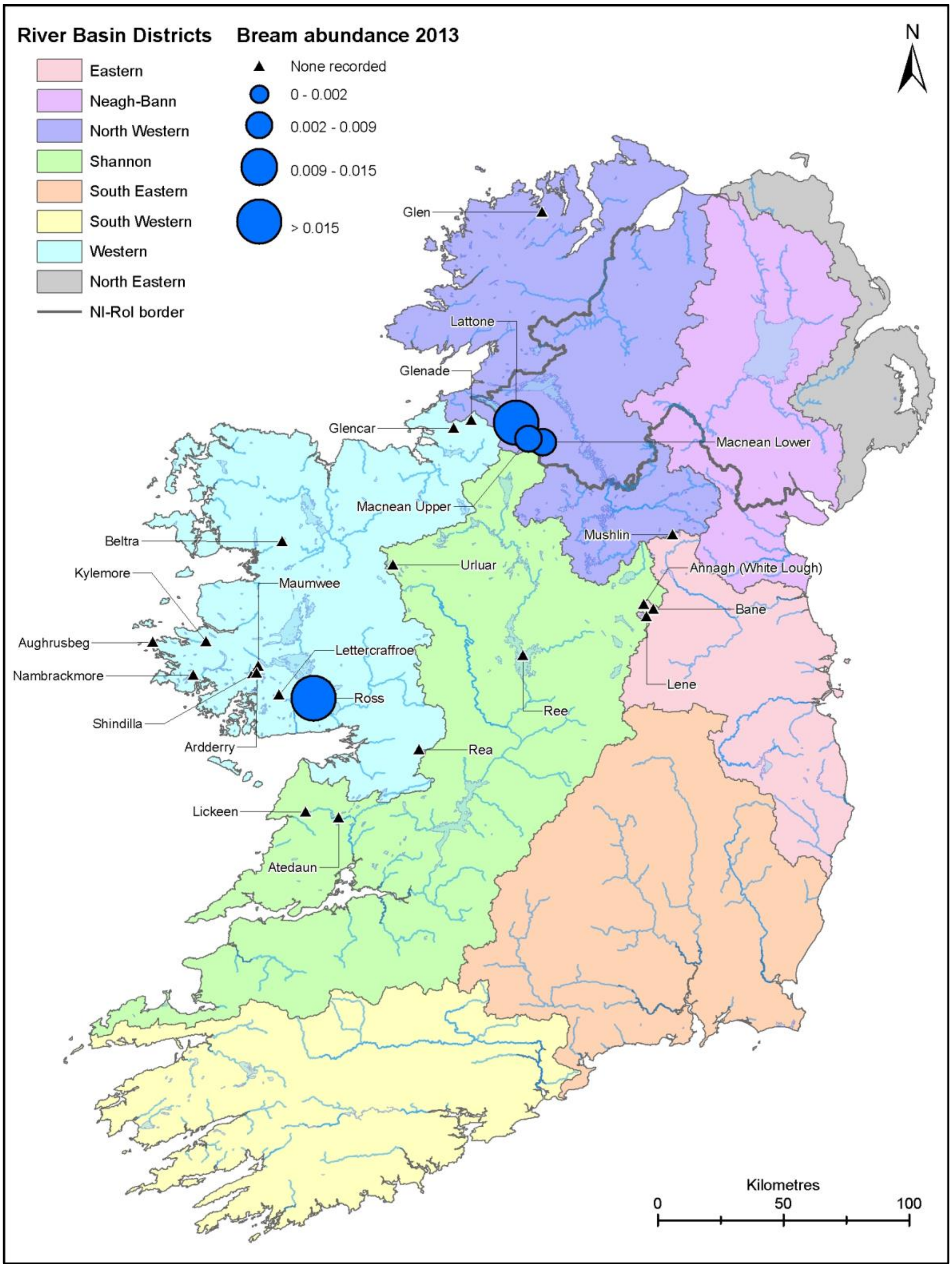

Fig. 4.13. Bream distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

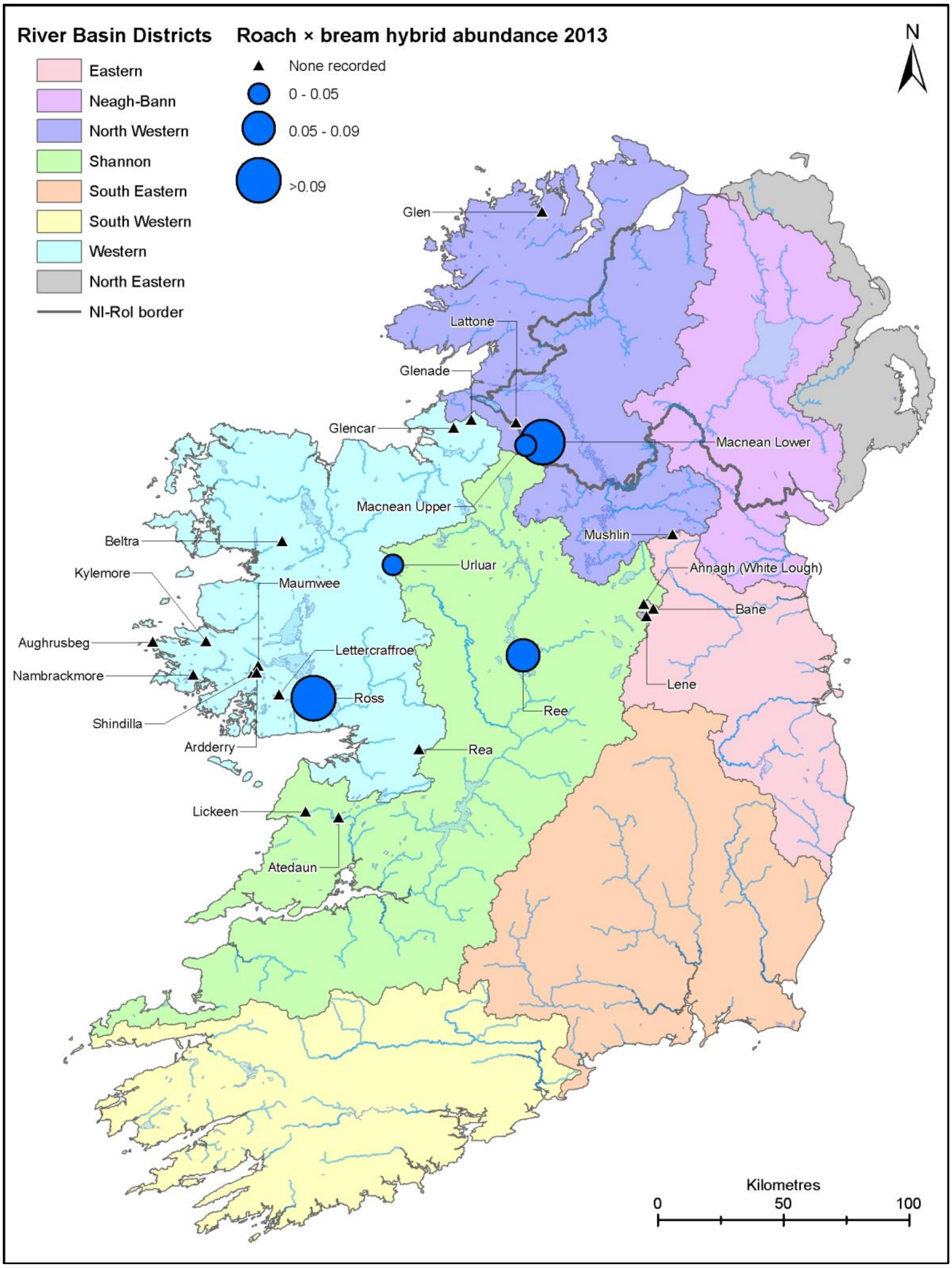

Fig. 4.14. Roach × beam hybrid distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2013

4.1.3 Fish abundance and biomass

The abundance (mean CPUE - mean number of fish/m of net) and biomass (mean BPUE - mean weight (g) of fish/m of net) of the principal fish species recorded in lakes surveyed during the 2013 surveillance monitoring programme are shown in Figures 4.15 to 4.36.

Overall the highest abundance and the highest biomass of eels amongst all lakes surveyed during 2013 were recorded in Lough Rea (a high alkalinity lake in Co. Galway) (Figs. 4.15 and 4.16).

The highest abundance and the highest biomass of brown trout were recorded in Maumwee Lough (a low alkalinity lake in Co. Galway (Figs. 4.17 and 4.18).

Sea trout abundance and biomass was highest in Glencar Lough (a high alkalinity lake in Co. Sligo) amongst all lakes surveyed (Figs. 4.19 and 4.20).

Glen Lough (a low alkalinity lake in Co. Donegal) had the highest abundance of char and the highest biomass of char was recorded in Kylemore Lough (a low alkalinity lake in Co. Galway) (Figs. 4.21 and 4.22).

Lough Mushlin (a low alkalinity lake in Co. Cavan) had the highest perch abundance and the highest perch biomass was recorded in Lattone Lough (a moderate alkalinity lake in Co. Fermanagh) (Figs. 4.23 and 4.24).

Glenade Lough (a moderate alkalinity lake in Co. Leitrim) had the highest roach abundance and the highest roach biomass was recorded in Urlaur Lough (a moderate alkalinity lake in Co. Mayo) (Figs. 4.25 and 4.26).

Urlaur Lough (a moderate alkalinity lake in Co. Mayo) had the highest pike abundance and the highest pike biomass was recorded in Ross Lake (a high alkalinity lake in Co. Galway) (Figs. 4.27 and 4.28).

Bream abundance and biomass was highest in Lattone Lough (a moderate alkalinity lake in Co. Fermanagh) (Figs. 4.29 and 4.30).

Aughrusbeg Lough (a moderate alkalinity lake in Co. Galway) had the highest rudd abundance and Lough Mushlin (a low alkalinity lake in Co. Cavan) had the highest biomass amongst the seven lakes where rudd were recorded (Figs. 4.31 and 4.32).

Three-spined stickleback abundance and biomass was highest in Aughrusbeg Lough (a moderate alkalinity lake in Co. Galway) (Figs. 4.33 and 4.34).

The highest abundance of roach x bream hybrids was recorded in Lough MacNean Lower (a moderate alkalinity lake in Co. Fermanagh and the highest biomass of roach x bream hybrids was in Lough Ree (a high alkalinity lake in Co. Longford/ Roscommon/Westmeath) (Figs. 4.35 and 4.36).

