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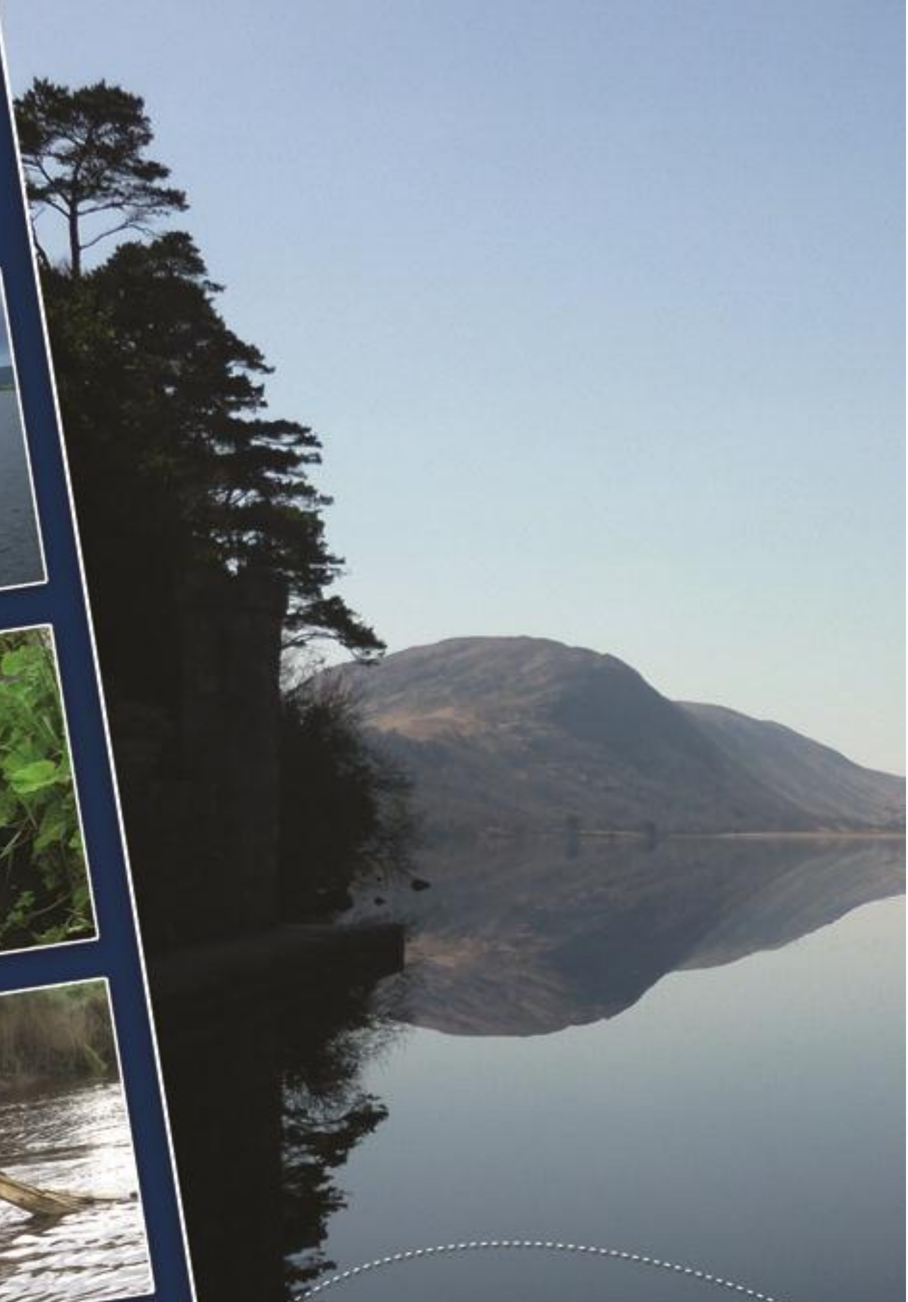

Sampling Fish for the Water Framework Directive

Summary Report 2011

Iascach Intíre Éireann
Inland Fisheries Ireland

Sampling Fish for the Water Framework Directive - Summary Report 2011

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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 are responsible for monitoring fish for the Water Framework Directive. The dedicated WFD staff based at IFI Swords 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 2011, the WFD surveillance monitoring programme was 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 waterbodies; however, despite this, concerted efforts by the WFD team in IFI Swords, 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, Swords; however, it is gratefully acknowledged that without the support and commitment of the management and staff in the IFI regional offices during 2011, 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 2011 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 2012.

Ciaran Byrne

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Dr Ciaran Byrne
CEO, Inland Fisheries Ireland

August 2012

Foreword

Welcome to Inland Fisheries Ireland's Sampling Fish for the Water Framework Directive – Summary Report 2011.

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 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 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.

The first year of the second three year cycle began in 2010 with an extensive surveillance monitoring programme. A total of 25 lakes, 25 transitional waters and 43 river sites were surveyed, and over 50,000 fish captured and examined. The second year of the second three year cycle began in 2011 with another extensive surveillance monitoring programme. A total of 29 lakes, 2 transitional waters and 65 river sites were surveyed, and over 34,000 fish captured and examined. 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 four 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 decision makers, angling clubs, fishery owners and other interested parties. Detailed reports for each water body surveyed in 2011 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 from 2007 to 2010. Data from the 2011 surveillance monitoring programme will be available on this map viewer later in 2012.

In addition to the above, the IFI WFD team are also providing fish samples to IFIs National Eel Monitoring Programme and the Celtic Sea Trout Project whilst also collaborating with other IFI projects, e.g. the EU Habitats Directive project in relation to conservation 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,
August 2012

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 the extended deadlines (refer to the River Basin Management Plans at www wfdireland.ie).

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.

Surveillance monitoring locations for all biological quality elements, including fish, have been set out in the WFD Water Monitoring Programme published by the Environmental Protection Agency (EPA) in 2006. 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 surveyed in a three year rolling programme. In 2011, a comprehensive fish surveillance monitoring programme was conducted, with 65 river sites, 29 lakes and 2 transitional waters 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 2011 surveillance monitoring programme and highlights the current status of each water body in accordance with the fish populations present.

Twenty-nine lakes were surveyed during 2011, with a total of 17 fish species (sea trout are included as a separate 'variety' of trout) and three types of hybrids being recorded. Eel was the most common fish species recorded, being found in all lakes surveyed (100%). This was followed by brown trout, perch, pike and roach which were present in 72%, 66%, 48% and 48% of lakes respectively. In general, salmonids were the dominant species in the north, west and south-west of the country. Sea trout were captured in six lakes in the north-west, west and south-west; Lough Beagh, Glencullin Lough, Carrowmore Lake, Lough Brin and Lough Leane. Arctic char were recorded in six lakes in the south-west, north-west and west; Lough Acoose, Lough Caragh, Lough Leane, Lough Beagh, Lough Melvin and Lough Talt. Perch, followed by pike and roach were the most widely distributed non-native species recorded during the 2011 surveillance monitoring programme, with perch being present in 19 lakes and pike along with roach being present in 14 out of the 29 lakes surveyed.

An ecological classification tool for fish in lakes (FIL1) was developed for the island of Ireland using Republic of Ireland and Northern Ireland data collected during the NSSHARE Fish in Lakes project (2005 and 2006) and during WFD fish surveillance monitoring (2007 to 2010) (Kelly *et al*., 2008b; Kelly *et al*., 2012). All lakes surveyed during 2011 have been assigned a draft ecological status based on the fish populations present; eight lakes were classified as High, ten were classified as Good, five were classified as Moderate and seven were classified as Poor/Bad. The geographical variation in ecological status reflects the change in fish communities (mainly salmonids) from upland lakes with little human disturbance to the fish communities associated with lowland lakes subject to more intensive anthropogenic pressures (mainly percids and cyprinids).

A total of 65 river sites were surveyed during 2011 using boat-based electric-fishing gear for the non-wadeable sites and hand-set electric-fishing gear for the wadeable sites. A total of 14 fish species (sea trout are included as a separate 'variety' of trout) and one type of hybrid were recorded. Species richness ranged from ten in the Rye Water (Kildare bridge site) to zero species in the Piperstown stream site. Brown trout was the most common species recorded, being present in 89% of sites surveyed, followed by three-spined stickleback (66%), eels (60%), stone loach (55%), salmon (49%) and lamprey (46%). Brown trout and salmon population densities were greater in wadeable streams using bank-based electric-fishing gear compared to deeper rivers surveyed using boat-based electric-fishing gear. This is mainly due to the preference for juvenile salmonids to inhabit shallow riffle areas.

An ecological status classification tool for fish in Irish rivers has also recently been developed, broadly based on the 'Fisheries Classification Scheme 2' used by the Environment Agency in England and Wales (SNIFFER, 2011). The new tool, 'FCS2 Ireland', has updated and improved the original FCS2 model using data from Northern Ireland and the Republic of Ireland to produce a WFD compliant statistical model for assigning ecological status to Irish rivers based on fish population parameters. This tool, along with expert opinion, was used to classify all river sites surveyed during 2011; eight river sites were classified as High, 21 were classified as Good, 28 were classified as Moderate, six were classified as Poor and one was classified as Bad ecological status.

Two transitional water bodies were surveyed during 2011. These were Castlemaine Harbour and Cromane Estuary, both of which are located in Dingle Bay. A total of 26 fish species (sea trout are included as a separate 'variety' of trout) were recorded across both water bodies. Twelve fish species were captured in Castlemaine Harbour and 19 species in Cromane Estuary. Five species were common to both water bodies. Some important species encountered during these surveys included brown trout, salmon, European sea bass and pollack.

An ecological classification tool (Transitional Fish Classification Index – TFCI) for fish in transitional waters has also been developed for the Island of Ireland (Ecoregion 17) using IFI and Northern

Ireland Environment Agency (NIEA) data (Coates *et al*., 2007). Using the TFCI, Castlemaine Harbour was assigned a draft ecological classification of of "Good" and Cromane Estuary as "Moderate".

In addition to the Water Framework Directive requirements of information on ecological status, the work conducted in 2011 provides more comprehensive information on fish stocks in a large number of Irish surface waters. For example, in September salmon were identified in the Tolka River, indicating a return for this species to this river for the first time in over 100 years. 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, Dr. Ciara Wogerbauer 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, 2010 to 2012. Mr. Michael Behan, Ms. Karen Kelly, Ms. Sinead O'Reilly and Ms. Patricia Wilson assisted with fieldwork during these surveys.

Acknowledgements

The authors wish to gratefully acknowledge the help and co-operation of the Directors and their staff from the seven regional IFI river basin district offices and also all their colleagues in IFI, Swords. Cooperation 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 land owners who provided site access for surveys. Many angling clubs also kindly supported the surveys (including the Glenbeg Angling Club in County Kerry, the Lough Melvin Rossinver Fishery and the Lough Owel anglers) and their help is also gratefully acknowledged. Mr. Michael Wade from Delphi Fishery, Co. Mayo and Mr. Roderick Perceval, Templehouse, Co. Sligo provided access to their respective fisheries and their help is gratefully acknowledged. The authors would also like to thank National Parks and Wildlife service (NPWS) and their staff in Glenveagh and Killarney National Parks for facilitating access and providing assistance during the Lough Barra, Lough Beagh, Lough Leane and Upper Lake Killarney surveys.

The authors would also like to acknowledge the funding provided for the project from the Department of Communication, Energy and Natural resources (DCENR) for 2011.

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 Swords, Co. Dublin operating alongside seven regional offices; Eastern River Basin District (IFI, Blackrock), South-Eastern River Basin District (IFI, Clonmel), South-Western River Basin District (IFI, Macroom), Shannon International River Basin District (IFI, Limerick), Western River Basin District (IFI, Ballina and IFI, Galway) and North-Western International River Basin District (IFI, Ballyshannon).

TABLE OF CONTENTS

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, in 2006, a programme of monitoring to be carried out in Ireland in order to meet the legislative requirements of the WFD.

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 will provide new information on the status of fish species present in these waterbodies 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.

The WFD fish surveillance monitoring programme in 2011 has again been extensive and 65 river sites, 29 lakes and two transitional water bodies were successfully surveyed nationwide. A team of scientists from the Research and Development section of IFI Swords carried out the monitoring surveys 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 and various netting techniques are being used in lakes and estuaries. Survey work was conducted between June and October, which is the optimum time for sampling fish in Ireland. Although relatively favourable weather conditions, particularly during the early field season, facilitated the completion of most surveys, reductions in staffing levels and resources resulted in some river sites and transitional water bodies planned for 2011 being deferred until 2012.

This report summarises the main findings of the fish stock surveys in all water bodies (lakes, rivers and transitional waters) surveyed during 2011 and reports the current ecological status of the fish stocks in each, using newly developed ecological classification tools, are also presented here.

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-nine lakes (30 water bodies), ranging in size from 24.5ha (Lough Brin) to 11,519.9ha (Lough Corrib Upper), were surveyed between June and October 2011. 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 five different RBDs (Table 2.1, Fig. 2.1).

Seven lakes were surveyed in the South Western River Basin District (SWRBD) (Lough Acoose, Lough Caragh, Lough Allua, Glenbeg Lough, Lough Leane, Upper Lake and Lough Brin). Six lakes were surveyed in the Shannon International River Basin District (ShIRBD), ranging in size from 52.9ha (Annaghmore Lough) to 1808.2ha (Lough Sheelin). One lake was surveyed in the Eastern River Basin District (ERBD) (Upper Lough Skeagh). Eight lakes were surveyed in the North Western International River Basin District (NWIRBD), ranging in size from 36.2ha (Derrybrick Lough) to 2197ha (Lough Melvin) and seven lakes (eight water bodies) were surveyed in the Western River Basin District (WRBD), ranging in size from 34.1ha (Glencullin Lough) to 11519.9ha (Lough Corrib Upper). Summary details of all lakes surveyed in 2011 are shown in Table 2.1.

Table 2.1. Summary details of lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2011

Lake name	Water body code	Catchment	Easting	Northing	WFD Typology	Area (ha)	Mean depth (m)	Max depth (m)
SWRBD								
Acoose	SW_22_208	Caragh	75602	85287	4	66.3	>4.0	19.0
Allua	SW_19_4	Lee	118989	65591	4	135.9	4.0	28.4
Brin	SW_21_402	Blackwater	78334	77451	3	24.5	5.9	13.0
Caragh	SW_22_207	Caragh	71986	90432	4	488.7	11.0	39.0
Glenbeg	SW_21_444	Coastal	70632	53003	4	66.2		32.0
Leane	SW_22_185	Laune	93171	88660	8	1944.3	13.0	60.0
Upper Lake Killarney	SW_22_186	Laune	90931	82113	4	166.7	14.5	36.0
ShIRBD								
Annaghmore	SH_26_669	Shannon Upr	189942	283670	10	52.9	<4.0	16.0
Cavetown	SH_26_705	Shannon Upr	183228	297430	10	64.0	<4.0	20.0
Meelagh	SH_26_711	Shannon Upr	189093	312025	6	115.7	<4.0	14.0
O' Flynn	SH_26_693	Suck	158361	279690	10	136.9	4.5	14.5
Owel	SH_26_703	Inny	240155	258633	8	1017.6	>4.0	22.0
Sheelin	SH_26_709	Inny	244291	283941	12	1808.2	4.4	15.0
ERBD								
Skeagh Upper	EA_07_267	Boyne	265083	301342	6	61.0	2.2	4.9
NWIRBD								
Barra	NW_38_84	Gweebarra	193447	411876	4	62.3	4.4	12.0
Beagh	NW_38_80a	Lackagh	202074	421485	4	259.0	9.2	46.5
Corglass	NW_36_655	Erne	234842	308823	9	34.3	1.6	6.0
Derrybrick	NW_36_400	Erne	234514	312044	9	36.2	2.1	5.0
Egish	NW_36_671	Erne	277884	312744	10	117.0	3.3	10.0
Fern	NW_39_13	Leannan	218292	424349	6	181.0	2.0	3.0
Kiltooris	NW_38_47	Coastal	167183	396339	5	43.3	<4.0	14.0
Melvin	NW_35_160	Drowes	189530	353752	8	2197.0	7.8	40.0
WRBD								
Gill	WE_35_158	Garavogue	175363	333545	8	1375.3	>4.0	31.0
Carrowmore	WE_33_1914	Owenmore	83597.47	327913.36	6	911.2	<4.0	2.5
Easky	WE_35_136	Easky	144396	323036	2	118.7	3.0	10.5
Glencullin	WE_32_487	Bundorragha	81952	269647	1	34.1	<4.0	13.0
Corrib Lower	WE_30_666a	Corrib	127105	236016	10	5042.0	<4.0	6.8
Corrib Upper	WE_30_666b	Corrib	113819	248676	12	11519.0	>4.0	42.0
Talt	WE_34_405	Moy	139683	315172	8	96.9	>4.0	40.0
Templehouse	WE_35_157	Ballysadare	161565	317148	10	118.6	2.6	5.3

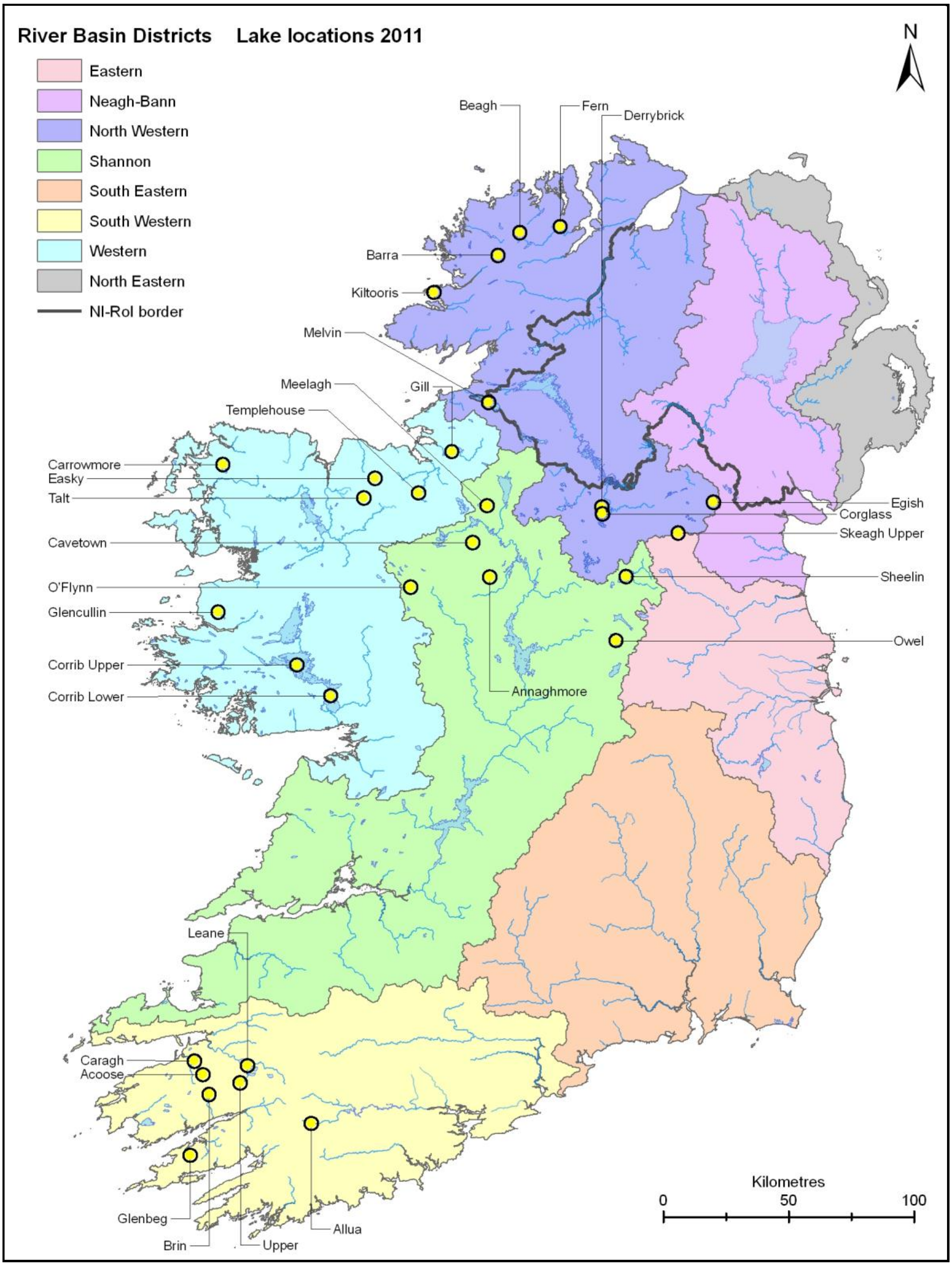

Fig. 2.1. Location of the 29 lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2011

2.2 Rivers

Sixty-five river sites, ranging in surface area from 80m^2 (Mayne River, Co. Dublin) to 1,679m^2 (Owenavorragh River, Co. Wexford), were surveyed between July and September 2011. 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 Ireland (Table 2.2, Table 2.3 and Fig. 2.2).

Twenty-one river sites were surveyed in the ERBD and all of which were shallow and suitable for bank based electric-fishing equipment. These ranged in surface area from 80m^2 (Mayne River) to 626m^2 (River Dodder at Beaver Row). Seven river sites were surveyed in the SERBD, with surface areas ranging from 180m^2 (Duncormick River) and 1679 m^2 (Owenavorragh River). Only one river (Owenavorragh) was deep enough to require the use of boat based electric-fishing equipment. Seventeen river sites were surveyed in the ShIRBD, ranging in size from 130m^2 (Inny at Oldcastle) to 1652m^2 Scramoge (Riverdale). Of these sites, five required boat based electric-fishing equipment for the surveys. Five sites were surveyed in the SWRBD (all wadeable) and these ranged in size from 167m^2 (Glashaboy River) to 311m^2 (Womanagh River). Six sites were surveyed in the WRBD (all wadeable), ranging in size from 124m^2 (Tobercurry River) to 531m^2 (Glennamong River). Finally nine sites were surveyed in the NWIRBD (all wadeable), which ranged in size from 183m^2 (Ballyhallan River) to 393m^2 (Swanlinbar 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 October 2011

River	Site name	Catchment	Site Code	Waterbody code
ERBD Wadeable sites				
Avoca	1km N of Woodenbridge	Avoca	10A030800	EA_10_1477
Baltracey	Fraynes Br.	Liffey	09C030600	EA_09_1129
Brittas	Br. just off R114	Liffey	09B020100	EA_09_465
Broadmeadow	Lispopple Br.	Broadmeadow	08B020700	EA_08_295
Camac	Riverside Estate Br.	Liffey	09C020310	EA_09_1872
Camac	Moneenalion Commons Br.	Liffey	09C020250	EA_09_12
Dodder	Footbridge, Beaver Row	Liffey	09D010900	EA_09_587
Dodder	Mount Carmel Hospital	Liffey	09D010680	EA_09_587
Dodder	Bohernabreena	Liffey	09D010100	EA_09_1656
Piperstown	Tributary at Corrageen	Liffey	09P030200	EA_09_1656
Griffeen	Griffeen Avenue Br.	Liffey	09G050300	EA_09_242
Griffeen	Grange Castle	Liffey	09G050200	EA_09_242
Lyreen	Lyreen Angling Centre	Liffey	09L020100	EA_09_611
Mayne	Wellfield Br.	Mayne	09M030500	EA_09_1428
Owendoher	Cruagh Road Br.	Liffey	09O011100	EA_09_1867
Pinkeen	Br. S. of Calliagawee	Tolka	09P020500	EA_09_1538
Ratoath	Br. in Ratoath	Broadmeadow	08R010150	EA_08_240
Rye	Kildare Br.	Liffey	09R010400	EA_09_246
Rye	Balfeaghan Br.	Liffey	09R010100	EA_09_608
Tolka	Violet Hill Drive	Tolka	09T011100	EA_09_1868
Ward	Br. d/s of Scotchstone Br.	Broadmeadow	08W010620	EA_08_670
SERBD Wadeable sites				
Ballyroan	Gloreen Br.	Nore	15B010200	SE_15_1938
Banoge	Br u/s Owenavorragh confl	Owenavorragh	11B020300	SE_11_257
Douglas (Ballon)	Sragh Br.	Slaney	12D030200	SE_12_789
Duag	Br. u/s Ballyporeen	Suir	16D030100	SE_16_639
Duncormick	Br. nr Duncormick Rly St.	Duncormick	13D010350	SE_13_745
Nuenna	Br. d/s Clomantagh	Nore	15N020100	SE_15_1029
SERBD Non-Wadeable sites				
Owenavorragh	Br. N of Ballinamona	Owenavorragh	11O010500	SE_11_251
SWRBD Wadeable sites				
Glashaboy	Ballyvorisheen Br.	Glashaboy	19G010200	SW_19_755
Gweestin	Gweestin Br.	Laune	22G061200	SW_22_2207
Martin	Bawnafinny Br.	Lee	19M010600	SW_19_838
Shanowen	Ford u/s Maine confl	Maine	22S010100	SW_22_3452
Womanagh	ATV centre	Womanagh	19W011300	SW_19_1793

Table 2.2 ctn. Location and codes of river sites surveyed for the WFD fish surveillance monitoring programme, July to October 2011

River	Site name	Catchment	Site Code	Waterbody code
ShIRBD Wadeable sites				
Boor	Br. NW of Kilbillaghan	Shannon Upr	26B071100	SH_26_3921
Bow	Bow River Br.	Shannon Lwr	25B100100	SH_25_2145
Camlin	Br. just S of Killoe	Shannon Upr	26C010500	SH_26_3927_2
Deel (Newcastlewest)	Br. near Balliniska	Shannon Est Sth	24D020400	SH_24_863
Gourna	Beside railway Br.	Bunratty	27G020600	SH_27_885
Gourna	Br. u/s Owenogarney confl	Bunratty	27G020550	SH_27_885
Graney	Caher Br.	Shannon Lwr	25G040025	SH_25_2081
Inny	Br. 1 km S of Oldcastle	Inny	26I010100	SH_26_2060
Inny	Tully	Inny	26I010220	SH_26_2664
Little (Cloghan)	Br. SW of Cloghan	Shannon Lwr	25L010200	SH_25_3014
Mountnugent	Mountnugent Br.	Inny	26M020500	SH_26_2742
Mountnugent	Racraveen	Inny	26I010450	SH_26_2742
ShIRBD Non-wadeable sites				
Camlin	Br. W. of Lisnabo	Shannon Upr	26C011000	SH_26_3927_2
Clodiagh (Tullamore)	Br. at Rahan	Shannon Lwr	25C060500	SH_25_2952
Scramoge	Br. N.E. of Riverdale	Shannon Upr	26S010320	SH_26_3801
Scramoge	Carrowclogher	Shannon Upr	26S010330	SH_26_3801
Silver (Kilcormac)	Lumcloon Br.	Shannon Lwr	25S020700	SH_25_3701
WRBD Wadeable sites				
Ballinglen	Ballinglen Br.	Ballinglen	33B010100	WE_33_2091
Behy	Behy Br.	Moy	34B080400	WE_34_3999
Castlebar	Br. 2.5 km d/s Castlebar	Moy	34C010200	WE_34_3953
Clydagh(Castlebar)	Br. NW Ardvarney	Moy	34C050030	WE_34_314
Glennamong	Br. u/s Lough Feeagh	Srahmore	32G030100	WE_32_2441
Tobercurry	Br. just u/s of Moy	Moy	34T020200	WE_34_2633
NWIRBD Wadeable sites				
Ballyhallan	Br. u/s Clonmany River	Clonmany	40B010200	NW_40_1082
Burnfoot	Br. in Burnfoot	Burnfoot	39B020600	NW_39_1105
Cronaniv	Br. u/s Dunlewy Lough	Clady	38C060100	NW_38_800
Dromore	Drummuck	Erne	36D020012	NW_36_30
Glaskeelan	Br. W. of Roshin	Leannan	39G050100	NW_39_1136
Owentocker	D/s of Br. in Ardara	Owentocker	38O060300	NW_38_3037
Swanlinbar	D/s Swanlinbar Br.	Erne	36S010290	NW_36_18
Swilly	Swilly Br. (near Breenagh)	Swilly	39S020050	NW_39_1508
Waterfoot	Letter Br.	Erne	36W030700	XB_36_west_5

Table 2.3.Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, July to October 2011

River	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ERBD Wadeable sites					
Avoca	386.3	13.50	567	0.40	0.50
Baltracey	21.3	3.13	138	0.15	0.35
Brittas	9.2	2.70	227	0.13	0.28
Broadmeadow	93.9	9.12	410	0.10	0.31
Camac (Riverside)	32.9	3.98	151	0.23	0.67
Camac (Moneenalion)	21.2	4.08	155	0.11	0.25
Dodder (Beaver Row)	104.6	13.32	626	0.21	0.48
Dodder (Mount Carmel)	93.2	11.62	407	0.24	0.40
Dodder (Bohernabreena)	31.8	6.37	274	0.16	0.43
Piperstown	2.6	1.82	85	0.06	0.21
Griffeen (Avenue)	27.0	3.72	164	0.09	0.18
Griffeen (Grange Castle)	21.4	1.90	80	0.18	0.27
Lyreen River	88.0	4.28	171	0.08	0.15
Mayne River	15.0	1.90	80	0.24	0.45
Owendoher River	3.2	3.65	164	0.21	0.46
Pinkeen River	13.7	3.08	123	0.18	0.40
Ratoath Stream	14.5	2.98	107	0.09	0.17
Rye Water (Kildare Br.)	179.4	6.87	288	0.27	0.48
Rye Water (Balfeaghan Br.)	36.7	3.38	152	0.18	0.47
Tolka River	136.3	8.72	340	0.35	0.67
Ward River	61.8	3.60	180	0.14	0.28
SERBD Wadeable sites					
Ballyroan	39.3	4.97	189	0.15	0.31
Banoge	29.4	4.45	334	0.18	0.44
Douglas (Ballon)	15.2	4.05	365	0.13	0.25
Duag	16.4	4.20	210	0.14	0.28
Duncormick	36.4	4.00	180	0.19	0.46
Nuenna	22.8	5.28	232	0.25	0.50
SERBD Non-Wadeable sites					
Owenavorragh	82.9	7.30	1679	0.41	0.83
SWRBD Wadeable sites					
Glashaboy	15.4	3.70	167	0.25	0.37
Gweestin	67.8	7.97	271	0.43	0.82
Martin	88.5	6.80	306	0.23	0.69
Shanowen	41.4	7.23	289	0.21	0.46
Womanagh	66.9	6.90	338	0.36	0.62

Table 2.3 ctn. Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, July to October 2011

River	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ShIRBD Wadeable sites					
Boor	53.7	4.73	237	0.31	0.89
Bow	10.8	5.33	240	0.14	0.62
Camlin (Killoe)	114.7	6.57	236	0.41	0.61
Deel (Newcastlewest)	152.7	8.52	426	0.28	0.59
Gourna (Railway)	15.3	4.98	219	0.22	0.42
Gourna (Owenogarney)	15.0	4.18	188	0.17	0.41
Graney (Caher Br.)	13.7	5.62	213	0.12	0.39
Inny (Oldcastle)	13.2	3.25	130	0.23	0.51
Inny (Tully)	52.6	5.12	220	0.23	0.54
Little (Cloghan)	29.9	3.62	264	0.17	0.47
Mountnugent (Mountnugent Br.)	91.1	7.03	309	0.31	0.57
Mountnugent (Racraveen)	87.9	6.32	208	0.19	0.42
ShIRBD Non-Wadeable sites					
Camlin (Lisnabo)	260.4	11.00	1133	0.55	0.74
Clodiagh(Tullamore)	253.4	7.83	1253	0.56	1.00
Scramoge (Riverdale)	137.1	7.00	1652	0.66	1.20
Scramoge (Carrowclogher)	137.2	6.00	648	0.62	0.85
Silver (Kilcormac)	156.4	7.00	938	0.47	1.16
WRBD Wadeable sites					
Ballinglen	33.1	9.90	416	0.15	0.36
Behy	35.3	6.93	291	0.14	0.26
Castlebar	90.2	6.98	335	0.08	0.15
Clydagh (Castlebar)	6.3	5.57	256	0.08	0.20
Glennamong	15.3	7.08	531	0.20	0.70
Tobercurry	24.8	2.82	124	0.18	0.36
NWIRBD Wadeable sites					
Ballyhallan	8.7	4.57	183	0.24	0.45
Burnfoot	20.8	4.33	208	0.21	0.40
Cronaniv Burn	6.9	5.60	252	0.21	0.57
Dromore	37.1	5.68	227	0.21	0.39
Glaskeelan	16.5	5.80	255	0.35	0.56
Owentocker	43.1	8.43	354	0.36	0.80
Swanlinbar	21.6	8.55	393	0.24	0.50
Swilly	18.9	7.57	341	0.37	0.72
Waterfoot	29.3	7.62	335	0.08	0.16

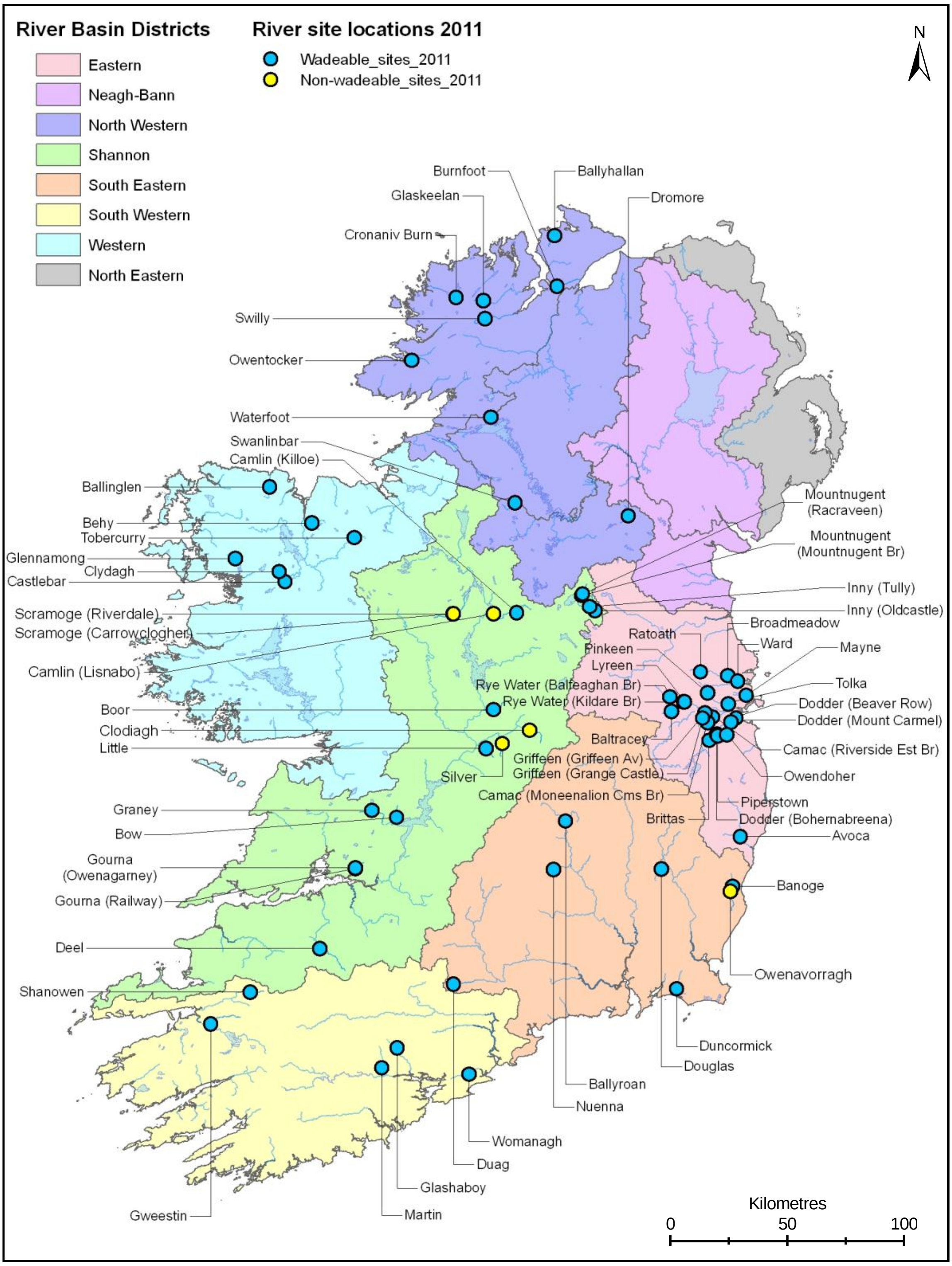

Fig. 2.2. Location of the 65 river sites surveyed for the WFD fish surveillance monitoring programme, July to October 2011

2.3 Transitional waters

Two transitional water bodies, Castlemaine Harbour and Cromane Estuary were surveyed in September 2011 (Table 2.4 and Fig. 2.3).

Both water bodies were located in Dingle Bay, Co. Kerry, covering an area of 6.36m^2 and 50.87m^2 for Castlemaine Harbour and Cromane Estuary respectively.

Table 2.4.Transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2011 (TW=transitional)

Water body	MS Code	Easting	Northing	Type	Area (km^2)
Castlemaine Harbour	SW_230_0200	076494	100820	TW	6.36
Cromane Estuary	SW_230_0100	067394	095673	TW	50.87

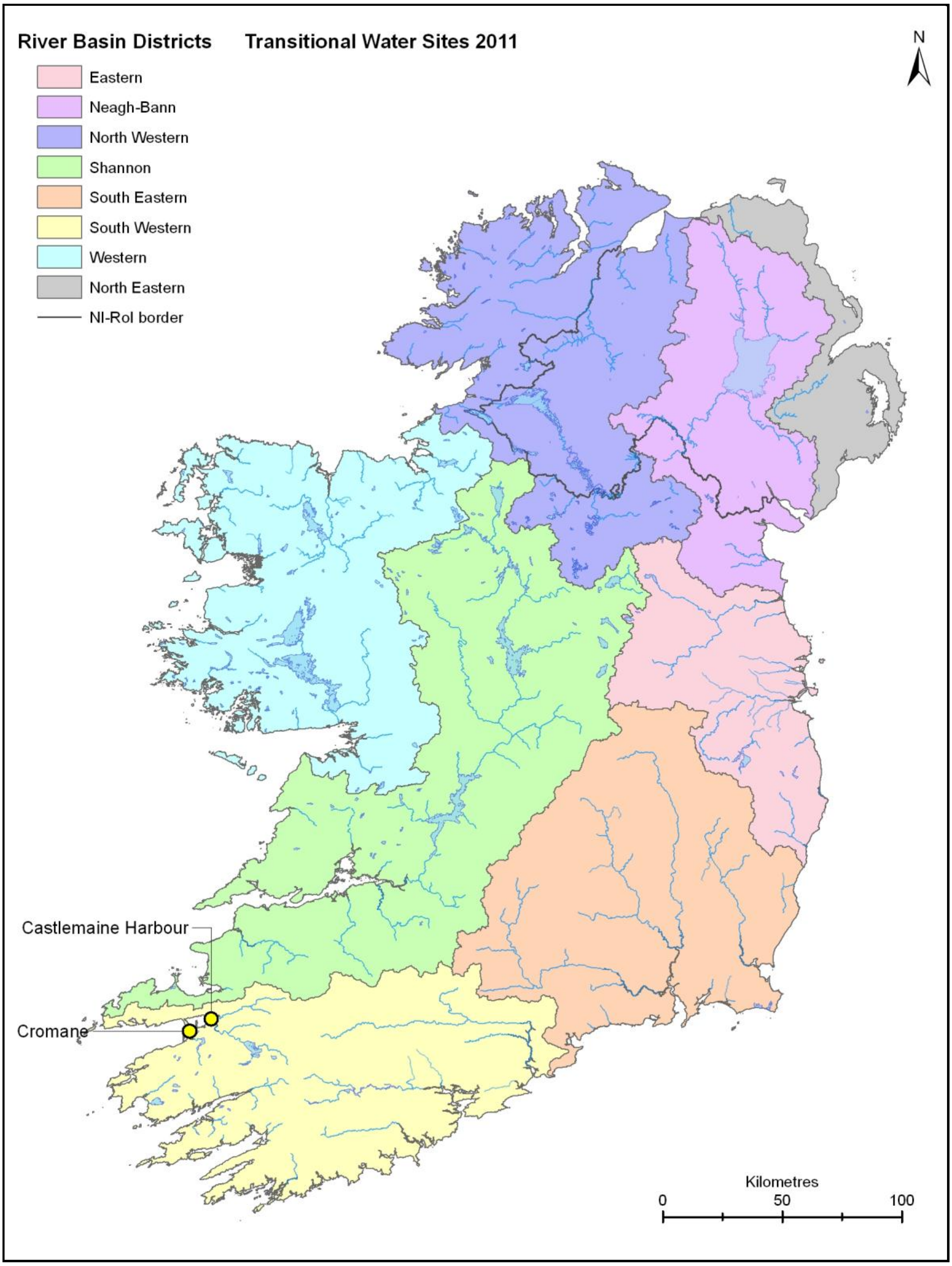

Fig. 2.3. Location of the two transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2011

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 and a multi-method netting approach is used in 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 (12 panel, 5-55mm mesh size) CEN standard survey gill nets (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 3 fyke nets; leader size 8m x 0.5m, Plate 3.3) 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. 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 Lough Sheelin, Co. Westmeath

Plate 3.2. Setting a surface floating monofilament multi-mesh CEN standard survey gill net on Lough Corrib, Co. Galway

Plate 3.3. Setting fyke nets on Lough Corrib, 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 are 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 and cathodes, depending on the width of the site. Sampling areas were isolated using stop nets, or where this was not feasible, regions clearly delineated by instream hydraulic or physical breakpoints, such as well-defined shallow riffles or weirs were utilised. Where possible, three electric fishing passes were conducted at each site.

In small wadeable channels (<0.5-0.7m in depth), portable landing nets (anode) connected to control boxes and portable generators (bank-based) or electric fishing backpacks 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 generator (a) Griffeen River (Grange Castle) and a boat-based generator (b) Owenavorragh River (2011)

Fish from each pass were sorted and processed separately. Length and weight of all fish captured were measured and scales were removed from a subsample of fish 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, description of the stream origin and type, 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, percentage substrate type and instream cover were visually assessed. Wetted width was measured at six transects and depth was measured at five intervals along the reach fished. 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 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 2011

Environmental / abiotic variable	Min	Max	Mean	Footnote
River reach sampled				
Length fished (m)	33	236	57	1
Mean depth (m)	0.06	0.66	0.24	2
Max depth (m)	0.15	1.20	0.49	3
Wetted width (m)	1.82	13.50	5.88	4
Surface area (m^2)	79.80	1679.00	345.65	5
Shade	0	3	-	6
Instream cover	0	90	30	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	3	-	9
Velocity	1	4	-	10
Conductivity @ 25^0c (µS/cm)	43.7	707.8	379.0	-
Water temperature (^{o}c)	10.7	18.9	13.9	-
Salinity (ppm)	0.01	0.37	0.19	-
pH	7.1	8.9	8.2	-
Dissolved oxygen (mg/l)	6.1	13.9	22.3	-
Flow type (%)				
Riffle	0	83	27.05	7
Glide	8.33	100	55.51	7
Pool	0	75	17.64	7
Substrate type (%)				
Bedrock	0	10	0.23	7
Boulder	0	35	9.82	7
Cobble	0	85	42.99	7
Gravel	5	95	29.66	7
Sand	0	58	12.94	7
Mud/silt	0	33	4.36	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 (100–200m) in open water areas adjacent to beach seining locations
- Fyke nets set overnight in selected areas adjacent to beach seining locations

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 (Plate 3.6). 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 a position where it lay parallel to the shore before being slowly drawn shoreward (Plate 3.7).

Plate 3.6. Beach seining: deploying the net from a boat

Plate 3.7. Beach seining: hauling the net towards shore by hand

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 aboard 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 in 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 3.8m rigid inflatable boat (RIB).

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 sand or gravel substrate, 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. Beam trawl used for 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 lengths. 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 was 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 lake surveys were aged (five fish from each 1cm class); fish scales were aged using a microfiche reader. Perch opercular bones were prepared for ageing by boiling, cleaning and drying and were aged 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 for aging by the method of ‘cutting and burning’ and were 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.

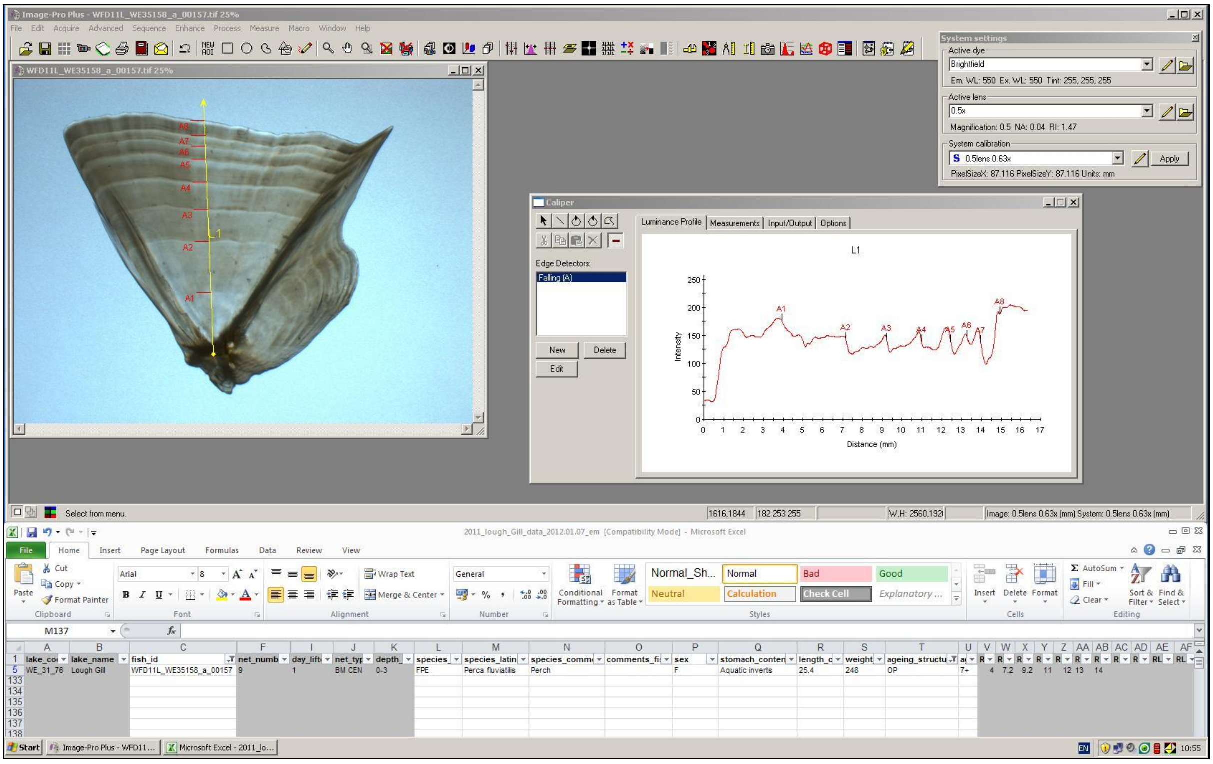

Plate 3.10. Opercular bone aging using binocular microscope/digital camera system with Image Pro Plus software (a 7+ perch from Lough Gill)

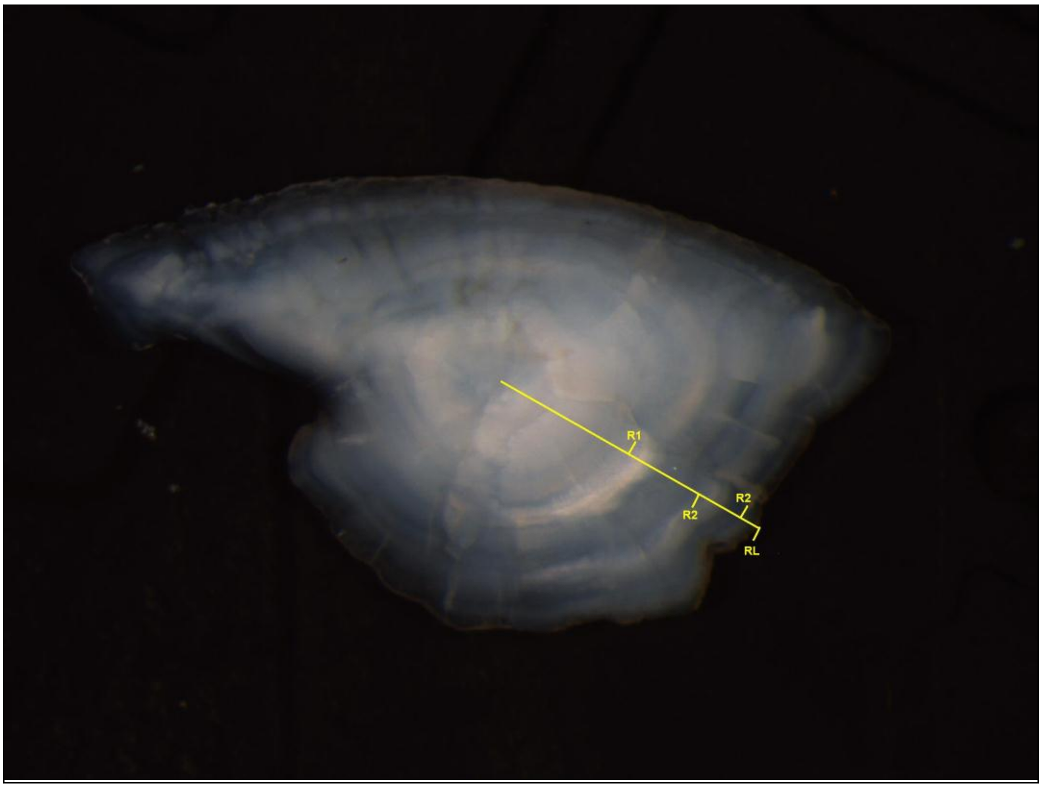

Plate 3.11. Char otolith (3+) from Lough Caragh, Co. Kerry

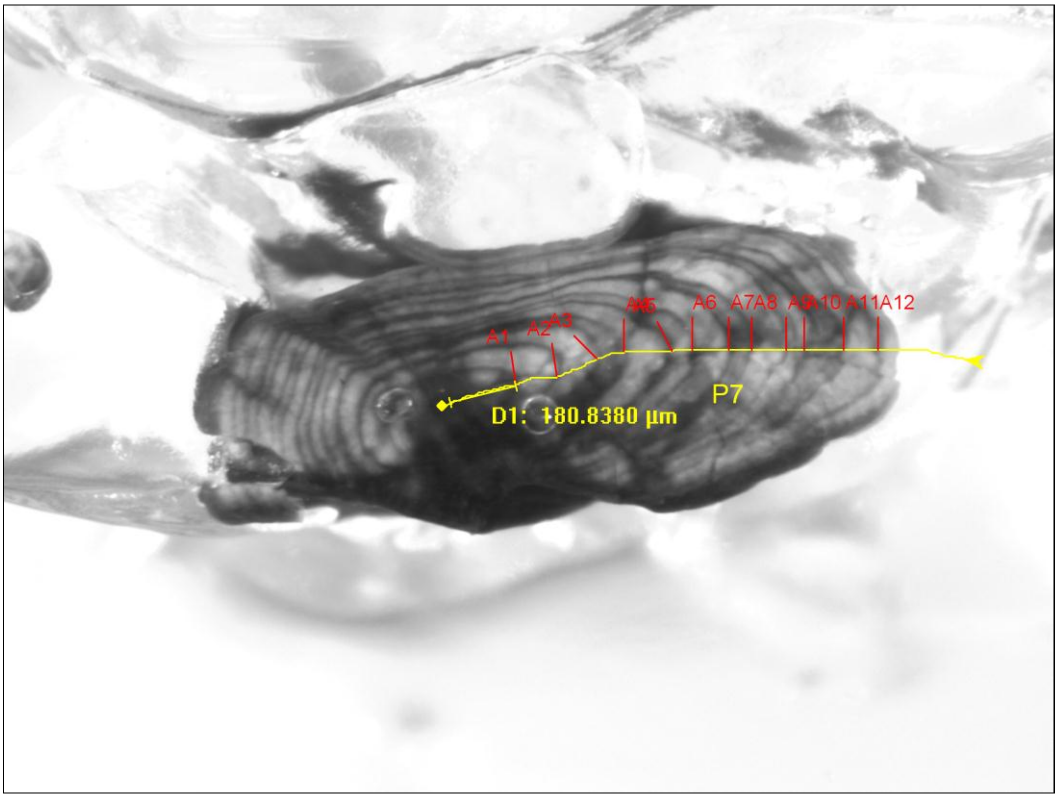

Plate 3.12. Eel otolith (12+) from Lough Derg

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 project. 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 aging, 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 continued to be developed during 2011 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 WFD surveillance monitoring is to consider the changes which may occur to the biota as a consequence of the unwanted spread of non-native species, such as the zebra mussel, from water body to water body. 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 (Caffrey, 2010) and this is followed diligently by staff in 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. Plate 3.14 below shows a typical echo sounder setup for use in freshwater hydroacoustic fish surveys. Hydroacoustic surveys were carried out in 2011 on Lough Corrib and Lough Melvin and results from these surveys will be compiled at a later date.

