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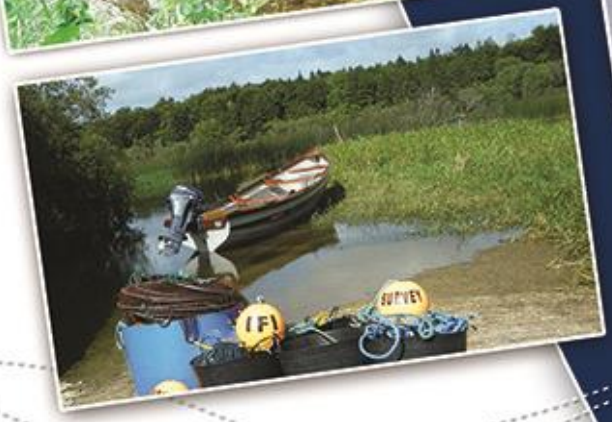

Sampling Fish for the Water Framework Directive

Summary Report 2012

Iascach Intíre Éireann
Inland Fisheries Ireland

Sampling Fish for the Water Framework Directive - Summary Report 2012

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Inland Fisheries Ireland CEO's Statement

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

Inland Fisheries Ireland is responsible for monitoring fish for the Water Framework Directive. The dedicated WFD staff based at IFI 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 2012, the WFD surveillance monitoring programme was influenced by the difficult circumstances surrounding the current economic climate and the extremely unfavourable weather. 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 2012, 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 2012 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 2013.

Dr Ciaran Byrne
CEO, Inland Fisheries Ireland

June 2013

Foreword

Welcome to Inland Fisheries Ireland's Sampling Fish for the Water Framework Directive – Summary Report 2012.

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, two transitional waters and 65 river sites were surveyed, and over 34,000 fish captured and examined. The final year of the second three year cycle began in 2012 with a total of 23 lakes, 58 river sites and three transitional waterbodies being surveyed. 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 five 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, managers, legislators, angling clubs, fishery owners and other interested parties. Detailed reports for each water body surveyed in 2012 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 2012. Data from the 2012 surveillance monitoring programme will be available on this map viewer later in 2013.

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,
June 2013

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 2012, a comprehensive fish surveillance monitoring programme was conducted, with 58 river sites, 23 lakes and 3 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 2012 surveillance monitoring programme and highlights the current status of each water body in accordance with the fish populations present.

Twenty-three lakes were surveyed during 2012, with a total of 16 fish species (sea trout are included as a separate 'variety' of trout) and one type of hybrid being recorded. Eel was the most common fish species recorded, occurring in 22 out of the 23 lakes surveyed (95.6%). This was followed by brown trout, perch, pike and roach which were present in 73.9%, 60.8%, 56.5% and 30.4% of lakes respectively. In general, salmonids were the dominant species in the north-west, west, south-west and eastern areas of the country. Sea trout were only captured in two lakes in the west and north-west and Arctic char were recorded in four lakes in the west and north-west. Perch, followed by pike were the most widely distributed, non-native species recorded during the 2012 surveillance monitoring programme, with perch being present in 14 lakes and pike being present in 13 of the 23 lakes surveyed.

All lakes surveyed during 2012 have been assigned a draft ecological status using the Fish in Lakes tool (FIL2) (Kelly *et al*., 2012b) based on the fish populations present. Ten were classified as High, four were classified as Good, three were classified as Moderate, four were classified as Poor and two were classified as Bad ecological status. 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 58 river sites were surveyed during 2012 using boat-based electric-fishing gear for the non-wadeable sites and hand-set electric-fishing gear for the wadeable sites. A total of 16 fish species (sea trout are included as a separate 'variety' of trout) and one type of hybrid were recorded. Species richness ranged from 12, plus one hybrid, to one. Brown trout was the most common species recorded, being present in 95% of sites surveyed, followed by salmon (78%), European eels (71%), three-spined stickleback (71%), stone loach (45%) and minnow (38%). 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 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 'FSC2 Ireland' (SNIFFER, 2011) along with expert opinion, was used to classify all river sites surveyed during 2012; three river sites were classified as High, 34 were classified as Good, 15 were classified as Moderate and four were classified as Poor.

Three transitional water bodies were surveyed during 2012. These were the Boyne Estuary, the Erne Estuary and the Gweebarra Estuary. A total of 26 fish species (sea trout are included as a separate 'variety' of trout) were recorded across the three water bodies. Twenty-three fish species were captured in the Boyne Estuary, 14 in the Gweebarra Estuary and ten in the Erne Estuary. Six species including, five-bearded rockling, flounder, lesser sandeel, pollack, sand goby and three-spined stickleback, were common to all three water bodies. Some important angling species encountered during these surveys included brown trout, sea trout, salmon and cod.

An ecological classification tool (Transitional Fish Classification Index – TFCI) for fish in transitional waters was used to assign ecological status to each transitional waterbody (Coates *et al*., 2007). The Boyne Estuary was assigned a draft ecological classification of Good, the Erne Estuary as Moderate and the Gweebarra Estuary as Moderate.

In addition to the Water Framework Directive requirements of information on ecological status, the work conducted in 2012 provides more comprehensive information on fish stocks in a large number of Irish surface waters. For example, in June pollan were recorded in Lough Derg, 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 Wögerbauer 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. Dr. Letizia Cocchiglia, Ms. Karen Kelly, Mr. Kilian Kelly, Mr. Samuel Thomas, Dr. Bernadette O'Neill and Ms. Sinead O'Reilly assisted with fieldwork during these surveys.

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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 Lough Anure Anglers, the Rosses Anglers Association and the Dunfanaghy Angling Association in County Donegal) and their help is also gratefully acknowledged. Mr. Michael Wade from Delphi Fishery, County Mayo provided access to Doo Lough and his help is gratefully acknowledged. The authors would also like to thank Mr. David Cooke and his family for access and help on the Lough Sessiagh survey, Mr. Michael Dillon at Inchicronan Lough and Mr. Kevin Madden at Lough Alewnaghta, County Clare who provided access to the lake. Access to Lough Dan was courtesy of Scouting Ireland and Lough Tay was courtesy of Tom Clinton, estate manager.

The authors would also like to acknowledge the funding provided for the project from the Department of Communication, Energy and Natural resources (DCENR) for 2012.

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).

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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 is 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 2012 has again been extensive and 58 river sites, 23 lakes and three transitional water bodies were successfully surveyed nationwide. A team of IFI staff carried out the monitoring surveys (scientists from the Research and Development section of IFI Swords in conjunction with staff from the IFI river basin district offices). The surveys were

conducted using a suite of European standard methods; electric fishing is the main survey method used in rivers, with various netting techniques being used in lakes and estuaries. Survey work was conducted from May to October, which is the optimum time for sampling fish in Ireland. Unfavourable weather conditions and heavy flooding resulted in some surveys being deferred until 2013.

This report summarises the main findings of the fish stock surveys in all water bodies (lakes, rivers and transitional waters) surveyed during 2012 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-three lakes water bodies, ranging in size from 8.0ha (Lough Caum) to 11,650.5ha (Lough Derg), were surveyed between June and October 2012. 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).

Two lakes were surveyed in the Eastern River Basin District (ERBD) (Lough Tay and Lough Dan). Eight lakes were surveyed in the Shannon International River Basin District (ShIRBD), ranging in size from 8.0ha (Lough Caum) to 11650.5ha (Lough Derg). One lake was surveyed in the Neagh Bann International River Basin District (NBIRBD) (Lough Muckno). Six lakes were surveyed in the North Western International River Basin District (NWIRBD), ranging in size from 15.2ha (Lough Nasnahida) to 133.1ha (Lough Anure) and six lakes were surveyed in the Western River Basin District (WRBD), ranging in size from 102.9ha (Lough Bunny) to 8217.8ha (Lough Mask). Summary details of all lakes surveyed in 2012 are shown in Table 2.1.

Table 2.1. Summary details of lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2012

Lake name	Water body code	Catchment	Easting	Northing	WFD Typology	Area (ha)	Mean depth (m)	Max depth (m)
ShIRBD								
Alewnaghta	SH_25_189	Shannon Lwr	176007	191239	6	54.6	<4	4.5
Cam	SH_23_74	Owencashla	59756	107933	1	8.0	2.7	15.0
Cullaun	SH_27_115	Fergus	131562	190586	11	49.7	6.7	21.0
Derg	SH_25_191a	Shannon Lwr	174621	185223	12	11650.5	6.0	36.0
Dromore	SH_27_82	Fergus	134531	185841	11	49.1	5.9	20.0
Gur	SH_24_99	Shannon Est Sth	163821	140656	10	78.9	2.4	5.0
Inchicronan	SH_27_126	Fergus	139166	186157	10	116.7	<4	18.8
Muckanagh	SH_27_94	Fergus	137123	192809	10	96.1	3.0	19.0
NBIRBD								
Muckno	NB_06_56	Fane	285437	317763	8	355.9	5.9	27.7
ERBD								
Dan	EA_10_29	Ovoca	315219	203607	4	102.9	13.5	40.0
Tay	EA_10_25	Ovoca	316106	207550	3	50.0	10.1	35.0
NWIRBD								
Anure	NW_38_83	Gweedore	181982	416578	2	133.1	2.0	11.9
Dungloe	NW_38_692	Coastal	178268	411931	2	65.1	1.3	7.5
Kindrum	NW_38_670	Coastal	218669	443076	8	60.8	6.6	15.0
Nasnahida	NW_38_67	Owenamarve	185263	407788	1	15.2	<4	11.0
Sessiagh	NW_38_61	Coastal	204279	436150	7	24.1	4.0	20.9
White	NW_36_647	Erne	266270	318268	6	53.8	<4	6.0
WRBD								
Arrow	WE_35_159	Ballysadare	178991	312053	12	1247.0	9.0	33.0
Bunny	WE_27_114	Kinvarra	137491	196757	10	102.9	2.7	14.0
Carra	WE_30_347	Corrib	117662	272566	10	1564.5	1.8	19.0
Cullin	WE_34_406a	Moy	122864	302926	10	1023.6	<4	3.0
Doo	WE_32_490	Owenerk	83426	268311	4	154.5	>4	46.0
Mask	WE_30_665	Corrib	110294	263408	12	8217.8	5.0	57.0

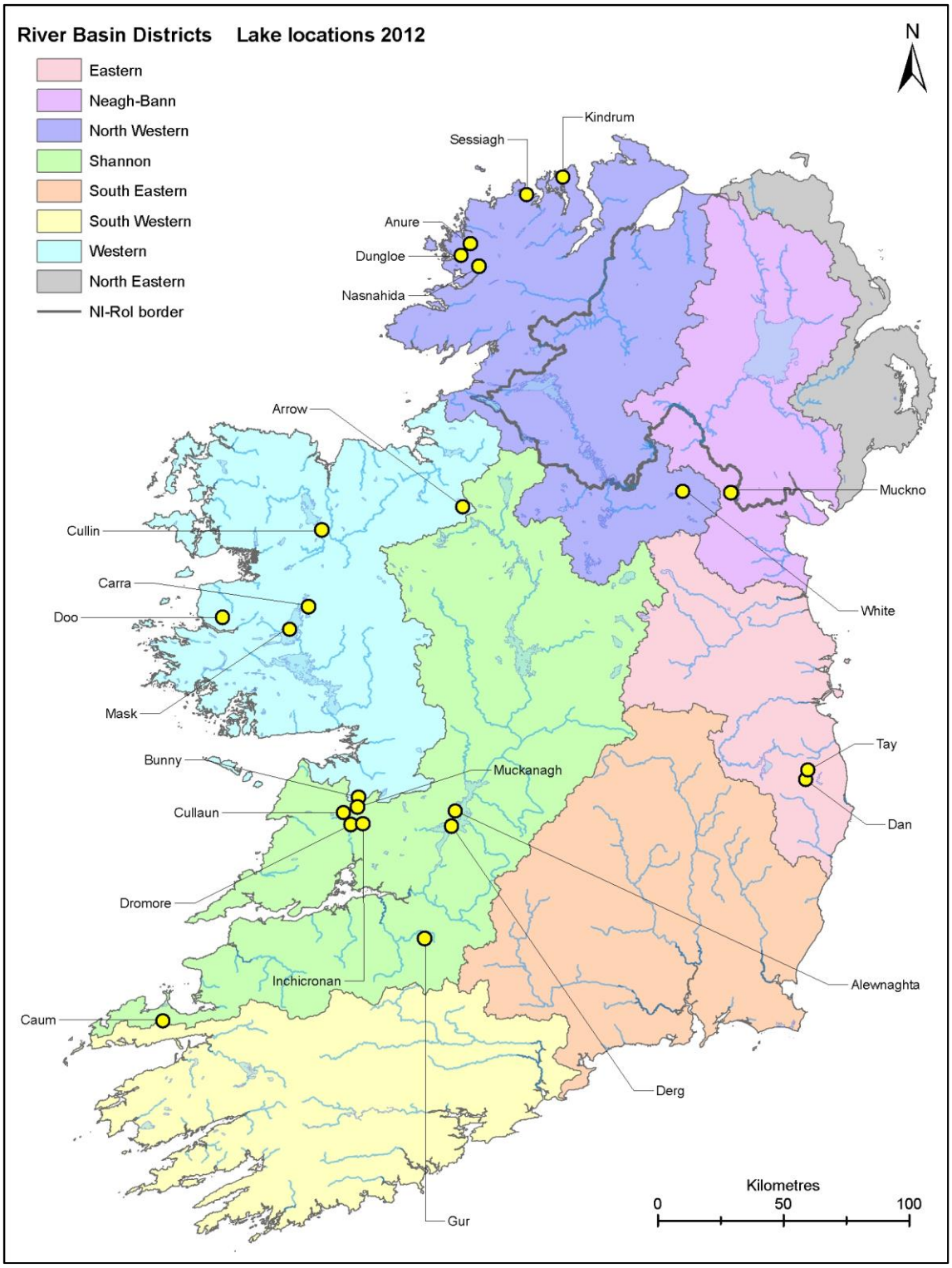

Fig. 2.1. Location of the 23 lakes surveyed for the WFD fish surveillance monitoring programme, June to October 2012

2.2 Rivers

Fifty-eight river sites, ranging in surface area from 92m^2 (Tyshe River Site A) to 25,531m^2 (River Barrow (Dunleckny), Co. Carlow), were surveyed between May and September 2012. Catchments encompassing each river water body were classified according to size as follows; <10km^2, <100km^2, <1000km^2 and <10000km^2. Sites were distributed throughout all seven RBDs within the Republic of Ireland (Table 2.2, Table 2.3 and Fig. 2.2).

Eight river sites were surveyed in the ERBD with surface areas ranging from 212m^2 (Athboy River, Clonleasan House Site A) to 4,228m^2 (River Liffey at Ballyward Bridge). Only the River Liffey was deep enough to require the use of boat based electric-fishing equipment. Fifteen river sites were surveyed in the SERBD, with surface areas ranging from 102m^2 (Tully Stream, Soomeragh Br. Site B) to 25531 m^2 (River Barrow, Dunleckny). Of these sites, eight were non-wadeable requiring boat based electric-fishing equipment (all on the River Barrow), with the remaining seven wadeable, requiring bank based equipment. Fifteen river sites were surveyed in the ShIRBD, ranging in size from 92m^2 (Tyshe River, Ardfert Friary Site A) to 6786m^2 (River Maigue, Castleroberts Br.). Of these sites, nine were wadeable and six were non-wadeable. Five sites were surveyed in the SWRBD, ranging in size from 430m^2 (both the Argideen and Adrigole Rivers) to 3910m^2 (Awbeg River). Of these, two were wadeable and three were non-wadeable. Eleven sites were surveyed in the WRBD (all wadeable except for two), ranging in size from 205m^2 (Gowlan River, Site A) to 17861m^2 (River Moy, Ardnaree Br.). Two sites were surveyed in the NWIRBD, the Clady River (wadeable) with a surface area of 380m^2 and the Eany Water (non-wadeable) with a surface area of 7,849m^2. Finally two sites were surveyed in the NBIRBD (both wadeable), with surface areas of 209m^2 (Big River, Ballygoly Br.) and 358m^2 (White River, Coneyburrow Br.). 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, May to September 2012

River	Site name	Catchment	Site Code	Waterbody code
ERBD Wadeable sites				
Athboy	Br. nr Clonleasan Ho_A	Boyne	07A010100A	EA_07_971
Athboy	Br. nr Clonleasan Ho_B	Boyne	07A010100B	EA_07_971
Dargle	Bahana_A	Dargle	10D010005A	EA_10_1148
Glencree	Br. u/s Dargle R confl_A	Dargle	10G010200A	EA_10_367
Glenealo	Br. d/s Upper Lake_A	Avoca	10G050200A	EA_10_793
Glenealo (Shop)	Br. d/s Upper Lake_B	Avoca	10G050200B	EA_10_793
Nanny (Meath)	Br. at Julianstown_A	Nanny	08N010700A	EA_08_814
ERBD Non-Wadeable sites				
Liffey	500 m d/s Ballyward Br._A	Liffey	09L010250A	EA_09_1175
NBIRBD Wadeable sites				
Big (Louth)	Ballygoly Br._A	Castletown	06B010100A	NB_06_642
White (Louth)	Coneyburrow Br._B	Dee	06W010500B	NB_06_550
NWIRBD Wadeable sites				
Clady (Donegal)	Bryan's Br._A	Clady	38C040150A	NW_38_4124
NWIRBD Non-Wadeable sites				
Eany Water	Just d/s Eany Beg/More confl_A	Eany water	37E030300A	NW_37_3646
SERBD Wadeable sites				
Burren	Ullard Br._A	Barrow	14B050100A	SE_14_1781
Burren	Ullard Br._B	Barrow	14B050100B	SE_14_1781
Dinin	Dinin Br._A	Nore	15D020800A	SE_15_1955
Greese	Br. NE of Belan House_A	Burren	14G040350A	SE_14_946
Greese	Br. NE of Belan House_B	Burren	14G040350B	SE_14_946
Lerr	Prumplestown Br._A	Burren	14L010200A	SE_14_157
Tully Stream	Soomeragh Br_A	Barrow	14T020390A	SE_14_842
Tully Stream	Soomeragh Br_B	Barrow	14T020390B	SE_14_842
SERBD Non-Wadeable sites				
Barrow	Bagenalstown (Slipway to lock)_A	Barrow	14B012870A	SE_14_196
Barrow	Ballykeenan Lock_A	Barrow	14B013440A	SE_14_1909
Barrow	Dunleckny (Swimming pool)_A	Barrow	14B012820A	SE_14_196
Barrow	Graiguenamanagh Br._A	Barrow	14B013500A	SE_14_1909
Barrow	Leighlinbridge Lord Bagenal Hotel_A	Barrow	14B012690A	SE_14_196
Barrow	Pass Br._B	Barrow	14B011000A	SE_14_196_1
Barrow	Upper Tinnahinch Lock_A	Barrow	14B013510A	SE_14_1909

Table 2.2 ctn. Location and codes of river sites surveyed for the WFD fish surveillance monitoring programme, May to September 2012

	Site name	Catchment	Site Code	Waterbody code
ShIRBD Wadeable sites				
Ballyfinboy	Ballinderry Br._A	Shannon Lwr	25B020750A	SH_25_1853
Bilboa	Br u/s Blackboy Br - Bilboa Br._A	Shannon Lwr	25B030080A	SH_25_486
Caher	Br. 2 km d/s Formoyle_A	Caher	28C010200A	SH_28_106
Dead	Pope's Bridge_A	Shannon Lwr	25D010100A	SH_25_1893
Dead	Pope's Bridge_B	Shannon Lwr	25D010100B	SH_25_1893
Owvane (Limerick)	Br. u/s (SE of) Loghill_A	Shannon Est sth	24O020200A	SH_24_878
Owveg (Kerry)	Owveg Br._B	Feale	23O050200B	SH_23_1743
Tyshe	West br. Ardfert at Friary_A	Tyshe	23T020400A	SH_23_427
Tyshe	West br. Ardfert at Friary_B	Tyshe	23T020400B	SH_23_427
ShIRBD Non-Wadeable sites				
Creegh	Drumellihy Br._A	Creegh	28C021500A	SH_28_709
Kilcrow	Ballyshrule Br._A	Shannon Lwr	25K010700A	SH_25_334
Little Brosna	Riverstown Br._A	Shannon Lwr	25L020700A	SH_25_633
Maigue	Castleroberts Br._A	Shannon Est Sth	24M010900A	SH_24_1675
Nenagh	Ballysoilshaun Br._A	Shannon Lwr	25N010300A	SH_25_335
Tullamore	Br. SW of Ballycowen br._A	Shannon Lwr	25T030400A	SH_25_3798
SWRBD Wadeable sites				
Adrigole	0.5km d/s of Glashduff confl._A	Adrigole	21A010150A	SW_21_8052
Argideen	Ballinoroher Ford_B	Argideen	20A020150B	SW_20_2251
SWRBD Non-Wadeable sites				
Awbeg (Buttevant)	Kilcummer Br._A	Blackwater	18A051300A	SW_18_2677
Bride (Waterford)	Footbr. N of Ballynella_A	Blackwater	18B050500A	SW_18_2778
Bride (Waterford)	Footbr. N of Ballynella_B	Blackwater	18B050500B	SW_18_2778
WRBD Wadeable sites				
Black (Shrule)	Br. at Kilshanvy_A	Corrib	30B020100A	WE_30_2928
Black (Shrule)	Br. at Kilshanvy_B	Corrib	30B020100B	WE_30_2928
Bunowen (Louisburgh)	Tully Br._A	Bunowen	32B030100A	WE_32_3740
Dunneill	Donaghintraine Br._A	Dunneill	35D060200A	WE_35_1430
Dunneill	Dromore West_A	Dunneill	35D060170A	WE_35_3210
Glenamoy	Glenamoy Village_A	Glenamoy	33G010075A	WE_33_3238
Gowlan	Track west of Lough Black_A	Easky	35G030050A	WE_35_1187
Gowlan	Track west of Lough Black_B	Easky	35G030050B	WE_35_1187
Owenbrin	Br. u/s L. Mask_A	Corrib	30O010200A	WE_30_1063
WRBD Non-Wadeable sites				
Deel (Crossmolina)	Bridge at Castle Gore_A	Moy	34D010400A	WE_34_3896_3
Moy	U/s Ardnaree Br._A	Moy	34M021020A	WE_34_3982