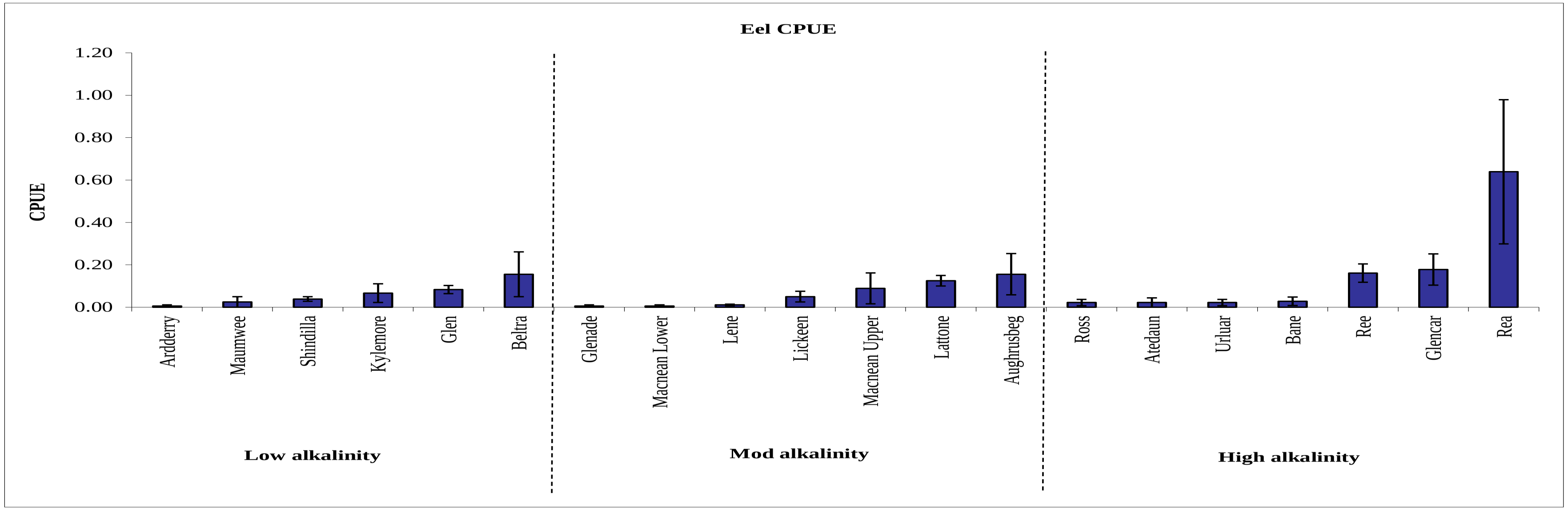

Fig. 4.15. Eel abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

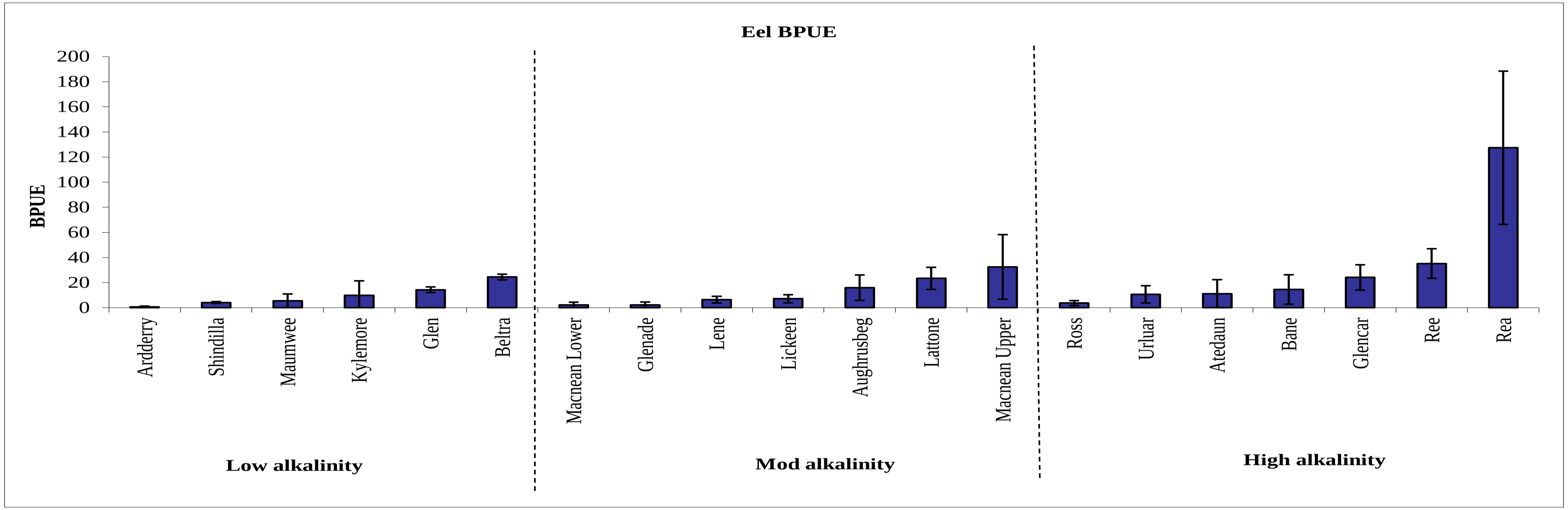

Fig. 4.16. Eel biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

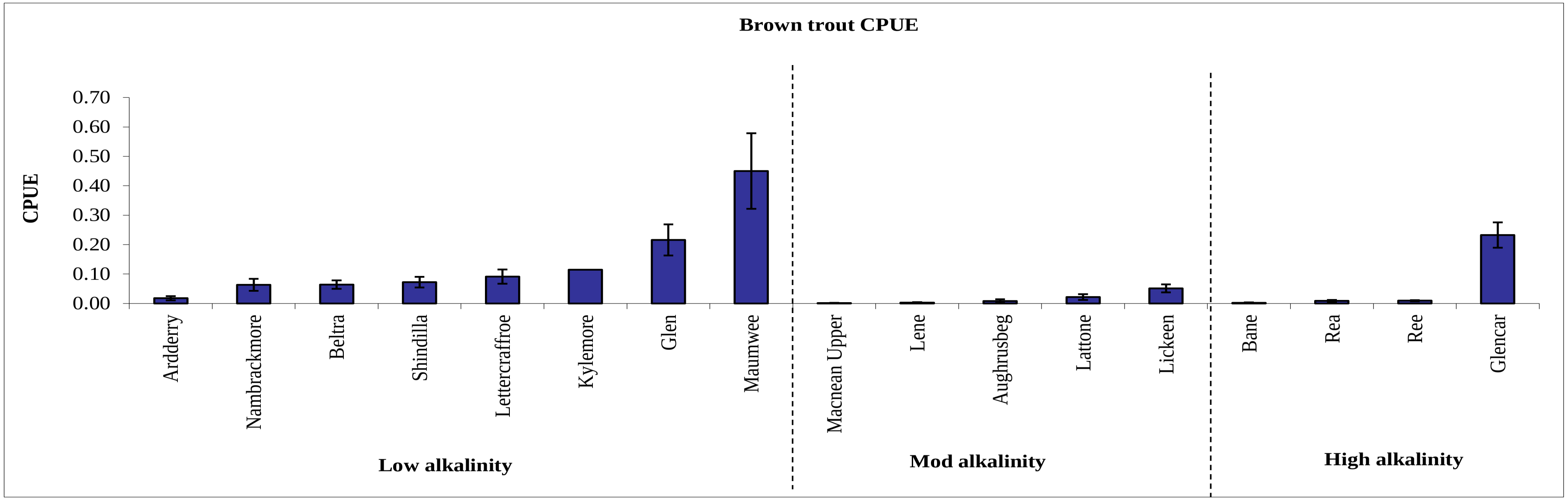

Fig. 4.17. Brown trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

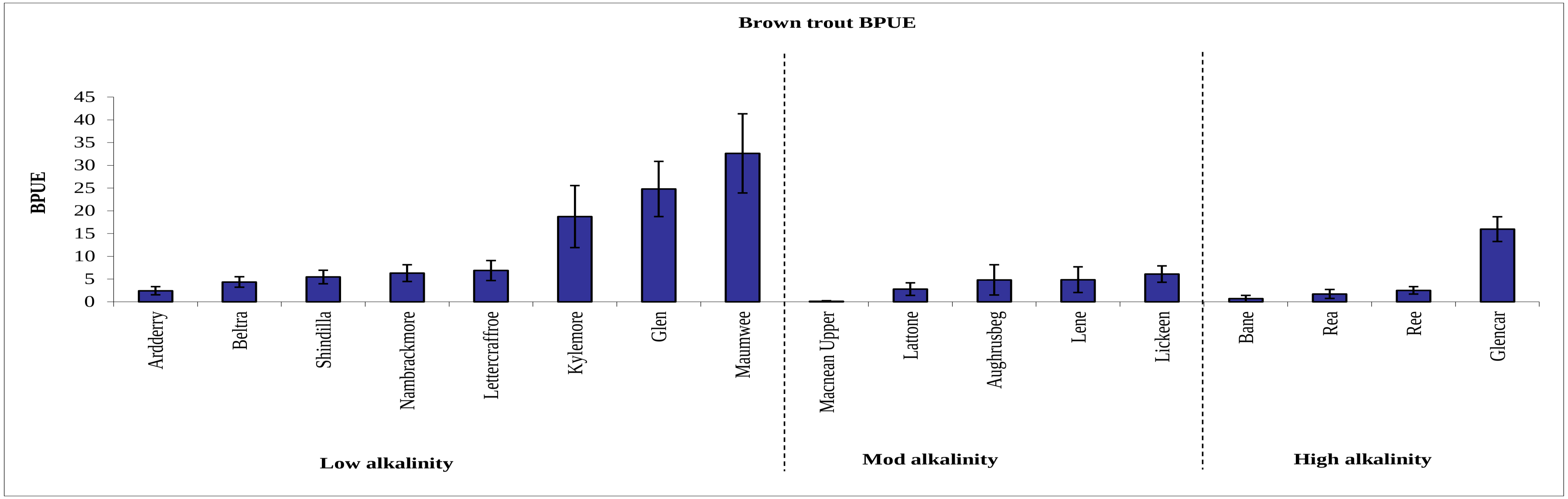

Fig. 4.18. Brown trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

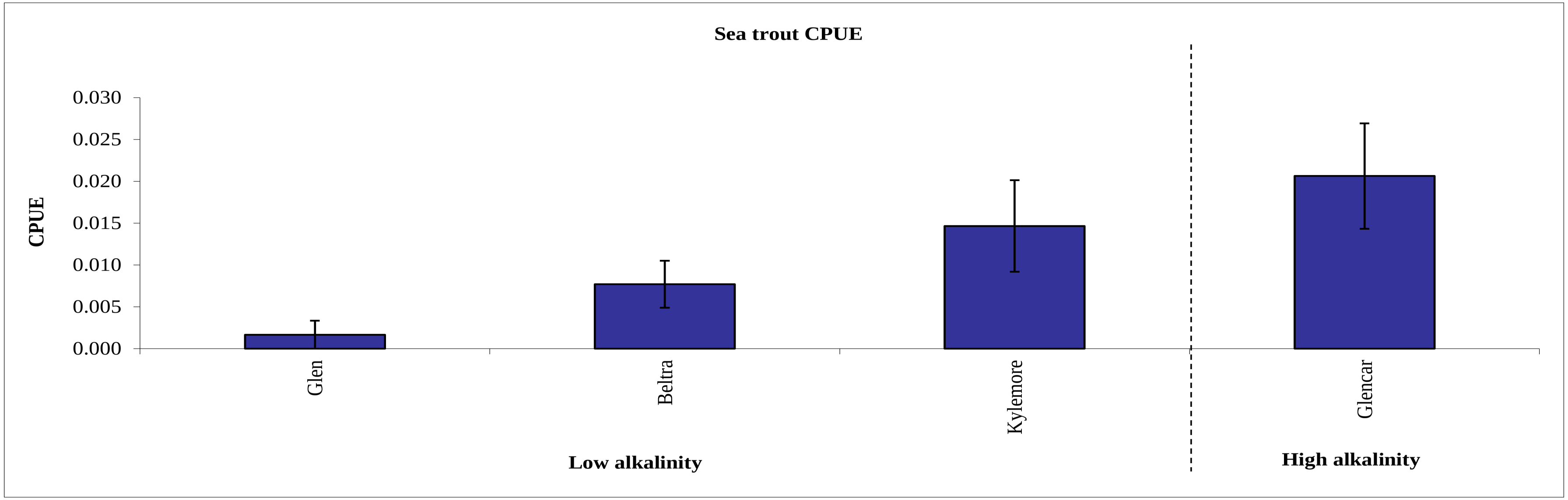

Fig. 4.19. Sea trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

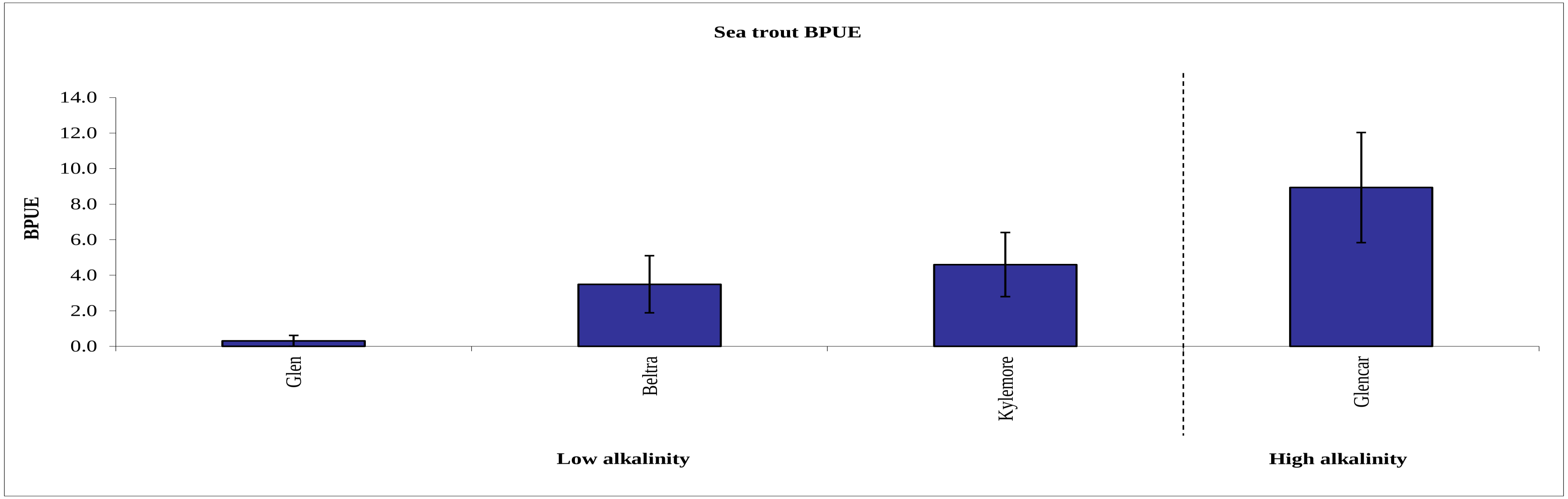

Fig. 4.20. Sea trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

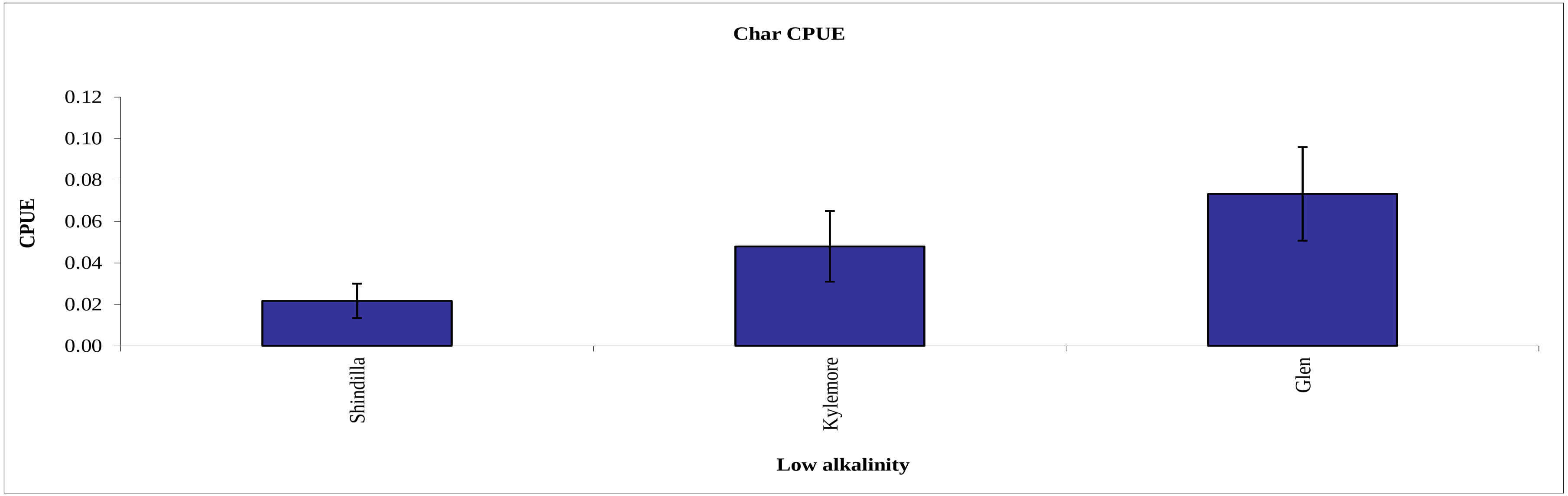

Fig. 4.21. Char abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

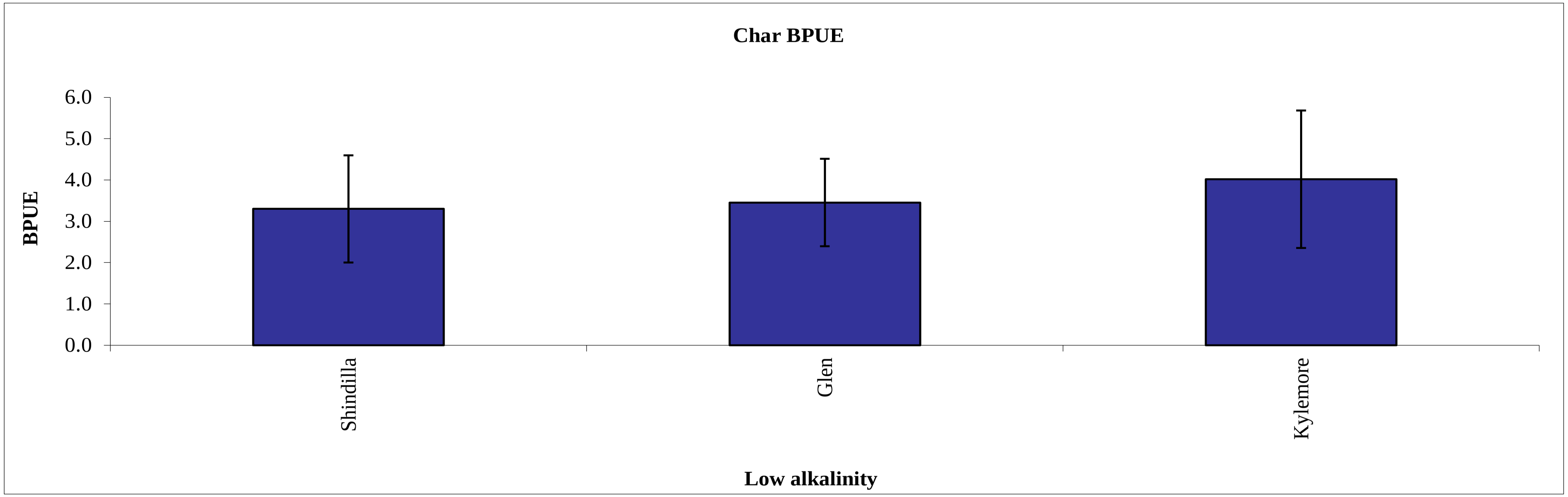

Fig. 4.22. Char biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

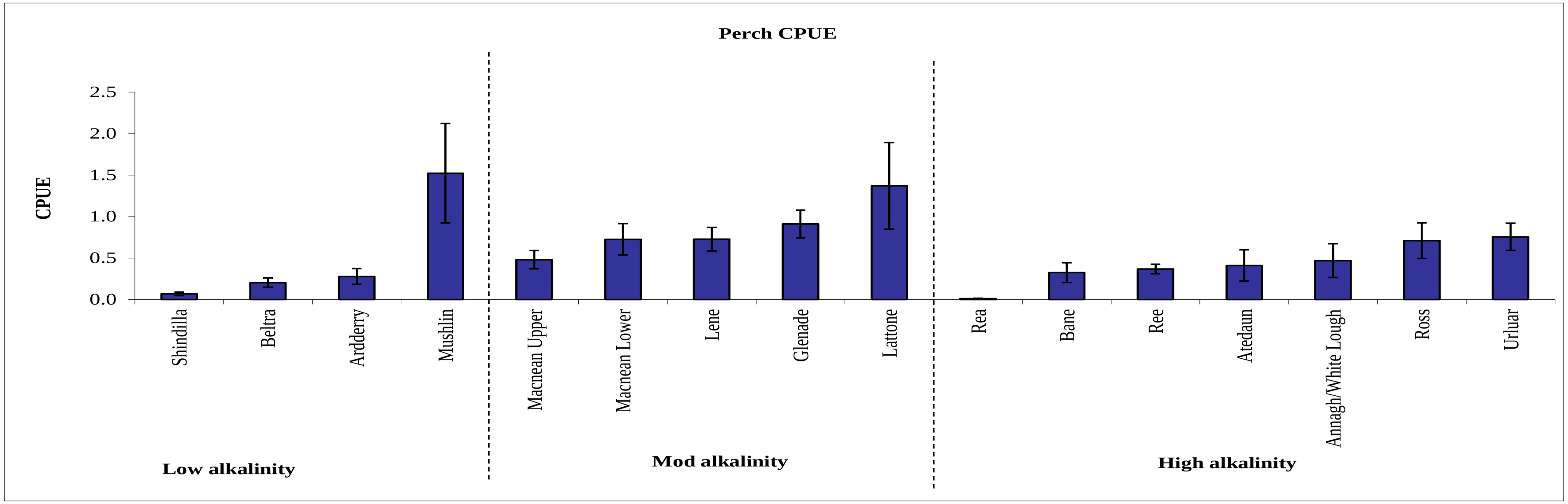

Fig. 4.23. Perch abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

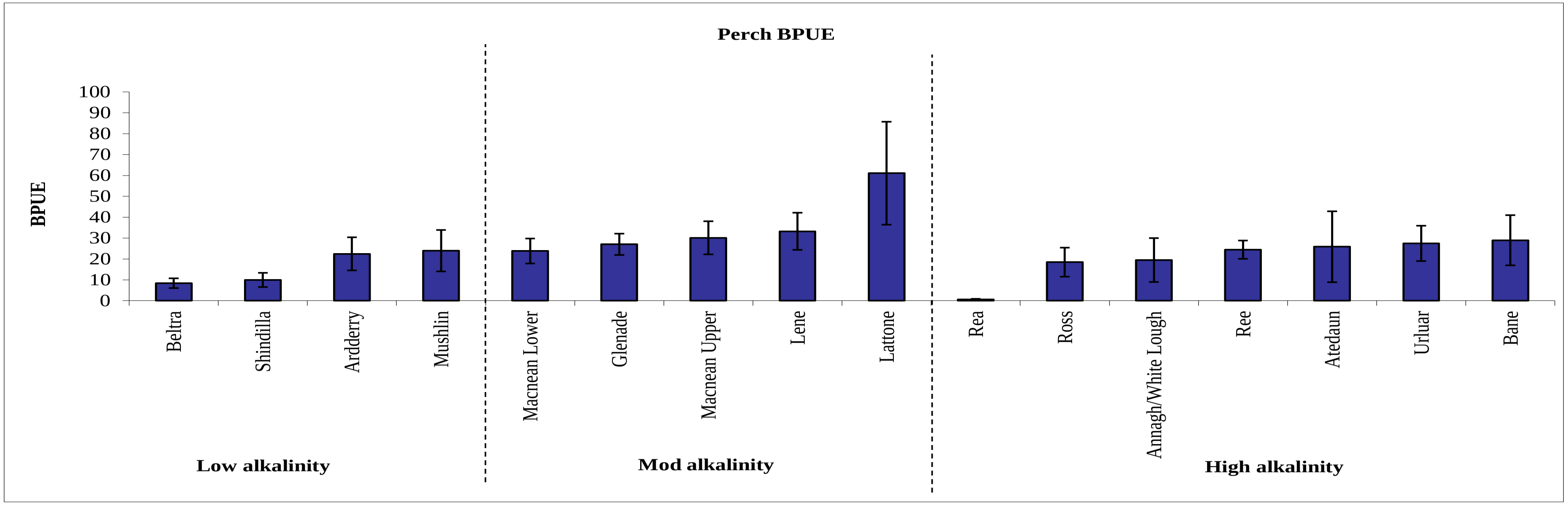

Fig. 4.24. Perch biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

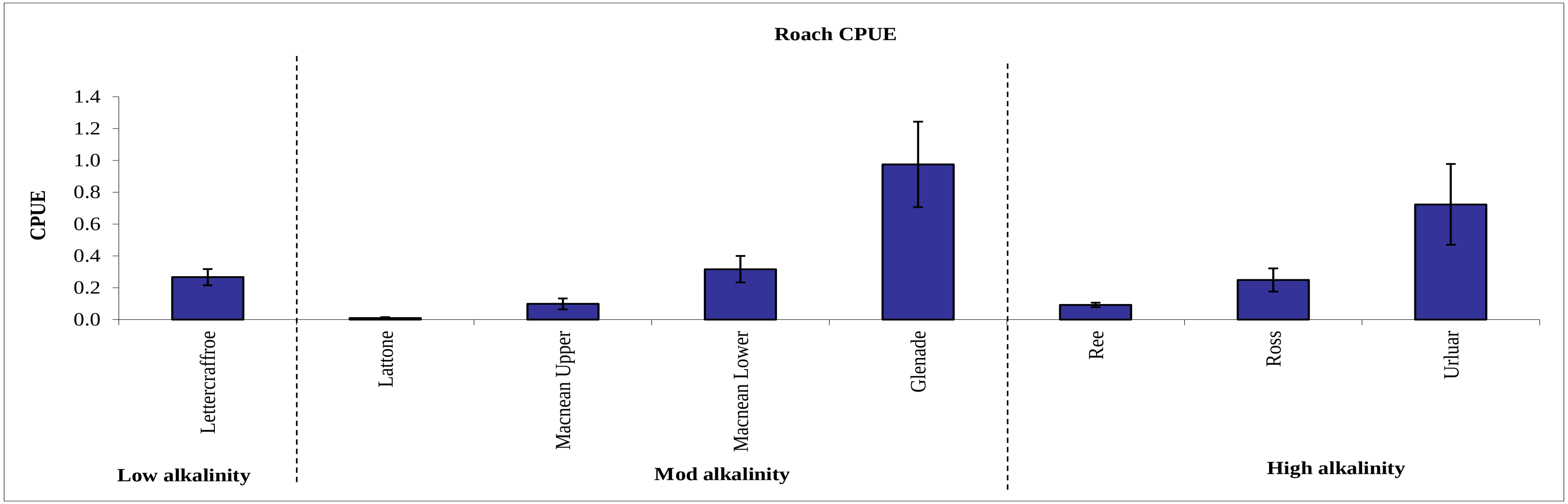

Fig. 4.25. Roach abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

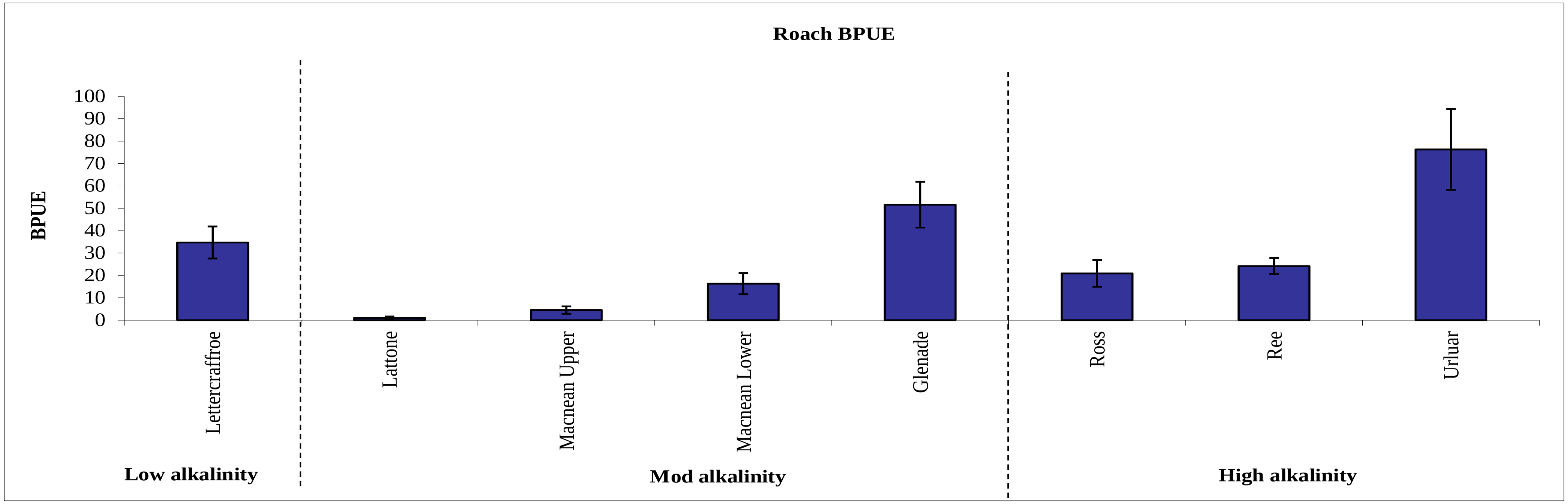

Fig. 4.26. Roach biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

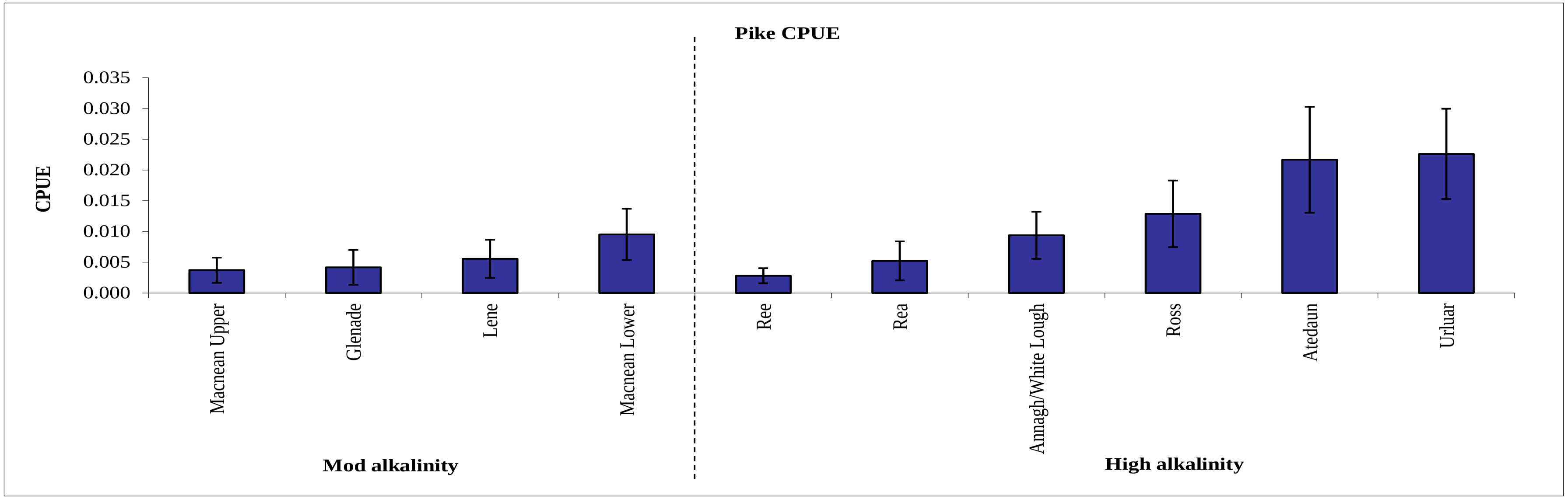

Fig. 4.27. Pike abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

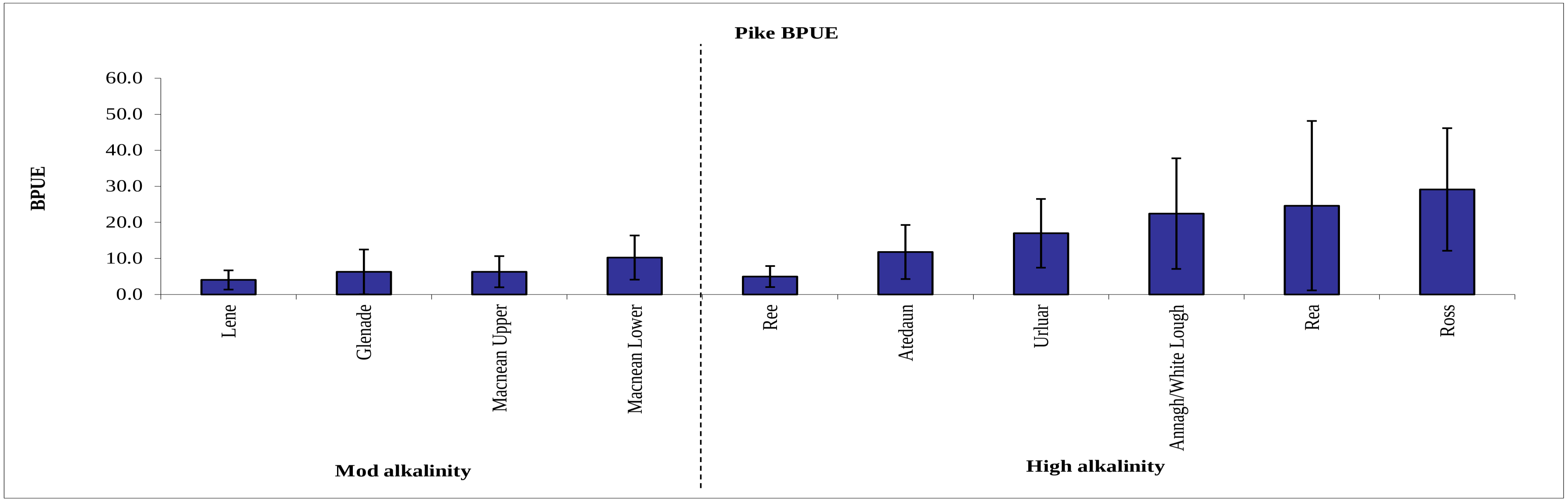

Fig. 4.28. Pike biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

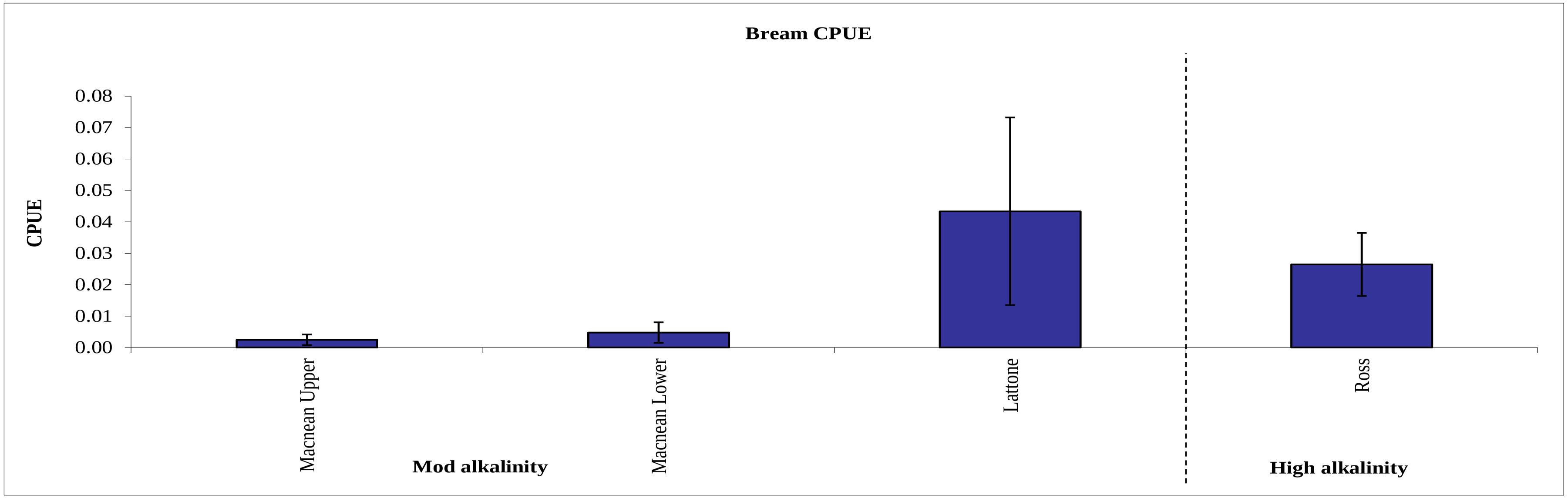

Fig. 4.29. Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

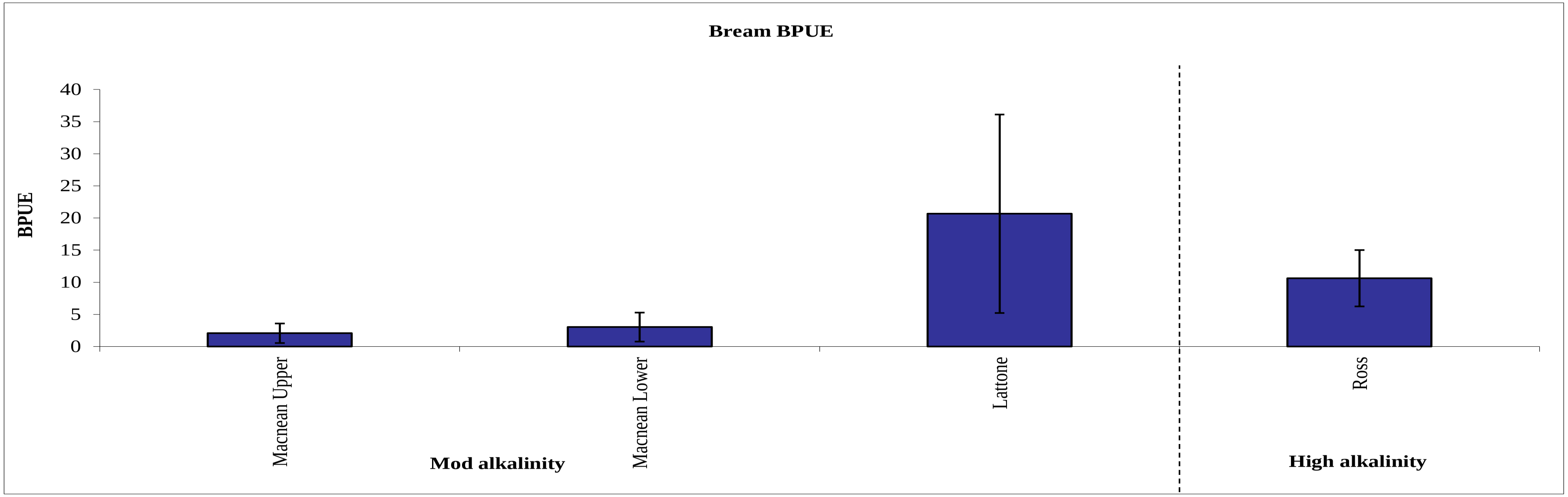

Fig. 4.30. Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

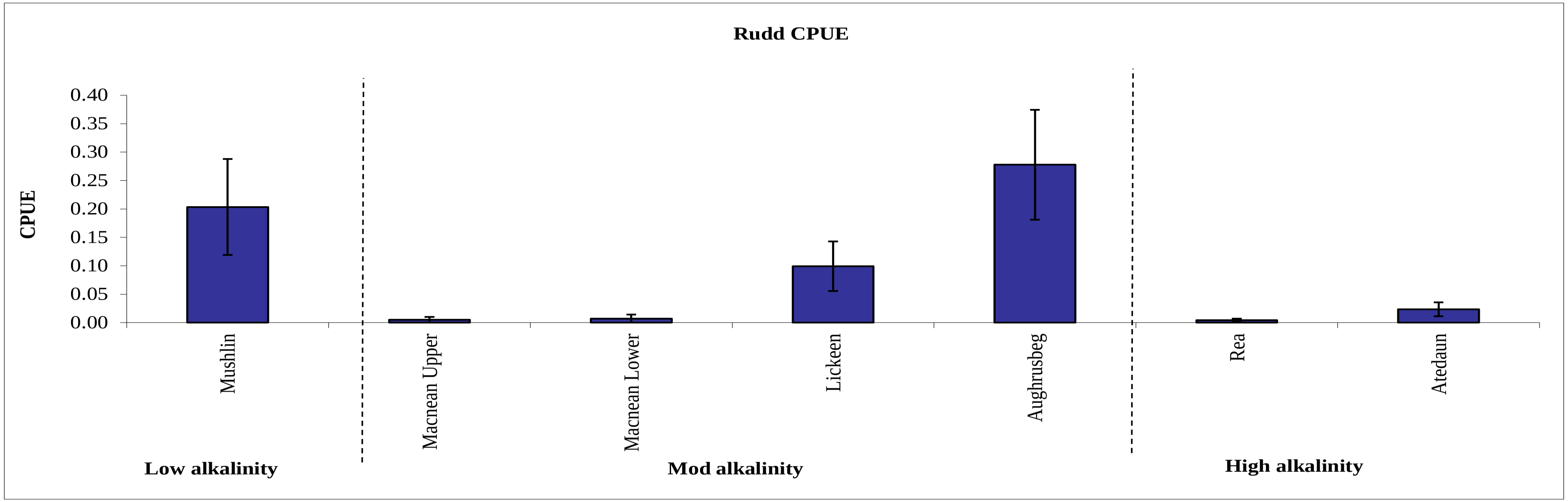

Fig. 4.31. Rudd abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

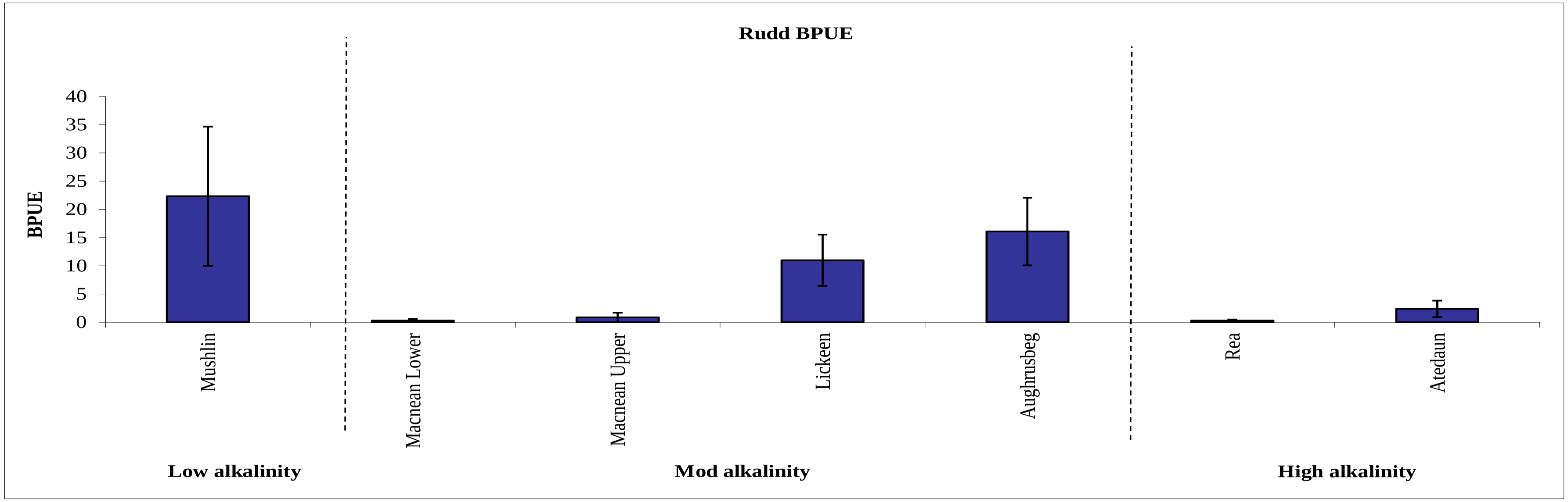

Fig. 4.32. Rudd biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

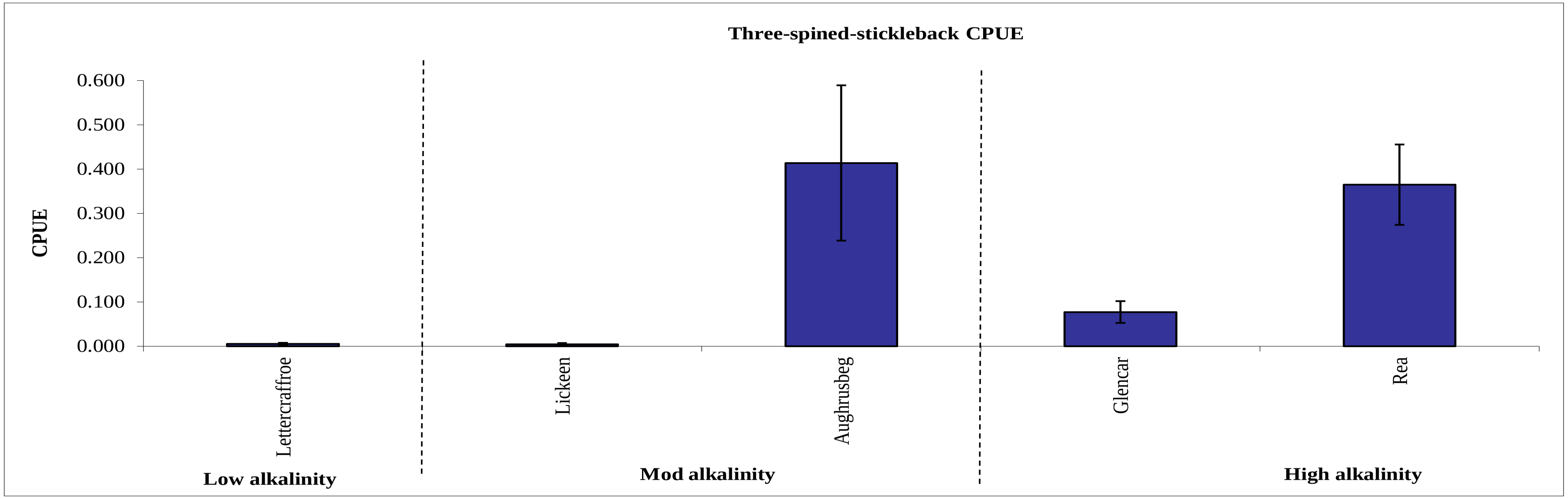

Fig. 4.33. Three-spined stickleback abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

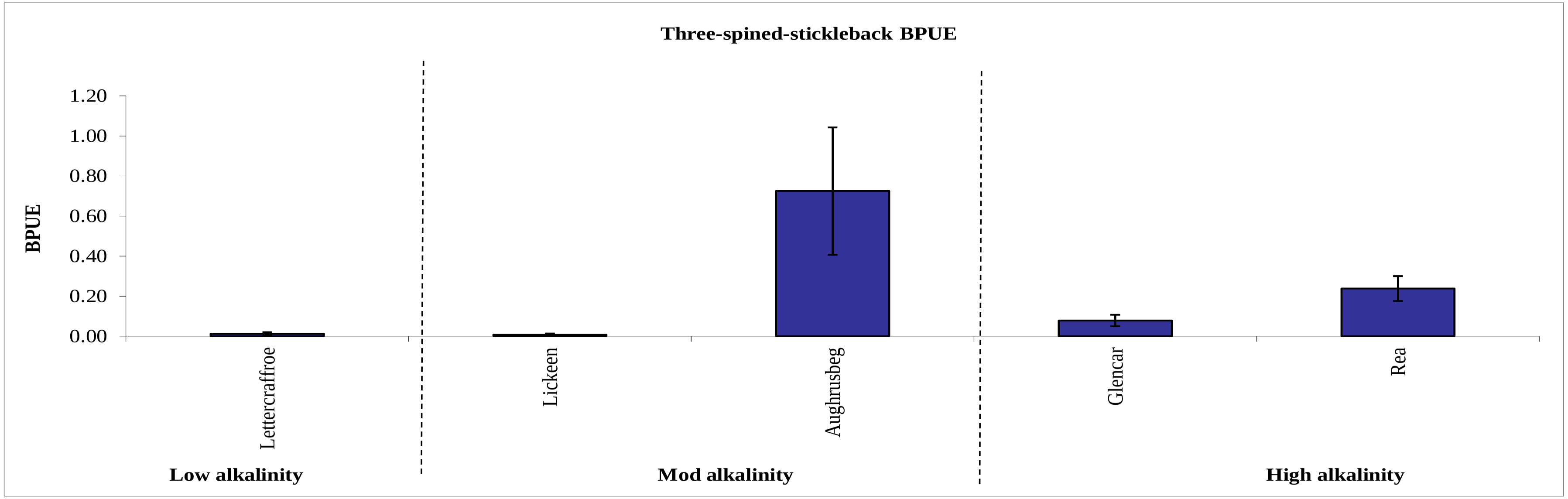

Fig. 4.34. Three-spined stickleback biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

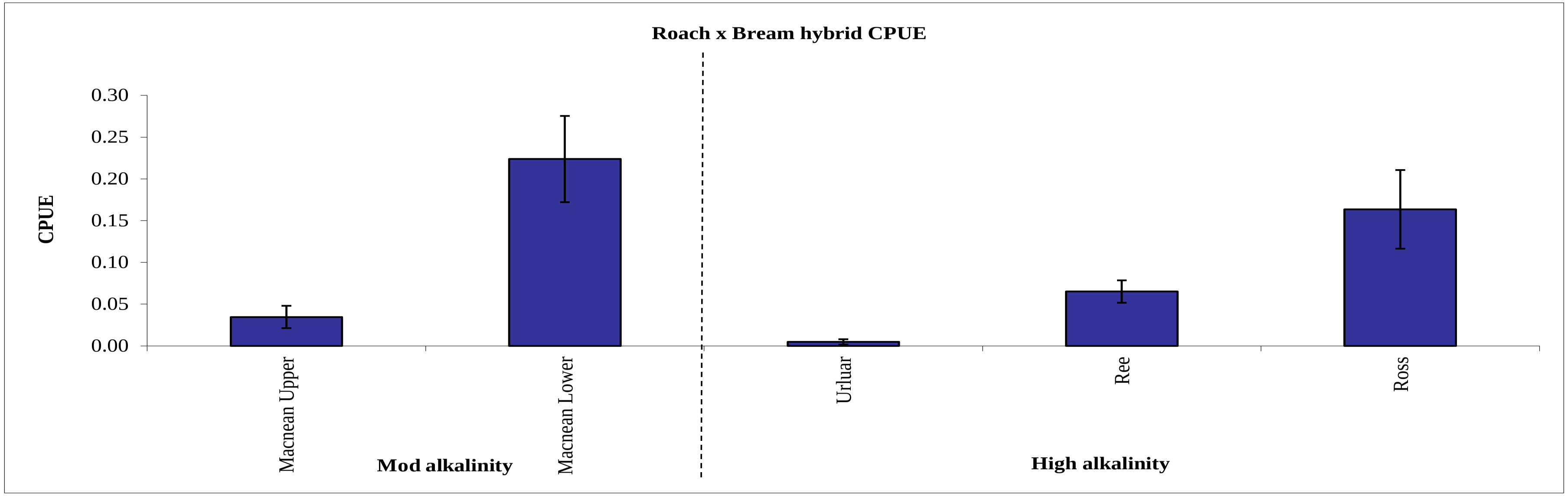

Fig. 4.35. Roach x Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2013

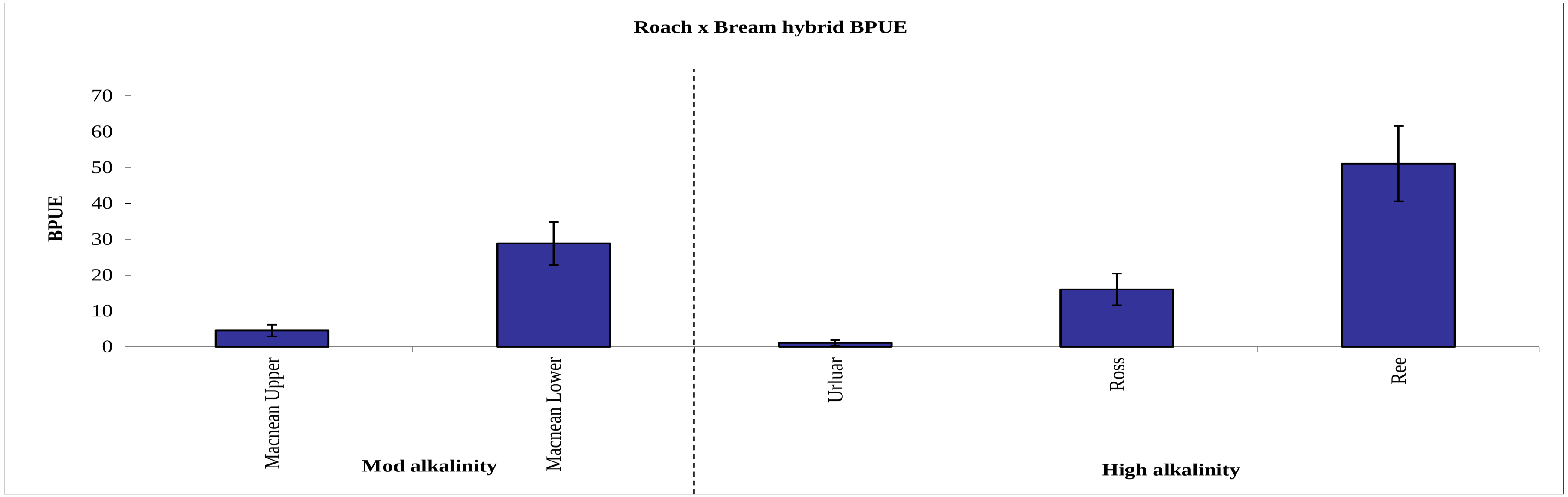

Fig. 4.36. Roach x Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2013

4.1.4 Fish Growth

4.1.4.1 Growth of brown trout, perch and roach

Scales from 555 brown trout (17 lakes), 695 roach (eight lakes), 127 rudd (four lakes), otoliths from approximately 70 char (three lakes) and opercular bones from 1,185 perch (16 lakes) were examined for age and growth analysis. Mean lengths at age (L1 = back calculated length at the end of the first winter, etc.) for the three dominant species; brown trout, perch and roach were back-calculated and growth curves plotted (Figs. 4.37 to 4.39). Details of back calculated mean lengths at age for brown trout, perch and roach are given in Appendices 3, 4 and 5 respectively. Overall brown trout from Lough Lene showed the fastest growth at L4 (Fig. 4.37). Perch from Lough Shindilla and Lough Bane and roach from Glenade Lough, Lough Ree and Urlaur Lough showed the fastest growth rates (Fig. 4.38 and Fig 4.39).

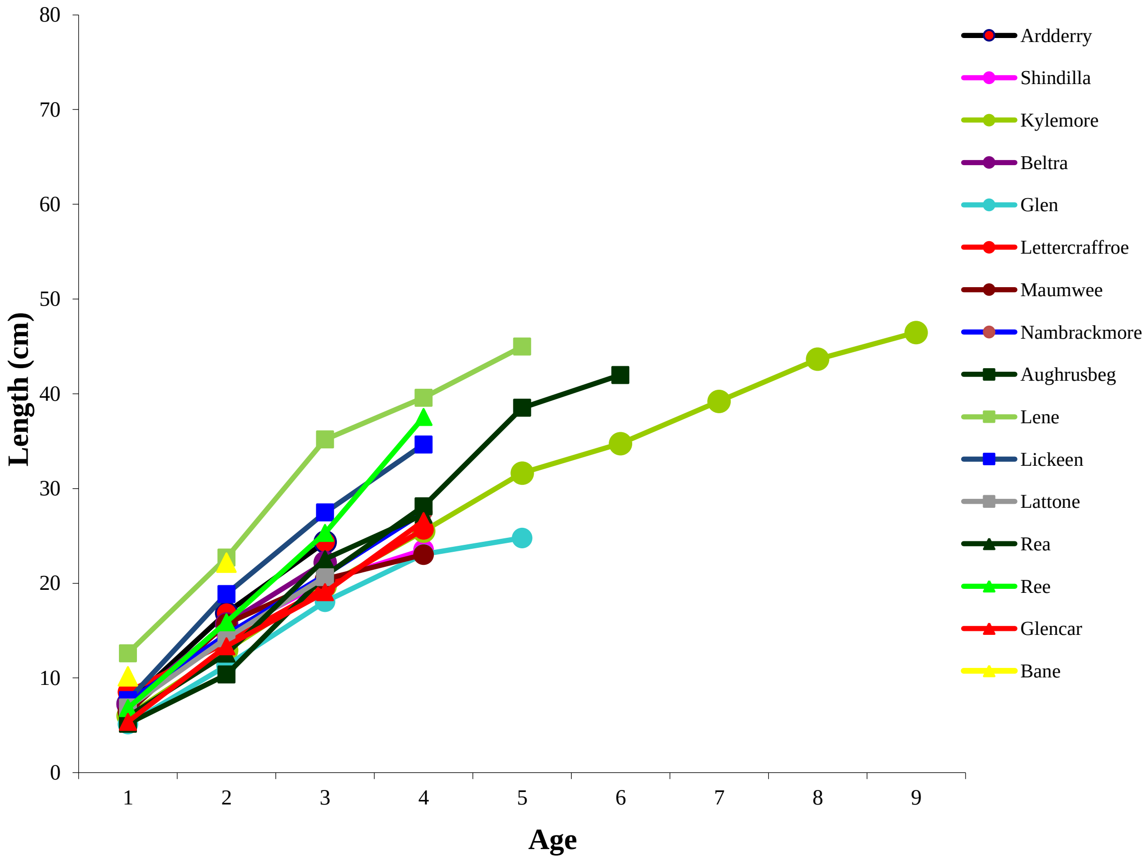

Fig. 4.37. Mean lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2013 (note: circles indicate low alkalinity lakes, squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

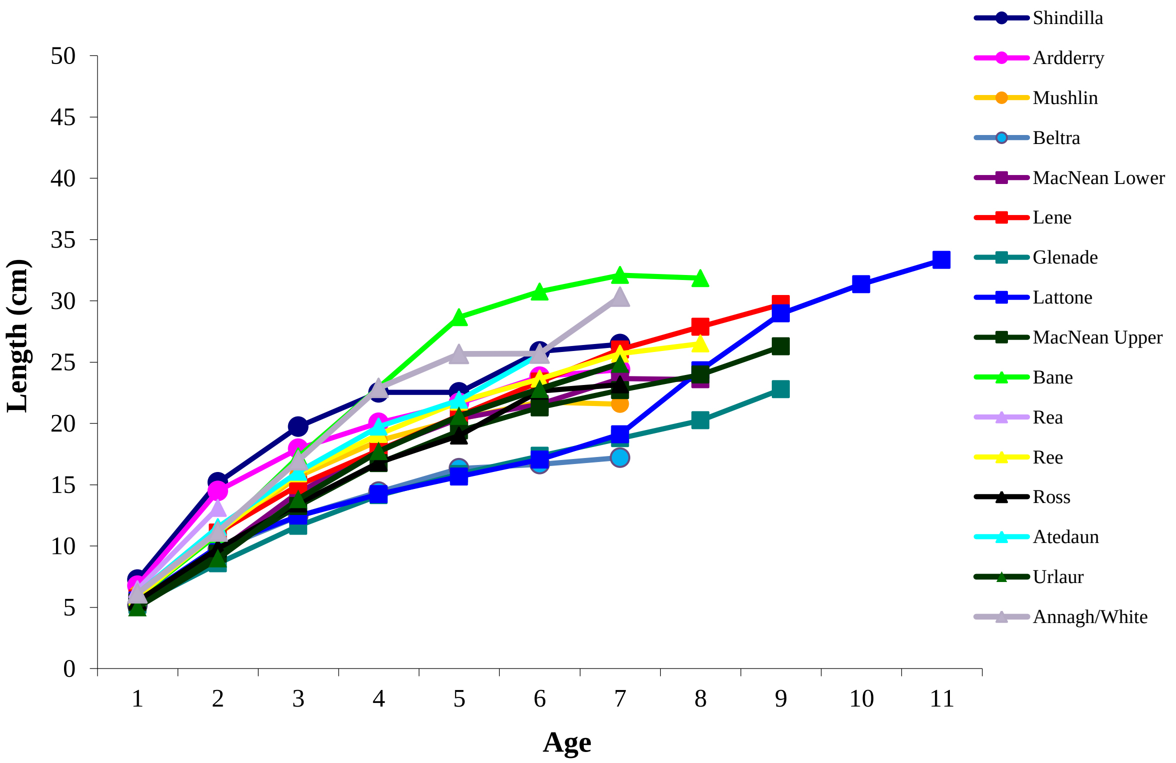

Fig. 4.38. Mean lengths at age of perch in lakes surveyed for WFD fish monitoring 2013 (note: squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

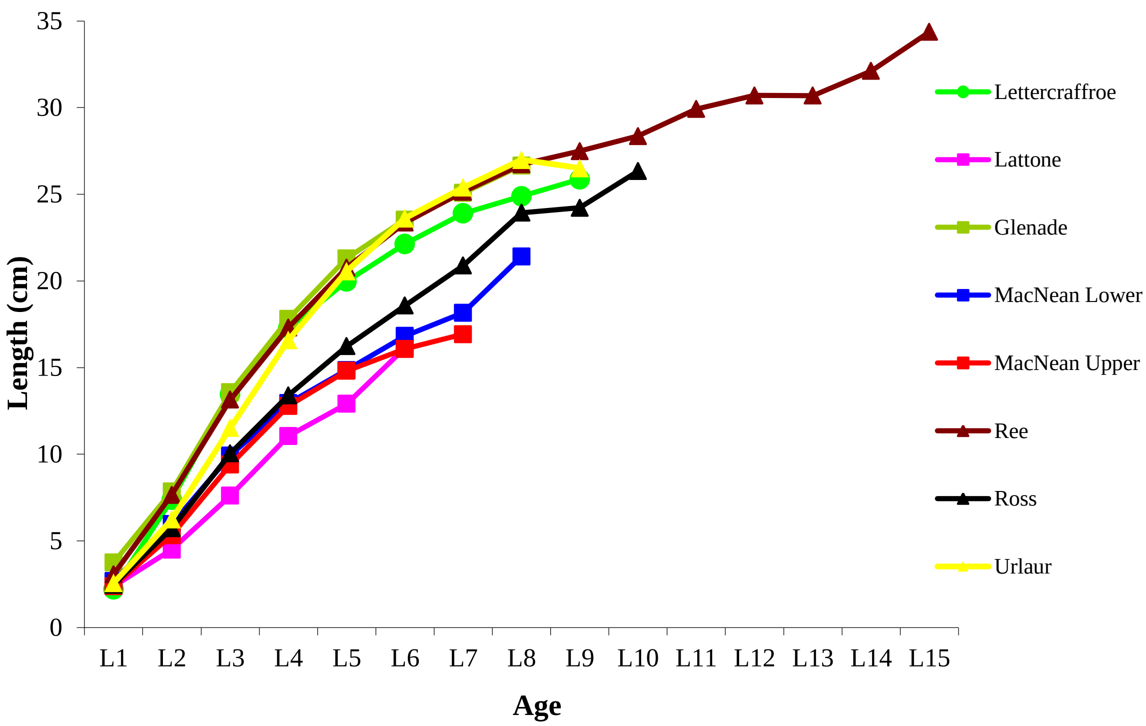

Fig. 4.39. Mean lengths at age of roach in lakes surveyed for WFD fish monitoring 2013 (note: squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

4.1.4.2 Growth of brown trout in low, moderate and high alkalinity lakes

The differences in brown trout mean length at age among the three alkalinity groups for L1 to L4 were assessed. Brown trout from moderate alkalinity lakes surveyed during 2013 displayed a slightly faster mean growth rate than those from low and high alkalinity lakes, however, the only significant difference was at the end of year 4 where the moderate alkalinity lakes had a significantly faster growth rate than the low alkalinity lakes ($z = -2.324$, $P<0.05$) (Fig. 4.40) (Appendix 3).

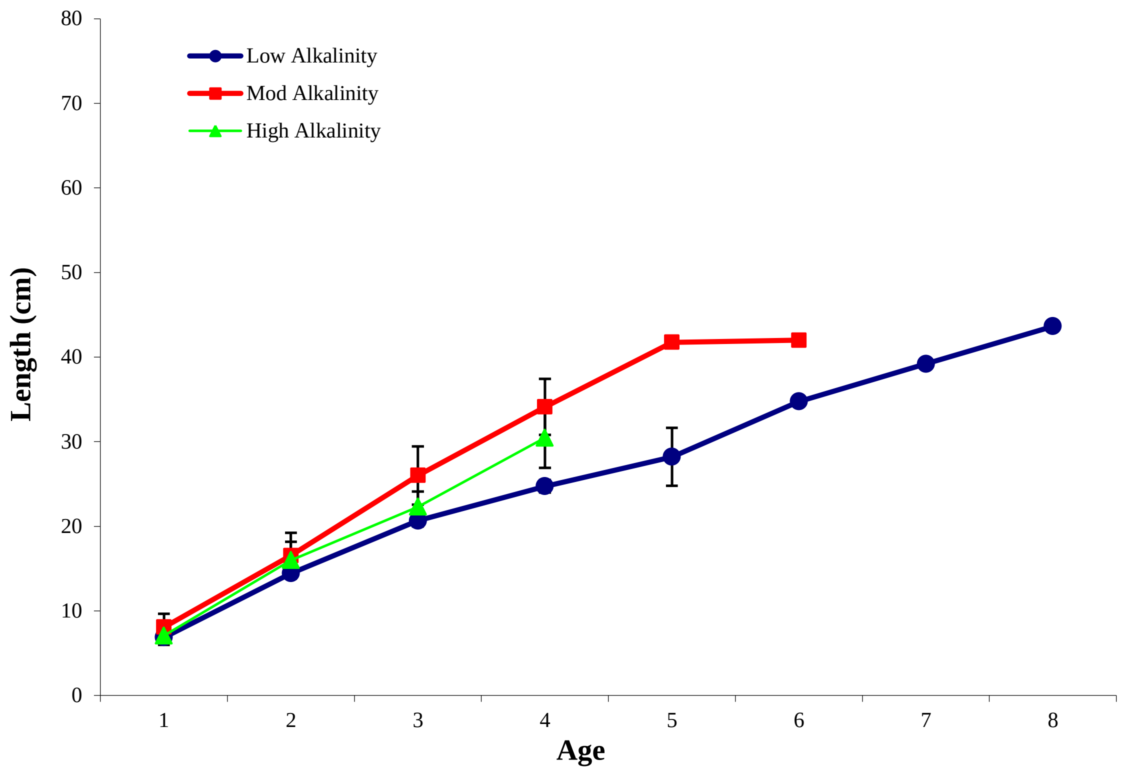

Fig 4.40. Mean (±SE) lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2013

Kennedy and Fitzmaurice (1971) related brown trout growth rates to alkalinity, classifying the growth of brown trout in lakes into the following four categories based on the mean length at the end of the fourth year (L4):

1) very slow – mean L4 = 20–25cm
2) slow – mean L4 = 25–30cm
3) fast – mean L4 = 30–35cm
4) very fast – mean L4 = 35–40cm

This classification was applied to the brown trout captured from 12 lakes during 2013; three were classified as very slow, six were classified as slow, one was classified as fast and two were classified as very fast (Table 4.3). Trout from Ardderry Lough, Lough Bane, Beltra Lough, Lattone Lough and Lough MacNean Upper were not classified as there were no four year old fish captured on these lakes, or the L4 value was outside Kennedy and Fitzmaurice's range.

Table 4.3. Categories of growth of trout in lakes as per Kennedy and Fitzmaurice (1971)

Very slow	Slow	Fast	Very fast
Shindilla	Aughrusbeg	Lickeen	Lene
Maumwee	Glencar		Ree
Glen	Kylemore		
	Lettercraffroe		
	Nambrackmore		
	Rea		

4.1.4.3 Growth of non-native fish species in low, moderate and high alkalinity lakes

The differences in perch and roach mean length at age among the three alkalinity groups for L1 to L7 were assessed. Both perch and roach were recorded in low, moderate and high alkalinity lakes. Overall, the mean length at age of both perch and roach were slightly higher in the low alkalinity and high alkalinity lakes than in the moderate alkalinity lakes; however, only perch in high alkalinity lakes displayed a significantly faster growth at the end of year 5 and 6 than those from the moderate alkalinity lakes ($z = -2.104$, $P<0.05$ and $z = -2.373$, $P<0.05$) (Fig. 4.41 and Fig. 4.42). Appendices 4 and 5 give a summary of the mean back calculated lengths at age of perch and roach from the 16 and eight lakes respectively.