Plate 3.14. Left: Hydroacoustic transducers mounted on a boat (front - horizontally beaming, rear - vertical beaming). Transducers are lifted out of the water for illustrative purposes. Right: Laptop computer controlling the transducers via General Purpose Transeivers (GPT).

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 char or pollan, which tend to inhabit the deeper areas of lakes. Hydroacoustics can be used very effectively to locate areas where shoals of deep water fish are present and targeted ground-truth netting can then be used for species confirmation. 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. These methods have recently been used, for example, to confirm the presence of a new population of pollan in Lough Allen (Harrison *et al*., 2010). During the 2010 WFD fish monitoring programme, the same methods were used to assess the current status of pollan in Lough Ree (Harrison *et al*., 2012). An example of an echogram showing a pollan shoal in Lough Ree is shown in Figure 3.15. The maximum water depth is approximately 30m, with a distinct shoal of pollan between 18 and 25m.

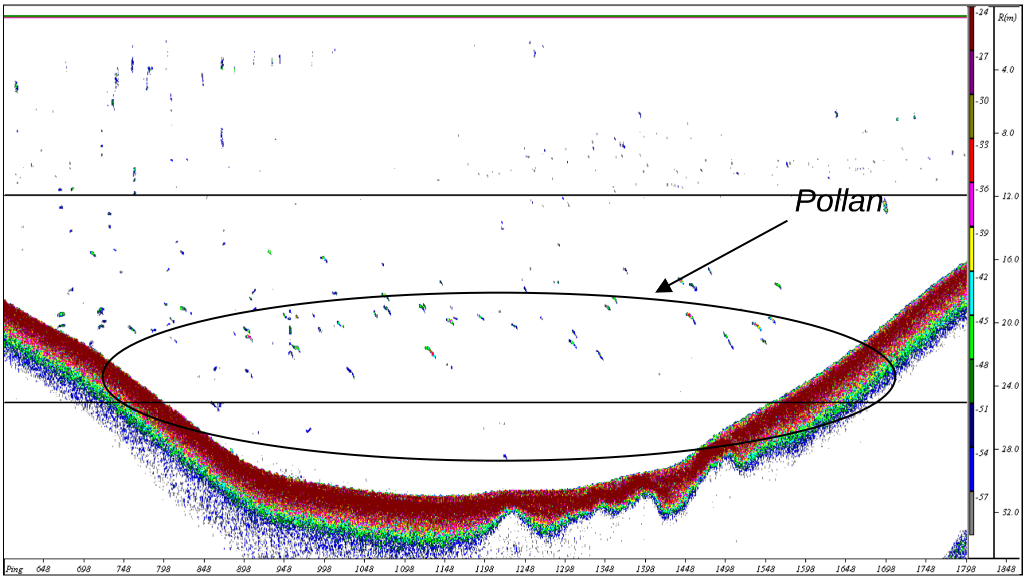

Fig. 3.15. Example of an echogram showing a pollan shoal from Lough Ree during post-processing

Further development in both hydroacoustic technology and survey methodology will see hydroacoustics play an increasing role in future WFD monitoring within IFI. 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. Hydroacoustic technology will also continue to be used to support other important work within IFI, including working with the Habitats Directive fish monitoring team in assessing the population status of priority species such as pollan, shad and Arctic char.

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 29 lakes surveyed during 2011 is shown in Table 4.1and Figure 4.1.

Table 4.1. List of fish species recorded in the 29 lakes surveyed during 2011

	Scientific name	Common name	Number of lakes	% of lakes
	NATIVE SPECIES			
1	*Anguilla anguilla*	Eel	29	100.0
2	*Salmo trutta*	Brown trout	21	72.4
3	*Gasterosteus aculeatus*	Three-spined stickleback	9	31.0
4	*Salmo salar*	Adult salmon	8	27.5
4	*Salmo salar*	Juvenile salmon	8	27.5
5	*Salvelinus alpinus*	Char	6	20.6
6	*Salmo trutta*	Sea trout*	6	20.6
7	*Platichthys flesus*	Flounder	2	6.9
8	*Alosa fallax killarnensis*	Killarney Shad	1	3.4
9	*Petromyzon marinus*	Sea lamprey	1	3.4
	NON NATIVE SPECIES (influencing ecology)			
10	*Perca fluviatilis*	Perch	19	66
11	*Esox lucius*	Pike	14	48.2
12	*Rutilus rutilus*	Roach	14	48.2
13	*Abramis brama*	Bream	6	20.6
14	*Phoxinus phoxinus*	Minnow	4	13.7
	NON NATIVE SPECIES (generally not influencing ecology)			
15	*Scardinius erythropthalmus*	Rudd	8	27.5
16	*Tinca tinca*	Tench	8	27.5
17	Gobio gobio	Gudgeon	2	6.9
	Hybrids			
	Rutilus rutilus x Abramis brama	Roach x bream hybrid	12	41.3
	Rutilus rutilus x Scardinius erythropthalmus	Roach x rudd hybrid	4	13.7
	Scardinius erythropthalmus x Abramis brama	Rudd x bream hybrid	1	3.4

*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 three types of hybrids were recorded (Table 4.1). Eel was the most common fish species recorded, occurring in all lakes surveyed (100%). This was followed by brown trout, perch, pike and roach which were present in 72%, 66%, 48% and 48% of lakes respectively (Fig. 4.1).

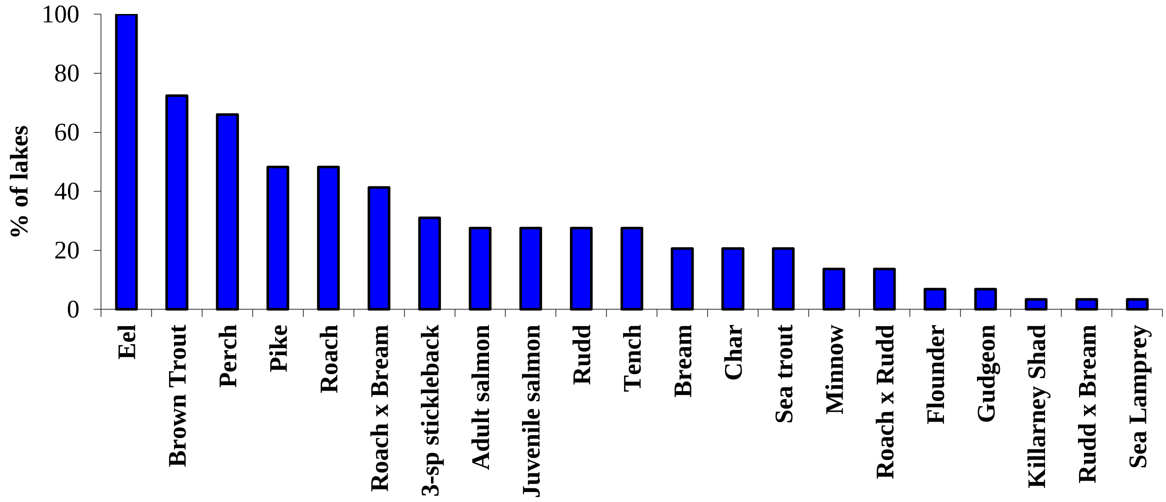

Fig. 4.1.Percentage of lakes surveyed for WFD fish surveillance monitoring during 2011 containing each fish species

Fish species richness (excluding hybrids) ranged from two species on Glenbeg Lough, Co. Cork to a maximum of ten species on Lough Leane, Co. Kerry (Table 4.2, Fig. 4.2). The highest number of native species (seven species) was also recorded in Lough Leane. Native species (Group 1) were present in all lakes surveyed, Group 2 species were present in 22 lakes and Group 3 species were present in 11 lakes (Table 4.2).

Table 4.2. Fish species richness in the 29 lakes surveyed for WFD fish monitoring during 2011

Lake	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Leane	10	7	1	2
Corrib (Lower)	8	4	4	0
Corrib (Upper)	8	3	4	1
Allua	8	2	4	2
Gill	8	4	4	0
Owel	8	3	3	2
Annaghmore	7	2	3	2
Templehouse	7	1	4	2
Melvin	7*	5	1	1
Beagh	6	5	1	0
Upper Lake	7	3	2	2
Caragh	6	5	1	0
Carrowmore	6	5	1	0
Corglass	6	1	3	2
Sheelin	6	2	3	1
Cavetown	5	1	4	0
Meelagh	5	1	3	1
O'Flynn	5	2	3	0
Skeagh Upper	5	1	4	0
Talt	5	4	1	0
Acoose	4	4	0	0
Derrybrick	4	1	3	0
Egish	4	1	3	0
Fern	4	4	0	0
Glencullin	5	5	0	0
Brin	4	3	1	0
Barra	3	3	0	0
Easky	3	3	0	0
Kiltooris	3	3	0	0
Glenbeg	2	2	0	0

*****Ten species if trout segregated into ferox, gillaroo and sonaghan

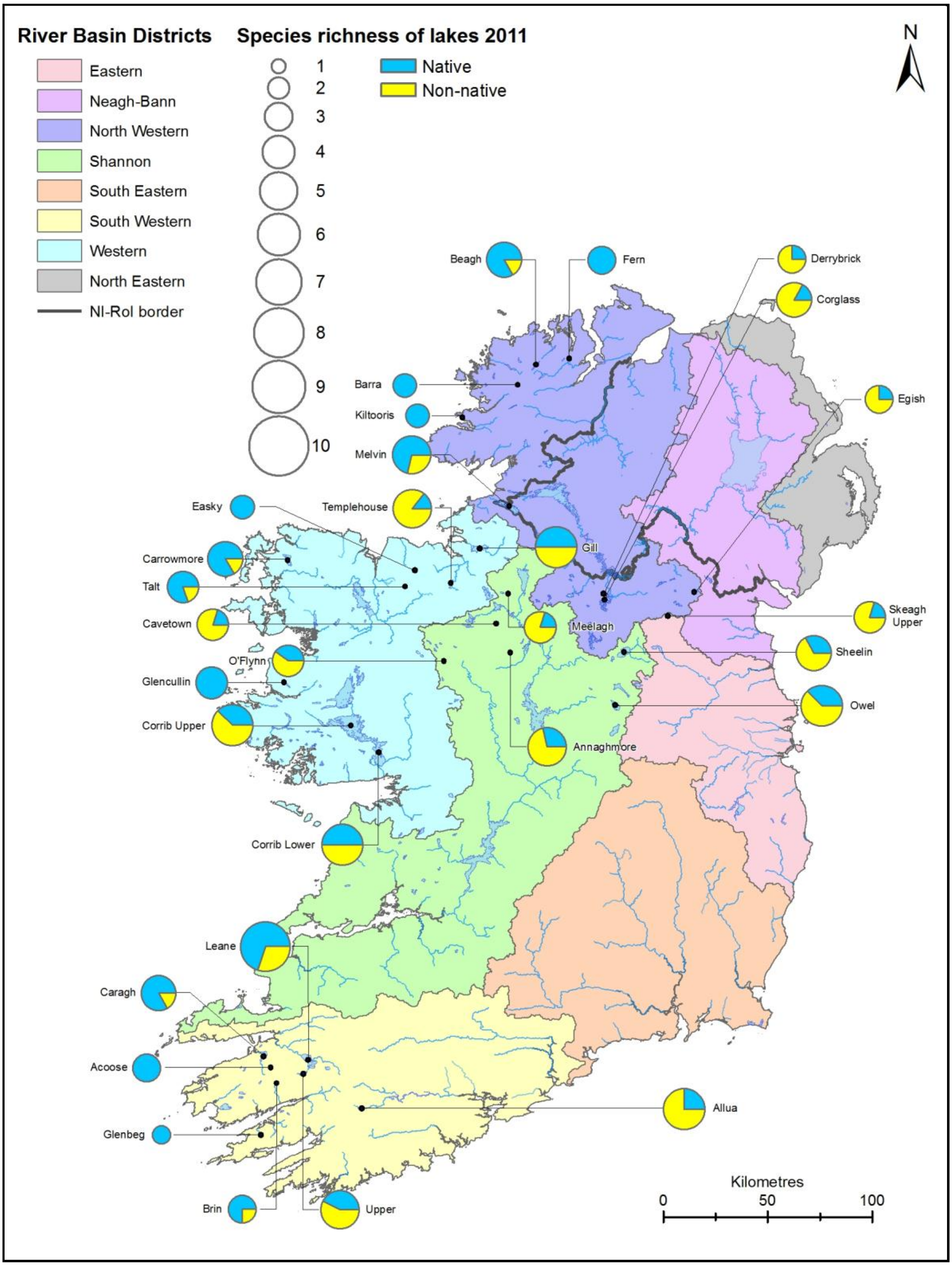

Fig. 4.2. Fish species richness in the 29 lakes surveyed for WFD fish monitoring during 2011

4.1.2 Fish species distribution

The distribution and abundance of each fish species amongst all lakes surveyed during 2011 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 all 29 lakes surveyed (Fig. 4.3). In general, salmonids were more abundant towards the north, west and south-west of the country (Figs. 4.4 to 4.7). Sea trout were only captured in six lakes located close to the coast in the north-west, west and south-west (Lough Beagh, Glencullin Lough, Carrowmore Lake, Lough Brin and Lough Leane) (Fig. 4.5). Juvenile salmon were recorded in eight lakes (Lough Acoose, Lough Beagh, Lough Caragh, Lower Lough Corrib, Lough Gill, Lough Fern, Lough Leane and Upper Lake) and adult salmon in eight lakes (Lough Acoose, Lough Barra, Carromore Lake, Lower Lough Corrib, Lough Easky, Lough Fern, Lough Melvin and Glencullin Lough) (Fig. 4.6). Char were recorded in six lakes in the SWRBD, NWRBD and WRBD (Lough Acoose, Lough Caragh, Lough Leane, Lough Beagh, Lough Melvin and Lough Talt) (Fig. 4.7). Killarney shad were recorded in Lough Leane, Co. Kerry. Three-spined stickleback were also mainly restricted to the west and north-west of the country, being present in four lakes in the WRBD, three in the NWRBD and two lakes 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 and roach were the most widely distributed non-native species recorded during the 2011 surveillance monitoring programme, with perch (Fig. 4.9) being present in 19 lakes and pike (Fig. 4.10) being present in 14 of the 29 lakes surveyed. Roach were captured in 14 lakes (three in the NWIRBD, three in the WRBD, one in the SWRBD, one in the ERBD and six in the ShIRBD) (Fig. 4.11). Rudd were recorded in eight lakes (two lakes within the ShIRBD, two in the NWRBD, one in the WRBD and three in the SWRBD) (Fig. 4.12). Bream were recorded in six lakes, roach x bream hybrids were recorded in twelve lakes, roach x rudd hybrids were recorded in four lakes, tench were recorded in eight lakes (Figs. 4.13 to 4.15) and rudd x bream hybrids were recorded in one lake.

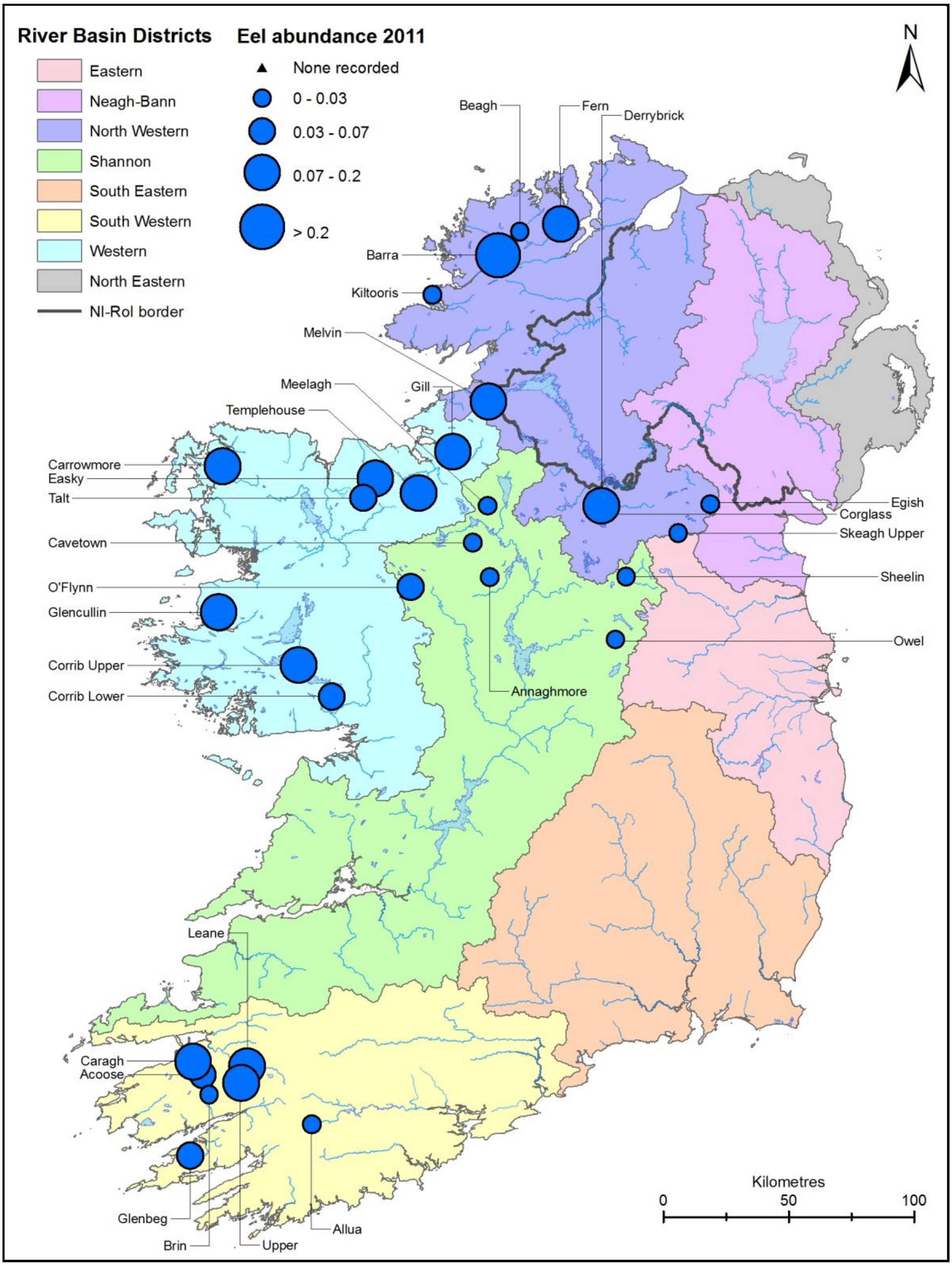

Fig. 4.3. Eel distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

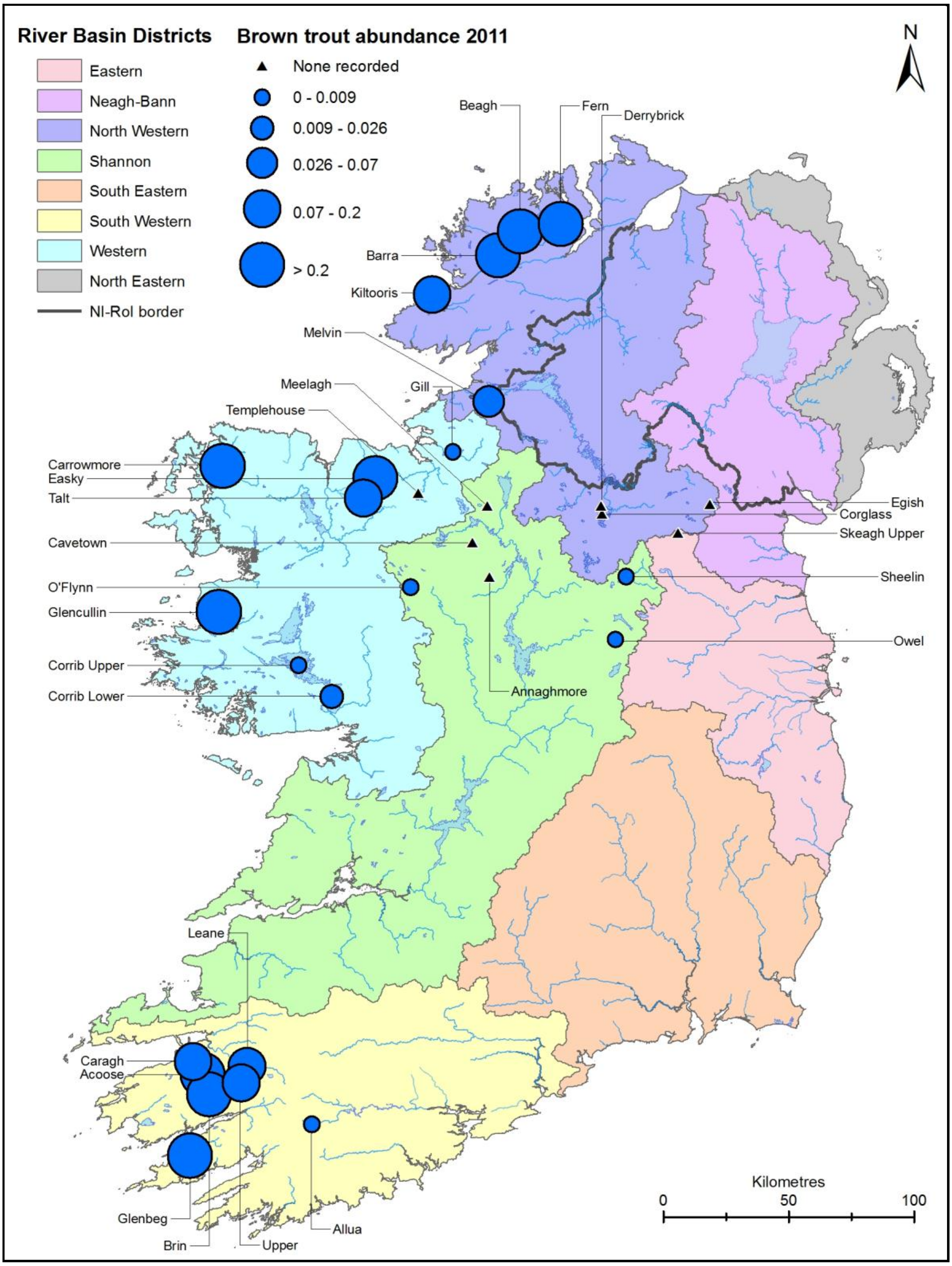

Fig. 4.4. Brown trout (both wild and stocked brown trout) distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

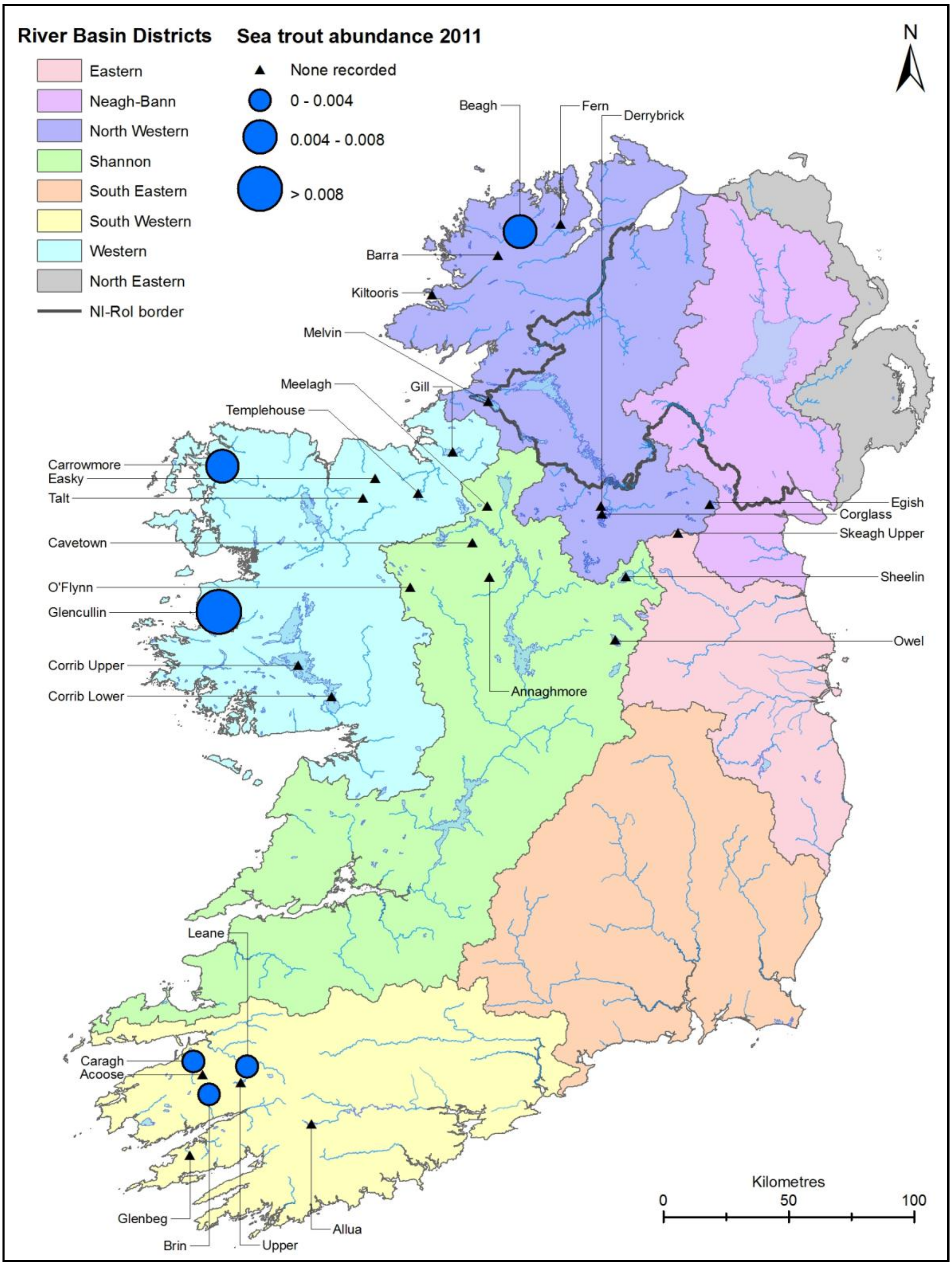

Fig. 4.5. Sea trout distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

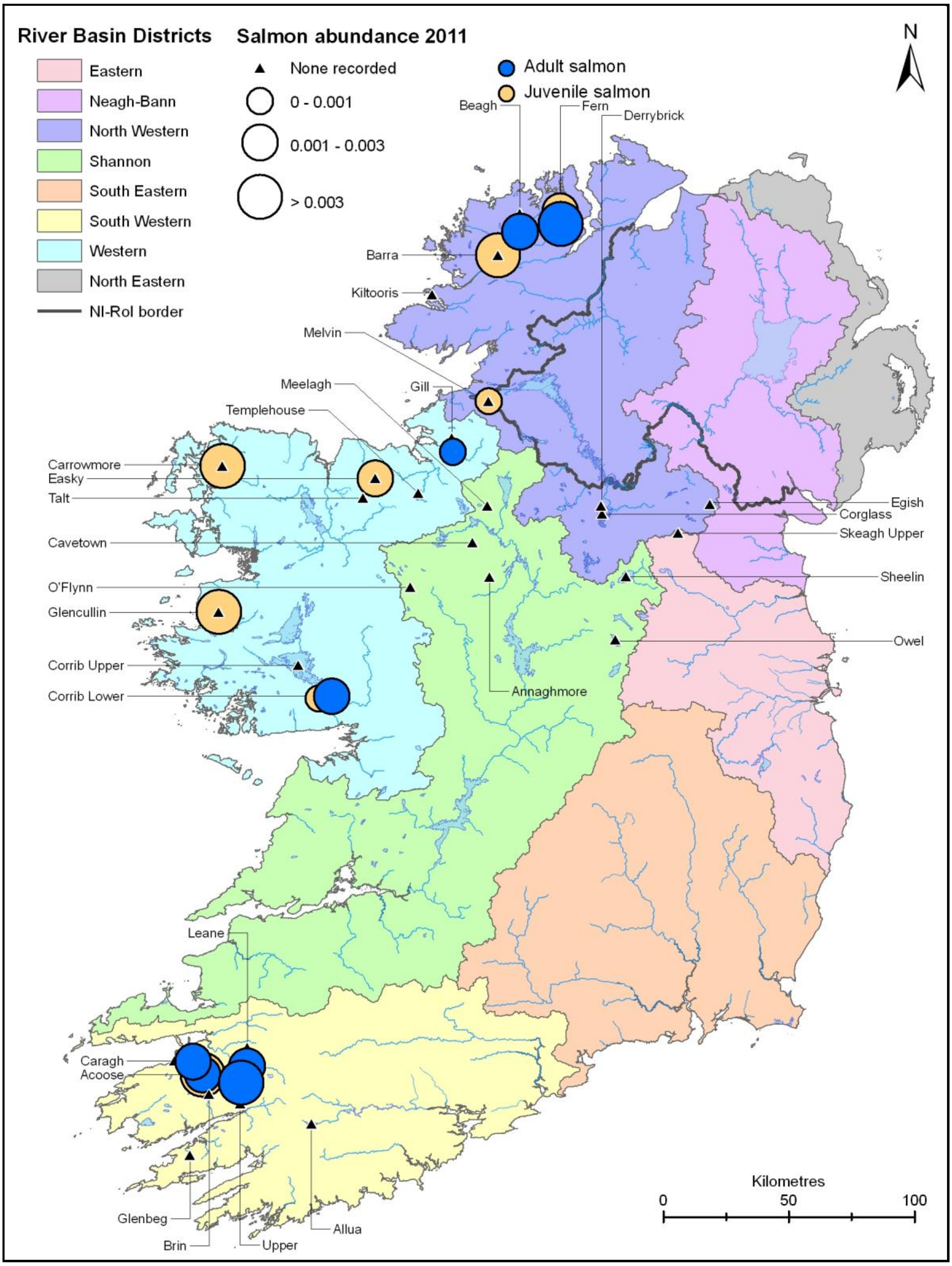

Fig. 4.6. Salmon distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

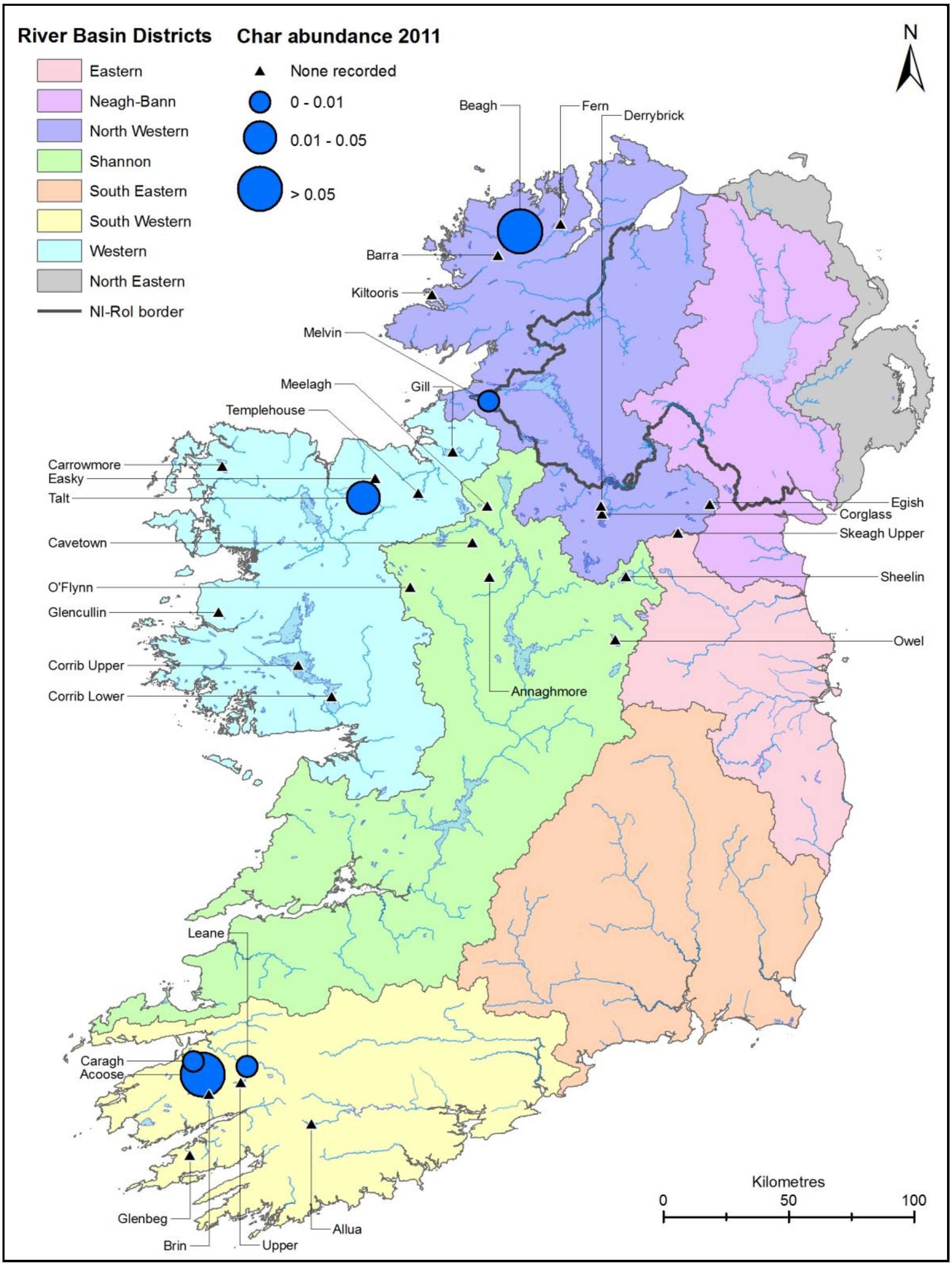

Fig. 4.7. Char distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

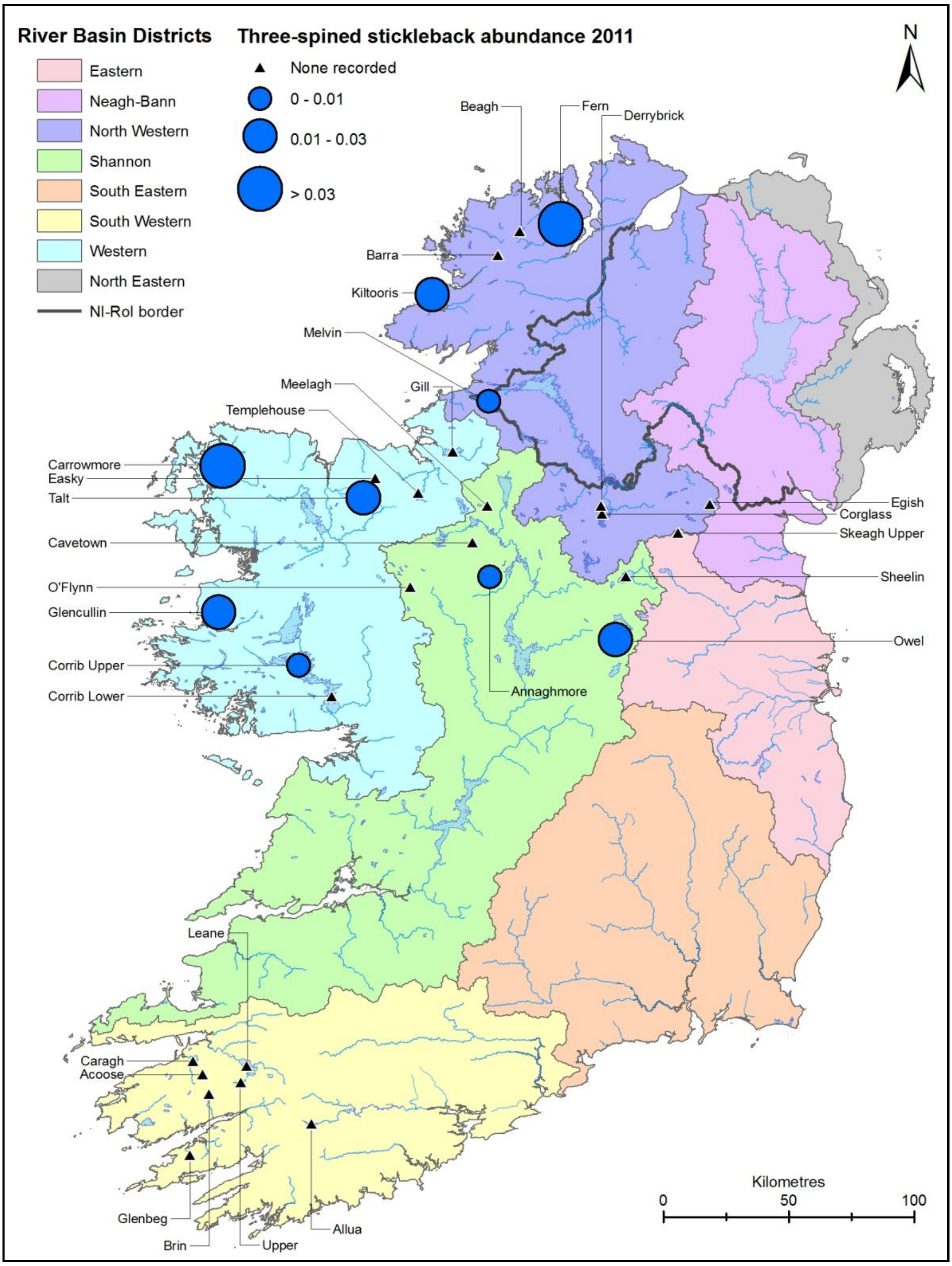

Fig. 4.8. Three-spined stickleback distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