Table 2.3. Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, May to September 2012

River	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ERBD Wadeable sites					
Athboy (Br. nr Clonleasan Ho._A)	78.02	5.30	212	0.55	0.77
Athboy (Br. nr Clonleasan Ho._B)	78.02	6.23	249	0.49	0.74
Dargle (Bahana_A)	12.92	7.98	311	0.19	0.37
Glencree (Br. u/s Dargle confl_A)	33.86	8.90	401	0.39	0.85
Glenealo (Br. d/s Upper Lake_A)	18.73	7.33	242	0.44	0.78
Glenealo (Br. d/s Upper Lake_B)	18.85	7.25	276	0.40	0.91
Nanny (Meath) (Br. at Julianstown_A)	221.68	11.40	456	0.48	0.75
ERBD Non-Wadeable sites					
Liffey (500 m d/s Ballyward Br._A)	87.70	14.83	4228	0.55	2.77
NBIRBD Wadeable sites					
Big (Louth) (Ballygoly Br._A)	10.58	4.35	209	0.31	0.72
White (Louth) (Coneyburrow Br._B)	55.13	7.95	358	0.34	0.58
NWIRBD Wadeable sites					
Clady (Donegal) (Bryan's Br._A)	78.63	10.27	380	0.28	0.61
NWIRBD Non-Wadeable sites					
Eany Water (Just d/s Eany Beg/More confl_A)	93.87	23.50	7849	0.56	1.90
SERBD Wadeable sites					
Burren (Ullard Br._A)	38.49	3.97	159	0.70	0.79
Burren (Ullard Br._B)	38.49	5.40	216	0.56	0.82
Dinin (Dinin Br._A)	299.23	15.52	667	0.31	0.79
Greese (Br. NE of Belan House_A)	102.39	7.67	307	0.50	0.67
Greese (Br. NE of Belan House_B)	102.39	7.37	258	0.54	0.68
Lerr (Prumplestown Br._A)	75.87	5.93	225	0.34	0.53
Tully Stream (Soomeragh Br_A)	44.13	4.07	163	0.41	0.71
Tully Stream (Soomeragh Br_B)	44.13	3.50	102	0.52	0.75
SERBD Non-Wadeable sites					
Barrow (Bagenalstown (Slipway to lock)_A)	2401.33	16.17	16377	1.41	2.00
Barrow (Ballykeenan Lock_A)	2760.76	35.60	11143	1.57	2.45
Barrow (Dunleckny (Swimming pool)_A)	2390.38	40.33	25531	1.56	2.25
Barrow (Graiguenamanagh Br._A)	2777.72	42.60	15549	2.20	3.40
Barrow (Leighlinbridge Lord Bagenal Hotel_A)	2356.86	36.00	16380	1.04	1.40
Barrow (Pass Br._B)	1125.58	30.17	10951	0.55	0.85
Barrow (Upper Tinnahinch Lock_A)	2788.49	40.80	20645	1.73	2.50

Table 2.3 ctn. Physical characteristics of river sites surveyed for the WFD fish surveillance monitoring programme, May to September 2012

River	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ShIRBD Wadeable sites					
Ballyfinboy (Ballinderry Br._A)	184.86	7.25	254	0.43	0.78
Bilboa (Br u/s Blackboy Br - Bilboa Br._A)	85.13	13.83	553	0.22	0.40
Caher (Br. 2 km d/s Formoyle_A)	14.91	4.95	223	0.20	0.43
Dead (Pope's Bridge_A)	61.94	6.43	161	0.27	0.40
Dead (Pope's Bridge_B)	61.94	6.25	250	0.34	0.63
Owvane (Limerick) (Br. u/s (SE of) Loghill_A)	74.99	15.22	609	0.23	0.51
Owveg (Kerry) (Owveg Br._B)	18.53	7.63	344	0.18	0.42
Tyshe (West br. Ardfert at Friary_A)	8.52	2.97	92	0.23	0.54
Tyshe (West br. Ardfert at Friary_B)	8.52	4.25	170	0.13	0.21
ShIRBD Non-Wadeable sites					
Creegh (Drumellihy Br._A)	76.00	7.65	1071	0.43	0.90
Kilcrow (Ballyshrule Br._A)	216.10	11.17	1720	0.51	1.29
Little Brosna (Riverstown Br._A)	317.55	11.43	1646	0.54	0.87
Maigue (Castleroberts Br._A)	805.99	33.80	13149	0.87	1.79
Nenagh (Ballysoilshaun Br._A)	82.44	8.45	980	0.51	0.92
Tullamore (Br. SW of Ballycowen Br._A)	124.50	7.42	786	0.59	0.97
SWRBD Wadeable sites					
Adrigole (0.5km d/s of Glashduff confl._A)	26.28	10.75	430	0.30	0.58
Argideen (Ballinoroher Weir_A)	82.41	12.65	430	0.32	0.62
SWRBD Non-Wadeable sites					
Awbeg (Buttevant) (Kilcummer Br._A)	350.44	19.17	3910	0.49	1.25
Bride (Waterford) (Footbr. N of Ballynella_A)	226.78	20.17	3126	0.60	1.03
Bride (Waterford) (Footbr. N of Ballynella_B)	227.01	15.50	2806	0.67	1.07
WRBD Wadeable sites					
Black (Shrule) (Br. at Kilshanvy_A)	3.12	6.55	262	0.34	0.61
Black (Shrule) (Br. at Kilshanvy_B)	3.12	6.45	206	0.43	0.81
Bunowen (Louisburgh) (Tully Br._A)	28.11	8.35	334	0.32	0.70
Dunneill (Donaghintraine Br._A)	24.35	8.63	389	0.18	0.32
Dunneill (Dromore West_A)	13.77	10.88	468	0.55	11.00
Glenamoy (Glenamoy Village_A)	74.80	10.48	419	0.19	0.32
Gowlan (Track west of Lough Black_A)	17.00	5.13	205	0.38	0.70
Gowlan (Track west of Lough Black_B)	17.00	6.43	257	0.34	0.70
Owenbrin (Br. u/s L. Mask_A)	23.82	8.48	339	0.36	0.68
WRBD Non-Wadeable sites					
Deel (Crossmolina) (Bridge at Castle Gore_A)	229.59	19.00	4085	0.92	1.70
Moy (U/s Ardnaree Br._A)	1948.13	45.33	17861	1.93	4.35

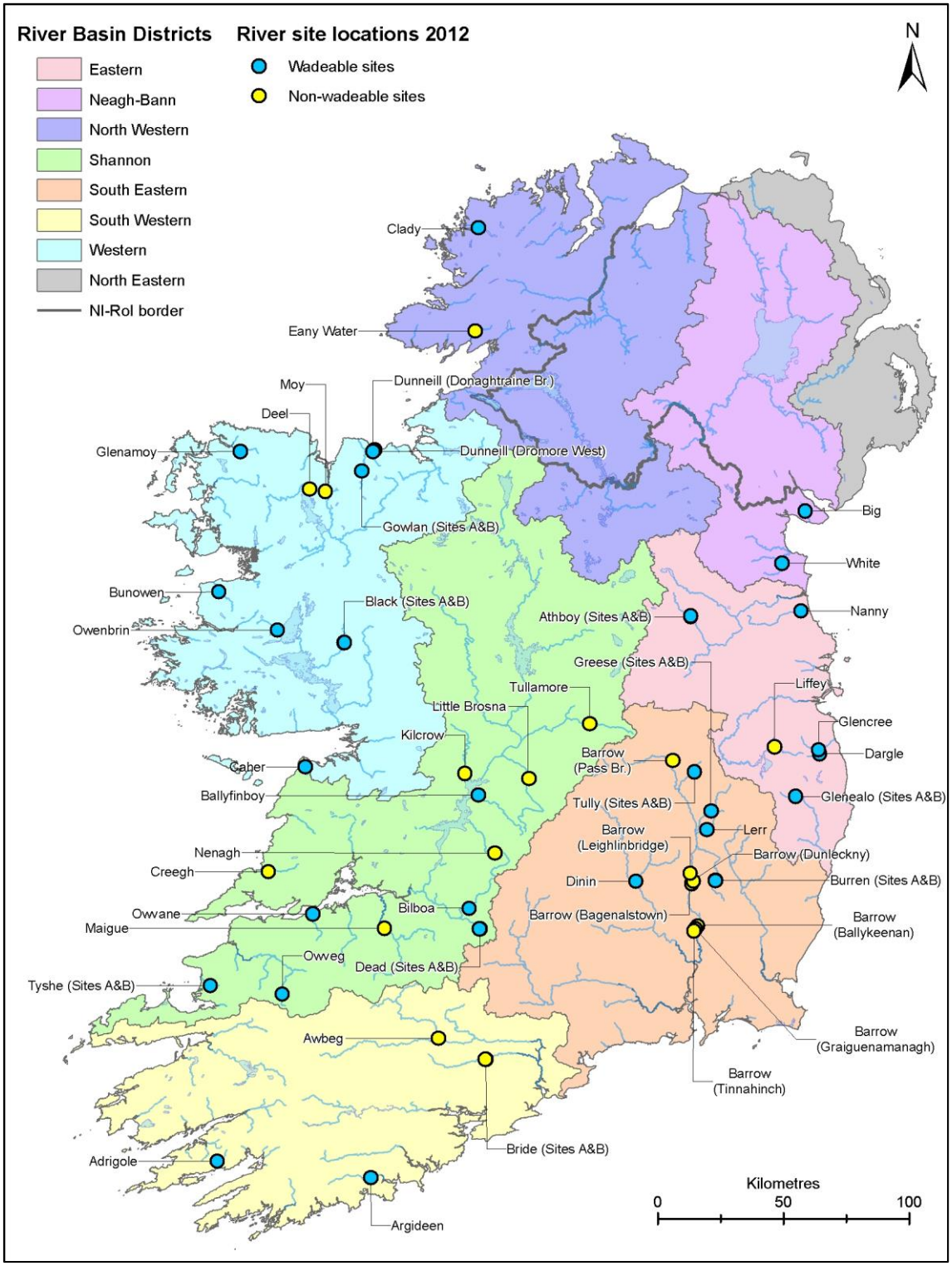

Fig. 2.2. Location of the 58 river sites surveyed for the WFD fish surveillance monitoring programme, June to October 2012

2.3 Transitional waters

Three transitional water bodies, Boyne Estuary, Erne Estuary and Gweebarra Estuary were surveyed in October 2012 (Table 2.4 and Fig. 2.3).

The Boyne Estuary covers an area of 3.16km^2 and is located on Ireland's east coast near Drogheda in the Eastern River Basin District (ERBD). Both the Erne and the Gweebarra transitional water bodies are located in Co. Donegal in the North Western International River Basin District (NWIRBD), covering an area of 2.57km^2 and 8.26km^2 for the Erne Estuary and Gweebarra Estuaries respectively.

Table 2.4.Transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2012 (TW=transitional)

Water body	MS Code	Easting	Northing	Type	Area (km^2)
Boyne Estuary	EA_010_0100	313778	276399	TW	3.16
Erne Estuary	NW_030_0100	307493	308320	TW	2.57
Gweebarra Estuary	NW_120_0100	311060	304506	TW	8.26

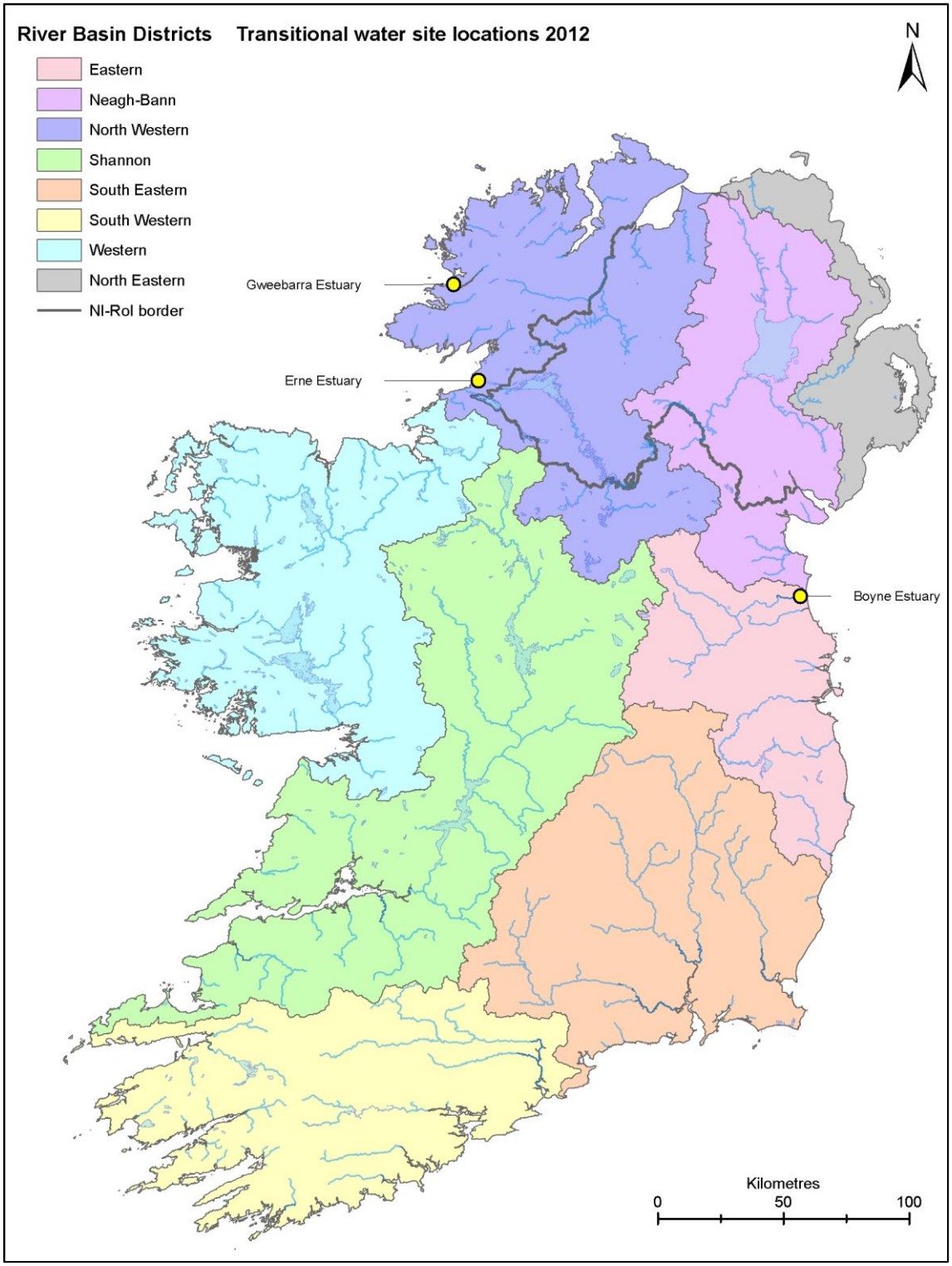

Fig. 2.3. Location of the three transitional water bodies surveyed for the WFD fish surveillance monitoring programme, October 2012

3. METHODS

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

3.1 Lakes

3.1.1 Survey methodology

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

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

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

3.1.2 Processing of fish

All fish were counted, measured and weighed on site. 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 3.3).

Plate 3.1. Retrieving a monofilament multi-mesh CEN standard survey gill net on Lough Derg, Co. Tipperary

Plate 3.2. A surface floating monofilament multi-mesh CEN standard survey gill net on Lough Mask, Co. Mayo

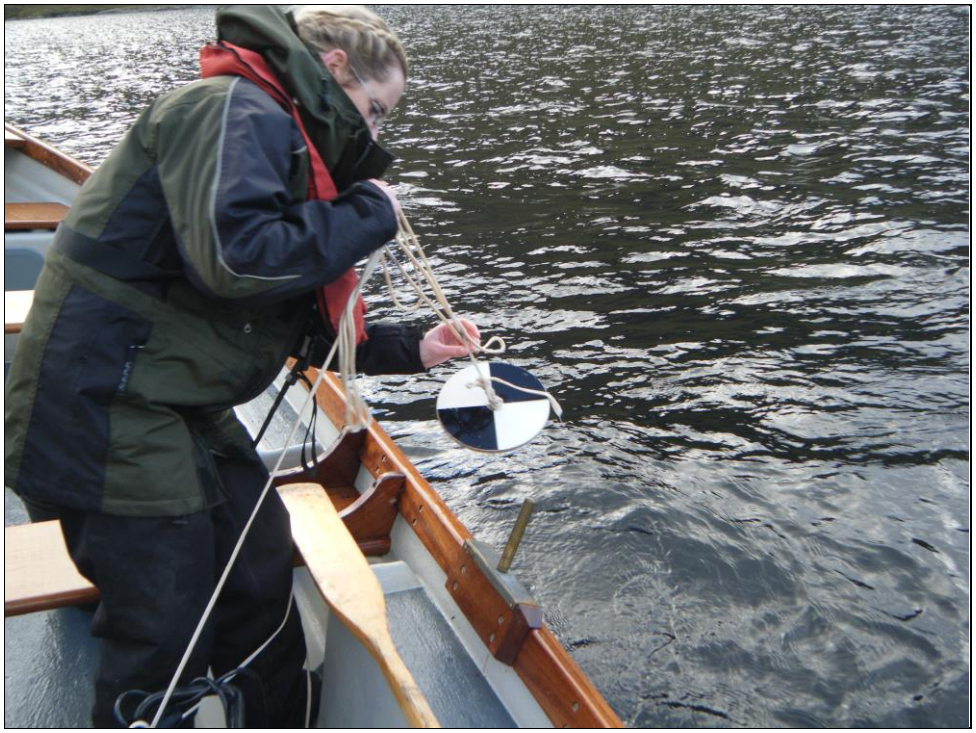

Plate 3.3. Recording secchi depth on Doo Lough, Co. Mayo

3.2 Rivers

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

3.2.1 Survey methodology

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

In small wadeable channels (<0.5-0.7m in depth), bank-based equipment, consisting of landing nets with integrated anodes connected to control boxes and portable generators were used to sample in an upstream direction (Plate 3.4a). In larger, deeper channels (>0.5-1.5m), fishing was carried out from a

flat-bottomed boat(s) in a downstream direction using a generator, control box, a pair of anodes and a cathode (Plate 3.4b). A representative sample of all habitats was sampled (i.e. riffle, glide, pool).

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

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

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

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

3.2.2 Habitat assessment

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

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

Table 3.1. Environmental and abiotic variables recorded for all river sites surveyed for WFD fish surveillance monitoring in 2012

Environmental / abiotic variable	Min	Mean	Max	Footnote
River reach sampled				
Length fished (m)	25	137	1013	1
Mean depth (m)	0.13	0.57	2.2	2
Max depth (m)	0.21	1.2	11	3
Wetted width (m)	3	13.3	45.3	4
Surface area (m^2)	92	3300	25531	5
Shade	0	-	3	6
Instream cover	0	17	90	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	-	6	10
Conductivity @ 25^0c (µS/cm)	28	429	766	-
Water temperature (^{o}c)	11.2	14.1	19.8	-
pH	5.6	7.3	8	-
Dissolved oxygen (mg/l)	6.3	10.1	13	-
Dissolved oxygen (%)	61	99	124	-
Flow type (%)				
Riffle	5	29	80	7
Glide	10	63	100	7
Pool	5	25	50	7
Substrate type (%)				
Bedrock	0	5	10	7
Boulder	1	12	50	7
Cobble	1	36	75	7
Gravel	5	34	84	7
Sand	5	20	60	7
Mud/silt	1	17	70	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: net deployed 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 set off 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 substrate of sand or gravel, as trawling over soft

sediments can cause the net to foul with mud and make the recovery of the trawl extremely difficult. After each trawl the net was hauled aboard and the fish were processed.