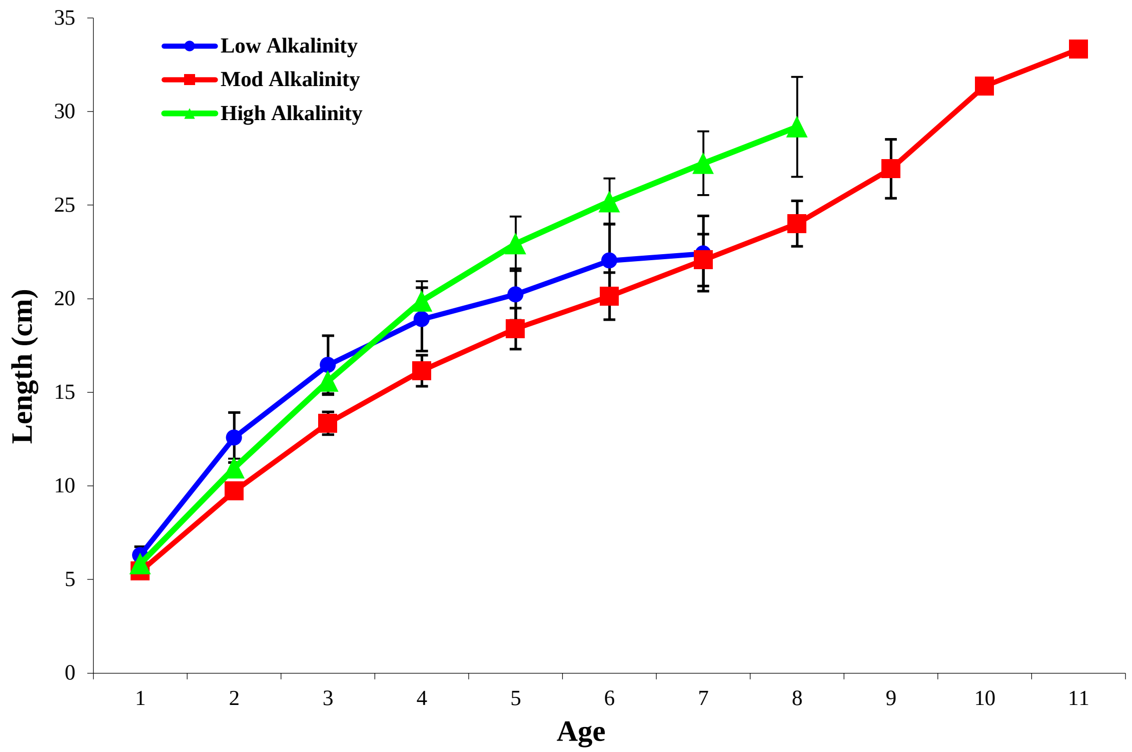

Fig 4.41. Mean (±SE) length at age of perch in lakes surveyed for WFD fish monitoring 2013

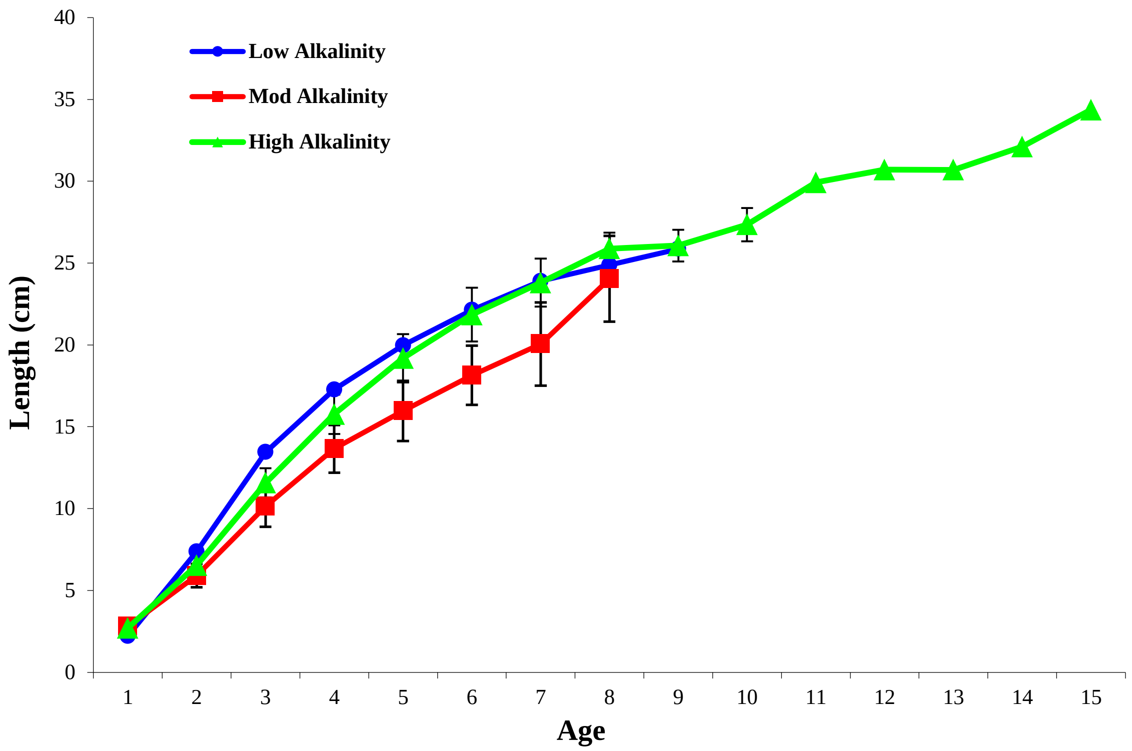

Fig 4.42. Mean (±SE) length at age of roach in lakes surveyed for WFD fish monitoring 2013

4.1.5 Ecological status - Classification of lakes using 'FIL2'

An essential step in the WFD monitoring process is the classification of the ecological status of lakes, which in turn will assist in identifying the objectives that must be set in the individual River Basin Management Plans (RBMPs).

The Fish in Lakes ecological classification tool (FIL2) assigns lakes in Ecoregion 17 (Ireland) to ecological status classes ranging from High to Bad using fish population parameters relating to species composition, abundance and age structure (Kelly *et al*., 2012b). FIL2 is a further development of the original FIL1 ecological classification tool (Kelly *et. al.*, 2008b) and it has been successfully intercalibrated in a cross Europe exercise. It combines a discriminant analysis model, providing a discrete assessment of status class with an ecological quality ratio (EQR) model, providing WFD compliant quantitative ecological quality ratios between 0 and 1 (Kelly *et al*., 2012b).

All 24 lakes surveyed during 2013 were assigned a draft ecological status class using the FIL2 ecological classification tool, together with expert opinion; six were classified as High, eight were classified as Good, one was classified as Moderate, six were classified as Poor and two were classified as Bad ecological status (Table 4.4, Figure 4.43). One lake could not be classified. The full output from the FIL2 ecological classification tool is given in Appendix 6.

Table 4.4. Classification of lakes using the Fish in Lakes (FIL2) classification tool

Lake	FIL2 Typology	Ecological Status Class (FIL2 Tool + expert opinion)
Bane	3	High
Beltra	2	High
Glen	1	High
Glencar	4	High
Kylemore	2	High
Shindilla	2	High
Ardderry	1	Good
Atedaun	3	Good
Lene	4	Good
Lettercraffroe	2	Good
Nambrackmore	1	Good
Macnean Upper	2	Good
Maumwee	1	Good
Annagh/White Lough	4	Good
Rea	4	Moderate
Glenade	3	Poor
Lickeen	2	Poor
Macnean Lower	1	Poor
Ree	4	Poor
Ross (Corrib)	3	Poor
Aughrusbeg	1	Poor
Lattone	1	Bad
Urluar	3	Bad
Mushlin	1	N/A

Ecological status is subject to change upon review

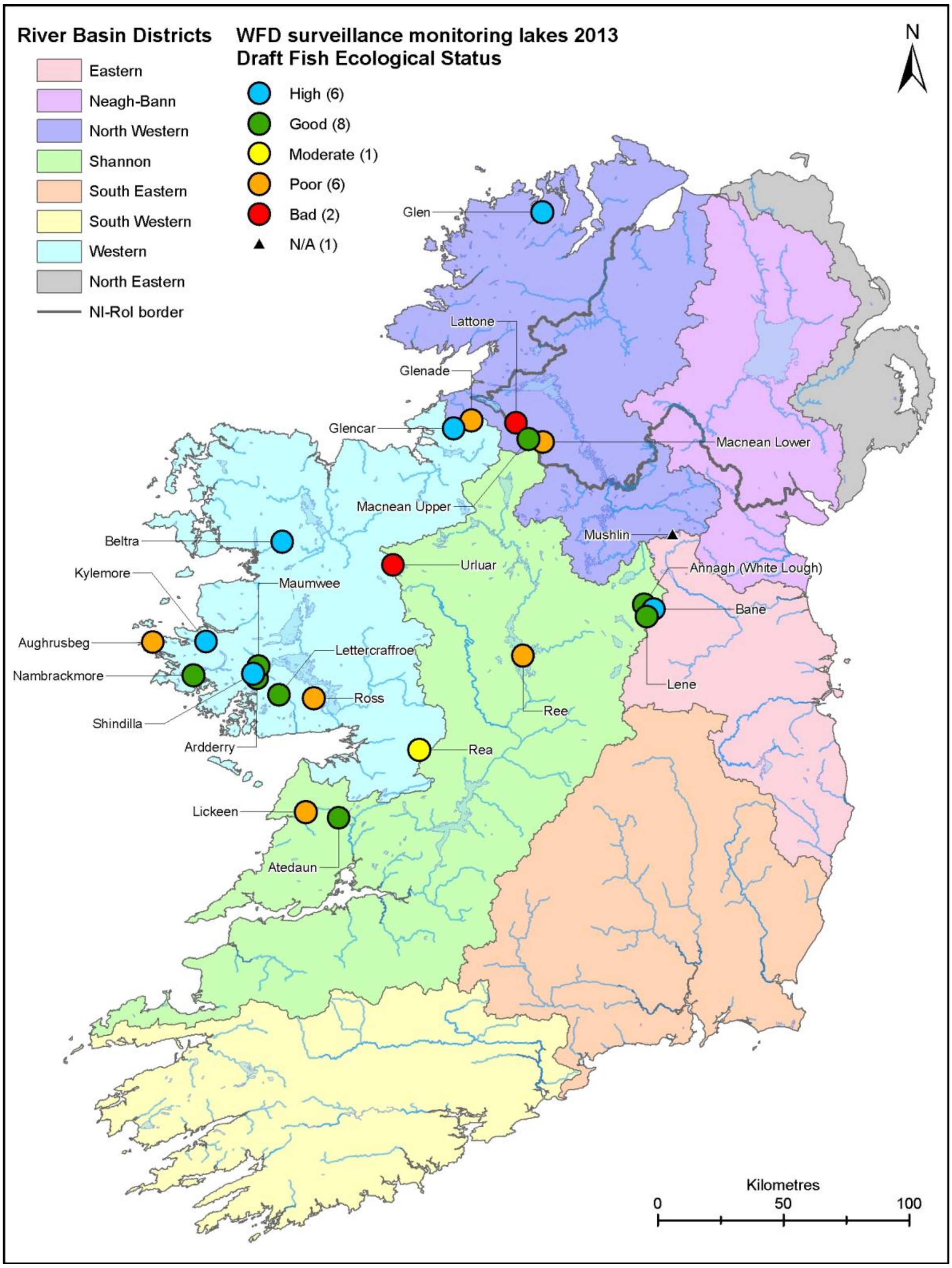

Fig. 4.43. Ecological classification of lakes surveyed during 2013 using the FIL2 ecological

4.2 Rivers

4.2.1 Fish species composition and species richness

Trout, salmon and eels are ubiquitous in Ireland and occur in practically all waters to which they can gain access. Irish freshwaters contain only 11 truly native fish species, comprising three salmonids, one coregonid, European eel, one shad, two sticklebacks and three lampreys (Kelly *et al*., 2007c, Champ *et al*., 2009). Three fish groups have been identified and agreed for Ecoregion 17 by a panel of fishery experts (Kelly *et al*., 2008b). These are Group 1 – native species, Group 2 – non-native species influencing ecology and Group 3 – non-native species generally not influencing ecology. In the absence of major human disturbance, a river fish community is considered to be in reference state in relation to fish, when the population is dominated by salmonids, or euryhaline species with an arctic marine past, i.e. when native fish species from Group 1 are the only species present in the river (Kelly *et al*., 2007c). A list of fish species recorded in the 63 river sites surveyed during 2013 is shown in Table 4.5. The percentage of river sites in which each fish species occurred is shown in Figure 4.44.

Table 4.5. List of fish species recorded in the 63 river sites surveyed during 2013

	Scientific name	Common name	Number of river sites	% river sites
	NATIVE SPECIES			
1	*Salmo trutta*	Brown trout	59	93.7
2	*Anguilla anguilla*	Eel	44	69.8
3	*Salmo salar*	Salmon	39	61.9
4	*Gasterosteus aculeatus*	Three-spined stickleback	32	50.8
5	*Lampetra* sp.	Lamprey sp.	31	49.2
6	*Platichthys flesus*	Flounder	4	6.4
7	*Pungitius pungitius*	Nine-spined stickleback	2	3.2
8	*Salmo trutta*	Sea trout *	1	1.6
	NON NATIVE (influencing ecology)			
9	*Barbatula barbatula*	Stone loach	32	50.8
10	*Phoxinus phoxinus*	Minnow	22	34.9
11	*Perca fluviatilis*	Perch	20	31.8
12	*Rutilus rutilus*	Roach	13	20.6
13	*Esox lucius*	Pike	10	15.9
14	*Leuciscus leuciscus*	Dace	3	4.8
15	*Abramis brama*	Bream	2	3.2
	Rutilus rutilus x Abramis brama	Roach x bream hybrid	1	1.6
	NON NATIVE SPECIES (generally not influencing ecology)			
16	*Gobio gobio*	Gudgeon	14	22.2

*sea trout are included as a separate "variety" of trout

A total of 16 fish species (sea trout are included as a separate "variety" of trout) and one hybrid were recorded in the 63 river sites surveyed during 2013. Brown trout was the most widespread species occurring in 93.7% of the sites surveyed, followed by European eel (69.8%), salmon (61.9%), three-spined stickleback (50.8%), stone loach (50.8%), lamprey sp. (49.2%), minnow (34.9%), perch (31.8%), gudgeon (22.2%), roach (20.6%), pike (15.9%), flounder (6.4%), dace (4.8%), nine-spined stickleback (3.2%) and bream (3.2%). Sea trout and roach x bream hybrids were only recorded in one site each (1.6%) (Table 4.5 and Fig. 4.45).

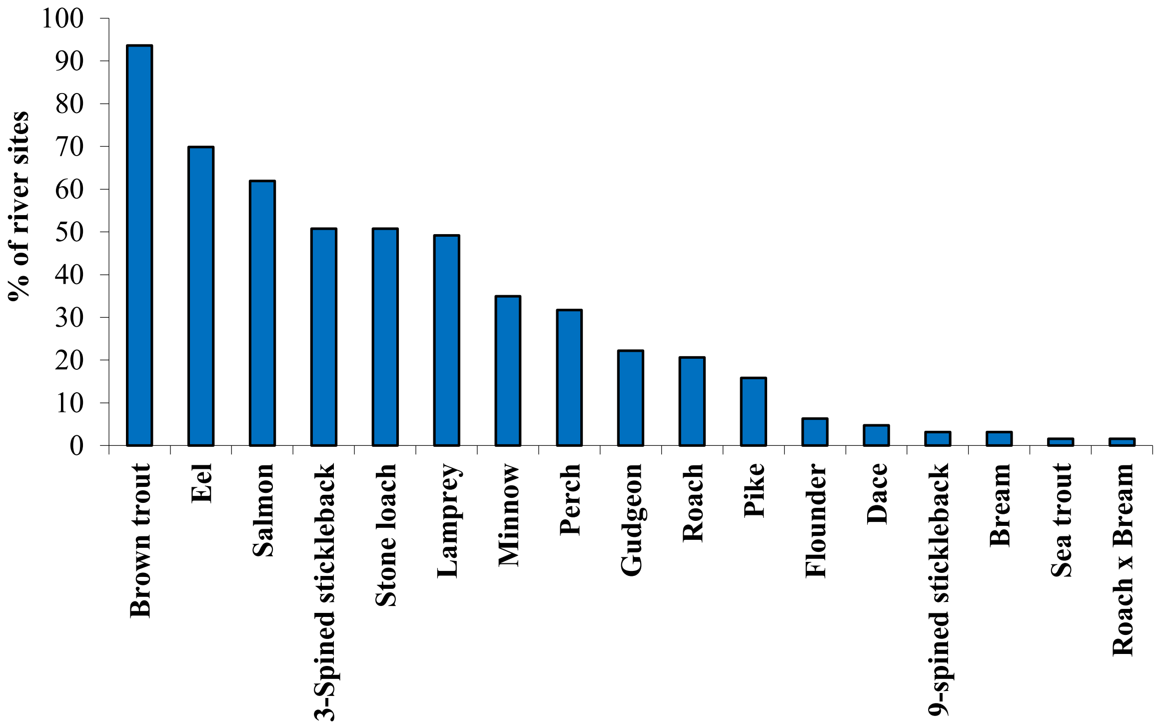

Fig. 4.44. Percentage of sites where each fish species was recorded (total of 63 river sites surveyed) during WFD surveillance monitoring 2013

Fish species richness (including sea trout and hybrids) ranged from one species in the Glenfelly, Graney and Nuenna Rivers to a maximum of 12 species in the River Lee at Lee Fields (Table 4.6 and Fig. 4.45). Native species were present in all of the sites surveyed. Seventeen of the 63 sites contained exclusively native species (27%). The maximum number of native species captured in any site was seven and this was recorded in the River Vartry in Co. Wicklow (Table 4.6). Group 2 species (non-native species influencing ecology) were present at 46 sites. The maximum number of non-native species recorded at any one site was seven, recorded at two sites, the River Lee (Lee fields), Co. Cork and Annalee, Co. Cavan. One Group 3 species (gudgeon) was present among the river sites surveyed, recorded at 14 sites.

Table 4.6. Species richness in each river site surveyed for WFD fish monitoring 2013

Site	RBD	Species richness	No. native species (Group 1)	No. of Non-native species (Group 2)	No. of non-native (Group 3)
Wadeable sites					
Abbert (Bridge at Bullaun_A)	WRBD	9	6	3	0
Blackwater (Kells), (Just u/s L. Ramor_A)	ERBD	8	4	3	1
Vartry (Newrath Br._A)	ERBD	8	7	1	0
Dodder (Footbr. Beaver Row_B)	ERBD	7	6	1	0
Gowran (Br. N of G'bridge (S Channel)_A)	SERBD	7	5	2	0
Boor (Br. NW of Kilbillaghan_B)	SHIRBD	7	4	3	0
Mountnugent (Mountnugent Br._A)	SHIRBD	7	3	4	0
White (Coneyburrow Br._B)	NBIRBD	6	4	2	0
Ballyroan (Ballydine Br._A)	SERBD	6	5	1	0
Glory (Br. E of Raheen_A)	SERBD	6	5	1	0
Broadford (Br. u/s Doon Lough_A)	SHIRBD	6	3	2	1
Gourna (Br. u/s Owenogarney R confl_C)	SHIRBD	6	5	1	0
Moyree (Br. u/s Fergus _A)	SHIRBD	6	4	2	0
Owendalluleegh (Br. SE Killafeen_A)	WRBD	6	3	2	1
Fane (Br. d/s of Inishkeen_A)	NBIRBD	5	4	1	0
Ballyroan (Gloreen Br._D)	SERBD	5	4	1	0
Banoge (Br. u/s Owenavorragh R confl_A)	SERBD	5	4	1	0
Douglas (Ballon)(Sragh Br._B)	SERBD	5	3	2	0
Slaney (Waterloo Br._A)	SERBD	5	4	1	0
Gourna (Beside railway Br._A)	SHIRBD	5	4	1	0
Dalua (Footbr. SW of Liscongill_A)	SWRBD	5	4	1	0
Lee (Cork), (Inchinossig Br._A)	SWRBD	5	3	2	0
Banoge (d/s of N11 bridge_A)	SERBD	4	4	0	0
Clody (Ford (Br.) 3km u/s Bunclody_B)	SERBD	4	4	0	0
Ballyfinboy (Ballinderry Br._A)	SHIRBD	4	3	1	0
Ballyfinboy (Br. just u/s L. Derg_A)	SHIRBD	4	3	1	0
Fergus, (Poplar Br._B)	SHIRBD	4	4	0	0
Newport (Rossaguile Br._A)	SHIRBD	4	3	1	0
Spancilhill (Br. NW, near Spancilhill_A)	SHIRBD	4	3	1	0
Araglin (Elizabeth's Br._A)	SWRBD	4	4	0	0
Cummeragh (Footbr. u/s Owengarriff confl_A)	SWRBD	4	4	0	0
Owvane (Lisheen / Piersons Br. (LHS)_A)	SWRBD	4	3	1	0
Screeb (L.Aughawoolia_A)	WRBD	4	3	1	0
Nier (Br. ENE of Ballymacarbry_A)	SERBD	3	3	0	0
Broadford (Broadford (Village)_A)	SHIRBD	3	3	0	0
Adrigole (D/s of Glashduff Adrigole confl_A)	SWRBD	3	3	0	0
Licky (Br. NE of Glenlicky_A)	SWRBD	3	3	0	0
Owenboliska (Caravan Park_A)	WRBD	3	3	0	0

* Roach x bream hybrids included in this table

Table 4.6 ctn. Species richness in each river site surveyed for WFD fish monitoring 2013

Site	RBD	Species richness	No. native species (Group 1)	No. of Non-native species (Group 2)	No. of non-native (Group 3)
Avonbeg (Greenan Br._A)	ERBD	2	2	0	0
Dodder (D/s P'town Str., Bohernabreena_A)	ERBD	2	1	1	0
Dodder (Mount Carmel Hospital_A)	ERBD	2	2	0	0
Gowran (Grange Lower_A)	SERBD	2	2	0	0
Bow (Bow Br._A)	SHIRBD	2	1	1	0
Glendine (Knockloskeraun Br. S of M_A)	SHIRBD	2	2	0	0
Nuenna (Br. d/s Clomantagh_B)	SERBD	1	1	0	0
Glenafelly (Br. 3km E of Longford_A)	SHIRBD	1	1	0	0
Graney (Caher Br. S of L.Graney_A)	SHIRBD	1	1	0	0
Non-wadeable sites					
Lee (Cork), (Lee Fields_A)	SWRBD	12	5	6	1
Annalee (0.2km d/s Cavan R confl_A)	NWIRBD	9	2	6	1
Blackwater (Munster), (Killavullen Br._A)	SWRBD	9	5	3	1
Blackwater (Munster), (Lismore Br._A)	SWRBD	9	4	4	1
Fergus, (Br. near Clonroad House_A)	SHIRBD	8	6	2	0
Suck, (Cloondacarra Br._A)	SHIRBD	8	2	5	1
Funshion, (Br. u/s Blackwater R confl_A)	SWRBD	8	5	3	0
Erne (Bellahillan Br._A)	NWIRBD	7	3	3	1
Finn (Monaghan)(Cumber Br._A)	NWIRBD	7	3	3	1
Suck, (Ballyforan Br._A)	SHIRBD	7	1	5	1
Blackwater (Munster), (Nohaval Br._A)	SWRBD	7	4	2	1
Liffey (500 m d/s Ballyward Br._A)	ERBD	6	2	4	0
Liffey (Kilcullen Br._A)	ERBD	6	3	3	0
Dromore (Drummuck_A)	NWIRBD	6	4	2	0
Erne (Kilconny Belturbet (RHS)_A)	NWIRBD	6	2	3	1
Cullies (Br. nr Kilbrackan House_A)	NWIRBD	5	1	3	1

* Roach x bream hybrids included in this table

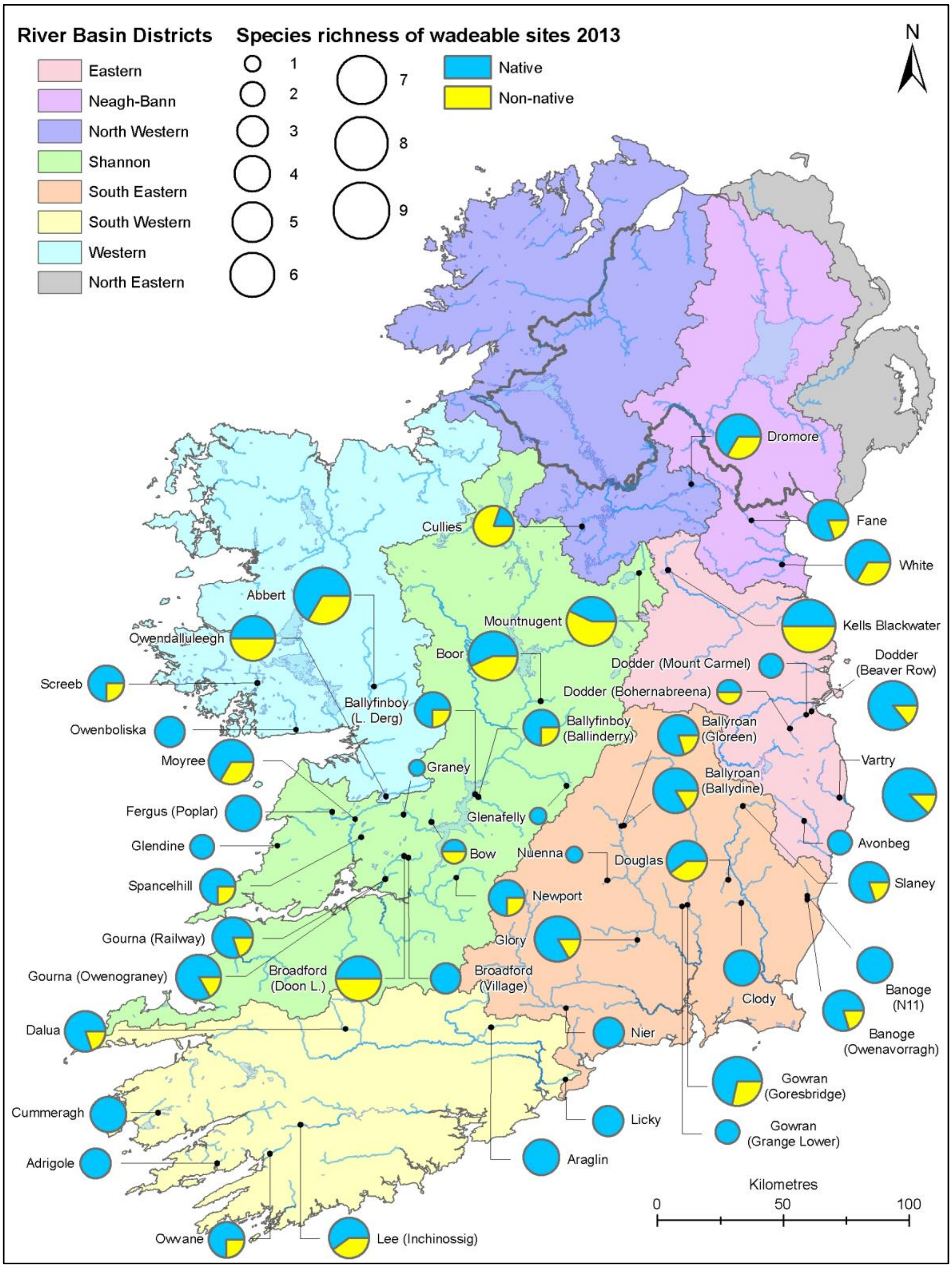

Fig. 4.45. Fish species richness at wadeable river sites surveyed using boat based electric-fishing equipment for WFD fish monitoring 2013

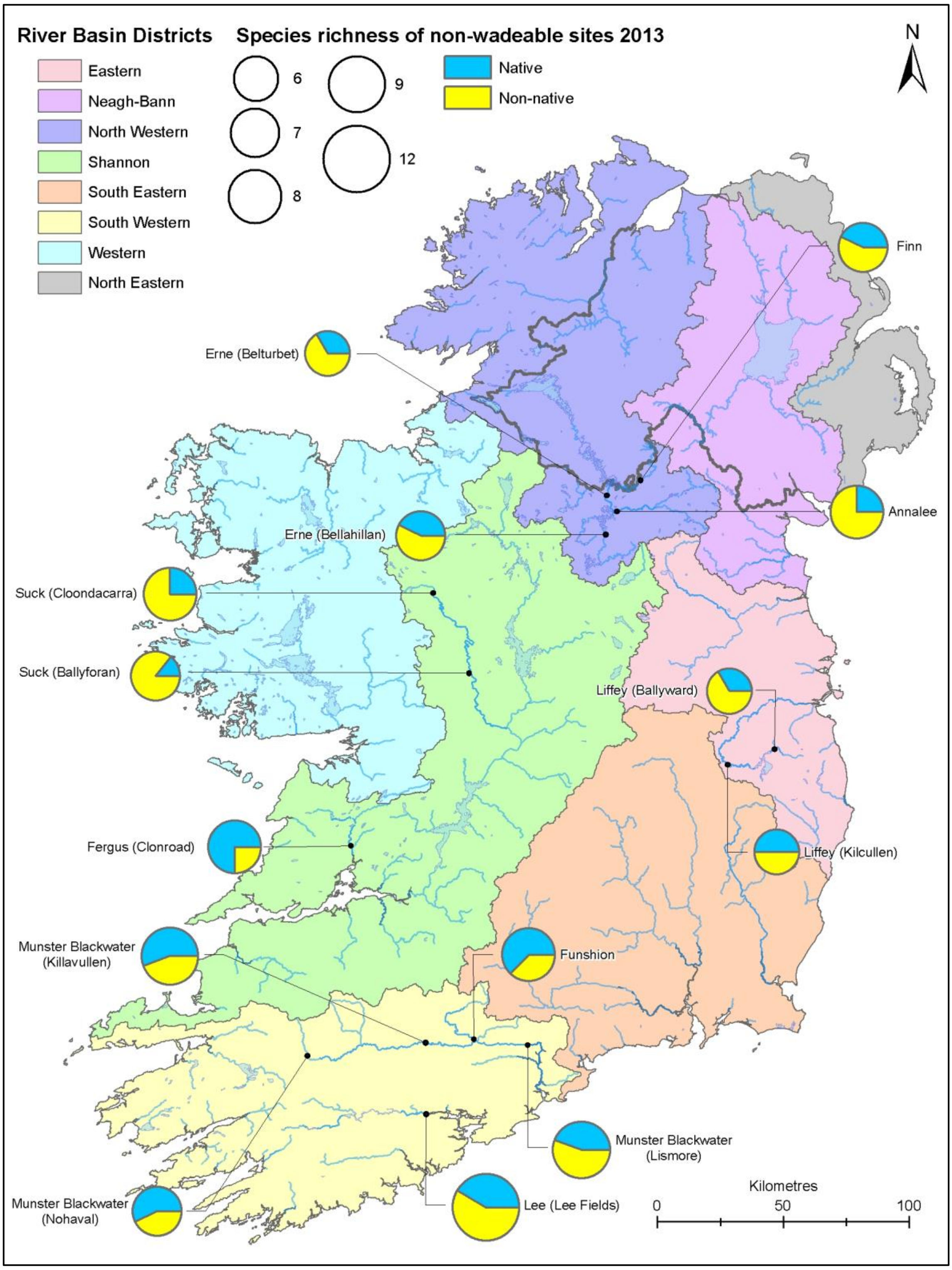

Fig. 4.46. Fish species richness at non-wadeable river sites surveyed using handset electric-fishing equipment for WFD fish monitoring 2013

4.2.2 Fish species distribution and abundance

Brown trout were the most widely distributed species among river sites surveyed in 2013, being recorded in 59 of the 63 sites (Fig. 4.47 to Fig. 4.50). Brown trout fry (0+) were present in 58 sites (Fig. 4.47 and Fig. 4.48), while older brown trout (1+ and older) were encountered in 59 sites (Fig. 4.49 and Fig. 4.50). Brown trout fry (0+) densities were generally higher in the small shallower wadeable streams than in the non-wadeable deeper rivers where boat based electric-fishing was used to carry out the survey. In wadeable streams, the highest densities of fry (0.193 fish/m^2) and 1+ and older fish (0.337 fish/m^2) were both recorded in the Bow River site (ShIRBD). In non-wadeable rivers sites, the highest densities of both brown trout fry (0+) (0.013 fish/m^2) and 1+ and older fish (0.037 fish/m^2) were captured in the River Liffey (Kilcullen Br.) (ERBD) and Munster Blackwater River (Nohaval Br.) (SWRBD) respectively.

Sea trout were only recorded in one river site in 2013, the Vartry River at Newrath Br., with an abundance of 0.01 fish/m^2. (Fig. 4.51 and Fig. 4.52).

Salmon fry (0+) and older salmon (1+ & older) were also widely distributed throughout the country, being present in 38 sites (Fig. 4.53 to Fig. 4.56). Abundance of salmon followed a similar trend to that of brown trout, where fry (0+) densities were generally more abundant in shallow wadeable streams, than in non-wadeable deeper channels, sampled with boat based electric-fishing equipment. In wadeable streams, the greatest densities of fry (0+) (0.377 fish/m^2) and 1+ and older fish (0.211 fish/m^2) were recorded in the Cummeragh (SWRBD) and Nier Rivers (SERBD) respectively. For non-wadeable streams, the highest densites of salmon fry (0+) (0.023 fish/m^2) and 1+ and older fish (0.032 fish/m^2) were captured in the Munster Blackwater River (Nohaval Br.) (SWRBD).

Eels were present in 44 river sites (Fig. 4.57 and Fig. 4.58). The highest eel density was recorded in the River Dodder at Beaver Row (0.053 fish/m^2) (ERBD). Higher eel densities were recorded in wadeable sites when compared to non-wadeable sites.

Flounder were recorded in only four sites located very close to the coast, with their highest density recorded in the Vartry River at Newrath Br. (0.029 fish/m^2) (ERBD) (Fig. 4.59 and Fig. 4.60).

Three-spined stickleback were distributed throughout the country, being captured in a total of 32 sites (Fig. 4.61 and Fig. 4.62). Their highest density (1.760 fish/m^2) was recorded in the White River at Coneyburrow Br. (NBIRBD). Nine-spined stickleback were recorded in both the Dromore (NWIRBD) and Abbert (WRBD) Rivers, with the Dromore River recording the higher density (0.004 fish/m^2) (Fig. 4.63 and Fig. 4.64).

Juvenile lamprey were recorded in 31 river sites, with their highest density (0.082 fish/m^2) recorded in the Gourna River (Owenogarney confl.) (ShIRBD) (Fig. 4.65 and Fig. 4.66). Stone loach were recorded in 32 sites throughout the country. Their highest density was recorded in the White River at

Coneyburrow Br. (0.160 fish/m^2) (NBIRBD) (Fig. 4.67 and Fig. 4.68). Minnow were recorded in 22 river sites, with their greatest density (1.006 fish/m^2) in the Owvane River (SWRBD) (Fig. 4.69 and Fig. 4.70).

Dace were captured at three sites, all on the Munster Blackwater system (SWRBD) (Fig. 4.71 and Fig. 4.72). Their highest density was recorded in River Blackwater at Killavullen Br. (0.006fish/m^2).

Roach were recorded in 13 river sites (Fig. 4.73 and Fig. 4.74). The greatest density of roach (0.185 fish/m^2) was recorded in the Cullies River (NWIRBD). Bream were only caught during two surveys in 2013, two individuals in the Annalee River (NWIRBD) and one individual in the River Lee at Lee Fields (SWRBD). Roach x bream hybrids were only recorded in the Annalee River and only a single individual was recorded.

Gudgeon were recorded in 14 river sites, with the Cullies River (NWIRBD) again recording the highest density (0.118 fish/m^2) (Fig. 4.75 and Fig. 4.76).

Perch were recorded in 20 sites, (Fig. 4.77 and Fig. 4.78). Their highest density (0.130 fish/m^2) was recorded in the Cullies River (NWIRBD).

Pike were captured at ten river sites (Fig. 4.79 and Fig. 4.80). The Cullies River (NWIRBD) recorded the highest density (0.012 fish/m^2).

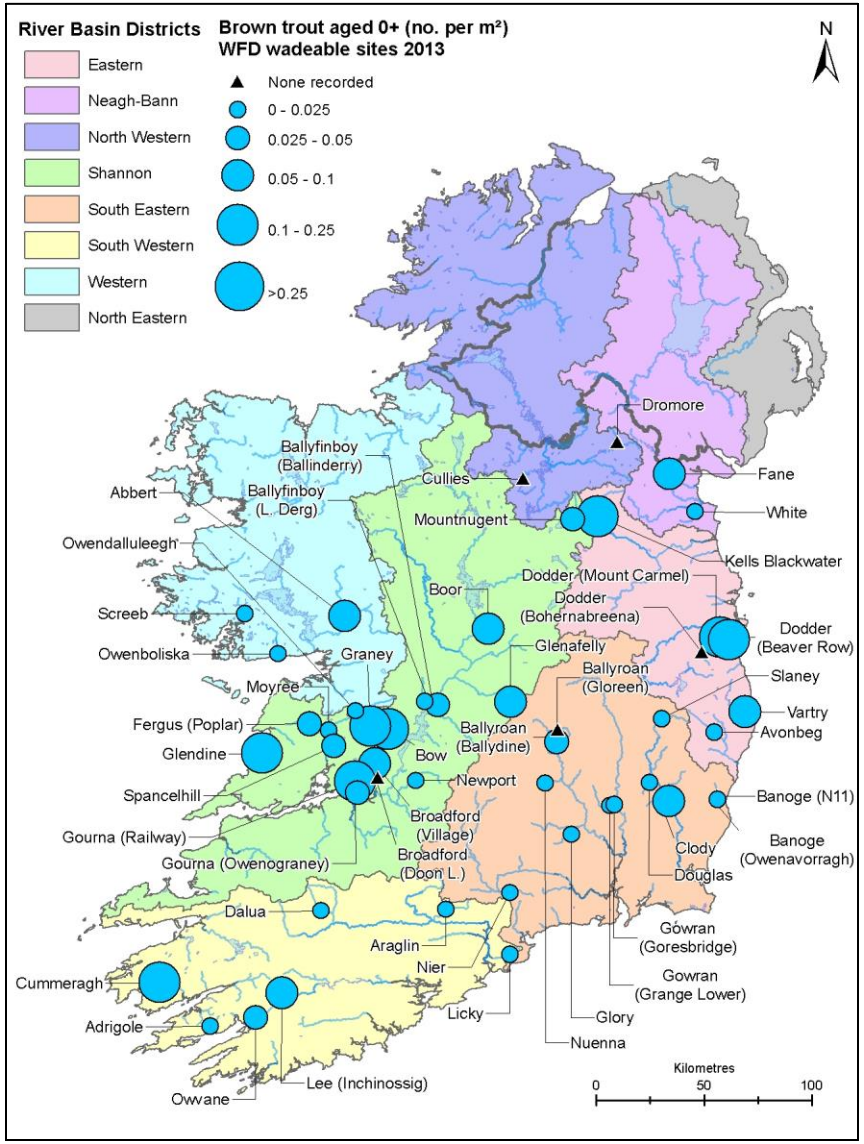

Fig. 4.47. Distribution and abundance of 0+ brown trout at wadeable river sites surveyed for WFD fish monitoring 2013

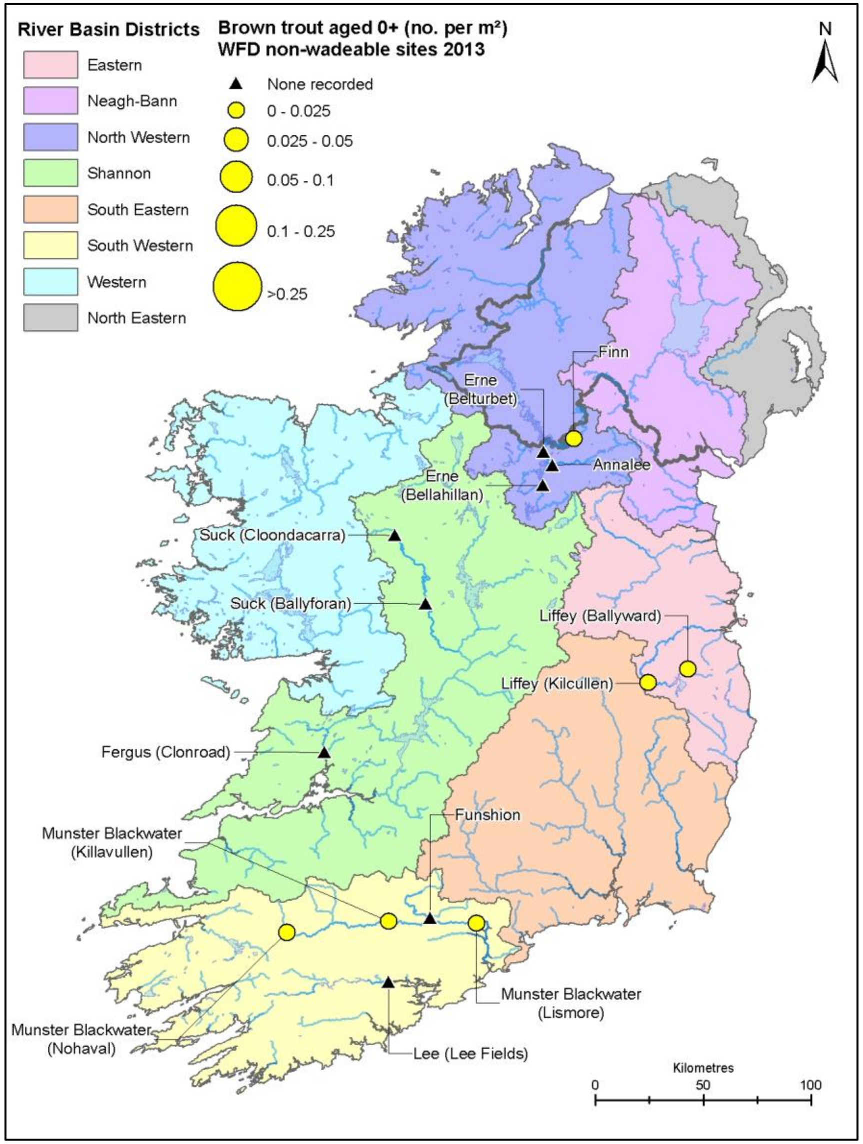

Fig. 4.48. Distribution and abundance of 0+ brown trout at non-wadeable river sites surveyed for WFD fish monitoring 2013