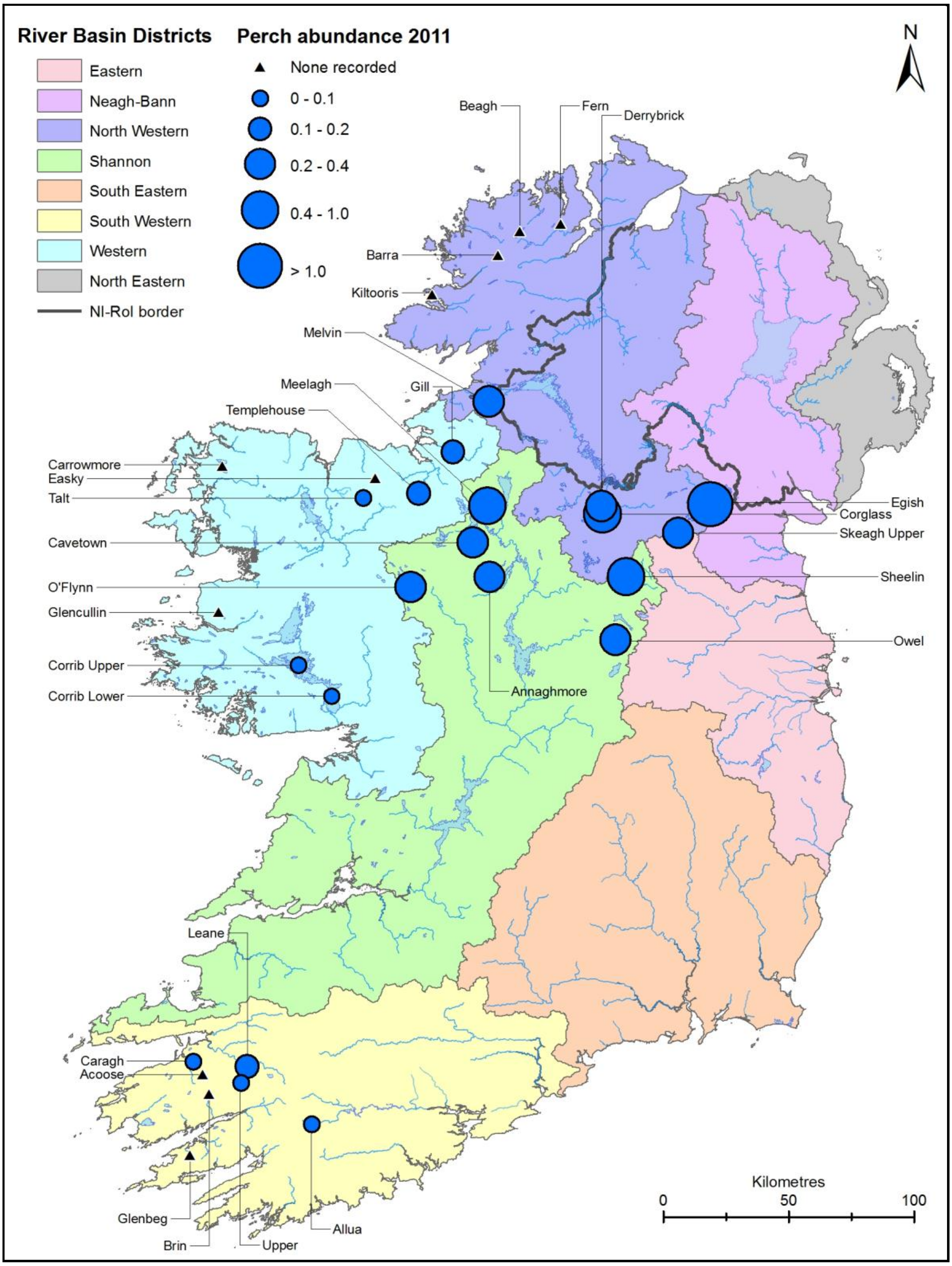

Fig. 4.9. Perch distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

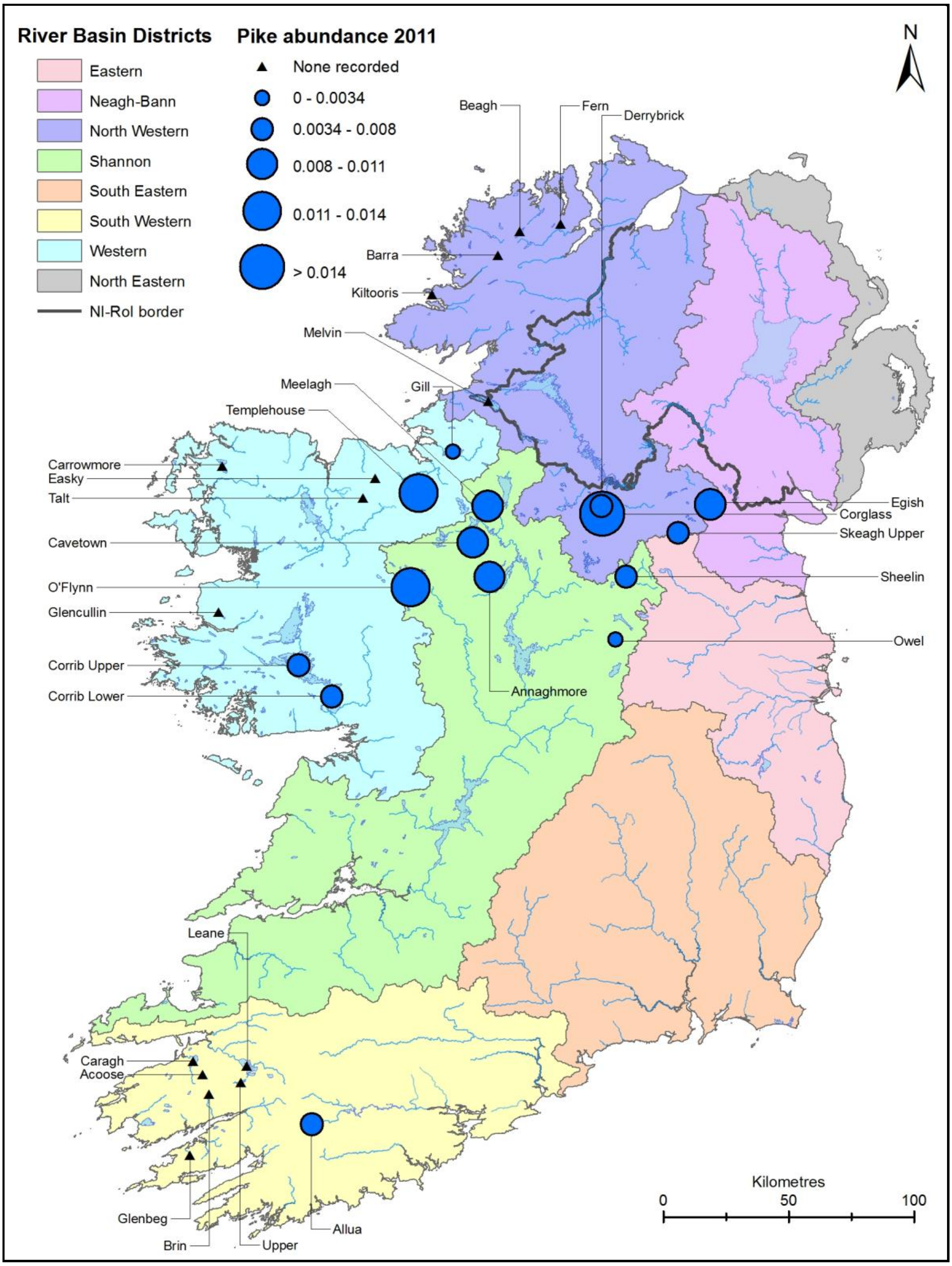

Fig. 4.10. Pike distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

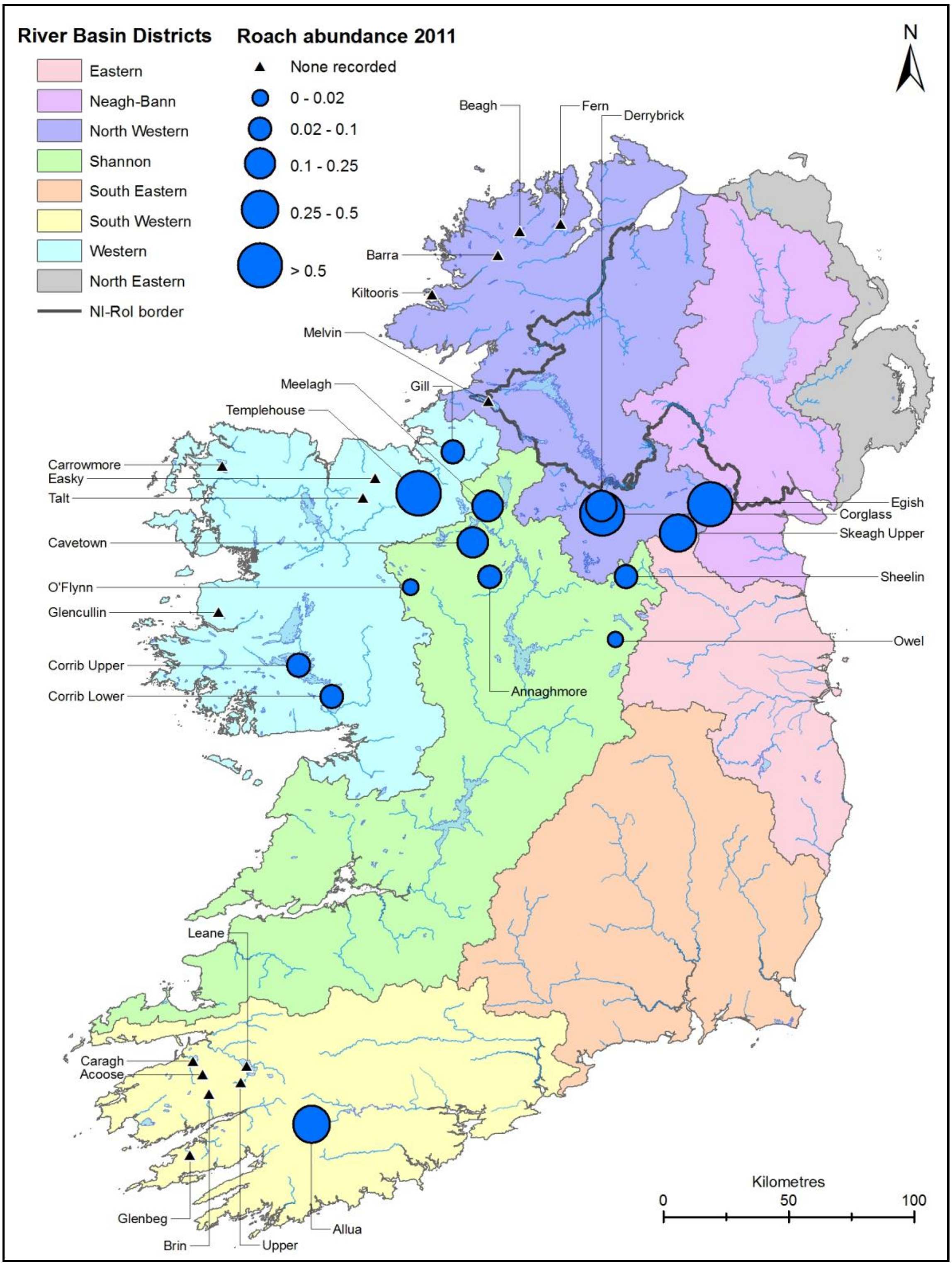

Fig. 4.11. Roach distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

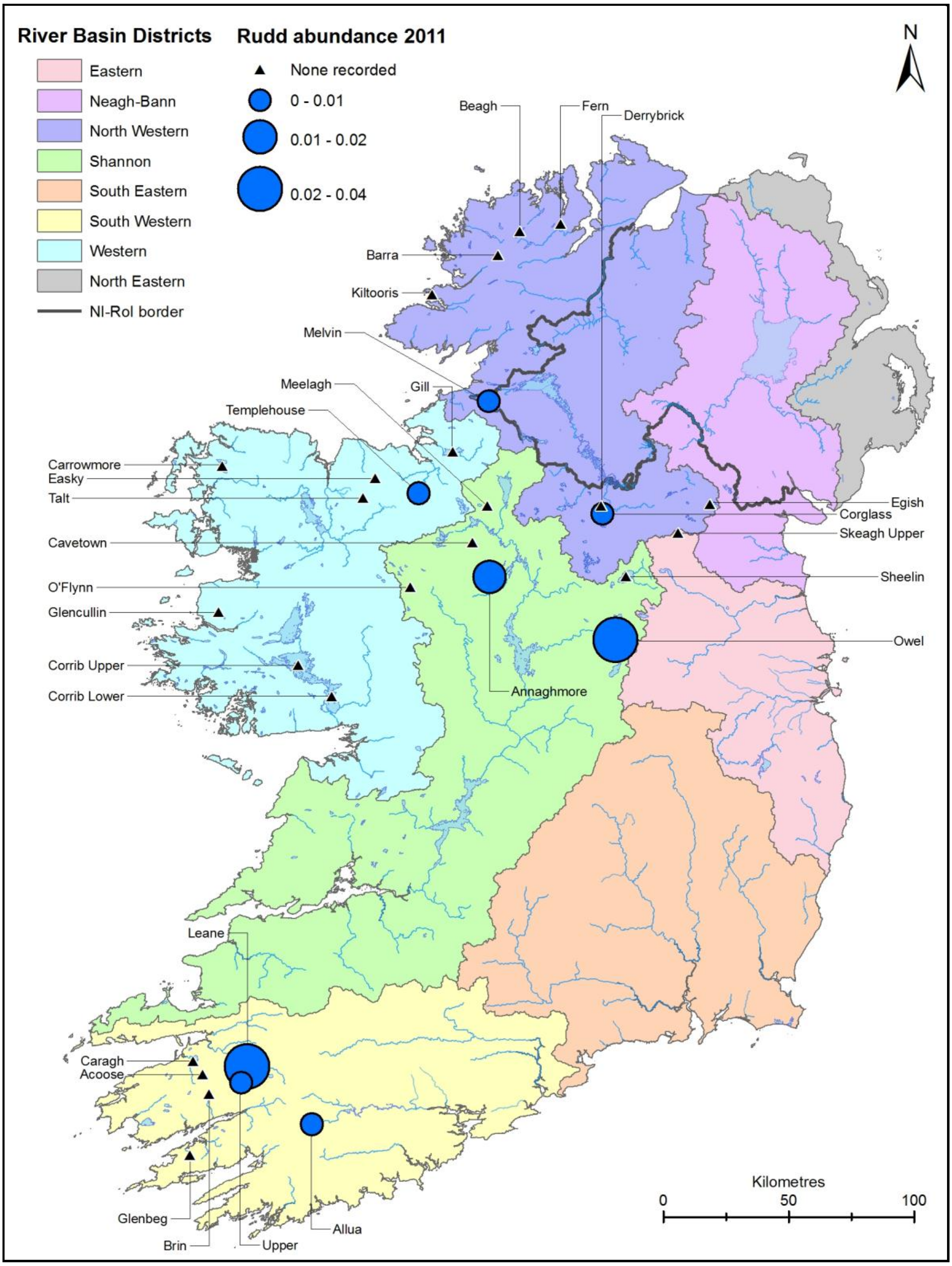

Fig. 4.12. Rudd distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

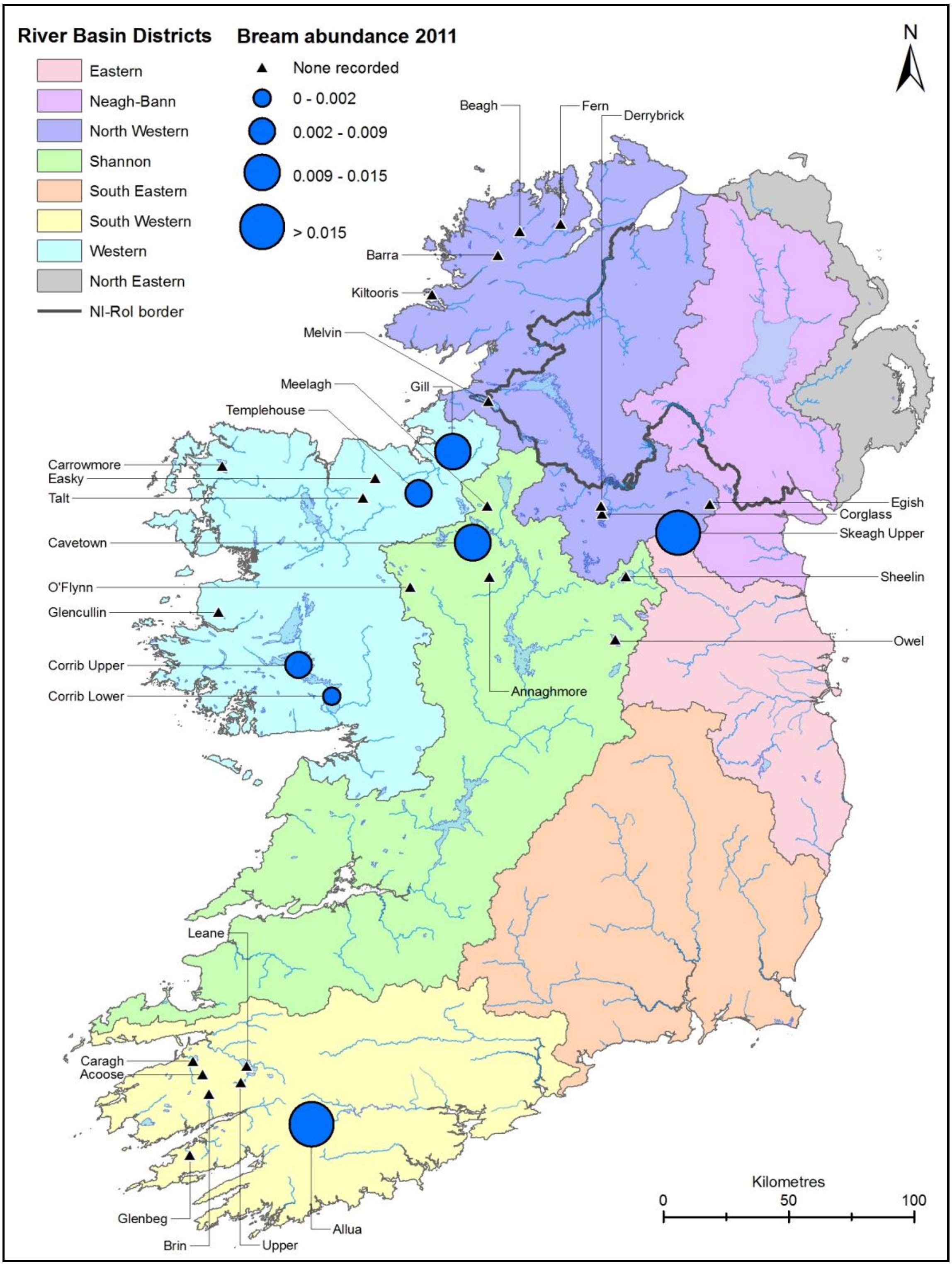

Fig. 4.13. Bream distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

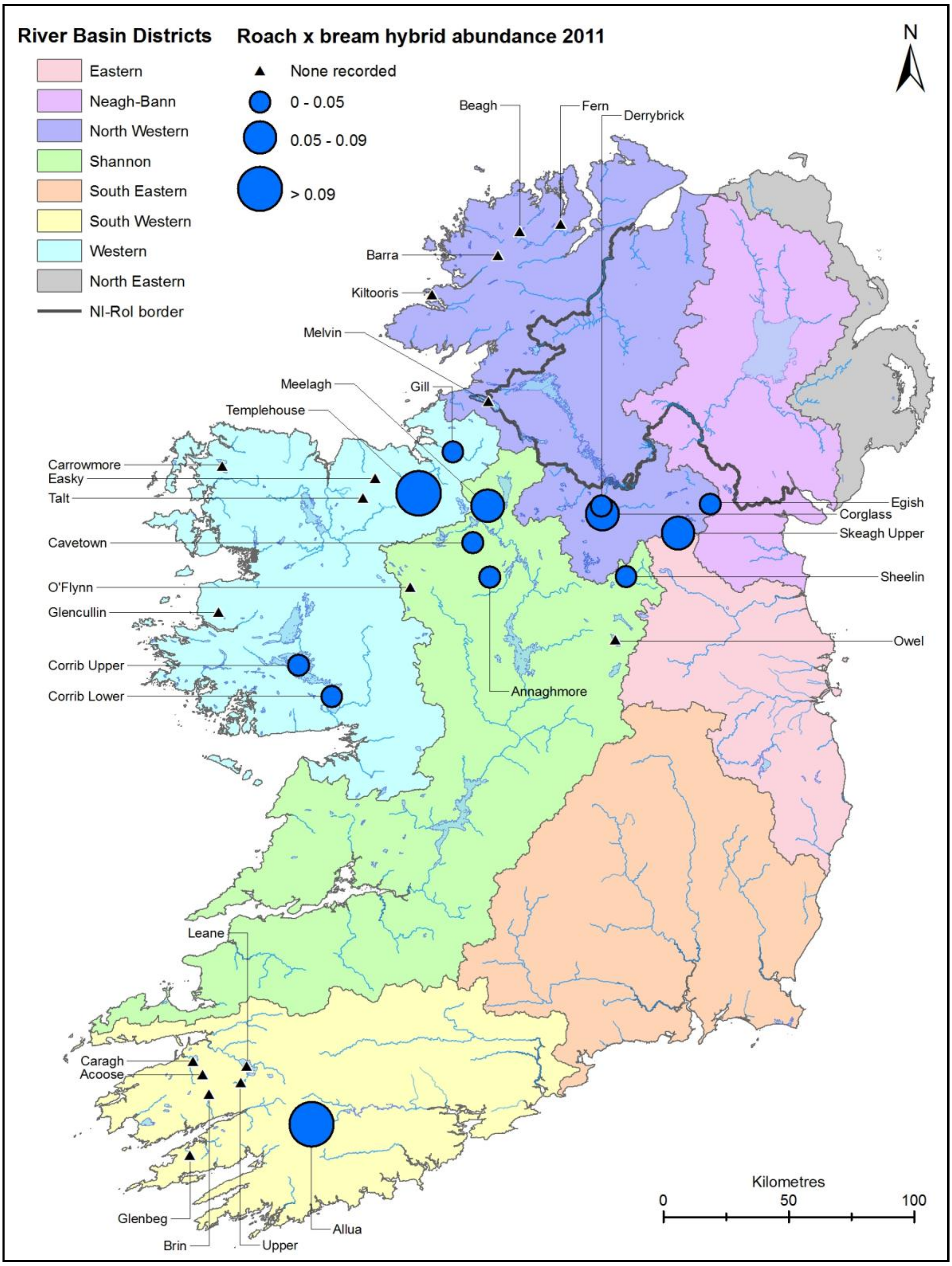

Fig. 4.14. Roach x bream hybrid distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

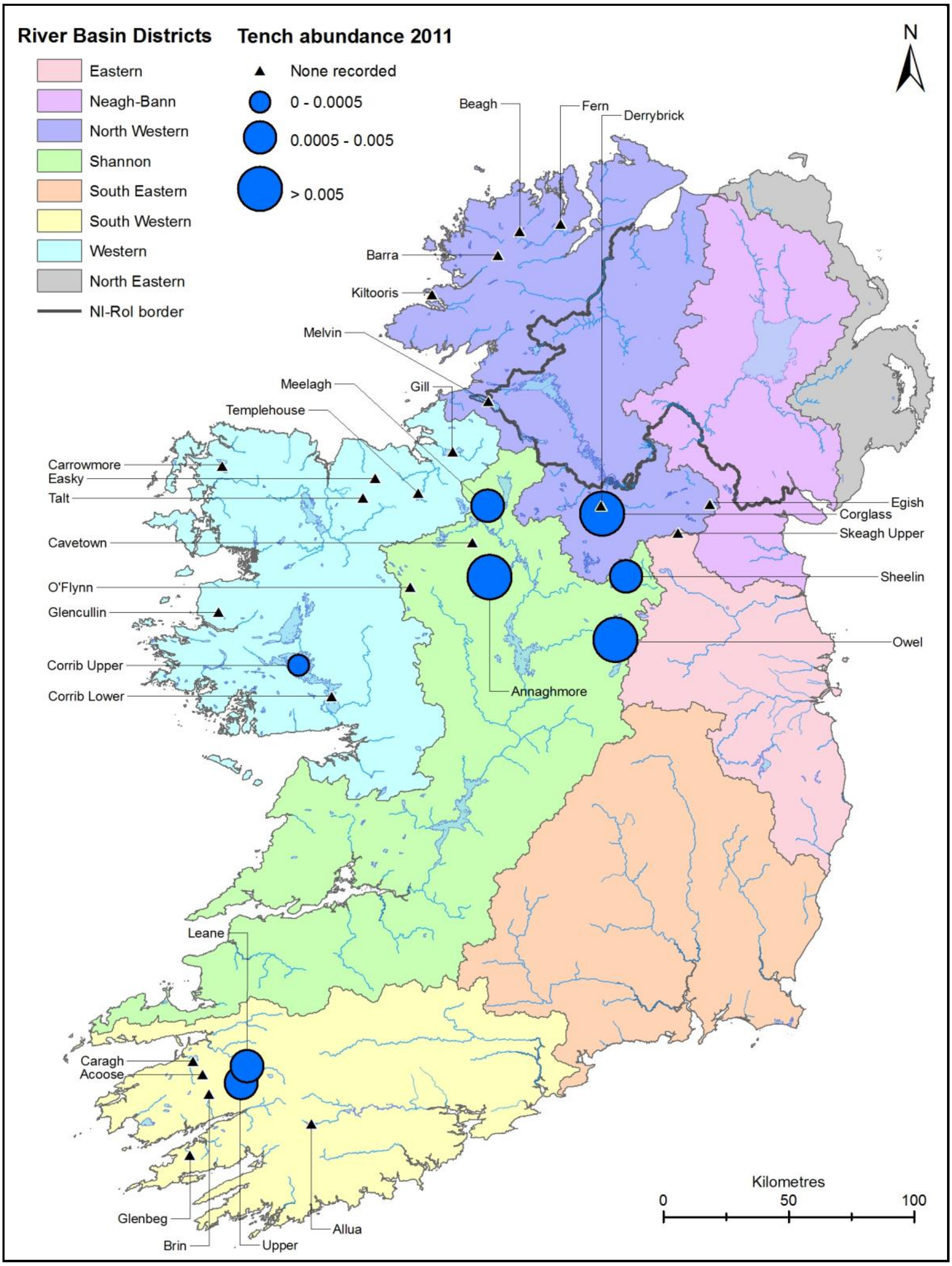

Fig. 4.15. Tench distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2011

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 2011 surveillance monitoring programme are shown in Figures 4.16 to 4.37.

The highest abundance of eels amongst all lakes surveyed during 2011 was recorded in Lough Barra (a low alkalinity lake in Co. Donegal) and Templehouse Lake (a high alkalinity lake in Co. Sligo) had the highest biomass of eels amongst all lakes surveyed (Figs. 4.16 and 4.17). The abundance of eels was generally lower in catchments where connectivity to the sea is poor e.g. Shannon or Lee catchments.

Overall the highest abundance of brown trout was recorded in Glenbeg Lough (a low alkalinity lake in Co. Cork) and the highest biomass of brown trout was recorded in Lough Fern (a moderate alkalinity lake in Co. Donegal) (Figs. 4.18 and 4.19).

Sea trout abundance and biomass was highest in Glencullin Lough (a low alkalinity lake in Co. Mayo) amongst all lakes surveyed (Figs. 4.20 and 4.21).

Lough Acoose (a low alkalinity lake in Co. Kerry) had the highest abundance and the highest biomass of char recorded amongst all the lakes surveyed (Figs. 4.22 and 4.23).

Lough Egish (a high alkalinity lake in Co. Monaghan) had the highest perch abundance and the highest perch biomass was recorded in Lough Sheelin (a high alkalinity lake in Co. Cavan) (Figs. 4.24 and 4.25).

Roach abundance and biomass was highest in Templehouse Lake (a high alkalinity lake in Co. Sligo) (Figs. 4.26 and 4.27).

Pike abundance and biomass was highest in Corglass Lough (a high alkalinity lake in Co. Cavan) (Figs. 4.28 and 4.29).

Bream abundance and biomass was highest in Upper Lough Skeagh (a moderate alkalinity lake in Co. Cavan) (Figs. 4.30 and 4.31).

Corglass Lough (a high alkalinity lake in Co. Cavan) had both the highest abundance and the highest biomass of tench amongst the eight lakes where tench were recorded (Figs. 4.32 and 4.33).

The highest abundance of rudd was recorded in Lough Leane (a moderate alkalinity lake in Co. Kerry) and the highest biomass of rudd was recorded in Annaghmore Lough (a high alkalinity lake in Co. Roscommon) (Figs. 4.34 and 4.35).

The highest abundance of roach x bream hybrids was recorded in Templehouse Lake (a high alkalinity lake in Co. Sligo) and the highest biomass of roach x bream hybrids was recorded in Derrybrick Lough (a high alkalinity lake in Co. Cavan) (Figs. 4.36 and 4.37).