Plate 3.9. Hauling a 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 individual fish length. Once processing was complete the majority of fish were returned to the water alive. Representative sub-samples of a number of abundant fish species were measured (fork length) to the nearest millimetre. Any fish species that could not be identified on site 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 lakes were aged (five fish from each 1cm class). Fish scales were read using a microfiche reader. Perch opercular bones were prepared by boiling, cleaning and drying, before ageing them using a binocular microscope/digital camera system with Image Pro Plus software (Plate 3.10). Char otoliths were cleared in 70% ethanol and aged using a binocular microscope (Plate 3.11). Eel otoliths were prepared by the method of 'cutting and burning' and then subsequently aged using a binocular microscope/digital camera system with Image Pro Plus software (Plate 3.12). Back calculated lengths at age were determined in the laboratory.

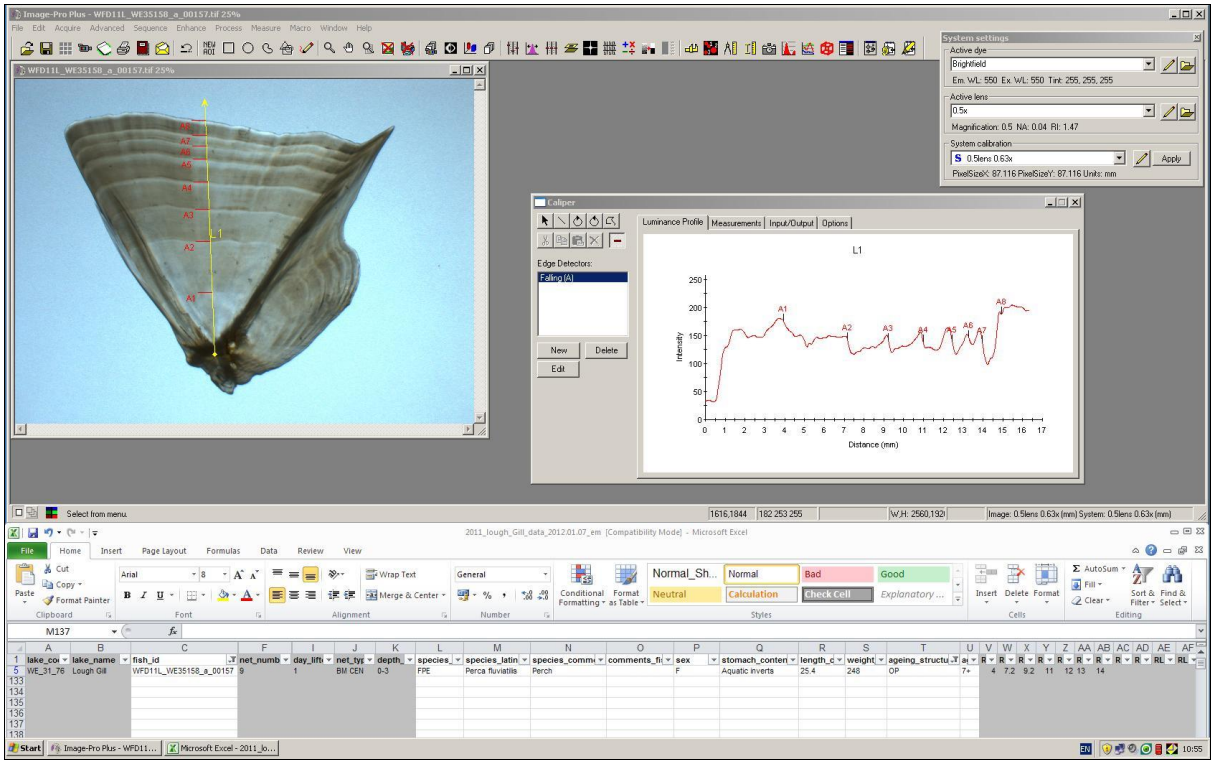

Plate 3.10. Opercular bone ageing using binocular microscope/digital camera system with Image Pro Plus software (a 7+ perch from Lough Gill)

Plate 3.11. Char otolith (4+) from Doo Lough, Co. Mayo

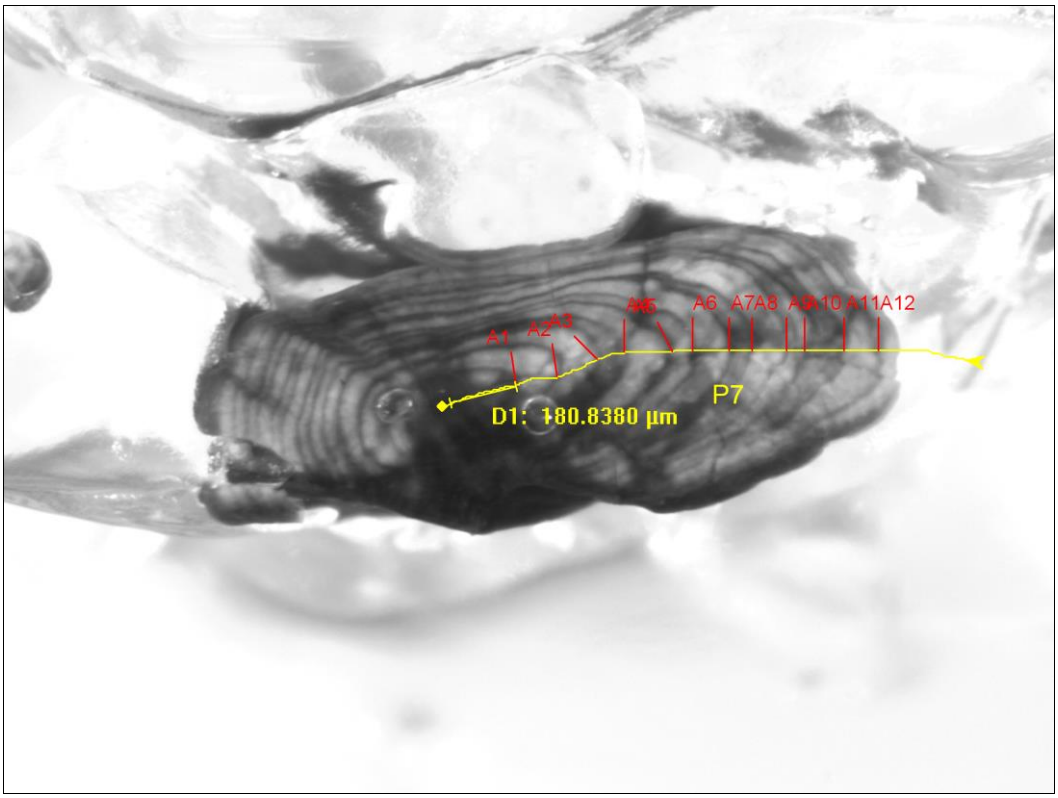

Plate 3.12. Eel otolith (12+) from Lough Derg

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 programme. All IFI WFD staff have been trained in electric fishing techniques, fish identification, sampling methods (including gill netting, seine netting, fyke netting and beam trawling), fish ageing, data analyses, off road driving and personal survival techniques.

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

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

3.6 Biosecurity - disinfection and decontamination procedures

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

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

3.7 Hydroacoustic technology: new survey method development

Hydroacoustics (or echo sounding) is the use of sound energy to remotely gather information from a water body by transmitting a pulse of sound into the water and assessing the position and strength of the returning echo. Hydroacoustic surveys have become a very useful tool in freshwater fish stock assessment, providing invaluable information on fish abundance, size distribution, spatial distribution and behaviour, whilst limiting the destructive use of gill nets. Plate 3.14 below shows a typical echo sounder setup for use in freshwater hydroacoustic fish surveys. Hydroacoustic surveys were carried out in 2012 on Lough Mask and Lough Derg 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 Transceivers (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 shoals of deep water fish and targeted ground-truth netting can then be used for species identification. Abundance estimates can subsequently be calculated from the acoustic data. Furthermore, the spatial distribution and size distribution of species of interest can also be assessed. These methods have been used 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).

These methods have recently been used in Lough Derg in 2012. Initial results indicate that the pollan population is currently at low levels, no large shoals were detected. However, as a result of this targeted approach, the continued presence of pollan was confirmed by ground-truth netting and 0+ and 1+ pollan were captured indicating reproductive success. An example of an echogram showing pollan in Lough Derg is shown in Figure 3.15. The maximum water depth is approximately 29m, with three distinct pollan echoes between 22m and 26m.

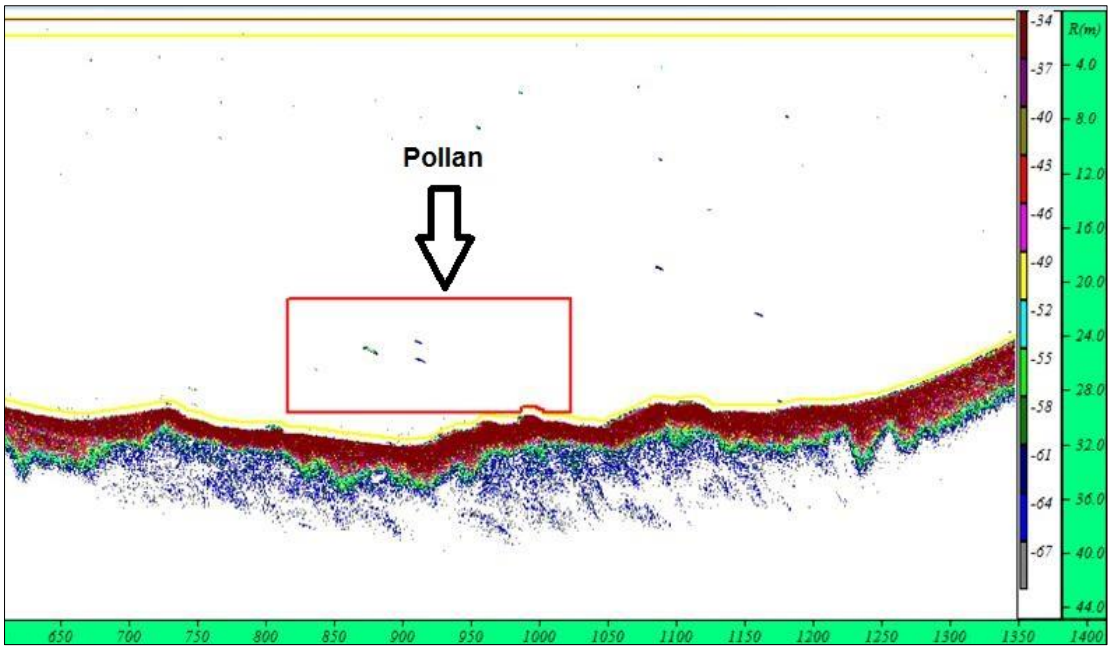

Fig. 3.15. Example of an echogram showing a pollan shoal from Lough Derg during post-processing

Further development in both hydroacoustic technology and survey methodology will see hydroacoustics play an increasing role in future WFD monitoring within IFI. 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, Killarney shad and Arctic char, as well as supporting a PhD which will incorporate hydroacoustic technology into existing standard sampling protocols used to assign ecological and conservation status for the Water Framework and Habitats Directive. Ongoing cooperation with other Member States in developing the CEN standard will help to progress this work. IFI staff participated in an intercalibration exercise of echosounders for monitoring fish in deep lakes in Lake Windermere, England in November 2011 in conjunction with other Member States (Winfield *et al.*, 2012).

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 23 lakes surveyed during 2012 is shown in Table 4.1 and Figure 4.1.

Table 4.1. List of fish species recorded in the 23 lakes surveyed during 2012

	Scientific name	Common name	Number of lakes	% of lakes
	NATIVE SPECIES			
1	*Anguilla anguilla*	Eel	22	95.6
2	*Salmo trutta*	Brown trout	17	73.9
3	*Gasterosteus aculeatus*	Three-spined stickleback	7	30.4
4	*Salmo salar*	Adult salmon	1	4.3
4	*Salmo salar*	Juvenile salmon	3	13.0
5	*Salvelinus alpinus*	Char	4	17.4
6	*Salmo trutta*	Sea trout*	2	8.7
7	*Coregonus autumnalis*	Pollan	1	4.3
	NON NATIVE SPECIES (influencing ecology)			
8	*Perca fluviatilis*	Perch	14	60.8
9	*Esox lucius*	Pike	13	56.5
10	*Rutilus rutilus*	Roach	7	30.4
11	*Abramis brama*	Bream	5	21.7
12	*Phoxinus phoxinus*	Minnow	2	8.7
13	*Oncorhynchus mykiss*	Rainbow trout	1	4.3
	NON NATIVE SPECIES (generally not influencing ecology)			
14	*Scardinius erythropthalmus*	Rudd	7	30.4
15	*Tinca tinca*	Tench	3	13.0
16	*Gobio gobio*	Gudgeon	1	4.3
	Hybrids			
	Rutilus rutilus x Abramis brama	Roach x bream hybrid	6	26.1

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

A total of 16 fish species (sea trout are included as a separate "variety" of trout) and one type of hybrid was recorded (Table 4.1). Eel was the most common fish species recorded, occurring in 22 out of the 23 lakes surveyed (95.6%). This was followed by brown trout, perch, pike and roach which were present in 73.9%, 60.8%, 56.5% and 30.4% of lakes respectively (Fig. 4.1).

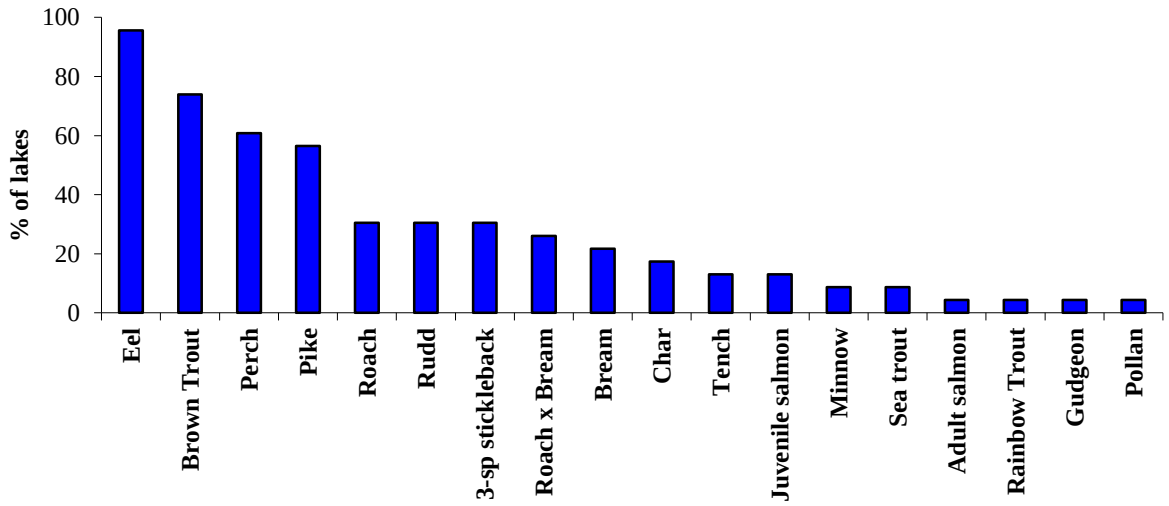

Fig. 4.1.Percentage of lakes surveyed for WFD fish surveillance monitoring during 2012 containing each fish species

Fish species richness (excluding hybrids) ranged from one species on Lough Tay, Co. Wicklow to a maximum of eight species on Lough Arrow, Co. Sligo (Table 4.2, Fig. 4.2). The highest number of native species (six species) was recorded in Doo Lough, Co. Mayo. Native species (Group 1) were present in all lakes surveyed, Group 2 species were present in 17 lakes and Group 3 species were present in 10 lakes (Table 4.2).

Table 4.2. Fish species richness in the 23 lakes surveyed for WFD fish monitoring during 2012

Lake	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Arrow	8	3	4	1
Derg	7	3	4	0
Mask	7	3	4	0
Muckanagh	7	3	2	2
Muckno	7	2	4	1
Cullin	6	3	2	1
Doo	6	6	0	0
Alewnaghta	5	1	4	0
Carra	5	3	2	0
Cullaun	5	2	2	1
White	5	1	3	1
Anure	4	3	1	0
Bunny	4	1	2	1
Dromore	4	1	2	1
Gur	4	1	2	1
Inchicronan	4	1	2	1
Kindrum	4	4	0	0
Sessiagh	4	4	0	0
Dungloe	4	4	0	0
Cam	3	2	1	0
Dan	3	2	1	0
Nasnahida	2	2	0	0
Tay	1	1	0	0

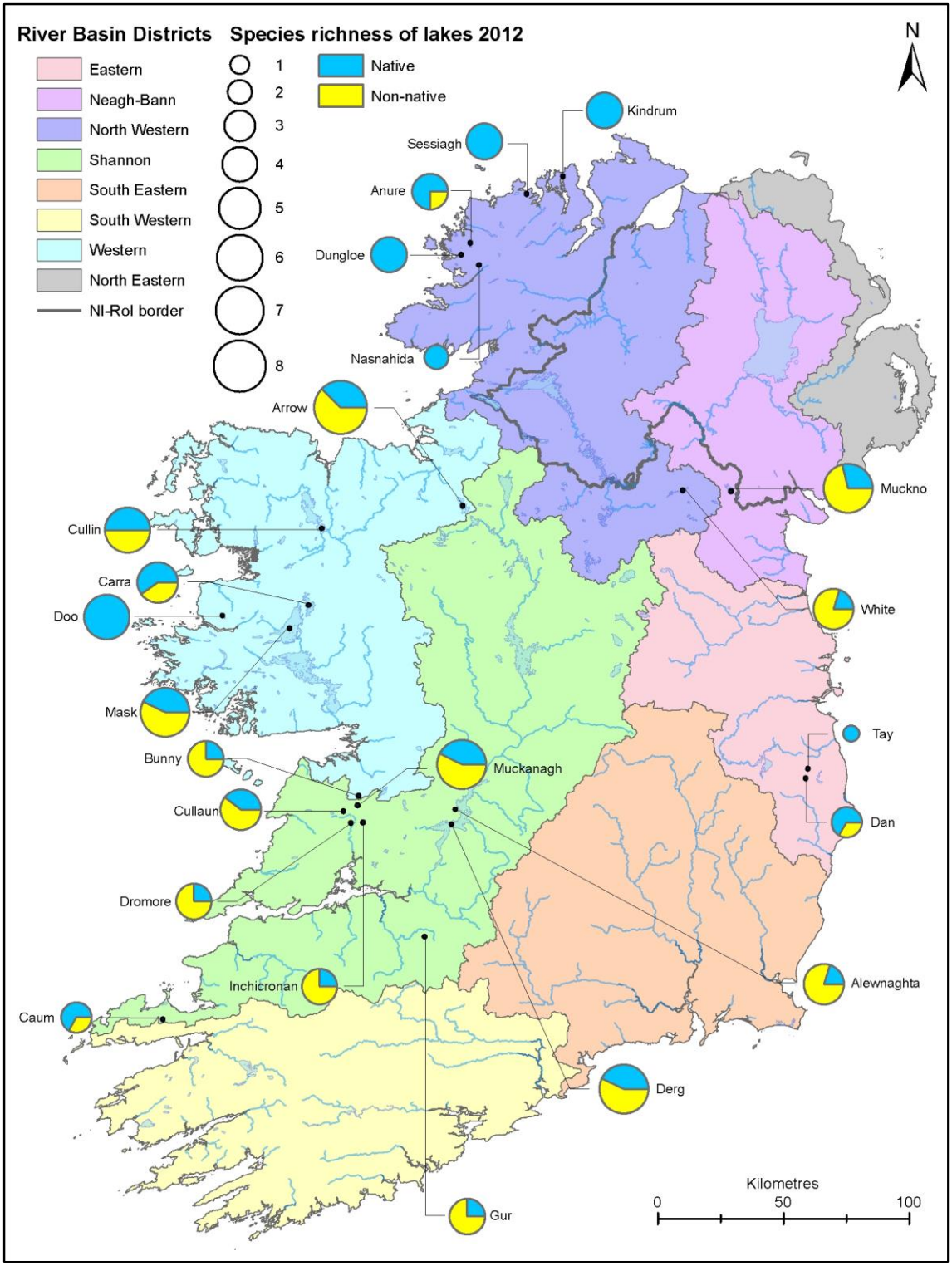

Fig. 4.2. Fish species richness in the 23 lakes surveyed for WFD fish monitoring during 2012

4.1.2 Fish species distribution

The distribution and abundance of each fish species amongst all lakes surveyed during 2012 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 22 out of 23 lakes surveyed (Fig. 4.3). In general, salmonids were more abundant towards the north-west, west, south-west and eastern areas of the country (Figs. 4.4 to 4.7). Sea trout were present in two lakes in the west and north-west, Doo Lough and Dunglow Lough (Fig. 4.5). Juvenile salmon were recorded in three lakes (Lough Anure, Doo Lough and Dunglow Lough) and adult salmon in one lake (Doo Lough) (Fig. 4.6). Char were recorded in four lakes in the NWIRBD and WRBD (Kindrum Lough, Lough Sessiagh, Doo Lough and Lough Mask) (Fig. 4.7). Three-spined stickleback were also mainly restricted to the west and north-west of the country, being present in four lakes in the WRBD, two in the NWIRBD and one lake in the ShIRBD (Fig. 4.8).