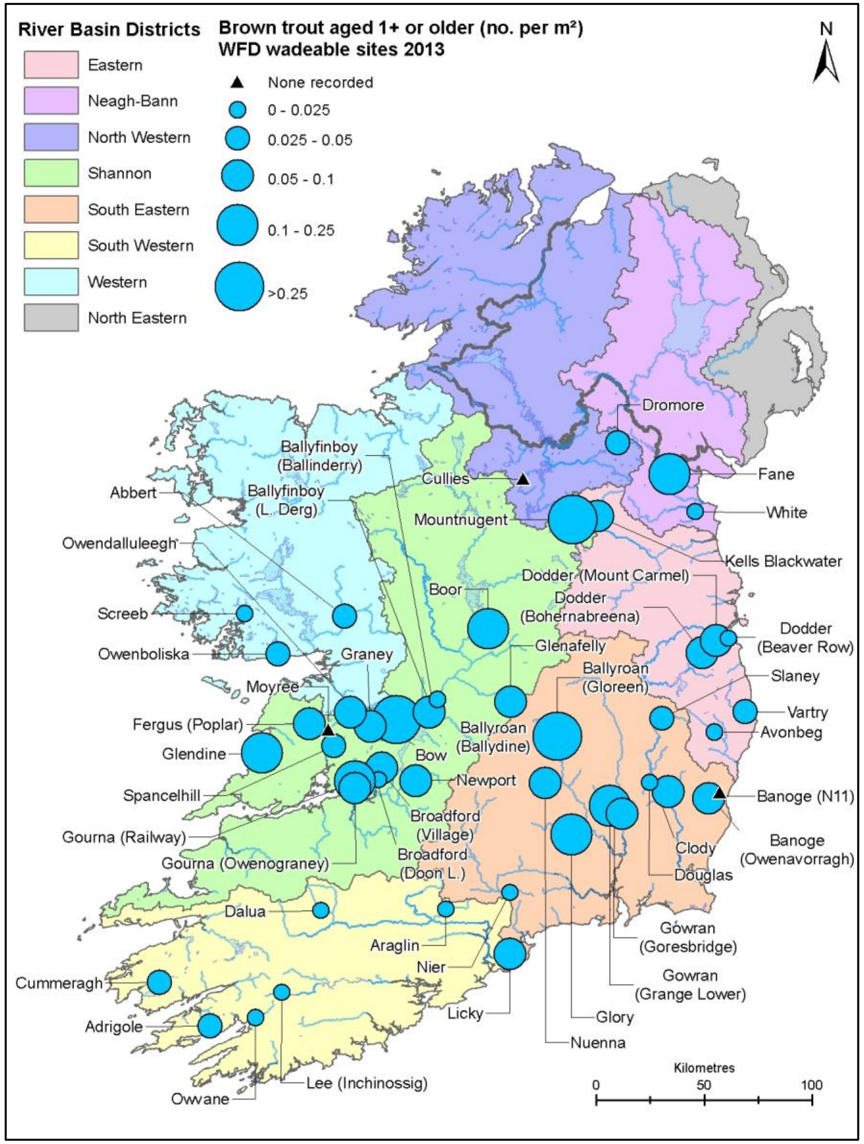

Fig. 4.49. Distribution and abundance of 1+ or older brown trout at wadeable river sites surveyed for WFD fish monitoring 2013

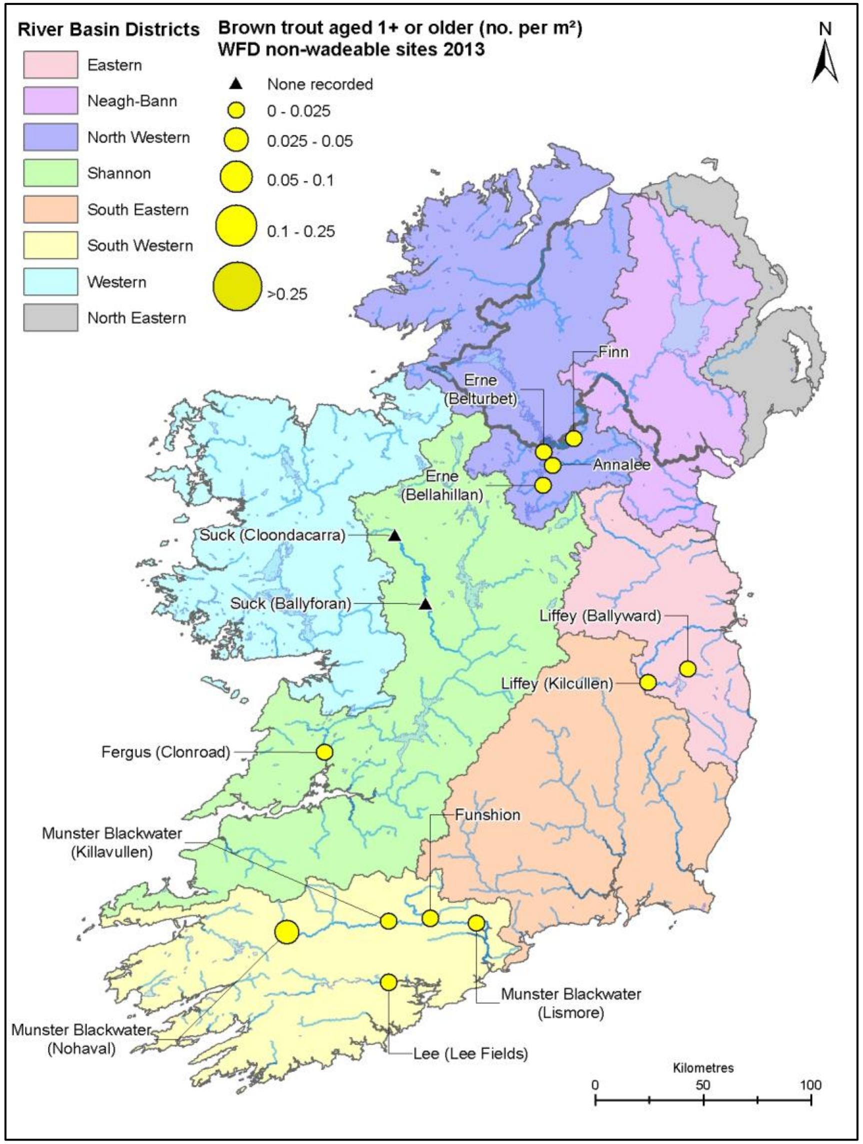

Fig. 4.50. Distribution and abundance of 1+ or older brown trout at non-wadeable river sites surveyed for WFD fish monitoring

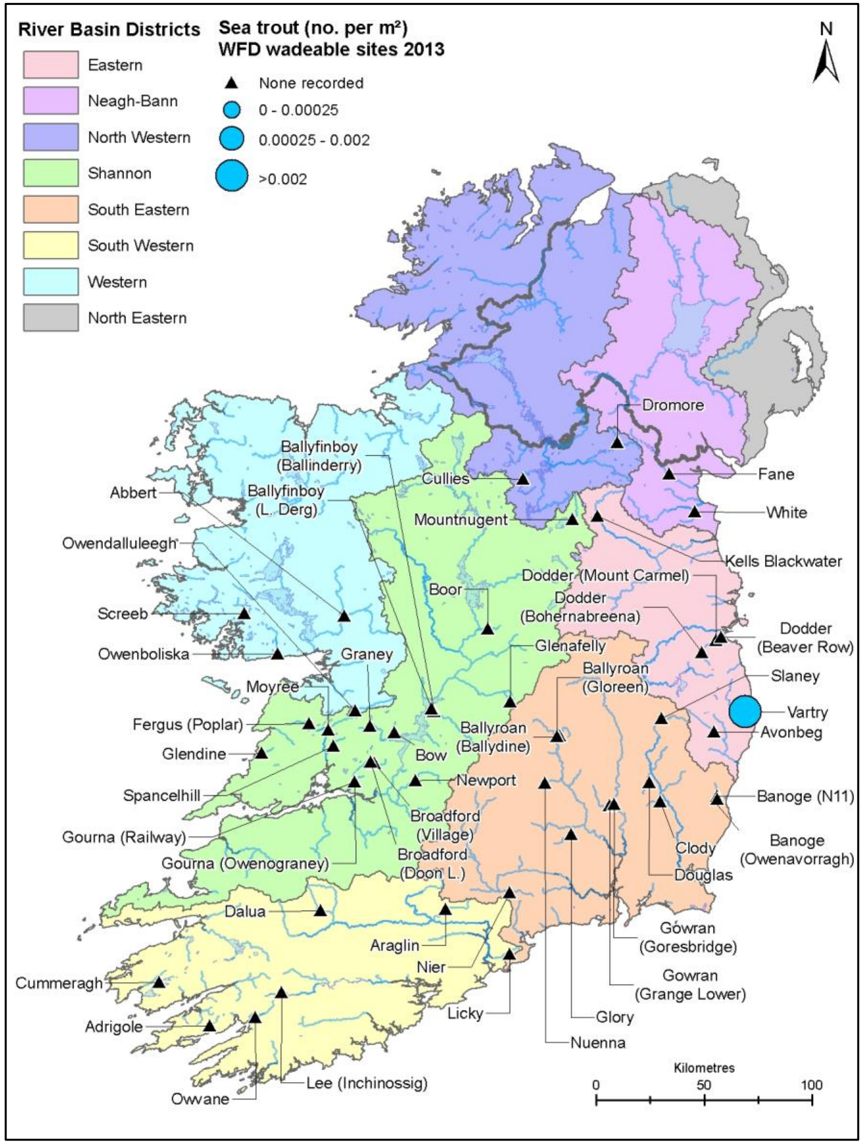

Fig. 4.51. Distribution and abundance of sea trout at wadeable river sites surveyed for WFD fish monitoring 2013

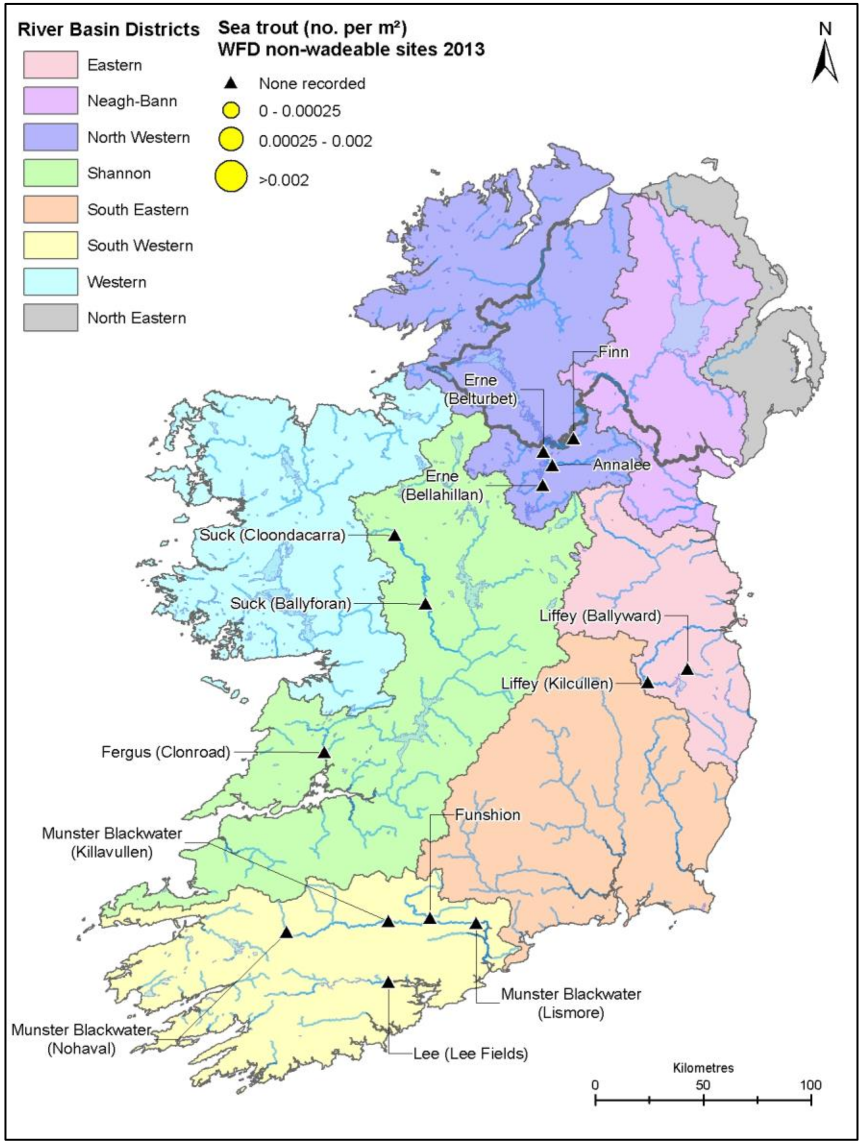

Fig. 4.52. Distribution and abundance of sea trout at non-wadeable river sites surveyed for WFD fish monitoring 2013

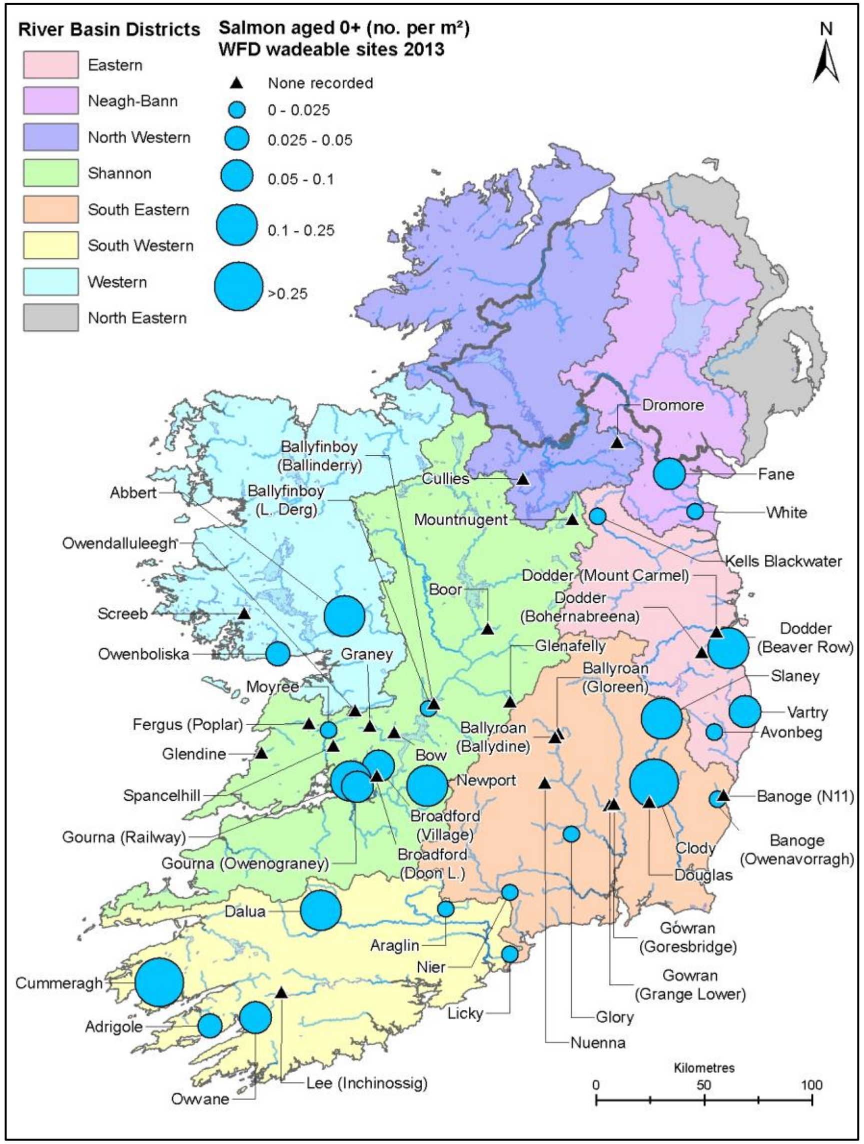

Fig. 4.53. Distribution and abundance of 0+ salmon at wadeable river sites surveyed for WFD fish monitoring 2013

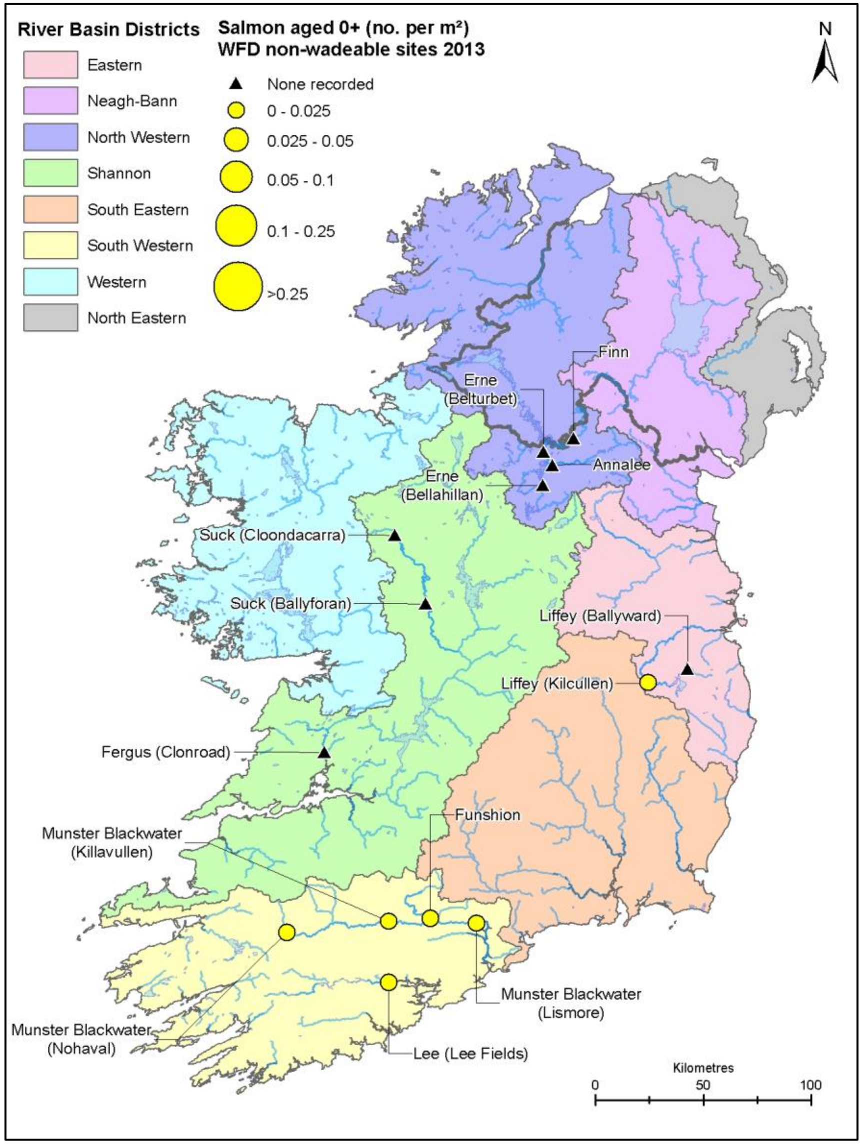

Fig. 4.54. Distribution and abundance of 0+ salmon at non-wadeable river sites surveyed for WFD fish monitoring 2013

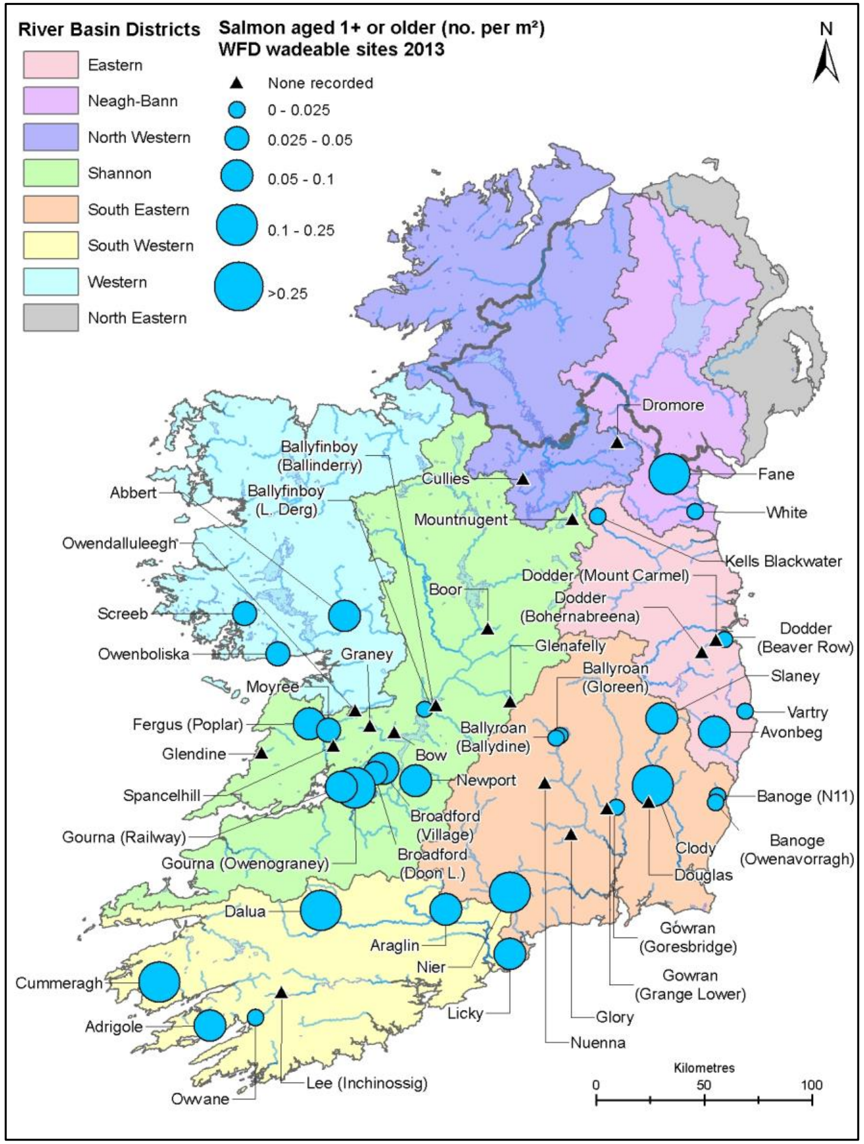

Fig. 4.55. Distribution and abundance of 1+ or older salmon at wadeable river sites surveyed for WFD fish monitoring 2013

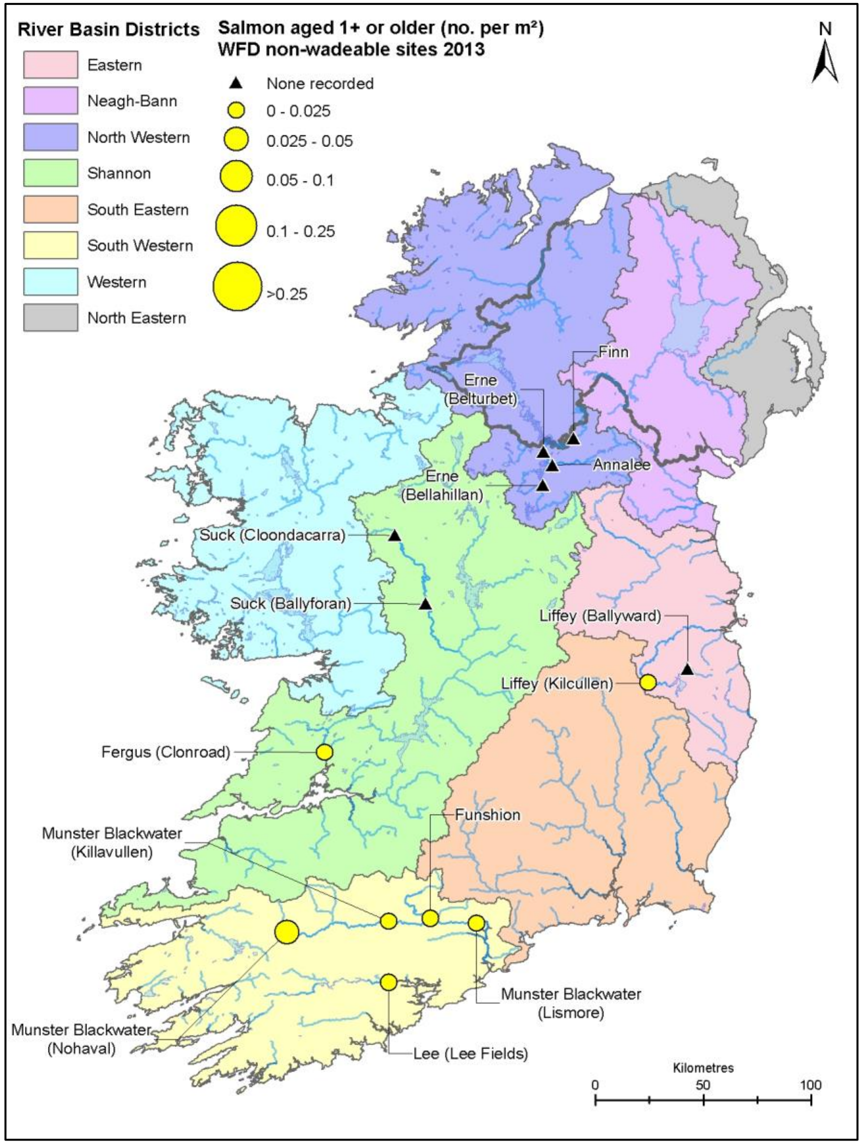

Fig. 4.56. Distribution and abundance of 1+ or older salmon at non-wadeable river sites surveyed for WFD fish monitoring 2013

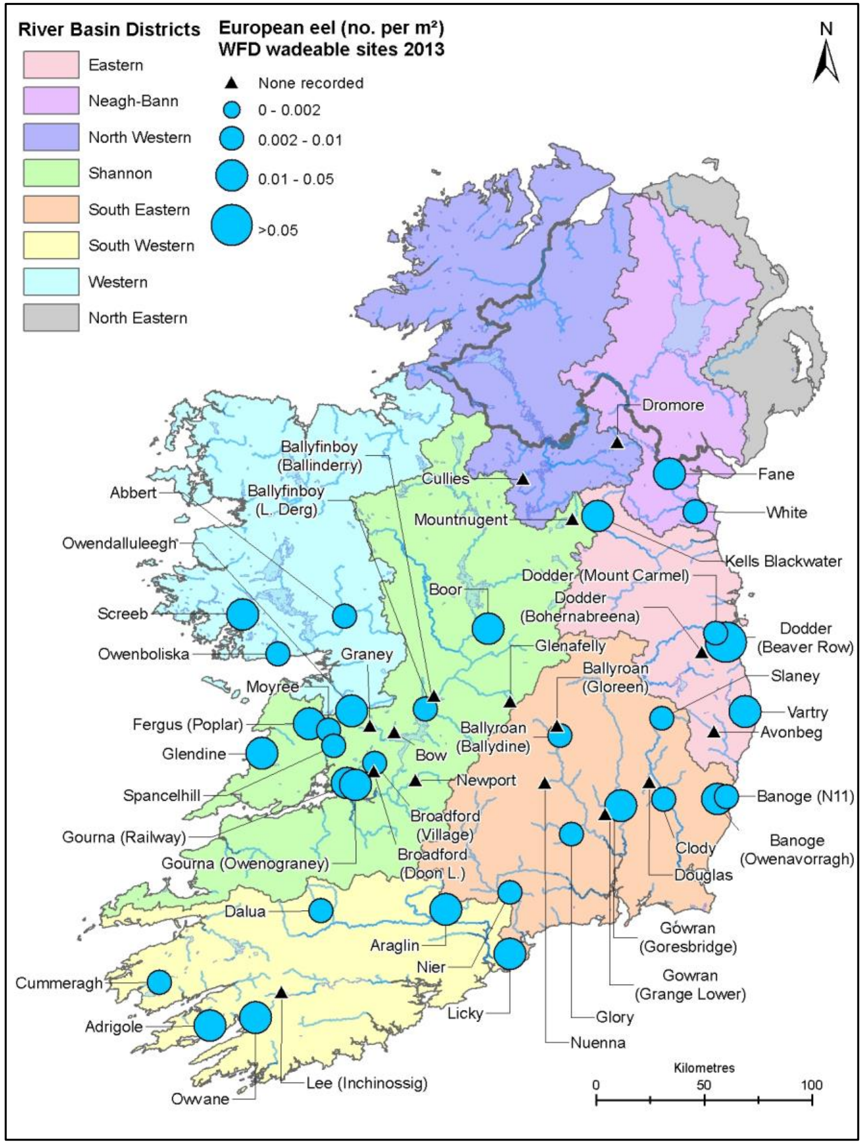

Fig. 4.57. Distribution and abundance of European eel at wadeable river sites surveyed for WFD fish monitoring 2013

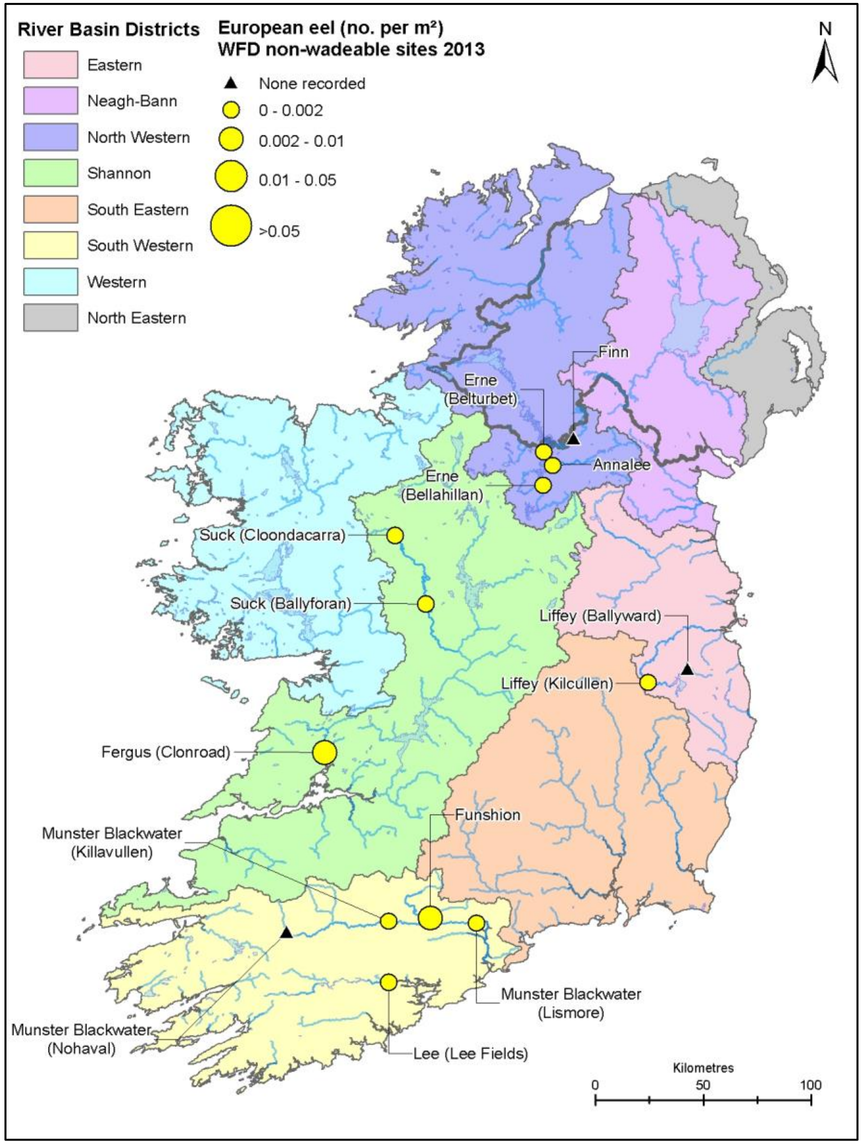

Fig. 4.58. Distribution and abundance of European eel at non-wadeable river sites surveyed for WFD fish monitoring 2013

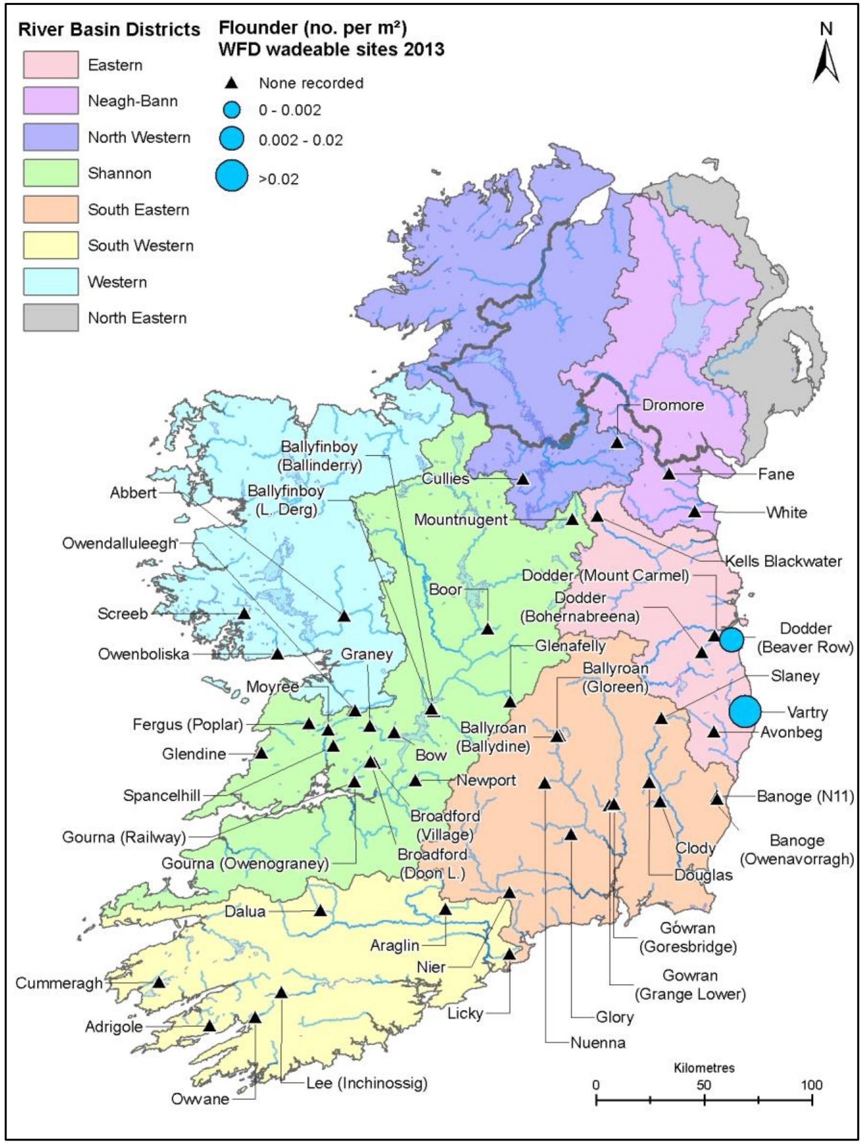

Fig. 4.59. Distribution and abundance of flounder at wadeable river sites surveyed for WFD fish monitoring 2013

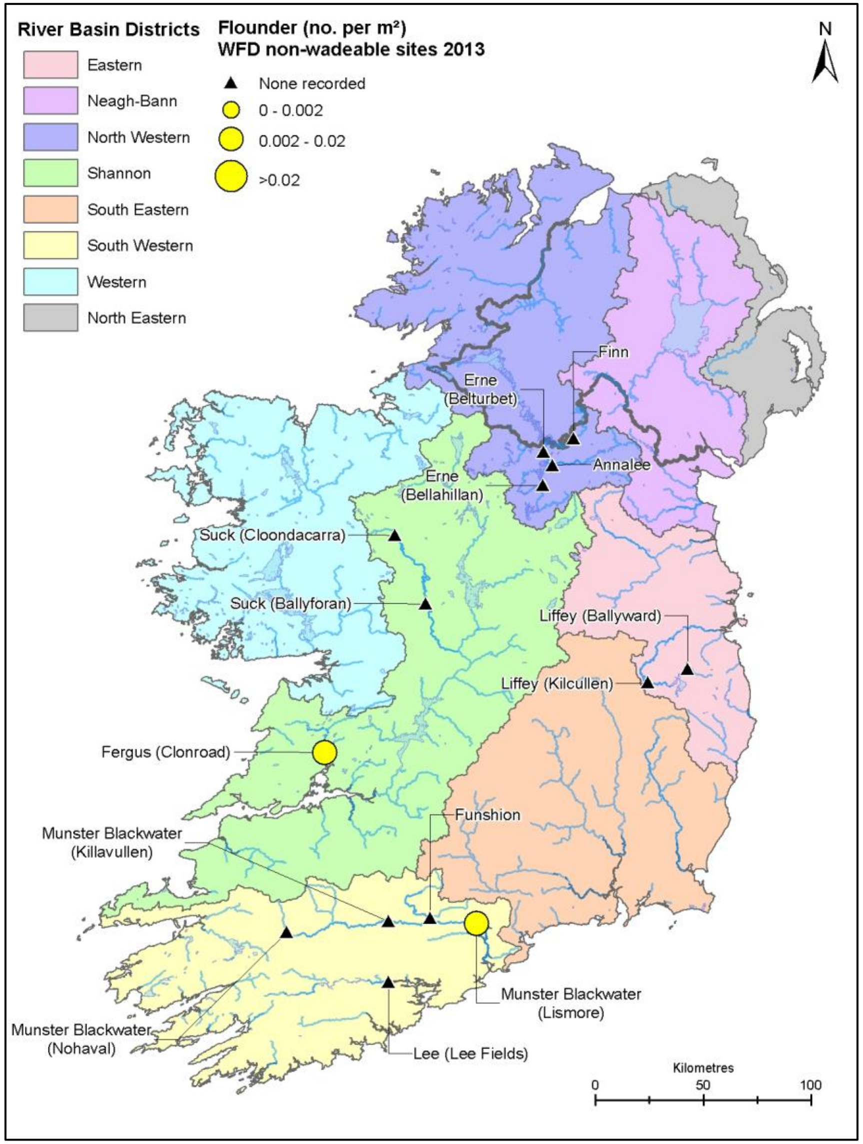

Fig. 4.60. Distribution and abundance of flounder at non-wadeable river sites surveyed for WFD fish monitoring 2013

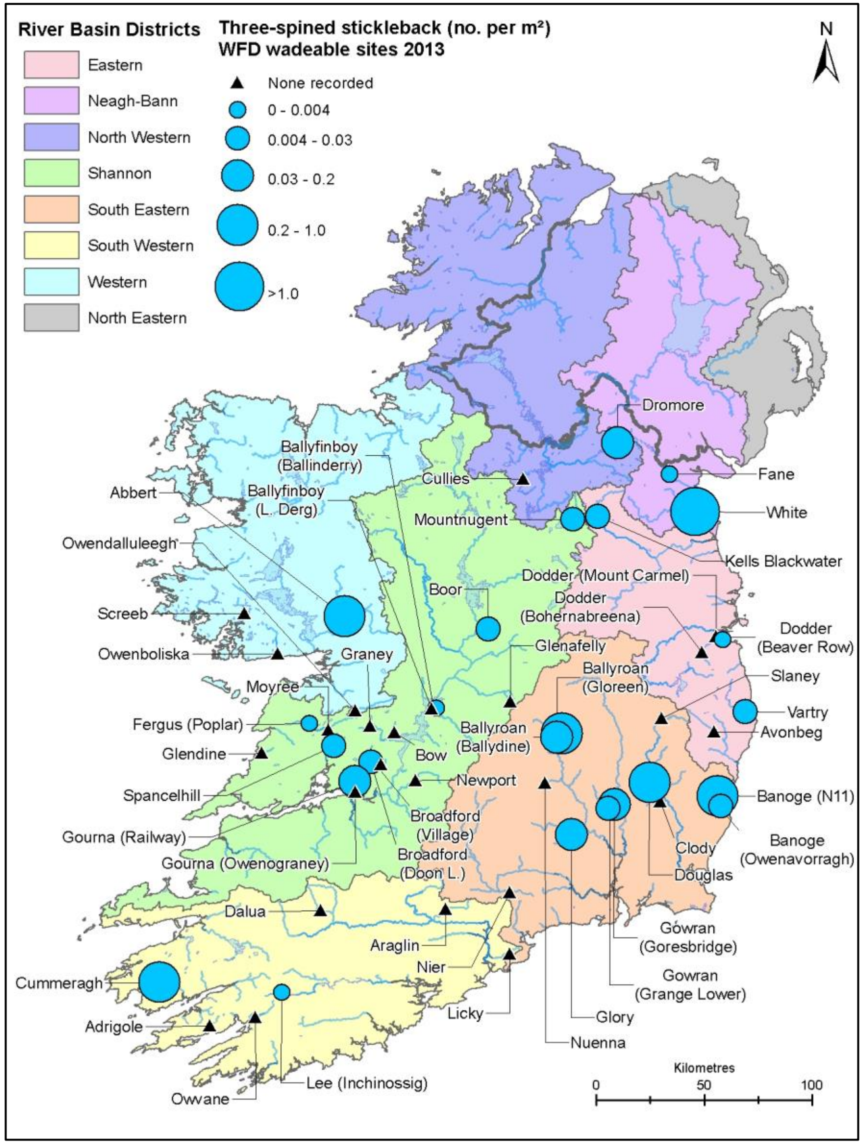

Fig. 4.61. Distribution and abundance of three-spined stickleback at wadeable river sites surveyed for WFD fish monitoring 2013