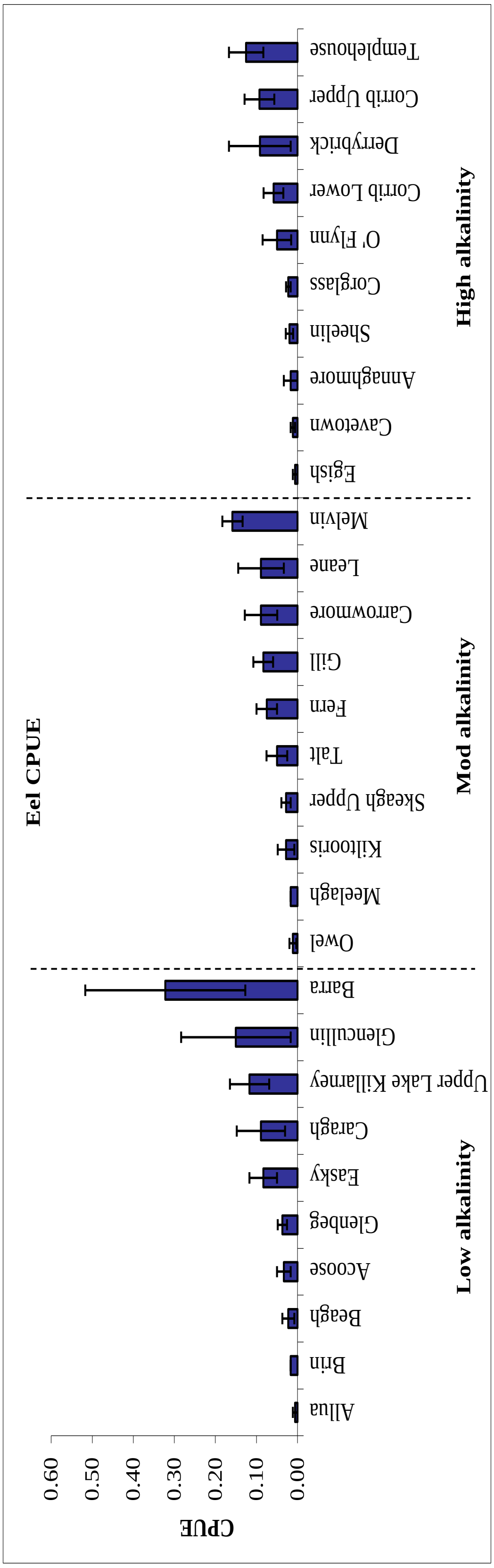

Fig. 4.16. Eel abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

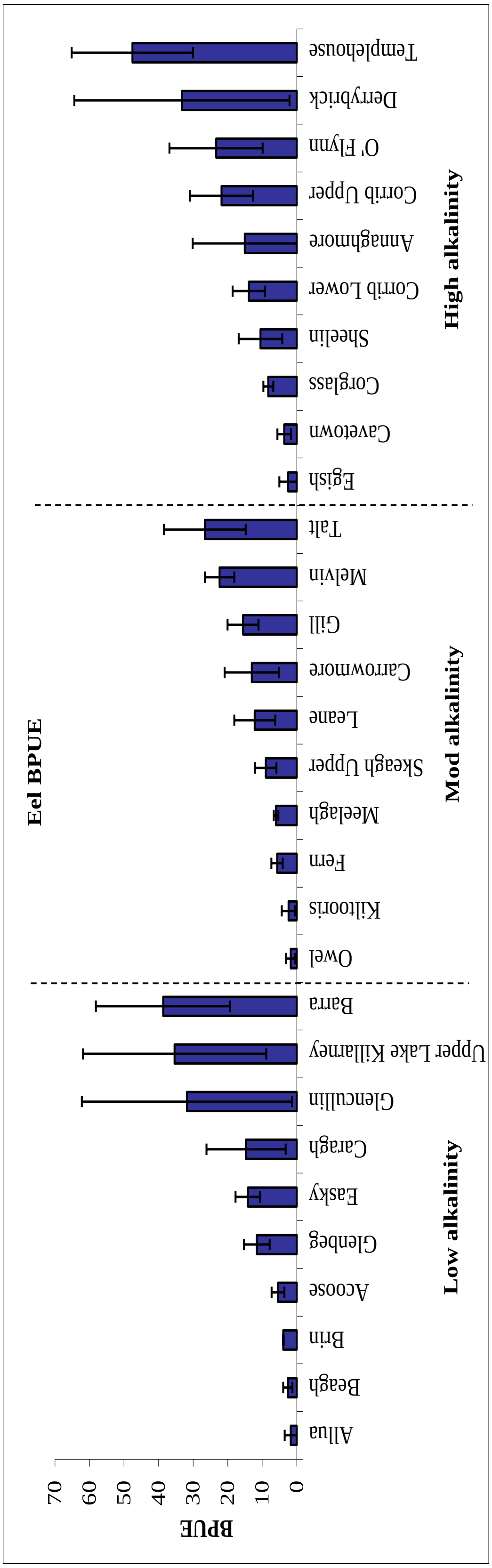

Fig. 4.17. Eel biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

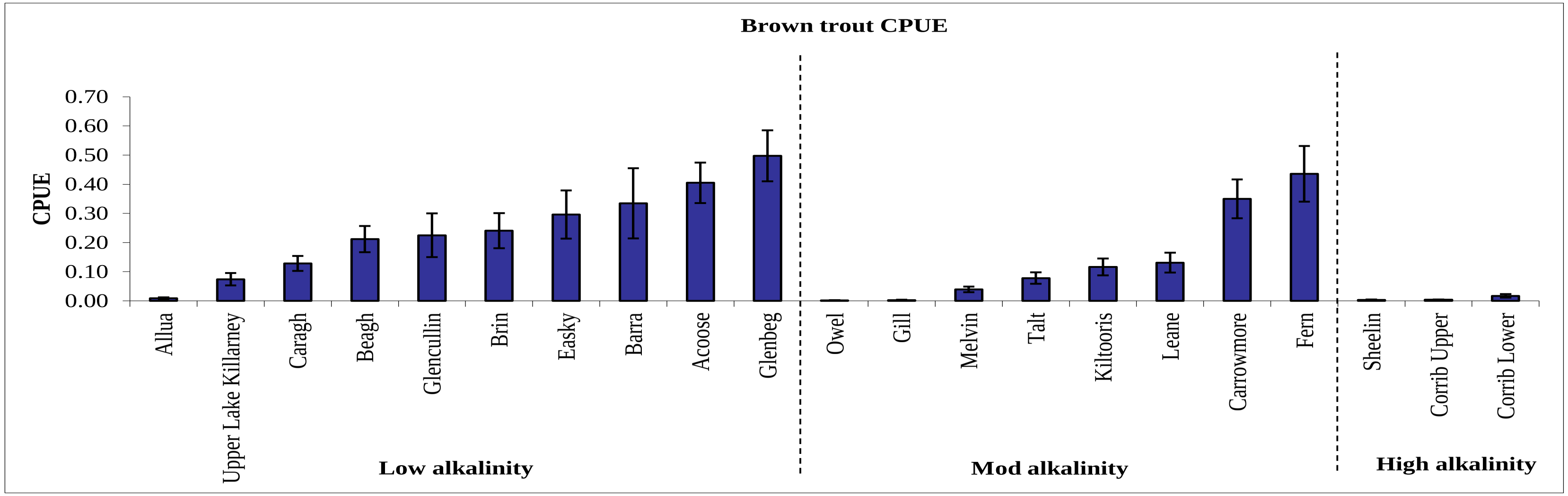

Fig. 4.18. Brown trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

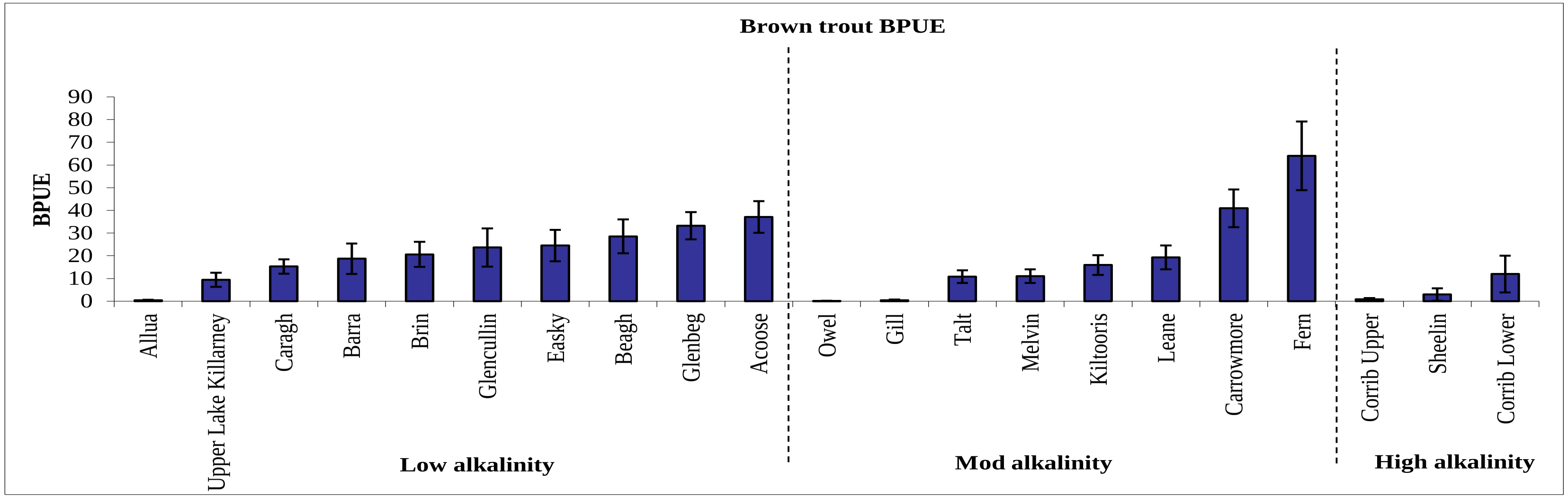

Fig. 4.19. Brown trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

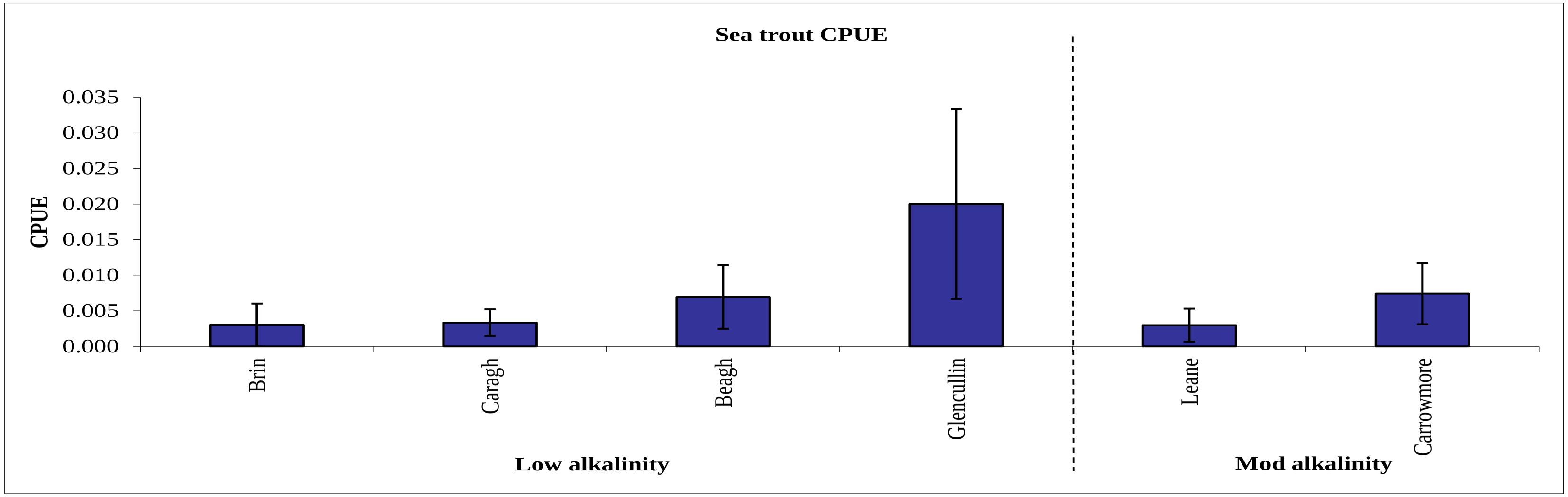

Fig. 4.20. Sea trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

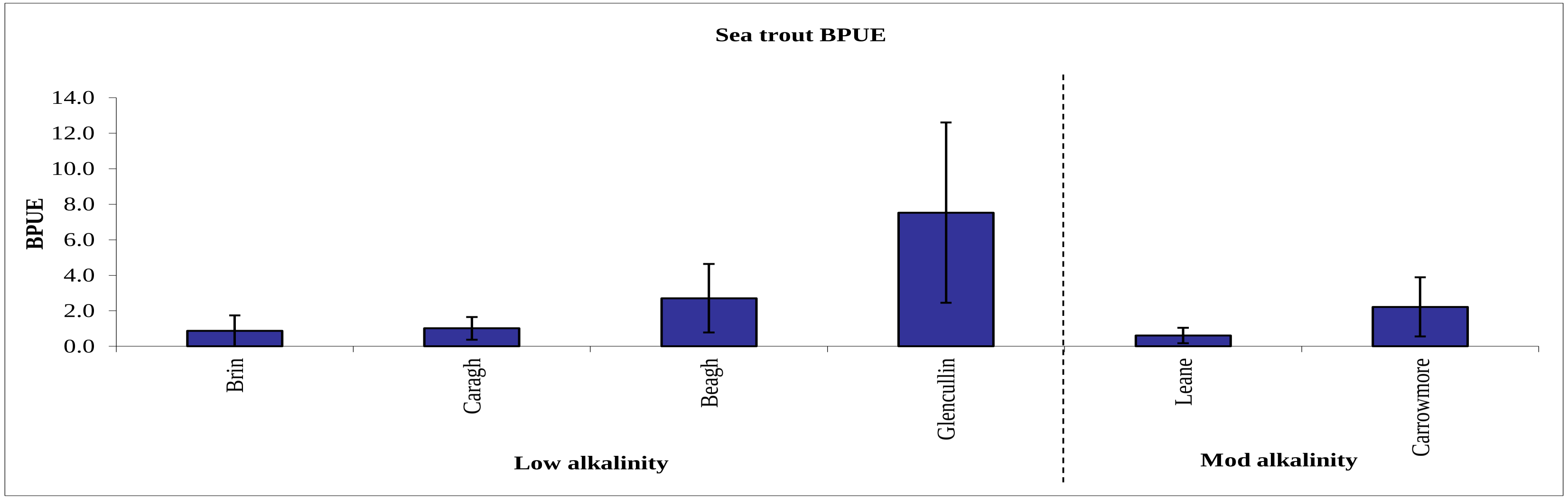

Fig. 4.21. Sea trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

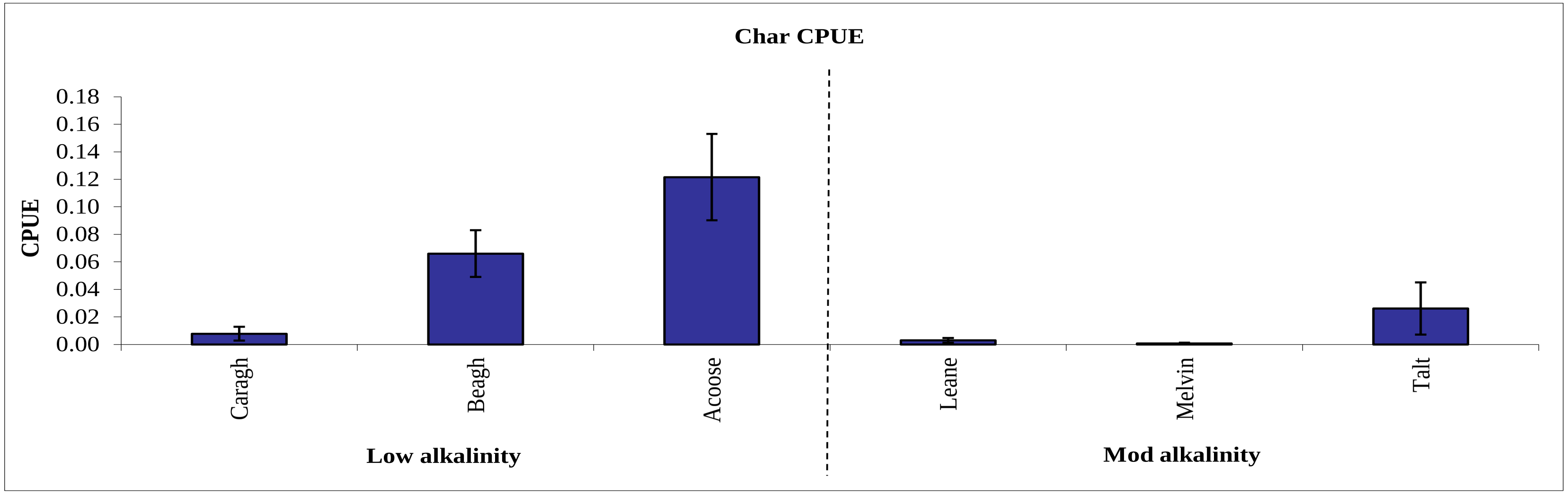

Fig. 4.22. Char abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

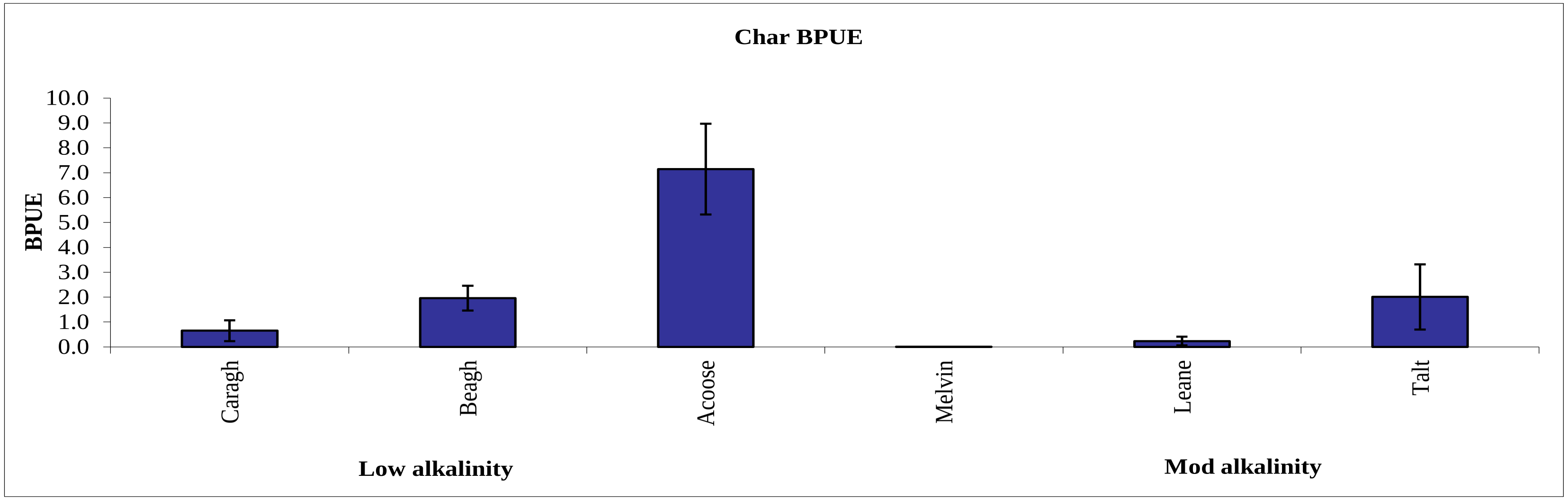

Fig. 4.23. Char biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

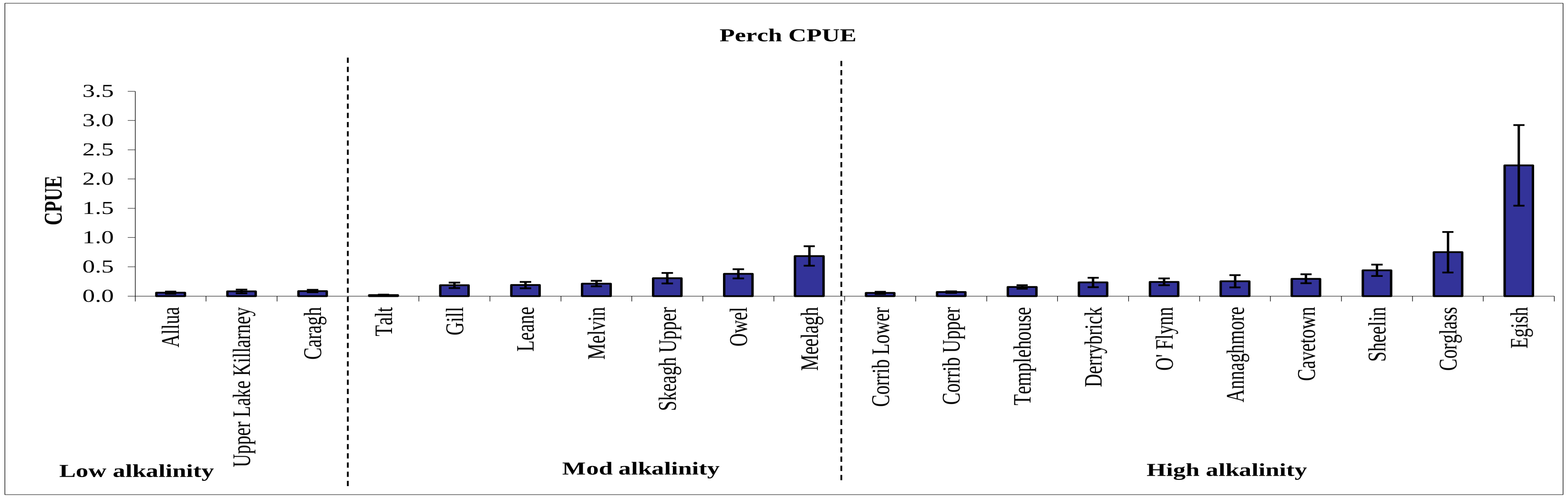

Fig. 4.24. Perch abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

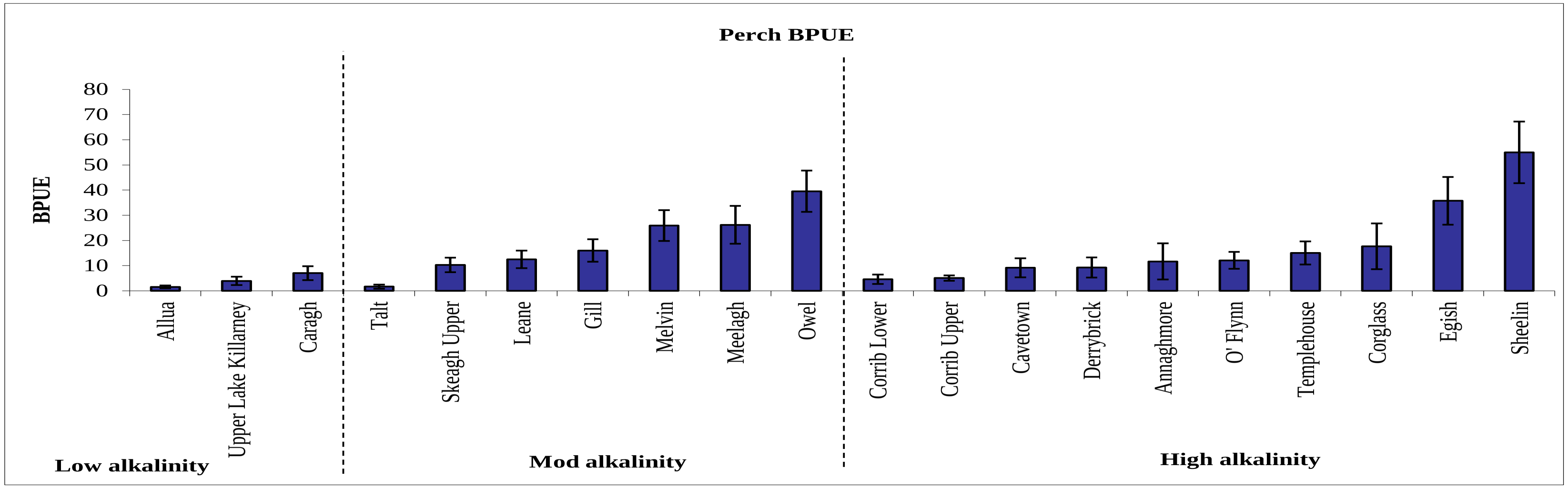

Fig. 4.25. Perch biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

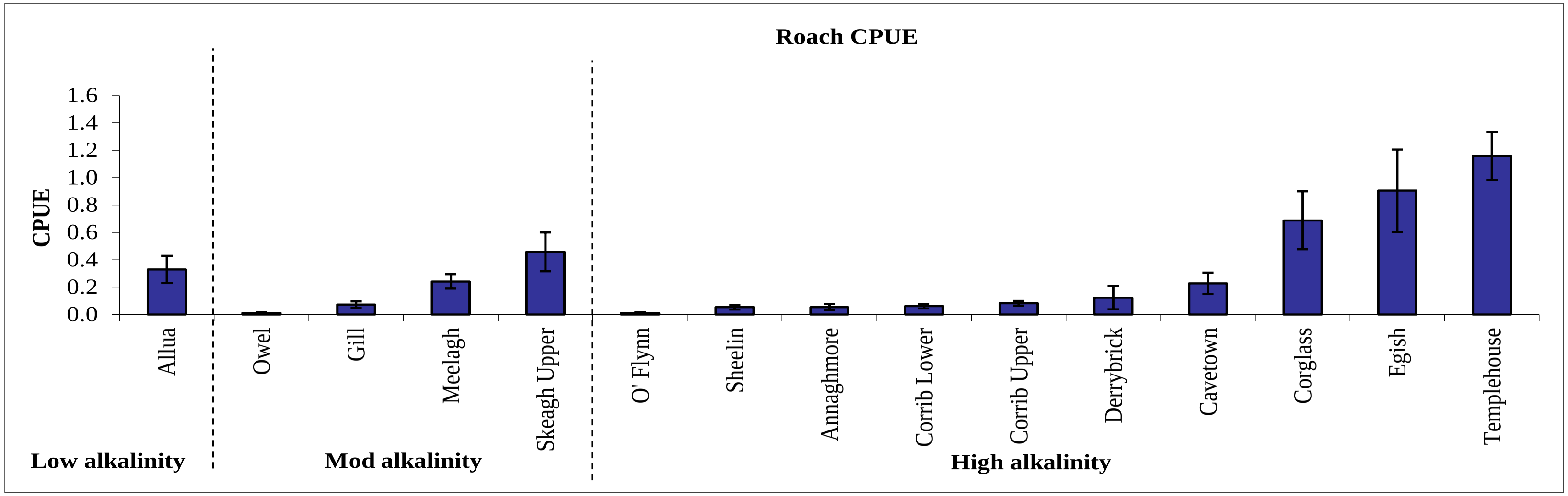

Fig. 4.26. Roach abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

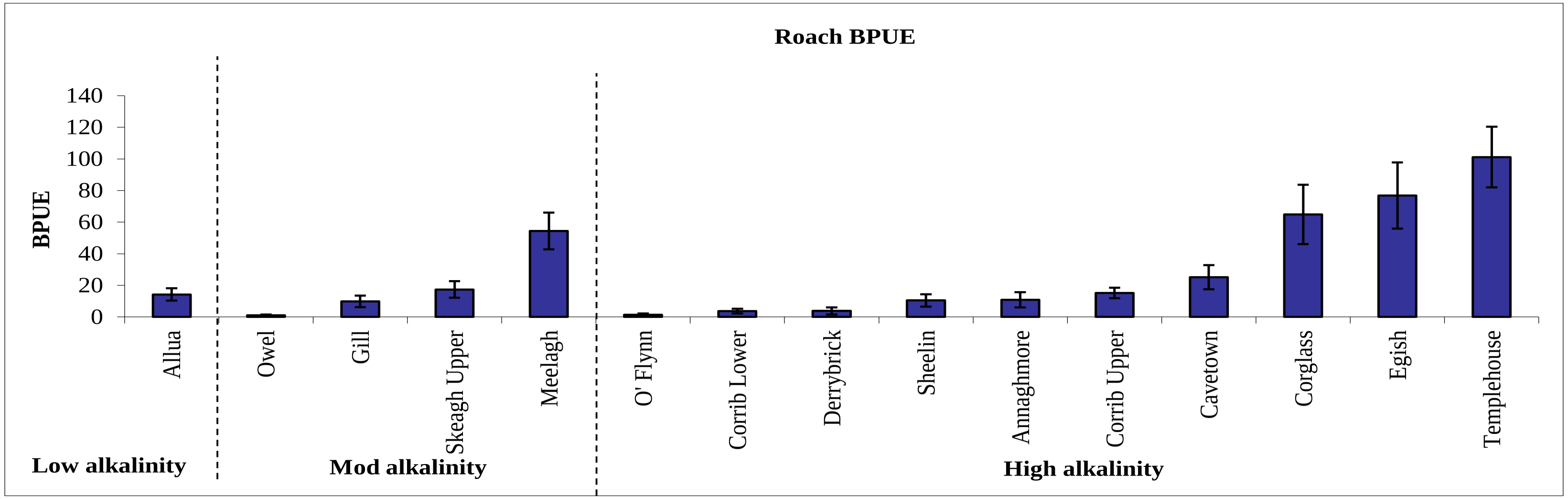

Fig. 4.27. Roach biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

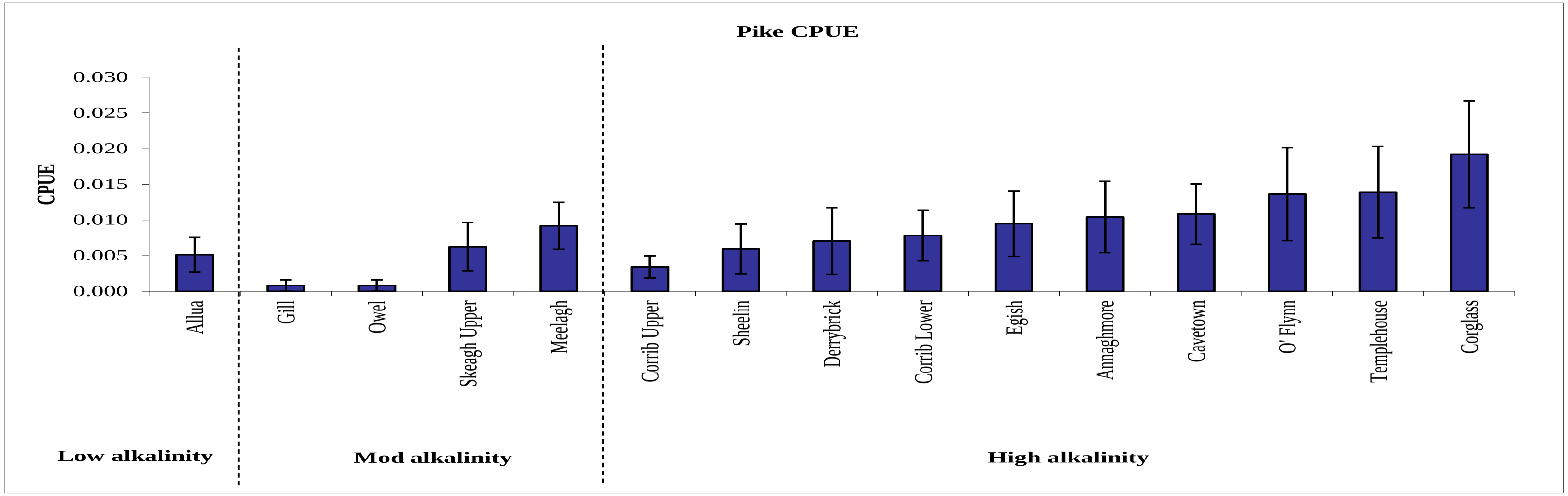

Fig. 4.28. Pike abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

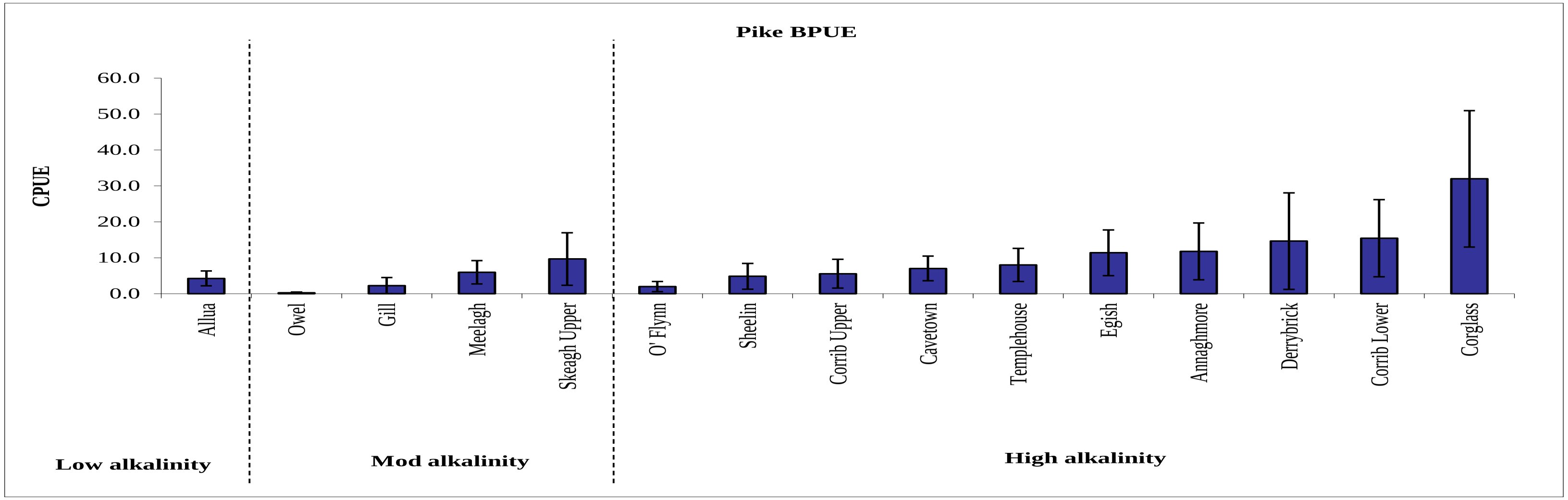

Fig. 4.29. Pike biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

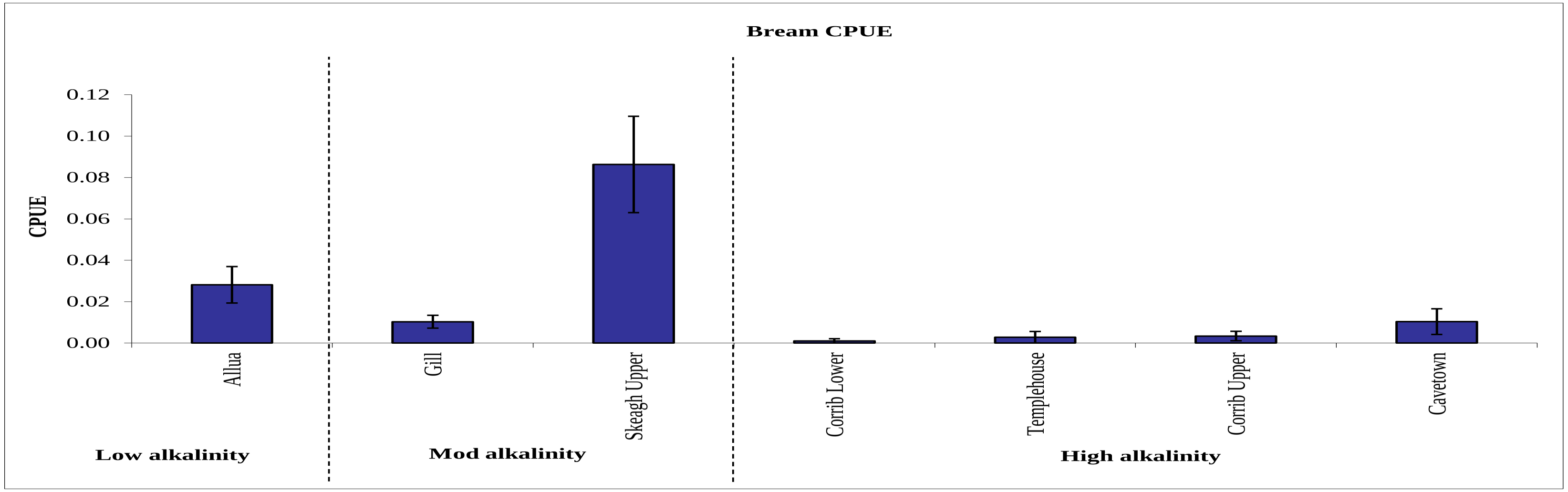

Fig. 4.30. Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

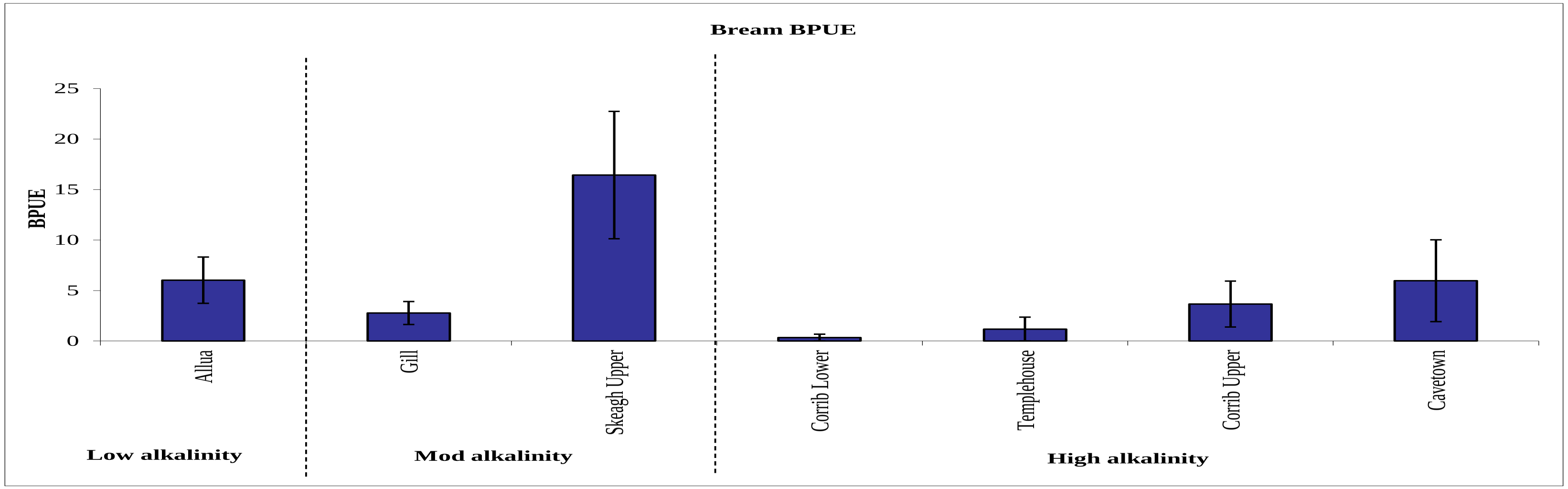

Fig. 4.31. Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

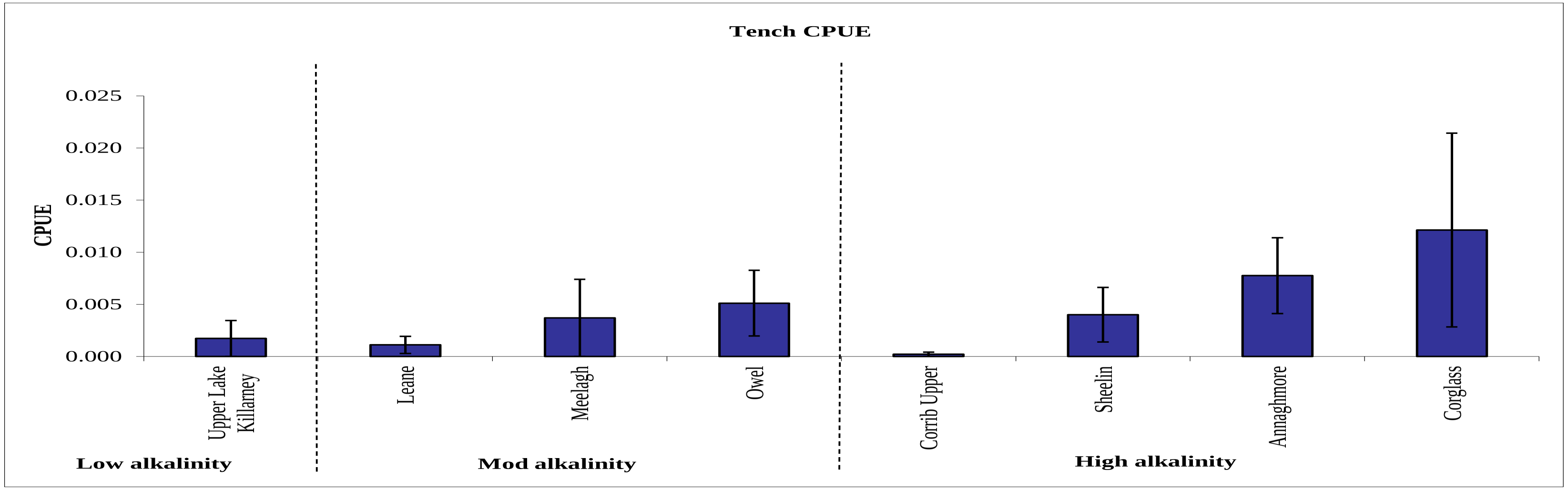

Fig. 4.32. Tench abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

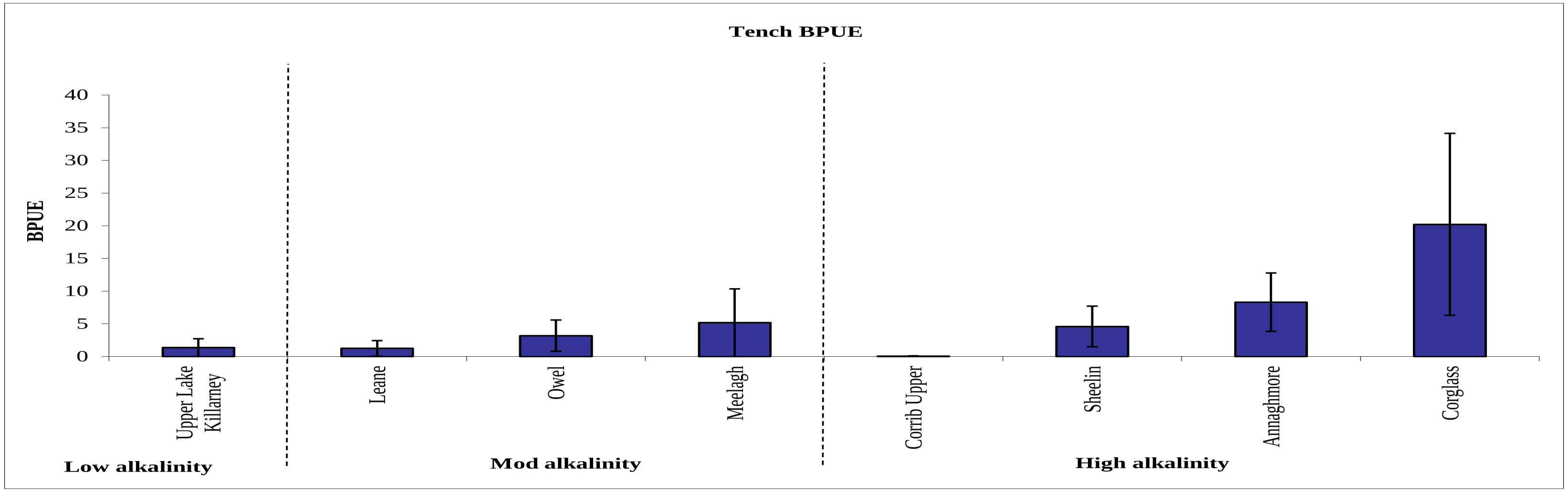

Fig. 4.33. Tench biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

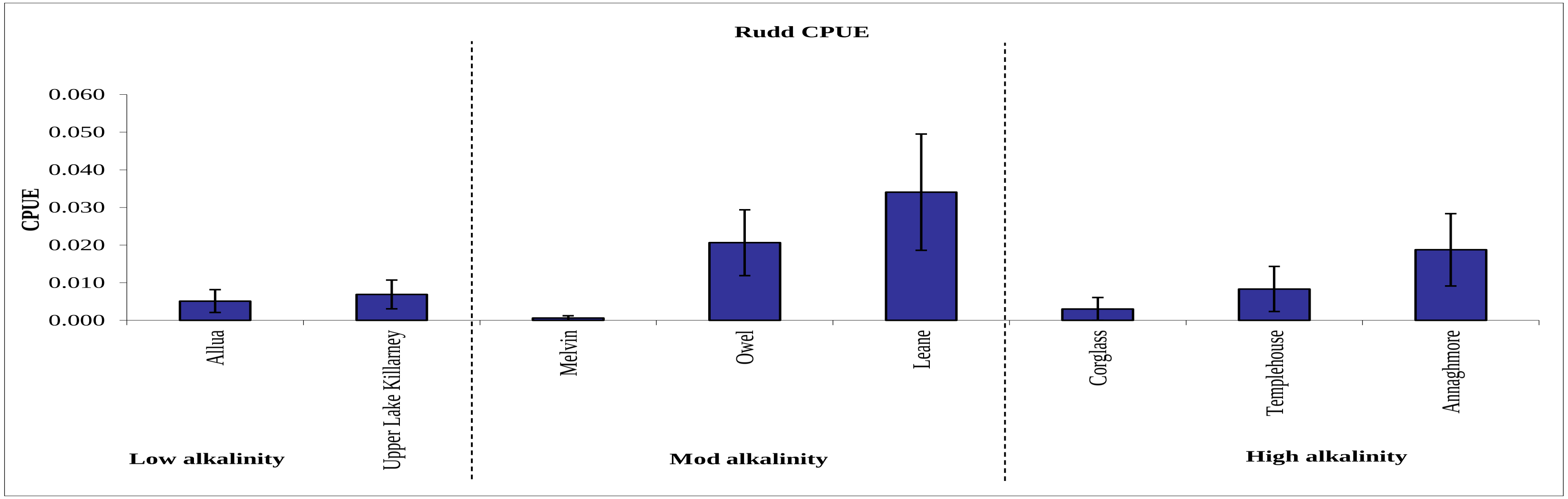

Fig. 4.34. Rudd abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

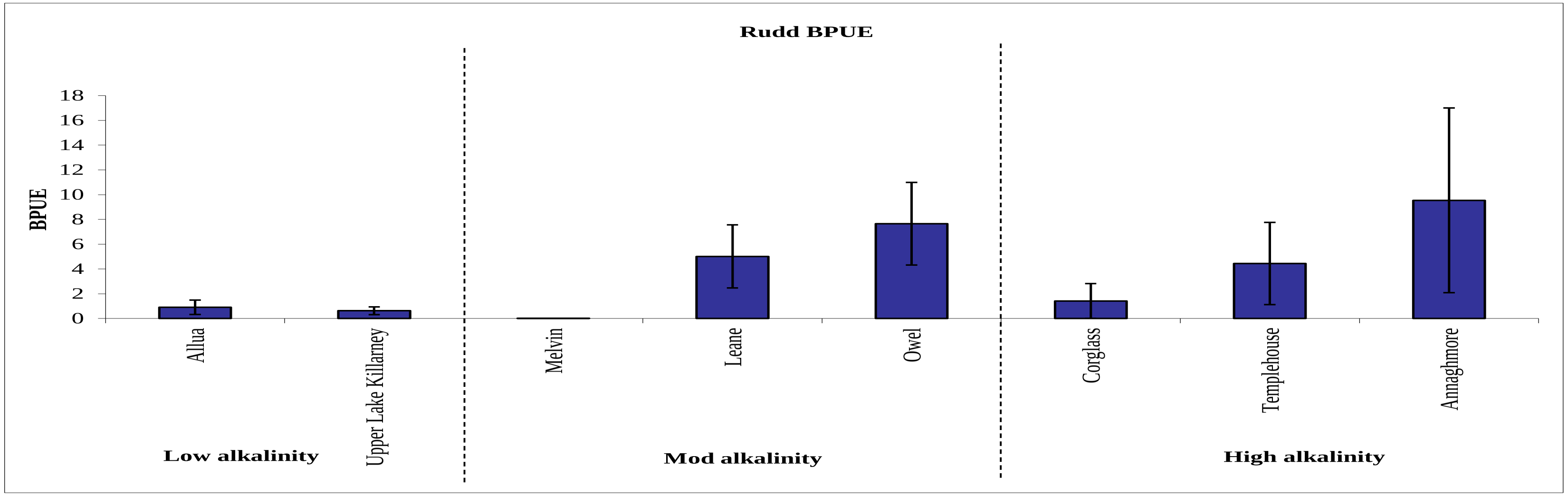

Fig. 4.35. Rudd biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

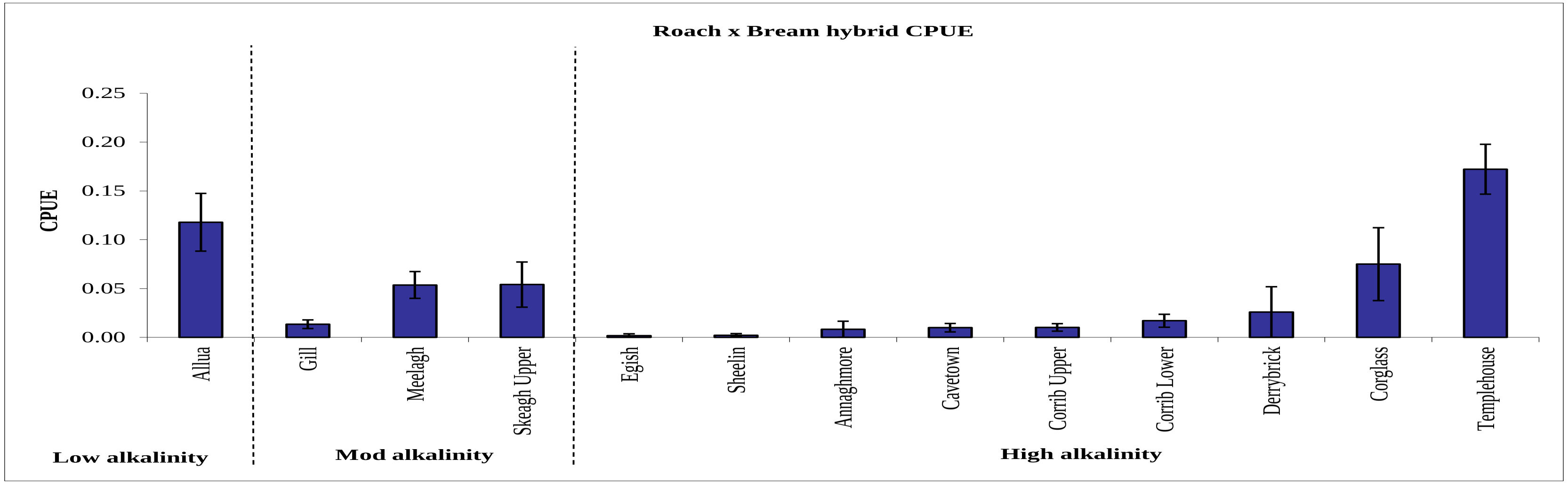

Fig. 4.36. Roach x Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2011

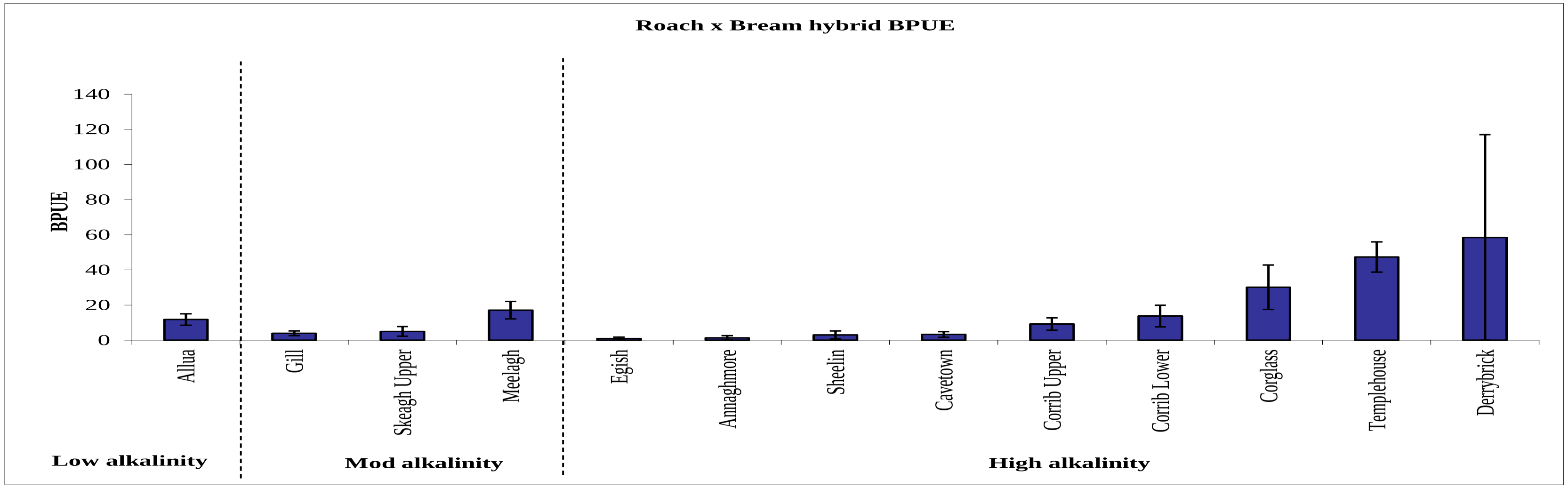

Fig. 4.37. Roach x Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2011

4.1.4 Fish Growth

4.1.4.1 Growth of brown trout, perch and roach

Scales from 971 brown trout (21 lakes), 832 roach (14 lakes), 40 rudd (7 lakes), otoliths from 91 char (5 lakes) and opercular bones from 1,359 perch (19 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. 4.38 to 4.40). Details of back calculated mean lengths at age for brown trout, perch and roach are given in Appendices 3, 4 and 5 respectively.

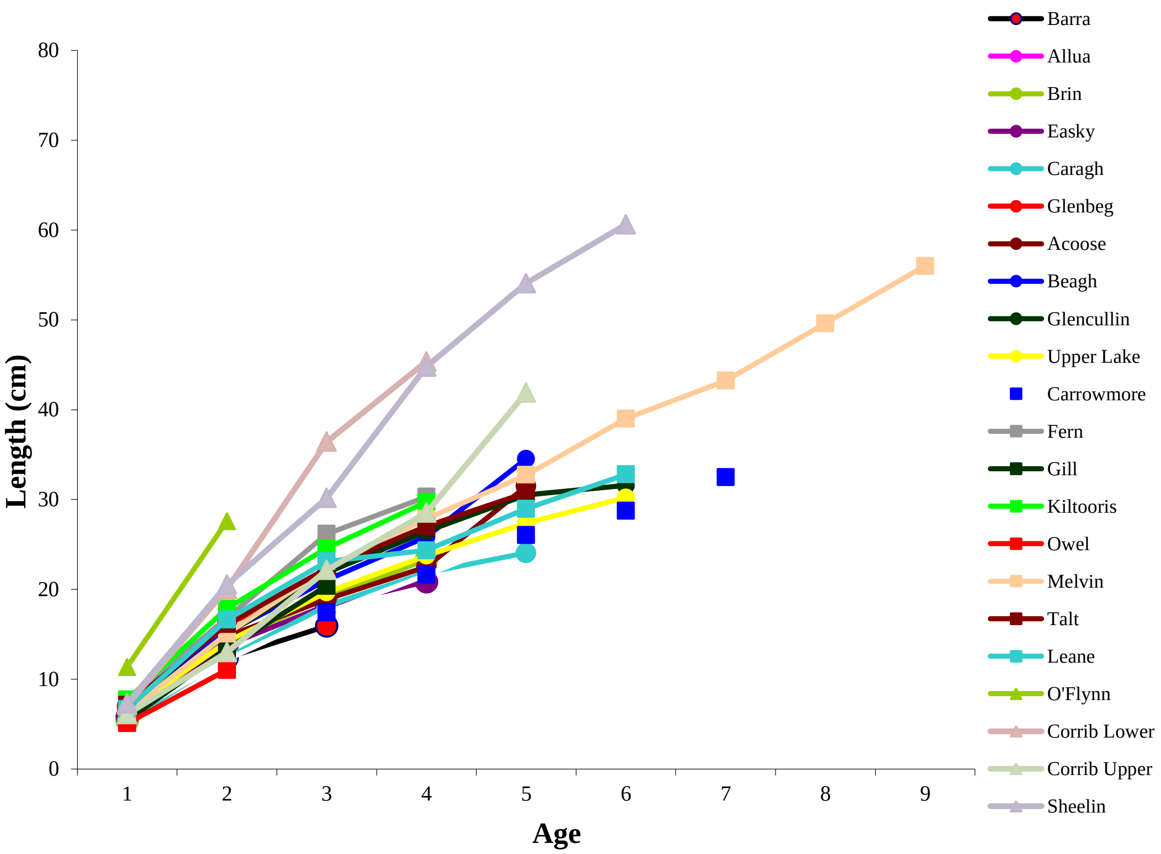

Fig. 4.38. Mean lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2011 (note: circles indicate low alkalinity lakes, squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

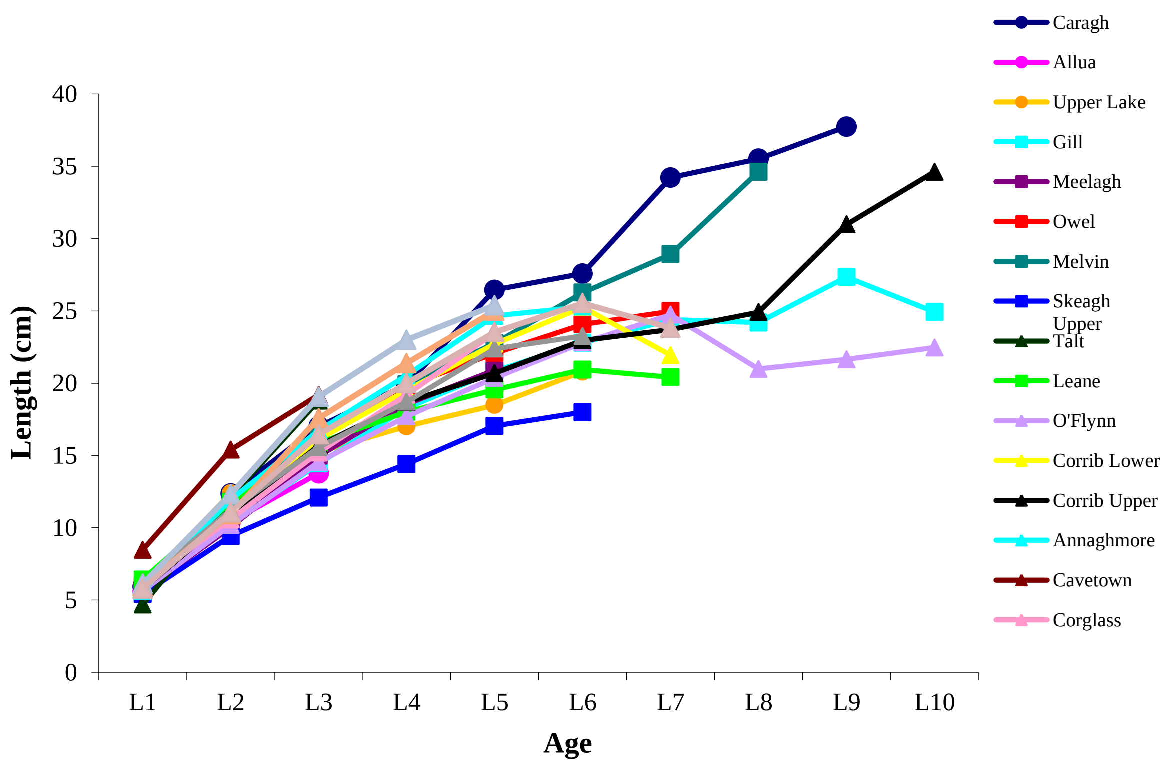

Fig. 4.39. Mean lengths at age of perch in lakes surveyed for WFD fish monitoring 2010 (note: circles indicate low alkalinity lakes, squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

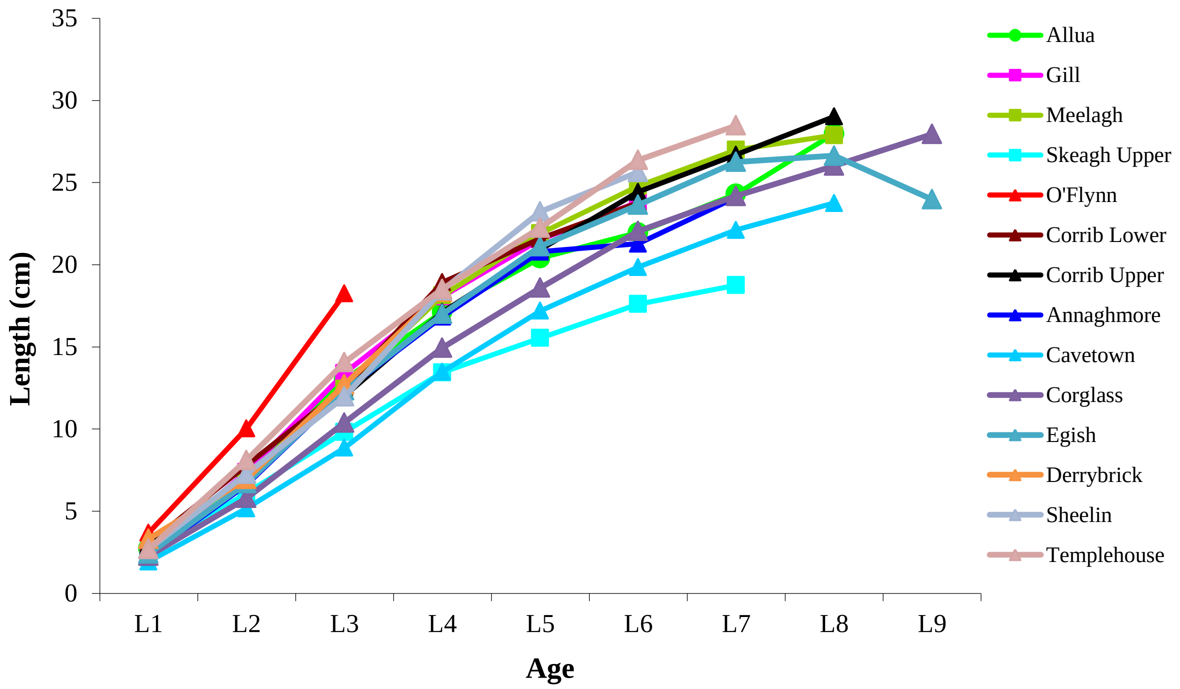

Fig. 4.40. Mean lengths at age of roach in lakes surveyed for WFD fish monitoring 2010 (note: circles indicate low alkalinity lakes, squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

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

Brown trout from high alkalinity lakes surveyed during 2011 displayed a significantly faster growth at the end of year 2, 3, 4 and 5 than those from the low and moderate alkalinity lakes (Fig. 4.41) (one-way ANOVA, L2 - $F_{2, 21}$=6.556, $P<0.05$; L3 - $F_{2, 18}$=10.492, $P<0.05$; L4 - $F_{2, 15}$=13.587, $P<0.05$; L5 - $F_{2, 10}$=13.592, $P<0.05$) (Fig. 4.41).

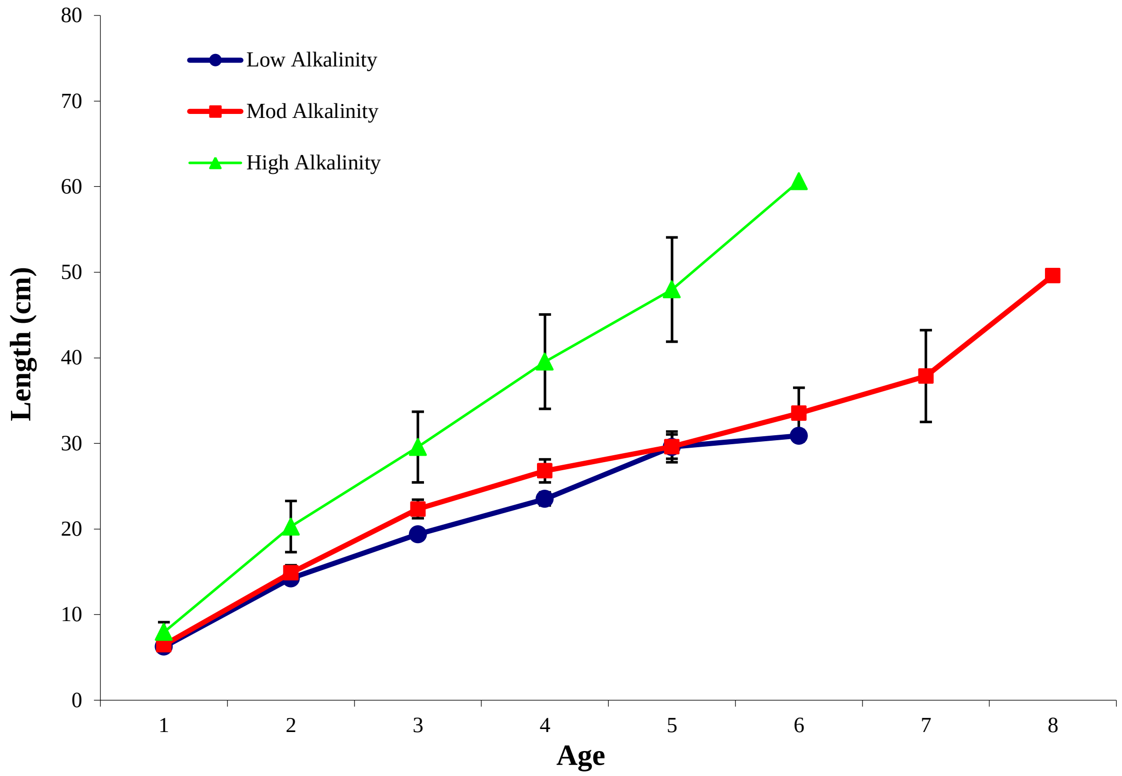

Fig 4.41. Mean (±SE) lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2011

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 15 lakes during 2011; seven were classified as very slow, five were classified as slow, one was classified as fast and two were classified as very fast (Table 4.3). Trout from Lough O'Flynn, Lough Barra, Lough Allua, Lough Gill, Glenbeg Lough and Lough Owel were not classified as there were no four year old fish captured on these lakes.

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

Very slow	Slow	Fast	Very fast
Acoose	Talt	Fern	Corrib (upper & lower)
Leane	Kiltooris		Sheelin
Upper	Beagh		
Caragh	Glencullin		
Brin	Melvin		
Easky			
Carrowmore			

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

Both perch and roach were recorded in low, moderate and high alkalinity lakes. Overall, the mean length at age for L1 to L6 of both perch and roach were slightly higher in the high alkalinity lakes than in the low and moderate alkalinity lakes, however these differences were not significant (one-way ANOVA) (Figs. 4.42 and 4.43). Appendices 4 and 5 give a summary of the mean back calculated lengths at age of perch and roach from the 19 and 14 lakes respectively.

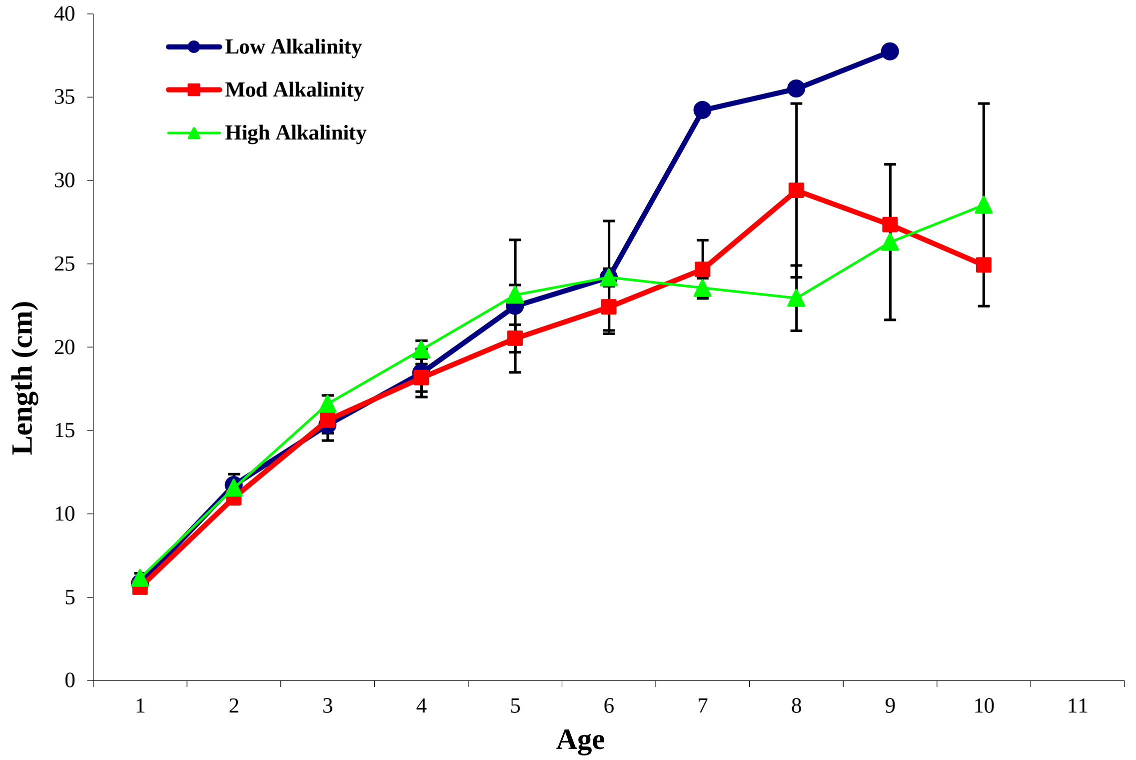

Fig 4.42. Mean (±SE) length at age of perch in lakes surveyed for WFD fish monitoring 2011

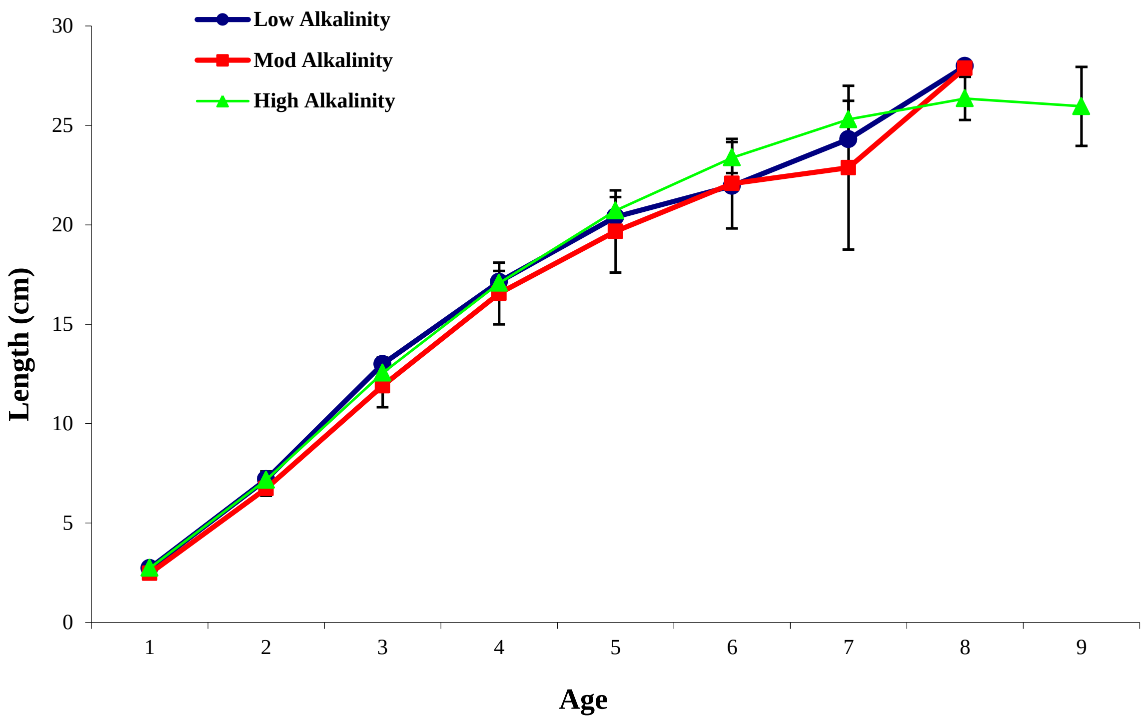

Fig 4.43. Mean (±SE) length at age of roach in lakes surveyed for WFD fish monitoring 2011

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 abundance, species composition and age structure (Kelly *et al*., 2012). 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*., 2012).

All 29 lakes surveyed during 2011 were assigned a draft ecological status class using the FIL2 ecological classification tool, together with expert opinion; eight were classified as High, ten were classified as Good, five were classified as Moderate and seven were classified as Poor/Bad ecological status (Table 4.4, Figure 4.44). 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)
Barra	1	High
Caragh	2	High
Carrowmore	1	High
Glenbeg	2	High
Glencullin	1	High
Kiltooris	1	High
Melvin	2	High
Talt	4	High
Acoose	2	Good
Beagh	2	Good
Brin	1	Good
Cavetown	4	Good
Easky	1	Good
Fern	1	Good
Gill	4	Good
Leane	2	Good
O' Flynn	3	Good
Owel	4	Good
Allua	2	Moderate
Annaghmore	3	Moderate
Corrib Lower	3	Moderate
Sheelin	3	Moderate
Upper Lake Killarney	2	Moderate
Corglass	3	Poor/Bad
Corrib Upper	4	Poor/Bad
Derrybrick	3	Poor/Bad
Egish	3	Poor/Bad
Meelagh	3	Poor/Bad
Skeagh Upper	1	Poor/Bad
Templehouse	3	Poor/Bad

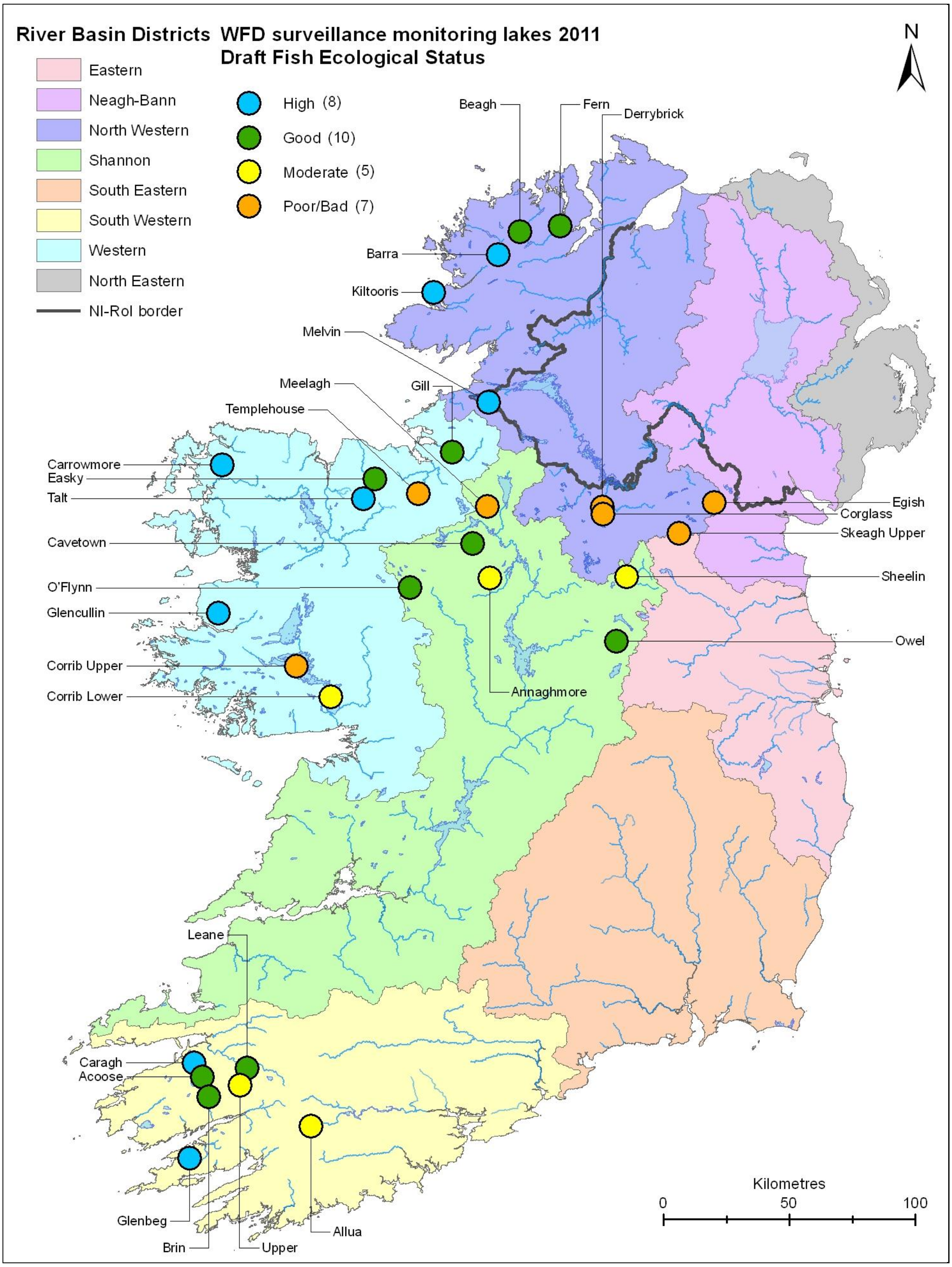

Fig. 4.44. Ecological classification of lakes surveyed during 2011 using the FIL2 ecological classification tool

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 are able to 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 if the population is dominated by salmonids or euryhaline species with an arctic marine past, i.e. native fish species (Group 1) are the only species present in the river (Kelly *et al*., 2007c). A list of fish species recorded in the 65 river sites surveyed during 2011 is shown in Table 4.5. The percentage of river sites in which each fish species occurred is shown in Figure 4.45.

Table 4.5. List of fish species recorded in the 65 river sites surveyed during 2011

	Scientific name	Common name	Number of river sites	% river sites
	NATIVE SPECIES			
1	*Salmo trutta*	Brown trout	58	89
2	*Gasterosteus aculeatus*	Three-spined stickleback	43	66
3	*Anguilla anguilla*	Eel	39	60
4	*Salmo salar*	Salmon	32	49
5	*Lampetra* sp.	Lamprey sp.	30	46
6	*Pungitius pungitius*	Nine-spined stickleback	7	11
7	*Salmo trutta*	Sea trout *	1	2
8	*Platichthys flesus*	Flounder	1	2
	NON NATIVE (influencing ecology)			
9	*Barbatula barbatula*	Stone loach	36	55
10	*Phoxinus phoxinus*	Minnow	23	35
11	*Rutilus rutilus*	Roach	7	11
12	*Perca fluviatilis*	Perch	4	6
13	*Esox lucius*	Pike	4	6
	NON NATIVE SPECIES (generally not influencing ecology)			
14	*Gobio gobio*	Gudgeon	7	11

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

A total of 14 fish species (sea trout are included as a separate "variety" of trout) were recorded in the 65 river sites surveyed during 2011. Brown trout was the most widespread species occurring in 89% of the sites surveyed, followed by three-spined stickleback (66%), eels (60%), stone loach (55%), salmon (49%), lamprey (46%), minnow (35%), gudgeon (11%), nine-spined stickleback (11%) and roach (11%). Perch, pike, flounder and sea trout were each found in less than 10% of the river sites surveyed (Table 4.5 and Fig. 4.45).

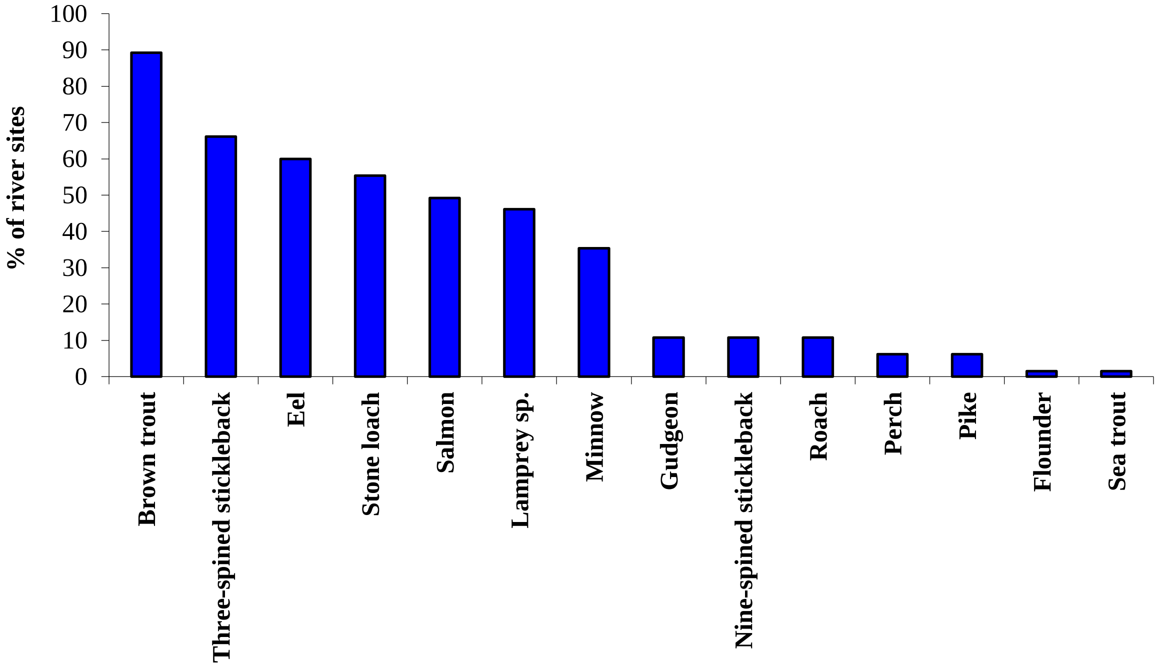

Fig. 4.45. Percentage of sites where each fish species was recorded (total of 65 river sites surveyed) during WFD surveillance monitoring 2011

Fish species richness ranged from zero species at one river site (Piperstown Stream in the ERBD) to a maximum of ten species in the Rye Water at Kildare Bridge (ERBD) (Table 4.6 and Figs. 4.46, 4.47a and 4.47b). Native species were present in all of the sites surveyed, except for the aforementioned site where no fish were recorded (Piperstown Stream). Twenty-one out of a total of 65 sites contained exclusively native species. The maximum number of native species captured in any site was five and this was recorded in two sites (Rye Water at Kildare Br. (ERBD) and Womanagh River (SWRBD)) (Table 4.6). Group 2 species (non-native species influencing ecology) were present at 43 sites. The maximum number of non-native species recorded at any one site was five species, recorded in both the Camlin River (Lisnabo) and Scramoge River (Riverdale). Only one Group 3 species (gudgeon) was present in the river sites surveyed, being recorded at six sites (Table 4.6).