The native Irish lake fish fauna has been augmented by the introduction of a large number of non-native species, introduced either deliberately, accidentally or through careless management, e.g. angling activities, aquaculture and the aquarium trade. Many non-native species have become established in the wild, the most widespread including pike, perch, roach, rudd and bream. The status of these species varies throughout Ireland, with much of the north-west and many areas in the west, south-west and east of Ireland still free from non-native species (Figs. 4.9 to 4.15). Perch, followed by pike were the most widely distributed non-native species recorded during the 2012 surveillance monitoring programme, with perch (Fig. 4.9) being present in 14 lakes and pike (Fig. 4.10) being present in 13 of the 23 lakes surveyed. Roach were captured in seven lakes (three in the WRBD, two in the ShIRBD, one in the NBIRBD and one in the NWIRBD) (Fig. 4.11). Rudd were recorded in seven lakes (five lakes within the ShIRBD and two in the WRBD) (Fig. 4.12). Bream were recorded in five lakes, roach x bream hybrids were recorded in six lakes and tench were recorded in three lakes (Figs. 4.13 to 4.15).

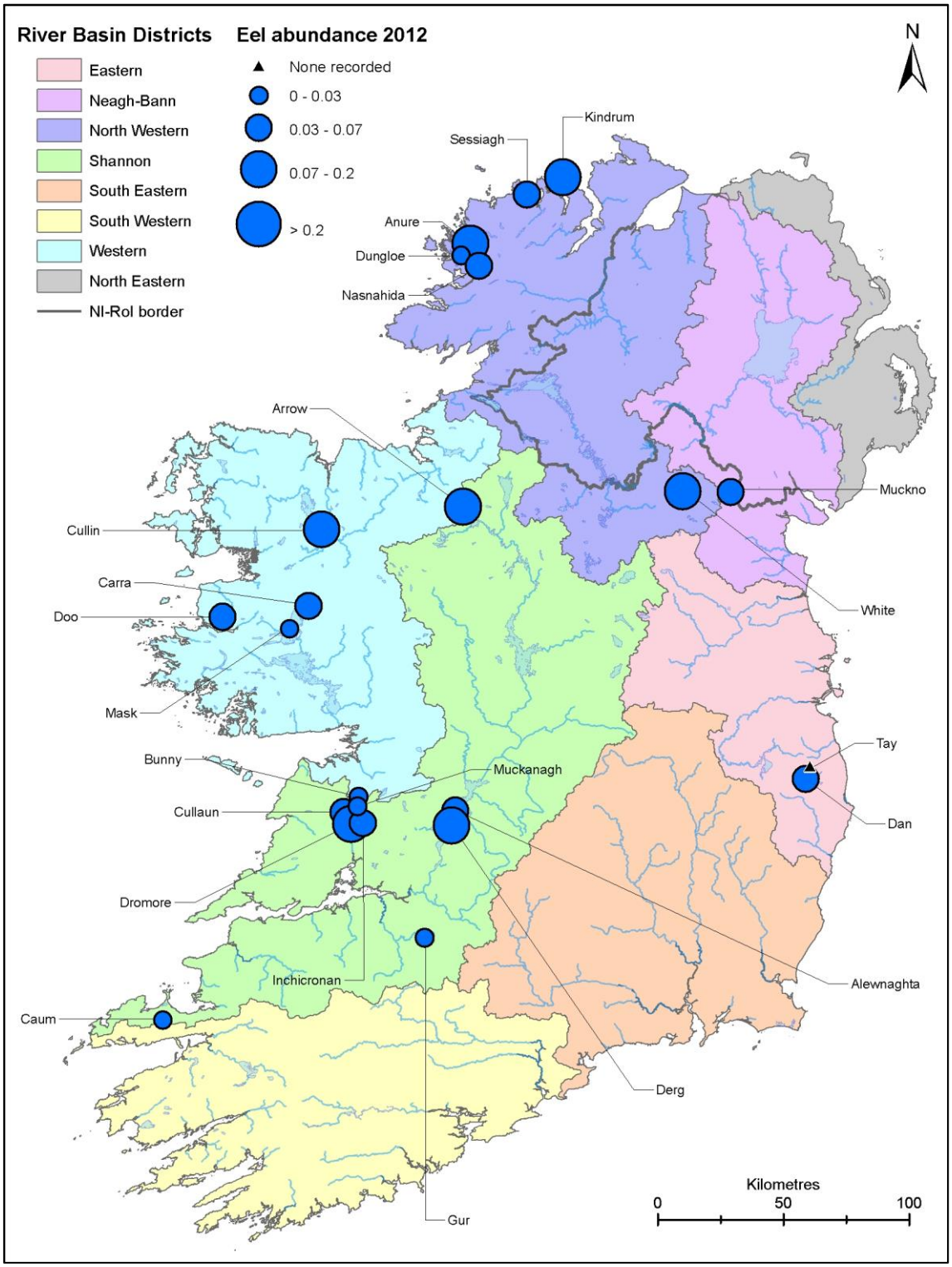

Fig. 4.3. Eel distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

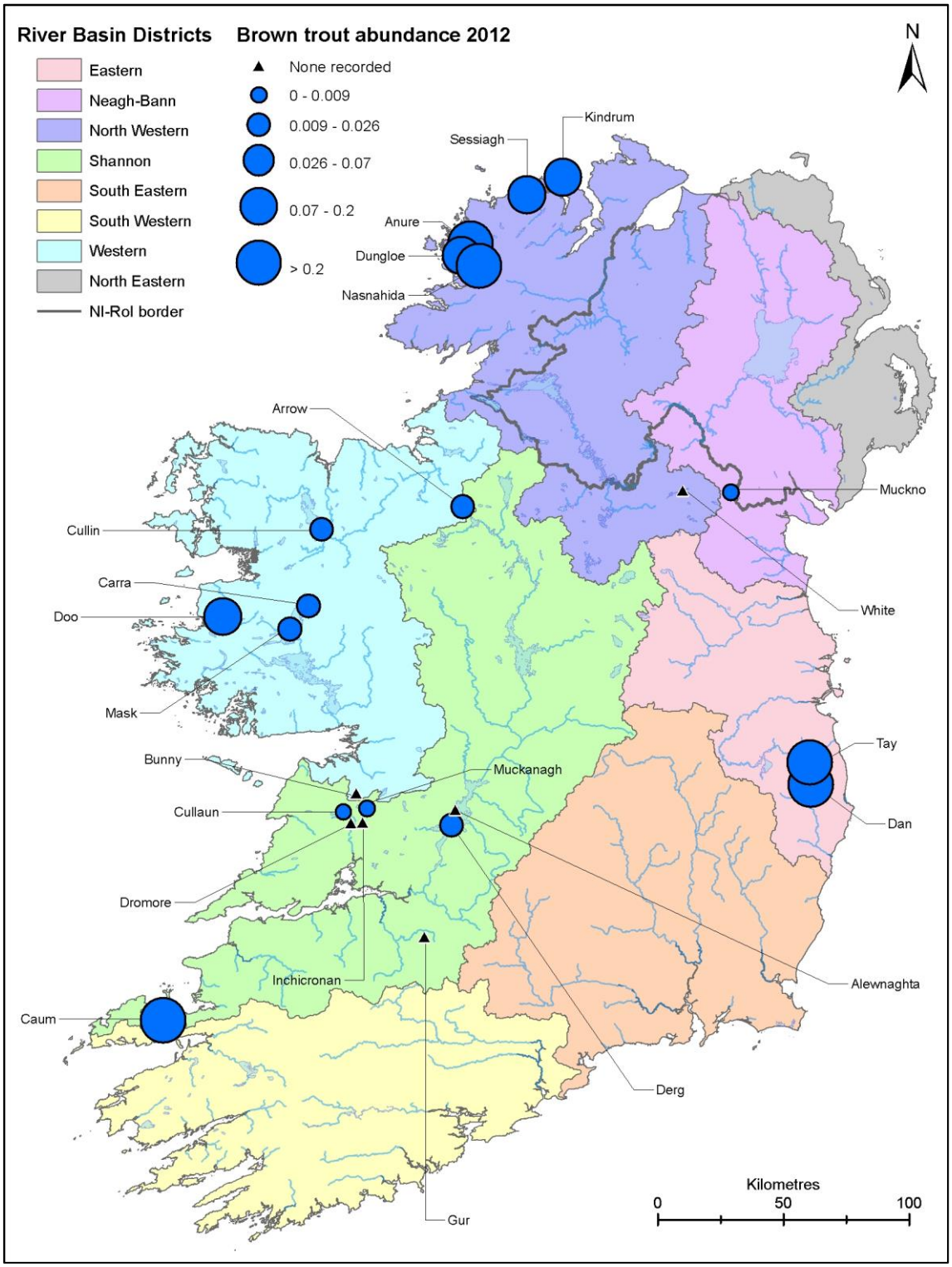

Fig. 4.4. Brown trout distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

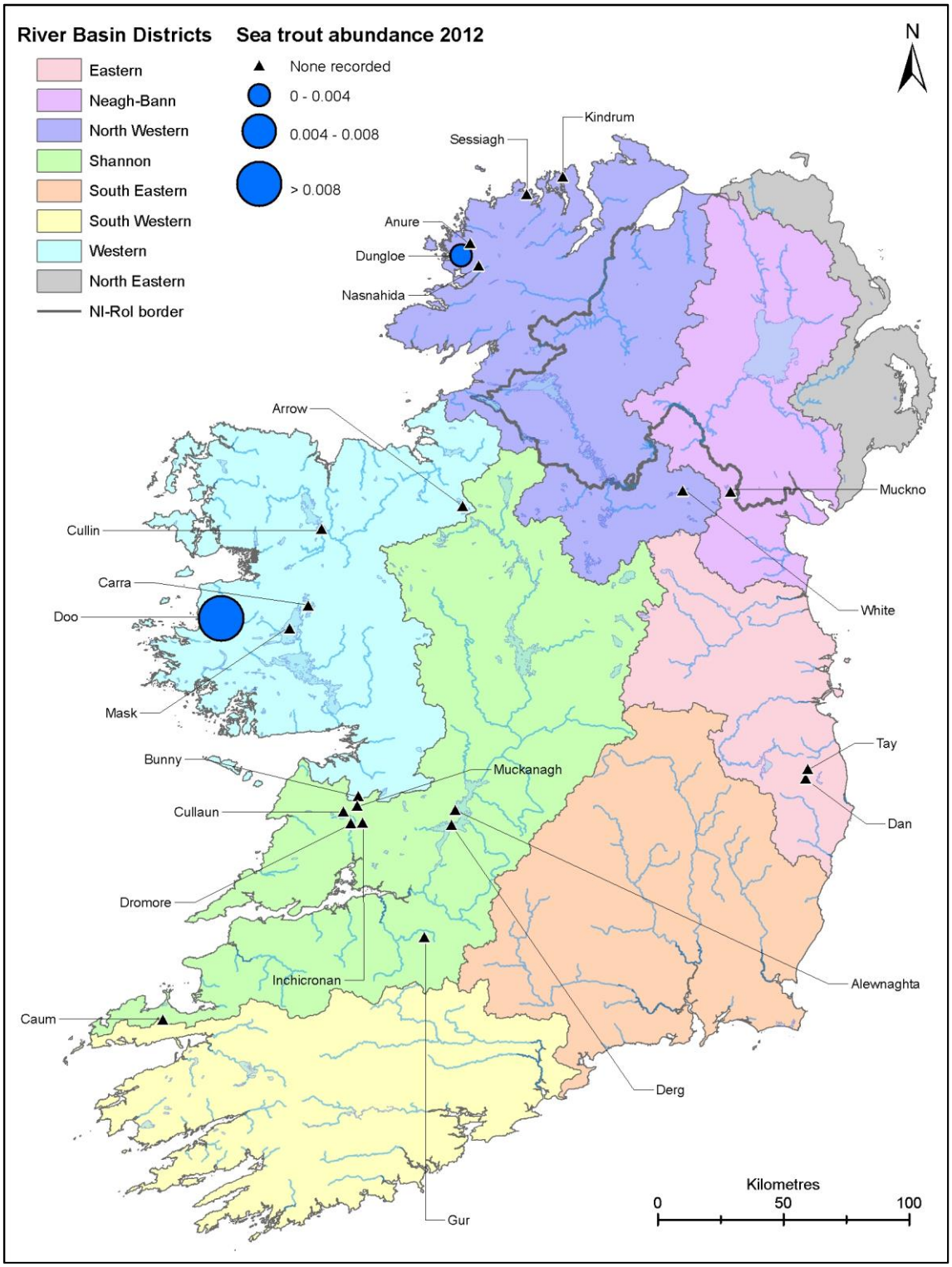

Fig. 4.5. Sea trout distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

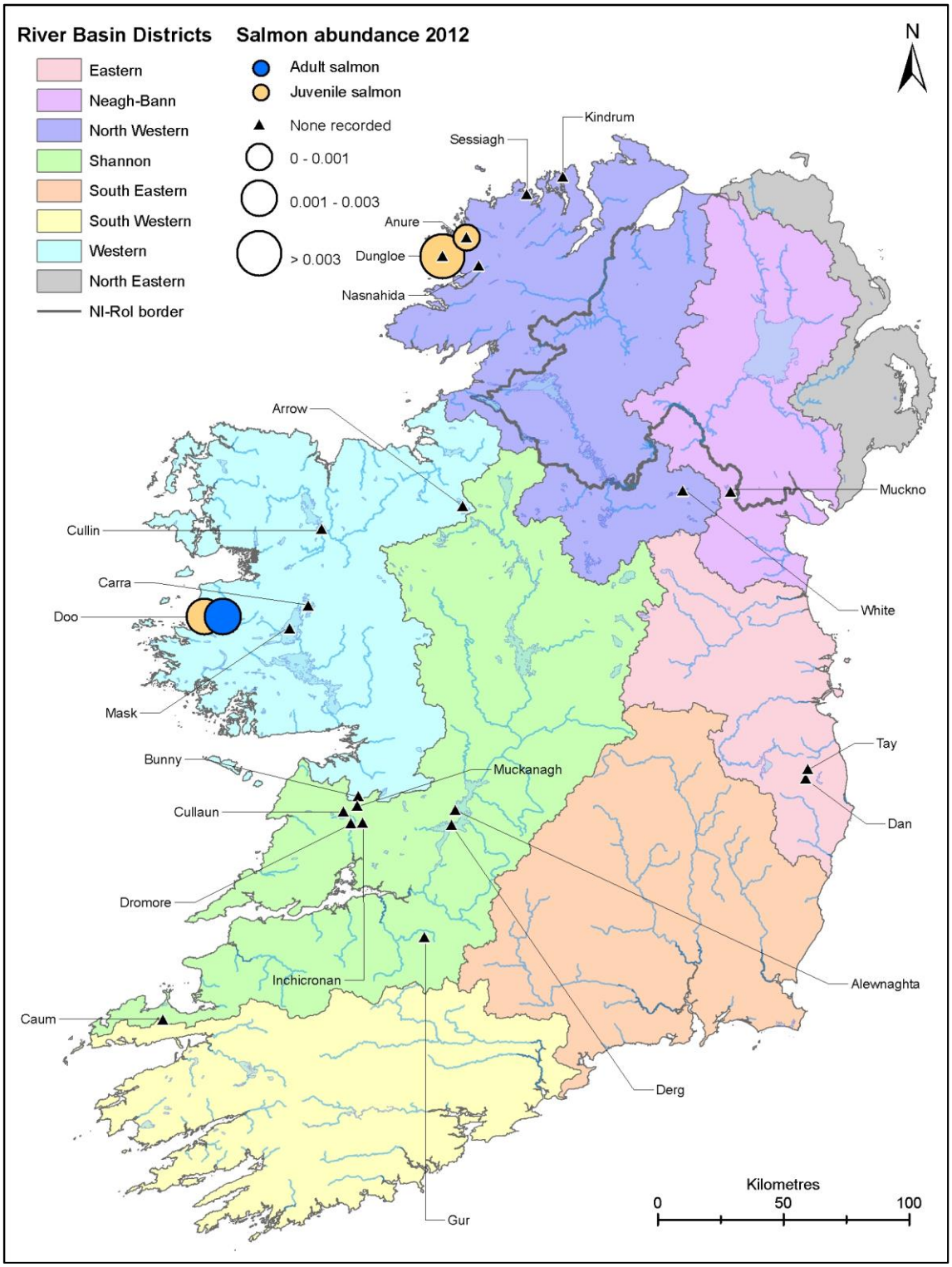

Fig. 4.6. Salmon distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

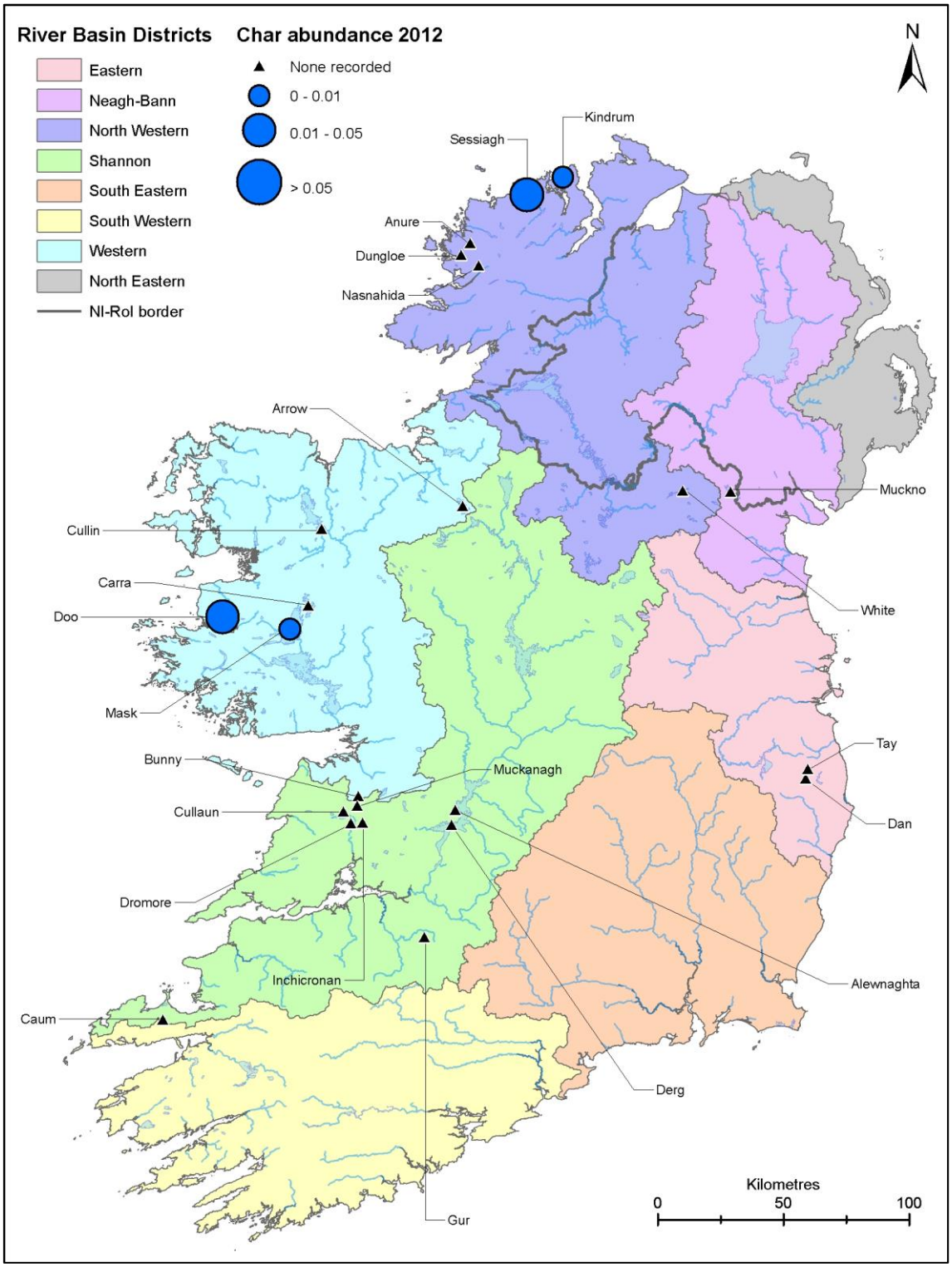

Fig. 4.7. Char distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

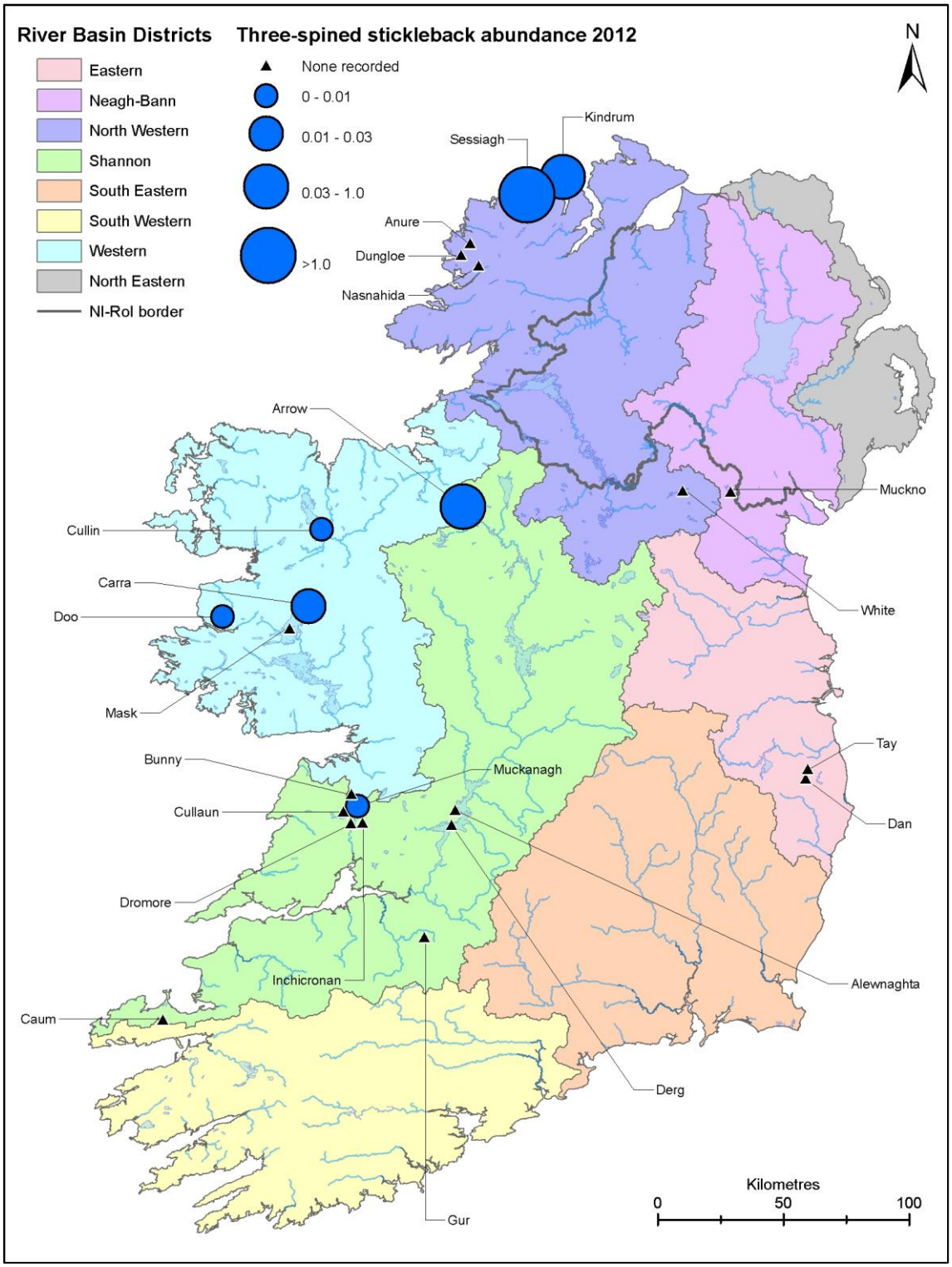

Fig. 4.8. Three-spined stickleback distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