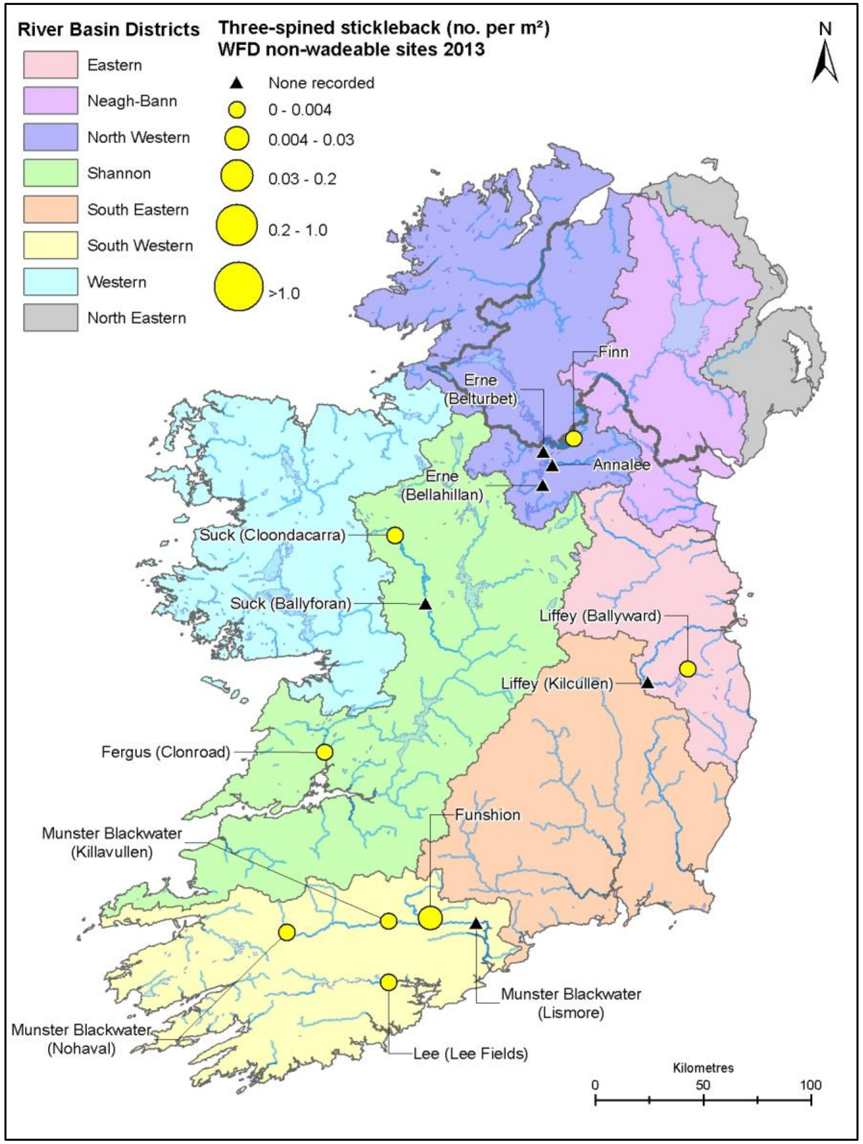

Fig. 4.62. Distribution and abundance of three-spined stickleback at non-wadeable river sites surveyed for WFD fish monitoring

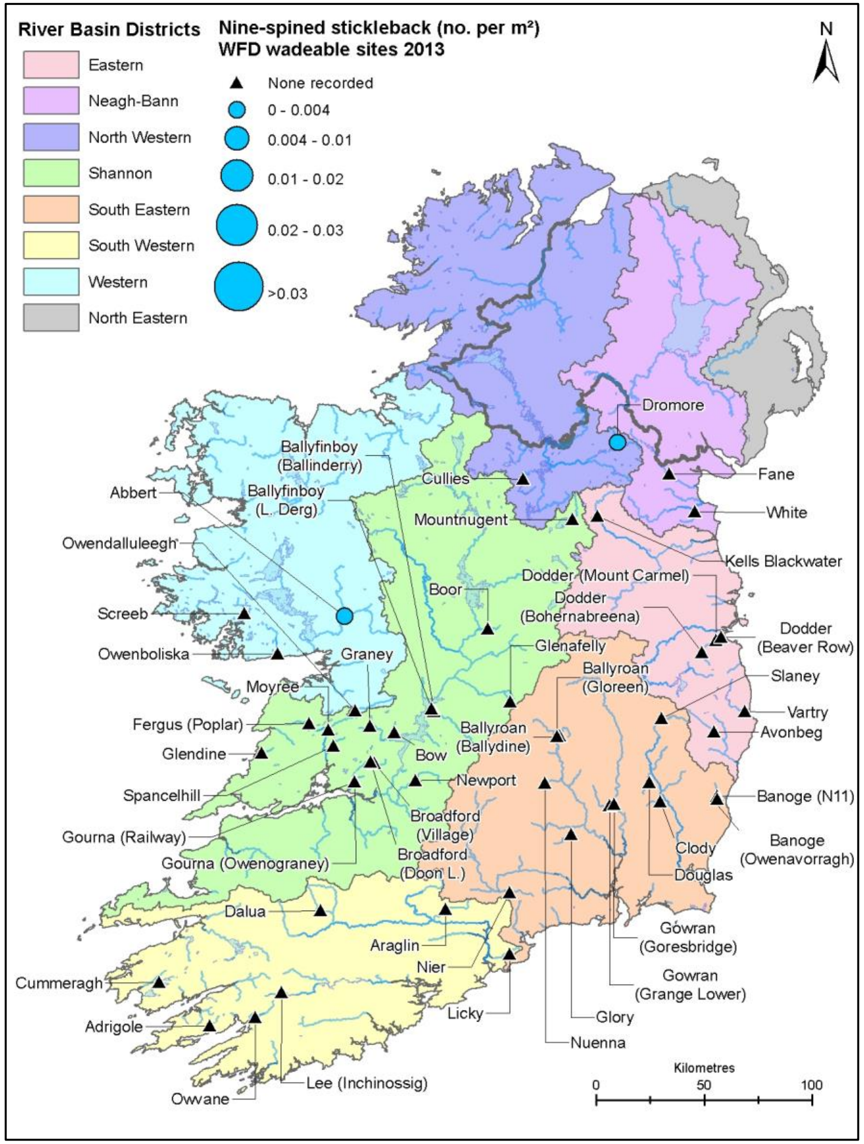

Fig. 4.63. Distribution and abundance of nine-spined stickleback at wadeable river sites surveyed for WFD fish monitoring 2013

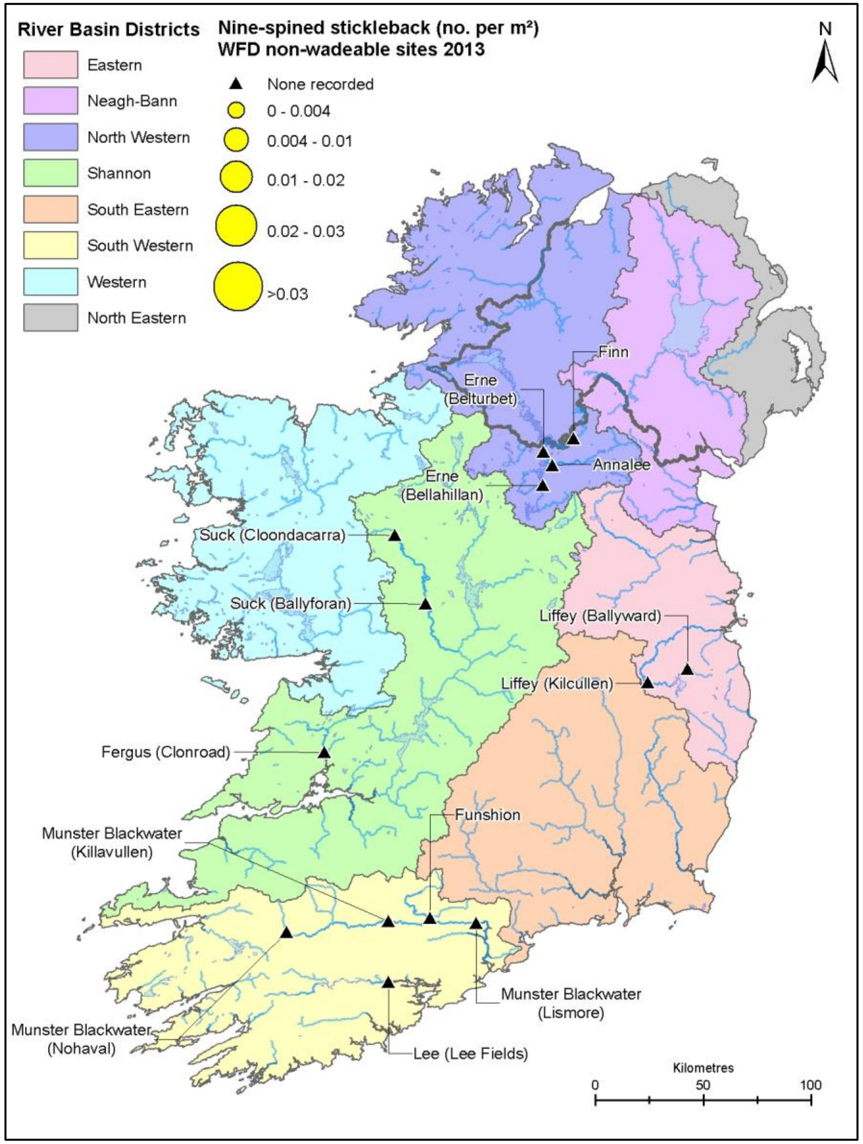

Fig. 4.64. Distribution and abundance of nine-spined stickleback at non-wadeable river sites surveyed for WFD fish monitoring 2013

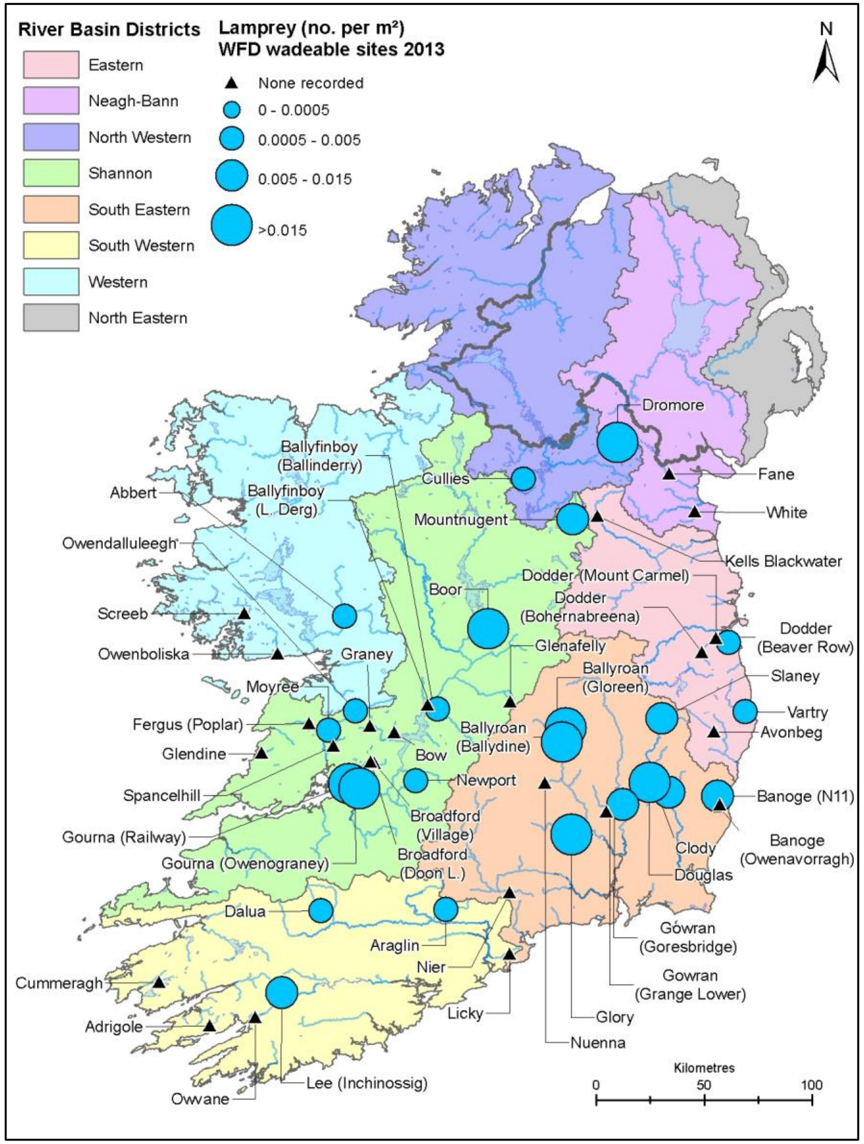

Fig. 4.65 Distribution and abundance of lamprey at wadeable river sites surveyed for WFD fish monitoring 2013

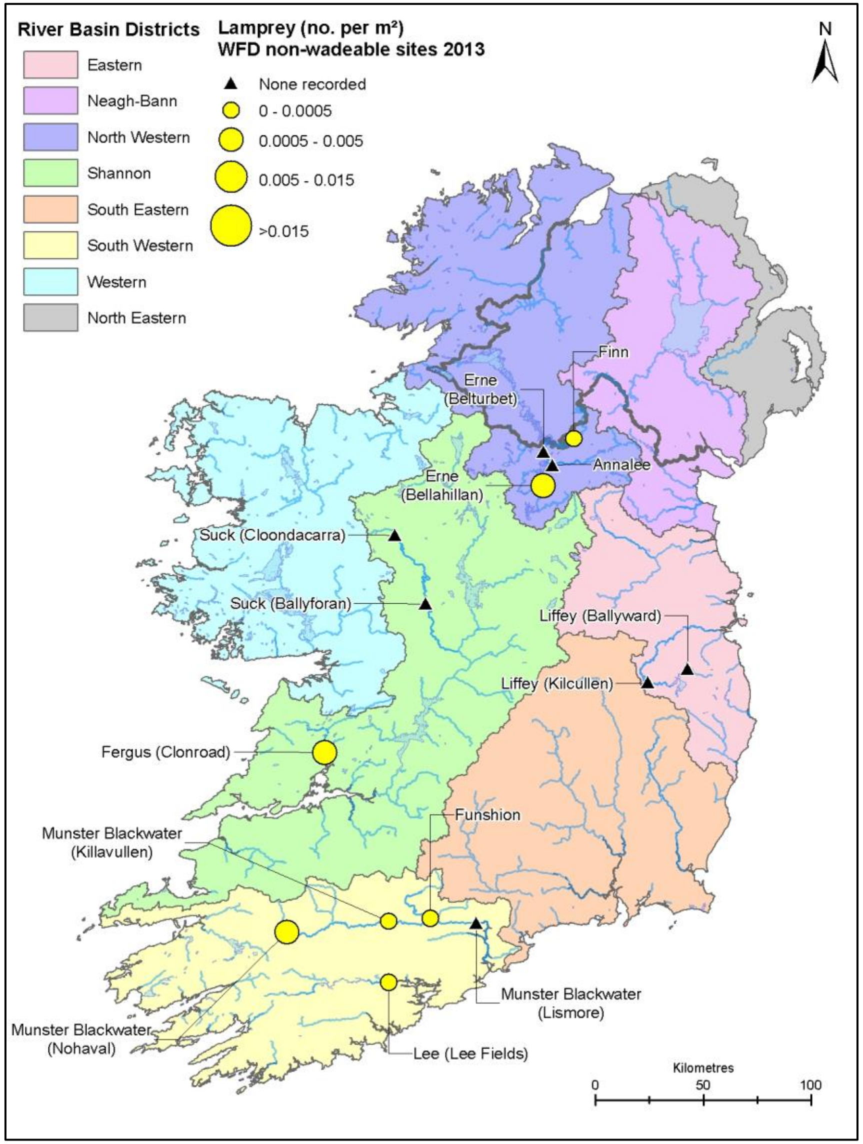

Fig. 4.66. Distribution and abundance of lamprey at non-wadeable river sites surveyed for WFD fish monitoring 2013

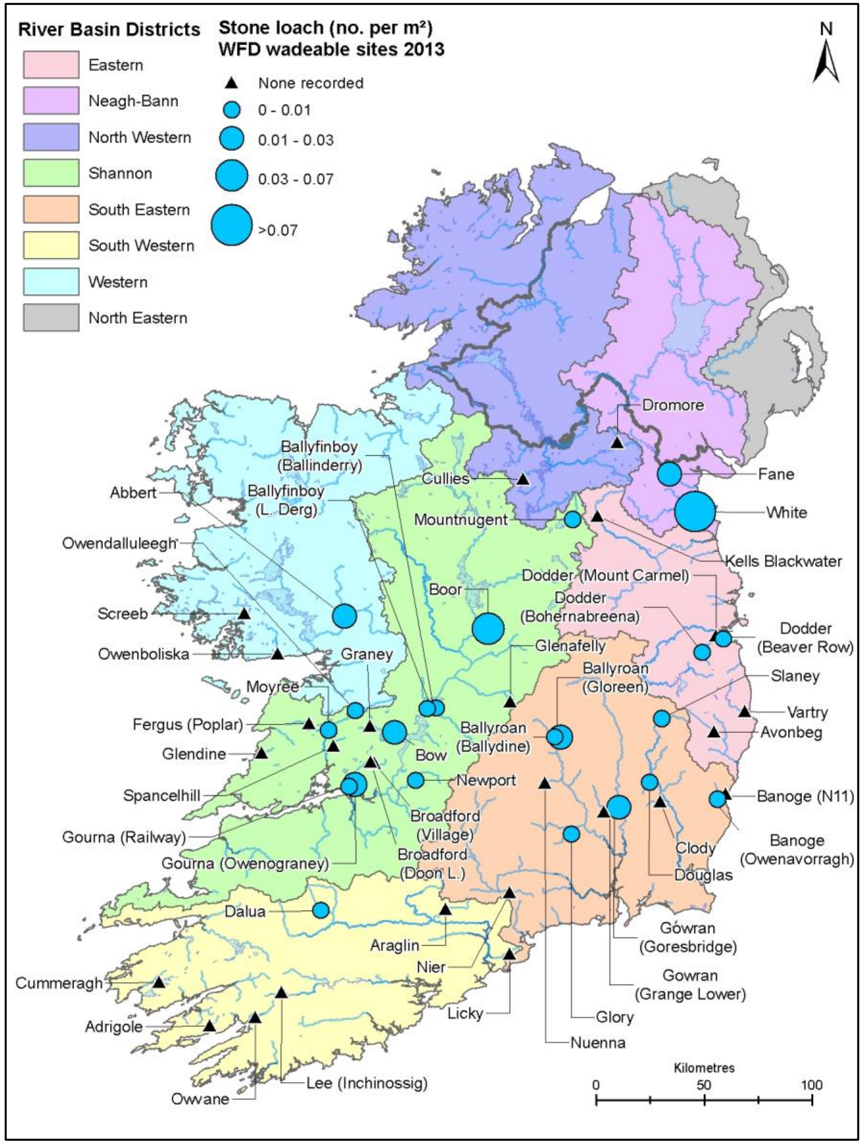

Fig. 4.67. Distribution and abundance of stone loach at wadeable river sites surveyed for WFD fish monitoring 2013

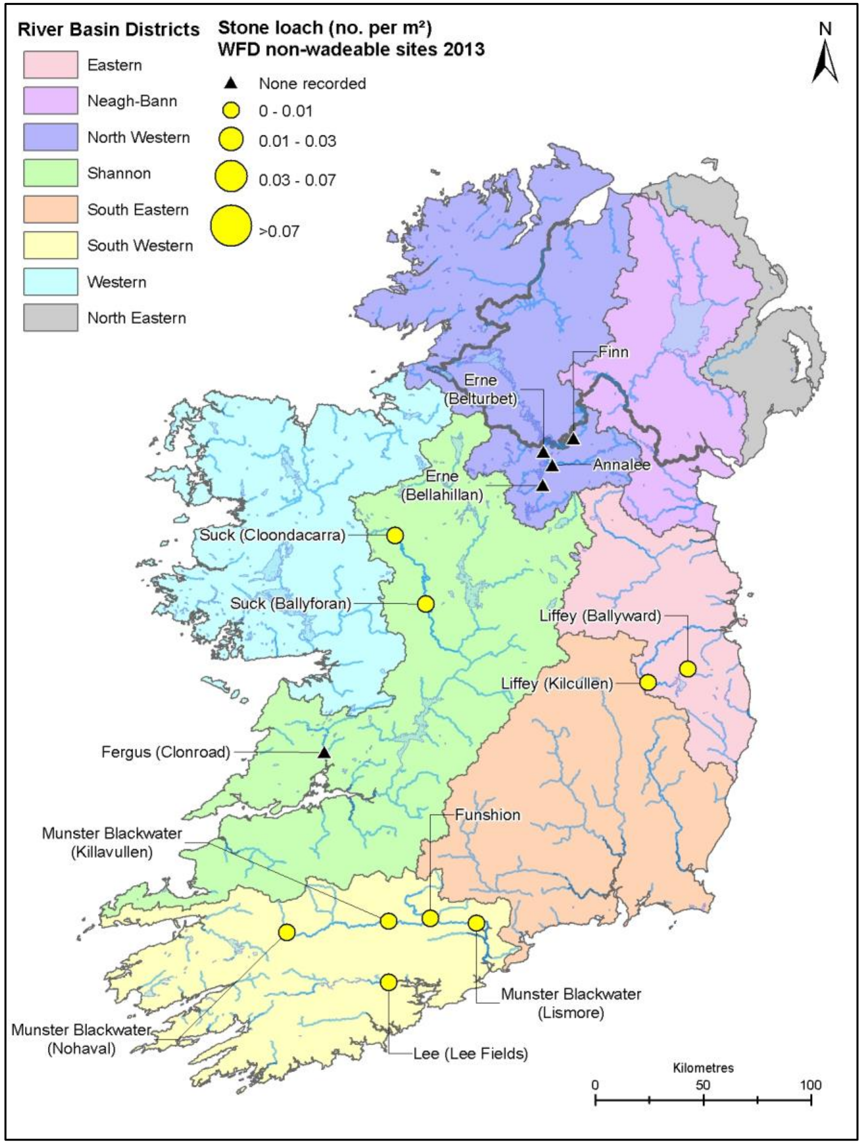

Fig. 4.68. Distribution and abundance of stone loach at non-wadeable river sites surveyed for WFD fish monitoring 2013

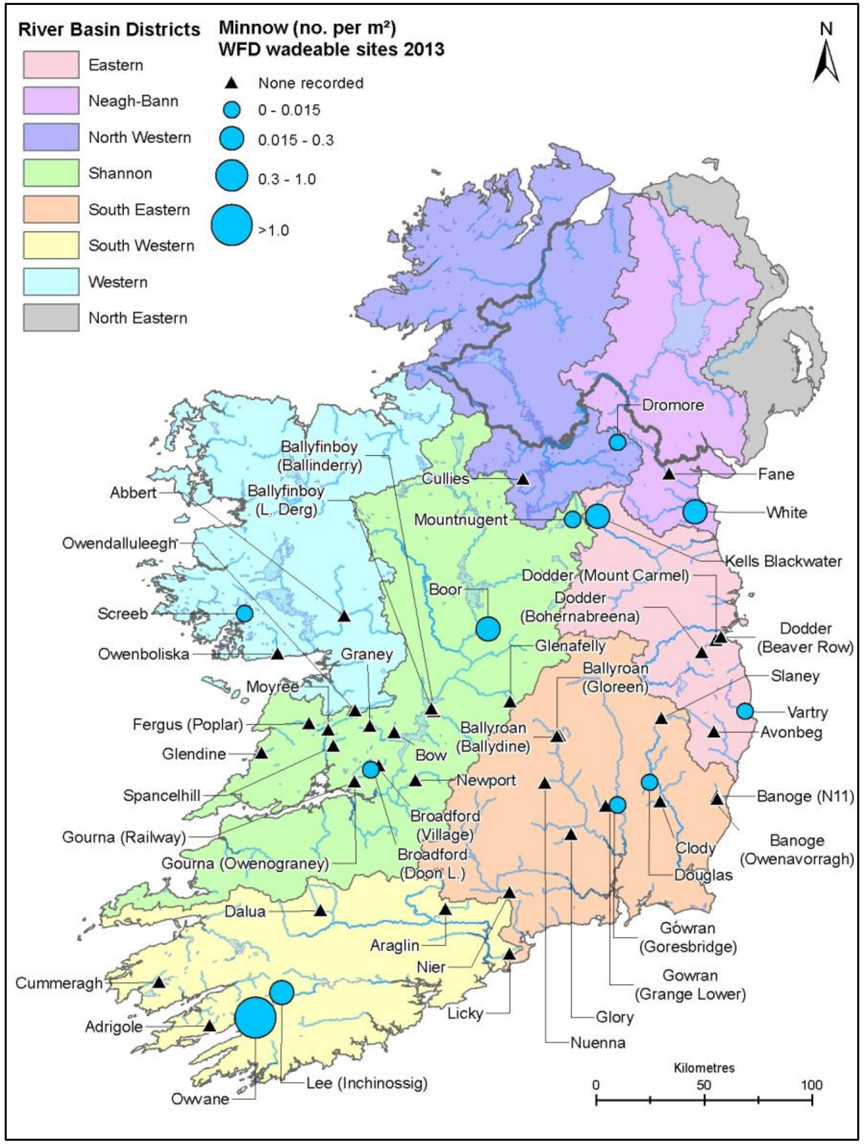

Fig. 4.69 Distribution and abundance of minnow at wadeable river sites surveyed for WFD fish monitoring 2013

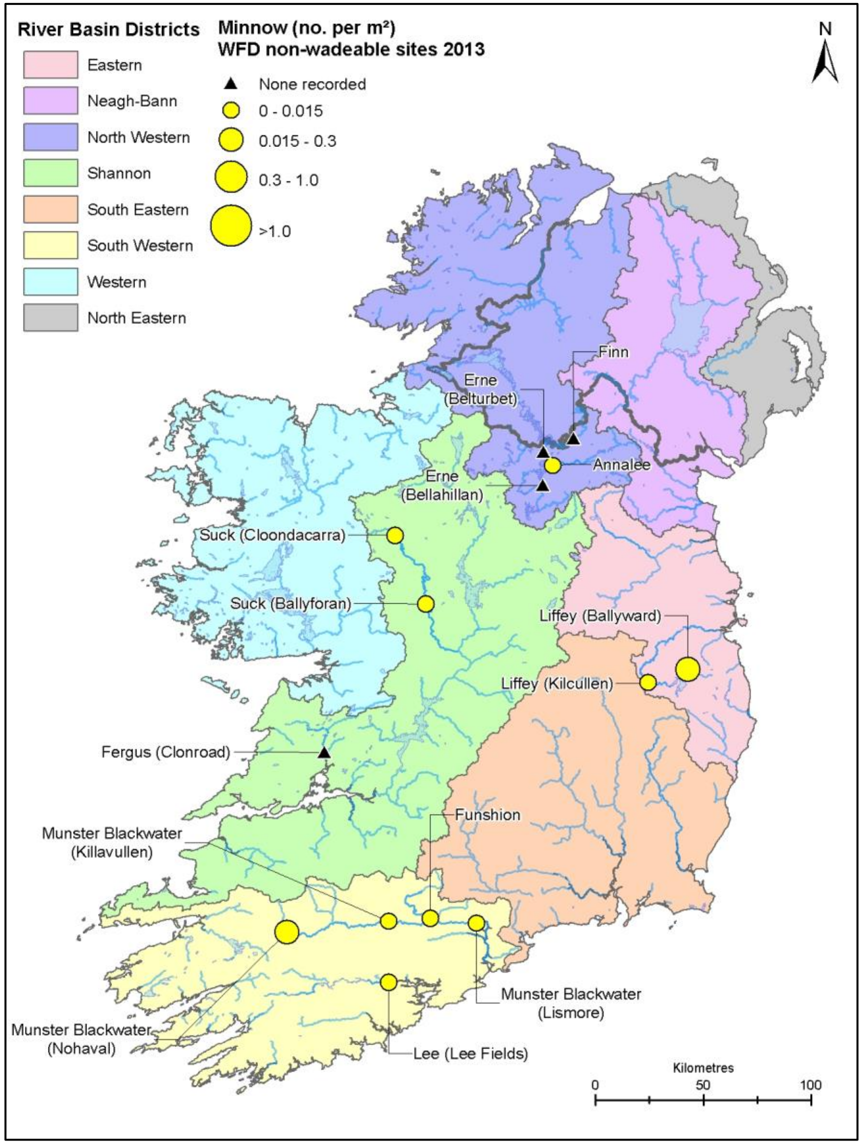

Fig. 4.70. Distribution and abundance of minnow at non-wadeable river sites surveyed for WFD fish monitoring 2013

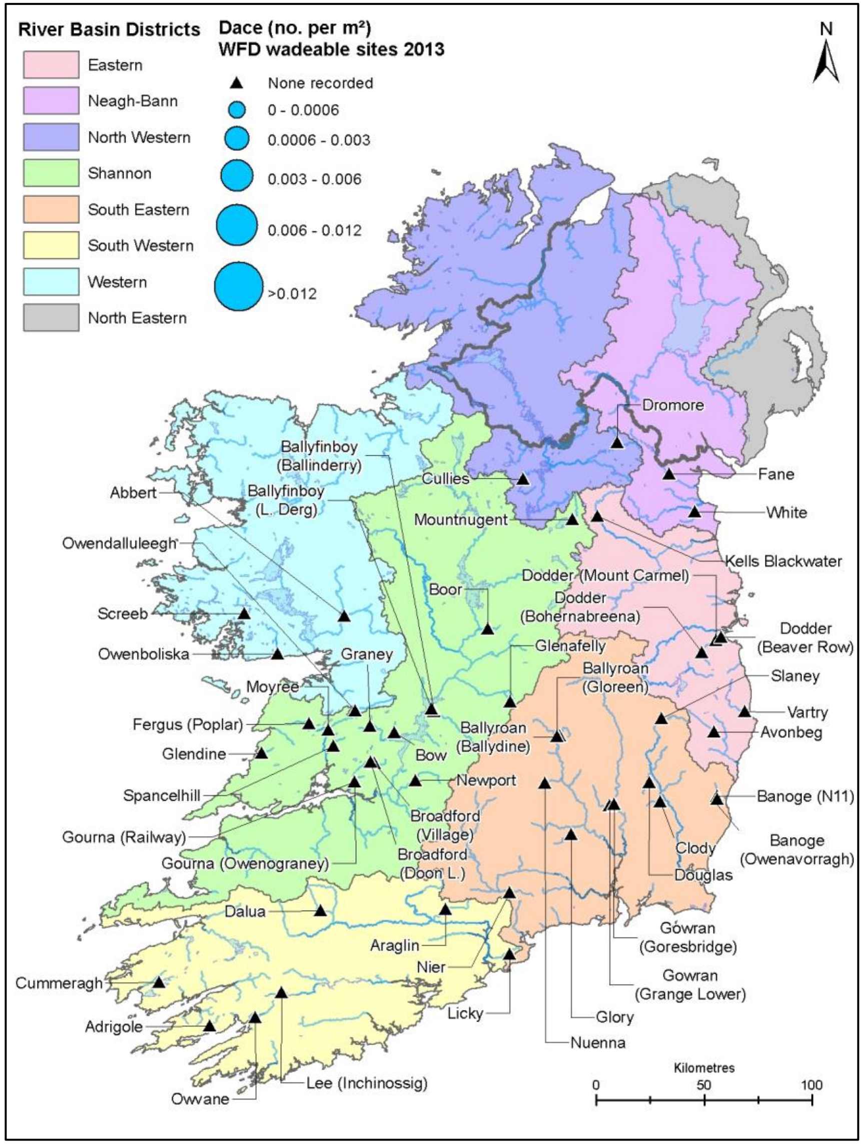

Fig. 4.71. Distribution and abundance of dace at wadeable river sites surveyed for WFD fish monitoring 2013

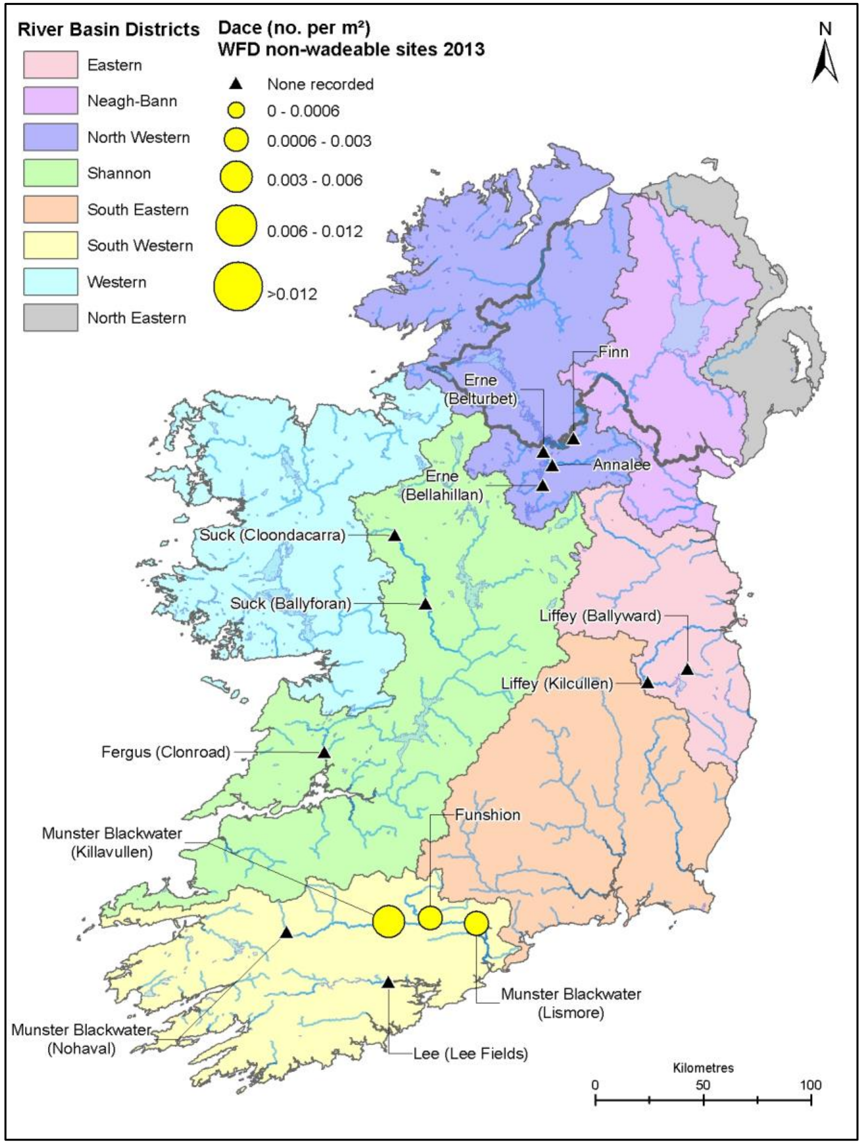

Fig. 4.72. Distribution and abundance of dace at non-wadeable river sites surveyed for WFD fish monitoring 2013

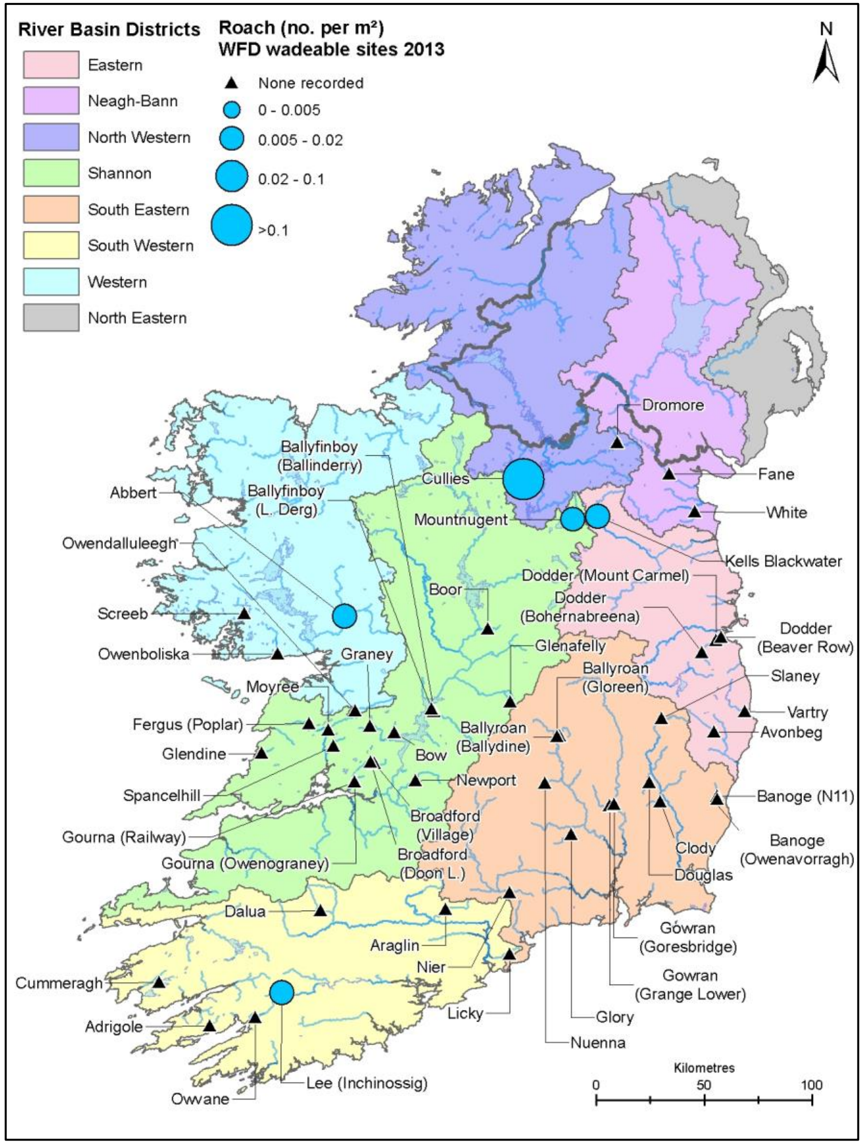

Fig. 4.73. Distribution and abundance of roach at wadeable river sites surveyed for WFD fish monitoring 2013

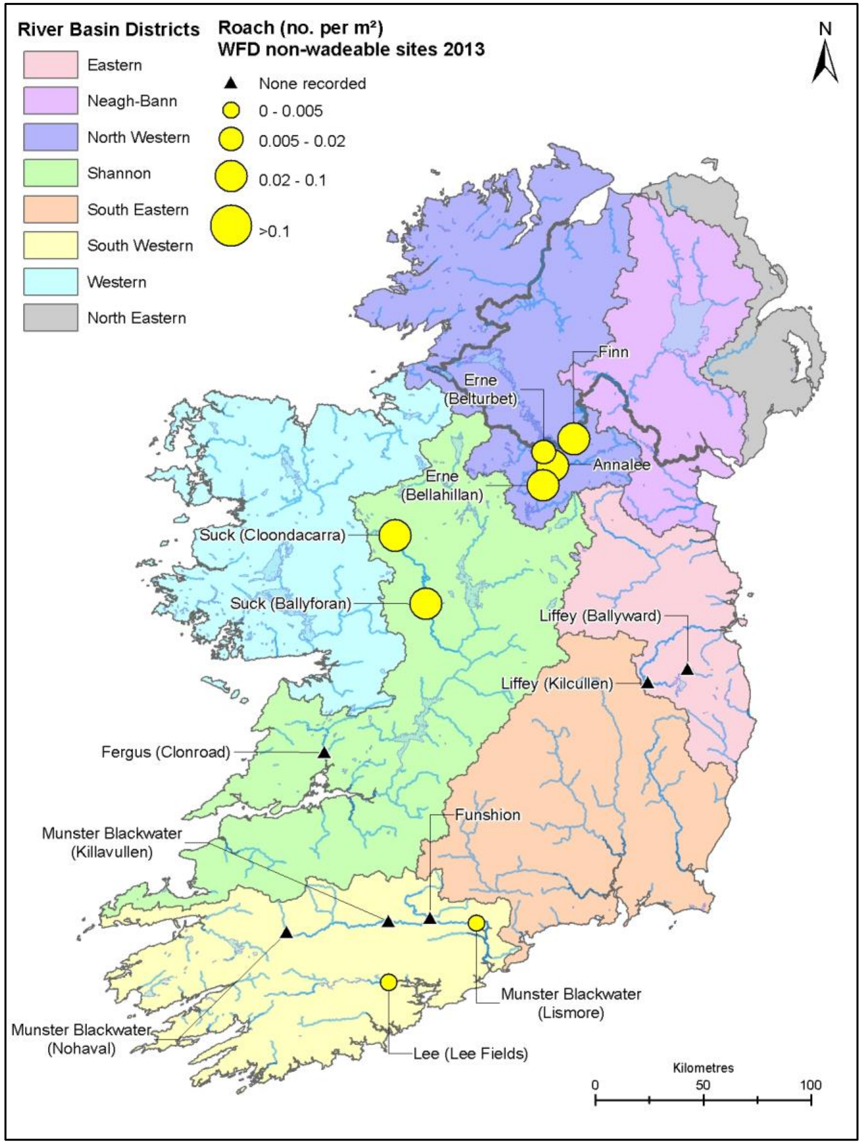

Fig. 4.74. Distribution and abundance of roach at non-wadeable river sites surveyed for WFD fish monitoring 2013