Table 4.6. Species richness in each river site surveyed for WFD fish monitoring 2011

Site	RBD	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Wadeable sites					
Rye Water (Kildare Br.)	ERBD	10	6	4	0
Lyreen (Lyreen angling centre)	ERBD	7	5	2	0
Gweestin (Gweestin Br.)	SWRBD	7	5	2	0
Broadmeadow Water (Lispopple Br.)	ERBD	6	4	2	0
Dodder (Beaver Row)	ERBD	6	4	2	0
Tolka (Violet Hill Drive)	ERBD	6	4	2	0
Ballyroan (Gloreen Br.)	SERBD	6	5	1	0
Banoge (Br u/s Owenavorragh confl)	SERBD	6	4	2	0
Martin (Bawnafinny Br.)	SWRBD	6	5	1	0
Womanagh (ATV centre)	SWRBD	6	6	0	0
Camlin (Killoe)	SHIRBD	6	2	2	1
Gourna (Beside railway Br.)	SHIRBD	6	5	1	0
Gourna (Br. u/s Owenogarney confl.)	SHIRBD	6	5	1	0
Mountnugent (Mountnugent Br.)	SHIRBD	6	3	3	0
Little (Cloghan) (Br. SW of Cloghan)	SHIRBD	6	4	2	0
Dromore (Drummuck)	NWIRBD	6	4	2	0
Waterfoot (Letter Br.)	NWIRBD	6	5	1	0
Dodder (Mount Carmel)	ERBD	5	3	2	0
Rye Water (Balfeaghan Br.)	ERBD	5	3	2	0
Ward (Br. d/s Scotchstone Br.)	ERBD	5	3	2	0
Douglas (Ballon) (Sragh Br.)	SERBD	5	4	1	0
Duag (Br. u/s Ballyporeen)	SERBD	5	4	1	0
Shanowen (Ford u/s Maine confluence)	SWRBD	5	4	1	0
Boor ((Br. NW Kilbillaghan)	SHIRBD	5	4	1	0
Deel (Newcastlewest) (Br. near Balliniska)	SHIRBD	5	3	2	0
Mountnugent (Racraveen)	SHIRBD	5	3	2	0
Castlebar (br. 2.5km d/s Castlebar)	WRBD	5	4	1	0
Tobercurry (Br. just u/s of Moy)	WRBD	5	3	2	0
Burnfoot (Br. in Burnfoot)	NWIRBD	5	5	0	0
Baltracey (Fraynes Br.)	ERBD	4	3	1	0
Camac (Riverside)	ERBD	4	3	1	0
Griffeen (Griffeen Park)	ERBD	4	3	1	0
Ratoath (Br. in Ratoath)	ERBD	4	3	1	0
Duncormick (Br. nr Duncormick Rly st.)	SERBD	4	3	1	0
Glashaboy (Ballyvorisheen Br.)	SWRBD	4	3	1	0
Behy (Behy Br.)	WRBD	4	4	0	0
Swanlinbar (D/s Swanlinbar Br.)	NWIRBD	4	3	0	1
Swilly (Swilly Br.)	NWIRBD	4	4	0	0
Dodder (Bohernabreena)	ERBD	3	2	1	0
Pinkeen (Br. S. of Calliagwee)	ERBD	3	2	1	0
Nuenna (Br. d/s Clomantagh)	SERBD	3	3	0	0
Bow (Bow River Br.)	SHIRBD	3	2	1	0
Graney (Caher Br.)	SHIRBD	3	2	1	0
Inny (Tully)	SHIRBD	3	3	0	0
Inny (Oldcastle)	SHIRBD	3	3	0	0

* Sea trout are included as a separate “variety” of trout

Table 4.6 ctn. Species richness in each river site surveyed for WFD fish monitoring 2011

Site	RBD	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Wadeable sites					
Ballinglen (Ballinglen Br.)	WRBD	3	3	0	0
Glennamong (Br. u/s Lough Feeagh)	WRBD	3	3	0	0
Ballyhallan (Br. u/s Clonmany River)	NWIRBD	3	3	0	0
Glaskeelan (Br. W of Roshin)	NWIRBD	3	3	0	0
Owentocker (D/s Br. in Ardara)	NWIRBD	3	3	0	0
Avoca (1km N of Woodenbridge)	ERBD	2	2	0	0
Camac (Moneenalion)	ERBD	2	2	0	0
Mayne (Wellfield Br.)	ERBD	2	2	0	0
Clydagh (Castlebar) (Br. NW Ardvarney)	WRBD	2	2	0	0
Cronaniv Burn (Br. u/s Dunlewy Lough)	NWIRBD	2	2	0	0
Brittas (Br. off R114)	ERBD	1	1	0	0
Griffeen (Grange Castle)	ERBD	1	1	0	0
Owendoher (Cruagh Road Br.)	ERBD	1	1	0	0
Piperstown (Tributary at Corrageen)	ERBD	0	0	0	0
Non-wadeable sites					
Camlin (Lisnabo)	SHIRBD	8	3	4	1
Scramoge (Riverdale)	SHIRBD	8	3	4	1
Owenavorragh (Br. n of Ballinamona)	SERBD	7	5	2	0
Scramoge (Carrowclogher)	SHIRBD	6	2	3	1
Silver (Kilcormac) (Lumcloon Br.)	SHIRBD	6	3	2	1
Clodiagh (Tullamore) (Br. at Rahan)	SHIRBD	5	2	2	1

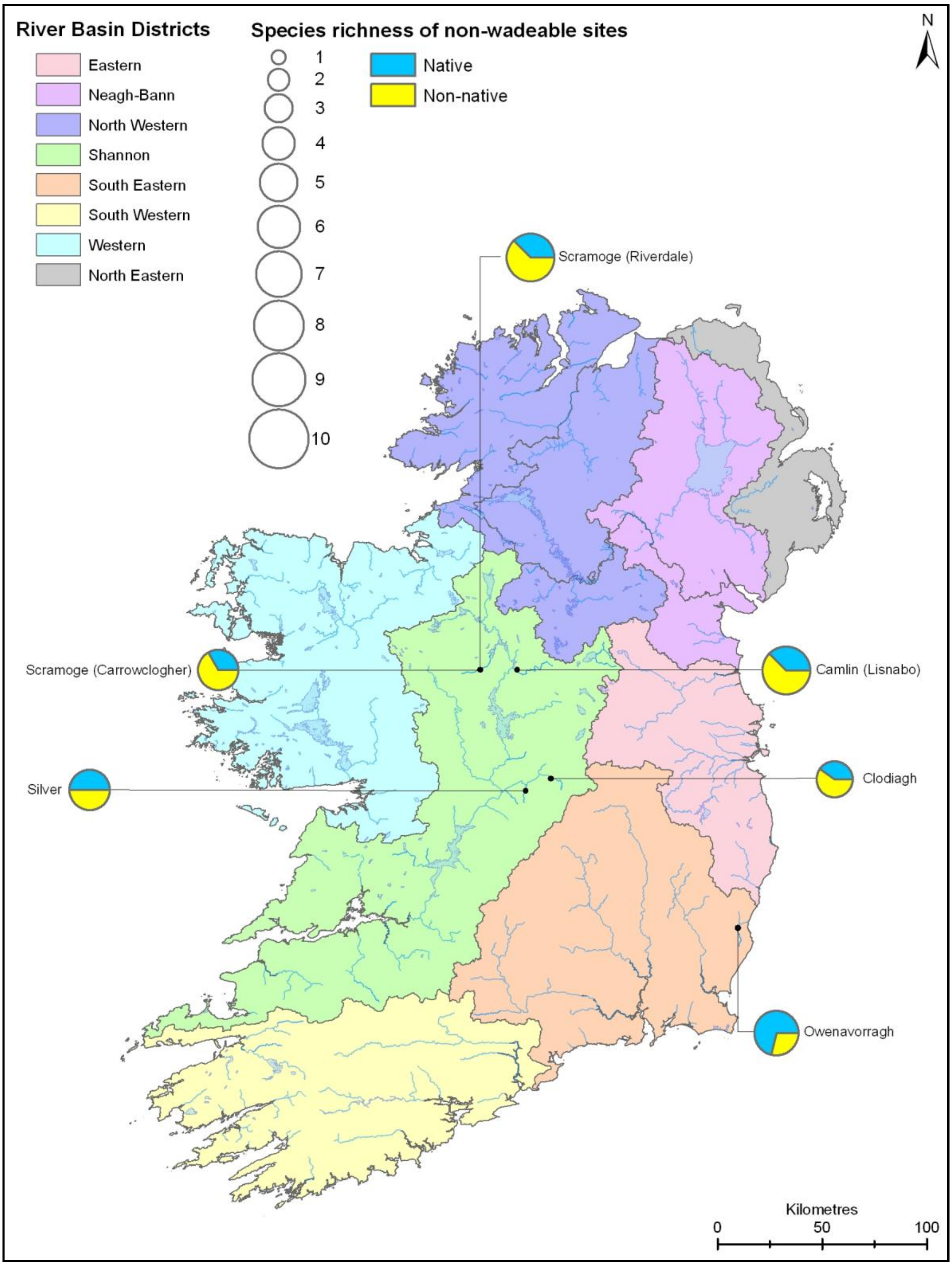

Fig. 4.46. Fish species richness at non-wadeable river sites surveyed using boat based electric-fishing equipment for WFD fish monitoring 2011

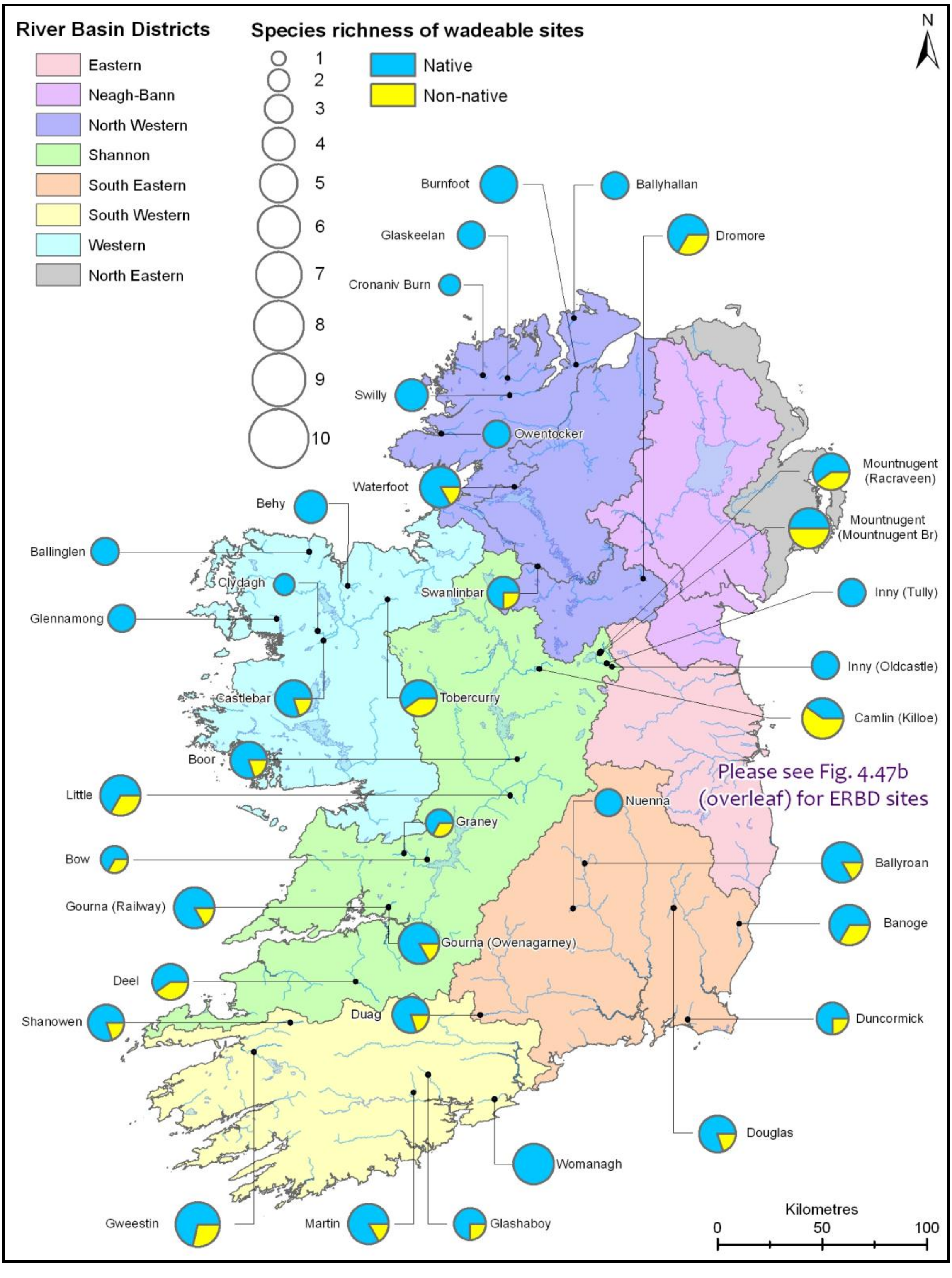

Fig. 4.47a. Fish species richness at wadeable river sites surveyed using handset electric-fishing equipment for WFD fish monitoring 2011

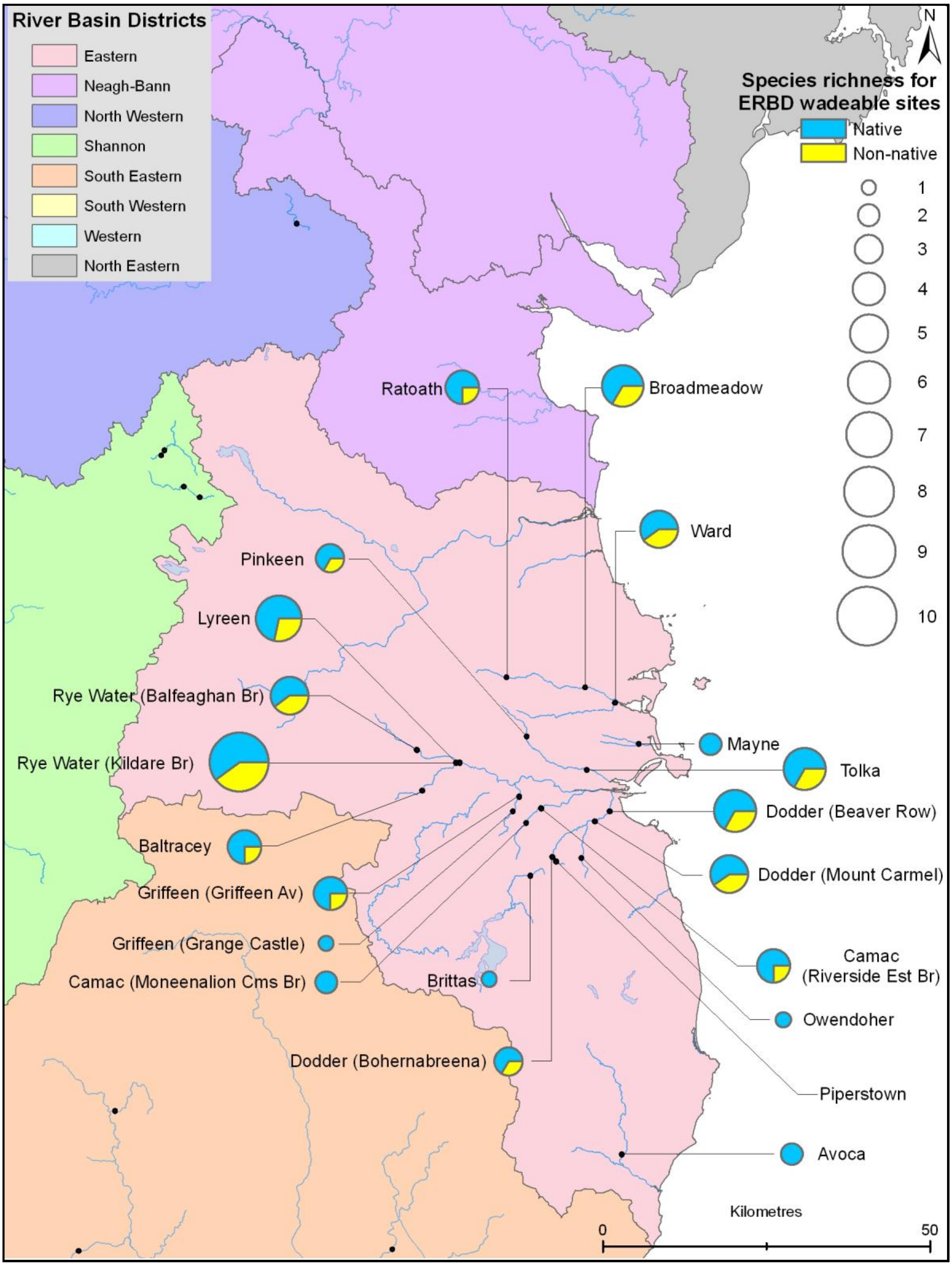

Fig. 4.47b. Fish species richness at wadeable river sites in the ERBD surveyed using handset electric-fishing equipment for WFD fish monitoring 2011

4.2.2 Fish species distribution and abundance

Brown trout were the most widely distributed species among sites surveyed in 2011, being recorded in 58 of the 65 sites (Fig. 4.48 to Fig. 4.51). Brown trout fry (0+) were present in 50 sites (Fig. 4.48 and Fig. 4.49), while older brown trout (1+ and older) were encountered in 53 sites (Fig. 4.50 and Fig. 4.51). 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 rivers surveyed with boat based electric-fishing equipment, the highest densities of both brown trout fry (0.42 fish/m^2) and 1+ and older fish (0.44 fish/m^2) were captured in the Silver River site (ShIRBD). In wadeable streams, the highest densities of fry (0.56 fish/m^2) and 1+ and older fish (0.22 fish/m^2) were recorded in the Inny River (Tully) site (ShIRBD) and Duncormick River site (SERBD) respectively.

Sea trout were only recorded in one site in 2011, the Owenavorragh in the SERBD (0.002 fish/m^2) (Fig. 4.52 and Fig. 4.53).

Salmon were also widely distributed throughout the country, being present in 32 sites. Salmon fry (0+) were captured in 29 sites (Fig. 4.54 and Fig. 4.55), while older salmon (1+ & older) were recorded in 26 sites (Fig. 4.56 and Fig. 4.57). This follows a similar trend to that of brown trout, where fry (0+) densities were generally higher in the shallow wadeable streams than in non-wadeable deeper channels sampled with boat based electric-fishing equipment. The highest density of 1+ and older fish in non-wadeable streams was captured in the Owenavorragh River at (0.004 fish/m^2). Among the wadeable streams, the highest densities of fry (0.83 fish/m^2) and 1+ and older fish (0.34 fish/m^2) were recorded in the Martin River site (SWRBD) and the Owentocker River site (NWIRBD) respectively.

Eels were present in 39 sites, and their distribution is shown in Fig. 4.58 and Fig. 4.59. The highest eel density was recorded in the Castlebar River (0.212 fish/m^2) in the WRBD. Higher eel densities were recorded in both wadeable sites and those river sites close to the coast. The lowest densities of eel were recorded in both non-wadeable sites on the Scramoge River in the Upper Shannon catchment.

Flounder were recorded in only one site located very close to the coast, the Womanagh River in the SWRBD, with a density of 0.01 fish/m^2 (Fig. 4.60 and Fig. 4.61).

Three-spined stickleback were distributed throughout the country, being captured in a total of 43 sites. (Fig. 4.62 and Fig. 4.63). Their highest density (6.08 fish/m^2) was recorded in the Baltracey River site within the ERBD. Nine-spined stickleback were recorded in seven sites (Fig. 4.64 and 4.65). Their greatest density was recorded in the Rye Water (Kildare Br. site) (0.11 fish/m^2).

Juvenile lamprey were recorded in 30 river sites, with their highest density (0.16 fish/m^2) recorded in the Baltracey River within the ERBD (Fig. 4.66 and Fig. 4.67). Stone loach were recorded in 36 sites throughout the country. Their highest density was recorded in the Banoge River (0.17 fish/m^2) within the SERBD, however, they were absent from most sites surveyed within the WRBD and NWIRBD (Fig. 4.68 and Fig. 4.69). Minnow were recorded in 23 river sites, with their greatest density (2.29 fish/m^2) in the Rye Water (Balfeaghan Br. site) in the ERBD (Fig. 4.70 and Fig. 4.71).

Roach were recorded in seven river sites, all in the northern half of the country in sites within the ERBD, WRBD and NWIRBD and ShIRBD (Fig. 4.72 and Fig. 4.73). The greatest density of roach recorded (0.23 fish/m^2) was in the Camlin River, Lisnabo site.

Perch were recorded in four sites, all within the ShIRBD (Fig. 4.74 and Fig. 4.75). Their highest density (0.02 fish/m^2) was recorded in the Scramoge River (Riverdale).

Pike were captured at four river sites during 2011 (Fig. 4.76 and Fig. 4.77). The Scramoge River (Riverdale) site within the ShIRBD had the highest density (0.004 fish/m^2).

Gudgeon were recorded in seven river sites, six within the ShIRBD and one within the NWIRBD (Fig. 4.78 and Fig. 4.79). The highest recorded density of gudgeon (0.19 fish/m^2) was observed in the Camlin River (Killoe) site.

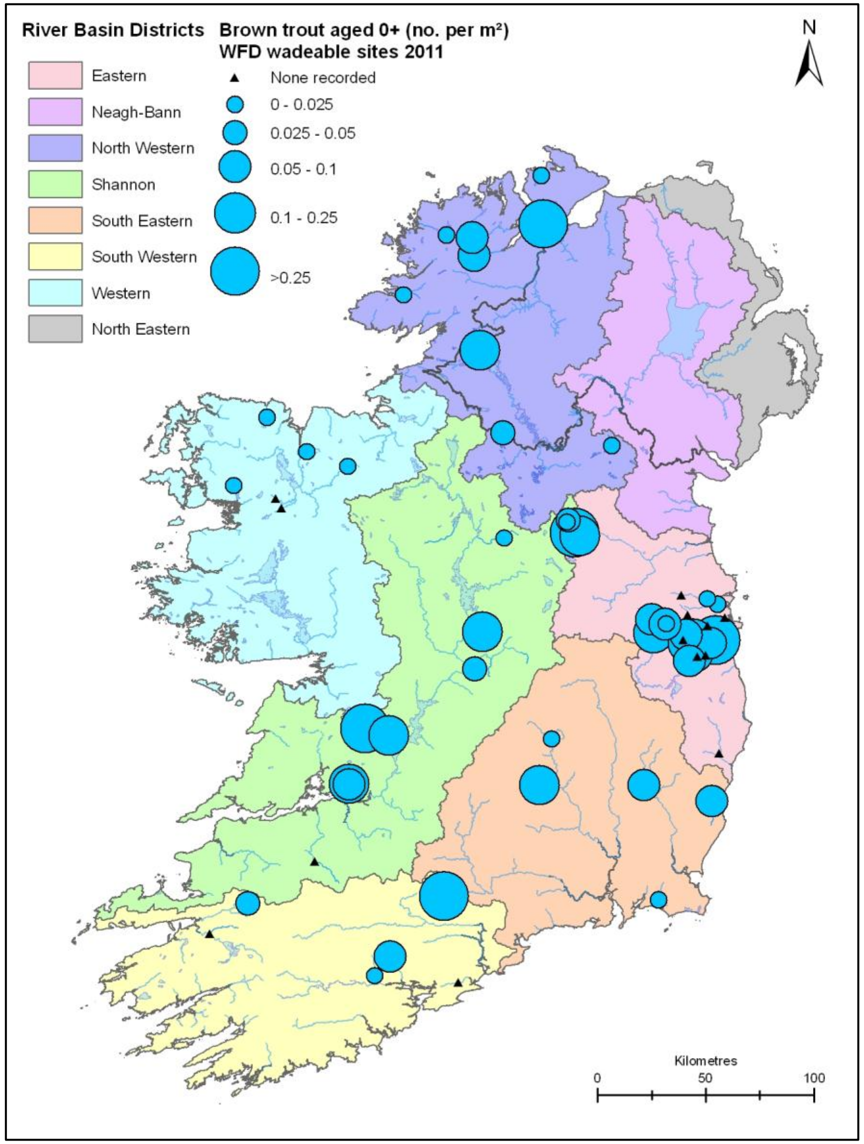

Fig. 4.48. Distribution and abundance of 0+ brown trout at wadeable river sites surveyed for WFD fish monitoring 2011

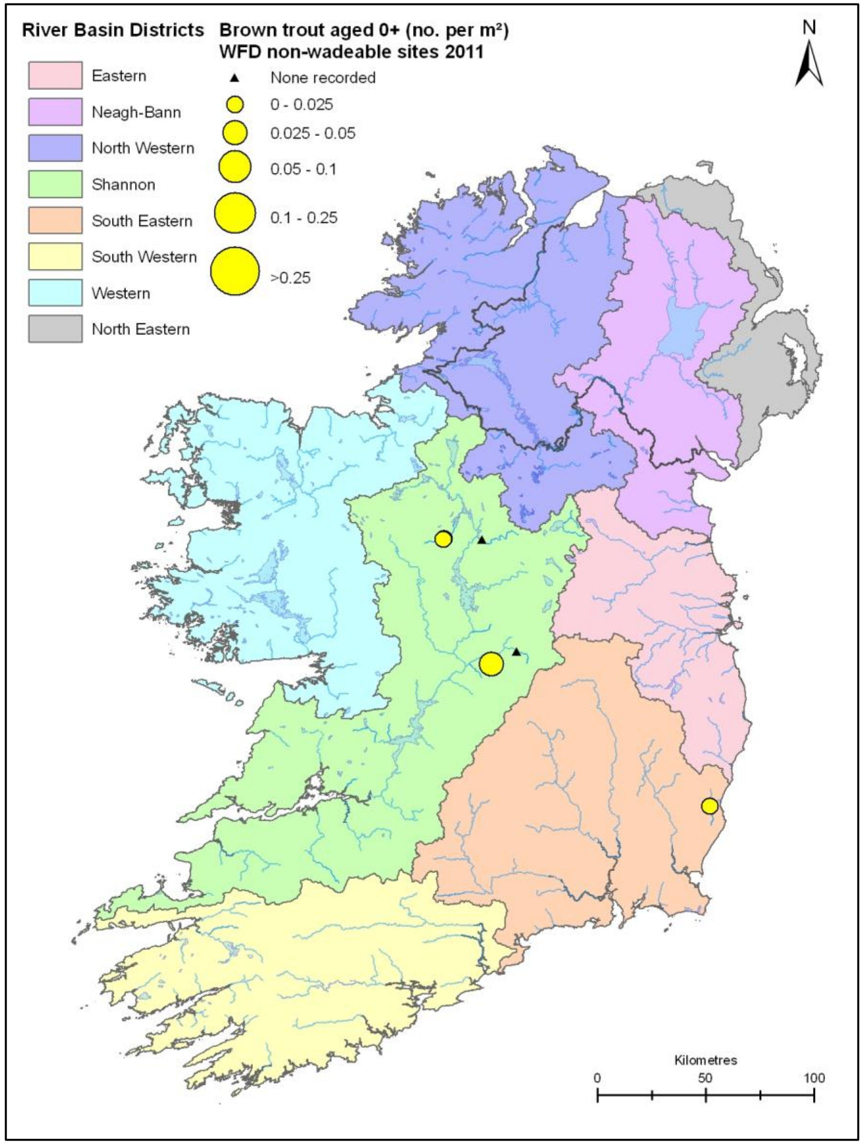

Fig. 4.49. Distribution and abundance of 0+ brown trout at non-wadeable river sites surveyed for WFD fish monitoring 2011

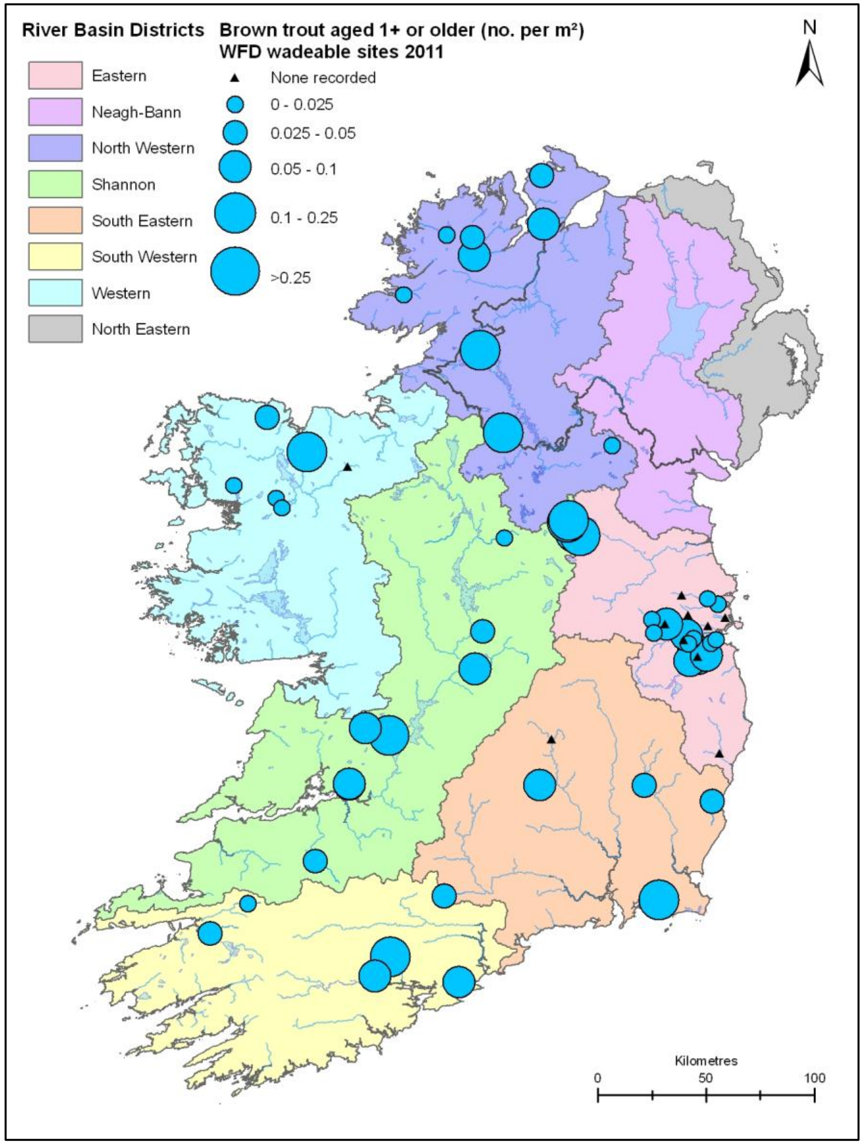

Fig. 4.50. Distribution and abundance of 1+ brown trout at wadeable river sites surveyed for WFD fish monitoring 2011

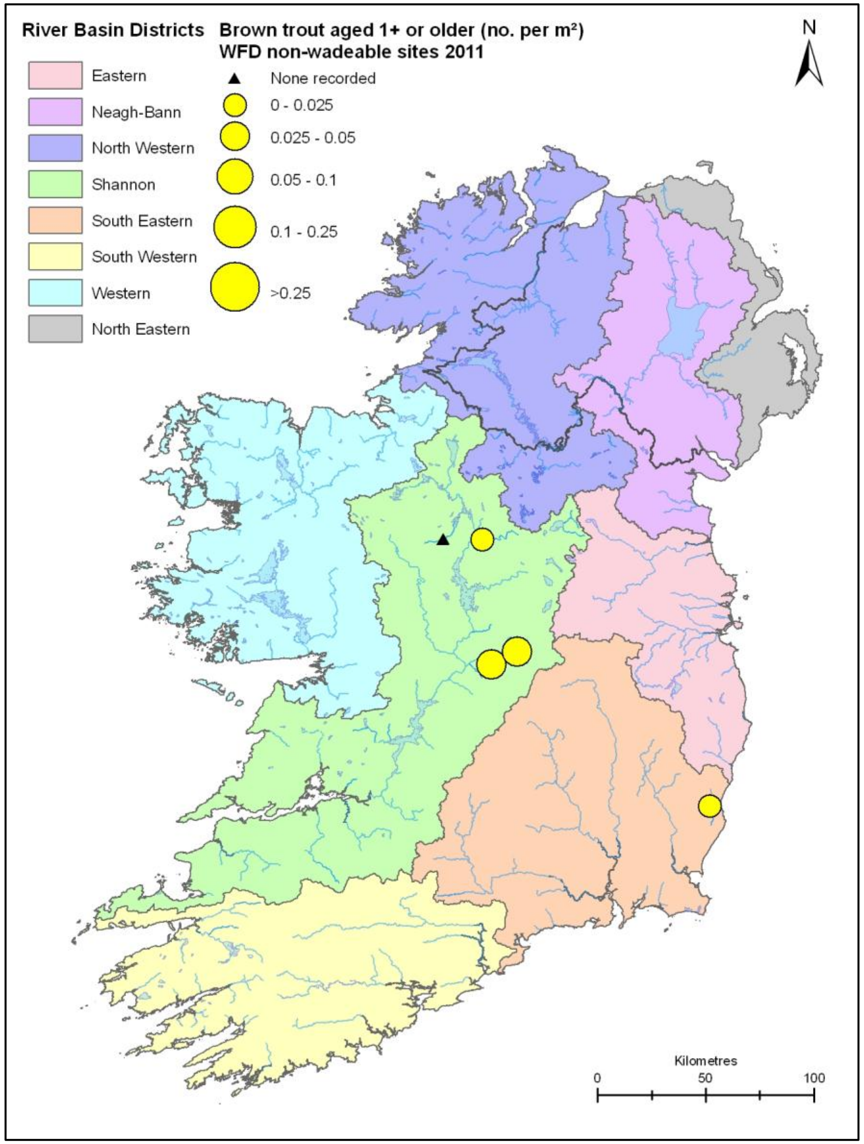

Fig. 4.51. Distribution and abundance of 1+ brown trout at non-wadeable river sites surveyed for WFD fish monitoring 2011

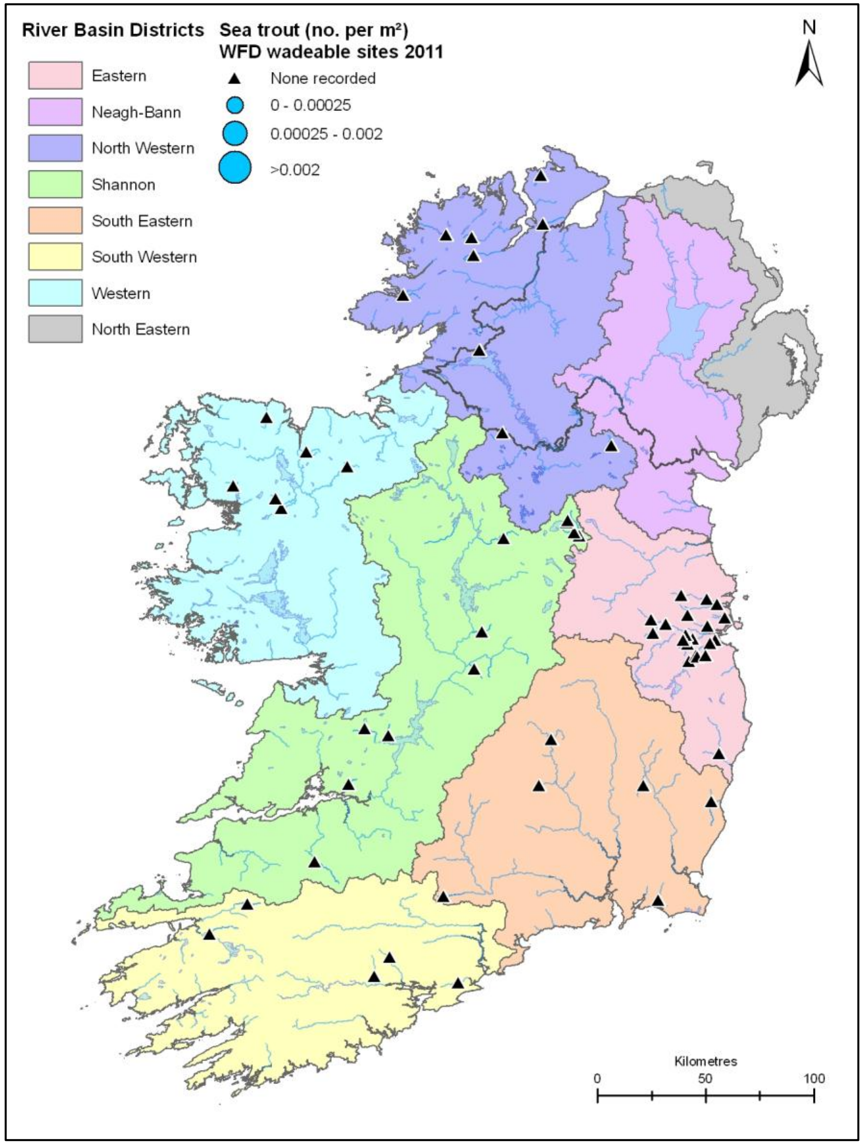

Fig. 4.52. Distribution and abundance of sea trout at wadeable river sites surveyed for WFD fish monitoring 2011

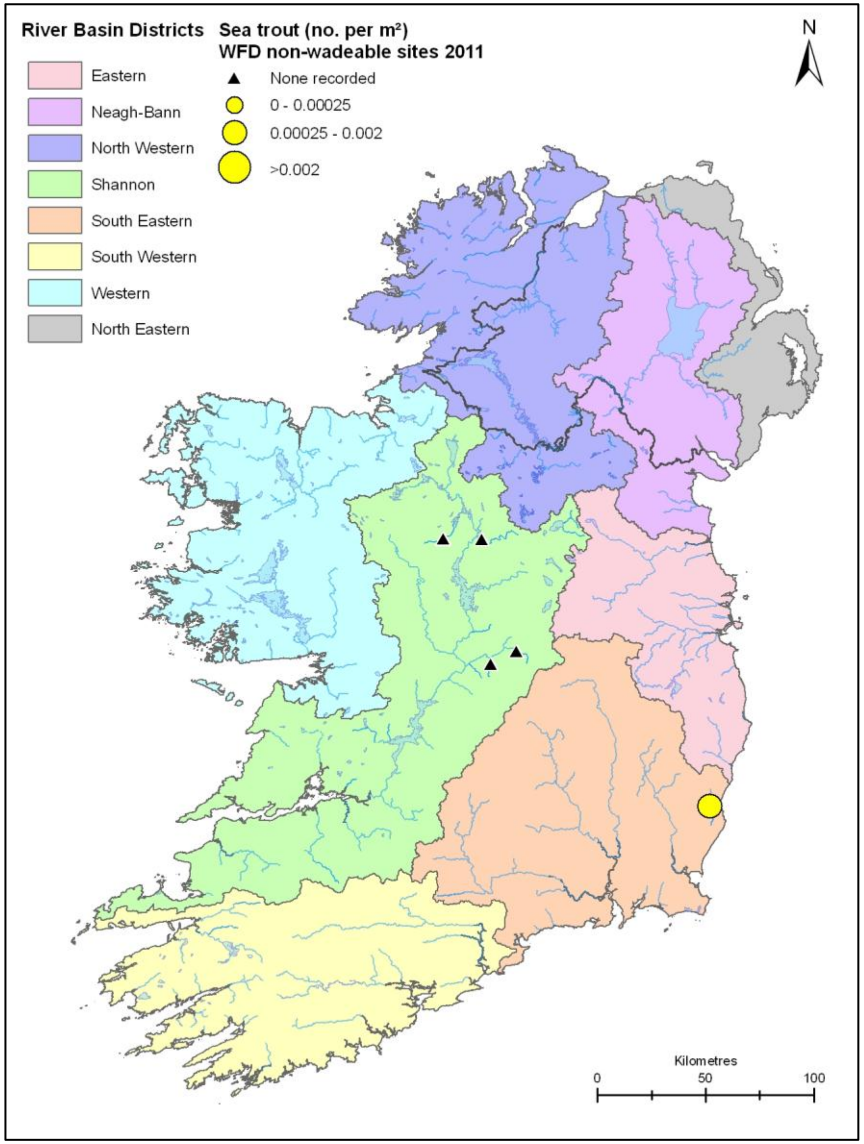

Fig. 4.53. Distribution and abundance of sea trout at non-wadeable river sites surveyed for WFD fish monitoring 2011

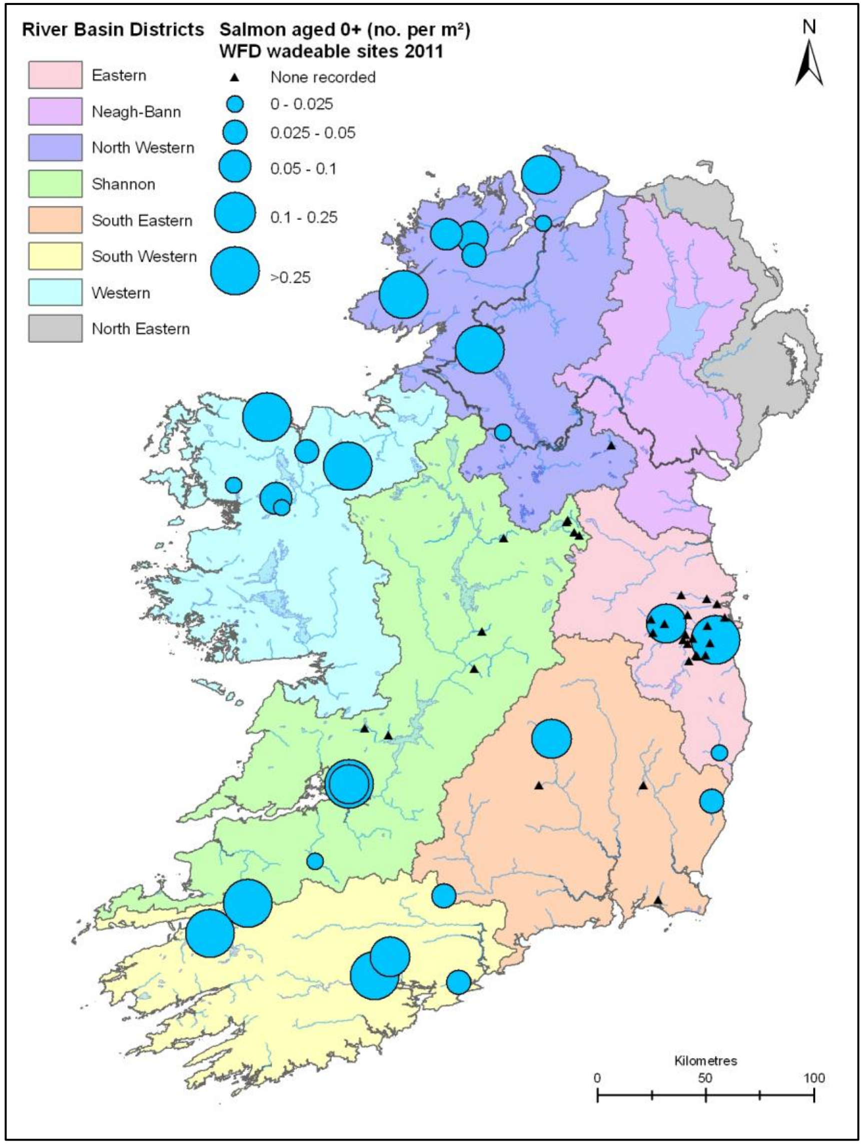

Fig. 4.54. Distribution and abundance of 0+ salmon at wadeable river sites surveyed for WFD fish monitoring 2011

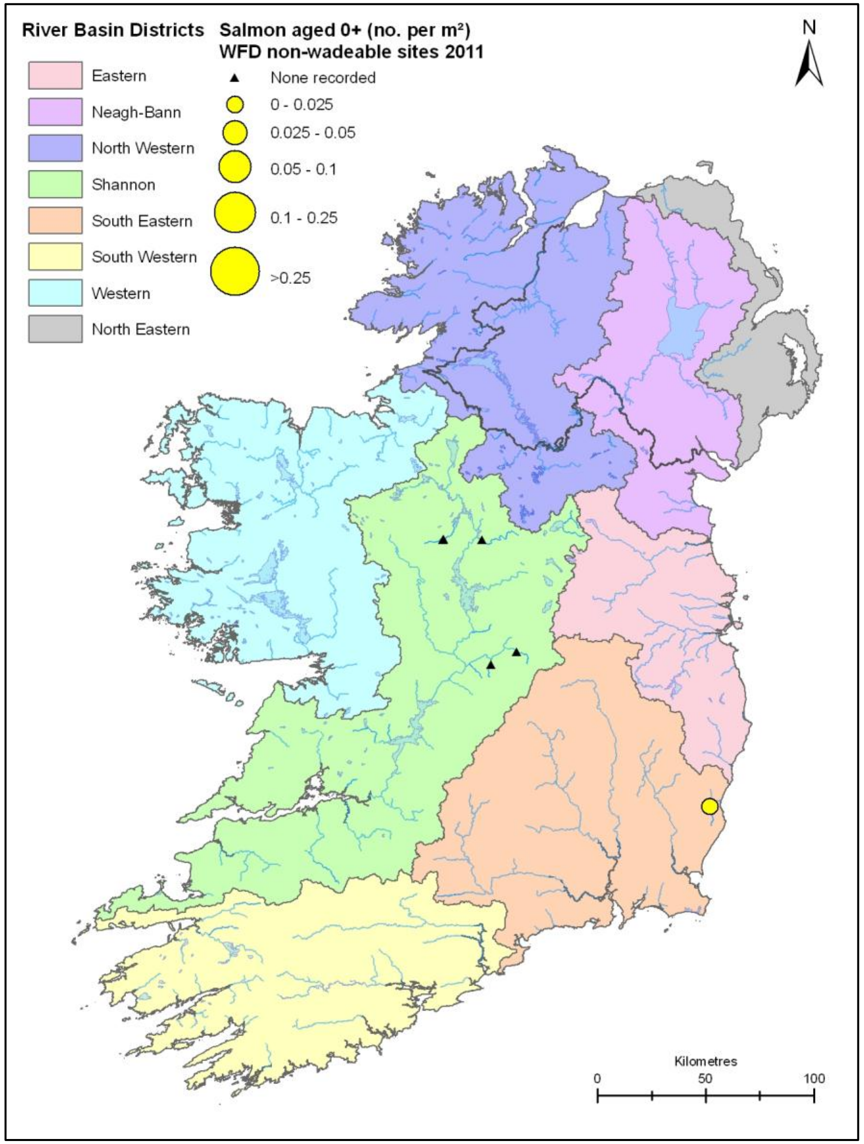

Fig. 4.55. Distribution and abundance of 0+ salmon at non-wadeable river sites surveyed for WFD fish monitoring 2011

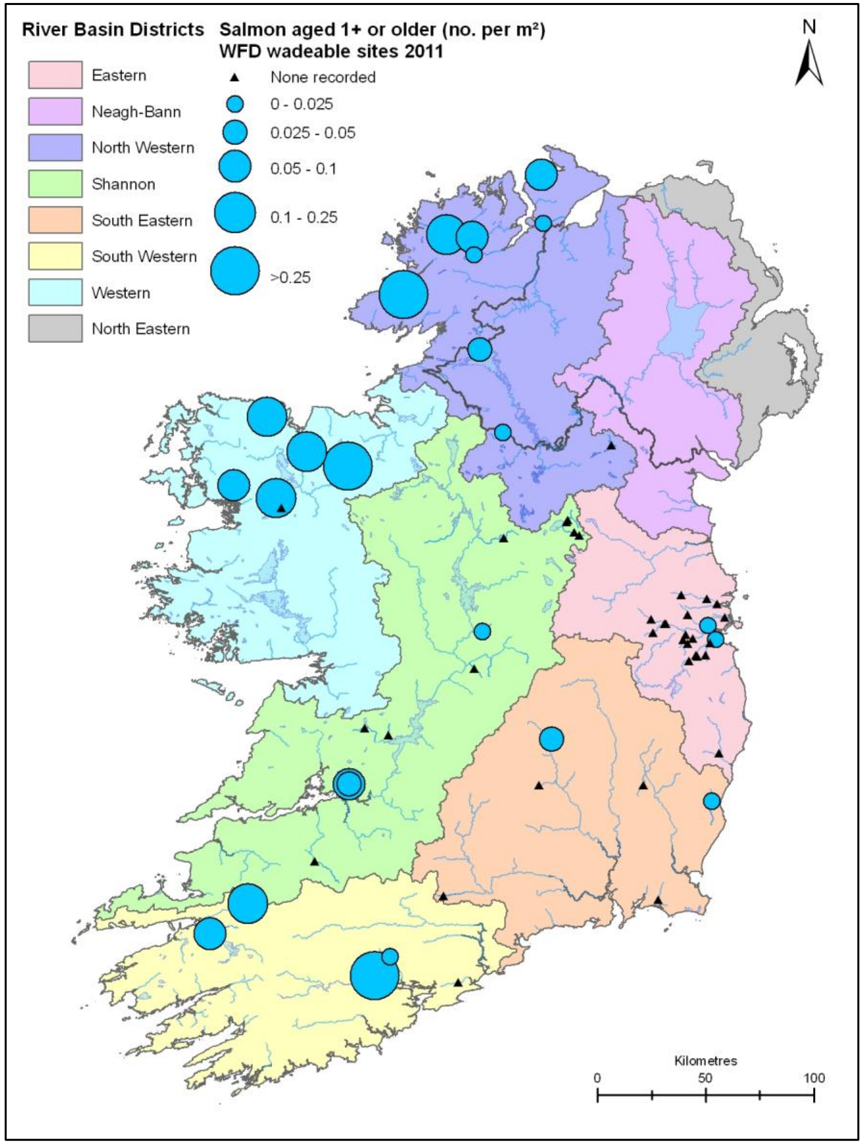

Fig. 4.56. Distribution and abundance of 1+ salmon at wadeable river sites surveyed for WFD fish monitoring 2011