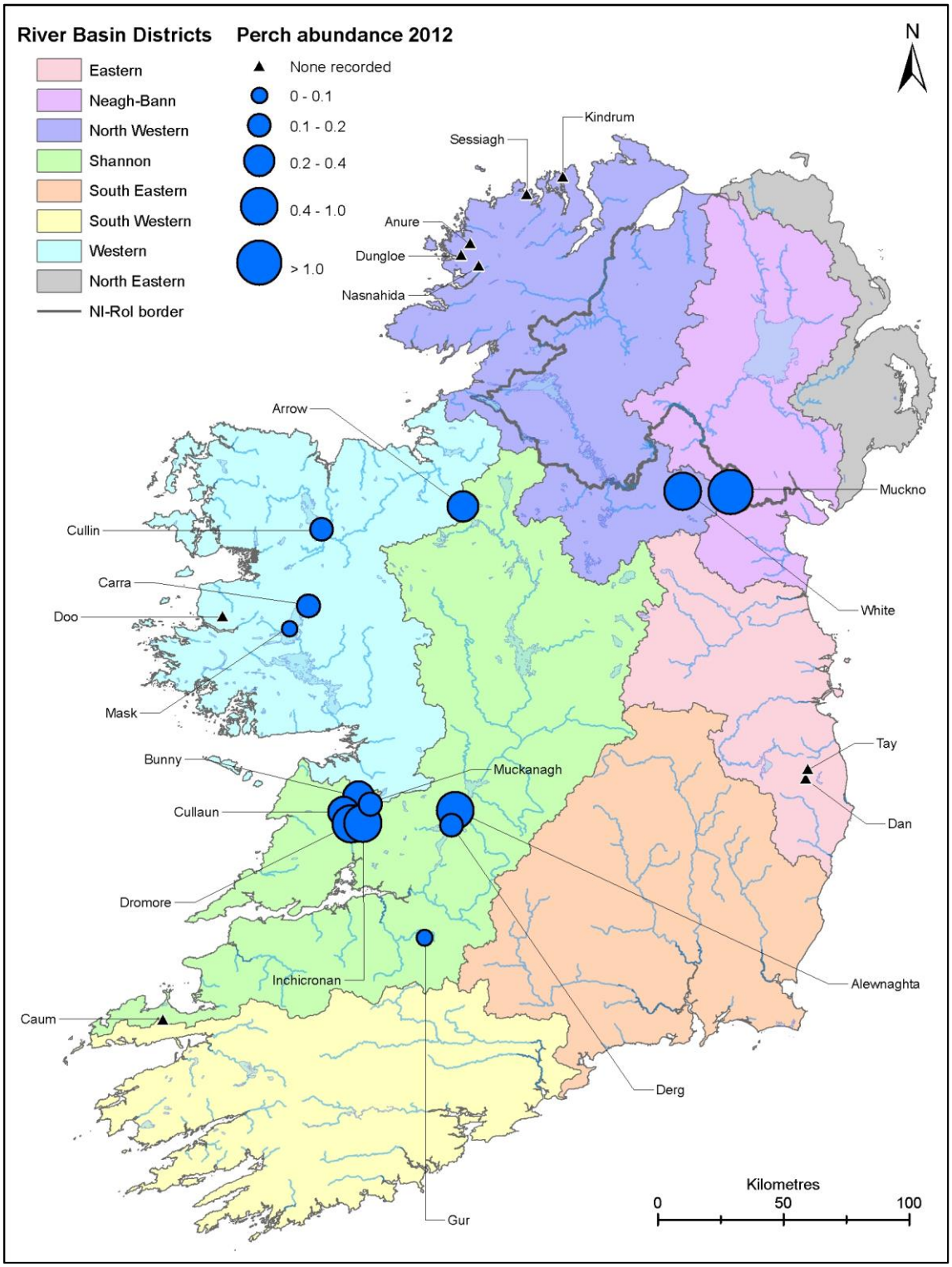

Fig. 4.9. Perch distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

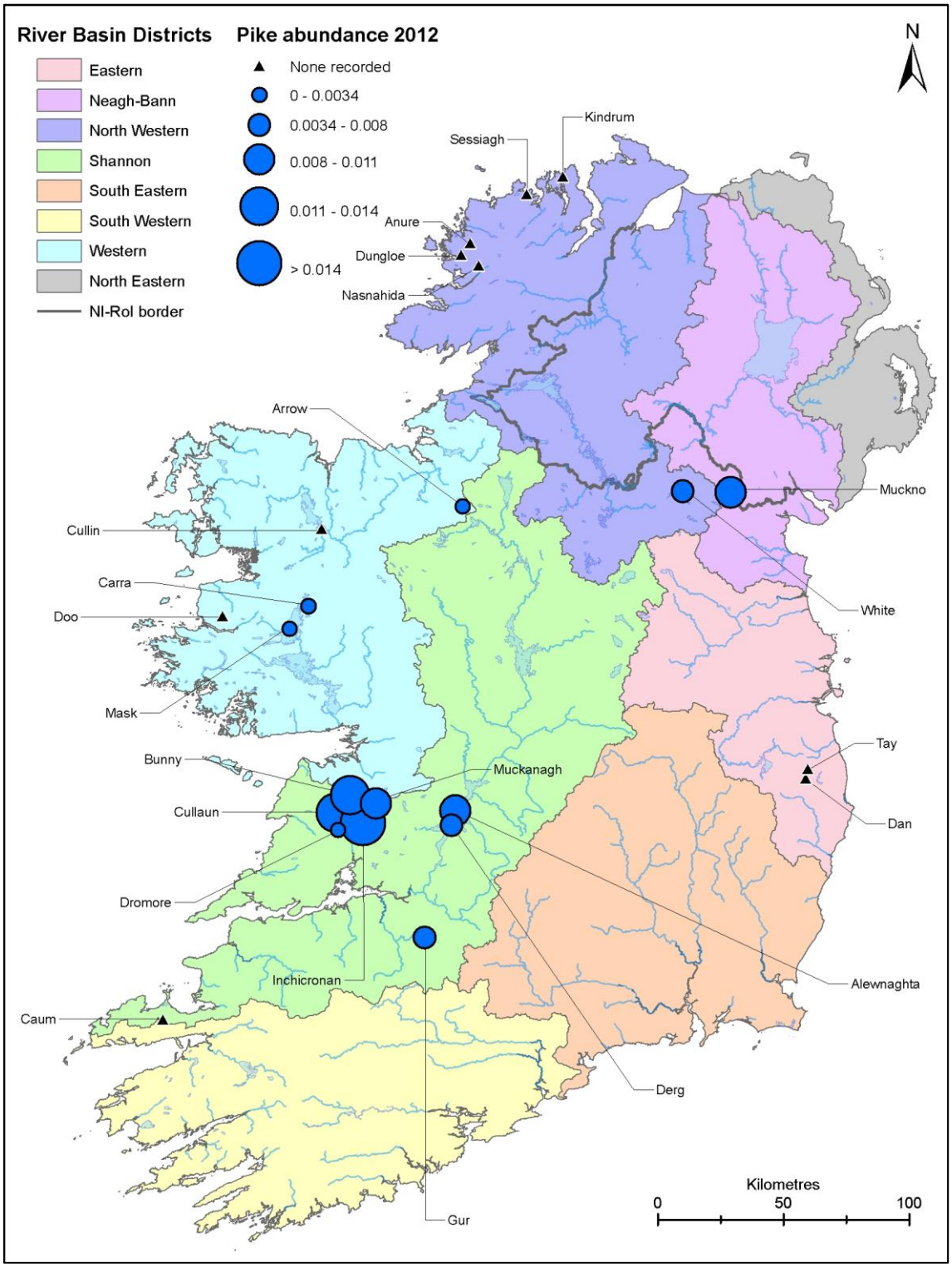

Fig. 4.10. Pike distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

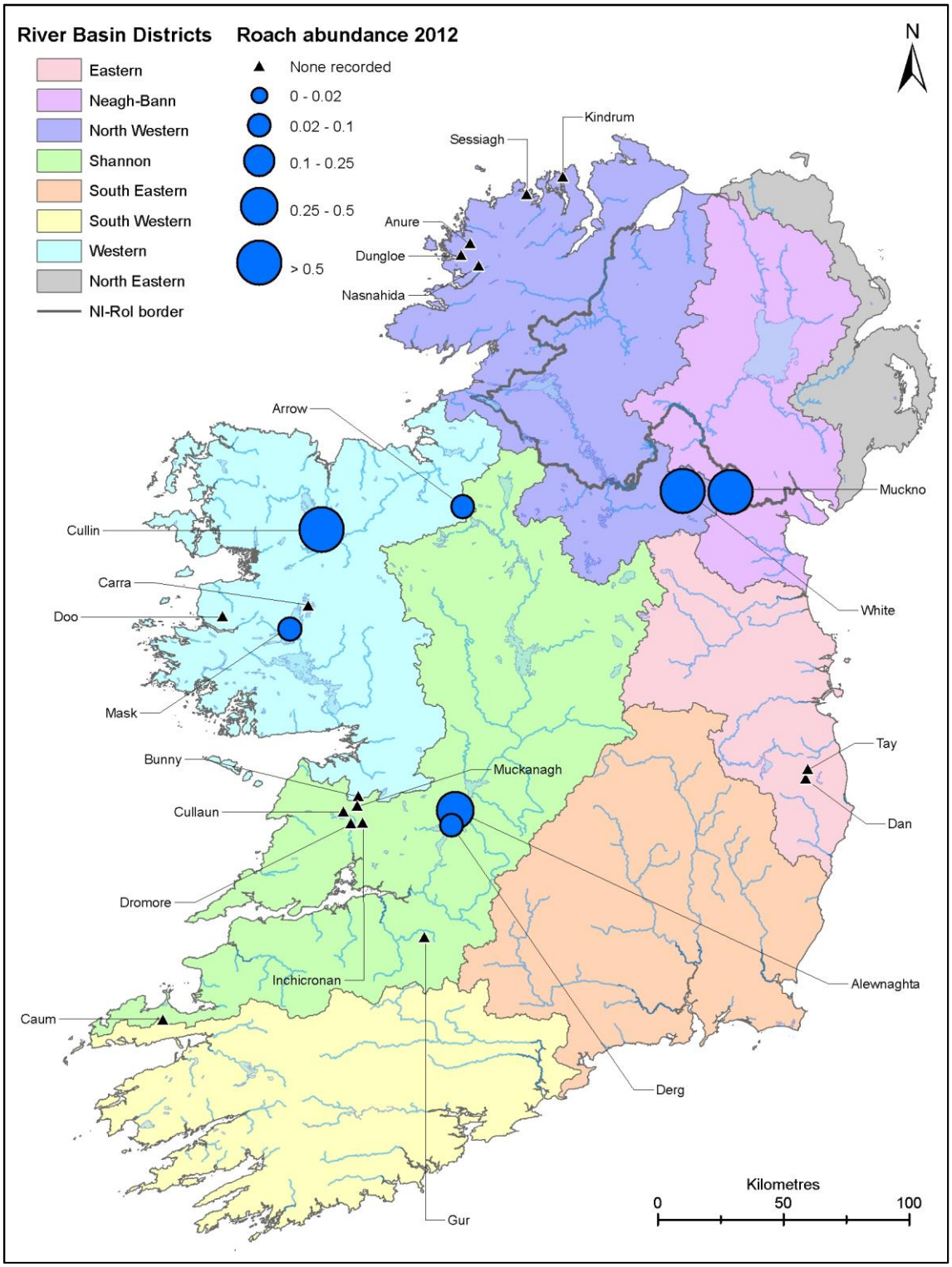

Fig. 4.11 Roach distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

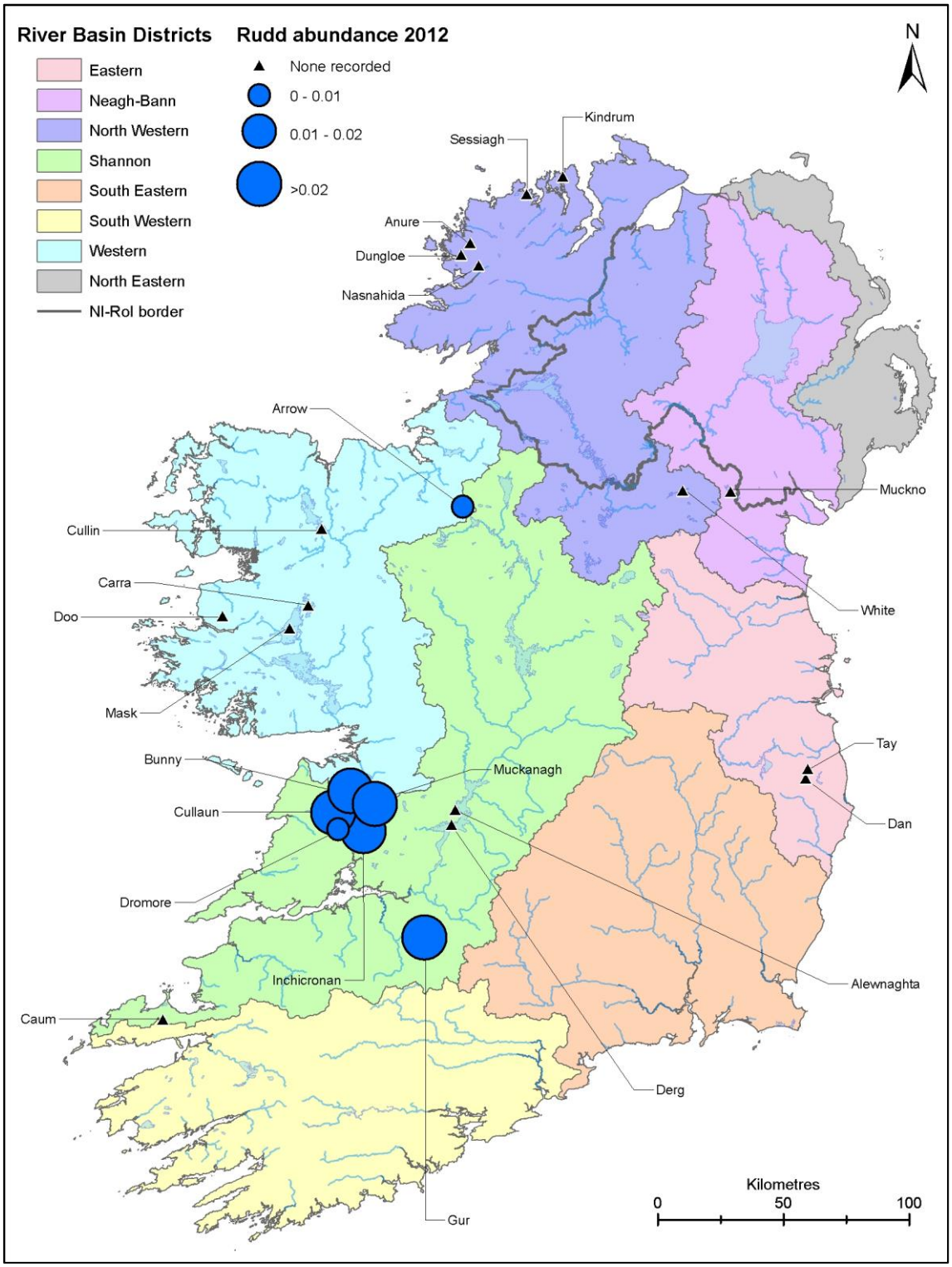

Fig. 4.12. Rudd distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

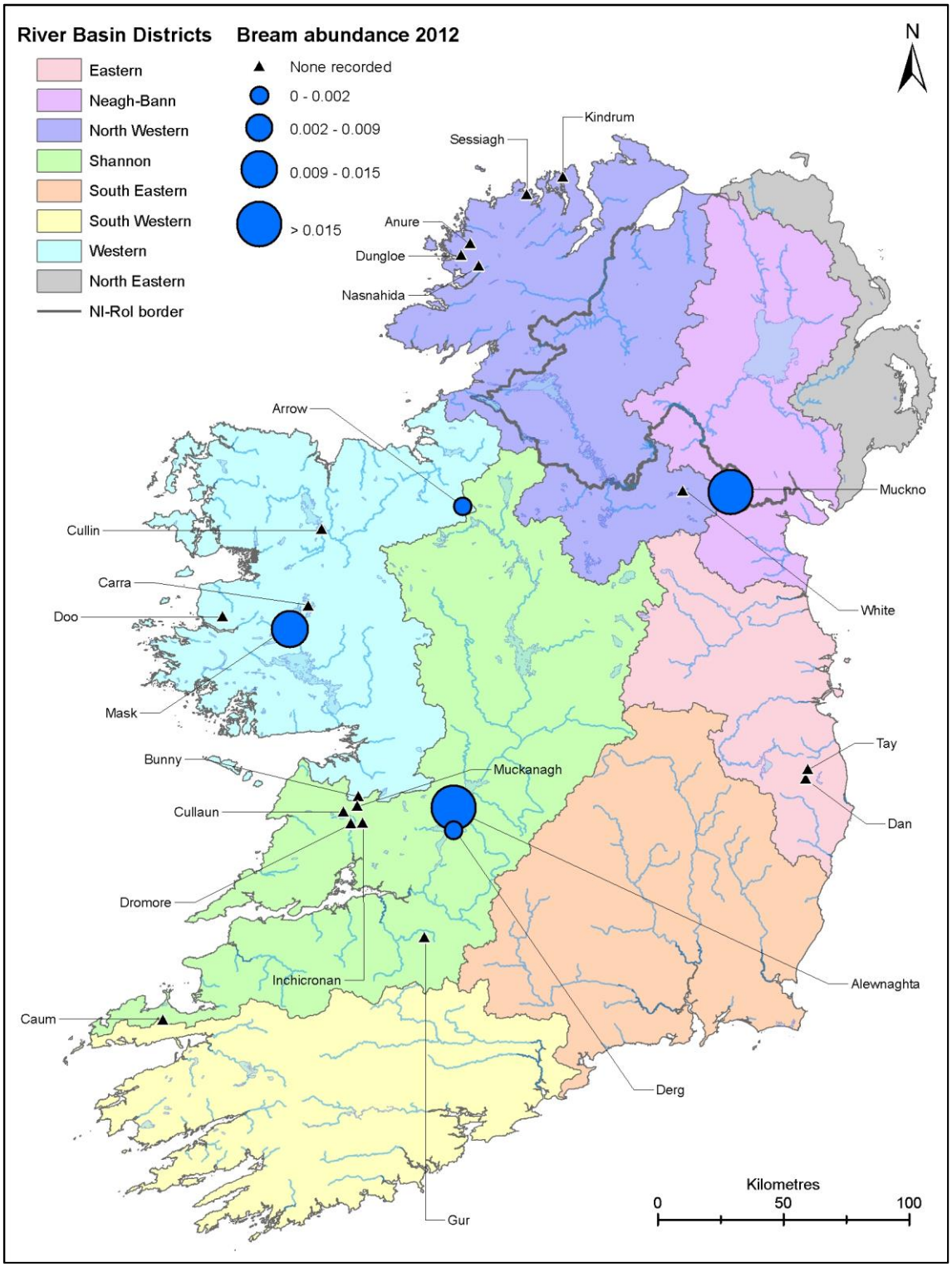

Fig. 4.13. Bream distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

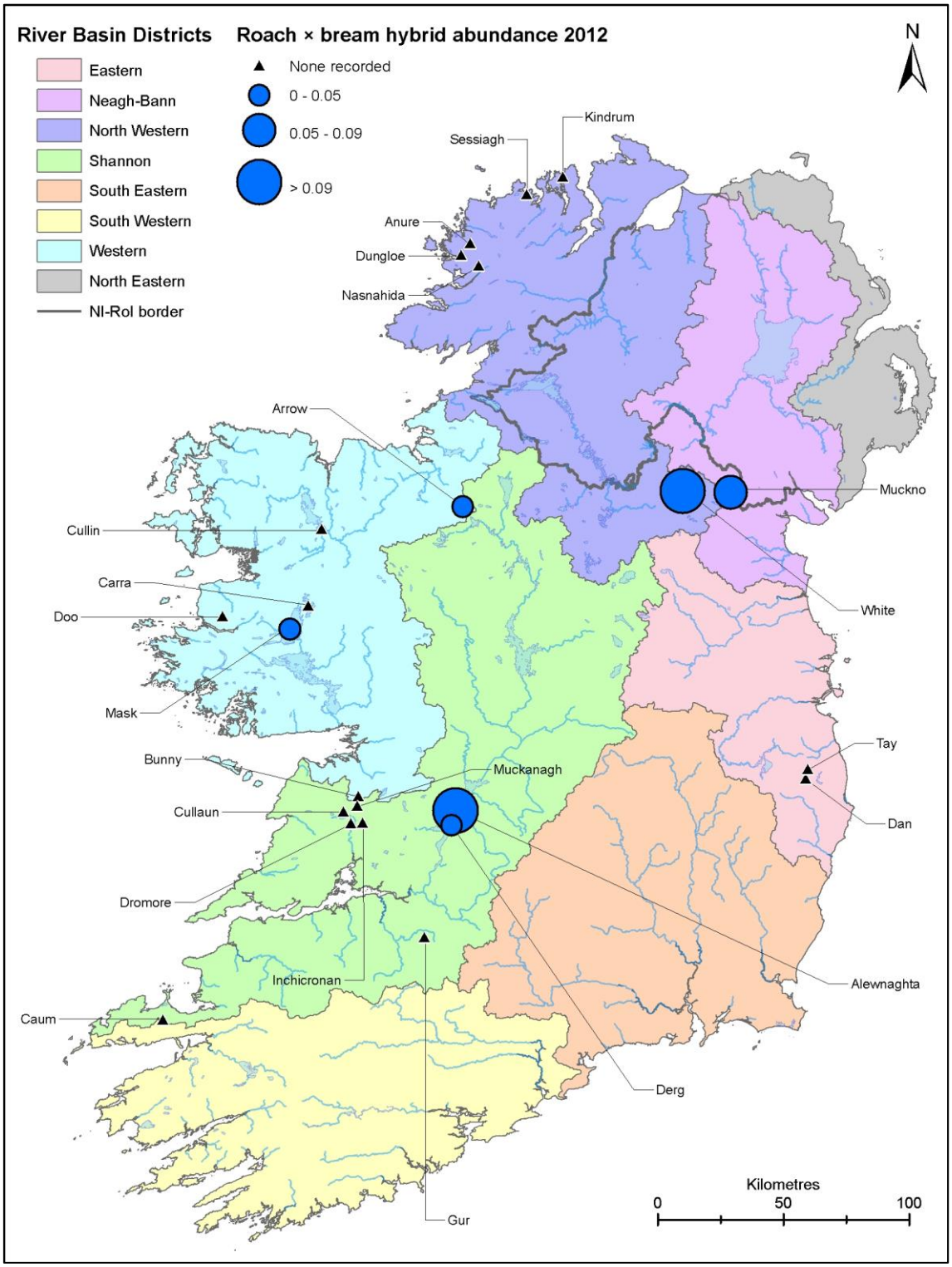

Fig. 4.14. Roach × bream hybrid distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

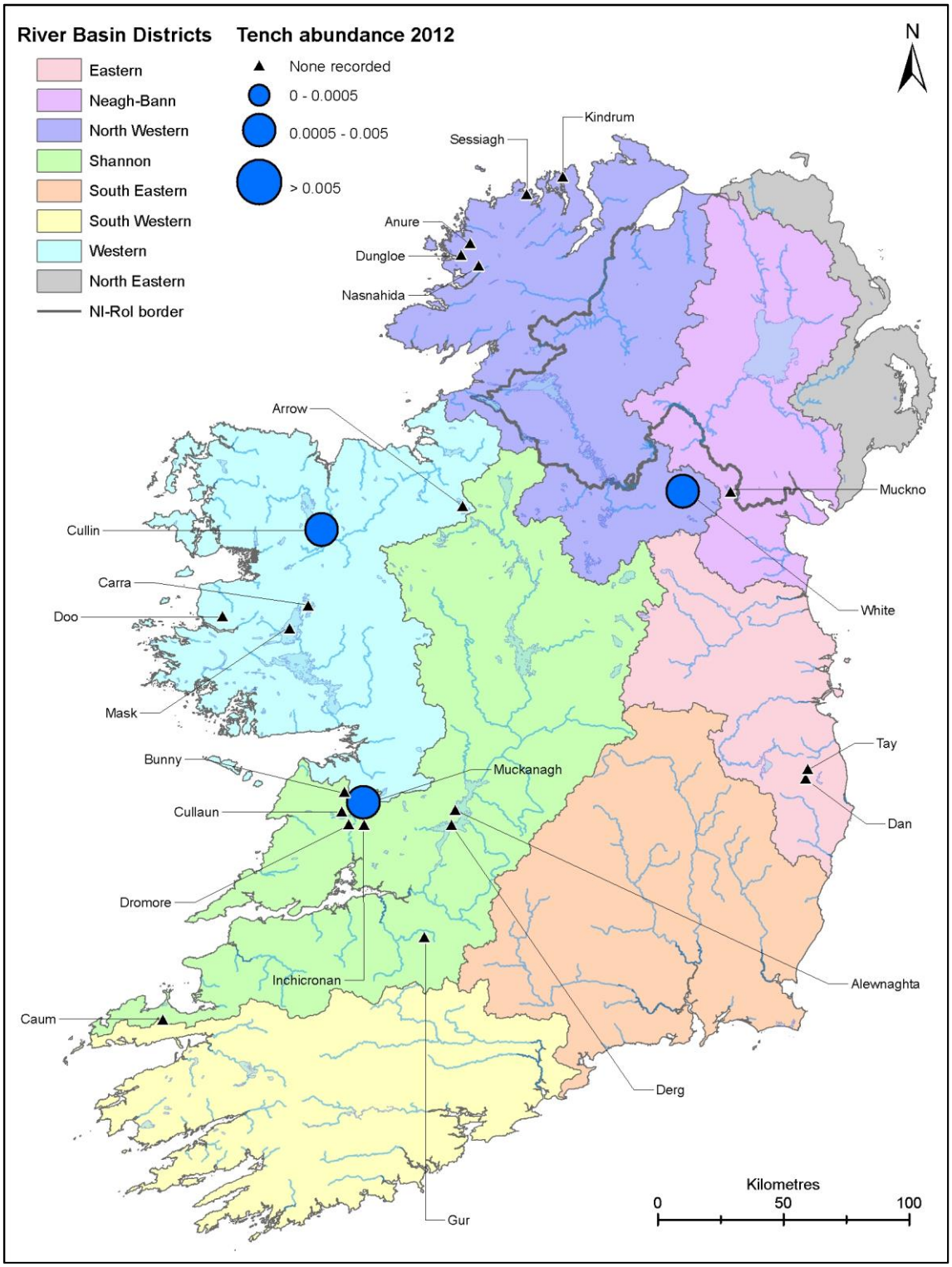

Fig. 4.15. Tench distribution and abundance (CPUE) in lakes surveyed for WFD fish monitoring during 2012

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 2012 surveillance monitoring programme are shown in Figures 4.16 to 4.37.

The highest abundance of eels amongst all lakes surveyed during 2012 was recorded in Lough Cullin (a high alkalinity lake in Co. Mayo) and Lough Arrow (a high alkalinity lake in Co. Sligo) had the highest biomass of eels amongst all lakes surveyed (Figs. 4.16 and 4.17).

Overall the highest abundance of brown trout was recorded in Lough Caum (a low alkalinity lake in Co. Kerry) and the highest biomass of brown trout was recorded in Lough Dan (a low alkalinity lake in Co. Wicklow) (Figs. 4.18 and 4.19).

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