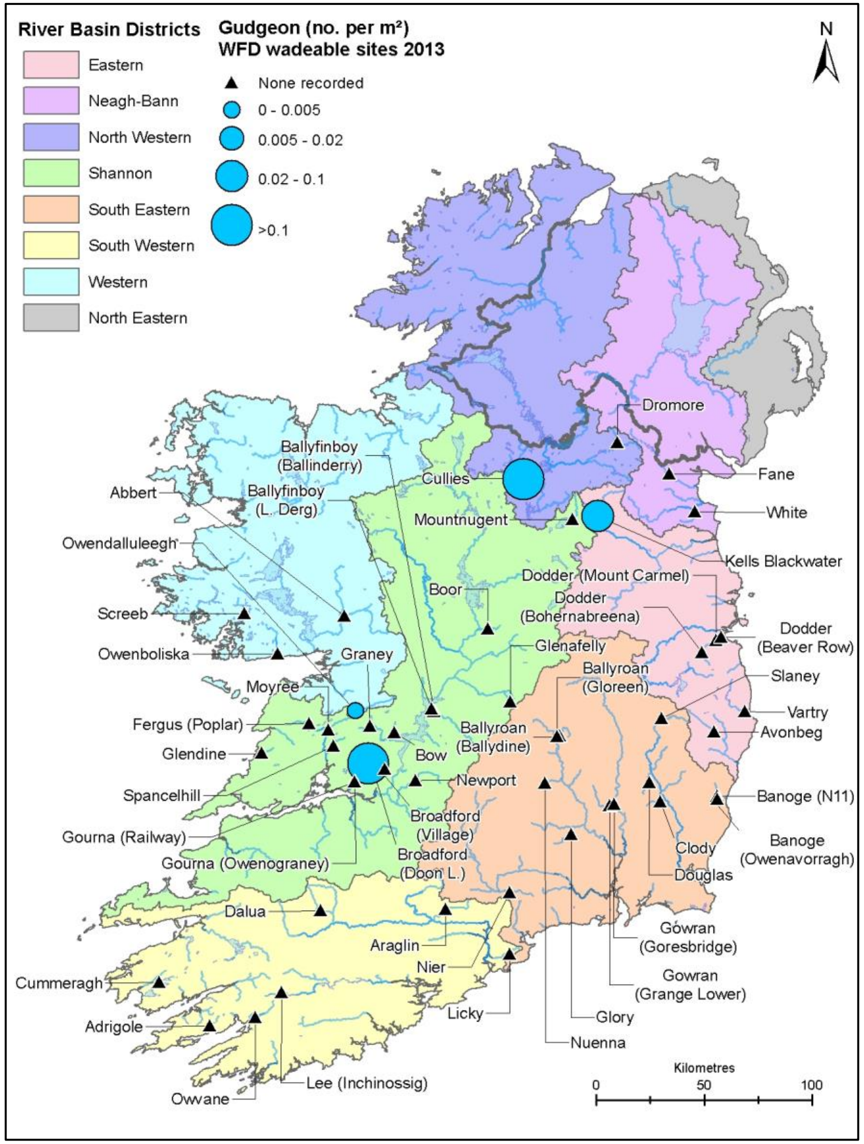

Fig. 4.75. Distribution and abundance of gudgeon at wadeable river sites surveyed for WFD fish monitoring 2013

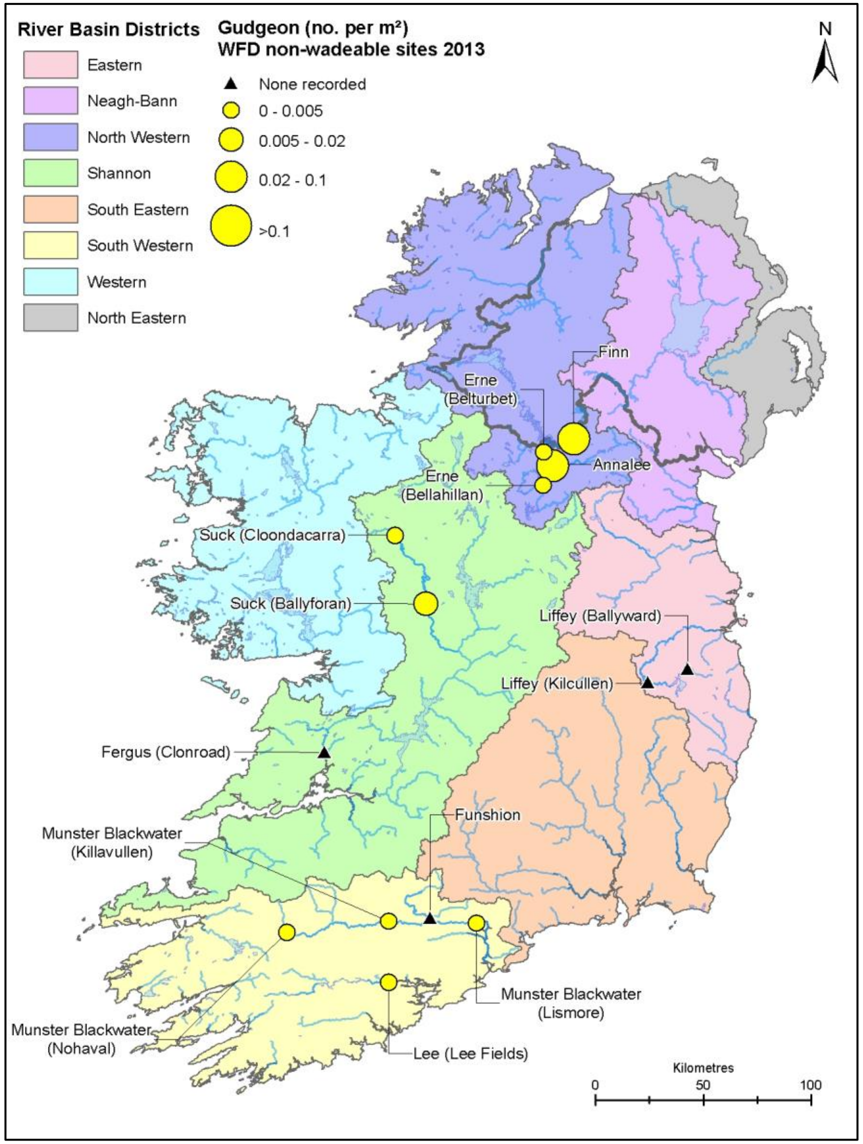

Fig. 4.76. Distribution and abundance of gudgeon at non-wadeable river sites surveyed for WFD fish monitoring 2013

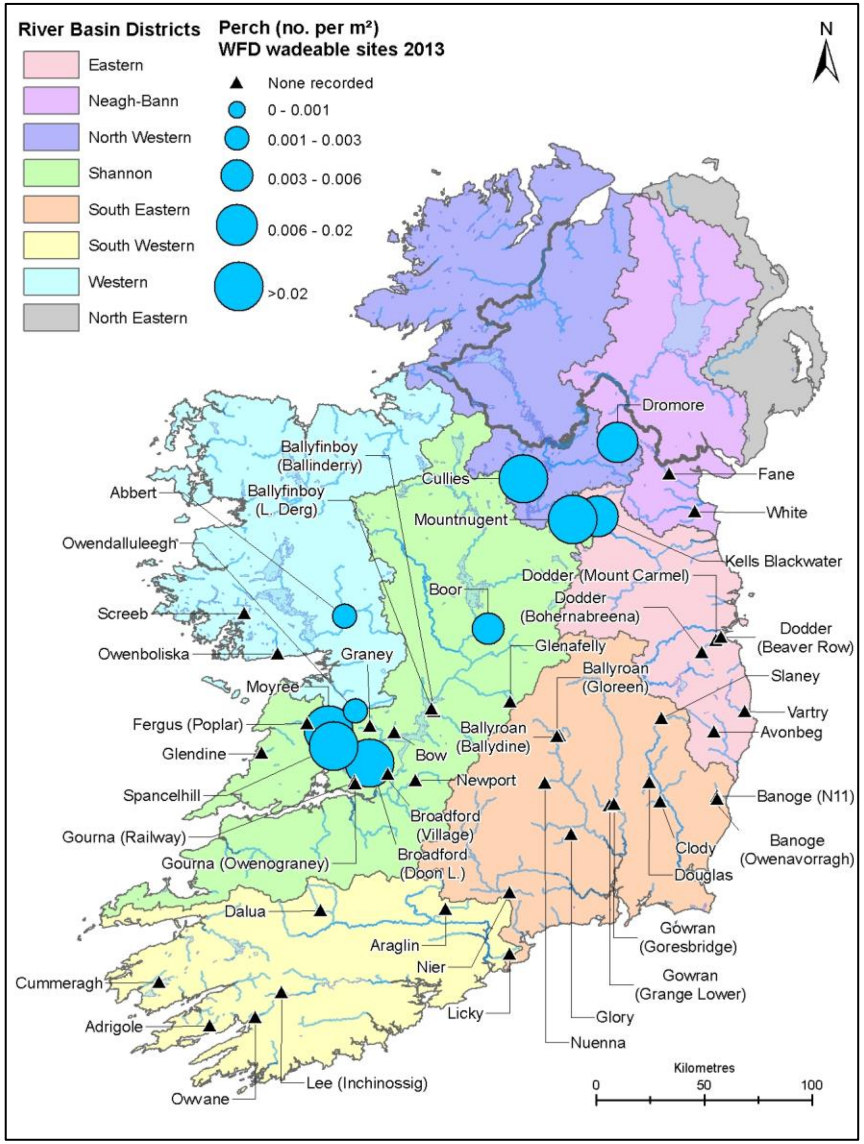

Fig. 4.77. Distribution and abundance of perch at wadeable river sites surveyed for WFD fish monitoring 2013

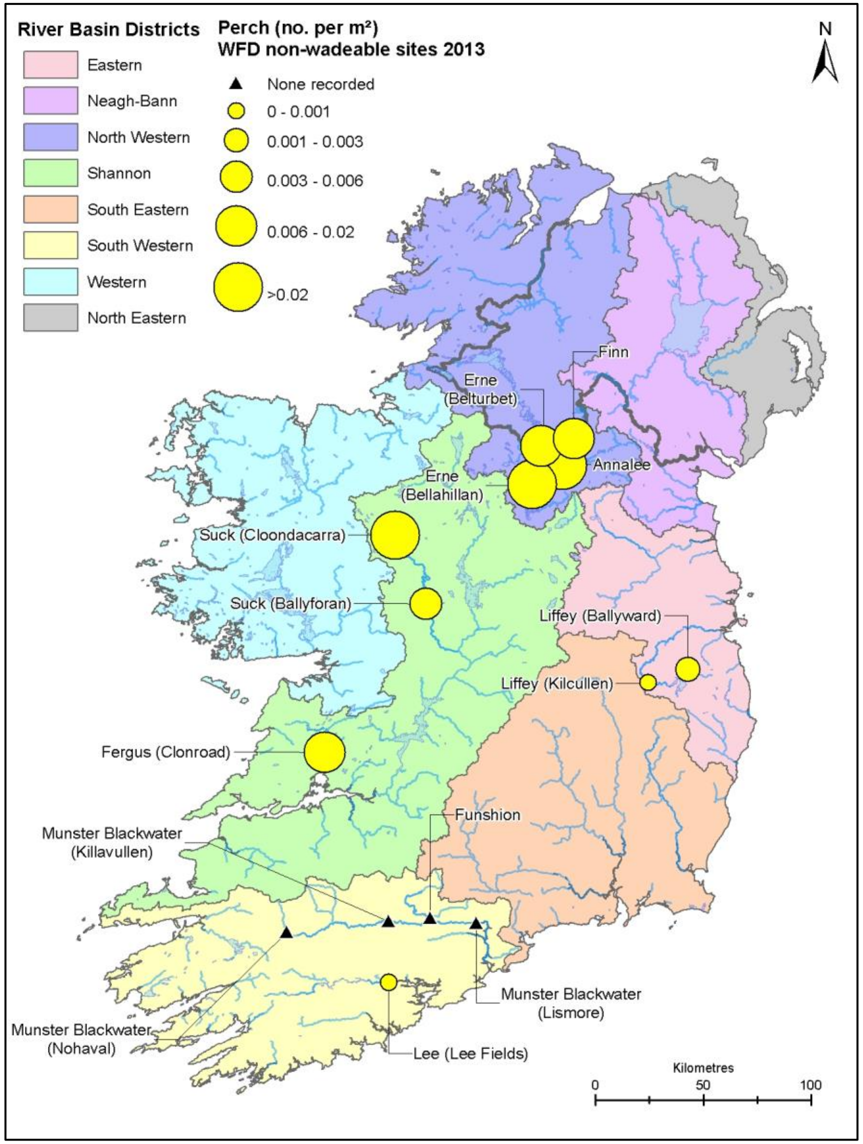

Fig. 4.78. Distribution and abundance of perch at non-wadeable river sites surveyed for WFD fish monitoring 2013

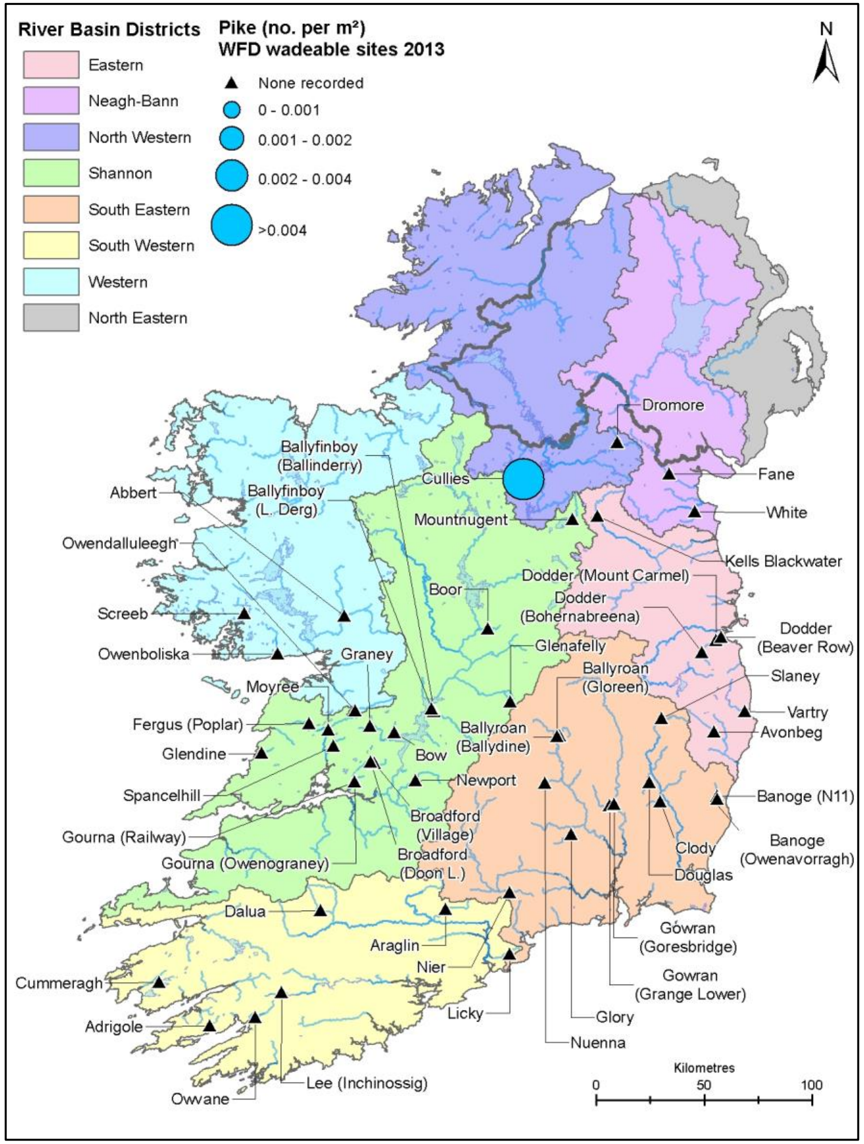

Fig. 4.79. Distribution and abundance of pike at wadeable river sites surveyed for WFD fish monitoring 2013

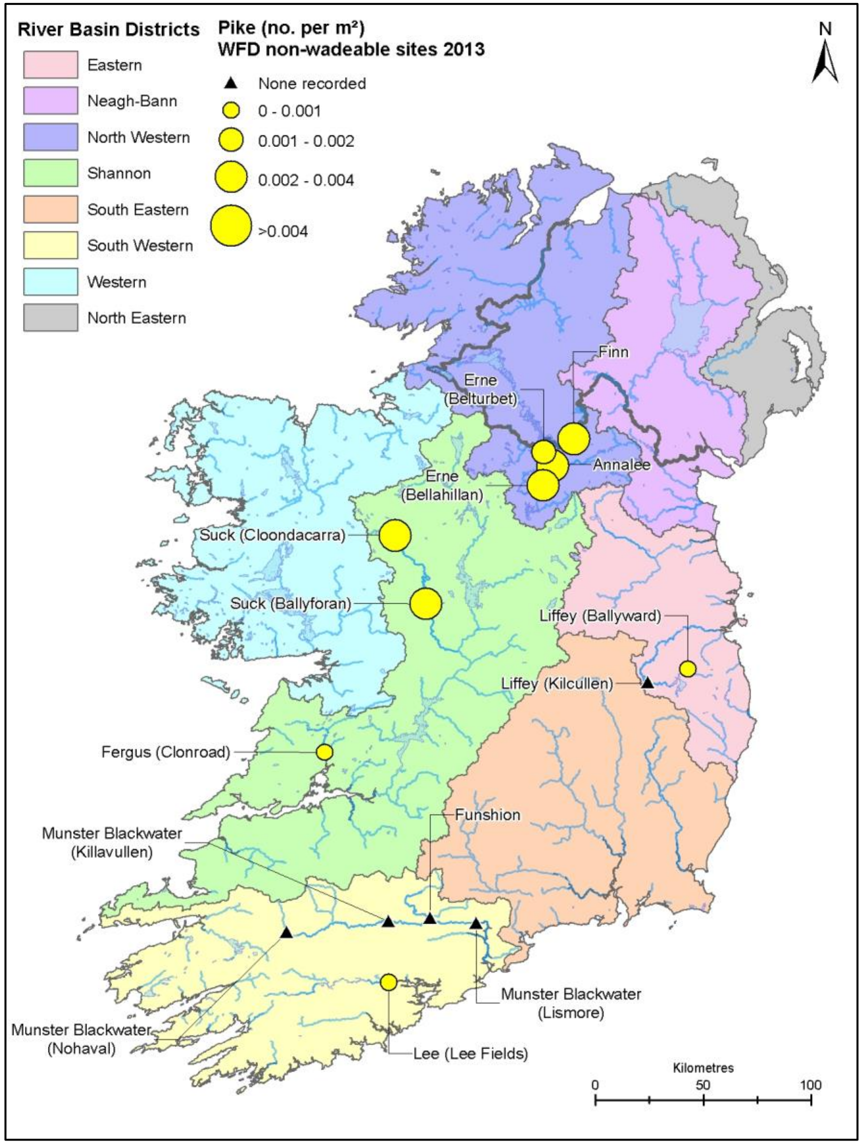

Fig. 4.80. Distribution and abundance of pike at non-wadeable river sites surveyed for WFD fish monitoring 2013

4.2.3 Fish growth in rivers

Scales from a total of 1,428 brown trout, 660 salmon, 450 roach, 114 pike, 24 dace, four sea trout, three bream and one roach x bream hybrid were examined for age and growth analysis. Where large numbers of any species were captured at a site, scales were analysed from a sub-sample of five fish within each 1cm size class.

Brown trout ages ranged from 0+ to 5+. Of the brown trout scales that were examined, 41.5% were fry (0+), 38% were aged 1+ and 16% were aged 2+. Older brown trout were relatively rare and accounted for only 3.5% of those examined. As might be expected, larger brown trout were more commonly recorded in the wider and deeper sites. The largest brown trout recorded during the survey was captured in the Dromore River (NWIRBD), measured 33.3cm, weighed 457g and was aged 3+. Appendix 7 provides a summary of the mean back-calculated lengths at age of brown trout in the sites surveyed.

A total of six sea trout were recorded in 2013 but only five were aged using scales. Three individuals were aged as two-year old smolts that returned to freshwater after only a few months at sea (2.0+, total age 2+); this type of fish is also known as a “finnock”. The remaining three individuals were identified as one sea-winter maidens: one of these fish was aged as a two-year smolt that spent one full year at sea before returning to freshwater (2.1+, total age 3+); the other two fish were aged as two-year smolts that had spent one year at sea but that also displayed some estuarine growth (2B.1+, total age 3+).

Salmon ages ranged from 0+ to 2+. Fry (0+) accounted for 55.5% of the salmon for which scales were examined, 41.5% were 1+ and those aged 2+ accounted for only 3%. The capture of adult salmon was avoided during these surveys. The largest juvenile salmon recorded measured 17.8cm in length and was captured in the Newport River. Appendix 8 shows a summary of the mean back-calculated length at age data for salmon in the sites surveyed.

Roach ranged in age from 0+ to 11+ (Appendix 9), with the largest roach, recorded in the Finn River, measuring 25.3cm in length, weighing 254g and aged 11+. The largest pike recorded was in the Fergus River at Clonroad Br. and measured 93.5cm and aged 4+ (Appendix 10).

4.2.3.1 Growth of brown trout

For each river site where sufficient brown trout numbers were captured (37 sites), the back-calculated mean lengths of brown trout at L2, L3 and L4 were compared to the back-calculated mean lengths described by Kennedy and Fitzmaurice (1971), and assigned descriptive growth categories (Table 4.7 and 4.8). A summary of the back calculated lengths for brown trout at applicable river sites surveyed during 2013 is shown in Appendix 7. Brown trout from 10 river sites were classed as very slow, 19 were classed as slow, five were classed as fast and one was classed as very fast (Table 4.8).

Table 4.7. Categories of growth of Irish stream and river brown trout (Kennedy and Fitzmaurice, 1971)

Growth category	Mean length (cm)			Alkalinity (mg $CaCO_3$ l^{-1})
	L2	L3	L4	
Very slow	12	15–16	17–18	10.0 – 20.0
Slow	13–14	18–19	20–21	25.0 – 100.1
Fast	18–20	24–25	29–30	25.0 – 140.1
Very fast	20	30	35–40	>150.1

Table 4.8. Categories of growth of brown trout in the WFD river sites 2013 using Kennedy and Fitzmaurice (1971)

Very slow	Slow	Fast	Very fast
Araglin (Elizabeth's Br.)	Ballyfinboy (Ballinderry Br.)	Ballyroan (Gloreen Br.)	Dromore (Drummuck)
Blackwater, River (Nohaval Br.)	Ballyfinboy (Lough Derg)	Erne (Belturbet Br.)	
Bow (Bow Br.)	Ballyroan (Ballydine Br.)	Finn (Cumber Br.)	
Clody (Ford near Bunclody)	Blackwater, River (Killavullen Br.)	Lee, River (Lee Fields)	
Dodder (Bohernabreena)	Blackwater, River (Lismore Br.)	Liffey (Kilcullen Br.)	
Lee, River (Inchinossig Br.)	Boor (Kilbillaghan Br.)		
Licky River (Glenlicky)	Broadford (Broadford Village)		
Owvane River (Pierson's Br.)	Fane (Inishkeen)		
Slaney (Waterloo Br.)	Fergus (Clonroad Br.)		
Vartry (Newrath Br.)	Funshion (Blackwater confl.)		
	Glory (Raheen)		
	Gowran (Grange Lower)		
	Liffey (Ballyward Br.)		
	Mountnugent (Mountnugent)		
	Newport (Rossaguile Br.)		
	Nier (Ballymacarbry)		
	Nuenna (Clonmantagh)		
	Owenboliska (Caravan Park)		
	Owendalluleegh (Killafeen Br.)		

River sites containing 1+ and older brown trout were divided into three categories based on their alkalinity; these were low = < 35 mg$CaCO_3$ l^{-1}, moderate = 35 - 100 mg$CaCO_3$ l^{-1}, and high > 100 mg$CaCO_3$ l^{-1}. Thirteen river sites were characterised as low alkalinity, 21 as moderate alkalinity and 24 as high alkalinity. The mean length at age data for each alkalinity category is shown in Fig. 4.81. Statistical analysis (Kruskal-Wallis tests) revealed that there was a significant difference in the mean L1 of brown trout among the three alkalinity groups ($H = 14.319$, $df = 2$, $p < 0.01$). Using Mann-Whitney tests, significant differences were identified for L1 between the low and moderate ($U = 50$, $p < 0.01$) and low and high alkalinity categories ($U = 42$, $p < 0.01$). There was also a significant difference in mean L2 among alkalinity groups ($H = 13.522$, $df = 2$, $p < 0.01$). Mann-Whitney tests showed significant differences between the low and moderate ($U = 46$, $p < 0.05$) and low and high ($U = 18$, $p < 0.01$) alkalinity categories. Finally, there was also a significant difference in mean L3 among alkalinity groups ($H = 10.354$, $df = 2$, $p < 0.01$). Mann-Whitney tests showed significant differences between the low and moderate ($U = 8$, $p < 0.01$) and low and high ($U = 9$, $p < 0.01$) alkalinity categories. Insufficient data was available to test L4 and L5 back calculated lengths.

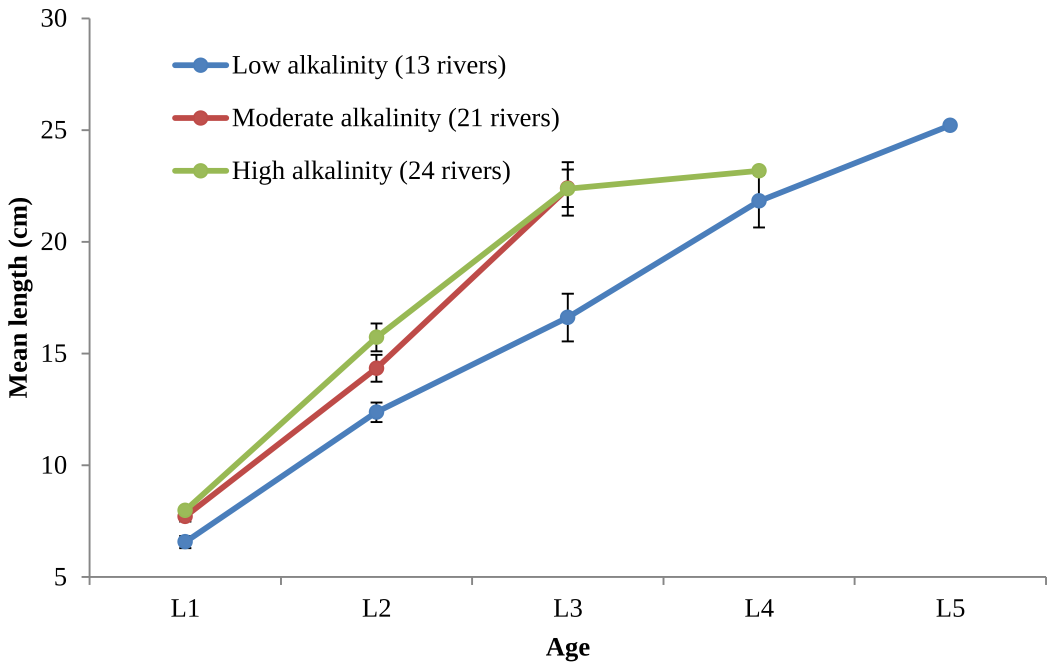

Fig. 4.81. Mean (±S.E.) back calculated lengths at age for brown trout in rivers within each alkalinity class

4.2.4 Ecological status – Classification of rivers using 'FCS2 Ireland'

An ecological classification tool for fish in rivers (FCS2 Ireland) has recently been developed for Ecoregion 17 (Republic of Ireland and Northern Ireland), along with a separate version for Scotland to comply with the requirements of the WFD (SNIFFER, 2011). Agencies throughout each of the three regions contributed data which was used in the model development. The tool works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) conditions using a geo-statistical model based on Bayesian probabilities. The resulting output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range, corresponding to the five ecological status classes of High, Good, Moderate, Poor and Bad. Confidence levels are assigned to each class and represented as probabilities. This tool has successfully completed the recent EU wide intercalibration exercise in order to standardise results across Europe. FCS2 Ireland has been used, along with expert opinion, to classify the 63 river sites surveyed during 2013. Expert opinion is essential to this process as it considers other factors not built into the tool, such as the occurrence of fish kills and the presence of invasive species. Five river sites were classified as High (7.9%), 27 as Good (42.9%), 28 as Moderate (44.4%), and three as Poor (4.8%) (Table 4.9, Fig. 4.82). When compared to previous status, three sites improved (Liffey (Kilcullen Br.), Clody and Fergus (Clonroad Br.)), five rivers deteriorated (Dodder (Beaver Row), Dodder (Bohernabreena), Lee (Inchinossig Br.), Nier and White (Coneyburrow Br.), while the remaining 55 sites remained unchanged.

Table 4.9. Ecological status of river sites surveyed for fish in 2013 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site name	Site Code	Previous ecological status	Ecological status 2013
ERBD Wadeable sites				
Avonbeg	Greenan Br._A	10A040600A	Good (2010)	Good
Blackwater (Kells)	Lough Ramor_A	07B010800A	Mod (2009)	Moderate (59%)
Dodder	Bohernabreena_A	09D010100A	Good (96%)(2011)	Moderate
Dodder	Beaver Row_B	09D010900B	High (70%)(2011)	Good (97%)
Dodder	Mount Carmel_A	09D010680A	Mod (88%)(2011)	Moderate
Vartry	Newrath Br._A	10V010300A	Good (2008)	Good (79%)
ERBD Non-Wadeable sites				
Liffey	Ballyward Br._A	09L010250A	Good (2009), Good (2012)	Good
Liffey	Kilcullen Br._A	09L010700A	Good (69%)(2008)	High (55%)
NBIRBD Wadeable sites				
Fane	Inniskeen_A	06F010650A	Good (2010)	Good
White (Louth)	Coneyburrow Br._B	06W010500B	Mod (77%)(2012)	Poor (100%)
NWIRBD Wadeable sites				
Cullies	Kilbrackan Br._A	36C030600A	Poor (93%)(2010)	Poor
Dromore	Drummuck_A	36D020125A	Poor (2011)	Poor (100%)
NWIRBD Non-Wadeable sites				
Annalee	Cavan confl_A	36A021400A	Mod (69%)(2008)	Moderate
Erne	Bellahillan Br._A	36E011100A	Mod (2009)	Moderate
Erne	Belturbet Br,_A	36E011400A	Mod (92%)(2008)	Moderate (99%)
Finn (Monaghan)	Cumber Br._A	36F010500A	Mod (77%)(2009)	Moderate (98%)
SERBD Wadeable sites				
Ballyroan	Ballydine Br._A	15B010150A	-	Moderate (94%)
Ballyroan	Gloreen Br._D	15B010200D	-	Moderate (81%)
Banoge	M11 Bridge_A	11B020230A	-	Moderate
Banoge	Owenavorragh confl_A	11B020300A	Mod (97%)(2008), Mod (2011)	Moderate (91%)
Clody	Ford near Bunclody_B	12C030200B	Good (75%)(2008)	High (100%)
Douglas (Ballon)	Sragh Br._B	12D030200B	Mod (97%)(2008), Mod (2011)	Moderate (91%)
Glory	Raheen_A	15G010200A	Moderate (2008)	Good (58%)
Gowran	Goresbridge_A	14G030300A	Mod (2010)	Moderate
Gowran	Grange Lower_A	14G030240A	-	Moderate (97%)
Nier	Ballymacarby_A	16N010100A	High (81%)(2008)	Good (99%)
Nuenna	Clomantagh_B	15N020100B	Mod (74%)(2008), Good (67%)(2011)	Moderate (77%)
Slaney	Waterloo Br._A	12S020400A	Good (2009), High (100%)(2010)	Good (63%)

Note: Ecological status is subject to change upon review

Table 4.9 ctn. Ecological status of river sites surveyed for fish in 2013 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site name	Site Code	Previous ecological status	Ecological status 2013
ShIRBD Wadeable sites				
Ballyfinboy	Ballinderry Br._A	25B020750A	Mod (2012)	Moderate
Ballyfinboy	Lough Derg_A	25B020800A	Mod (2009)	Moderate
Boor	Kilbillaghan Br._B	26B071100B	Good (75%)(2008), Good (82%)(2011)	Good
Bow	Bow Br._A	25B100100A	Good (82%)(2008), Mod (75%)(2011)	Moderate (99%)
Broadford	Doon Lough_A	27B020800A	Good (2009)	Good
Broadford	Broadford (Village)_A	27B020700A	-	Good
Fergus	Poplar Br._B	27F010100B	-	Good (89%)
Glenafelly	Glenafelly_A	25G210010A	Good (2008)	Good
Glendine	Knockloskeraun Br._A	28G020200A	Good (81%)(2009)	Good (84%)
Gourna	Railway Br._A	27G020600A	High (100%)(2011)	High (95%)
Gourna	Owenogarney confl_C	27G020550C	High (100%)(2011)	High (100%)
Graney	Caher Br._A	25G040025A	Good (2008), Good (2011)	Good
Mountnugent	Mountnugent Br._A	26M020500A	Good (2008), Good (72%)(2011)	Good
Moyree	Fergus Br._A	27M020700A	Mod (99%)(2009)	Moderate
Newport	Rossaguile Br._A	25N020150A	-	Good (90%)
Spancelhill	Spancelhill_A	27S030200A	Mod (2002)	Moderate (94%)
ShIRBD Non-Wadeable sites				
Fergus	Clonroad Br._A	27F010700A	Mod (99%)(2008)	Good (75%)
Suck	Ballyforan Br._A	26S071100A	Mod (2008)	Moderate (87%)
Suck	Cloondacarra Br._A	26S070300A	Mod (2008)	Moderate
SWRBD Wadeable sites				
Adrigole	Glashduff confl._A	21A010150A	Good (73%)(2012)	Good (97%)
Araglin	Elizabeth's Br._A	18A030200A	-	Good (100%)
Cummeragh	Owengarriff confl_A	21C040400A	High (100%)(2010)	High (100%)
Dalua	Liscongill_A	18D010200A	Good (100%)(2010)	Good (97%)
Lee (Cork)	Inchinossig Br._A	19L030100A	Good (2008)	Moderate
Licky	Glenlicky_A	18L010100A	Mod (88%)(2010)	Moderate (100%)
Owvane (Cork)	Piersons Br._A	21O070400A	-	Good (72%)
SWRBD Non-Wadeable sites				
Blackwater	Killavullen Br._A	18B021900A	Mod (92%)(2009)	Moderate
Blackwater	Lismore Br._A	18B022600A	Mod (94%)(2010)	Moderate (57%)
Blackwater	Nohaval Br._A	18B020200A	Good (2009), Good (2010)	Good
Funshion	Blackwater confl_A	18F051100A	Good (2010)	Good (98%)
Lee (Cork)	Lee Fields_A	19L030800A	Mod (73%)(2010)	Moderate
WRBD Wadeable sites				
Abbert	Bullaun Br._A	30A010500A	Good (92%)(2010)	Good
Owenboliska	Caravan Park_A	31O010180A	-	Good (78%)
Owendalluleegh	Killafeen Br._A	29O011000A	Mod (97%)(2009)	Moderate (92%)
Screeb	Lough Aughawoolia_A	31S010400A	-	Good

Note: Ecological status is subject to change upon review

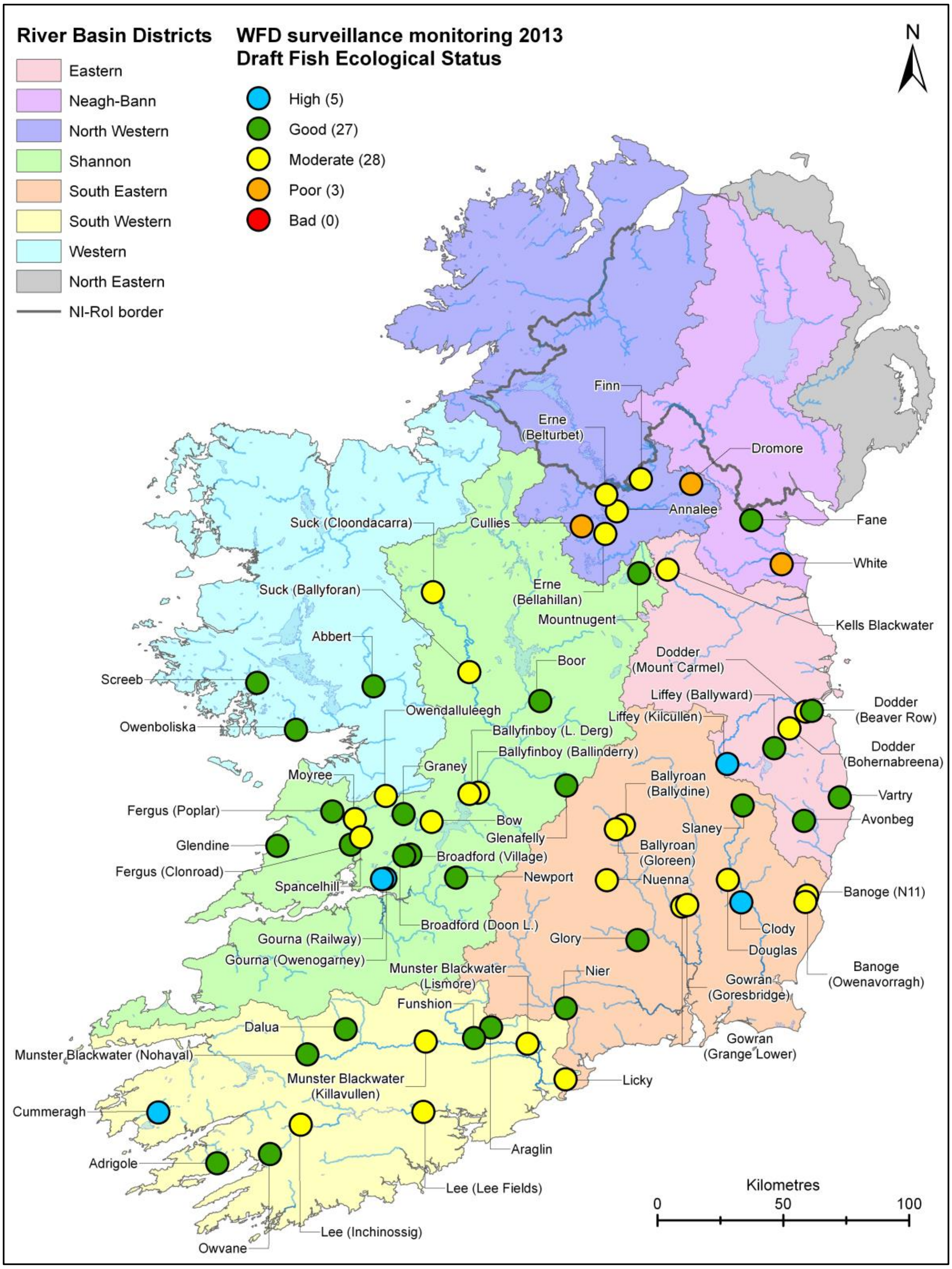

Fig. 4.82.Classification of river sites using the FCS2 Ireland classification tool

4.3 Transitional waters

4.3.1 Fish species composition and richness

The WFD requires that information be collected on the composition and abundance of fish species in transitional waters. These waters have been exploited by fish over a long evolutionary period, with many fish species availing of the highly productive nature of transitional waters for all or part of their life cycle. Fish species in transitional waters can be grouped into a number of different guilds depending on their life history (euryhaline, diadromous, estuarine, marine and freshwater). Some fish species are migratory, travelling through estuaries from the sea to reach spawning grounds in freshwater (e.g. salmon and lamprey), or migrating downstream through estuaries as adults to spawn at sea (e.g. eels).