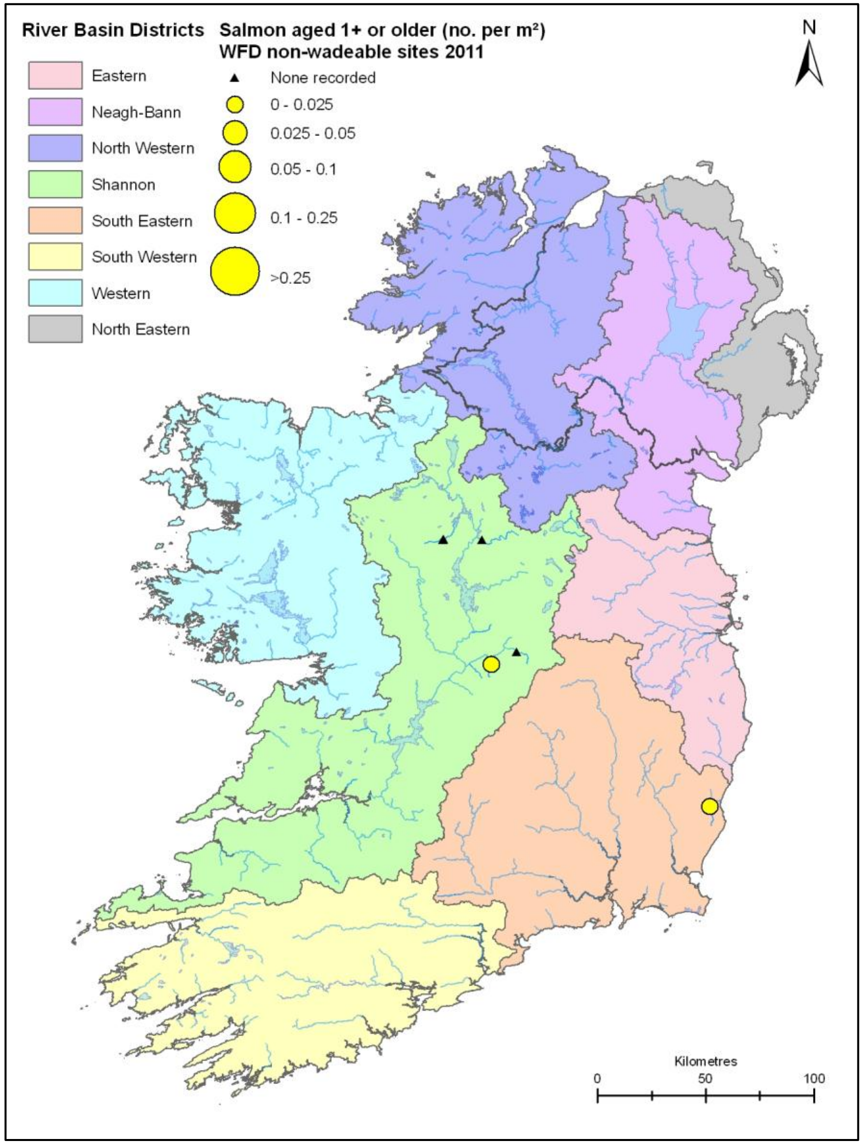

Fig. 4.57. Distribution and abundance of 1+ salmon at non-wadeable river sites surveyed for WFD fish monitoring 2011

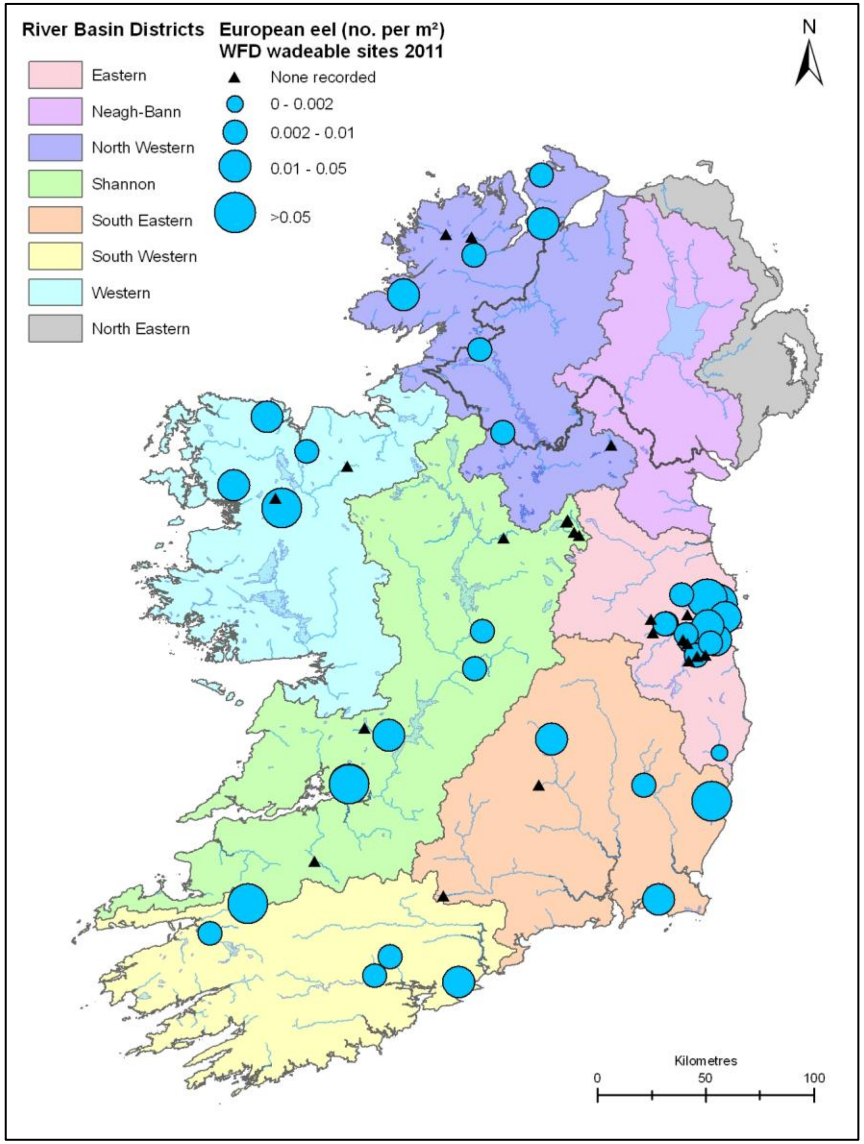

Fig. 4.58. Distribution and abundance of European eel at wadeable river sites surveyed for WFD fish monitoring 2011

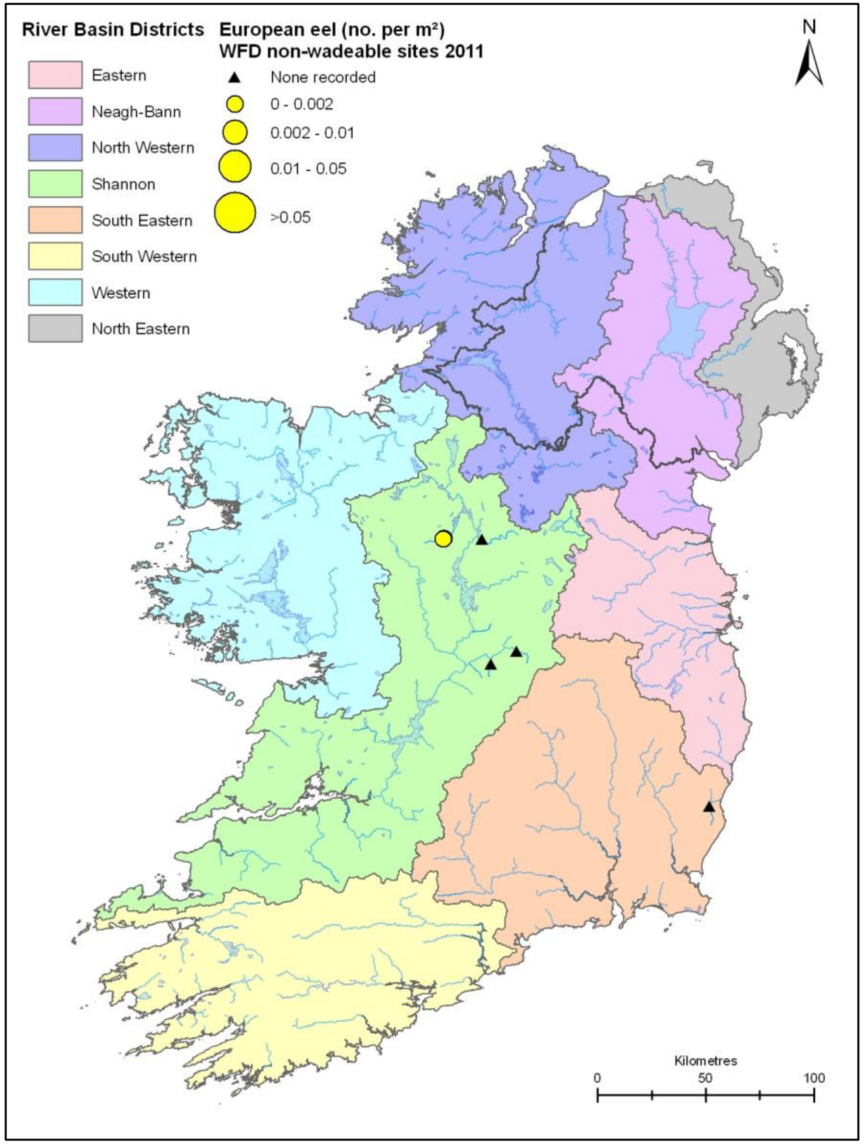

Fig. 4.59. Distribution and abundance of European eel at non-wadeable river sites surveyed for WFD fish monitoring 2011

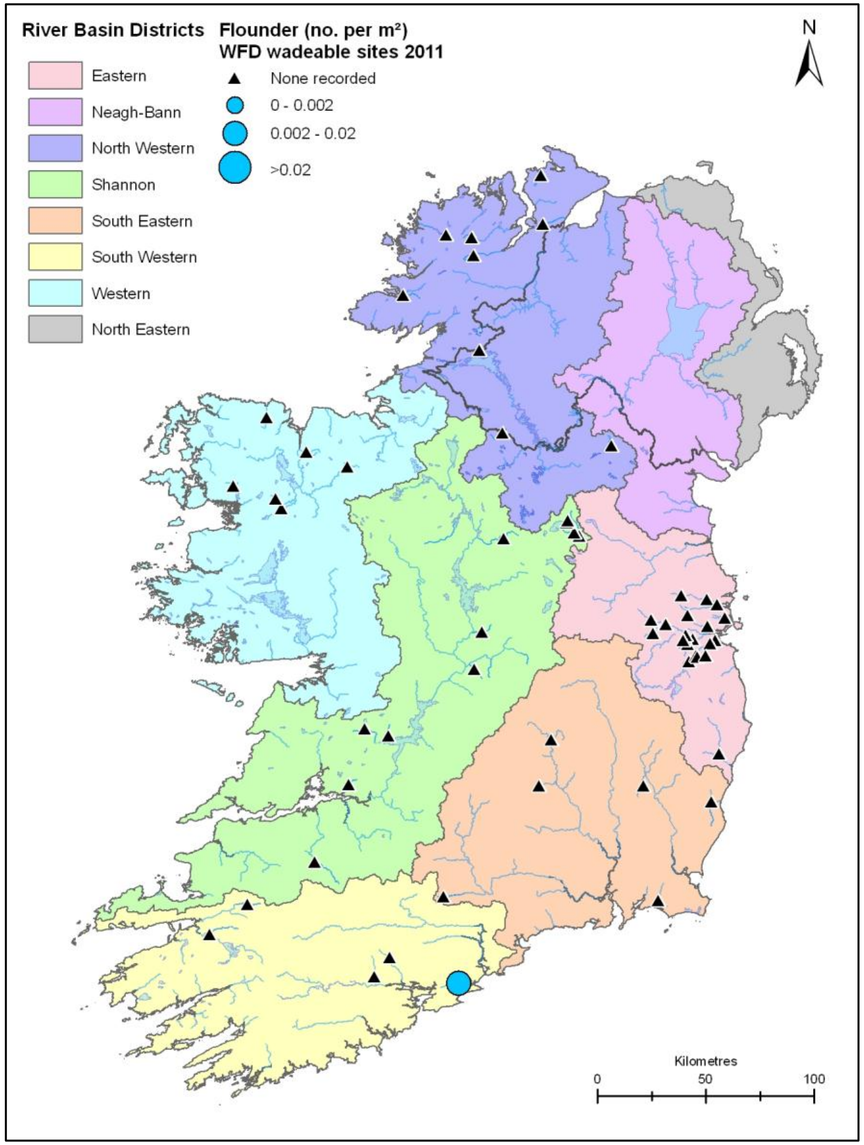

Fig. 4.60. Distribution and abundance of flounder at wadeable river sites surveyed for WFD fish monitoring 2011

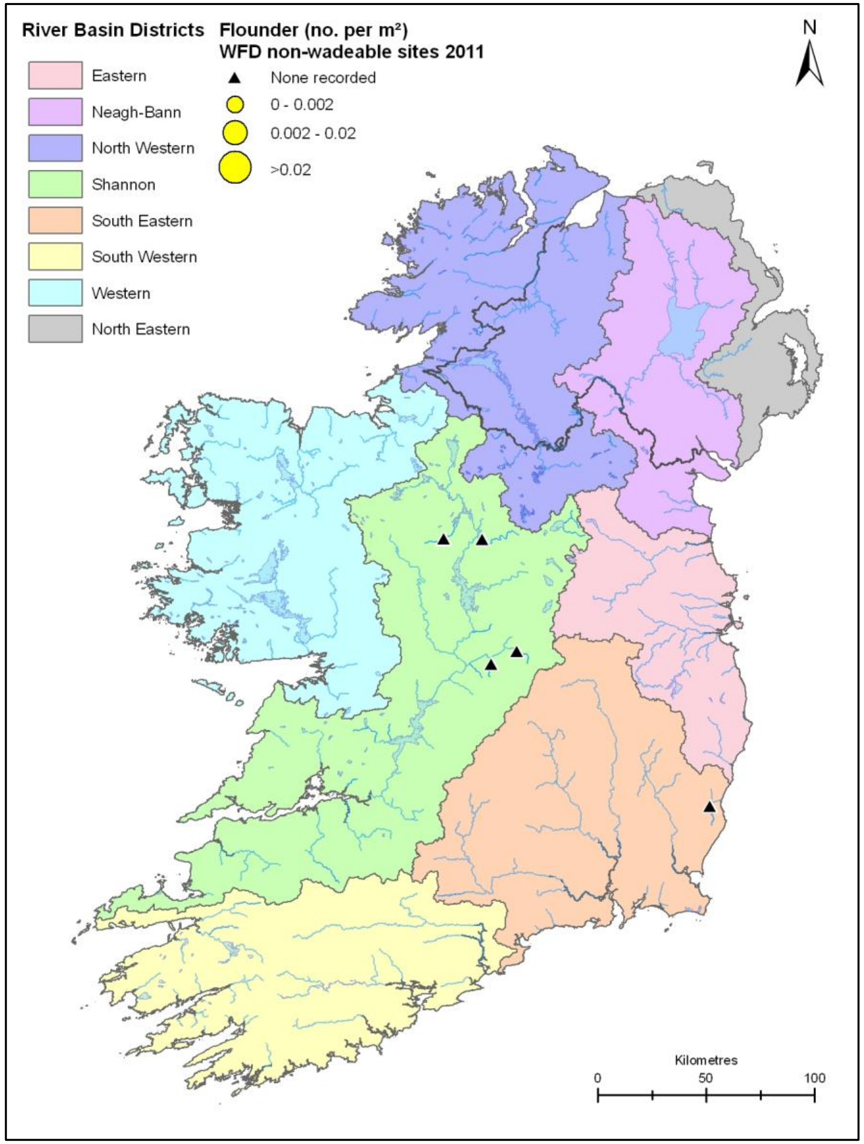

Fig. 4.61. Distribution and abundance of flounder at non-wadeable river sites surveyed for WFD fish monitoring 2011

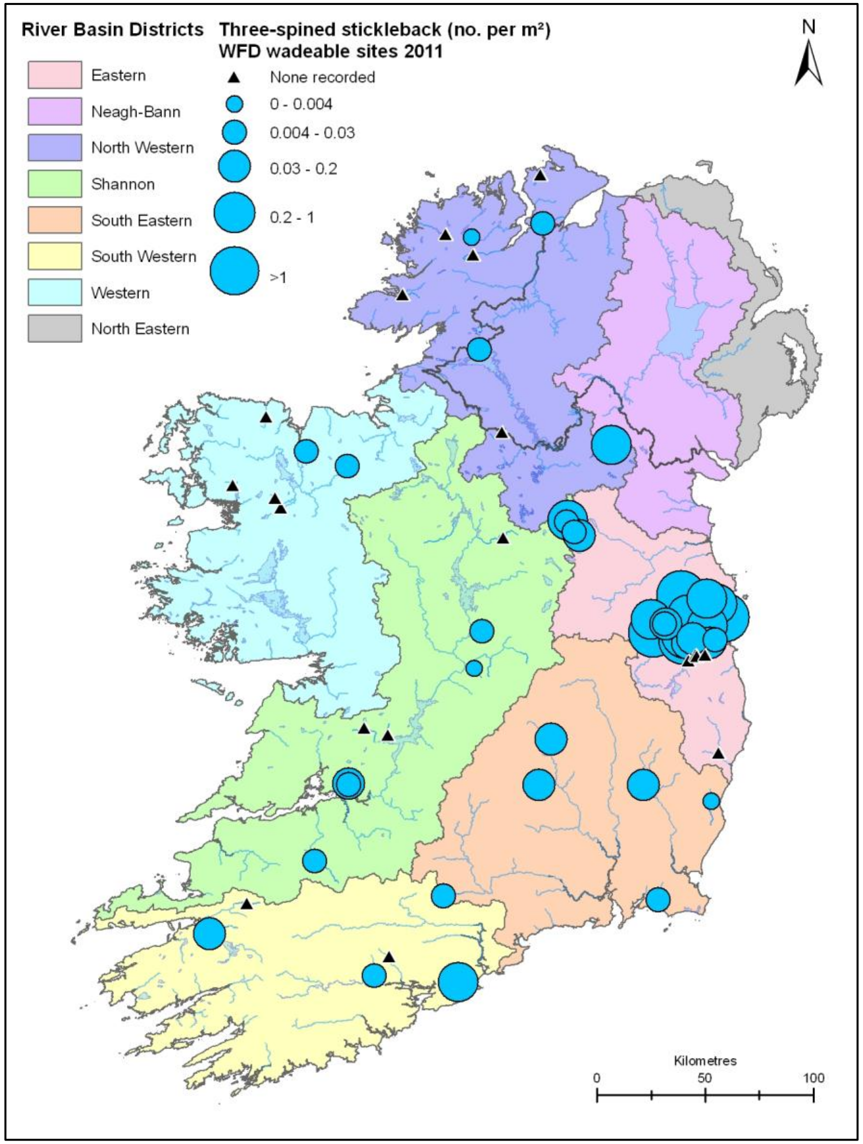

Fig. 4.62. Distribution and abundance of 3-sp stickleback at wadeable river sites surveyed for WFD fish monitoring 2011

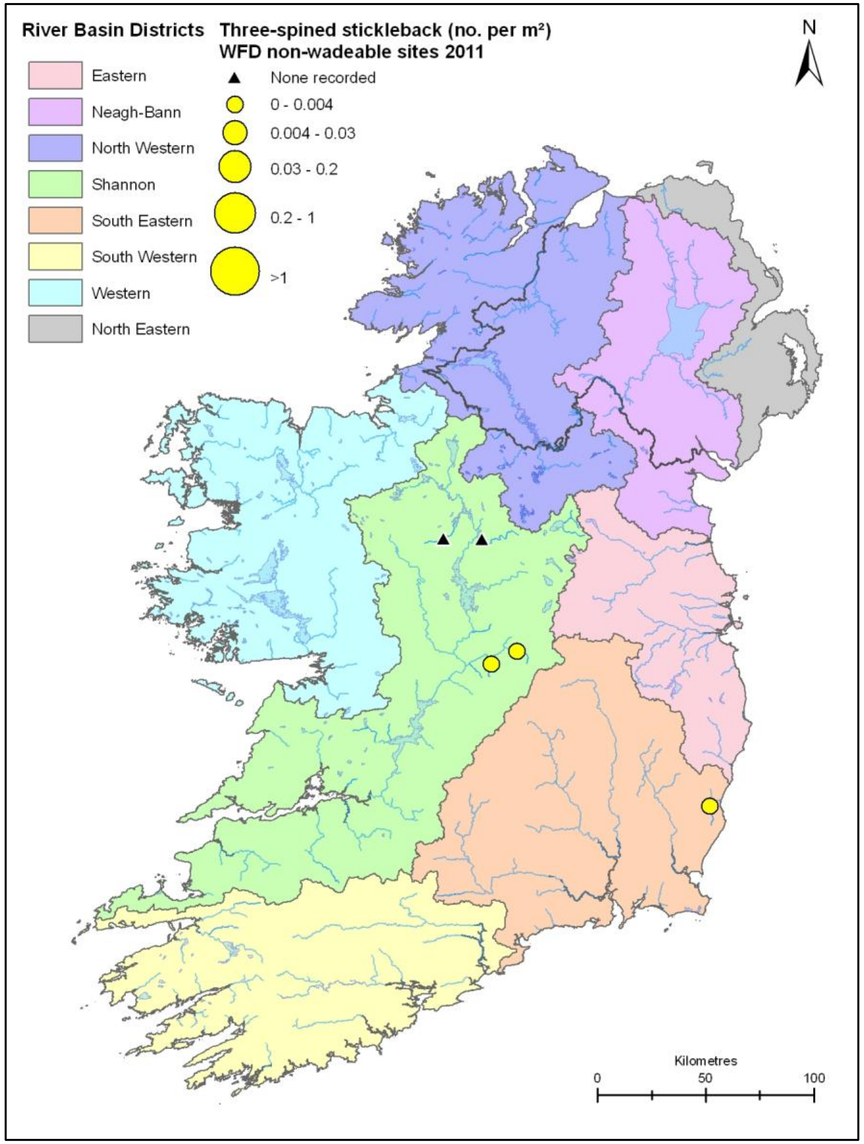

Fig. 4.63. Distribution and abundance of 3-sp stickleback at non-wadeable river sites surveyed for WFD fish monitoring 2011

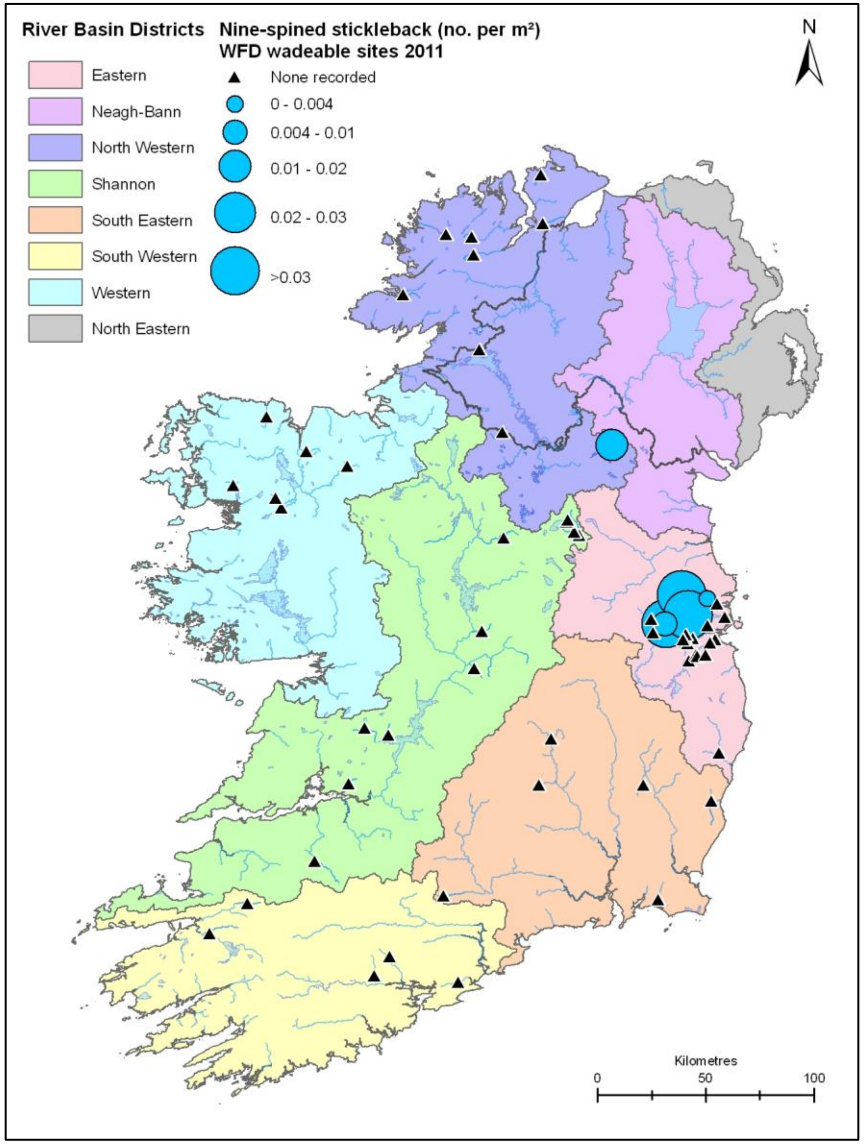

Fig. 4.64. Distribution and abundance of 9-sp stickleback at wadeable river sites surveyed for WFD fish monitoring 2011

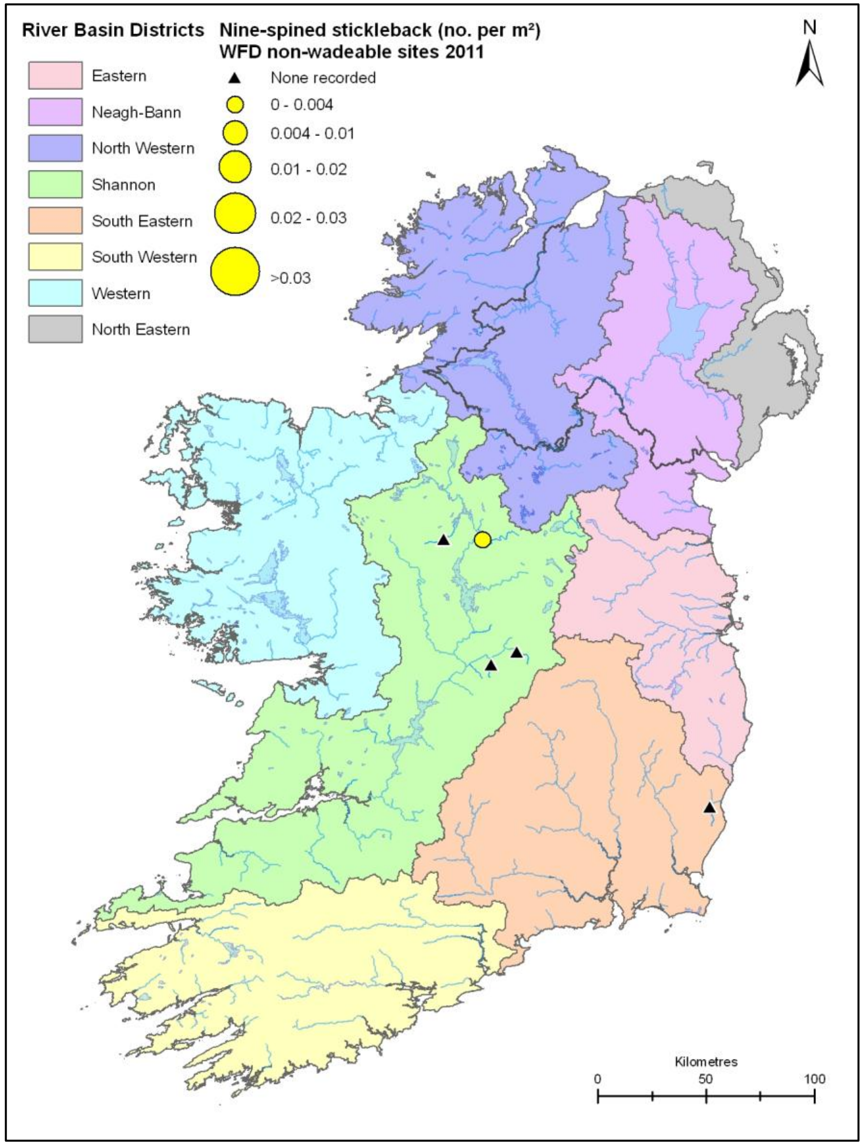

Fig. 4.65. Distribution and abundance of 9-sp stickleback at non-wadeable river sites surveyed for WFD fish monitoring 2011

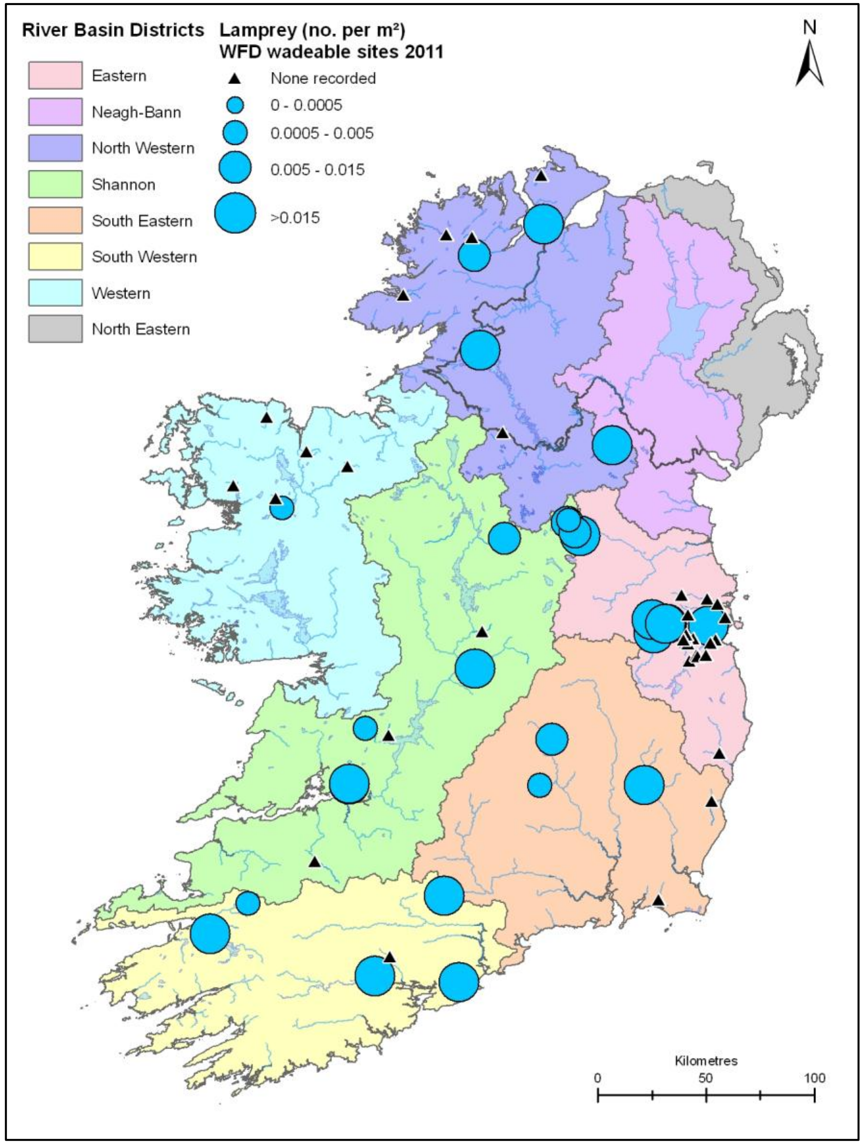

Fig. 4.66. Distribution and abundance of lamprey at wadeable river sites surveyed for WFD fish monitoring 2011

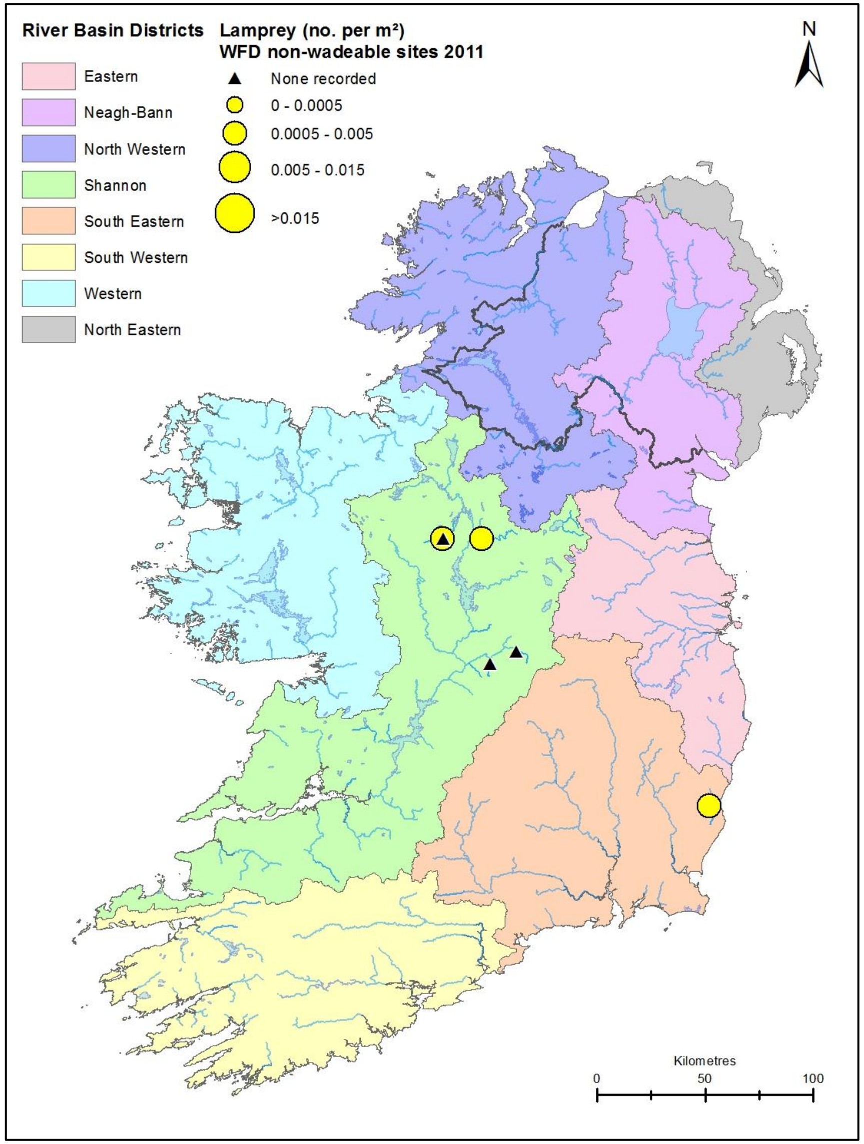

Fig. 4.67. Distribution and abundance of lamprey at non-wadeable river sites surveyed for WFD fish monitoring 2011

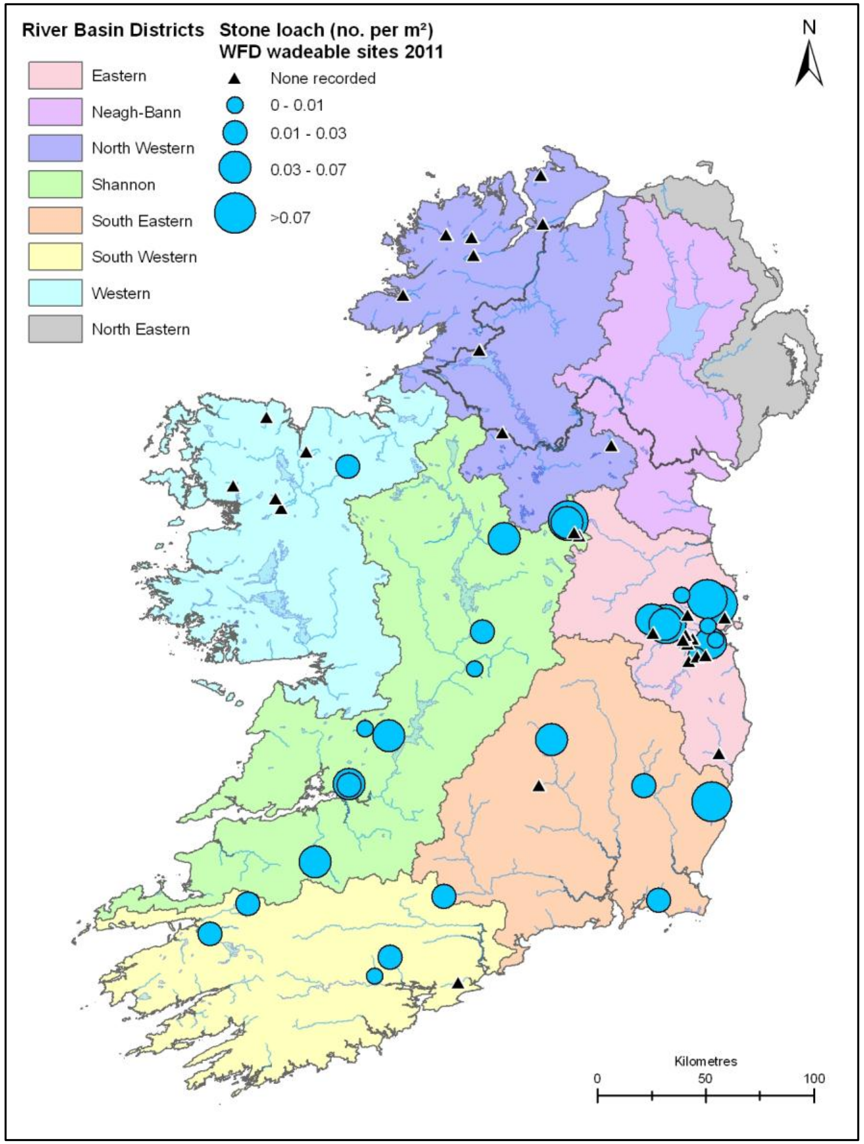

Fig. 4.68. Distribution and abundance of stone loach at wadeable river sites surveyed for WFD fish monitoring 2011

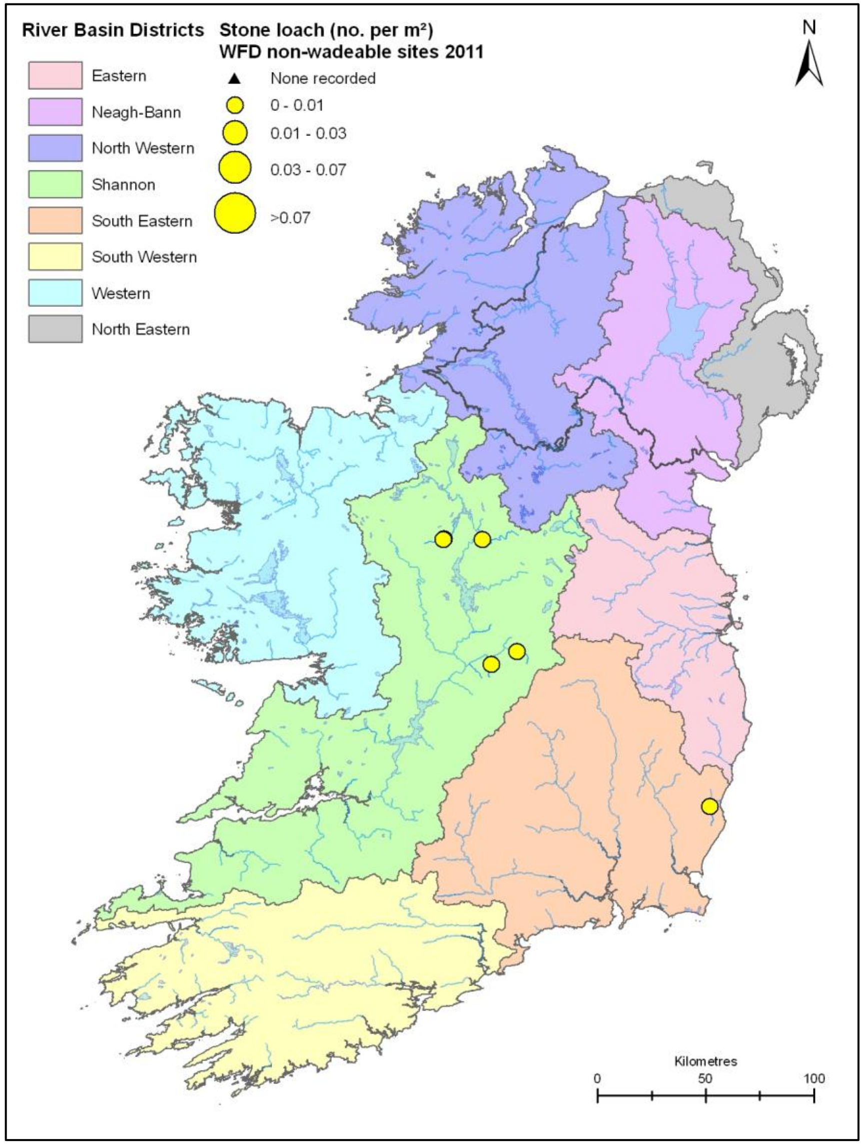

Fig. 4.69. Distribution and abundance of stone loach at non-wadeable river sites surveyed for WFD fish monitoring 2011

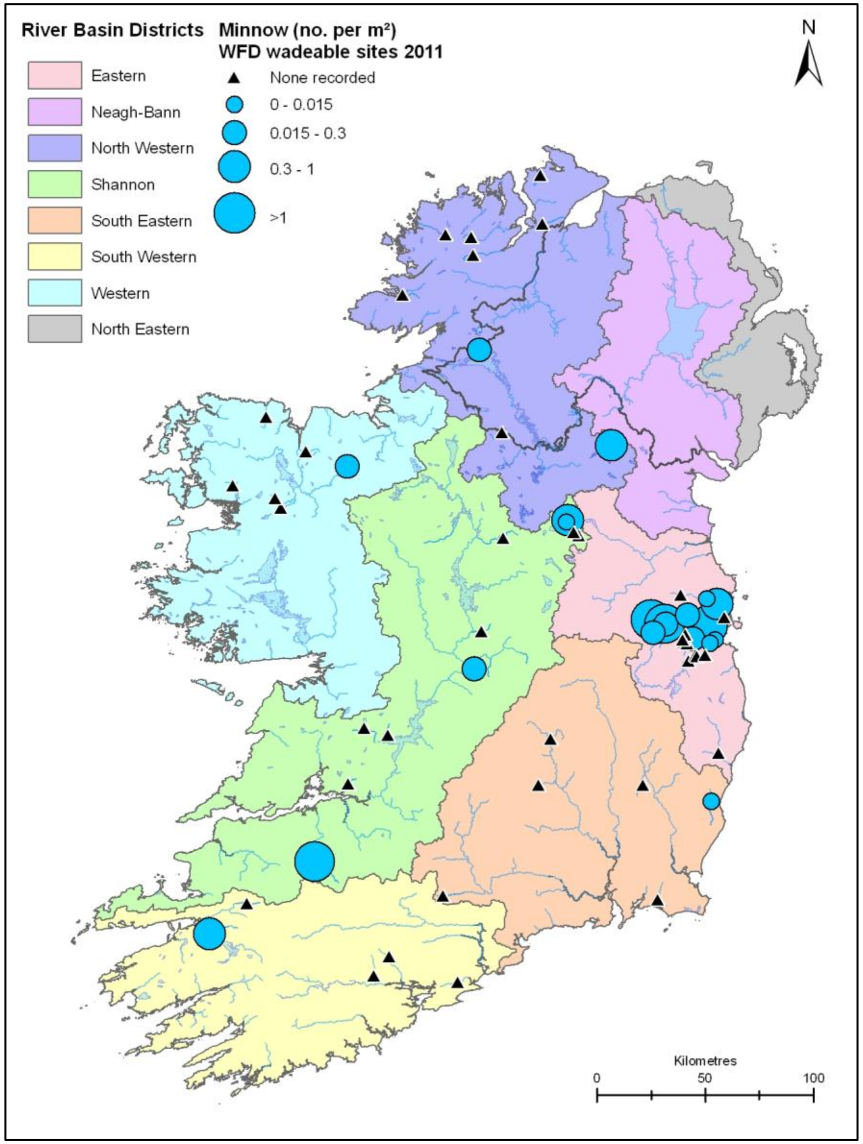

Fig. 4.70. Distribution and abundance of minnow at wadeable river sites surveyed for WFD fish monitoring 2011

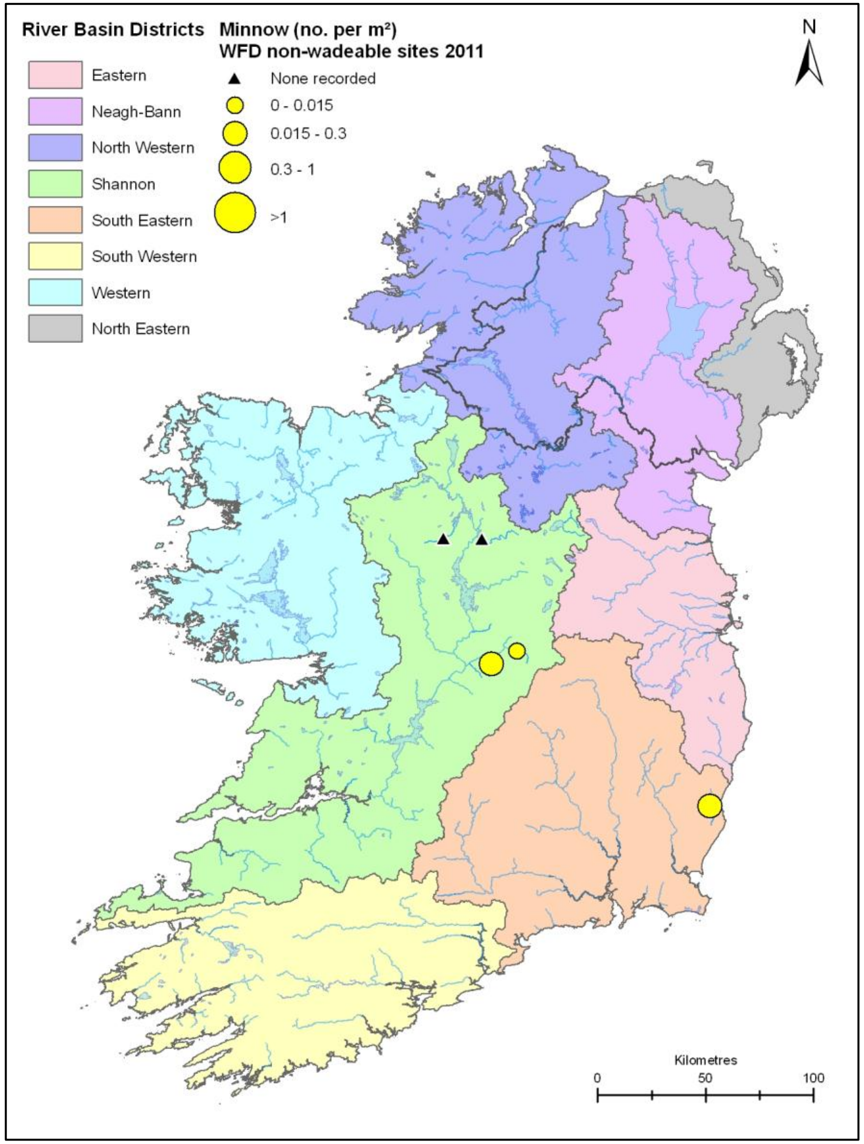

Fig. 4.71. Distribution and abundance of minnow at non-wadeable river sites surveyed for WFD fish monitoring 2011

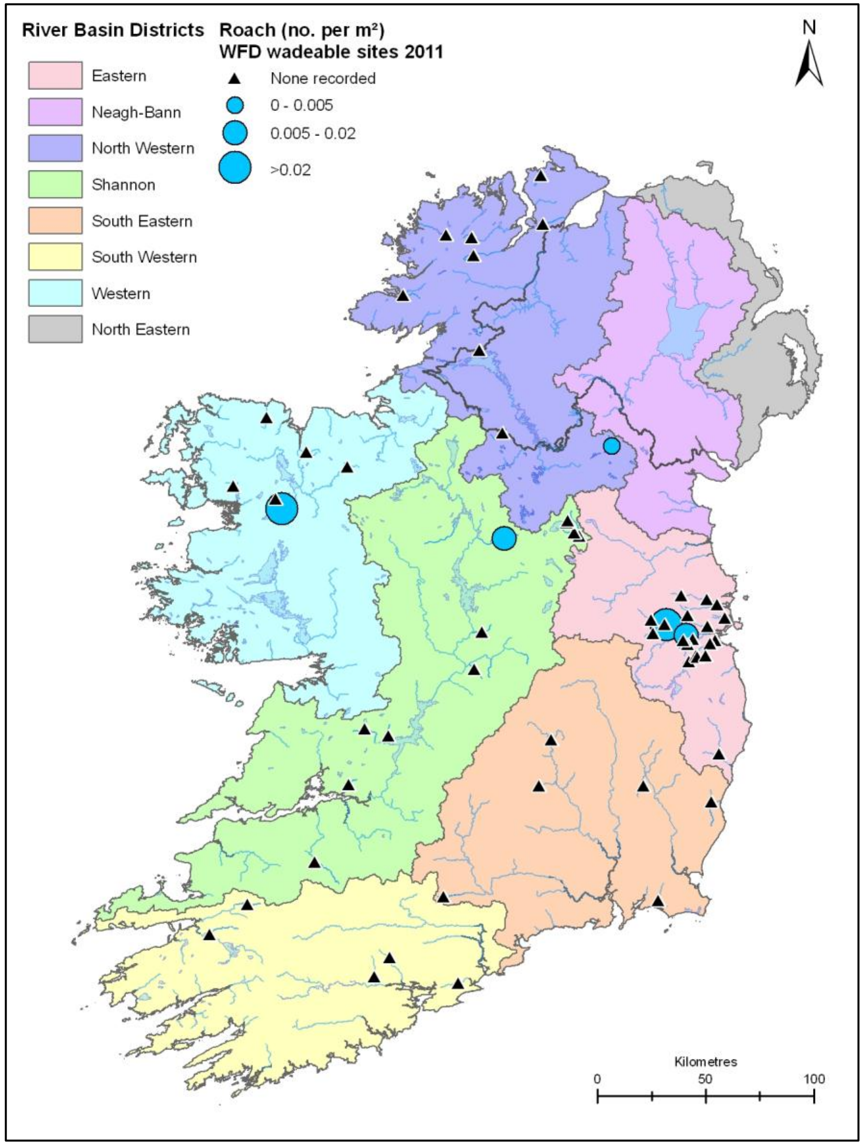

Fig. 4.72. Distribution and abundance of roach at wadeable river sites surveyed for WFD fish monitoring 2011