Doo Lough (a low alkalinity lake in Co. Mayo) also had the highest abundance of char and the highest biomass of char was recorded in Lough Sessiagh (a moderate alkalinity lake in Co. Donegal) (Figs. 4.22 and 4.23).

Lough Muckno (a moderate alkalinity lake in Co. Monaghan) had the highest perch abundance and the highest perch biomass was recorded in White Lough (a moderate alkalinity lake in Co. Monaghan) (Figs. 4.24 and 4.25).

Lough Muckno (a moderate alkalinity lake in Co. Monaghan) also had the highest roach abundance and the highest roach biomass was recorded in Lough Cullin (a moderate alkalinity lake in Co. Mayo) (Figs. 4.26 and 4.27).

Inchicronan Lough (a high alkalinity lake in Co. Clare) had the highest pike abundance and the highest pike biomass was recorded in Lough Alewnaghta (a moderate alkalinity lake in Co. Clare) (Figs. 4.28 and 4.29).

Bream abundance and biomass was highest in Lough Muckno (a moderate alkalinity lake in Co. Monaghan) (Figs. 4.30 and 4.31).

White Lough (a moderate alkalinity lake in Co. Monaghan) had both the highest abundance and the highest biomass of tench amongst the three lakes where tench were recorded (Figs. 4.32 and 4.33).

The highest abundance and biomass of rudd was recorded in Lough Gur (a high alkalinity lake in Co. Limerick) (Figs. 4.34 and 4.35).

The highest abundance of roach x bream hybrids was recorded in White Lough (a moderate alkalinity lake in Co. Monaghan) and the highest biomass of roach x bream hybrids was in Lough Alewnaghta (a moderate alkalinity lake in Co. Clare) (Figs. 4.36 and 4.37).