Ten transitional waterbodies were surveyed during 2013; seven waterbodies within the Barrow-Suir-Nore system (SERBD) and two lagoon waterbodies in the SWRBD (Drongawn Lough and Gill Lough) (Table 4.10). The Barrow-Suir-Nore Estuary waterbody was the most diverse water body surveyed with a total of 22 species of fish present (Table 4.10). The Barrow-Suir-Nore Estuary waterbody is the closest water body to the sea within the system and, as such, was dominated by marine species. Within this system, the water bodies higher up towards the freshwater riverine section of each river tended to have less species, reflecting the poorer diversity of species present in freshwater. Lough Gill was the least diverse water body surveyed, which is a characteristic feature of many coastal lagoons, where freshwater species are limited by high salinity and marine species are limited by restricted connectivity to the sea.

Table 4.10. Species richness and most abundant species present in each transitional water body surveyed during 2013

Water body	Type	Species richness	Most abundant species
Barrow Suir Nore Estuary	Transitional	22	Plaice
Suir Estuary, Lower	Transitional	18	Sprat
Suir Estuary, Middle	Transitional	18	Flounder
New Ross Port	Transitional	17	Sand goby
Drongawn Lough	Lagoon	15	Sand smelt
Nore Estuary	Transitional	13	Sand goby
Barrow Estuary, Upper	Transitional	10	Dace
Suir Estuary, Upper	Freshwater tidal	9	Flounder
Barrow Nore Estuary, Upper	Transitional	7	Sand goby
Gill, Lough	Lagoon	7	Three-spined stickleback

Note: *sea trout are included as a separate "variety" of trout

A total of 39 fish species (sea trout are included as a separate "variety" of trout) were recorded in the ten transitional water bodies surveyed during 2013 (Table 4.11).

Table 4.11. Species present in ten transitional water bodies surveyed during 2013

	Scientific name	Common name	Number of transitional water bodies	% transitional water bodies
1	*Pomatoschistus minutus*	Sand goby	10	100
2	*Anguilla anguilla*	European eel	9	90
3	*Platichthys flesus*	Flounder	9	90
4	*Osmerus eperlanus*	Smelt	8	80
5	*Salmo trutta*	Brown trout	7	70
6	*Gasterosteus aculeatus*	Three-spined stickleback	7	70
7	*Leuciscus leuciscus*	Dace	6	60
8	*Sprattus sprattus*	Sprat	6	60
9	*Alosa fallax*	Twaite shad	6	60
10	*Pleuronectes platessa*	Plaice	5	50
11	*Chelon labrosus*	Thick-lipped grey mullet	5	50
12	*Dicentrarchus labrax*	European seabass	4	40
13	*Trisopterus minutus*	Poor cod	4	40
14	*Merlangius merlangus*	Whiting	4	40
15	*Trachurus trachurus*	Atlantic horse mackerel/Scad	3	30
16	*Gadus morhua*	Cod	3	30
17	*Syngnathus typhle*	Deep-snouted pipefish	3	30
18	*Ciliata mustela*	Five-bearded rockling	3	30
19	*Clupea harengus*	Herring	3	30
20	*Pollachius pollachius*	Pollack	3	30
21	*Rutilus rutilus*	Roach	3	30
22	*Salmo trutta*	Sea trout	3	30
23	*Gobius niger*	Black goby	2	20
24	*Hippoglossoides platessoides*	Long rough dab	2	20
25	*Syngnathus rostellatus*	Nilsson's pipefish	2	20
26	*Atherina presbyter*	Sand smelt	2	20
27	*Barbatula barbatula*	Stone loach	2	20
28	*Solea solea*	Common sole	1	10
29	*Crenilabrus melops*	Corkwing wrasse	1	10
30	*Limanda limanda*	Dab	1	10
31	*Liza aurata*	Golden grey mullet	1	10
32	*Echiichthys vipera*	Lesser weever	1	10
33	*Pomatoschistus pictus*	Painted goby	1	10
34	*Perca fluviatilis*	Perch	1	10
35	*Agonus cataphractus*	Pogge	1	10
36	*Centrolabrus exoletus*	Rock cook wrasse	1	10
37	*Salmo salar*	Salmon	1	10
38	*Petromyzon marinus*	Sea lamprey	1	10
39	*Psetta maxima*	Turbot	1	10

4.3.2 Fish species distribution

A large number of juvenile and immature fish were captured within the ten sites surveyed, indicating the essential nursery function of these transitional water bodies e.g. flounder, plaice, twaite shad, thick-lipped grey mullet and flounder. Important angling species were also recorded across the ten water bodies, including, brown trout, sea trout, salmon, European seabass, pollack and cod.

Different species were captured using the three different netting methods of beach seine net, fyke net and beam trawl net, giving some insight as to their distribution within each water body. Flounder were caught in abundance using all three methods, while thick-lipped grey mullet and three-spined stickleback were more prevalent in beach seine nets. Fyke and beach seine netting were the most effective fishing methods used during these surveys. Although a small number of species were captured exclusively using beam trawl nets e.g. dab and common sole, the vast majority were also captured using the other two methods, and in much greater numbers.

In addition to the required fish metrics (fish species composition and abundance), the WFD also requires Member States to report on the presence/absence of type-specific disturbance sensitive or indicator species. Of particular importance are the diadromous or migratory fish species such as eel, salmon, sea trout, lampreys, smelt and shad. Parts of the 10 water bodies surveyed during 2013 are incorporated in the series of Special Areas of Conservation (SACs) designated nationally. The European eel, which is considered "critically endangered", the Atlantic salmon and twaite shad (Plate 3.14), listed as "vulnerable" and the sea lamprey, listed as "near threatened" in the Red List for Amphibians, Reptiles and Fish (King *et al*., 2011), were recorded during these surveys.

Plate 3.14. Juvenile twaite shad caught in 2013

European eel is listed as a declining species and is included in Appendix II of the Convention on international trade in endangered species of wild flora and fauna (CITES). European Regulation (Regulation R (EC) 1100/2007) has set up measures for the recovery of the European eel stock. During 2013, eels were recorded in low numbers in all but one transitional water body surveyed, the

Barrow-Suir-Nore Estuary. Data from these WFD surveys is also used to support the National Eel Management Plan (O' Leary *et al.*, 2012).

4.3.3 Ecological status - Classification of transitional waters using 'TFCI'

An essential step in the WFD monitoring process is the classification of the status of transitional waters, which in turn will assist in identifying the objectives that must be set in the individual River Basin Management Plans. An extensive number of IFI surveys completed throughout Ireland has provided a valuable dataset which has been amalgamated with data collected by the Northern Ireland Environment Agency (NIEA) and used to develop a classification tool for fish in transitional waters - the 'Transitional Fish Classification Index' or TFCI. The tool uses the Index of Biotic Integrity (IBI) approach broadly based on that developed both for South African waters and the UK, with a total of ten metrics used in the index calculation (Harrison and Whitfield, 2004; Coates *et al*., 2007). The TFCI has been successfully intercalibrated in a Europe-wide exercise; however, it will undergo further development in the future to account for differences in typology and type specific reference conditions.

The 2013 and previous status classifications (2007 and 2010) for each water body are shown in Table 4.12. Using the TFCI, four water bodies were classified as Moderate and six water bodies as Good (Table 4.12, Fig. 4.83). One water body, the Upper Barrow Estuary, showed a decrease in quality status from Good to Moderate. Three water bodies, Drongawn Lough, Lough Gill and the Middle Suir Estuary increased in status from Moderate to Good. The remaining six water bodies had no change in status, with the Upper Barrow, Nore Estuary, Nore Estuary and Upper Suir Estuary remaining Moderate and the Barrow, Suir, Nore Estuary, New Ross Port and Lower Suir Estuary remaining Good.

Table 4.12. Draft fish Ecological Status Classification of transitional water bodies surveyed during 2013 using the Transitional Fish Classification Index (TFCI)

Water body	Type	Previous Ecological Status		
		2007	2010	2013
Barrow Estuary, Upper	Transitional	Poor	Good	Moderate
Barrow Nore Estuary, Upper	Transitional	Poor	Moderate	Moderate
Barrow Suir Nore Estuary	Transitional	Good	Good	Good
Drongawn Lough	Lagoon	N/A	Moderate	Good
Gill, Lough	Lagoon	N/A	Moderate	Good
New Ross Port	Transitional	Moderate	Good	Good
Nore Estuary	Transitional	Poor	Moderate	Moderate
Suir Estuary, Lower	Transitional	Moderate	Good	Good
Suir Estuary, Middle	Transitional	Good	Moderate	Good
Suir Estuary, Upper	Freshwater tidal	Moderate	Moderate	Moderate

***** Ecological status is subject to change upon review

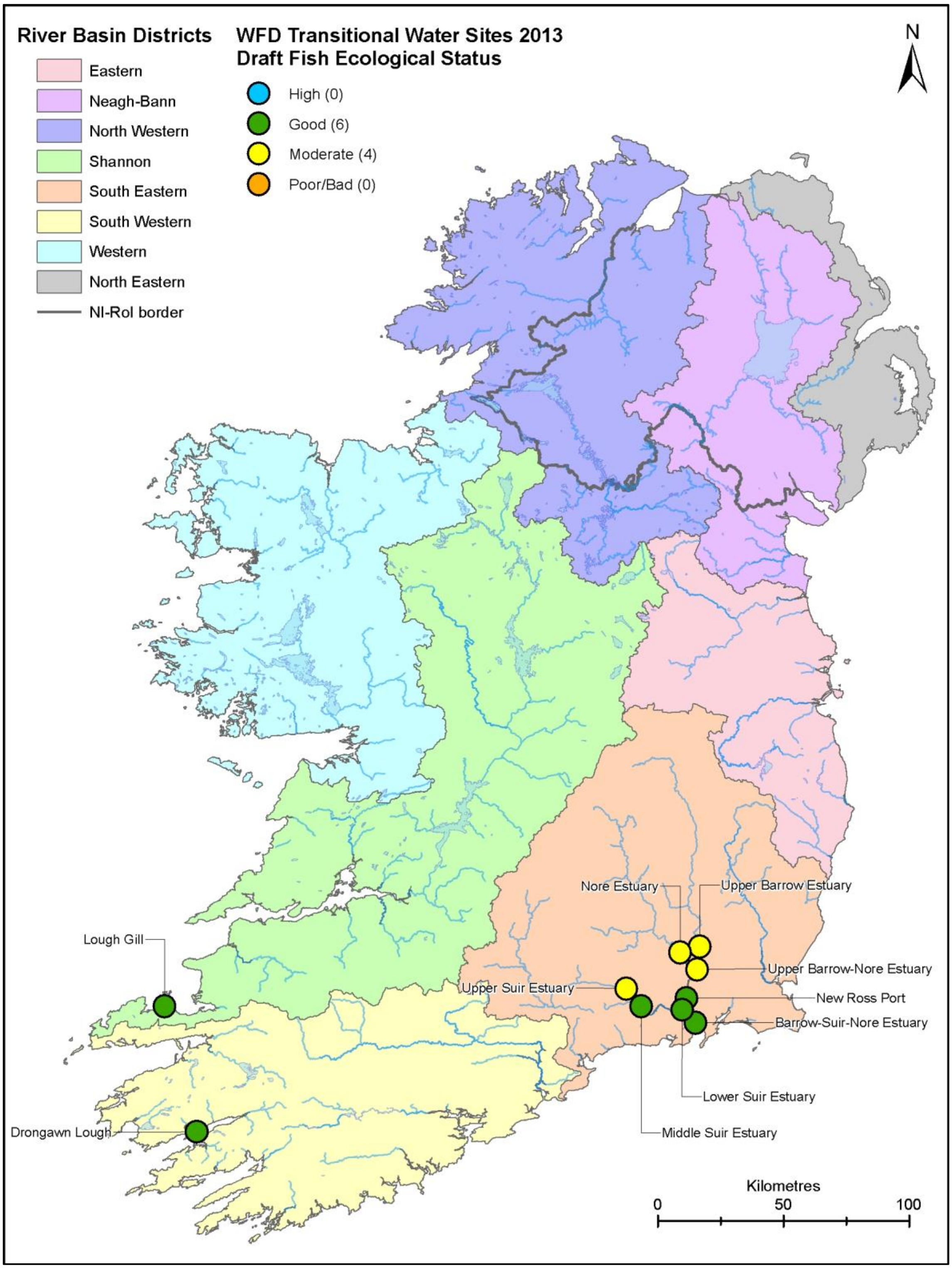

Fig. 4.83 Draft fish Ecological Status Classification of transitional water bodies surveyed during 2013 using the Transitional Fish Classification Index (TFCI)

5. DISCUSSION

5.1 Species richness

A total of 17 fish species (sea trout are included as a separate "variety" of trout) were recorded in the 24 lakes surveyed during the 2013 WFD surveillance monitoring season. Roach x bream hybrids were also recorded. European eels, followed by brown trout and perch were the three most widely distributed species recorded during 2013. The maximum number of fish species recorded in any lake was seven (Glencar Lough, WRBD and Lough MacNean Upper, NWIRBD), with a mixture of native and non-native fish species being captured in these lakes.

A total of 16 fish species (including sea trout) and one type of hybrid were recorded in the 63 river sites surveyed during the 2013 WFD surveillance monitoring season. Brown trout, European eel and salmon were the most widely distributed fish species recorded during 2013. The maximum number of fish species recorded in any one river site was 12 in the River Lee at Lee Fields in Cork and this included a mixture of native and non-native species. No sea trout or hybrids were recorded at this site.

A total of 39 fish species (including sea trout) were recorded in the ten transitional waterbodies surveyed during the 2013 WFD surveillance monitoring season.

5.2 Distribution of native species

Irish freshwaters were colonised after the last ice age by fish species that had the capacity to survive in saline and fresh water. These indigenous species represent the native fish fauna of the island of Ireland. The native fish community of Irish lakes and rivers in the absence of anthropogenic influences is one dominated by salmonids, including the glacial relict Arctic char (*Salvelinus alpinus*) (Kelly *et al.*, 2007c).

Brown trout occur in almost every rivulet, brook, stream and river in Ireland (Kennedy and Fitzmaurice, 1971). This is reflected in the 2013 fish surveillance monitoring programme for rivers, in which 59 out of 63 (93.7%) of river sites surveyed contained brown trout. Brown trout were also recorded in 17 out of 24 (70.8%) of lakes surveyed, mainly being absent in lakes where non-native fish dominated. These values for brown trout prevalence are similar to previous work carried out in Irish lakes and rivers (Kelly *et al.*, 2007a and 2007c, Kelly *et al.*, 2008a and 2008b and Kelly *et al.*, 2009, 2010, 2011, 2012a and 2013).

Salmon and eels occur in every water body in Ireland to which they can gain access (Moriarty and Dekker, 1997; McGinnity *et al.*, 2003). Eels were recorded in 20 out of 24 (83.3%) lakes surveyed and 44 out of 63 (69.8%) river sites. Salmon were recorded in 39 (61.9%) river sites and in 5 (20.8%)

of the lakes surveyed. Salmon are not often captured in lake surveys due to the transient nature of their life cycle.

Arctic char were recorded in three lakes during 2013 (Glen Lough, Kylemore Lough and Shindilla Lough), however, numbers were low in some of them. No char were recorded in Ardderry Lough where there was previously a population. A number of char populations have become extinct over the last 30 years and this has been attributed mainly to deterioration in water quality or acidification, for example in Lough Dan (Igoe *et al.*, 2005). Water abstraction is an additional pressure which can affect the status of char populations due to the potential exposure of spawning beds (Igoe, F., ICCG, *pers. comm.*).

The absence of native species such as trout, salmon and char within specific catchments is related to various factors, including deterioration in water quality, the presence of impoundments preventing fish passage, drainage and modification of river morphology, habitat deterioration and translocation and competition from non-native species. The WFD sets out three main objectives; to preserve, protect and restore the quality of the aquatic environment. The WFD does not specifically refer to the prevention of fish passage by impoundments; however, Member States must ensure that the physical condition of surface waters (e.g. those affected by drainage schemes) supports ecological standards (ShIRBD, 2009). Measures are being introduced to rectify this, e.g. IFI's Environmental River Enhancement Programme (EREP) conducted on behalf of the Office of Public Works (OPW).

5.3 Distribution of non-native fish species

The native Irish freshwater fish fauna has been augmented by a large number of non-native species (e.g. perch, pike, dace, bream, tench, roach and rainbow trout). These have been introduced either deliberately or accidentally through careless management, e.g. angling activities, aquaculture and the aquarium trade. A non-native species is one that has been either intentionally or accidentally released into an environment outside of its natural geographical habitat range (Barton and Heard, 2005). Many of these species have become established in the wild throughout Irish lakes and rivers, e.g. pike, perch, roach, rudd and bream.

Non-native fish species were present in 23 out of the 24 lakes surveyed during 2013. Overall, the majority of high alkalinity lakes (in parts of the midlands, west and the north-west) exhibited higher species richness than low alkalinity lakes, reflecting the presence of non-native species in these lakes. Non-native species were also present in 46 out of the 63 river sites surveyed. In previous years, rivers located in the northern portion of the ShIRBD and southern part of the NWIRBD often tended to have higher species richness levels, due to the presence of non-native species (Kelly *et al*., 2009, 2010, 2011, 2012a and 2013) and this was also evident in the rivers sampled in 2013. Non-native freshwater species were also present in six of the ten transitional water bodies surveyed, all on the

Barrow-Suir-Nore system. Dace were recorded in six water bodies, roach in three, and perch in one water body.

Pike, perch and roach are three of the most common non-native fish species recorded in Irish waters. In 2013, these species were recorded in a cluster of lakes mainly in counties Galway, Clare, Westmeath, Roscommon, Sligo and Cavan/Fermanagh. Many river sites within the NWIRBD, ShIRBD and SWRBD, as well as a small number of sites within the WRBD and ERBD also had these species present. Recent research suggests that pike may have colonised Irish waters naturally, without the intervention of man and therefore be mislabelled as a non-native species (Pedreschi *et al*., 2013); however, further evidence may be needed to verify this. The Shannon-Erne Waterway has facilitated the movement of non-native species between the Shannon and Erne catchments, resulting in their gradual spread. There were records of these species in other catchments during 2013 with no access to the Shannon and Erne catchments (e.g. River Lee (cork) and Abbert River in Co. Galway, Ross Lake, Lough Shindilla, Ardderry Lough, Lattone Lough, Lough Lene, Lough Bane and Lough Annagh/White, providing evidence that these fish have been deliberately or accidently relocated to new catchments over the past 60 years.

The presence of abundant populations of non-native fish species can also be an indicator of ecosystem health as many of these species are more tolerant to water pollution than native species such as salmon, trout and char. Researchers have found a general trend of increasing species richness, abundance and biomass among tolerant non-native species that corresponds with deteriorating water quality in both lakes and rivers (Kelly *et al*., 2007a and 2007c and Kelly *et al*., 2008b). Salmonids were the dominant fish species in ultraoligo/oligotrophic lakes. This dominance decreases and changes to a population dominated by non-native fish species as trophic status increases; however, this change is only observed in water bodies where non-native fish species are present to begin with (Kelly *et al*., 2008b).

The status of non-native species varies throughout Ireland. Data collected for the WFD to date confirms that many areas of the north-west, west and south-west are the last areas of the country to which these non-native species have not yet been translocated. Every effort must be made to preserve the status of the native fish populations, whilst preventing the introduction of non-native species to these areas, as this may affect the ecological status of the water body.

5.4 Effects of non-native species on indigenous fish populations

The introduction of pike and its subsequent spread to a large proportion of the country has had an adverse effect on the indigenous salmonid populations (Fitzmaurice, 1984). Brown trout were not recorded in seven lakes surveyed during 2013 (Annagh/White Lough, Lough Atedaun, Glenade Lough, Lough MacNean Lower, Lough Mushlin, Urlaur Lough and Ross Lake). In waters where brown trout, cyprinids and perch are abundant, pike prey on brown trout in preference to other fish species (Fitzmaurice, 1984). Toner (1957) showed that 51.0% to 66.6% of pike stomachs from Lough Corrib contained trout.

Roach were present in eight out of the 24 lakes surveyed during 2013, and 13 out of the 63 river sites surveyed (mostly in the ShIRBD and NWIRBD but also in the SWRBD and ERBD. Roach, accidentally introduced to Ireland in 1889 (Went, 1950), have been translocated to many waters, mostly by anglers (Fitzmaurice, 1981), over the last 60 years. Roach is a species which has been shown to affect salmonid production and cause a decline in brown trout angling catches (Fitzmaurice, 1984). Within a few years of being introduced into a water body they can become the dominant species due to their high fecundity. They usually displace brown trout, while rudd stocks disappear, almost to the point of extinction (Fitzmaurice, 1981).

Water bodies with non-native invasive fish species such as roach will not meet high status for WFD purposes due to the presence of these species. Future introductions of non-native species will also lead to a downgrading of the ecological status of a water body.

5.5 Fish age and growth

Age analysis of fish captured during WFD fish monitoring in 2013 demonstrated that there was a large variation in the growth of a variety of fish species amongst both lakes and rivers, with alkalinity being one of the main factors influencing growth.

The mean lengths at age of brown trout in moderate alkalinity lakes showed a faster growth rate than those in low and high alkalinity lakes, however, the only significant difference was at the end of year 4 where the moderate alkalinity lakes had a significantly faster growth rate than the low alkalinity lakes. Overall, the mean length at age of both perch and roach were slightly higher in the low alkalinity and high alkalinity lakes than in the moderate alkalinity lakes; however, only perch in high alkalinity lakes displayed a significantly faster growth at the end of year 5 and 6 than those from the moderate alkalinity lakes.

Brown trout in rivers exhibited similar growth patterns, with the mean lengths at age of brown trout in high alkalinity rivers generally being higher than those in moderate or low alkalinity rivers.

In rivers, the range of salmonid age classes differed to that of lakes, reflecting the different dominant life history stages in the two water body types. Lower numbers of juvenile salmonid age classes were recorded in lakes than in rivers, as most salmonids spend one or two years in nursery streams before migrating downstream into larger rivers or lakes.

Growth of brown trout in Irish lakes is known to be influenced by a number of factors (Kennedy and Fitzmaurice, 1971; Everhart, 1975):

1. The type of streams in which the trout spawn and the length of time the young trout spend in it
2. The shape of the growth curve after the first three years of life
3. The age at which the trout are cropped by anglers
4. Food availability (amount and size)
5. The number of fish using the same food resource
6. Temperature, oxygen and other water quality factors

Alkalinity is also known to have an influence on the growth rate of fish in both lakes and rivers (e.g. Kelly *et al*., 2008, 2009, 2010, 2011, 2012a and 2013). In waters deficient in calcium, the diversity, abundance and biomass of both molluscs (Hincks and Mackie, 1997 and Mellina and Rasmussen, 1994) and macroinvertebrates (Koetsier *et al*., 1996) can be limited. Therefore, alkalinity and calcium can directly affect the fauna present and subsequent availability of food for fish populations. In Irish lakes there appear to be few exceptions to the rule that the more alkaline the water, the faster the brown trout growth rate. In general, the average size of brown trout caught by anglers in any given water body, is related to the rate of growth in that water body (Kennedy and Fitzmaurice, 1971), with anglers recording larger fish from the water bodies with faster growth rates. Exceptions to this rule usually involve major differences in stock density between small lakes, with consequent differences in the amount of food available to individual fish (Kennedy and Fitzmaurice, 1971). There is some evidence to suggest that, in low alkalinity lakes, growth is faster when the conductivity is high (usually because of maritime influence) than where the conductivity is very low (Kennedy and Fitzmaurice, 1971). Furthermore, in less productive lakes, trout are slow growing, relatively short-lived and less selective in their feeding than in richer waters.

Stock density (e.g. overstocking) can also have an effect on the growth of brown trout. In small lakes, overstocking becomes a problem, particularly if spawning facilities are extensive but food limited. A study of 14 lakes in the Rosses, Co. Donegal in 1966 demonstrated the inverse relationship between stock density and growth rate (Kennedy and Fitzmaurice, 1971).

The amount of food available is another factor which influences the rate of growth of brown trout in lakes. From a biological perspective, it is a waste of energy for fish to seek foods which are small, scarce and hard to catch (Kennedy and Fitzmaurice, 1971). If fish are to grow well, they must be able to obtain large amounts of suitable food organisms of suitable size, and with a minimum search effort. This is possible when there are large standing crops of suitable foods which are never fully grazed (Kennedy and Fitzmaurice, 1969).

5.6 Ecological status classifications

An essential step in the WFD process is the ecological classification of the status of lakes, rivers and transitional waters, which in turn will assist in identifying the objectives that must be set in the individual River Basin District Management Plans. During 2010 the "Fish in Lakes" ecological classification tool developed during the NS SHARE "Fish in Lakes" Project (Kelly *et al.*, 2008b) was improved using additional data to make it fully WFD compliant (Kelly *et al*, 2012b). The tool combines a discriminant analysis model with an ecological quality ratio (EQR) model providing an ecological quality ratio (EQR) between 0 and 1 with 95% confidence intervals. Expert opinion is also used on some occasions where invasive fish species are present. This new classification tool (FIL2) was successfully intercalibrated with other European Member States during 2011 and used to assign ecological status classes to lakes surveyed from 2008-2012. Of the 24 lakes surveyed during 2013, six were classified as High, eight were classified as Good, one was classified as Moderate, six were classified as Poor and two were classified as Bad ecological status in terms of fish. One lake could not be classified. The geographical variation in ecological status reflects the change in fish communities in response to pressure; from upland lakes with little human disturbance dominated by intolerant fish communities (salmonids) to lowland lakes subject to more intensive anthropogenic pressures dominated by tolerant fish species such as perch, roach and bream.

An ecological classification tool for fish in rivers was developed and completed for Ecoregion 17 (Republic of Ireland and Northern Ireland) (FCS2 Ireland), along with a separate version for Scotland to comply with the requirements of the WFD in early 2011 (SNIFFER, 2011). The tool works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) conditions using a geo-statistical model based on Bayesian probabilities. The resulting output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range corresponding to the five ecological status classes of High, Good, Moderate, Poor and Bad. Confidence levels are assigned to each class and represented as probabilities. The tool has been successfully intercalibrated in a project to standardise ecological status classifications across Europe. FCS2 Ireland has been used to classify the 63 river sites surveyed during 2013; five river sites were classified as High, 27 as Good, 28 as Moderate and three as Poor.

A new preliminary WFD fish classification tool, Transitional Fish Classification Index or TCFI, has also been developed for the island of Ireland (Ecoregion 1) using Northern Ireland Environment Agency (NIEA) and IFI data. This is a multi-metric tool based on similar tools developed for transitional waters in South Africa and the UK (Harrison and Whitfield, 2004; Coates *et al.*, 2007). The ten transitional water bodies surveyed in 2013 were assigned a draft ecological classification using the TFCI. Four water bodies were assigned Moderate status, while six were classed as Good.

The TFCI has been successfully intercalibrated in a Europe-wide exercise but may be subject to further development in the future.

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APPENDIX 1

Biologically verified typology for lakes in the Republic of Ireland

Type	Alkalinity	Depth	Size
1	Low (<20mg/l CaCO3)	Shallow mean depth <4m (<12m)	Small <50 ha
2	Low (<20mg/l CaCO3)	Shallow (mean depth <4m(>12m)	Large >50 ha
3	Low (<20mg/l CaCO3)	Deep mean depth >4m (<12m)	Small <50 ha
4	Low (<20mg/l CaCO3)	Deep (mean depth >4m(>12m)	Large >50 ha
5	Moderate (20-100 mg/l CaCO3)	Shallow mean depth <4m (<12m)	Small <50 ha
6	Moderate (20-100 mg/l CaCO3)	Shallow (mean depth <4m(>12m)	Large >50 ha
7	Moderate (20-100 mg/l CaCO3)	Deep mean depth >4m (<12m)	Small <50 ha
8	Moderate (20-100 mg/l CaCO3)	Deep (mean depth >4m(>12m)	Large >50 ha
9	High (>100mg/l CaCO3)	Shallow mean depth <4m (<12m)	Small <50 ha
10	High (>100mg/l CaCO3)	Shallow (mean depth <4m(>12m)	Large >50 ha
11	High (>100mg/l CaCO3)	Deep mean depth >4m (<12m)	Small <50 ha
12	High (>100mg/l CaCO3)	Deep (mean depth >4m(>12m)	Large >50 ha
13	Some lakes >300m altitude		

APPENDIX 2

Presence/absence of each species captured in each lake during 2013

Lake	Three-spined stickleback	Nine-spined stickleback	Sea trout	Flounder	Char	Salmon	Brown Trout	Eel	Minnow	Perch	Pike	Roach	Bream	Stoneloach	Tench	Rudd	Roach x Bream	Rainbow trout
Annagh or White Lough										x	x							x
Ardderry							x	x		x								
Atedaun								x		x	x			x		x		
Aughrusbeg	x						x	x								x		
Bane							x	x		x								x
Beltra			x			x	x	x		x								
Glen			x		x	x	x	x	x									
Glenade								x		x	x	x						
Glencar	x		x	x		x	x	x	x									
Kylemore			x		x	x	x	x	x									
Lattone							x	x		x		x	x					
Lene							x	x		x	x				x			x
Lettercraffroe	x						x					x						
Lickeen	x						x	x								x		
Macnean Lower								x		x	x	x	x			x	x	
Macnean Upper							x	x		x	x	x	x			x	x	
Maumwee						x	x	x	x									
Mushlin										x						x		
Nambrackmore							x											
Rea		x					x	x		x	x					x		
Ree							x	x		x	x	x		x			x	
Ross								x		x	x	x	x				x	
Shindilla					x	x	x	x		x								
Urluar		x						x		x	x	x					x	

APPENDIX 3

Lengths at age of brown trout in 17 lakes surveyed during 2013 (L1=back calculated length of trout at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	Growth Category
Ardderry	Mean	7.3	16.9	24.4							n/a
	n	9	7	5							
	S.D.	1.7	3.0	1.6							
	S.E.	0.6	1.1	0.7							
	Min.	4.4	11.8	22.4							
	Max.	9.8	20.9	26.0							
Aughrusbeg	Mean	5.2	10.4	20.8	28.1	38.5	42.0				Slow
	n	3	3	3	1	1	1				
	S.D.	1.4	1.5	0.3	.	.	.				
	S.E.	0.8	0.9	0.2	.	.	.				
	Min.	3.8	8.8	20.4	28.1	38.5	42.0				
	Max.	6.7	11.9	21.0	28.1	38.5	42.0				
Beltra	Mean	7.2	15.7	22.2							n/a
	n	27	17	6							
	S.D.	1.6	2.5	2.4							
	S.E.	0.3	0.6	1.0							
	Min.	4.3	11.9	17.7							
	Max.	9.9	21.0	24.7							
Glen	Mean	5.1	11.3	18.0	23.1	24.8					Very Slow
	n	105	100	85	44	8					
	S.D.	1.2	2.9	2.5	2.3	2.8					
	S.E.	0.1	0.3	0.3	0.3	1.0					
	Min.	3.1	7.1	13.5	17.9	20.7					
	Max.	9.0	19.2	23.9	28.4	30.5					
Glencar	Mean	5.4	13.4	19.0	26.6						Slow
	n	88	52	21	2						
	S.D.	1.5	2.3	2.9	3.3	2.9					
	S.E.	0.1	0.4	0.5	1.7						
	Min.	3.0	8.1	13.6	24.9						
	Max.	8.5	18.9	23.0	28.3						
Kylemore	Mean	6.0	12.9	19.7	25.5	31.6	34.8	39.2	43.7	46.5	Slow
	n	62	54	32	15	4	1	1	1	1	
	S.D.	1.4	2.3	4.0	10.5	18.6	.	.	.	.	
	S.E.	0.2	0.3	0.5	0.9	1.4	.	.	.	.	
	Min.	3.5	8.7	14.2	18.1	28.5	34.8	39.2	43.7	46.5	
	Max.	9.3	18.9	24.6	30.8	34.2	34.8	39.2	43.7	46.5	
Lattone	Mean	6.9	14.2	20.6							n/a
	n	6	5	5							
	S.D.	1.4	1.7	1.3							
	S.E.	0.6	0.8	0.6							
	Min.	5.0	12.5	18.8							
	Max.	8.6	16.0	22.4							

APPENDIX 3 continued

Lengths at age of brown trout in 17 lakes surveyed during 2013 (L1=back calculated length of trout at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	Growth Category
Lettercraffroe	Mean	8.5	13.7	19.5	25.7					Slow
	n	45	14	4	3					
	S.D.	1.7	3.1	4.1	3.3					
	S.E.	0.3	0.8	2.0	1.9					
	Min.	5.4	9.0	14.4	22.0					
	Max.	12.2	19.1	23.3	28.4					
Lene	Mean	12.6	22.7	35.2	39.6	45.0				Very Fast
	n	2	2	2	1	1				
	S.D.	0.007	4.1	6.0	.	.				
	S.E.	0.005	2.9	4.2	.	.				
	Min.	12.6	19.8	30.9	39.6	45.0				
	Max.	12.6	25.6	39.4	39.6	45.0				
Lickeen	Mean	7.7	18.9	27.5	34.6					Fast
	n	36	20	3	1					
	S.D.	1.4	3.3	5.0	.					
	S.E.	0.2	0.7	2.9	.					
	Min.	5.1	12.5	22.7	34.6					
	Max.	10.8	25.0	32.7	34.6					
Maumwee	Mean	6.4	15.7	20.4	23.0					Very Slow
	n	80	46	17	3					
	S.D.	1.7	2.6	2.1	1.5					
	S.E.	0.2	0.4	0.5	0.9					
	Min.	3.5	9.2	16.3	21.7					
	Max.	9.6	20.6	23.7	24.6					
Nambrackmore	Mean	7.5	14.6	20.9	27.5					Slow
	n	17	12	6	1					
	S.D.	1.2	2.8	2.0	.					
	S.E.	0.3	0.8	0.8	.					
	Min.	4.6	11.6	18.7	27.5					
	Max.	10.6	19.7	24.5	27.5					
Rea	Mean	5.9	12.6	22.6	27.3					Slow
	n	7	6	3	1					
	S.D.	1.0	2.2	2.7	.					
	S.E.	0.4	0.9	1.6	.					
	Min.	4.8	10.0	19.4	27.3					
	Max.	7.8	15.3	24.3	27.3					

APPENDIX 3 continued

Lengths at age of brown trout in 17 lakes surveyed during 2013 (L1=back calculated length of trout at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	Growth Category
Ree	Mean	6.8	15.9	25.3	37.5					Very fast
	n	18	17	7	1					
	S.D.	1.3	3.1	4.6	.					
	S.E.	0.3	0.7	1.7	.					
	Min.	4.5	10.4	20.0	37.5					
	Max.	9.3	20.0	31.2	37.5					
Shindilla	Mean	6.9	14.6	20.2	23.5					Very Slow
	n	49	28	13	1					
	S.D.	1.3	2.7	2.9	.					
	S.E.	0.2	0.5	0.8	.					
	Min.	4.3	9.4	14.7	23.5					
	Max.	10.0	19.0	23.7	23.5					

APPENDIX 4

Lengths at age of perch in 16 lakes surveyed during 2013 (L1=back calculated length of perch at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Annagh/White	Mean	6.1	11.2	17.0	22.9	25.7	25.7	30.3				
	n	61	22	14	11	3	2	1				
	S.D.	0.9	2.4	3.3	3.4	3.9	4.8	.				
	S.E.	0.1	0.5	0.9	1.0	2.2	3.4	.				
	Min.	4.7	6.9	11.0	15.8	21.2	22.3	30.3				
	Max.	8.6	16.9	22.3	27.3	28.2	29.1	30.3				
Ardderry	Mean	6.8	14.5	17.9	20.1	21.7	23.8	24.4				
	n	57	41	36	25	12	2	1				
	S.D.	0.9	1.5	1.7	1.6	1.8	0.5	.				
	S.E.	0.1	0.2	0.3	0.3	0.5	0.4	.				
	Min.	4.2	11.1	15.2	16.9	17.7	23.4	24.4				
	Max.	8.8	18.6	21.2	22.5	23.6	24.2	24.4				
Atedaun	Mean	6.2	11.5	16.1	19.7	21.9	25.6					
	n	74	49	28	13	4	1					
	S.D.	0.8	1.9	2.1	1.8	2.7	.					
	S.E.	0.1	0.3	0.4	0.5	1.3	.					
	Min.	4.1	7.5	11.8	16.0	18.1	25.6					
	Max.	9.0	15.9	19.7	23.1	24.2	25.6					
Bane	Mean	5.8	11.0	17.3	23.0	28.7	30.8	32.1	31.9			
	n	96	68	51	24	7	6	5	2			
	S.D.	1.0	1.9	2.6	3.7	1.6	1.6	1.7	0.4			
	S.E.	0.1	0.2	0.4	0.8	0.6	0.6	0.8	0.3			
	Min.	4.1	8.2	10.9	15.0	26.5	29.3	30.9	31.6			
	Max.	8.7	18.7	22.9	27.3	31.0	33.6	34.9	32.1			
Beltra	Mean	5.2	9.7	12.4	14.4	16.3	16.7	17.2	16.8			
	n	53	47	41	33	16	9	2	1			
	S.D.	0.9	1.5	2.1	2.1	2.9	1.3	1.5	.			
	S.E.	0.1	0.2	0.3	0.4	0.7	0.4	1.1	.			
	Min.	3.4	7.0	8.8	10.2	12.4	14.9	16.2	16.8			
	Max.	8.1	14.4	18.8	21.3	25.9	18.3	18.3	16.8			

APPENDIX 4 continued

Lengths at age of perch in 16 lakes surveyed during 2013 (L1=back calculated length of perch at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Glenade	Mean	5.2	9.7	12.4	14.4	16.3	16.7	17.2	16.8			
	n	53	47	41	33	16	9	2	1			
	S.D.	0.9	1.5	2.1	2.1	2.9	1.3	1.5	.			
	S.E.	0.1	0.2	0.3	0.4	0.7	0.4	1.1	.			
	Min.	3.4	7.0	8.8	10.2	12.4	14.9	16.2	16.8			
	Max.	8.1	14.4	18.8	21.3	25.9	18.3	18.3	16.8			
Lattone	Mean	5.6	10.0	12.5	14.2	15.7	17.0	19.1	24.3	29.0	31.4	33.3
	n	56	52	42	35	29	23	11	1	1	1	1
	S.D.	0.6	0.9	0.9	1.2	1.5	1.9	2.7				
	S.E.	0.1	0.1	0.1	0.2	0.3	0.4	0.8	.	.	.	.
	Min.	4.0	7.8	10.6	12.5	13.3	14.2	14.8	24.3	29.0	31.4	33.3
	Max.	7.0	11.5	14.2	17.6	19.3	21.7	22.5	24.3	29.0	31.4	33.3
Lene	Mean	5.7	11.1	15.0	17.8	20.6	23.4	26.0	27.9	29.7		
	n	92	62	55	45	18	12	5	4	1		
	S.D.	0.8	1.2	1.7	2.3	2.4	2.2	3.0	3.4	.		
	S.E.	0.1	0.1	0.2	0.3	0.6	0.6	1.3	1.7	.		
	Min.	3.7	8.3	11.3	12.6	16.7	20.1	21.0	23.0	29.7		
	Max.	7.6	13.5	19.5	22.3	24.8	26.9	28.2	30.9	29.7		
MacNean Lower	Mean	5.3	9.5	14.4	17.9	20.4	21.6	23.7	23.6			
	n	82	62	48	28	17	10	4	1			
	S.D.	0.8	1.2	1.5	1.6	1.8	1.6	1.2	.			
	S.E.	0.1	0.2	0.2	0.3	0.4	0.5	0.6	.			
	Min.	3.4	7.7	11.2	14.7	16.6	18.9	22.6	23.6			
	Max.	8.2	13.9	17.1	21.3	22.9	23.7	24.7	23.6			
MacNean Upper	Mean	5.4	9.4	13.3	16.8	19.4	21.3	22.7	24.0	26.3		
	n	108	89	68	50	43	28	15	11	7		
	S.D.	0.7	1.3	1.6	1.7	1.9	2.4	2.5	2.9	1.7		
	S.E.	0.1	0.1	0.2	0.2	0.3	0.5	0.7	0.9	0.6		
	Min.	3.7	5.9	9.1	11.9	13.9	15.8	17.3	17.7	24.5		
	Max.	7.7	12.9	17.5	20.4	22.6	25.2	25.8	27.9	28.8		
Mushlin	Mean	6.0	11.0	15.7	18.6	20.4	21.8	21.6				
	n	48	25	22	9	3	2	1				
	S.D.	0.8	0.9	1.1	1.6	2.9	4.3	.				
	S.E.	0.1	0.2	0.2	0.5	1.7	3.0	.				
	Min.	4.1	9.6	13.6	15.7	17.2	18.7	21.6				
	Max.	7.9	13.3	17.5	20.7	23.1	24.8	21.6				
Rea	Mean	6.5	13.1									
	n	8	6									
	S.D.	0.7	1.4									
	S.E.	0.2	0.6									
	Min.	5.8	11.6									
	Max.	7.4	14.9									
Ree	Mean	5.9	11.2	15.9	19.1	21.8	23.6	25.7	26.5			
	n	119	95	68	53	35	29	17	5			
	S.D.	0.9	1.6	1.8	2.0	2.0	1.8	1.8	1.3			
	S.E.	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.6			
	Min.	3.9	7.2	11.0	13.7	17.3	18.9	22.4	24.7			
	Max.	8.3	15.2	20.0	23.7	25.6	26.5	28.5	28.1			
Ross	Mean	5.5	9.8	13.5	16.8	19.0	22.6	23.2				
	n	88	49	43	29	13	7	3				
	S.D.	0.9	1.3	1.6	2.6	4.0	5.4	5.3				
	S.E.	0.1	0.2	0.2	0.5	1.1	2.0	3.1				
	Min.	3.2	6.8	10.2	12.8	15.1	17.2	19.0				
	Max.	8.1	13.2	19.7	25.9	29.3	33.6	29.2				