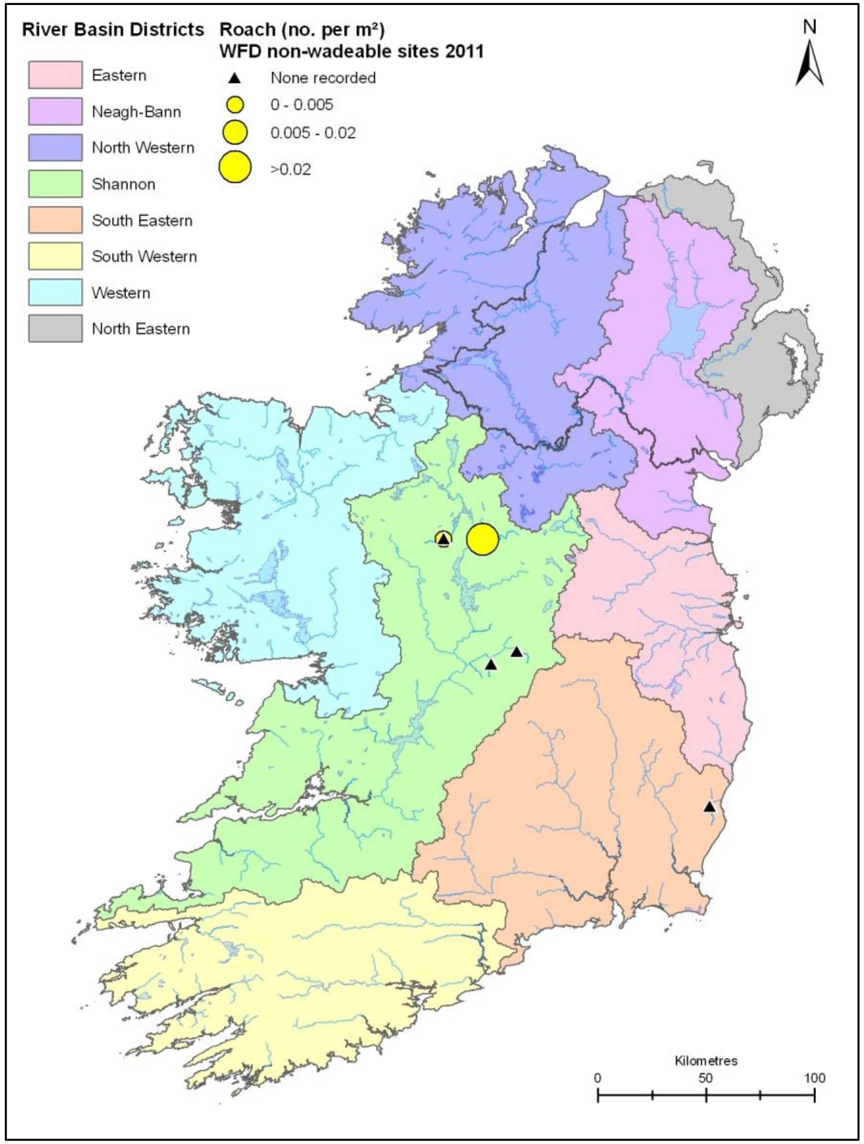

Fig. 4.73. Distribution and abundance of roach at non-wadeable river sites surveyed for WFD fish monitoring 2011

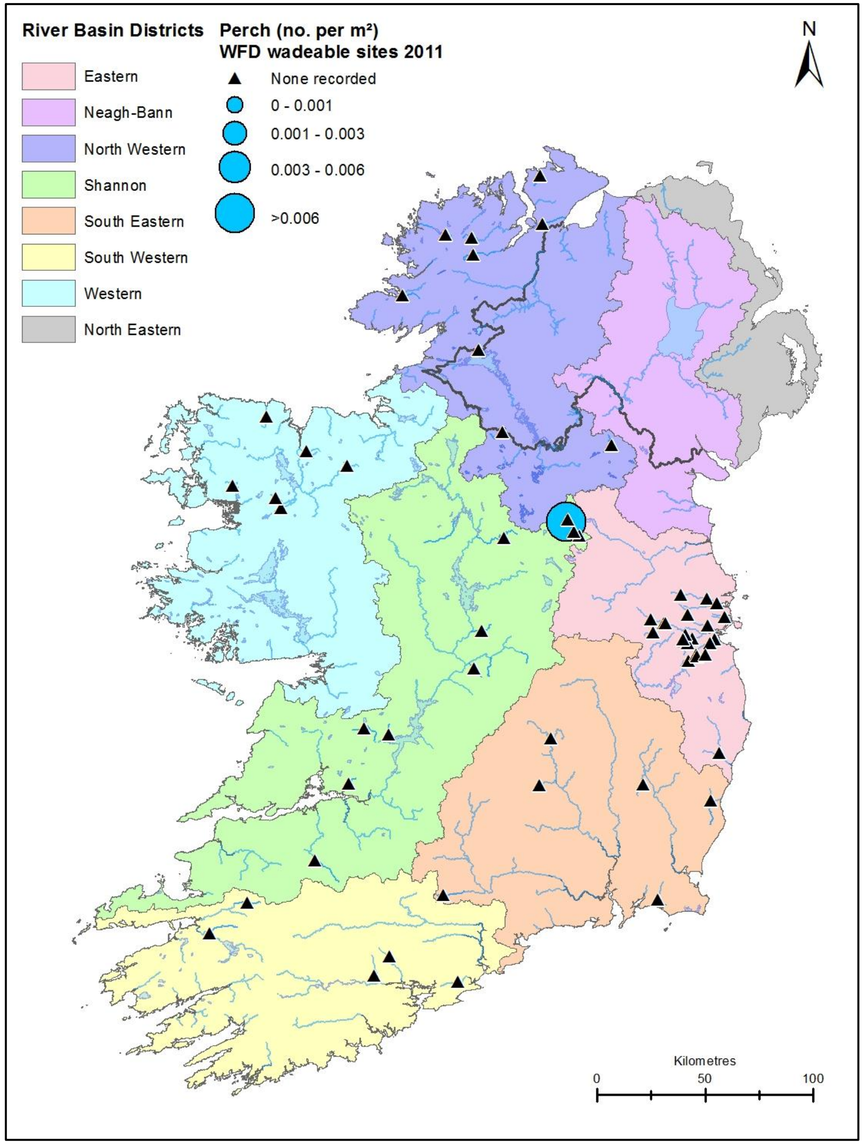

Fig. 4.74. Distribution and abundance of perch at wadeable river sites surveyed for WFD fish monitoring 2011

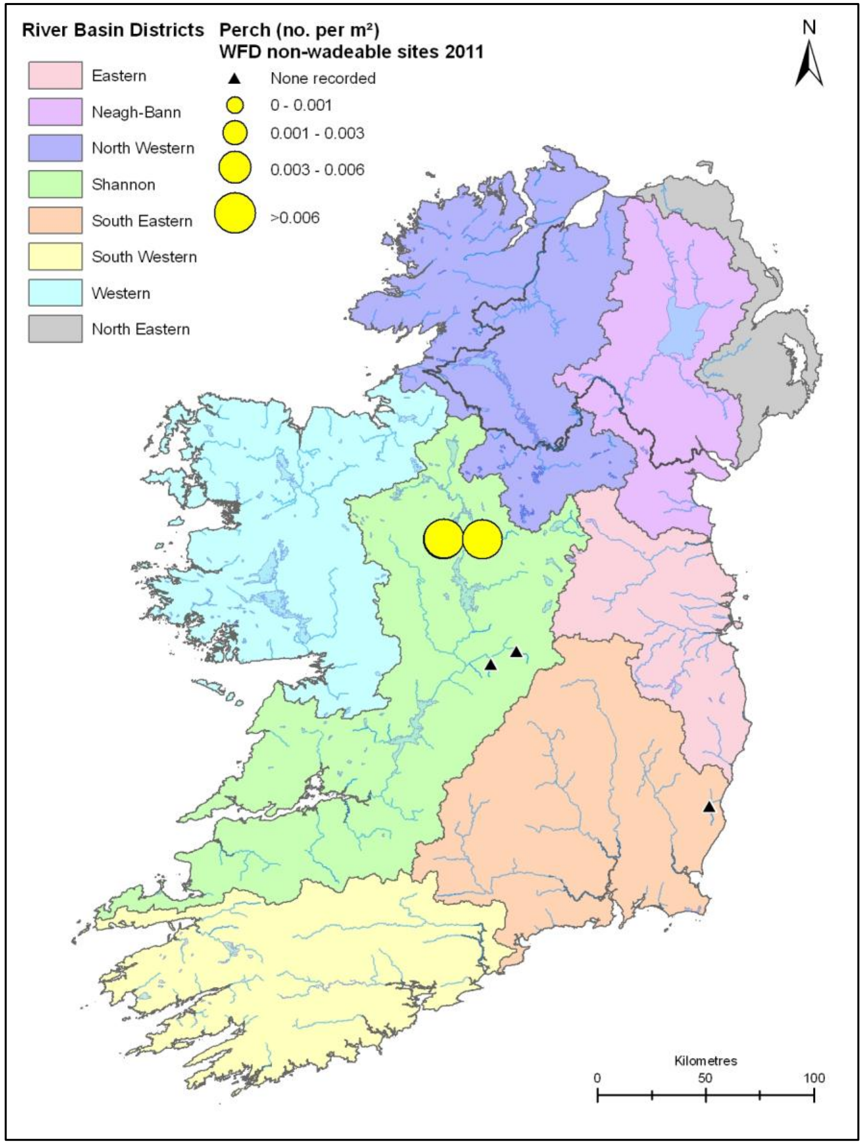

Fig. 4.75. Distribution and abundance of perch at non-wadeable river sites surveyed for WFD fish monitoring 2011

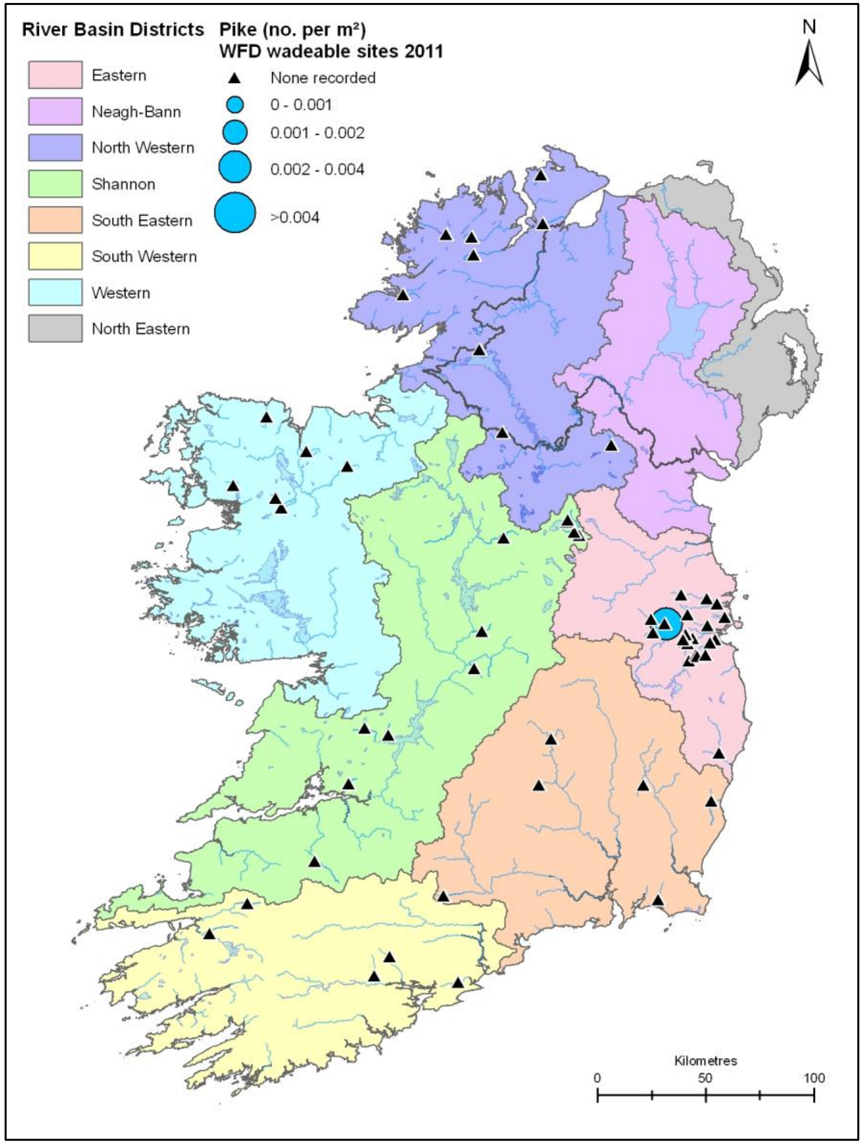

Fig. 4.76. Distribution and abundance of pike at wadeable river sites surveyed for WFD fish monitoring 2011

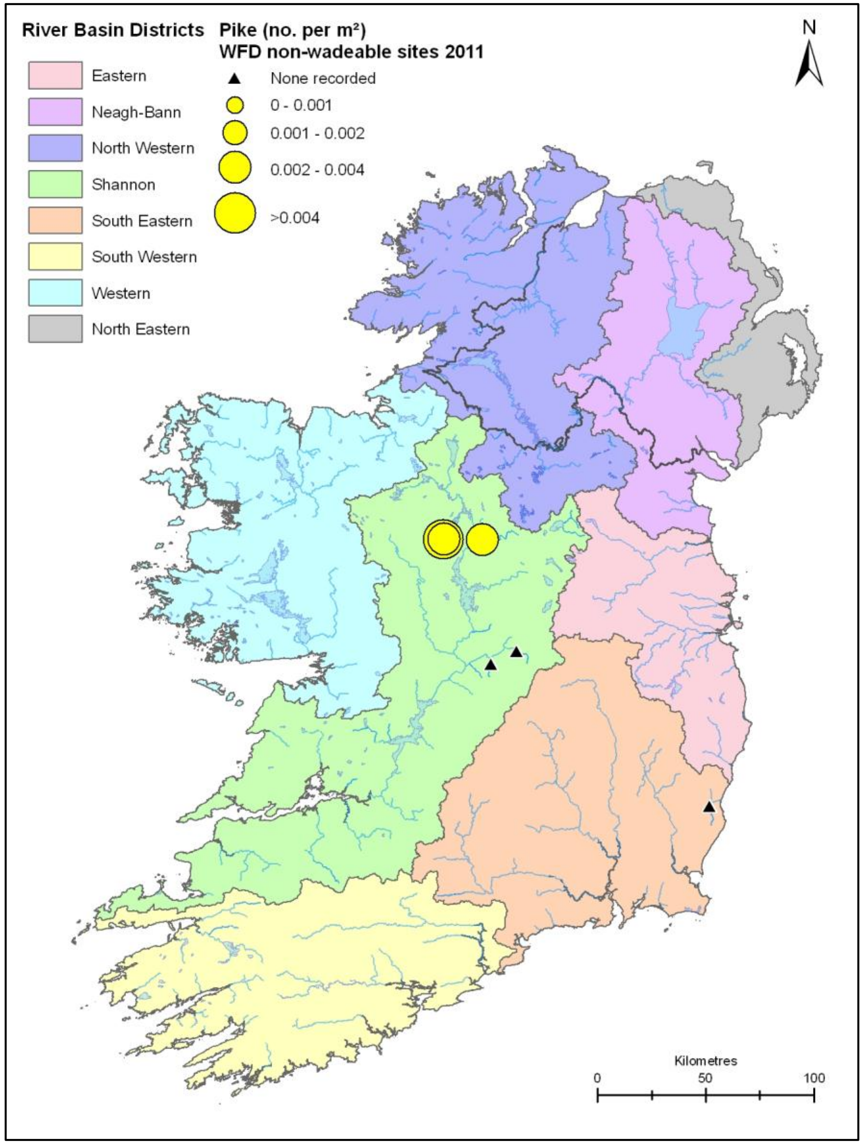

Fig. 4.77. Distribution and abundance of pike at non-wadeable river sites surveyed for WFD fish monitoring 2011

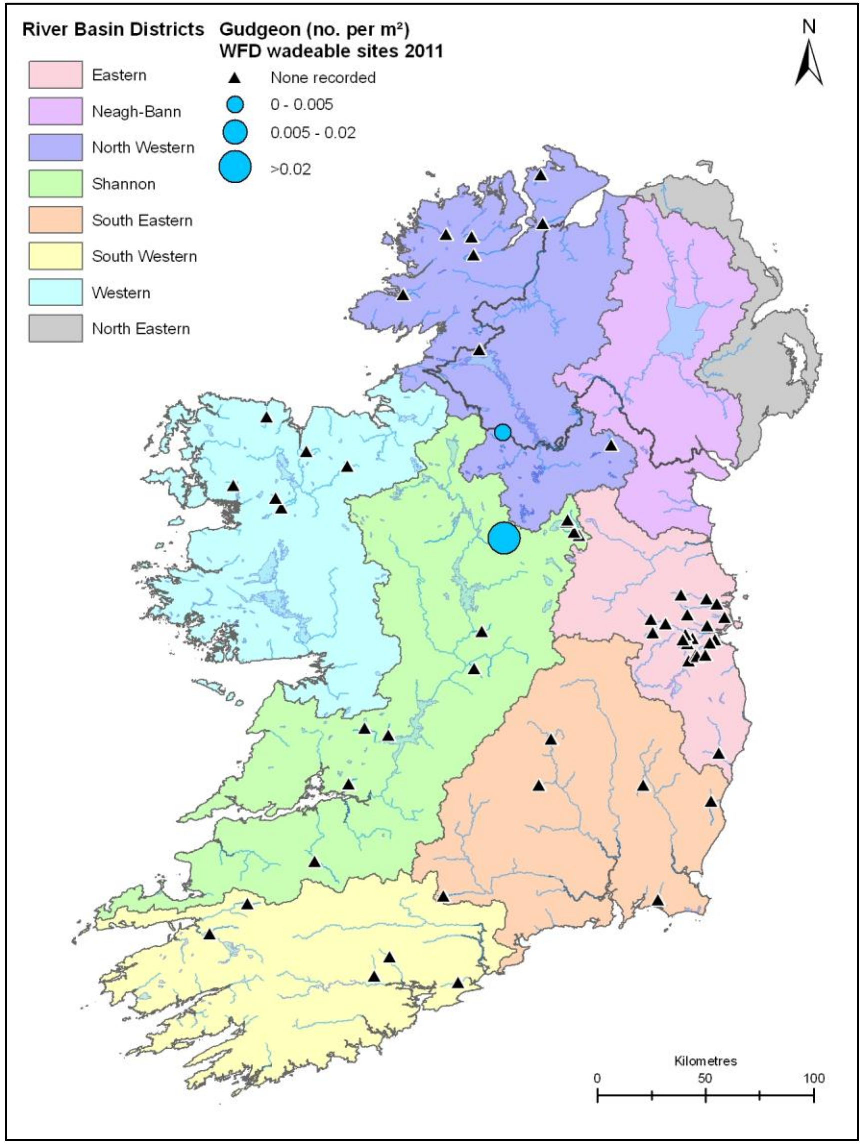

Fig. 4.78. Distribution and abundance of gudgeon at wadeable river sites surveyed for WFD fish monitoring 2011

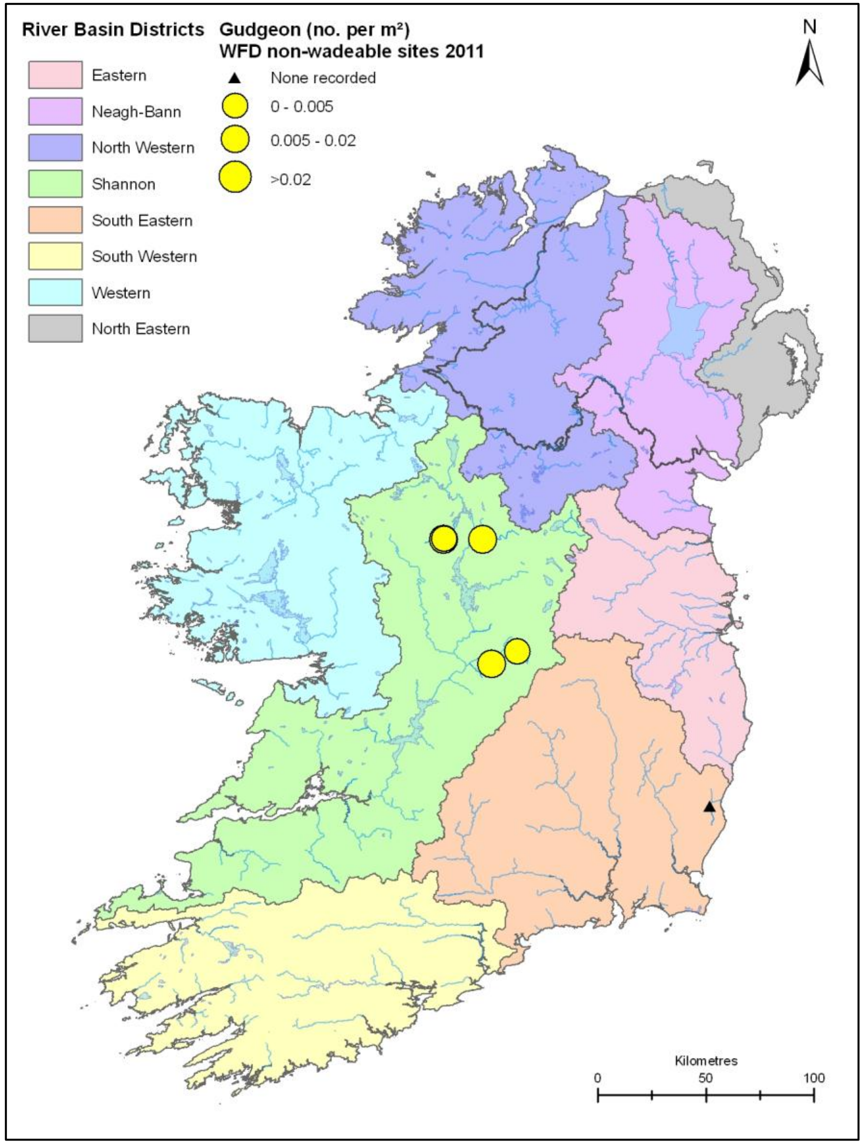

Fig. 4.79. Distribution and abundance of gudgeon at non-wadeable river sites surveyed for WFD fish monitoring 2011

4.2.3 Fish Growth

Scales from a total of 1,092 brown trout (55 river sites), 406 salmon (31 river sites), five sea trout (1 river site), 122 roach (5 river sites) and 22 pike (4 river sites) 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 4+. Fry (0+) made up 23% of the fish for which scales were examined, and 60% of the fish examined were aged 1+. Older fish aged 3+ and 4+ were relatively rare and accounted for only 3% of fish 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 Clodiagh River at Rahan, Co. Offaly, was aged at 4+, measured 41.9cm in length and 936g in weight. Appendix 7 provides a summary of the mean back-calculated lengths at age of brown trout in the 52 river sites surveyed.

Sea trout were only recorded in the Owenavorragh River, Co. Wexford. Scale reading showed that all the fish examined were aged 2.0+, indicating that they had spent 2 years in freshwater and had travelled to sea for a brief period before returning later that same year to the river.

Salmon ages ranged from 0+ to 2+. Fry (0+) made up 23% of the fish for which scales were examined, and the remaining fish examined were composed of juveniles aged 1+ and 2+, which accounted for 66% and 11% of the population respectively. No adult salmon were captured during the surveillance monitoring programme for rivers in 2011, and the largest juvenile salmon recorded was a smolt measuring 18.8cm in length and 81g in weight that was captured in the River Dodder (Beaver Row). Appendix 8 provides a summary of the mean back-calculated lengths at age of salmon in 28 rivers.

The Camlin River at Lisnabo, Co. Longford, was the site at which the largest roach, pike and perch recorded during the 2011 surveys were all captured. Roach ranged in age from 0+ to 8+, and the largest roach recorded measured 26.2cm in length, weighed 395g and aged 8+. The largest and oldest pike recorded was an individual measuring 51.3cm, weighing 1.068kg and aged 2+. The largest perch that was captured measured 28.7cm in length and 427g in weight.

4.2.3.1 Growth of brown trout

For each river site where sufficient brown trout numbers were captured (7 river 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 the 52 river sites surveyed during 2011 is shown in Appendix 7. Brown trout from two river sites were classed as very slow, three were classed as slow, one was 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 2011 using Kennedy and Fitzmaurice (1971)

Very slow	Slow	Fast	Very fast
Burnfoot	Martin	Clodiagh	Owenavorragh
Swanlinbar	Dodder (Bohernabreena)		
	Silver (Lumcloon)		

River sites containing 1+ and older brown trout were divided up 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}. Eight river sites were characterised as low alkalinity, seven as moderate alkalinity and 37 as high alkalinity. Statistical analysis revealed that there was a significant difference in the mean L1 of brown trout among the three alkalinity groups ($F_{2,51}$=7.433, $p<0.01$), with Fishers Least Significant Difference (FLSD) post-hoc test showing that the mean L1 was significantly lower in low alkalinity rivers when compared to high alkalinity rivers. There was also a significant difference in mean L2 among alkalinity groups ($F_{2,37}$=6.317, $p<0.01$), with FLSD post-hoc tests showing that the mean L2 was also significantly lower in low and moderate alkalinity rivers when compared to high alkalinity rivers. In addition there was also a significant difference in the mean L3 between alkalinity groups ($F_{2,14}$=4.766, $p<0.05$), with a FLSD post-hoc test showing that the mean L3 was significantly lower in moderate alkalinity rivers when compared to high alkalinity rivers. Insufficient data was available to test differences between L4 in each alkalinity type (Fig.4.80).

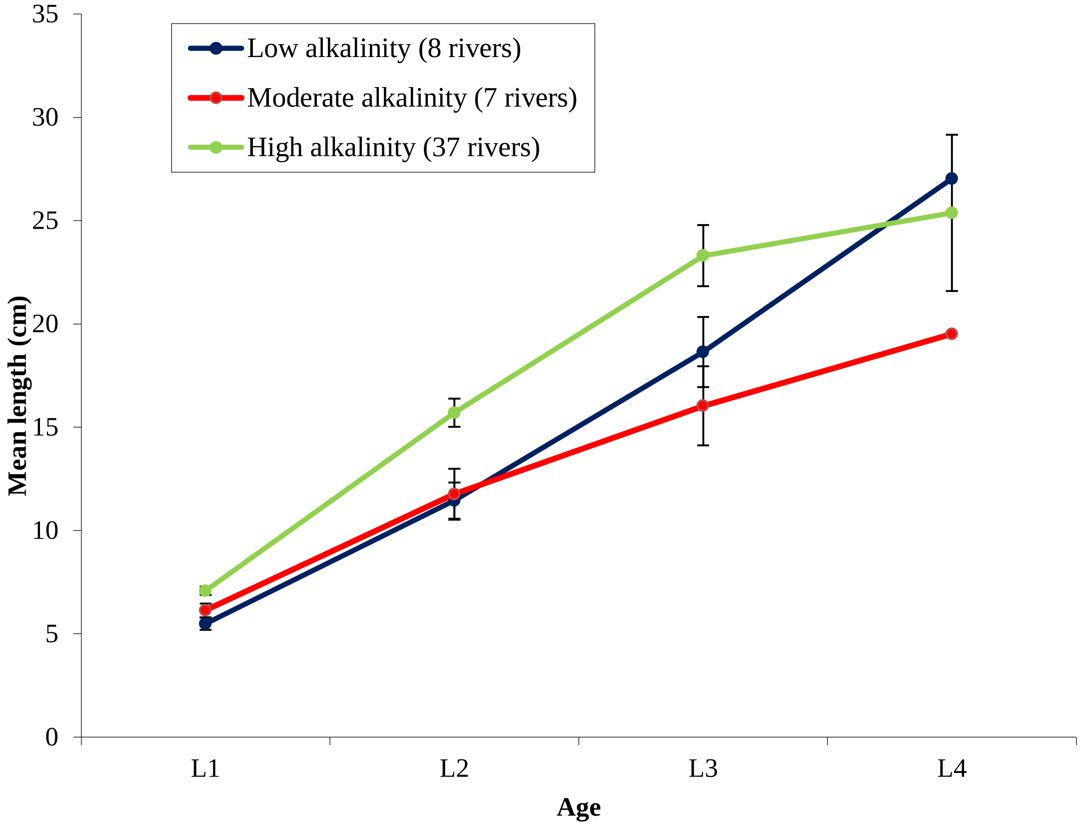

Fig. 4.80. Mean (±S.E.) back calculated lengths at age for brown trout in rivers within each alkalinity class

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

An ecological classification tool for fish in rivers 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. It was recommended during the earlier stages of this project that an approach similar to that developed by the Environment Agency in England and Wales (Fisheries Classification Scheme 2, or 'FCS2') be used. This approach has broadly been followed and improved to develop the new classification tool – 'FCS2 Ireland'. 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 resultant output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range corresponding with 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 recently successfully completed an EU wide intercalibration exercise in order to standardise results across Europe. FCS2 Ireland has been used, along with expert opinion, to classify 64 of the 65 river sites surveyed during 2011; eight (12.5%) river sites were classified as High, 21 (32.8%) as Good, 28 (43.7%) as Moderate, six as Poor (9.3%) and one (1.5%) as Bad ecological status (Table 4.9, Fig. 4.81). The Piperstown stream was not assigned a status classification as no fish were captured at the site; the absence of fish at the site was attributed to low water levels.

Table 4.9. Ecological status of river sites surveyed for fish in 2011 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site name	Catchment	Site Code	Ecological status
ERBD Wadeable sites				
Avoca	1km N of Woodenbridge	Avoca	10A030800	Bad (100%)
Baltracey	Fraynes Br.	Liffey	09C030600	Moderate
Brittas	Br. just off R114	Liffey	09B020100	Good
Broadmeadow	Lispopple Br.	Broadmeadow	08B020700	Moderate (83%)
Camac	Riverside Estate Br.	Liffey	09C020310	Moderate (91%)
Camac	Moneenalion Commons Br.	Liffey	09C020250	Moderate (81%)
Dodder	Footbridge, Beaver Row	Liffey	09D010900	High (70%)
Dodder	Mount Carmel Hospital	Liffey	09D010680	Moderate (87%)
Dodder	Bohernabreena	Liffey	09D010100	Good (98%)
Piperstown	Tributary at Corrageen	Liffey	09P030200	NA*
Griffeen	Griffeen Avenue Br.	Liffey	09G050300	Moderate (92%)
Griffeen	Grange Castle	Liffey	09G050200	Moderate (62%)
Lyreen	Lyreen Angling Centre	Liffey	09L020100	Moderate (94%)
Mayne	Wellfield Br.	Mayne	09M030500	Moderate (96%)
Owendoher	Cruagh Road Br.	Liffey	09O011100	Poor (100%)
Pinkeen	Br. S. of Calliagawee	Tolka	09P020500	Poor (84%)
Ratoath	Br. in Ratoath	Broadmeadow	08R010150	Moderate
Rye	Kildare Br.	Liffey	09R010400	Good (59%)
Rye	Balfeaghan Br.	Liffey	09R010100	Good (88%)
Tolka	Violet Hill Drive	Tolka	09T011100	Poor (66%)
Ward	Br. d/s of Scotchstone Br.	Broadmeadow	08W010620	Moderate
SERBD Wadeable sites				
Ballyroan	Gloreen Br.	Nore	15B010200	Moderate
Banoge	Br u/s Owenavorragh confl	Owenavorragh	11B020300	Moderate
Douglas (Ballon)	Sragh Br.	Slaney	12D030200	Moderate (52%)
Duag	Br. u/s Ballyporeen	Suir	16D030100	Moderate (100%)
Duncormick	Br. nr Duncormick Rly St.	Duncormick	13D010350	Moderate (79%)
Nuenna	Br. d/s Clomantagh	Nore	15N020100	Good (68%)
SERBD Non-Wadeable sites				
Owenavorragh	Br. N of Ballinamona	Owenavorragh	11O010500	Moderate (78%)
SWRBD Wadeable sites				
Glashaboy	Ballyvorisheen Br.	Glashaboy	19G010200	Good (97%)
Gweestin	Gweestin Br.	Laune	22G061200	Good (86%)
Martin	Bawnafinny Br.	Lee	19M010600	High (89%)
Shanowen	Ford u/s Maine confl	Maine	22S010100	High (100%)
Womanagh	ATV centre	Womanagh	19W011300	Good (58%)

**The Piperstown stream was not assigned a status classification as no fish were captured at the site; the absence of fish at the site was attributed to low water levels.*

Table 4.9 ctn. Ecological status of river sites surveyed for fish in 2011 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site name	Catchment	Site Code	Ecological status
ShIRBD Wadeable sites				
Boor	Br. NW of Kilbillaghan	Shannon Upr	26B071100	Good (85%)
Bow	Bow River Br.	Shannon Lwr	25B100100	Moderate (72%)
Camlin	Br. just S of Killoe	Shannon Upr	26C010500	Moderate (62%)
Deel (Newcastlewest)	Br. near Balliniska	Shannon Est Sth	24D020400	Moderate (87%)
Gourna	Beside railway Br.	Bunratty	27G020600	High (100%)
Gourna	Br. u/s Owenogarney confl	Bunratty	27G020550	High (100%)
Graney	Caher Br.	Shannon Lwr	25G040025	Good
Inny	Br. 1 km S of Oldcastle	Inny	26I010100	Good
Inny	Tully	Inny	26I010220	Good
Little (Cloghan)	Br. SW of Cloghan	Shannon Lwr	25L010200	Moderate (78%)
Mountnugent	Mountnugent Br.	Inny	26M020500	Good (87%)
Mountnugent	Racraveen	Inny	26I010450	Good (79%)
ShIRBD Non-wadeable sites				
Camlin	Br. W. of Lisnabo	Shannon Upr	26C011000	Moderate (98%)
Clodiagh (Tullamore)	Br. at Rahan	Shannon Lwr	25C060500	Moderate (72%)
Scramoge	Br. N.E. of Riverdale	Shannon Upr	26S010320	Moderate (93%)
Scramoge	Carrowclogher	Shannon Upr	26S010330	Poor (99%)
Silver (Kilcormac)	Lumcloon Br.	Shannon Lwr	25S020700	Moderate
WRBD Wadeable sites				
Ballinglen	Ballinglen Br.	Ballinglen	33B010100	Good (92%)
Behy	Behy Br.	Moy	34B080400	High
Castlebar	Br. 2.5 km d/s Castlebar	Moy	34C010200	Poor (73%)
Clydagh(Castlebar)	Br. NW Ardvarney	Moy	34C050030	Moderate (87%)
Glennamong	Br. u/s Lough Feeagh	Srahmore	32G030100	Moderate (94%)
Tobercurry	Br. just u/s of Moy	Moy	34T020200	Good (100%)
NWIRBD Wadeable sites				
Ballyhallan	Br. u/s Clonmany River	Clonmany	40B010200	Good (79%)
Burnfoot	Br. in Burnfoot	Burnfoot	39B020600	Good (62%)
Cronaniv	Br. u/s Dunlewy Lough	Clady	38C060100	High
Dromore	Drummuck	Erne	36D020012	Poor (97%)
Glaskeelan	Br. W. of Roshin	Leannan	39G050100	Good (75%)
Owentocker	D/s of Br. in Ardara	Owentocker	38O060300	High (62%)
Swanlinbar	D/s Swanlinbar Br.	Erne	36S010290	Moderate (86%)
Swilly	Swilly Br. (near Breenagh)	Swilly	39S020050	Good (87%)
Waterfoot	Letter Br.	Erne	36W030700	Good

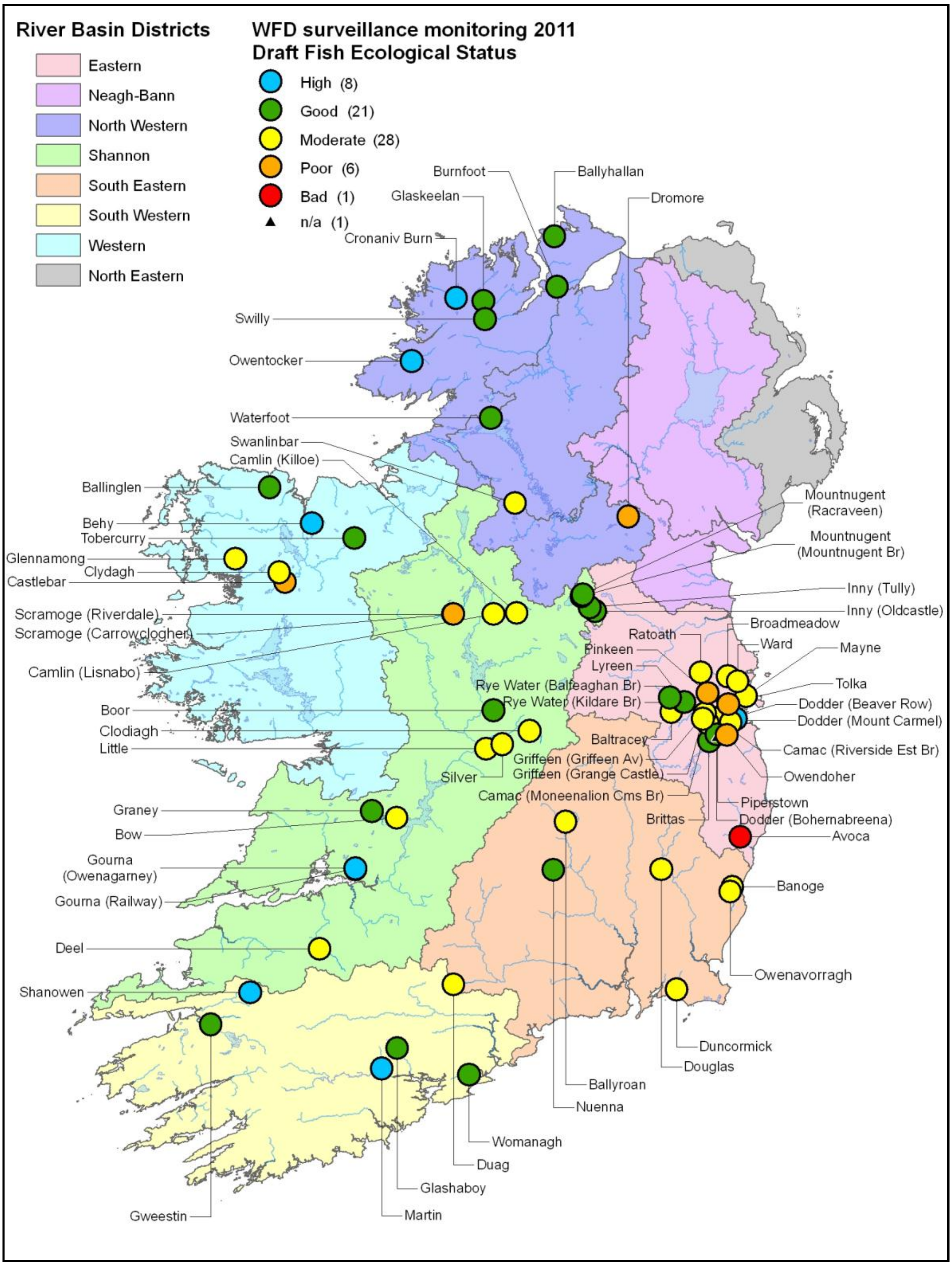

Fig. 4.81.Classification of river sites using the FCS2 Ireland classification tool

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).

A total of 26 fish species (sea trout are included as a separate "variety" of trout) were recorded in the two transitional water bodies surveyed during 2011 (Table 4.10).

Twelve and 19 species of fish were captured in Castlemaine Harbour and Cromane Estuary respectively, with five species (common goby, European eel, flounder, plaice and three-pined stickleback) recorded in both water bodies. Other commercially important fish recorded included brown trout, European sea bass, flounder, pollack, salmon and sea trout.

Table 4.10. Fish species recorded in the Castlemaine Harbour and Cromane Estuary waterbodies surveyed during October 2011

Scientific name	Common name	Castlemaine Total fish	Cromane Total fish
Salmo trutta	Brown trout	22	
Salmo trutta	Sea trout *	2	
Salmo salar	Salmon	20	
Anguilla anguilla	European eel	5	1
Phoxinus phoxinus	Minnow	4	
Platichthys flesus	Flounder	590	7
Gasterosteus aculeatus	Three-spined stickleback	39	1
Pungitius pungitius	Nine-spined stickleback	3	
Spinachia spinachia	Fifteen-spined stickleback		9
Psetta maxima	Turbot	1	
Pleuronectes platessa	Plaice	6	5
Dicentrarchus labrax	European seabass		3
Sprattus sprattus	Sprat		2124
Atherina presbyter	Sand smelt		29
Pomatoschistus microps	Common goby	380	35
Pomatoschistus minutus	Sand goby		20
Gobiusculus flavescens	Two-spotted goby		52
Pomatoschistus pictus	Painted goby		3
Scyliorhinus canicula	Lesser spotted dogfish		2
Ciliata mustela	Five-bearded rockling		27
Syngnathus acus	Greater pipefish		1
Pollachius pollachius	Pollack		12
Ammodytes tobianus	Lesser sandeel		11
Agonus cataphractus	Pogge		8
Crenilabrus melops	Corkwing wrasse		7
Chelon labrosus	Thick-lipped grey mullet	26	

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

4.3.2 Fish species distribution

A large number of juvenile and immature fish species were captured within the two sites surveyed, indicating the essential nursery function of these transitional water bodies e.g. thick lipped grey mullet and flounder.

A number of important angling species were also recorded in the two waterbodies. Flounder and plaice (Plate 4.2) were captured in both water bodies, thick-lipped grey mullet, sea trout, salmon and brown trout were captured in Castlemaine Harbour waterbody. Lesser-spotted dogfish (Plate 4.3) and sea bass (Plate 4.4) were also recorded in Cromane Estuary waterbody.

Plate 4.2. Plaice captured in Cromane Estuary, 2011

Plate 4.3. Lesser-spotted dogfish captured in Castlemaine Harbour, 2011

Plate 4.4. Sea bass captured in Cromane Estuary, 2011

In addition to the required fish metrics (fish species composition and abundance), 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 two water bodies surveyed during 2011 are incorporated in the series of Special Areas of Conservation (SACs), designated nationally. Two red list species that are considered vulnerable (salmon) or critically endangered (European eel) were recorded during these surveys.

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 2011, eels were present in low numbers in both transitional waterbodies. 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. IFI has completed 149 transitional water fish surveys in 83 water bodies to date (WFD and Habitats Directive data). This extremely valuable dataset has been amalgamated with data collected by the Northern Ireland Environment Agency (NIEA) where it has been used to develop a draft 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.

Using the TFCI, one waterbody (Castlemaine Harbour) was classified as "Good" and one waterbody (Cromane Estuary) was classified as "Moderate" (Table 4.11, Fig. 4.82).

Table 4.11. Draft fish Ecological Status Classification of transitional water bodies surveyed during 2011 using the Transitional Fish Classification Index (TFCI)

Water body	Type	Ecological status
Castlemaine Harbour	Transitional	Good
Cromane Estuary	Transitional	Moderate

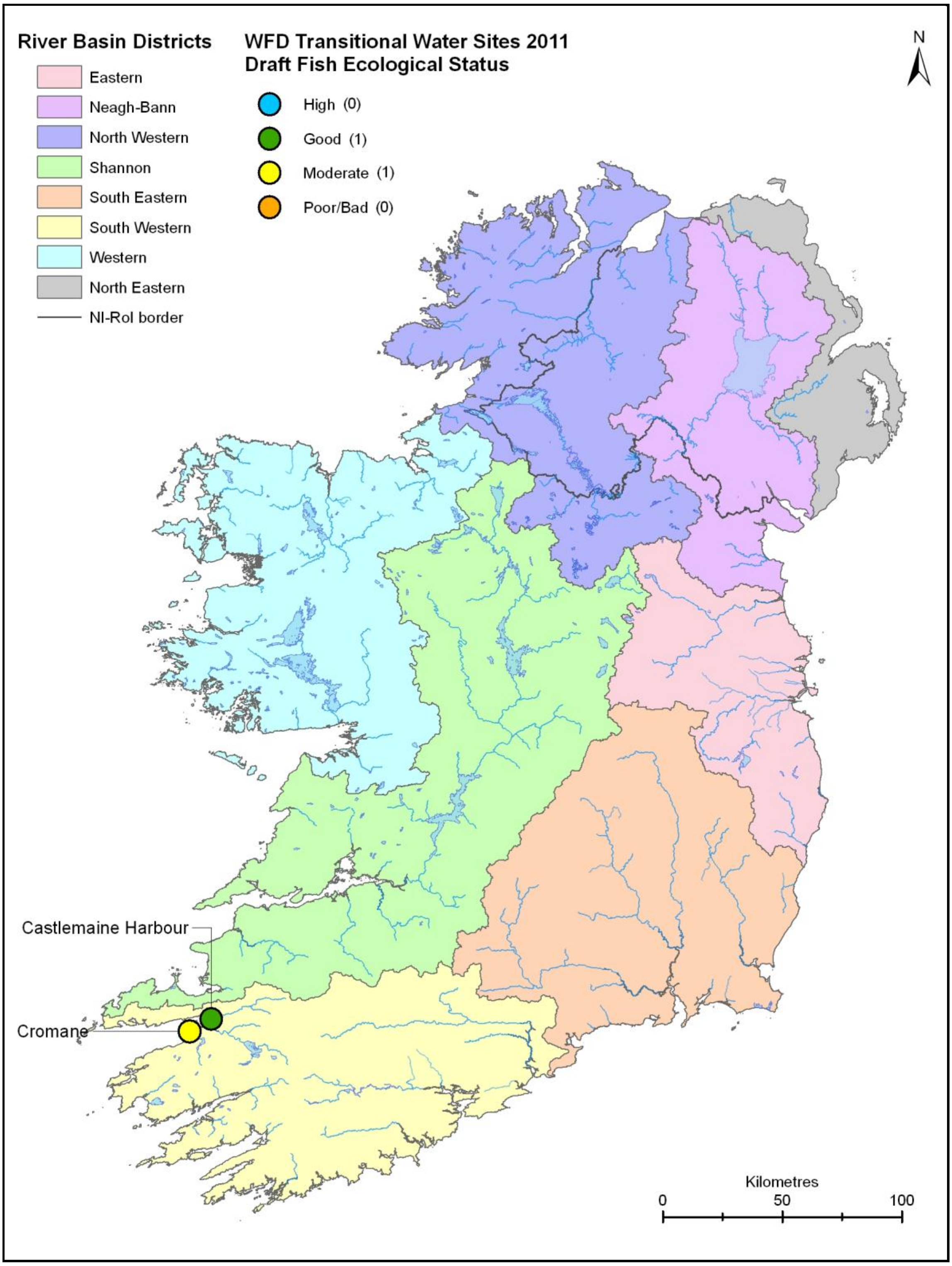

Fig. 4.82 Draft fish Ecological Status Classification of transitional water bodies surveyed during 2011 using the Transitional Fish Classification Index (TFCI)

5. DISCUSSION

5.1 Species richness

Ireland has a depauperate freshwater fish community compared with the rest of Europe. Maitland and Campbell (1992) estimate that *circa* 215 freshwater fish species occur in Europe, of which about 80 species exist in the north-western part. They identify 55 species in Britain, of which only 29 occur in Ireland. Of these 29, only 16 species are native to Ireland, with the remaining 13 species having been introduced. Some of these non-native species, such as pike (*Esox lucius*), were probably introduced in medieval times (Kelly *et al*., 2008a). Of the 16 native freshwater fish species, only 11 are classified as truly freshwater, with two (Twaite shad and smelt) being predominantly marine species that enter freshwater to spawn near the upstream limit of tidal influence, and three (Allis shad, sturgeon and flounder) being principally marine or estuarine species which may enter freshwater for variable periods (Kelly *et al*., 2007c; Champ *et al*., 2009).

A total of 17 fish species (sea trout are included as a separate "variety" of trout) were recorded in the 29 lakes surveyed during the 2011 WFD surveillance monitoring season. Three types of hybrids were also recorded. This compares with 17 fish species captured during 2008 (Kelly *et al*., 2009), 15 fish species captured during 2009 (Kelly *et al*., 2010) and 17 fish species captured during 2010 (Kelly *et al*., 2011). Eels, followed by brown trout and perch were the three most widely distributed species recorded during 2011. The maximum number of fish species recorded in any one lake was ten (Lough Leane, SWRBD), with a mixture of native and non-native fish species being captured in this lake.

A total of 14 fish species (sea trout are included as a separate "variety" of trout) were recorded in the 65 river sites surveyed during the 2011 WFD surveillance monitoring season. This compares with 15 fish species recorded in 2008 (Kelly *et al*., 2009), 16 fish species recorded during 2009 (Kelly *et al*., 2010) and 17 fish species recorded in 2010 (Kelly *et al*., 2011). Brown trout, three-spined stickleback, eels and stone loach were the most widely distributed fish species recorded during 2011. The maximum number of fish species recorded in any one river site was ten (Rye Water at Kildare Br., ERBD), again due to the presence of a mixture of native and non-native species.