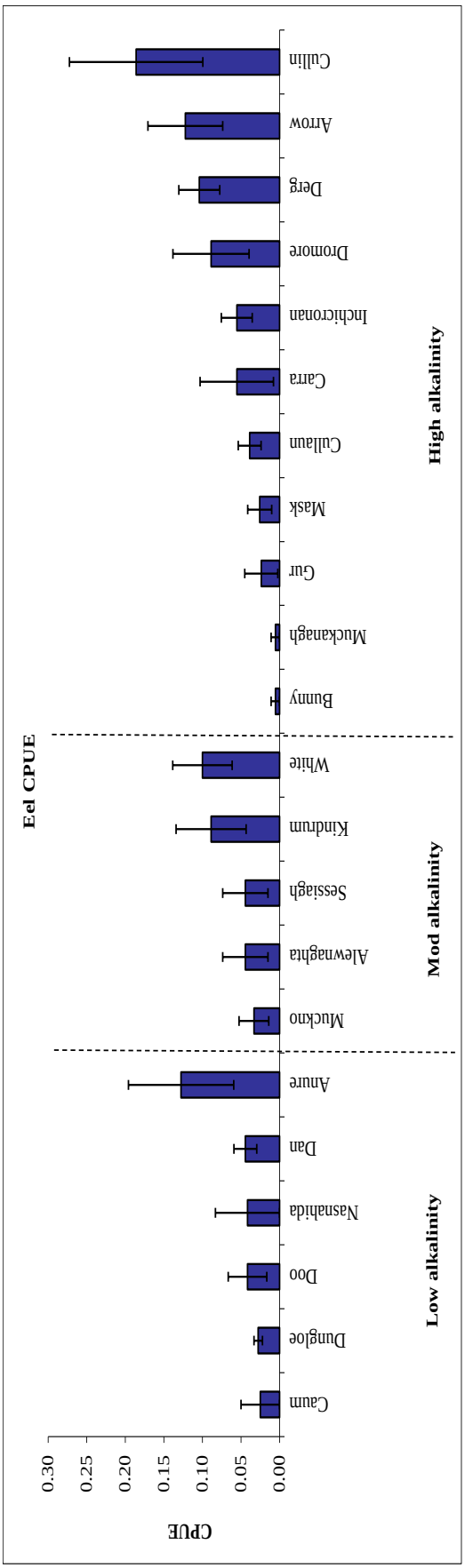

Fig. 4.16. Eel abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

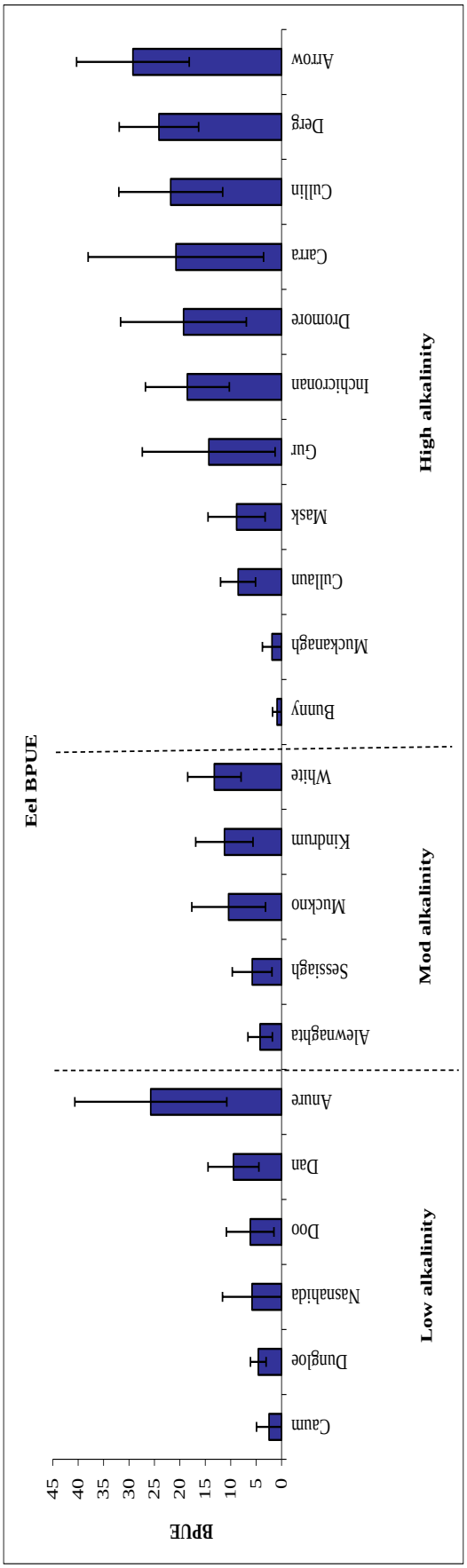

Fig. 4.17. Eel biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

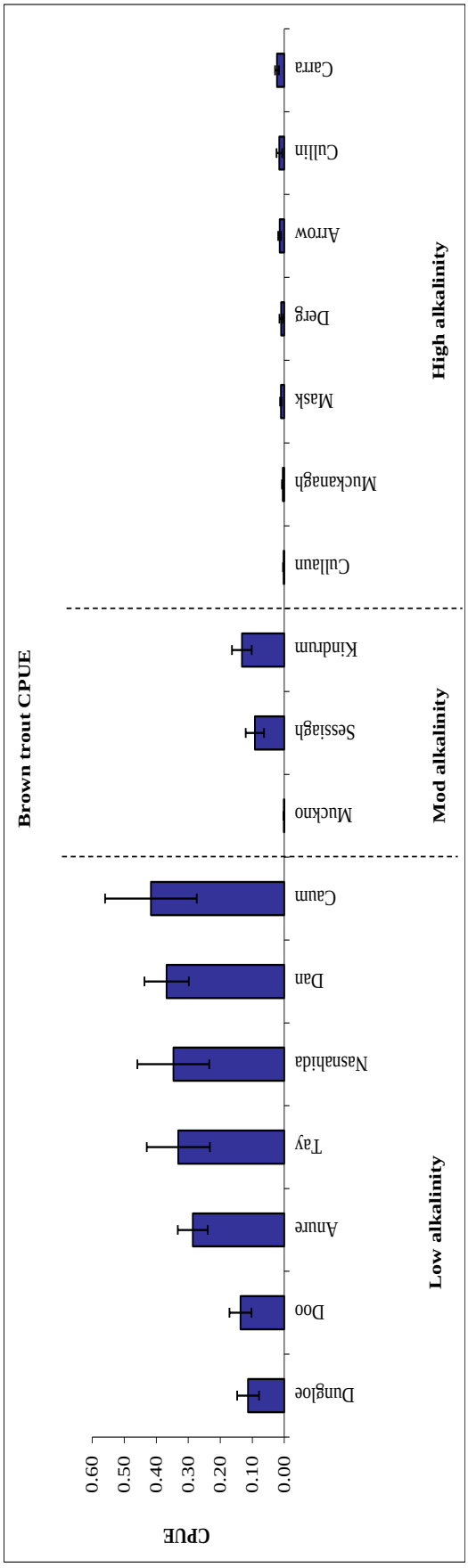

Fig. 4.18. Brown trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

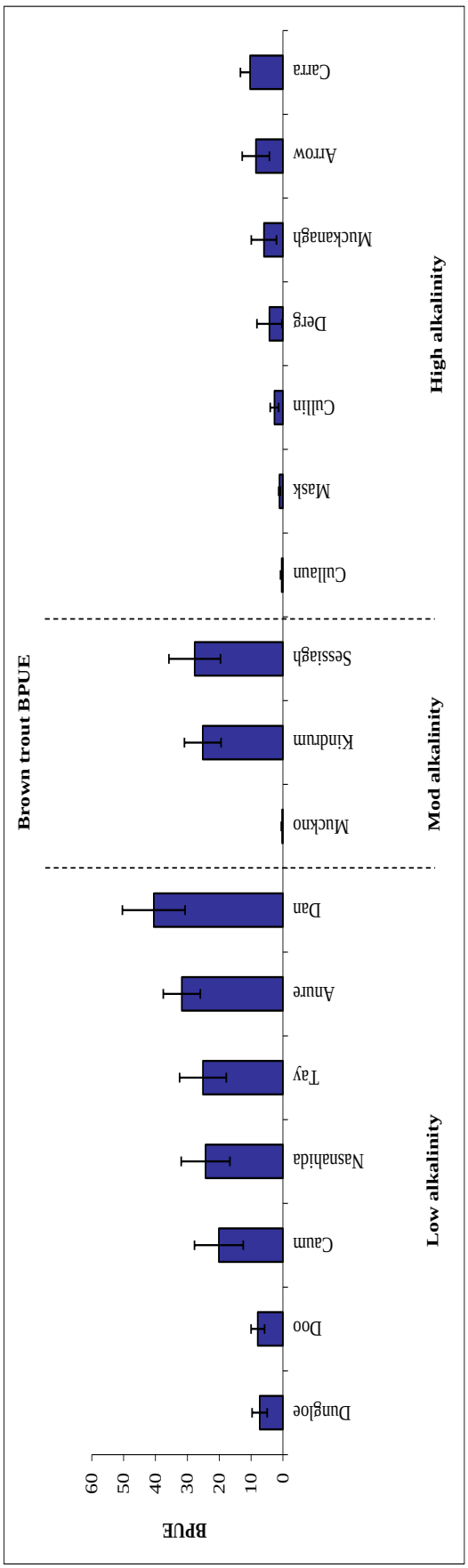

Fig. 4.19. Brown trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

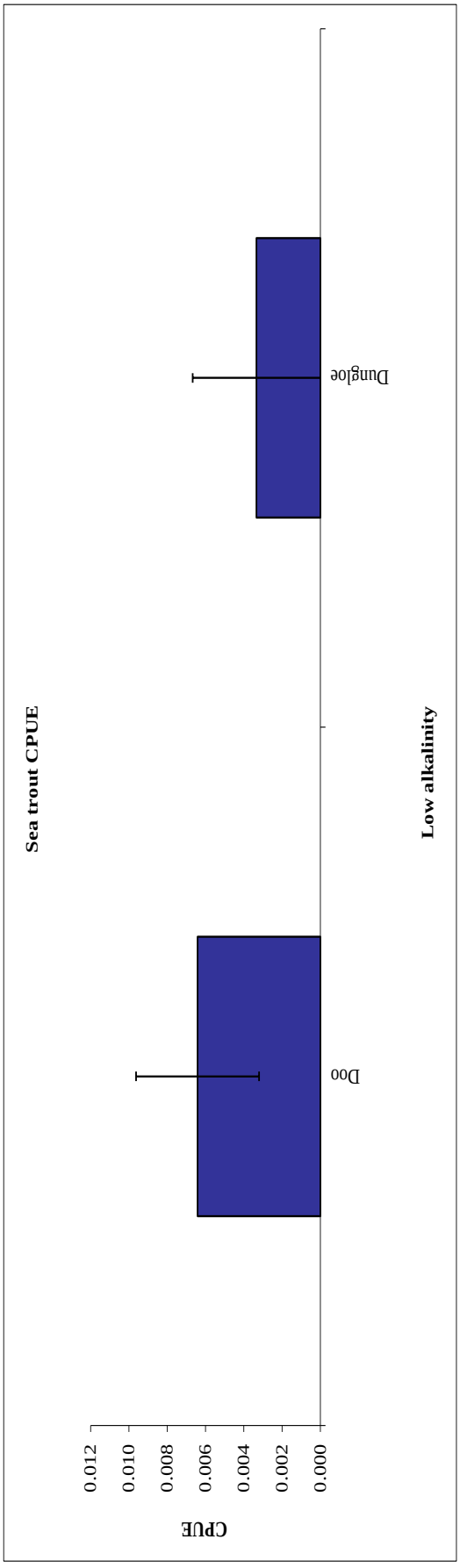

Fig. 4.20. Sea trout abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

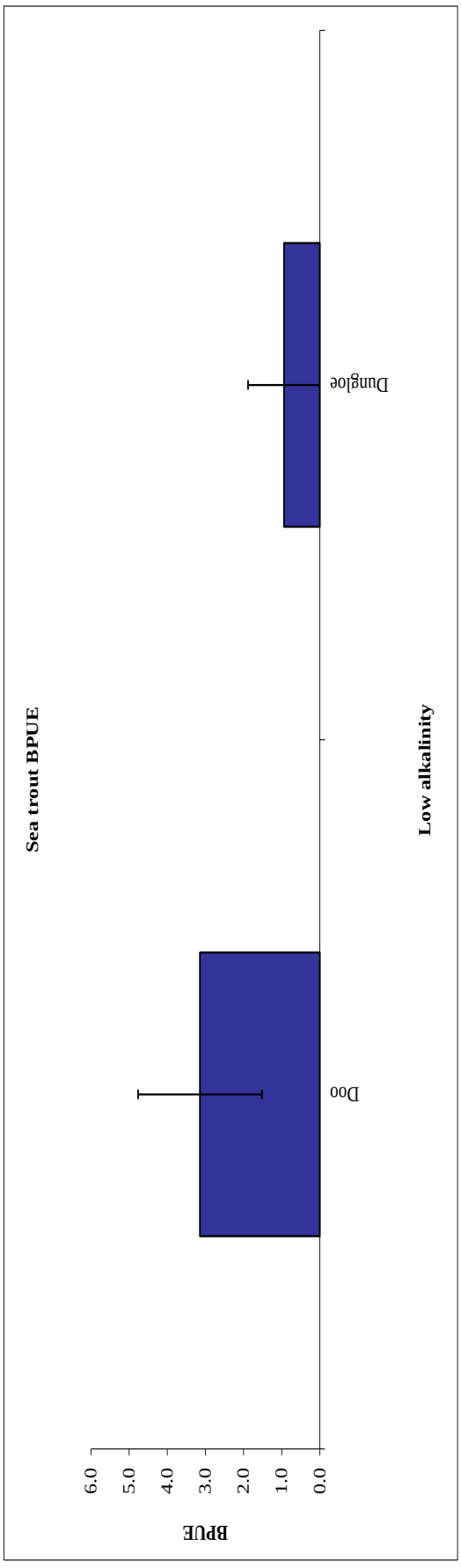

Fig. 4.21. Sea trout biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

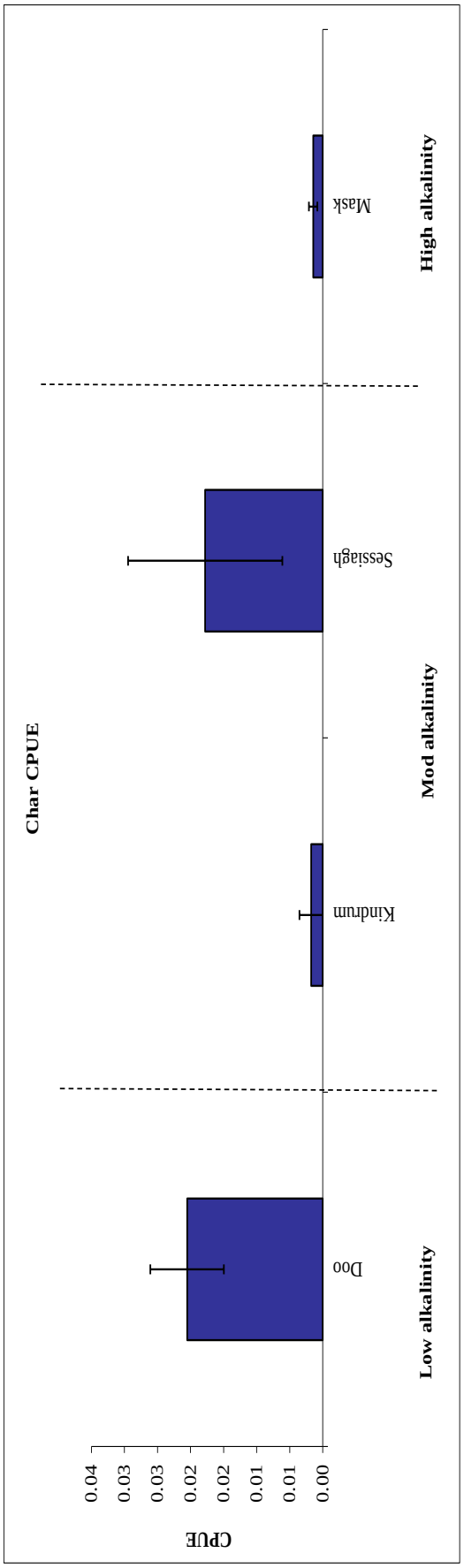

Fig. 4.22. Char abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

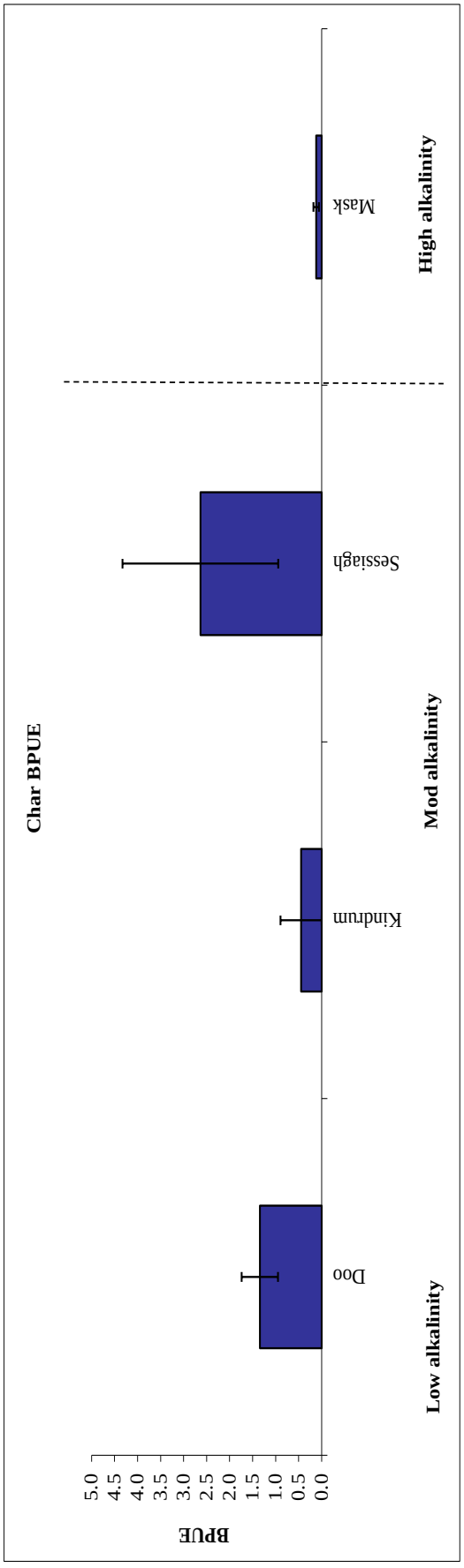

Fig. 4.23. Char biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

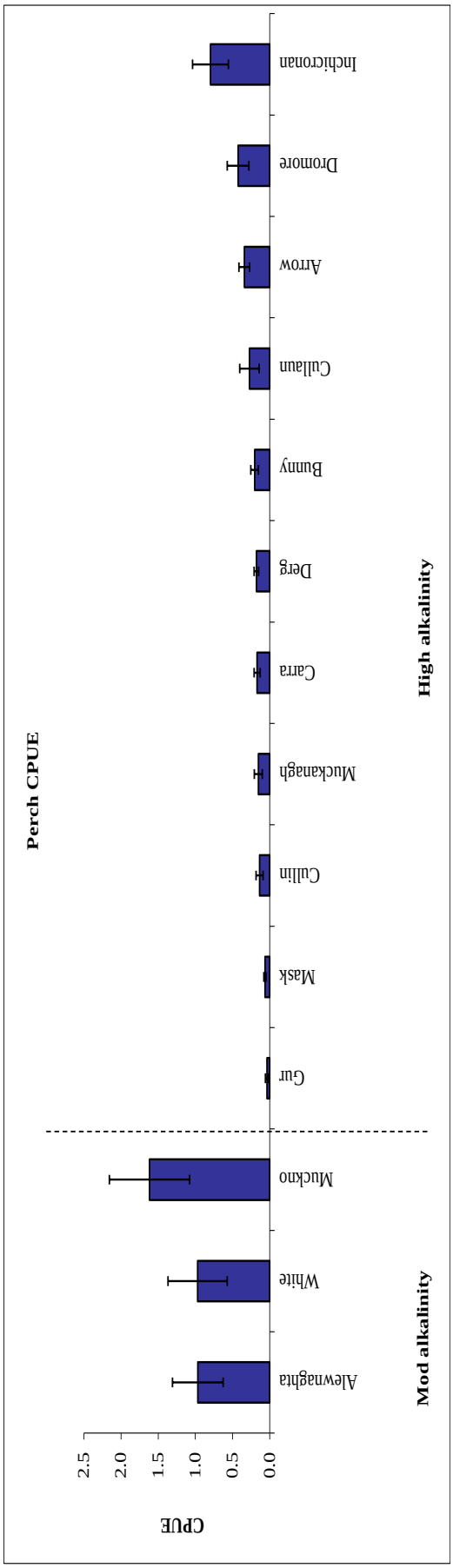

Fig. 4.24. Perch abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

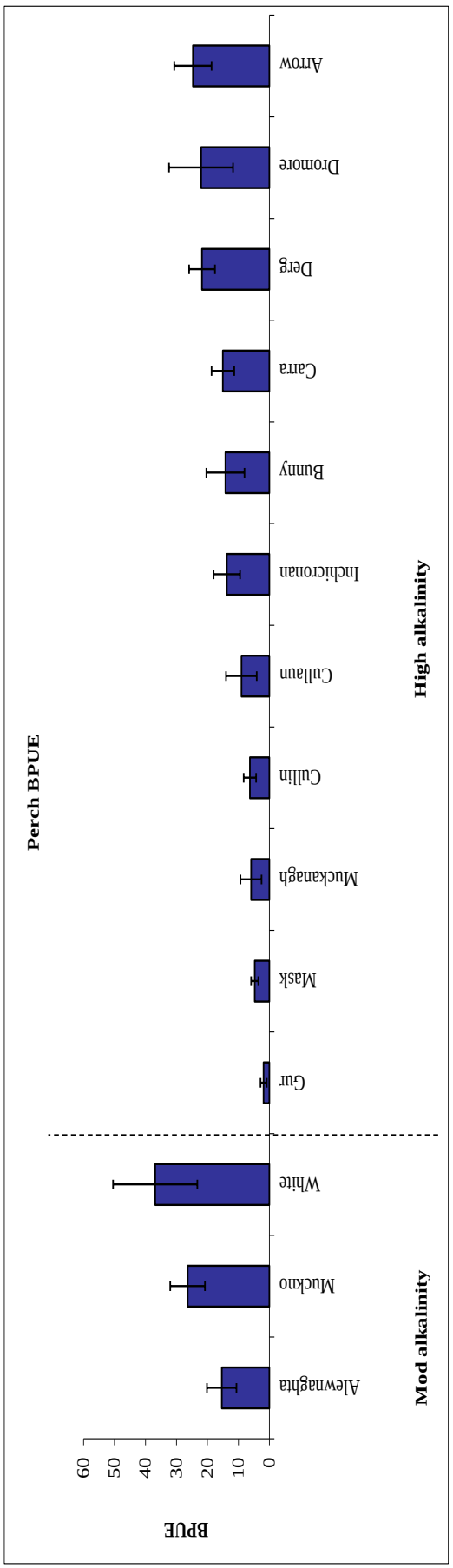

Fig. 4.25. Perch biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

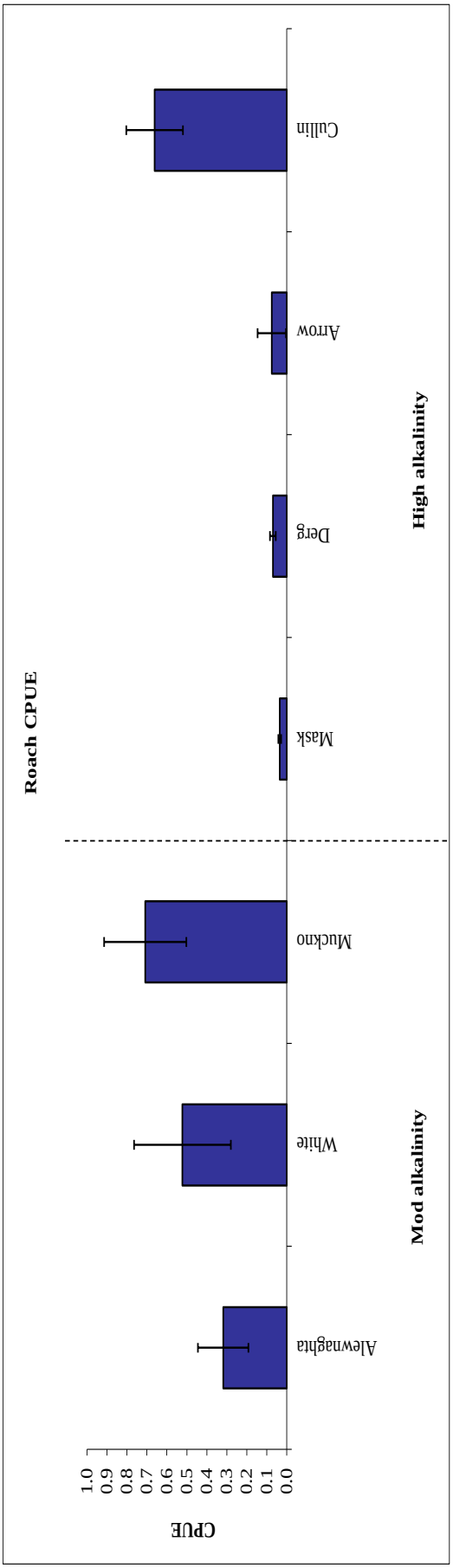