APPENDIX 4 continued

Lengths at age of perch in 16 lakes surveyed during 2013 (L1=back calculated length of perch at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Shindilla	Mean	7.2	15.2	19.7	22.5	22.5	25.9	26.5				
	n	36	28	28	21	8	1	1				
	S.D.	0.9	1.5	2.2	2.6	1.4	.	.				
	S.E.	0.2	0.3	0.4	0.6	0.5	.	.				
	Min.	6.1	13.5	16.3	19.1	21.0	25.9	26.5				
	Max.	9.4	19.6	23.7	28.7	25.1	25.9	26.5				
Urlaur	Mean	5.0	9.0	13.8	17.7	20.6	22.8	24.9				
	n	84	61	46	27	12	5	3				
	S.D.	0.8	1.3	1.7	2.1	2.0	2.0	2.6				
	S.E.	0.1	0.2	0.2	0.4	0.6	0.9	1.5				
	Min.	3.5	6.7	10.2	14.5	17.3	19.8	21.8				
	Max.	6.9	12.0	16.9	21.2	23.2	24.9	26.5				

APPENDIX 5

Lengths at age of roach in 8 lakes surveyed during 2013 (L1=back calculated length of roach at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15
Lattone	Mean	2.4	4.5	7.6	11.1	12.9	16.1									
	n	2	2	2	2	1	1									
	S.D.	0.3	1.0	1.3	1.9	.	.									
	S.E.	0.2	0.7	0.9	1.4	.	.									
	Min.	2.2	3.8	6.7	9.7	12.9	16.1									
	Max.	2.6	5.2	8.5	12.4	12.9	16.1									
Lettercraffroe	Mean	2.2	7.4	13.5	17.3	20.0	22.1	23.9	24.9	25.9						
	n	80	79	78	59	41	38	16	5	2						
	S.D.	0.7	1.4	1.6	1.4	1.7	1.2	1.1	1.4	0.7						
	S.E.	0.1	0.2	0.2	0.2	0.3	0.2	0.3	0.6	0.5						
	Min.	1.2	4.4	7.8	13.0	13.3	20.2	22.0	23.8	25.4						
	Max.	6.0	12.4	18.1	21.9	24.3	26.0	26.1	27.3	26.4						
MacNean Lower	Mean	2.7	6.0	9.9	12.9	14.9	16.8	18.2	21.4							
	n	78	77	69	43	29	22	11	3							
	S.D.	0.6	1.2	1.6	1.9	1.6	1.6	1.7	3.1							
	S.E.	0.1	0.1	0.2	0.3	0.3	0.3	0.5	1.8							
	Min.	1.7	4.0	6.6	7.6	10.3	13.5	16.1	18.9							
	Max.	4.2	9.8	13.6	16.0	17.3	19.6	21.3	24.9							
MacNean Upper	Mean	2.4	5.3	9.4	12.8	14.8	16.1	16.9								
	n	57	57	51	32	23	10	5								
	S.D.	0.6	1.4	1.8	2.1	2.1	2.6	3.3								
	S.E.	0.1	0.2	0.3	0.4	0.4	0.8	1.5								
	Min.	1.4	2.9	5.2	6.8	8.7	12.6	14.0								
	Max.	3.7	9.5	13.4	16.1	17.8	19.4	21.5								
Ree	Mean	3.1	7.7	13.1	17.3	20.8	23.4	25.1	26.7	27.5	28.4	29.9	30.7	30.7	32.1	34.4
	n	153	147	130	93	76	61	40	25	14	11	8	4	2	2	1
	S.D.	0.9	1.7	2.1	2.5	2.6	2.2	2.2	2.1	2.2	1.0	0.9	1.4	0.5	1.1	.
	S.E.	0.1	0.2	0.3	0.3	0.3	0.3	0.4	0.6	0.3	0.3	0.7	0.4	0.8	.	
	Min.	1.5	4.4	8.1	10.3	13.5	18.8	20.9	22.6	24.1	26.9	28.4	29.4	30.3	31.3	34.4
	Max.	6.9	13.5	19.8	22.9	25.2	26.9	28.2	30.1	32.9	29.6	30.8	32.3	31.1	32.9	34.4

APPENDIX 5 continued

Lengths at age of roach in 8 lakes surveyed during 2013 (L1=back calculated length of roach at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15
Ross	Mean	2.5	5.7	10.0	13.4	16.2	18.6	20.9	23.9	24.2	26.3					
	n	88	81	59	46	31	24	17	9	3	2					
	S.D.	0.6	1.4	1.6	1.5	1.1	1.5	2.1	2.8	3.5	5.3					
	S.E.	0.1	0.2	0.2	0.2	0.2	0.3	0.5	0.9	2.0	3.8					
	Min.	1.2	3.6	6.1	9.8	14.3	15.9	18.9	20.7	21.5	22.6					
	Max.	4.9	10.3	14.8	16.4	19.7	23.2	25.8	28.6	28.2	30.1					
Urlaur	Mean	2.6	6.2	11.5	16.6	20.6	23.6	25.4	27.0	26.5						
	n	103	98	75	58	35	27	18	9	3						
	S.D.	0.7	1.5	2.8	2.9	2.0	1.6	1.5	1.6	1.1						
	S.E.	0.1	0.2	0.3	0.4	0.3	0.3	0.4	0.5	0.6						
	Min.	1.5	3.6	5.7	11.3	16.9	20.4	22.4	23.8	25.3						
	Max.	4.9	9.9	17.6	22.0	25.7	27.5	27.4	29.0	27.3						
Glenade	Mean	3.7	7.9	13.6	17.8	21.3	23.5	25.1	26.7							
	n	133	106	88	73	47	7	2	1							
	S.D.	1.2	1.5	2.2	2.5	2.3	1.4	0.8	.							
	S.E.	0.1	0.1	0.2	0.3	0.3	0.5	0.6	.							
	Min.	1.6	3.7	6.3	12.2	17.0	21.2	24.5	26.7							
	Max.	7.0	13.9	18.4	24.7	27.6	25.7	25.6	26.7							

APPENDIX 6

Output from the FIL2 ecological classification tool

Lake	FIL2 Typology	EQR	EQR Lower 95% C.I.	EQR Upper 95% C.I.	Ecological Status Class	Final Ecological Status Class (with expert opinion)
Bane	3	0.772	0.610	0.880	High	High
Beltra	2	0.766	0.602	0.876	High	High
Glen	1	0.818	0.747	0.872	High	High
Glencar	4	0.849	0.494	0.970	High	High
Kylemore	2	0.761	0.695	0.817	High	High
Shindilla	3	0.838	0.740	0.904	High	High
Ardderry	1	0.575	0.439	0.701	Good	Good
Atedaun	3	0.690	0.569	0.790	Good	Good
Lene	4	0.630	0.408	0.808	Good	Good
Lettercraffroe	2	0.833	0.688	0.919	High	Good
Nambrackmore	1	0.753	0.662	0.826	Good	Good
Macnean Upper	1	0.606	0.439	0.752	Good	Good
Maumwee	2	0.699	0.632	0.759	Good	Good
Annagh/White Lough	4	0.156	0.023	0.586	Poor/Bad	Good
Rea	1	0.490	0.040	0.956	Moderate	Moderate
Glenade	3	0.258	0.204	0.321	Poor/Bad	Poor
Lickeen	2	0.074	0.020	0.241	Poor/Bad	Poor
Macnean Lower		0.012	0.005	0.028	Poor/Bad	Poor
Ree	4	0.278	0.083	0.620	Poor/Bad	Poor
Ross (Corrib)	4	0.142	0.098	0.201	Poor/Bad	Poor
Aughrusbeg	1	0.124	0.068	0.215	Poor/Bad	Poor
Lattone	1	0.012	0.005	0.031	Poor/Bad	Bad
Urluar	2	0.093	0.068	0.125	Poor/Bad	Bad
Mushlin	1	0.023	0.012	0.044	Poor/Bad	N/A

APPENDIX 7

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Abbert (Bullaun Br.)	Mean	6.4	14.4				n/a
	n	19	1				
	S.D.	1.0	n/a				
	S.E.	0.2	n/a				
	Min.	5.1	14.4				
	Max.	9.0	14.4				
Adrigole (Glashduff confl.)	Mean	7.6	14.1	12.8			n/a
	n	25	5	1			
	S.D.	1.7	2.7	n/a			
	S.E.	0.3	1.2	n/a			
	Min.	4.5	9.6	12.8			
	Max.	10.2	16.4	12.8			
Annalee (Cavan confl.)	Mean	9.0	13.4				n/a
	n	4	1				
	S.D.	2.2	n/a				
	S.E.	1.1	n/a				
	Min.	6.2	13.4				
	Max.	11.3	13.4				
Araglin (Elizabeth's Br.)	Mean	5.6	10.6				Very Slow
	n	23	7				
	S.D.	0.9	1.0				
	S.E.	0.2	0.4				
	Min.	4.0	9.4				
	Max.	7.4	11.9				
Avonbeg (Grennan Br.)	Mean	6.2	11.5	16.1	19.8	25.2	n/a
	n	10	4	1	1	1	
	S.D.	1.4	0.9	n/a	n/a	n/a	
	S.E.	0.4	0.4	n/a	n/a	n/a	
	Min.	4.8	10.8	16.1	19.8	25.2	
	Max.	9.0	12.8	16.1	19.8	25.2	
Ballyfinboy (Ballinderry Br.)	Mean	7.8	14.3	20.7			Slow
	n	4	2	1			
	S.D.	2.0	0.8	n/a			
	S.E.	1.0	0.6	n/a			
	Min.	6.5	13.7	20.7			
	Max.	10.7	14.9	20.7			
Ballyfinboy (Lough Derg)	Mean	8.9	14.2	18.1			Slow
	n	18	6	1			
	S.D.	1.6	2.8	n/a			
	S.E.	0.4	1.1	n/a			
	Min.	5.9	10.5	18.1			
	Max.	12.2	17.6	18.1			
Ballyroan (Ballydine Br.)	Mean	7.3	16.0	23.7			Slow
	n	18	6	1			
	S.D.	1.3	2.7	n/a			
	S.E.	0.3	1.1	n/a			
	Min.	4.9	12.0	23.7			
	Max.	9.5	19.7	23.7			

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Ballyroan (Gloreen Br.)	Mean	8.2	19.1				Fast
	n	38	7				
	S.D.	1.7	4.5				
	S.E.	0.3	1.7				
	Min.	5.3	12.2				
	Max.	12.8	24.6				
Banoge (Owenavorragh confl.)	Mean	9.1					n/a
	n	20					
	S.D.	2.0					
	S.E.	0.4					
	Min.	5.1					
	Max.	12.6					
Blackwater (Kells) (Lough Ramor)	Mean	8.2	16.9				n/a
	n	38	2				
	S.D.	2.2	5.2				
	S.E.	0.4	3.7				
	Min.	4.7	13.2				
	Max.	12.3	20.6				
Blackwater (Killavullen Br.)	Mean	8.7	16.9	24.4			Slow
	n	17	10	4			
	S.D.	1.9	1.7	1.9			
	S.E.	0.4	0.5	1.0			
	Min.	6.3	14.1	23.0			
	Max.	14.1	19.1	27.1			
Blackwater (Lismore Br.)	Mean	6.6	14.6	22.6			Slow
	n	7	4	1			
	S.D.	1.1	3.4	n/a			
	S.E.	0.4	1.7	n/a			
	Min.	5.4	11.8	22.6			
	Max.	8.9	19.5	22.6			
Blackwater (Nohaval Br.)	Mean	6.1	12.0	17.3	22.4		Very Slow
	n	54	37	15	2		
	S.D.	1.4	2.5	2.4	0.7		
	S.E.	0.2	0.4	0.6	0.5		
	Min.	3.3	7.2	13.8	21.9		
	Max.	9.7	18.6	22.8	22.9		
Boor (Kilbillaghan Br.)	Mean	7.6	14.8	20.1	23.2		Slow
	n	27	11	1	1		
	S.D.	1.6	1.6	n/a	n/a		
	S.E.	0.3	0.5	n/a	n/a		
	Min.	4.6	12.1	20.1	23.2		
	Max.	10.1	17.8	20.1	23.2		
Bow (Bow Br.)	Mean	6.3	11.8				Very Slow
	n	39	16				
	S.D.	1.4	1.4				
	S.E.	0.2	0.4				
	Min.	4.0	8.7				
	Max.	9.2	14.0				

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Broadford (Doon Lough)	Mean	7.5	13.0				n/a
	n	6	2				
	S.D.	2.4	0.2				
	S.E.	1.0	0.1				
	Min.	5.2	12.9				
	Max.	11.1	13.1				
Broadford (Broadford Village)	Mean	7.1	14.4				Slow
	n	25	12				
	S.D.	1.2	2.7				
	S.E.	0.2	0.8				
	Min.	4.6	10.8				
	Max.	10.4	18.5				
Clody (Ford near Bunclody)	Mean	6.0	12.0	16.7	20.3		Very slow
	n	32	12	4	1		
	S.D.	1.0	1.2	1.4	n/a		
	S.E.	0.2	0.4	0.7	n/a		
	Min.	4.3	10.1	14.7	20.3		
	Max.	8.9	14.8	18.1	20.3		
Cummeragh (Owengarriff confl.)	Mean	7.7					n/a
	n	9					
	S.D.	2.6					
	S.E.	0.9					
	Min.	4.4					
	Max.	12.4					
Dalua (Liscongill)	Mean	8.0					n/a
	n	3					
	S.D.	1.0					
	S.E.	0.6					
	Min.	6.9					
	Max.	8.8					
Dodder (Beaver Row)	Mean	8.4	11.0				n/a
	n	4	1				
	S.D.	2.6	n/a				
	S.E.	1.3	n/a				
	Min.	5.8	11.0				
	Max.	11.7	11.0				
Dodder (Bohernabreena)	Mean	7.3	12.7				Very slow
	n	26	12				
	S.D.	0.9	1.8				
	S.E.	0.2	0.5				
	Min.	5.4	10.2				
	Max.	9.1	16.9				
Dodder (Mount Carmel)	Mean	7.9					n/a
	n	28					
	S.D.	1.5					
	S.E.	0.3					
	Min.	5.7					
	Max.	12.6					

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Douglas (Sragh Br.)	Mean	7.6					n/a
	n	3					
	S.D.	1.0					
	S.E.	0.6					
	Min.	6.4					
	Max.	8.2					
Dromore (Drummuck)	Mean	8.6	22.0	31.0			Very Fast
	n	8	4	1			
	S.D.	1.1	1.6	n/a			
	S.E.	0.4	0.8	n/a			
	Min.	7.5	20.6	31.0			
	Max.	10.3	23.4	31.0			
Erne (Bellahillan Br.)	Mean	9.2	14.1	24.7			n/a
	n	3	1	1			
	S.D.	2.3	n/a	n/a			
	S.E.	1.4	n/a	n/a			
	Min.	6.6	14.1	24.7			
	Max.	11.1	14.1	24.7			
Erne (Belturbet Br.)	Mean	8.7	16.9	25.6			Fast
	n	22	12	3			
	S.D.	1.2	1.9	1.0			
	S.E.	0.2	0.5	0.6			
	Min.	5.8	12.5	24.7			
	Max.	10.6	19.2	26.7			
Fane (Inishkeen)	Mean	7.4	14.0	20.2			Slow
	n	53	35	8			
	S.D.	1.4	2.5	2.0			
	S.E.	0.2	0.4	0.7			
	Min.	5.1	10.2	16.0			
	Max.	11.1	19.6	22.9			
Fergus (Clonroad Br.)	Mean	6.7	14.6	24.0			Slow
	n	26	21	5			
	S.D.	1.6	2.8	2.1			
	S.E.	0.3	0.6	0.9			
	Min.	4.1	10.8	20.9			
	Max.	9.4	19.9	26.4			
Fergus (Poplar Br.)	Mean	8.3					n/a
	n	23					
	S.D.	1.1					
	S.E.	0.2					
	Min.	6.8					
	Max.	10.8					
Finn (Cumber Br.)	Mean	9.7	18.1				Fast
	n	21	6				
	S.D.	1.5	3.0				
	S.E.	0.3	1.2				
	Min.	6.3	15.6				
	Max.	11.6	23.3				

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Funshion (Blackwater confl.)	Mean	7.8	15.4	20.3			Slow
	n	19	19	6			
	S.D.	2.0	2.6	1.1			
	S.E.	0.5	0.6	0.5			
	Min.	5.4	9.7	18.6			
	Max.	11.5	20.9	21.3			
Glenafelly (Glenafelly Br.)	Mean	6.5	11.9				n/a
	n	12	1				
	S.D.	1.1	n/a				
	S.E.	0.3	n/a				
	Min.	5.0	11.9				
	Max.	8.3	11.9				
Glendine (Knockloskeraun Br.)	Mean	8.5	17.0				n/a
	n	17	1				
	S.D.	1.1	n/a				
	S.E.	0.3	n/a				
	Min.	6.7	17.0				
	Max.	10.9	17.0				
Glory (Raheen)	Mean	7.4	16.2	22.9			Slow
	n	44	17	1			
	S.D.	1.2	1.9	n/a			
	S.E.	0.2	0.5	n/a			
	Min.	5.2	13.3	22.9			
	Max.	10.0	19.7	22.9			
Gourna (Owenogarney confl.)	Mean	8.1	15.6				n/a
	n	28	2				
	S.D.	1.9	1.3				
	S.E.	0.4	0.9				
	Min.	4.0	14.7				
	Max.	11.8	16.6				
Gourna (Railway Br.)	Mean	7.8					n/a
	n	15					
	S.D.	1.3					
	S.E.	0.3					
	Min.	5.8					
	Max.	10.2					
Gowran (Goresbridge)	Mean	8.1					n/a
	n	14					
	S.D.	0.9					
	S.E.	0.2					
	Min.	6.7					
	Max.	9.3					
Gowran (Grange Lower)	Mean	7.7	14.5				Slow
	n	44	16				
	S.D.	1.6	1.3				
	S.E.	0.2	0.3				
	Min.	4.6	12.5				
	Max.	12.7	17.3				

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Graney (Caher Br.)	Mean	5.6	7.9				n/a
	n	18	1				
	S.D.	0.9	n/a				
	S.E.	0.2	n/a				
	Min.	3.9	7.9				
	Max.	7.8	7.9				
Lee, River (Inchinossig Br.)	Mean	5.5	10.9	15.3	20.4		Very Slow
	n	15	10	2	1		
	S.D.	1.1	2.3	0.4	n/a		
	S.E.	0.3	0.7	0.3	n/a		
	Min.	3.4	8.1	15.1	20.4		
	Max.	7.2	14.8	15.6	20.4		
Lee, River (Lee Fields)	Mean	8.0	19.6	25.1			Fast
	n	8	2	1			
	S.D.	1.6	3.0	n/a			
	S.E.	0.6	2.1	n/a			
	Min.	5.1	17.5	25.1			
	Max.	10.2	21.7	25.1			
Licky River (Glenlicky)	Mean	6.0	11.0	13.1			Very Slow
	n	21	8	1			
	S.D.	1.2	1.5	n/a			
	S.E.	0.3	0.5	n/a			
	Min.	4.7	9.1	13.1			
	Max.	9.5	13.0	13.1			
Liffey (Ballyward Br.)	Mean	7.8	15.8	23.7			Slow
	n	52	29	1			
	S.D.	1.5	2.4	n/a			
	S.E.	0.2	0.4	n/a			
	Min.	4.9	12.1	23.7			
	Max.	11.9	21.0	23.7			
Liffey (Kilcullen Br.)	Mean	8.8	18.7	24.5			Fast
	n	52	29	12			
	S.D.	2.1	3.3	3.7			
	S.E.	0.3	0.6	1.1			
	Min.	5.4	14.4	19.8			
	Max.	14.9	28.1	31.7			
Mountnugent (Mountnugent)	Mean	7.5	15.9				Slow
	n	35	5				
	S.D.	1.8	0.8				
	S.E.	0.3	0.4				
	Min.	4.8	15.1				
	Max.	11.8	17.1				
Newport (Rossaguile Br.)	Mean	6.6	12.9	19.2			Slow
	n	32	25	2			
	S.D.	1.3	2.0	2.3			
	S.E.	0.2	0.4	1.6			
	Min.	3.7	9.4	17.6			
	Max.	9.8	16.5	20.8			

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Nier (Ballymacarbry)	Mean	6.0	13.9	21.1	26.2		Slow
	n	31	8	1	1		
	S.D.	1.2	1.0	n/a	n/a		
	S.E.	0.2	0.4	n/a	n/a		
	Min.	3.6	12.4	21.1	26.2		
	Max.	8.6	15.3	21.1	26.2		
Nuenna (Clonmantagh)	Mean	7.2	13.2	18.5			Slow
	n	24	9	1			
	S.D.	1.5	1.5	n/a			
	S.E.	0.3	0.5	n/a			
	Min.	5.4	11.1	18.5			
	Max.	10.7	15.6	18.5			
Owenboliska (Caravan Park)	Mean	8.7	15.0	20.4			Slow
	n	22	7	2			
	S.D.	1.2	2.2	2.5			
	S.E.	0.3	0.8	1.8			
	Min.	6.1	12.1	18.6			
	Max.	10.3	18.1	22.2			
Owendalluleegh (Killafeen Br.)	Mean	8.6	15.9	19.0			Slow
	n	23	8	2			
	S.D.	1.0	3.0	4.8			
	S.E.	0.2	1.0	3.4			
	Min.	6.6	10.4	15.5			
	Max.	10.5	19.8	22.4			
Owvane River (Pierson's Br.)	Mean	6.5	12.4				Very Slow
	n	10	3				
	S.D.	2.0	2.9				
	S.E.	0.6	1.7				
	Min.	5.2	10.7				
	Max.	11.9	15.7				
Screeb (Lough Aughawoolia)	Mean	6.2					n/a
	n	3					
	S.D.	0.3					
	S.E.	0.2					
	Min.	5.8					
	Max.	6.4					
Slaney (Waterloo Br.)	Mean	6.7	12.5				Very Slow
	n	29	14				
	S.D.	1.4	2.6				
	S.E.	0.3	0.7				
	Min.	3.2	7.8				
	Max.	10.0	18.3				
Spancelhill (Spancelhill)	Mean	8.5					n/a
	n	3					
	S.D.	1.5					
	S.E.	0.8					
	Min.	7.0					
	Max.	9.9					

APPENDIX 7 continued

Summary of the growth of brown trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	Growth category
Vartry (Newrath Br.)	Mean	7.8	12.9	19.5			Very slow
	n	14	8	2			
	S.D.	1.7	2.5	1.9			
	S.E.	0.5	0.9	1.4			
	Min.	4.9	8.1	18.1			
	Max.	9.9	15.9	20.9			
White River (Coneyburrow Br.)	Mean	7.4					n/a
	n	2					
	S.D.	0.1					
	S.E.	0.1					
	Min.	7.3					
	Max.	7.5					

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Inland Fisheries Ireland

APPENDIX 8
Summary of the growth of salmon in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Abbert (Bullaun Br.)	Mean	5.4	
	n	18	
	S.D.	0.9	
	S.E.	0.2	
	Min	4.1	
	Max	7.1	
Adrigole (Glashduff confl.)	Mean	5.7	
	n	21.0	
	S.D.	1.1	
	S.E.	0.2	
	Min	3.9	
	Max	7.8	
Araglin (Elizabeth's Br.)	Mean	4.2	7.9
	n	29	12
	S.D.	0.9	0.9
	S.E.	0.2	0.3
	Min	3.0	6.1
	Max	7.0	9.8
Avonbeg (Grennan Br.)	Mean	4.9	8.3
	n	20	10
	S.D.	0.7	0.6
	S.E.	0.2	0.2
	Min	3.7	7.3
	Max	6.4	9.0
Ballyfinboy (Lough Derg)	Mean	4.6	
	n	1	
	S.D.	n/a	
	S.E.	n/a	
	Min	4.6	
	Max	4.6	
Ballyroan (Ballydine Br.)	Mean	6.5	
	n	1	
	S.D.	n/a	
	S.E.	n/a	
	Min	6.5	
	Max	6.5	
Ballyroan (Gloreen Br.)	Mean	5.6	
	n	4	
	S.D.	0.8	
	S.E.	0.4	
	Min	4.6	
	Max	6.3	
Banoge (Owenavorragh confl.)	Mean	8.0	
	n	8	
	S.D.	1.2	
	S.E.	0.4	
	Min	6.1	
	Max	9.6	

APPENDIX 8 continued

Summary of the growth of salmon in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Banoge (M11)	Mean	11.2	
	n	1	
	S.D.	n/a	
	S.E.	n/a	
	Min	11.2	
	Max	11.2	
Blackwater (Kells) (Lough Ramor)	Mean	7.2	
	n	3	
	S.D.	0.6	
	S.E.	0.3	
	Min	6.6	
	Max	7.7	
Blackwater, River (Killavullen Br.)	Mean	5.5	
	n	3	
	S.D.	0.7	
	S.E.	0.4	
	Min	4.6	
	Max	5.9	
Blackwater, River (Lismore Br.)	Mean	5.8	
	n	27	
	S.D.	1.0	
	S.E.	0.2	
	Min	4.3	
	Max	7.9	
Blackwater, River (Nohaval Br.)	Mean	5.1	
	n	19	
	S.D.	1.1	
	S.E.	0.2	
	Min	3.6	
	Max	7.4	
Broadford (Broadford Village)	Mean	5.1	
	n	17	
	S.D.	0.7	
	S.E.	0.2	
	Min	4.0	
	Max	6.5	
Broadford (Doon Lough)	Mean	5.5	
	n	10	
	S.D.	0.8	
	S.E.	0.3	
	Min	3.8	
	Max	6.8	
Clody (Ford near Bunclody)	Mean	5.6	
	n	22	
	S.D.	1.1	
	S.E.	0.2	
	Min	4.1	
	Max	7.6	

APPENDIX 8 continued

Summary of the growth of salmon in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Cummeragh (Owengarriff confl.)	Mean	4.4	7.4
	n	19	3
	S.D.	0.9	0.7
	S.E.	0.2	0.4
	Min	3.1	6.5
	Max	5.7	7.8
Dalua (Liscongill)	Mean	4.3	7.5
	n	27	9
	S.D.	0.6	0.8
	S.E.	0.1	0.3
	Min	3.1	6.4
	Max	6.0	8.9
Dodder (Beaver Row)	Mean	6.7	12.5
	n	8	2
	S.D.	0.6	0.4
	S.E.	0.2	0.3
	Min	5.5	12.2
	Max	7.5	12.8
Fane (Inishkeen)	Mean	5.8	9.2
	n	24	3
	S.D.	1.1	0.5
	S.E.	0.2	0.3
	Min	3.4	8.9
	Max	7.8	9.8
Fergus (Clonroad Br.)	Mean	4.7	
	n	10	
	S.D.	1.1	
	S.E.	0.3	
	Min	3.6	
	Max	6.6	
Fergus (Poplar Br.)	Mean	6.1	14.0
	n	19	2
	S.D.	1.1	0.1
	S.E.	0.2	0.1
	Min	4.7	13.9
	Max	8.9	14.1
Funshion (Blackwater confl.)	Mean	5.1	
	n	21	
	S.D.	1.0	
	S.E.	0.2	
	Min	3.0	
	Max	7.0	
Gourna (Owenogarney confl.)	Mean	5.5	
	n	17	
	S.D.	0.7	
	S.E.	0.2	
	Min	4.1	
	Max	7.1	

APPENDIX 8 continued

Summary of the growth of salmon in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Gourna (Railway Br.)	Mean	5.6	8.2
	n	18	1
	S.D.	0.8	n/a
	S.E.	0.2	n/a
	Min	4.1	8.2
	Max	6.8	8.2
Gowran (Goresbridge)	Mean	6.5	
	n	4	
	S.D.	2.1	
	S.E.	1.1	
	Min	3.4	
	Max	8.0	
Lee, River (Lee Fields)	Mean	6.3	
	n	5	
	S.D.	1.6	
	S.E.	0.7	
	Min	4.8	
	Max	8.9	
Licky River (Glenlicky)	Mean	5.4	9.5
	n	19	2
	S.D.	0.7	1.5
	S.E.	0.2	1.1
	Min	4.2	8.4
	Max	6.9	10.6
Liffey (Kilcullen Br.)	Mean	6.1	11.0
	n	26	2
	S.D.	1.0	0.1
	S.E.	0.2	0.1
	Min	4.3	10.9
	Max	8.0	11.0
Moyree (Fergus Br.)	Mean	6.0	
	n	18	
	S.D.	1.1	
	S.E.	0.3	
	Min	4.1	
	Max	7.9	
Newport (Rossaguile Br.)	Mean	5.1	13.5
	n	22	1
	S.D.	1.1	n/a
	S.E.	0.2	n/a
	Min	3.7	13.5
	Max	8.6	13.5
Nier (Ballymacarbry)	Mean	4.1	7.8
	n	34	12
	S.D.	0.9	0.7
	S.E.	0.2	0.2
	Min	3.2	6.4
	Max	7.8	8.5

APPENDIX 8 continued

Summary of the growth of salmon in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Owenboliska (Caravan Park)	Mean	6.5	9.5
	n	19	1
	S.D.	1.1	n/a
	S.E.	0.3	n/a
	Min	3.5	9.5
	Max	8.4	9.5
Owvane River (Pierson's Br.)	Mean	5.4	
	n	11	
	S.D.	0.7	
	S.E.	0.2	
	Min	4.3	
	Max	6.7	
Screeb (Lough Aughawoolia)	Mean	6.5	
	n	12	
	S.D.	1.0	
	S.E.	0.3	
	Min	5.1	
	Max	8.1	
Slaney (Waterloo Br.)	Mean	5.2	8.0
	n	24	3
	S.D.	1.0	0.0
	S.E.	0.2	0.0
	Min	3.7	8.0
	Max	7.6	8.0
Vartry (Newrath Br.)	Mean	7.0	
	n	3	
	S.D.	0.7	
	S.E.	0.4	
	Min	6.2	
	Max	7.6	
White River (Coneyburrow Br.)	Mean	6.4	
	n	1	
	S.D.	n/a	
	S.E.	n/a	
	Min	6.4	
	Max	6.4	

APPENDIX 9

Summary of the growth of roach in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Abbert (Bullaun Br.)	Mean	4.1									
	n	9									
	S.D.	0.6									
	S.E.	0.2									
	Min	3.2									
	Max	4.8									
Annalee (Cavan confl.)	Mean	2.2	5.1	8.7	11.9	14.6	17.2	19.0	20.7	21.7	22.5
	n	67	65	54	34	27	16	9	4	1	1
	S.D.	0.5	1.3	1.8	1.6	1.2	1.2	1.2	0.8	n/a	n/a
	S.E.	0.1	0.2	0.2	0.3	0.2	0.3	0.4	0.4	n/a	n/a
	Min	1.4	2.6	5.6	7.6	12.2	14.7	17.5	20.0	21.7	22.5
	Max	4.1	8.7	14.2	14.1	16.7	18.7	20.9	21.9	21.7	22.5
Blackwater (Lismore Br.)	Mean	3.7	5.7								
	n	3	3								
	S.D.	0.1	0.2								
	S.E.	0.0	0.1								
	Min	3.6	5.5								
	Max	3.8	5.9								
Cullies (Kilbracken Br.)	Mean	2.3	6.6	10.6	13.0	15.9	18.0	19.6			
	n	34	34	21	13	9	3	1			
	S.D.	0.4	1.1	1.8	1.3	0.8	1.1	n/a			
	S.E.	0.1	0.2	0.4	0.4	0.3	0.6	n/a			
	Min	1.4	4.3	7.1	11.4	14.7	17.1	19.6			
	Max	3.3	9.4	14.2	15.2	16.8	19.3	19.6			
Erne (Bellahillan Br.)	Mean	2.2	4.9	8.1	11.1	14.2	17.0	18.8	20.6		
	n	54	53	42	29	19	8	5	1		
	S.D.	0.5	1.1	1.5	1.6	1.2	1.3	0.4	n/a		
	S.E.	0.1	0.1	0.2	0.3	0.3	0.4	0.2	n/a		
	Min	1.2	2.7	4.4	8.5	12.5	15.6	18.5	20.6		
	Max	3.3	7.7	11.9	14.5	16.5	19.3	19.5	20.6		
Erne (Belturbet Br.)	Mean	2.4	5.6	9.3	12.0	14.3	16.2	17.9			
	n	40	40	39	25	19	11	8			
	S.D.	0.5	1.2	1.7	1.9	1.8	1.5	1.2			
	S.E.	0.1	0.2	0.3	0.4	0.4	0.5	0.4			
	Min	1.6	2.7	6.4	9.3	11.8	13.9	16.2			
	Max	3.7	7.6	14.0	17.3	19.3	18.9	20.0			
Finn (Cumber Br.)	Mean	2.0	4.6	7.9	11.0	13.4	15.8	17.7	20.0	22.2	23.7
	n	57	57	54	42	29	17	10	2	1	1
	S.D.	0.4	0.9	1.2	1.2	1.4	1.6	1.6	0.8	n/a	n/a
	S.E.	0.0	0.1	0.2	0.2	0.3	0.4	0.5	0.5	n/a	n/a
	Min	1.4	3.1	5.7	8.4	10.5	12.5	15.1	19.4	22.2	23.7
	Max	2.8	6.4	10.8	14.2	16.5	18.7	20.3	20.5	22.2	23.7
Lee, River (Inchinossig Br.)	Mean	4.0	8.1	9.9							
	n	6	6	1							
	S.D.	0.9	0.6	n/a							
	S.E.	0.4	0.2	n/a							
	Min	2.9	7.5	9.9							
	Max	5.1	9.1	9.9							

APPENDIX 9 continued

Summary of the growth of roach in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Suck (Ballyforan Br.)	Mean	2.0	4.1	7.7	10.1	13.1	15.5	16.8	18.1	20.0	
	n	79	60	55	31	26	13	4	3	1	
	S.D.	0.6	0.8	1.6	1.4	1.2	1.3	1.7	0.7	n/a	
	S.E.	0.1	0.1	0.2	0.3	0.2	0.4	0.8	0.4	n/a	
	Min	1.0	2.6	4.2	6.3	11.1	13.4	15.3	17.5	20.0	
	Max	4.0	5.9	11.4	13.5	15.5	17.7	18.9	18.8	20.0	
Suck (Cloondacarra Br.)	Mean	2.6	5.4	8.1	10.9	13.3	15.8	18.2	20.2	21.3	
	n	89	81	64	43	37	30	8	5	2	
	S.D.	0.8	1.2	1.3	1.6	1.6	1.8	1.1	0.7	0.0	
	S.E.	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.3	0.0	
	Min	1.1	3.0	6.0	8.2	10.6	12.4	16.3	19.6	21.3	
	Max	4.8	8.2	10.9	14.3	16.6	19.5	19.3	21.2	21.4	

APPENDIX 10

Summary of the growth of pike in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6
Lee, River (Lee Fields)	Mean	21.5	46.0	57.1			
	n	2.00	1.00	1.00			
	S.D.	1.2	n/a	n/a			
	S.E.	0.8	n/a	n/a			
	Min	20.7	46.0	57.1			
	Max	22.4	46.0	57.1			
Liffey (Ballyward Br.)	Mean	16.6	28.7				
	n	2.00	1.00				
	S.D.	0.8	n/a				
	S.E.	0.6	n/a				
	Min	16.0	28.7				
	Max	17.2	28.7				
Annalee (Cavan confl.)	Mean	18.9	30.3	41.2	50.0		
	n	20	4	3	2		
	S.D.	3.1	3.3	2.7	3.1		
	S.E.	0.7	1.6	1.6	2.2		
	Min	13.8	27.2	38.1	47.8		
	Max	26.1	35.0	43.3	52.2		
Cullies (Kilbracken Br.)	Mean	20.9					
	n	1					
	S.D.	n/a					
	S.E.	n/a					
	Min	20.9					
	Max	20.9					
Erne (Bellahillan Br.)	Mean	15.1	30.4	42.0	51.2	61.4	64.9
	n	20	12	8	7	2	2
	S.D.	2.2	4.0	4.4	5.1	1.1	1.6
	S.E.	0.5	1.2	1.5	1.9	0.8	1.1
	Min	10.9	22.5	35.1	43.4	60.6	63.8
	Max	18.2	35.4	47.5	55.5	62.2	66.0
Erne (Belturbet Br.)	Mean	17.4	30.6	40.9			
	n	6	2	1			
	S.D.	4.1	6.3	n/a			
	S.E.	1.7	4.5	n/a			
	Min	10.9	26.1	40.9			
	Max	21.4	35.1	40.9			
Finn (Cumber Br.)	Mean	22.3	39.6	52.9	65.4		
	n	4	3	2	1		
	S.D.	4.9	3.1	4.8	n/a		
	S.E.	2.4	1.8	3.4	n/a		
	Min	19.1	36.1	49.5	65.4		
	Max	29.5	41.9	56.3	65.4		
Fergus (Clonroad Br.)	Mean	26.9	50.7	67.6	79.1		
	n	5	3	3	2		
	S.D.	6.7	8.5	8.0	9.5		
	S.E.	3.0	4.9	4.6	6.7		
	Min	20.1	43.3	60.1	72.4		
	Max	34.9	60.0	76.1	85.8		

APPENDIX 10 continued

Summary of the growth of pike in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6
Suck (Ballyforan Br.)	Mean	19.9	29.8	47.2	60.7	70.7	
	n	28	23	6	3	1	
	S.D.	3.5	5.4	5.3	6.2	n/a	
	S.E.	0.7	1.1	2.2	3.6	n/a	
	Min	14.2	22.1	38.4	53.9	70.7	
	Max	26.9	40.4	53.3	66.2	70.7	
Suck (Cloondacarra Br.)	Mean	14.7	29.5	48.8			
	n	9	8	1			
	S.D.	3.5	2.9	n/a			
	S.E.	1.2	1.0	n/a			
	Min	10.9	26.1	48.8			
	Max	22.0	33.6	48.8			

APPENDIX 11

Summary of the growth of dace in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6
Blackwater (Killavullen Br.)	Mean	3.2	7.7	12.4	15.7	19.2	21.0
	S.D.	0.7	1.2	1.8	2.5	2.2	0.9
	S.E.	0.2	0.3	0.5	0.8	0.7	0.4
	n	15	15	15	10	9	5
	Min	2.4	5.	8.8	11.3	16.0	20.2
	Max	4.8	9.3	16.2	20.7	22.9	22.3
Blackwater (Lismore Br.)	Mean	3.3	8.5	13.0	21.3		
	S.D.	0.3	1.2	1.6	n/a		
	S.E.	0.2	0.6	0.8	n/a		
	n	5	5	4	1		
	Min	3.1	7.0	11.5	21.3		
	Max	3.9	10.1	15.2	21.3		
Funshion (Blackwater confl.)	Mean	4.4	9.1				
	S.D.	1.6	0.3				
	S.E.	0.8	0.2				
	n	4	2				
	Min	3.0	8.8				
	Max	6.1	9.3				

APPENDIX 12

Summary of the growth of sea trout in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3
Liffey (Ballyward Br.)	Mean	6.6	16.6	27.6
	n	1	1	1
	S.D.	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a
	Min	6.6	16.6	27.6
	Max	6.6	16.6	27.6

APPENDIX 13

Summary of the growth of bream in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9
Annalee (Cavan confl.)	Mean	3.0	7.1	11.9	15.1	20.4	22.8	27.2	27.3	30.7
	n	2	2	2	2	2	2	2	1	1
	S.D.	0.3	0.6	1.8	1.5	2.7	4.0	3.7	n/a	n/a
	S.E.	0.2	0.5	1.3	1.1	1.9	2.9	2.6	n/a	n/a
	Min	2.8	6.6	10.6	14.0	18.5	19.9	24.6	27.3	30.7
	Max	3.2	7.5	13.1	16.2	22.3	25.7	29.8	27.3	30.7

APPENDIX 14

Summary of the growth of roach x bream hybrids in rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6
Annalee (Cavan confl.)	Mean	2.4	6.3	11.2	14.5	19.8	21.5
	n	1	1	1	1	1	1
	S.D.	n/a	n/a	n/a	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a	n/a	n/a	n/a
	Min	2.4	6.3	11.2	14.5	19.8	21.5
	Max	2.4	6.3	11.2	14.5	19.8	21.5

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