A total of 26 fish species were recorded in the two transitional waters surveyed during the 2011 WFD surveillance monitoring season. This compares with 61, 31 and 55 species recorded during 2008, 2009 and 2010 respectively (Kelly *et al*., 2009, 2010 and 2011).

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 2011 fish surveillance monitoring programme for rivers, in which 89% of river sites surveyed contained brown trout. Brown trout were also recorded in 72% 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 and 2011).

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 all lakes surveyed and 60% of river sites. Salmon were recorded in 49% of river sites and in 44% of lakes surveyed. Salmon are not often captured in lake surveys due to the transient nature of their life cycle and the use of rivers as juvenile nursery habitat. Three large catchments (Shannon, Erne and Lee) no longer have self-sustaining populations of salmon and efforts are underway to restore salmon to these areas through a number of projects, for example, the Lee Restoration project (Gargan, P., IFI, *pers. comm.*) and the Atlantic Aquatic Resource Conservation Project (AARC) focussing on the River Shannon (IFI website - www.fisheriesireland.ie).

Char were recorded in six lakes during 2011 (Lough Acoose, Lough Beagh, Lough Caragh, Lough Leane, Lough Melvin and Lough Talt). Although historically present in Lough Allua, Lough Easky, Lough Egish, Lough Owel and Lough Corrib, no char specimens were captured in 2011 in these lakes, suggesting the likely local extinction of the species in these lakes. A number of char populations have become extinct over the last 30 years and this has been related mainly to deterioration in water quality or acidification, for example 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) and 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, 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 29 lakes surveyed during 2011. 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 44 out of the 65 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 and 2011) and this was also evident in the rivers sampled in 2011. Non-native freshwater species (minnow) were also present in one of the two transitional water bodies surveyed.

Pike, perch and roach are three of the most common non-native fish species recorded in Irish waters. In 2011, these species were recorded in a cluster of lakes mainly in counties Kerry/Cork, Galway and Sligo and throughout the NWIRBD and the ShIRBD, whilst they were present in river sites mainly in the upper ShIRBD and ERBD. 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 2011 with no access to the Shannon and Erne catchments (e.g. Castlebar River, Griffeen River and Rye Water, Lough Gill, Lough Talt, Templehouse Lake, Lough Melvin, Lough Corrib, Upper Lough Skeagh, Upper Lake, Lough Allua and Lough Caragh), providing evidence that these fish have been deliberately 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 that there are general trends for species richness, abundance and biomass of these tolerant non-native species to increase in relation to deterioration in 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 in 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 waterbody.

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 eight lakes surveyed during 2011 (Annaghmore Lough, Cavetown Lough, Corglass Lough, Derrybrick Lough, Lough Egish, Lough Meelagh, Upper Lough Skeagh and Templehouse 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 15 out of the 29 lakes surveyed during 2011, and 7 out of the 65 river sites surveyed (mostly in the midlands, west and northwest). Roach, accidentally introduced to Ireland in 1889 (Went, 1950), have been distributed 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 and 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 2011 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 high alkalinity lakes were significantly higher than those in moderate or low alkalinity lakes. Overall, the mean length at age for L1 to L6 of both perch and roach were observed to be slightly greater in the high alkalinity lakes than in the low and moderate alkalinity lakes, however, these were not significantly different.

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 has been shown to be influenced by a number of factors (Kennedy and Fitzmaurice, 1971; Everhart, 1975):

1. The types of streams in which the trout spawn and the length of time the young trout spend in them
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. In waters deficient in calcium, some species of molluscs, for example, cannot exist and few if any species are abundant, therefore calcium can directly affect the fauna and subsequent food availability 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. The average size of brown trout caught by anglers is, in general, related to the rate of growth (Kennedy and Fitzmaurice, 1971). 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 sizes with the minimum of searching. 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. 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 2008-2011. Of the 29 lakes (30 water bodies) surveyed during 2011, ten were classified as High, eight were classified as Good, five were classified as Moderate and seven were classified as Poor/Bad ecological status in terms of fish. 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), along with a separate version for Scotland to comply with the requirements of the WFD in early 2011 (SNIFFER, 2011). It was recommended during the earlier stages of this project that an approach similar to that developed by the Environment Agency in England and Wales (Fisheries Classification Scheme 2 - ‘FCS2’) be used. This approach has broadly been followed and improved to develop the new classification tool – ‘FCS2 Ireland’. 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 resultant output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range corresponding with 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 64 of the 65 river sites surveyed during 2011; eight river sites were classified as High, 21 as Good, 28 as Moderate, six as Poor and one as Bad.

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 two transitional water bodies surveyed in 2011 were assigned a draft ecological classification of Good status (Castlemaine Harbour) and Moderate status (Cromane estuary). The TFCI has been successfully intercalibrated in a Europe-wide exercise, however it will undergo further development in 2012 to account for differences in typologies and type specific reference conditions.

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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 2011

Lake	Three-spined stickleback	Flounder	Killarney Shad	Sea trout	Char	Salmon	Brown Trout	Eel	Sea Lamprey	Minnow	Perch	Pike	Roach	Bream	Gudgeon	Tench	Rudd	Roach x Bream	Roach x Rudd	Rudd x Bream
Acoose					x	x	x	x												
Allua							x	x			x	x	x	x	x		x	x		
Annaghmore	x							x			x	x	x			x	x	x		
Barra						x	x	x												
Beagh				x	x	x	x	x		x										
Brin				x			x	x		x										
Caragh				x	x	x	x	x			x									
Carrowmore	x			x		x	x	x		x										
Cavetown								x			x	x	x	x				x	x	
Corglass								x			x	x	x			x	x	x		
Corrib (Lower)						x	x	x	x		x	x	x	x				x		
Corrib (Upper)	x						x	x			x	x	x	x		x		x	x	
Derrybrick								x			x	x	x					x		
Easky						x	x	x												
Egish								x			x	x	x					x		
Fern	x					x	x	x												
Gill		x				x	x	x			x	x	x	x				x		
Glenbeg							x	x												
Glencullin	x			x		x	x	x												
Kiltooris	x						x	x												
Leane		x	x	x	x	x	x	x			x					x	x			
Meelagh								x			x	x	x			x		x		
Melvin	x				x	x	x	x			x						x		x	
O'Flynn							x	x			x	x	x							
Owel	x						x	x			x	x	x			x	x		x	
Sheelin							x	x			x	x	x			x		x		
Skeagh Upper								x			x	x	x	x				x		
Talt	x				x		x	x			x									
Templehouse								x			x	x	x	x	x		x	x		x
Upper Lake						x	x	x		x	x					x	x			

APPENDIX 3

Lengths at age of brown trout in 21 lakes surveyed during 2011 (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
O'Flynn	Mean	11.3	27.6							n/a
	n	4	4							
	S.D.	2.3	1.3							
	S.E.	1.1	0.6							
	Min.	8.8	26.1							
	Max.	14.0	29.2							
Corrib Lower	Mean	7.1	20.0	36.4	45.3					Very fast
	n	15	8	5	2					
	S.D.	1.4	6.1	9.9	6.2					
	S.E.	0.4	2.1	4.4	4.4					
	Min.	4.9	12.8	22.3	41.0					
	Max.	9.7	30.1	46.5	49.7					
Corrib Upper	Mean	6.1	13.0	22.2	28.5	n/a				Slow
	n	6	5	3	2	1				
	S.D.	1.3	1.8	3.7	6.5	.				
	S.E.	0.5	0.8	2.1	4.6	0.0				
	Min.	4.4	10.5	18.4	23.9	41.9				
	Max.	7.9	15.1	25.9	33.1	41.9				
Barra	Mean	5.4	12.4	15.9						n/a
	n	46	36	13						
	S.D.	1.5	3.0	2.1						
	S.E.	0.2	0.5	0.6						
	Min.	3.0	7.2	13.1						
	Max.	8.5	17.6	19.6						
Allua	Mean	7.0	14.3							n/a
	n	7	3							
	S.D.	1.3	1.6							
	S.E.	0.5	0.9							
	Min.	5.5	12.6							
	Max.	9.1	15.7							
Brin	Mean	5.4	14.2	19.0	23.3					Very slow
	n	59	44	14	3					
	S.D.	1.5	4.1	2.4	1.9					
	S.E.	0.2	0.6	0.6	1.1					
	Min.	3.3	7.4	14.6	21.6					
	Max.	9.2	21.5	23.1	25.4					
Carrowmore	Mean	5.9	12.2	17.4	21.6	26.0	28.7			Very slow
	n	114	98	76	55	28	11			
	S.D.	1.6	2.8	3.1	3.3	3.8	4.2			
	S.E.	0.1	0.3	0.4	0.5	0.7	1.3			
	Min.	2.8	6.5	12.3	15.9	20.4	23.6			
	Max.	9.8	21.4	29.6	33.9	33.5	36.3			

APPENDIX 3 continued

Lengths at age of brown trout in 21 lakes surveyed during 2011 (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
Easky	Mean	5.8	13.8	18.2	20.9					Very slow
	n	55	46	9	2					
	S.D.	1.7	2.6	2.9	3.2					
	S.E.	0.2	0.4	1.0	2.3					
	Min.	3.0	8.0	13.3	18.6					
	Max.	9.8	18.7	22.1	23.1					
Caragh	Mean	5.4	12.4	18.2	21.9	24.1				Very slow
	n	56	51	31	11	2				
	S.D.	1.4	3.5	2.8	2.9	0.5				
	S.E.	0.2	0.5	0.5	0.9	0.4				
	Min.	3.4	6.7	12.1	18.1	23.7				
	Max.	10.0	22.1	25.0	27.9	24.4				
Fern	Mean	7.6	16.8	26.2	30.3					Fast
	n	84	60	16	3					
	S.D.	2.1	3.4	4.6	6.9					
	S.E.	0.2	0.4	1.2	4.0					
	Min.	3.1	10.9	19.5	25.2					
	Max.	12.5	25.2	36.2	38.2					
Gill	Mean	5.4	13.4	20.4						n/a
	n	3	3	3						
	S.D.	1.1	1.1	3.7						
	S.E.	0.6	0.7	2.1						
	Min.	4.2	12.4	18.2						
	Max.	6.3	14.6	24.6						
Glenbeg	Mean	5.8	13.8	18.2	20.9					n/a
	n	55	46	9	2					
	S.D.	1.7	2.6	2.9	3.2					
	S.E.	0.2	0.4	1.0	2.3					
	Min.	3.0	8.0	13.3	18.6					
	Max.	9.8	18.7	22.1	23.1					
Kiltooris	Mean	7.7	17.9	24.6	n/a					Slow
	n	37	28	7	1					
	S.D.	1.6	2.1	2.9	.					
	S.E.	0.3	0.4	1.1	0.0					
	Min.	5.3	14.5	22.3	29.7					
	Max.	11.9	23.8	29.4	29.7					
Owel	Mean	5.1	n/a							n/a
	n	2	1							
	S.D.	1.1	.							
	S.E.	0.7	0.0							
	Min.	4.3	11.0							
	Max.	5.8	11.0							

APPENDIX 3 continued

Lengths at age of brown trout in 21 lakes surveyed during 2011 (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
Melvin	Mean	6.3	15.1	22.4	27.8	32.7	39.0	43.2	49.6	n/a	Slow
	n	61	52	37	23	10	6	5	3	1	
	S.D.	1.7	3.1	2.4	2.5	2.7	4.8	4.5	2.5	.	
	S.E.	0.2	0.4	0.4	0.5	0.9	1.9	2.0	1.4	.	
	Min.	3.2	9.2	18.2	23.4	29.4	35.1	38.6	47.3	55.9	
	Max.	10.0	21.4	26.7	31.5	38.4	46.8	48.9	52.2	55.9	
Talt	Mean	7.1	16.1	22.3	27.0	n/a					Slow
	n	46	37	23	8	1					
	S.D.	1.4	2.6	2.1	2.4	.					
	S.E.	0.2	0.4	0.4	0.8	0.0					
	Min.	4.3	9.6	18.6	24.1	30.8					
	Max.	10.1	21.6	25.4	30.4	30.8					
Leane	Mean	6.7	16.6	23.1	24.3	n/a	n/a				Very slow
	n	73	52	28	4	1	1				
	S.D.	1.6	3.2	2.2	2.2	.	.				
	S.E.	0.2	0.4	0.4	1.1	0.0	0.0				
	Min.	3.6	7.2	17.9	21.7	29.0	32.8				
	Max.	10.2	22.0	26.6	26.2	29.0	32.8				
Acoose	Mean	6.2	14.8	18.9	22.5	n/a					Very slow
	n	50	42	9	3	1					
	S.D.	1.9	3.5	1.4	1.3	.					
	S.E.	0.3	0.5	0.5	0.8	0.0					
	Min.	3.4	6.9	16.6	21.5	31.5					
	Max.	12.3	22.3	20.8	24.0	31.5					
Sheelin	Mean	7.3	20.5	30.2	n/a	n/a	n/a				Very fast
	n	4	2	2	1	1	1				
	S.D.	1.6	7.1	10.5	.	.	.				
	S.E.	0.8	5.0	7.5	0.0	0.0	0.0				
	Min.	5.9	15.5	22.7	44.8	54.1	60.6				
	Max.	8.7	25.5	37.6	44.8	54.1	60.6				
Beagh	Mean	7.4	15.2	21.1	25.9	34.5					Slow
	n	76	63	32	11	3					
	S.D.	1.6	2.8	2.2	3.6	11.4					
	S.E.	0.2	0.3	0.4	1.1	6.6					
	Min.	3.5	9.8	17.2	21.9	27.7					
	Max.	10.7	19.5	25.5	35.6	47.7					
Glencullin	Mean	6.5	15.1	21.9	26.5	30.5	n/a				Slow
	n	45	30	11	5	2	1				
	S.D.	2.0	2.5	3.3	1.8	1.7	.				
	S.E.	0.3	0.5	1.0	0.8	1.2	0.0				
	Min.	2.9	11.2	16.6	24.3	29.3	31.6				
	Max.	11.9	22.0	28.3	28.2	31.7	31.6				

APPENDIX 3 continued

Lengths at age of brown trout in 21 lakes surveyed during 2011 (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
Upper Lake	Mean	6.4	14.2	19.7	23.7	27.4	30.2			Very Slow
Killarney	n	45	39	25	7	3	2			
	S.D.	1.6	3.2	2.5	1.9	1.5	1.9			
	S.E.	0.2	0.5	0.5	0.7	0.9	1.4			
	Min.	3.2	8.0	15.2	21.6	25.9	28.8			
	Max.	9.2	20.2	25.3	26.3	28.9	31.6			

APPENDIX 4

Lengths at age of perch in 19 lakes surveyed during 2011 (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
O'Flynn	Mean	5.6	10.2	14.5	17.7	20.4	22.8	24.7	n/a	n/a	n/a
	n	80	63	36	16	7	2	2	1	1	1
	S.D.	0.9	1.3	1.6	1.8	2.8	5.2	6.7	.	.	.
	S.E.	0.1	0.2	0.3	0.4	1.1	3.7	4.7	0.0	0.0	0.0
	Min.	4.4	8.0	11.3	15.1	17.2	19.1	20.0	21.0	21.6	22.5
	Max.	8.4	13.8	16.9	20.5	24.4	26.5	29.4	21.0	21.6	22.5
Corrib Lower	Mean	5.9	11.1	16.1	19.5	22.7	25.3	n/a			
	n	55	44	29	14	8	2	1			
	S.D.	1.0	2.0	1.9	1.7	2.5	5.4	.			
	S.E.	0.1	0.3	0.4	0.5	0.9	3.9	.			
	Min.	3.5	6.7	11.8	15.5	19.4	21.4	21.9			
	Max.	7.9	15.7	20.9	22.7	27.4	29.1	21.9			
Corrib Upper	Mean	5.8	10.9	15.7	18.7	20.7	23.0	23.7	24.9	n/a	n/a
	n	83	72	53	40	18	8	4	3	1	1
	S.D.	0.8	1.7	1.8	2.1	2.3	2.2	2.5	3.8	.	.
	S.E.	0.1	0.2	0.3	0.3	0.5	0.8	1.2	2.2	0.0	0.0
	Min.	3.7	5.7	10.0	13.5	15.2	19.3	20.2	21.2	31.0	34.6
	Max.	7.5	15.0	20.4	23.6	24.9	25.1	25.6	28.7	31.0	34.6
Annaghmore	Mean	5.6	12.0	16.7	20.5	24.7	n/a				
	n	42	19	14	8	5	1				
	S.D.	1.0	2.0	2.1	2.4	2.0	.				
	S.E.	0.2	0.5	0.6	0.9	0.9	0.0				
	Min.	4.1	7.9	11.4	16.5	21.6	25.3				
	Max.	9.3	15.6	19.6	24.7	26.8	25.3				
Allua	Mean	5.6	10.4	13.8							
	n	30	7	2							
	S.D.	0.9	2.8	0.6							
	S.E.	0.2	1.1	0.5							
	Min.	3.4	8.0	13.3							
	Max.	6.8	15.5	14.2							
Cavetown	Mean	8.5	15.4	19.2							
	n	33	17	4							
	S.D.	1.9	5.5	0.3							
	S.E.	0.3	1.3	0.2							
	Min.	4.5	8.6	18.9							
	Max.	10.7	21.6	19.6							

APPENDIX 4 continued

Lengths at age of perch in 19 lakes surveyed during 2011 (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
Corglass	Mean	6.1	10.6	15.2	19.2	23.5					
	n	60	42	34	14	4					
	S.D.	0.7	1.1	1.9	1.9	0.8					
	S.E.	0.1	0.2	0.3	0.5	0.4					
	Min.	4.3	7.2	10.3	16.1	22.2					
	Max.	7.4	13.1	18.3	22.3	24.1					
Egish	Mean	6.2	11.2	15.6	18.7	22.4	n/a				
	n	97	75	53	32	19	1				
	S.D.	0.8	1.2	1.6	1.8	2.2	.				
	S.E.	0.1	0.1	0.2	0.3	0.5	0.0				
	Min.	5.1	8.1	12.0	15.5	18.9	23.3				
	Max.	8.9	14.5	20.3	25.0	28.5	23.3				
Caragh	Mean	5.9	12.4	17.0	19.9	26.4	27.6	34.2	n/a	n/a	
	n	52	42	20	12	4	3	2	1	1	
	S.D.	0.9	1.4	1.8	3.0	5.1	6.6	1.5	.	.	
	S.E.	0.1	0.2	0.4	0.9	2.6	3.8	1.0	0.0	0.0	
	Min.	4.2	8.6	14.0	15.6	19.3	20.1	33.2	35.5	37.7	
	Max.	8.4	14.8	20.9	25.8	31.3	32.3	35.2	35.5	37.7	
Derrybrick	Mean	6.0	10.9	17.6	21.4	25.0					
	n	41	14	6	3	2					
	S.D.	0.7	0.8	1.2	2.0	2.7					
	S.E.	0.1	0.2	0.5	1.1	1.9					
	Min.	4.6	9.4	15.8	19.1	23.1					
	Max.	7.5	12.3	18.7	22.7	26.9					
Gill	Mean	5.5	10.3	14.4	18.3	20.8	22.8	24.4	24.2	27.3	n/a
	n	112	92	62	52	40	24	12	3	2	1
	S.D.	0.8	1.3	1.8	2.3	2.2	2.2	2.9	4.2	4.0	.
	S.E.	0.1	0.1	0.2	0.3	0.4	0.5	0.8	2.4	2.8	0.0
	Min.	3.0	6.8	10.8	13.7	17.8	19.2	20.6	21.0	24.5	24.9
	Max.	7.4	13.1	18.0	24.6	25.9	28.5	30.0	29.0	30.2	24.9
Meelagh	Mean	5.6	10.0	15.0	18.5	20.9					
	n	50	37	29	22	9					
	S.D.	0.7	1.1	1.2	1.1	1.0					
	S.E.	0.1	0.2	0.2	0.2	0.3					
	Min.	4.0	8.4	11.4	16.7	19.7					
	Max.	7.5	13.8	17.2	20.9	22.5					
Owel	Mean	5.9	11.4	16.5	19.8	22.1	24.1	25.0			
	n	112	89	65	54	37	15	2			
	S.D.	0.8	1.4	1.7	1.5	1.7	1.9	3.6			
	S.E.	0.1	0.2	0.2	0.2	0.3	0.5	2.6			
	Min.	4.5	7.4	11.4	16.5	18.6	21.3	22.4			
	Max.	9.3	16.2	20.4	23.7	25.4	28.7	27.6			

APPENDIX 4 continued

Lengths at age of perch in 19 lakes surveyed during 2011 (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
Melvin	Mean	5.6	11.8	16.7	19.9	22.8	26.3	28.9	n/a		
	n	98	81	57	46	32	12	6	1		
	S.D.	0.7	1.4	2.0	2.4	2.4	3.0	3.4	.		
	S.E.	0.1	0.2	0.3	0.4	0.4	0.9	1.4	0.0		
	Min.	4.2	8.5	12.4	15.1	18.2	22.6	23.7	34.6		
	Max.	7.7	14.8	20.9	24.8	27.6	31.2	32.8	34.6		
Skeagh Upper	Mean	5.4	9.4	12.1	14.4	17.0	18.0				
	n	53	42	21	16	9	2				
	S.D.	0.7	0.8	1.1	1.4	2.9	3.4				
	S.E.	0.1	0.1	0.2	0.4	1.0	2.4				
	Min.	3.9	7.4	10.4	12.1	14.1	15.6				
	Max.	7.0	11.0	14.6	17.0	22.6	20.4				
Talt	Mean	4.7	12.1	18.8							
	n	12	7	4							
	S.D.	0.4	1.8	0.7							
	S.E.	0.1	0.7	0.4							
	Min.	3.9	10.0	17.7							
	Max.	5.5	14.4	19.4							
Leane	Mean	6.4	11.8	15.9	18.0	19.6	20.9	n/a			
	n	68	50	30	24	19	5	1			
	S.D.	0.9	1.7	1.9	1.5	1.3	0.8	.			
	S.E.	0.1	0.2	0.4	0.3	0.3	0.3	0.0			
	Min.	4.6	8.8	11.7	15.3	16.1	19.7	20.4			
	Max.	8.8	16.0	19.0	20.2	21.4	21.5	20.4			
Sheelin	Mean	6.1	12.3	19.1	23.0	25.4					
	n	110	93	60	42	40					
	S.D.	0.8	2.6	2.7	2.8	2.6					
	S.E.	0.1	0.3	0.3	0.4	0.4					
	Min.	4.4	7.4	11.3	14.2	20.1					
	Max.	8.6	18.6	24.7	28.1	31.6					
Templehouse	Mean	5.8	11.1	16.5	20.0	23.5	25.5	23.8			
	n	30	24	16	12	9	5	2			
	S.D.	0.9	2.6	3.3	3.7	4.5	4.3	2.4			
	S.E.	0.2	0.5	0.8	1.1	1.5	1.9	1.7			
	Min.	4.4	7.5	11.0	16.2	19.7	21.3	22.1			
	Max.	7.9	17.4	23.0	27.5	31.4	32.5	25.5			
Upper Lake	Mean	6.0	12.4	15.2	17.0	18.5	20.8				
	n	43	32	13	11	6	2				
	S.D.	1.0	1.4	1.7	2.0	2.6	1.1				
	S.E.	0.2	0.2	0.5	0.6	1.1	0.8				
	Min.	3.9	9.3	12.3	13.2	14.6	20.0				
	Max.	8.6	14.5	17.7	19.5	21.6	21.6				

APPENDIX 5

Lengths at age of roach in 14 lakes surveyed during 2011 (L1=back calculated length of roach at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9
O'Flynn	Mean	3.7	10.0	18.2						
	n	7	5	5						
	S.D.	0.8	1.0	0.9						
	S.E	0.3	0.5	0.4						
	Min.	2.8	8.6	17.3						
	Max.	5.0	11.3	19.6						
Corrib Lower	Mean	3.1	7.8	12.5	18.9	21.6	23.8			
	n	47	42	18	16	5	2			
	S.D.	0.9	1.7	2.5	1.9	1.6	1.1			
	S.E.	0.1	0.3	0.6	0.5	0.7	0.8			
	Min.	1.5	4.9	8.2	15.2	19.6	23.0			
	Max.	5.6	10.2	16.8	21.3	23.3	24.6			
Corrib Upper	Mean	2.9	7.2	12.0	17.1	20.9	24.4	26.7	29.0	
	n	90	90	83	62	42	21	8	2	
	S.D.	0.7	1.7	2.3	2.4	1.9	1.8	1.9	1.8	
	S.E.	0.1	0.2	0.3	0.3	0.3	0.4	0.7	1.3	
	Min.	1.8	3.9	7.1	11.9	16.1	20.0	24.1	27.7	
	Max.	5.1	12.3	17.3	22.4	24.1	27.0	29.5	30.3	
Annaghmore	Mean	2.3	6.6	12.3	16.8	20.8	21.3	24.1		
	n	23	23	20	11	7	2	2		
	S.D.	0.5	1.6	2.0	1.9	1.6	0.1	2.0		
	S.E.	0.1	0.3	0.5	0.6	0.6	0.1	1.4		
	Min.	1.4	4.6	9.6	14.4	18.8	21.2	22.7		
	Max.	3.5	10.6	16.7	21.1	22.8	21.3	25.5		
Allua	Mean	2.7	7.2	13.0	17.1	20.4	22.0	24.3	n/a	
	n	51	43	22	14	12	5	2	1	
	S.D.	0.8	2.0	2.6	1.7	1.5	1.0	2.3	.	
	S.E.	0.1	0.3	0.5	0.4	0.4	0.4	1.6	0.0	
	Min.	1.5	3.7	8.6	12.8	16.6	20.4	22.7	28.0	
	Max.	5.3	12.6	17.1	19.0	21.8	22.8	25.9	28.0	
Cavetown	Mean	1.9	5.2	8.9	13.5	17.2	19.9	22.1	n/a	
	n	60	60	51	43	36	29	16	1	
	S.D.	0.4	1.5	1.8	2.2	2.1	2.1	2.1	.	
	S.E.	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.0	
	Min.	1.3	2.3	5.8	8.4	12.6	16.0	17.8	23.8	
	Max.	3.8	9.5	12.3	17.5	21.0	23.8	25.7	23.8	
Corglass	Mean	2.3	5.8	10.4	15.0	18.6	22.0	24.2	26.0	28.0
	n	95	93	87	62	42	28	16	6	5
	S.D.	0.6	1.3	2.0	2.6	2.5	2.1	1.2	0.8	0.5
	S.E.	0.1	0.1	0.2	0.3	0.4	0.4	0.3	0.3	0.2
	Min.	1.2	3.2	5.4	10.4	13.5	17.9	22.5	25.2	27.5
	Max.	4.0	9.2	15.0	20.5	24.4	26.4	26.4	27.4	28.6

APPENDIX 5 continued

Lengths at age of roach in 14 lakes surveyed during 2011 (L1=back calculated length of roach at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9
Egish	Mean	2.4	6.7	12.4	17.0	21.1	23.6	26.3	26.6	n/a
	n	77	77	55	45	38	27	18	4	1
	S.D.	0.6	1.6	2.7	2.9	2.3	2.3	1.7	1.7	.
	S.E	0.1	0.2	0.4	0.4	0.4	0.4	0.4	0.8	0.0
	Min.	1.5	2.9	7.5	10.9	17.3	20.1	23.3	24.5	24.0
	Max.	4.4	10.5	16.7	21.9	25.3	27.7	28.6	28.6	24.0
Derrybrick	Mean	3.3	7.0	12.7	18.4					
	n	27	12	3	2					
	S.D.	0.8	1.4	2.9	0.5					
	S.E.	0.2	0.4	1.7	0.4					
	Min.	1.9	5.2	9.4	18.0					
	Max.	4.7	10.1	14.8	18.7					
Gill	Mean	2.4	7.4	13.4	18.1	21.5	23.8			
	n	72	65	53	44	24	6			
	S.D.	0.4	0.9	1.2	1.3	1.1	1.5			
	S.E.	0.0	0.1	0.2	0.2	0.2	0.6			
	Min.	1.7	5.4	10.8	15.5	19.7	22.6			
	Max.	3.5	9.2	16.3	21.4	24.2	26.6			
Meelagh	Mean	2.5	6.7	12.5	18.1	21.9	24.8	27.0	27.9	
	n	64	58	52	48	29	26	10	2	
	S.D.	0.6	1.4	1.7	1.8	2.0	1.7	1.6	0.3	
	S.E	0.1	0.2	0.2	0.3	0.4	0.3	0.5	0.2	
	Min.	1.7	3.9	7.5	14.5	17.9	20.9	24.9	27.6	
	Max.	4.9	10.1	15.5	21.3	26.1	28.1	30.3	28.1	
Skeagh Upper	Mean	2.5	6.1	9.8	13.5	15.5	17.6	18.8		
	n	62	57	38	29	23	13	7		
	S.D.	0.6	1.3	2.2	1.8	1.6	1.3	1.1		
	S.E.	0.1	0.2	0.4	0.3	0.3	0.4	0.4		
	Min.	1.4	3.2	5.9	9.4	11.0	15.6	17.8		
	Max.	4.3	8.7	13.5	16.0	18.4	20.1	20.8		
Sheelin	Mean	2.7	7.3	12.0	18.5	23.2	25.6			
	n	41	41	27	25	21	8			
	S.D.	0.6	1.8	2.6	2.6	2.6	2.9			
	S.E.	0.1	0.3	0.5	0.5	0.6	1.0			
	Min.	1.6	4.2	6.8	12.9	17.4	21.5			
	Max.	4.3	10.8	15.9	22.1	26.6	28.5			
Templehouse	Mean	2.7	8.1	14.1	18.5	22.2	26.4	n/a		
	n	106	93	70	52	36	6	1		
	S.D.	0.5	1.1	1.4	1.7	1.9	1.3	.		
	S.E.	0.0	0.1	0.2	0.2	0.3	0.5	0.0		
	Min.	1.4	4.5	10.7	14.4	18.0	24.9	28.5		
	Max.	4.1	11.4	16.5	22.5	25.4	28.5	28.5		

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)
Barra	1	0.8557	0.7884	0.9042	High	High
Caragh	2	0.781	0.7126	0.8369	High	High
Carrowmore	1	0.867	0.792	0.9178	High	High
Gill	4	0.7708	0.622	0.873	High	Good
Glenbeg	2	0.7703	0.6884	0.8358	High	High
Glencullin	1	0.8059	0.7334	0.8624	High	High
Kiltooris	1	0.7772	0.7074	0.8343	High	High
Melvin	2	0.8054	0.6775	0.8907	High	High
O' Flynn	3	0.8577	0.7696	0.9158	High	Good
Talt	4	0.8593	0.528	0.9709	High	High
Acoose	2	0.7228	0.5967	0.8213	Good	Good
Beagh	2	0.7581	0.679	0.8228	Good	Good
Brin	1	0.6687	0.5926	0.7368	Good	Good
Cavetown	4	0.6471	0.3739	0.8491	Good	Good
Easky	1	0.6114	0.5308	0.6863	Good	Good
Fern	1	0.6431	0.4868	0.7739	Good	Good
Leane	2	0.5784	0.4516	0.6956	Good	Good
Owel	4	0.6146	0.3467	0.8273	Good	Good
Allua	2	0.4837	0.3206	0.6503	Moderate	Moderate
Annaghmore	3	0.4442	0.3509	0.5415	Moderate	Moderate
Corrib Lower	3	0.4294	0.33	0.5348	Moderate	Moderate
Sheelin	3	0.4646	0.3021	0.635	Moderate	Moderate
Upper Lake Killarney	2	0.5077	0.3365	0.677	Moderate	Moderate
Corglass	3	0.0176	0.01	0.0307	Poor/Bad	Poor/Bad
Corrib Upper	4	0.2922	0.0574	0.7368	Poor/Bad	Poor/Bad
Derrybrick	3	0.2878	0.1997	0.3956	Poor/Bad	Poor/Bad
Egish	3	0.0834	0.0575	0.1196	Poor/Bad	Poor/Bad
Meelagh	3	0.1352	0.1011	0.1786	Poor/Bad	Poor/Bad
Skeagh Upper	1	0.059	0.0304	0.1117	Poor/Bad	Poor/Bad
Templehouse	3	0.0295	0.0145	0.059	Poor/Bad	Poor/Bad

APPENDIX 7

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Ballinglen	Mean	7.1	15.4			n/a
	S.D.	1.4	1.1			
	S.E.	0.4	0.5			
	n	11	5			
	Min	4.1	14.0			
	Max	9.2	16.8			
Ballyhallan	Mean	5.2	9.6			n/a
	S.D.	0.9	0.5			
	S.E.	0.3	0.4			
	n	10	2			
	Min	4.1	9.2			
	Max	6.4	10.0			
Baltracey	Mean	n/a				n/a
	S.D.	n/a				
	S.E.	n/a				
	n	1				
	Min	4.5				
	Max	4.5				
Banoge	Mean	7.2	n/a			n/a
	S.D.	1.4	n/a			
	S.E.	0.3	n/a			
	n	20	1			
	Min	5.2	18.1			
	Max	10.0	18.1			
Behy	Mean	6.6	15.6	n/a		n/a
	S.D.	1.1	0.6	n/a		
	S.E.	0.2	0.4	n/a		
	n	25	3	1		
	Min	4.6	15.0	19.4		
	Max	8.9	16.1	19.4		
Boor	Mean	7.4	n/a			n/a
	S.D.	1.4	n/a			
	S.E.	0.5	n/a			
	n	10	1			
	Min	5.8	16.5			
	Max	9.8	16.5			
Bow	Mean	6.2	12.3	15.1	n/a	n/a
	S.D.	1.4	1.7	n/a	n/a	
	S.E.	0.3	0.6	n/a	n/a	
	n	25	7	1	1	
	Min	4.8	9.4	15.1	18.9	
	Max	9.6	14.6	15.1	18.9	

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Brittas	Mean	6.0	11.7			n/a
	S.D.	1.3	1.2			
	S.E.	0.3	0.5			
	n	20	5			
	Min	4.3	10.5			
	Max	9.3	13.7			
Burnfoot	Mean	4.9	8.4	12.8		Very slow
	S.D.	1.2	1.2	0.6		
	S.E.	0.3	0.4	0.4		
	n	17	10	2		
	Min	2.9	7.0	12.4		
	Max	7.3	11.2	13.3		
Camac (Moneenalion)	Mean	n/a				n/a
	S.D.	n/a				
	S.E.	n/a				
	n	1				
	Min	10.3				
	Max	10.3				
Camac (Riverside)	Mean	8.4				n/a
	S.D.	1.1				
	S.E.	0.8				
	n	2				
	Min	7.6				
	Max	9.1				
Camlin (Killoe)	Mean	n/a				n/a
	S.D.	n/a				
	S.E.	n/a				
	n	1				
	Min	8.4				
	Max	8.4				
Camlin (Lisnabo)	Mean	6.9	n/a			n/a
	S.D.	0.1	n/a			
	S.E.	0.1	n/a			
	n	2	1			
	Min	6.8	13.7			
	Max	7.0	13.7			
Castlebar	Mean	n/a				n/a
	S.D.	n/a				
	S.E.	n/a				
	n	1				
	Min	6.1				
	Max	6.1				

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Clodiagh	Mean	8.1	19.0	27.3	n/a	Fast
	S.D.	1.7	3.2	3.0	n/a	
	S.E.	0.2	0.5	1.2	n/a	
	n	55	35	6	1	
	Min	4.1	11.1	22.0	32.0	
	Max	12.8	24.1	30.3	32.0	
Clydagh (Castlebar)	Mean	6.8				n/a
	S.D.	0.7				
	S.E.	0.4				
	n	3				
	Min	6.1				
	Max	7.3				
Cronaniv Burn	Mean	4.1				n/a
	S.D.	0.5				
	S.E.	0.2				
	n	5				
	Min	3.5				
	Max	4.9				
Deel (Newcastlewest)	Mean	5.9	13.6	n/a		n/a
	S.D.	1.8	1.6	n/a		
	S.E.	0.5	1.2	n/a		
	n	12	2	1		
	Min	3.2	12.5	28.3		
	Max	9.3	14.8	28.3		
Dodder (Beaver Row)	Mean	7.5	17.8			n/a
	S.D.	0.8	1.5			
	S.E.	0.5	1.1			
	n	3	2			
	Min	6.7	16.7			
	Max	8.4	18.9			
Dodder (Bohernabreena)	Mean	6.4	13.7			Slow
	S.D.	1.4	1.0			
	S.E.	0.3	0.4			
	n	31	7			
	Min	4.1	12.7			
	Max	9.4	15.6			
Dodder (Mount Carmel)	Mean	8.2	n/a			n/a
	S.D.	1.9	n/a			
	S.E.	0.7	n/a			
	n	8	1			
	Min	5.3	24.4			
	Max	12.0	24.4			

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Douglas	Mean	7.5	14.2			n/a
	S.D.	1.7	2.4			
	S.E.	0.4	1.7			
	n	16	2			
	Min	5.6	12.5			
	Max	11.7	15.8			
Dromore	Mean	5.5	n/a			n/a
	S.D.	2.4	n/a			
	S.E.	1.7	n/a			
	n	2	1			
	Min	3.8	10.6			
	Max	7.3	10.6			
Duag	Mean	5.6				n/a
	S.D.	0.8				
	S.E.	0.3				
	n	7				
	Min	4.4				
	Max	6.4				
Duncormick	Mean	8.5	17.5	24.6		n/a
	S.D.	1.5	2.6	1.0		
	S.E.	0.3	0.9	0.7		
	n	29	8	2		
	Min	5.6	14.4	23.9		
	Max	11.1	21.6	25.3		
Glashaboy	Mean	7.5				n/a
	S.D.	1.8				
	S.E.	0.4				
	n	26				
	Min	4.3				
	Max	11.7				
Glaskeelan	Mean	5.4	12.3	17.4		n/a
	S.D.	1.6	2.3	1.3		
	S.E.	0.5	1.0	0.9		
	n	12	5	2		
	Min	3.5	9.1	16.4		
	Max	8.6	14.9	18.3		
Glennamong	Mean	6.2				n/a
	S.D.	1.4				
	S.E.	0.4				
	n	15				
	Min	4.0				
	Max	8.5				

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Gourna (Owenogarney)	Mean	7.6	n/a			n/a
	S.D.	0.9	n/a			
	S.E.	0.2	n/a			
	n	16	1			
	Min	6.6	13.2			
	Max	10.0	13.2			
Gourna (Railway Br.)	Mean	6.5	15.4			n/a
	S.D.	1.1	0.0			
	S.E.	0.3	0.0			
	n	18	2			
	Min	4.5	15.4			
	Max	9.1	15.4			
Graney	Mean	5.3				n/a
	S.D.	1.3				
	S.E.	0.3				
	n	16				
	Min	3.5				
	Max	7.6				
Griffeen (Griffeen Ave.)	Mean	7.8				n/a
	S.D.	1.3				
	S.E.	0.4				
	n	13				
	Min	5.0				
	Max	9.4				
Gweestin	Mean	6.2	n/a	n/a		n/a
	S.D.	1.5	n/a	n/a		
	S.E.	0.5	n/a	n/a		
	n	9	1	1		
	Min	3.8	16.4	20.1		
	Max	8.8	16.4	20.1		
Inny (Oldcastle)	Mean	5.3	10.0			n/a
	S.D.	1.2	1.1			
	S.E.	0.3	0.8			
	n	23	2			
	Min	3.5	9.2			
	Max	7.8	10.8			
Inny (Tully)	Mean	5.8	14.4			n/a
	S.D.	1.4	2.7			
	S.E.	0.3	1.6			
	n	31	3			
	Min	3.3	11.4			
	Max	9.3	16.7			

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Little (Cloghan)	Mean	7.6	17.2	n/a		n/a
	S.D.	1.3	2.1	n/a		
	S.E.	0.3	1.2	n/a		
	n	18	3	1		
	Min	5.3	14.9	24.0		
	Max	10.3	18.9	24.0		
Martin	Mean	7.7	15.4	n/a		Slow
	S.D.	1.6	1.5	n/a		
	S.E.	0.3	0.4	n/a		
	n	39	13	1		
	Min	4.5	12.2	22.3		
	Max	10.6	19.1	22.3		
Mountnugent (Mountnugent Br.)	Mean	6.6	15.2			n/a
	S.D.	1.4	0.0			
	S.E.	0.3	0.0			
	n	29	2			
	Min	4.5	15.2			
	Max	10.4	15.2			
Mountnugent (Racraveen)	Mean	6.2	n/a			n/a
	S.D.	1.3	n/a			
	S.E.	0.3	n/a			
	n	21	1			
	Min	4.2	18.1			
	Max	8.4	18.1			
Nuenna	Mean	6.1	12.9			n/a
	S.D.	1.3	2.5			
	S.E.	0.3	1.1			
	n	22	5			
	Min	4.0	8.6			
	Max	8.4	14.6			
Owenavorragh	Mean	9.6	22.8	n/a		Very fast
	S.D.	1.8	3.7	n/a		
	S.E.	0.3	1.1	n/a		
	n	36	11	1		
	Min	6.5	14.3	28.1		
	Max	13.7	29.1	28.1		
Owendoher	Mean	5.9	12.2			n/a
	S.D.	1.2	1.0			
	S.E.	0.4	0.7			
	n	10	2			
	Min	4.6	11.5			
	Max	8.3	12.9			

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Owentocker	Mean	6.8	15.0	22.0	27.0	n/a
	S.D.	1.1	2.5	1.0	0.4	
	S.E.	0.4	1.0	0.6	0.3	
	n	8	7	3	2	
	Min	5.0	11.5	21.0	26.8	
	Max	7.9	18.6	22.9	27.3	
Rye Water (Balfeaghan Br.)	Mean	n/a	n/a			n/a
	S.D.	n/a	n/a			
	S.E.	n/a	n/a			
	n	1	1			
	Min	7.1	12.7			
	Max	7.1	12.7			
Rye Water (Kildare Br.)	Mean	8.2	n/a			n/a
	S.D.	1.6	n/a			
	S.E.	0.4	n/a			
	n	14	1			
	Min	5.4	10.2			
	Max	11.1	10.2			
Shanowen	Mean	6.6	11.8	n/a		n/a
	S.D.	1.1	1.4	n/a		
	S.E.	0.4	0.8	n/a		
	n	9	3	1		
	Min	5.1	10.9	18.4		
	Max	8.4	13.4	18.4		
Silver (Lumcloon)	Mean	7.7	16.3	20.6	25.3	Slow
	S.D.	1.8	3.7	1.9	n/a	
	S.E.	0.3	1.2	1.0	n/a	
	n	37	10	4	1	
	Min	4.3	10.4	19.2	25.3	
	Max	11.5	20.8	23.4	25.3	
Swanlinbar	Mean	5.3	8.6	12.7	19.5	Very slow
	S.D.	1.4	1.5	1.3	2.7	
	S.E.	0.3	0.4	0.8	1.9	
	n	26	12	3	2	
	Min	2.9	5.8	11.5	17.6	
	Max	8.6	10.5	14.2	21.4	
Swilly	Mean	5.3	10.0	n/a		n/a
	S.D.	0.9	2.0	n/a		
	S.E.	0.2	1.2	n/a		
	n	19	3	1		
	Min	3.2	7.9	16.6		
	Max	6.9	12.0	16.6		

APPENDIX 7 continued

Lengths at age of brown trout in 52 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth Category
Ward	Mean	n/a				n/a
	S.D.	n/a				
	S.E.	n/a				
	n	1				
	Min	6.1				
	Max	6.1				
Waterfoot	Mean	5.0	9.6			n/a
	S.D.	1.0	1.5			
	S.E.	0.2	0.6			
	n	32	6			
	Min	3.1	7.7			
	Max	6.7	11.6			
Womanagh	Mean	8.0	21.6			n/a
	S.D.	1.6	2.6			
	S.E.	0.3	1.9			
	n	23	2			
	Min	4.6	19.7			
	Max	11.9	23.4			

APPENDIX 8

Lengths at age of salmon in 28 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Ballinglen	Mean	4.5	7.2
	S.D.	0.9	0.1
	S.E.	0.2	0.1
	n	30	2
	Min	2.5	7.1
	Max	6.4	7.3
Ballyhallan	Mean	3.9	n/a
	S.D.	0.5	n/a
	S.E.	0.1	n/a
	n	11	1
	Min	3.0	8.7
	Max	4.6	8.7
Ballyroan	Mean	5.5	
	S.D.	0.7	
	S.E.	0.3	
	n	7	
	Min	4.4	
	Max	6.5	
Banoge	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	5.4	
	Max	5.4	
Behy	Mean	4.6	
	S.D.	0.8	
	S.E.	0.2	
	n	24	
	Min	3.1	
	Max	6.1	
Boor	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	5.5	
	Max	5.5	
Burnfoot	Mean		
	S.D.		
	S.E.		
	n		
	Min		
	Max		

APPENDIX 8 continued

Lengths at age of salmon in 28 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Clydagh (Castlebar)	Mean	5.4	
	S.D.	1.2	
	S.E.	0.3	
	n	16	
	Min	3.5	
	Max	8.8	
Cronaniv Burn	Mean	3.7	6.3
	S.D.	0.6	0.9
	S.E.	0.2	0.4
	n	12	7
	Min	2.4	5.1
	Max	4.4	8.1
Deel (Newcastlewest)	Mean		
	S.D.		
	S.E.		
	n		
	Min		
	Max		
Dodder (Beaver Row)	Mean	6.7	n/a
	S.D.	0.9	n/a
	S.E.	0.2	n/a
	n	15	1
	Min	5.1	14.8
	Max	8.3	14.8
Glashaboy	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	7.2	
	Max	7.2	
Glaskeelan	Mean	3.4	6.7
	S.D.	0.5	0.7
	S.E.	0.1	0.2
	n	17	11
	Min	2.6	5.9
	Max	4.3	7.9
Glennamong	Mean	5.3	8.4
	S.D.	1.0	1.1
	S.E.	0.3	0.5
	n	17	5
	Min	3.6	6.8
	Max	7.5	9.6

APPENDIX 8 continued

Lengths at age of salmon in 28 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Gourna (Owenogarney)	Mean	5.9	
	S.D.	1.2	
	S.E.	0.4	
	n	11	
	Min	4.4	
	Max	8.3	
Gourna (Railway Br.)	Mean	5.0	n/a
	S.D.	0.8	n/a
	S.E.	0.2	n/a
	n	15	1
	Min	3.8	9.5
	Max	6.6	9.5
Gweestin	Mean	3.6	
	S.D.	0.7	
	S.E.	0.2	
	n	20	
	Min	2.3	
	Max	5.2	
Martin	Mean	4.9	
	S.D.	1.0	
	S.E.	0.2	
	n	22	
	Min	2.6	
	Max	6.5	
Owenavorragh	Mean	6.0	
	S.D.	0.9	
	S.E.	0.3	
	n	9	
	Min	4.7	
	Max	7.7	
Owentocker	Mean	3.6	7.5
	S.D.	0.7	0.9
	S.E.	0.1	0.2
	n	23	15
	Min	2.5	6.1
	Max	5.5	8.9
Shanowen	Mean	5.1	
	S.D.	1.2	
	S.E.	0.3	
	n	23	
	Min	3.2	
	Max	7.6	

APPENDIX 8 continued

Lengths at age of salmon in 28 rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Silver (Kilcormac)	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	4.8	
	Max	4.8	
Swanlinbar	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	7.2	
	Max	7.2	
Swilly	Mean	4.3	
	S.D.	0.8	
	S.E.	0.3	
	n	9	
	Min	3.2	
	Max	5.8	
Tobercurry	Mean	4.0	
	S.D.	0.6	
	S.E.	0.1	
	n	22	
	Min	2.9	
	Max	5.3	
Tolka	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	3.6	
	Max	3.6	
Waterfoot	Mean	3.6	11.4
	S.D.	0.4	1.0
	S.E.	0.2	0.7
	n	3	2
	Min	3.2	10.7
	Max	4.0	12.1
Womanagh	Mean		
	S.D.		
	S.E.		
	n		
	Min		
	Max		

APPENDIX 9

Lengths at age of roach in five rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8
Camlin (Lisnabo)	Mean	2.4	5.6	9.7	14.1	17.3	20.4	23.1	24.8
	S.D.	0.7	1.1	1.5	1.5	1.5	1.4	0.9	1.1
	S.E.	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.6
	n	74	60	44	38	27	16	6	4
	Min	1.3	3.4	6.7	10.5	14.3	17.5	22.4	23.3
	Max	4.4	8.3	12.6	17.6	20.1	22.6	24.7	26.0
Castlebar	Mean	2.2	5.7	9.3	12.0				
	S.D.	0.4	1.5	1.4	2.5				
	S.E.	0.1	0.3	0.3	0.9				
	n	33	31	19	7				
	Min	1.7	3.8	6.7	9.1				
	Max	3.3	11.4	12.2	15.3				
Griffeen (Griffeen Ave.)	Mean	n/a	n/a						
	S.D.	n/a	n/a						
	S.E.	n/a	n/a						
	n	1	1						
	Min	2.8	5.3						
	Max	2.8	5.3						
Rye Water (Kildare Br.)	Mean	2.9	7.4	12.2	15.9	18.3	21.4		
	S.D.	0.5	2.2	1.8	1.6	1.7	2.6		
	S.E.	0.2	1.0	0.8	0.7	0.9	1.8		
	n	5	5	5	5	4	2		
	Min	2.3	4.1	9.7	14.0	16.8	19.6		
	Max	3.4	9.8	14.1	17.7	20.1	23.2		
Scramoge (Riverdale)	Mean	2.9	n/a						
	S.D.	0.0	n/a						
	S.E.	0.0	n/a						
	n	3	1						
	Min	2.9	4.8						
	Max	3.0	4.8						

APPENDIX 10

Lengths at age of sea trout in the Owenavorragh River surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River	age	L1	L2
Owenavorragh	Mean	9.7	24.0
	S.D.	2.2	1.9
	S.E.	0.6	0.4
	n	5	5
	Min	7.7	21.1
	Max	13.3	25.9

APPENDIX 11

Lengths at age of pike in four rivers surveyed during 2011 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2
Camlin (Lisnabo)	Mean	23.7	39.8
	S.D.	2.8	3.2
	S.E.	1.6	2.3
	n	3	2
	Min	21.4	37.5
	Max	26.8	42.0
Scramoge (Carrowclogher)	Mean	n/a	n/a
	S.D.	n/a	n/a
	S.E.	n/a	n/a
	n	1	1
	Min	14.3	23.3
	Max	14.3	23.3
Scramoge (Riverdale)	Mean	17.1	27.2
	S.D.	1.3	3.8
	S.E.	0.6	2.7
	n	5	2
	Min	15.3	24.5
	Max	18.8	29.9
Rye Water (Kildare Br.)	Mean	n/a	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Min	15.3	
	Max	15.3	

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