Fig. 4.26. Roach abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

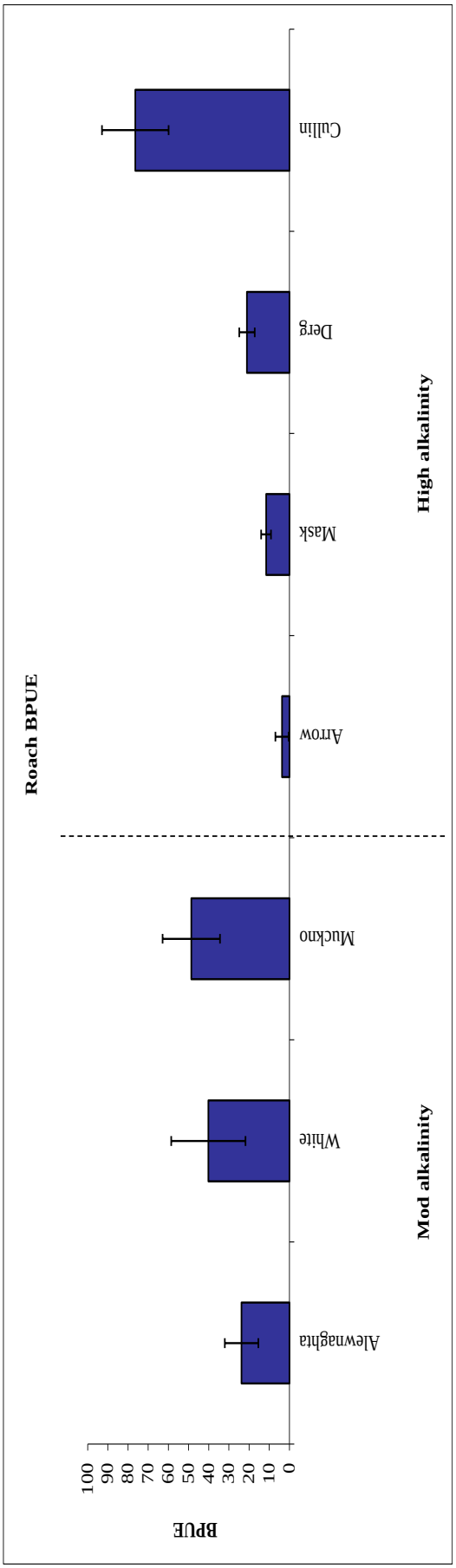

Fig. 4.27. Roach biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

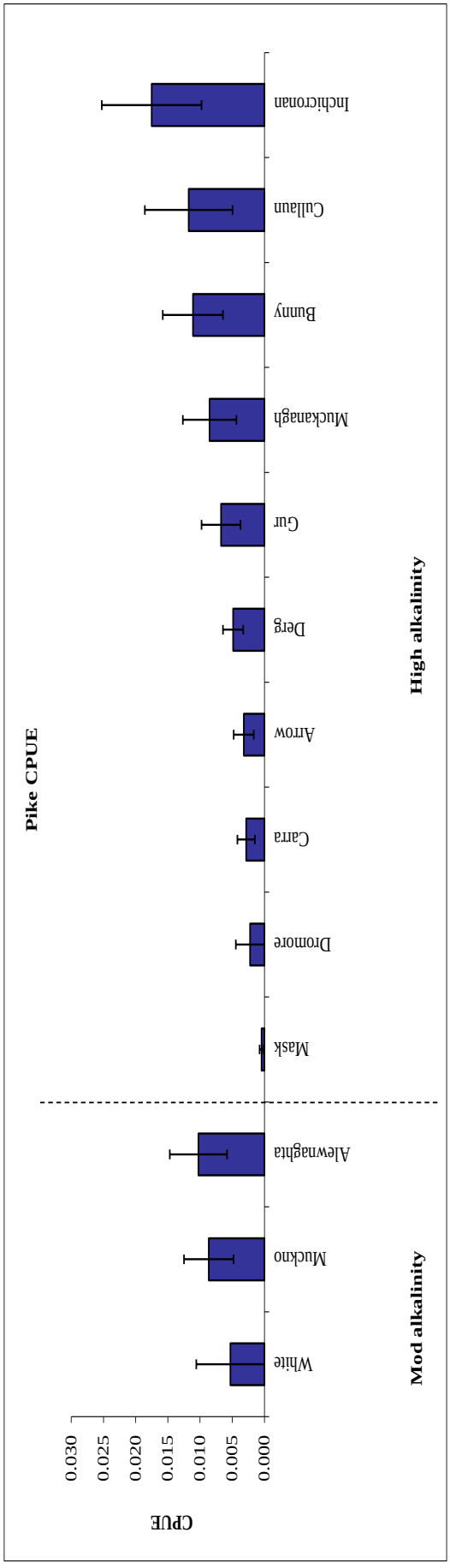

Fig. 4.28. Pike abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

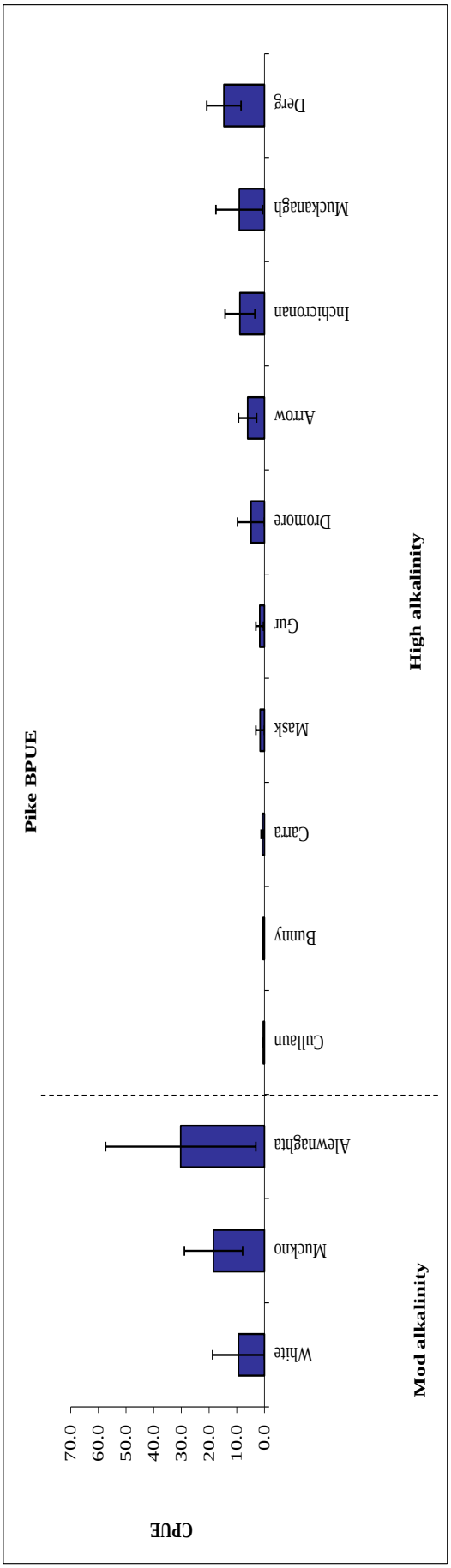

Fig. 4.29. Pike biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

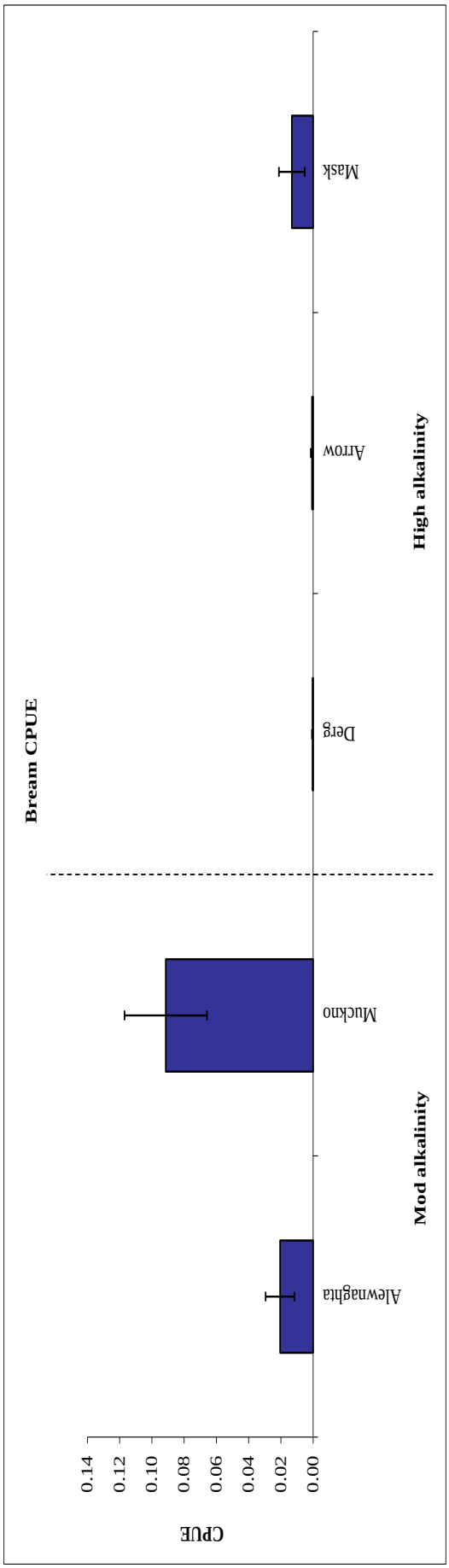

Fig. 4.30. Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

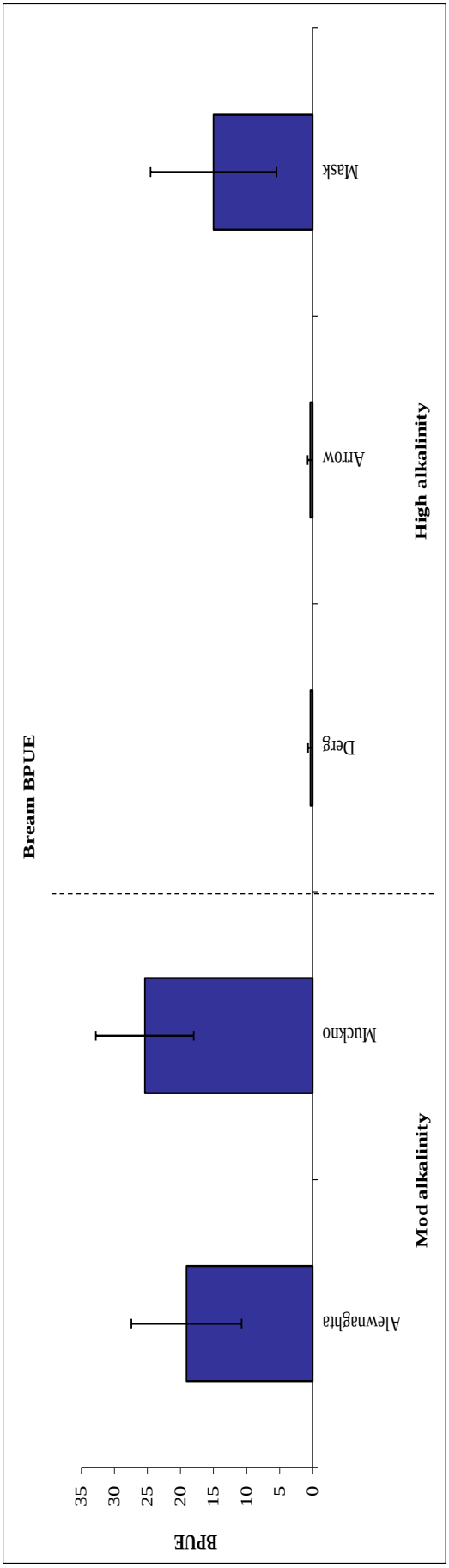

Fig. 4.31. Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

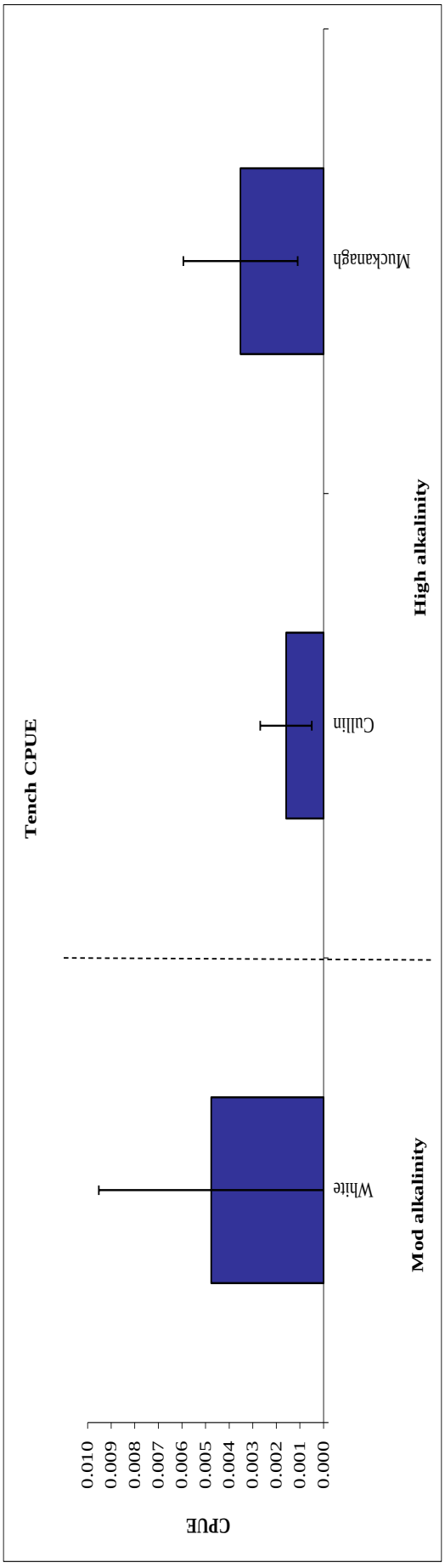

Fig. 4.32. Tench abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

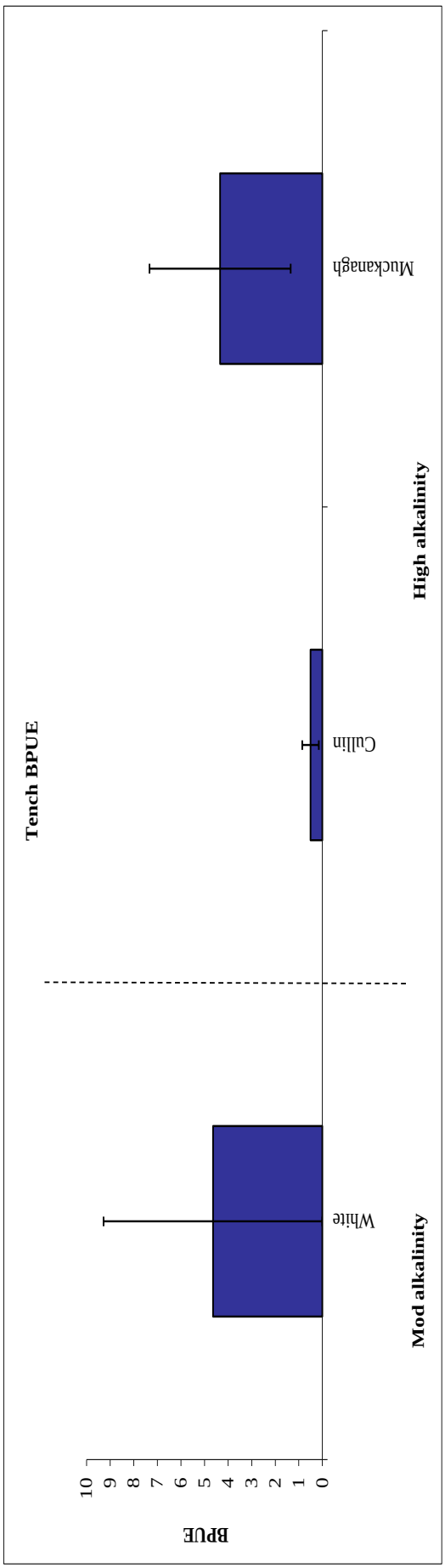

Fig. 4.33. Tench biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

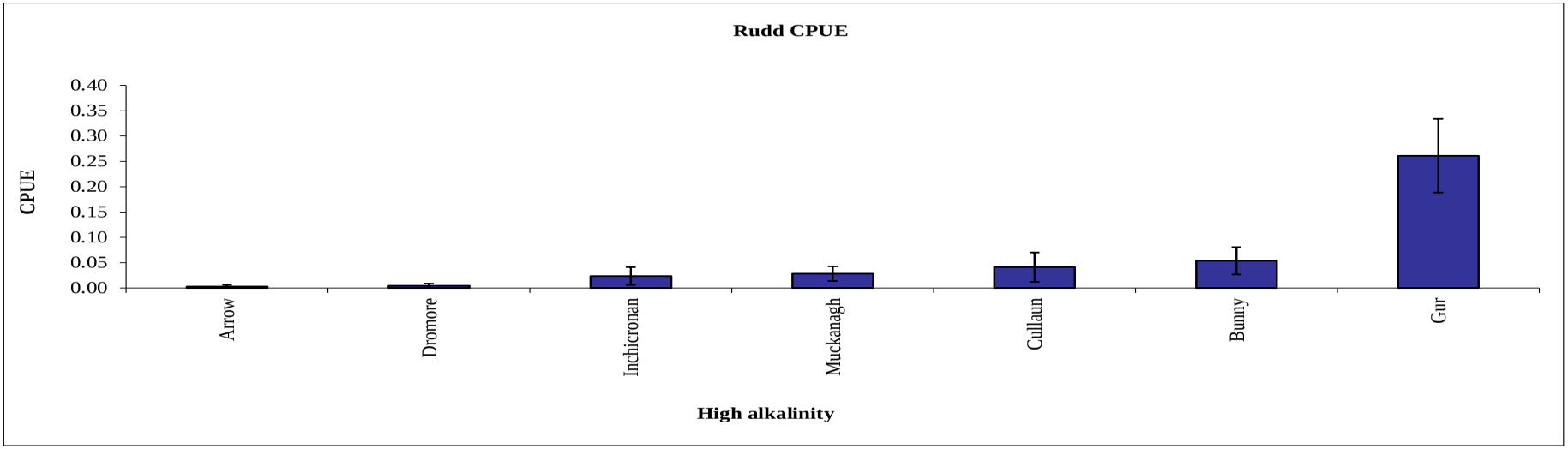

Fig. 4.34. Rudd abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

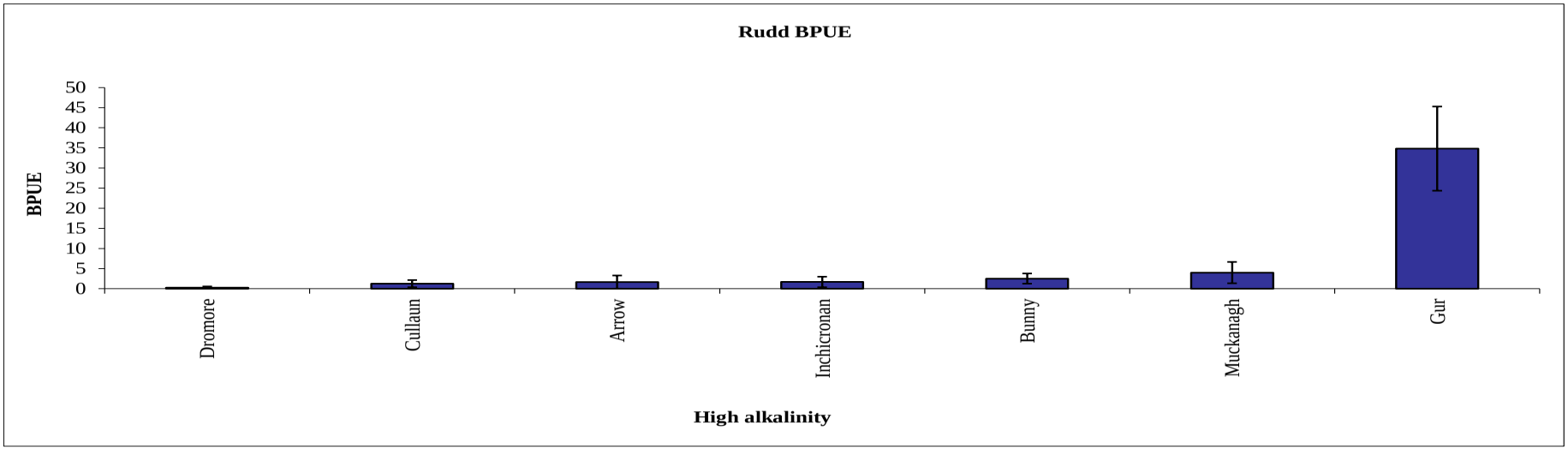

Fig. 4.35 Rudd biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

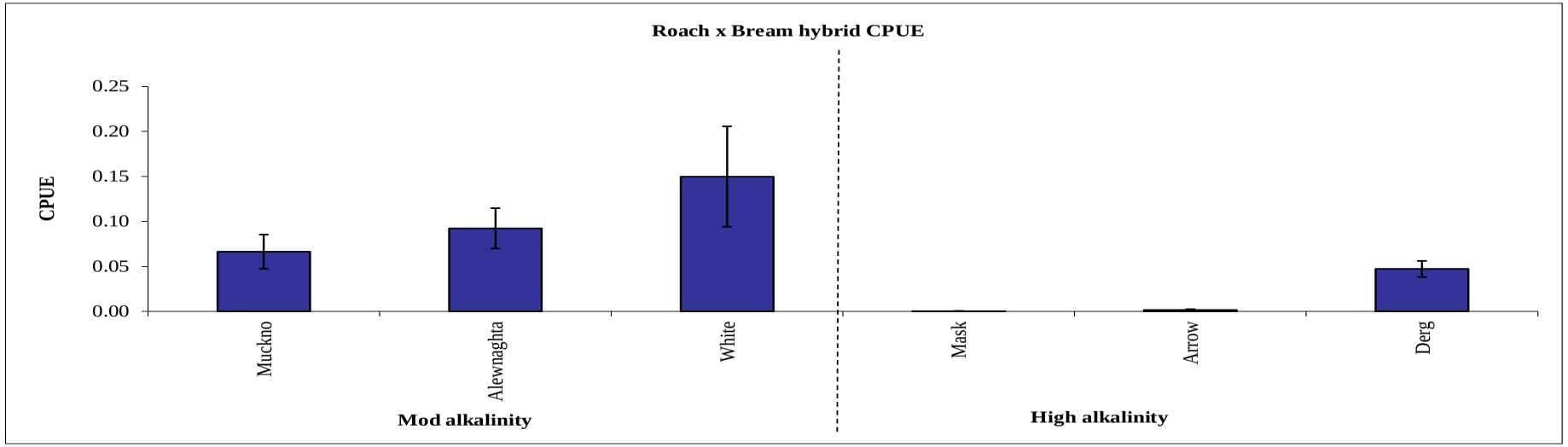

Fig. 4.36. Roach x Bream abundance (CPUE – mean (±SE) no. fish/m net) in lakes surveyed for WFD fish monitoring 2012

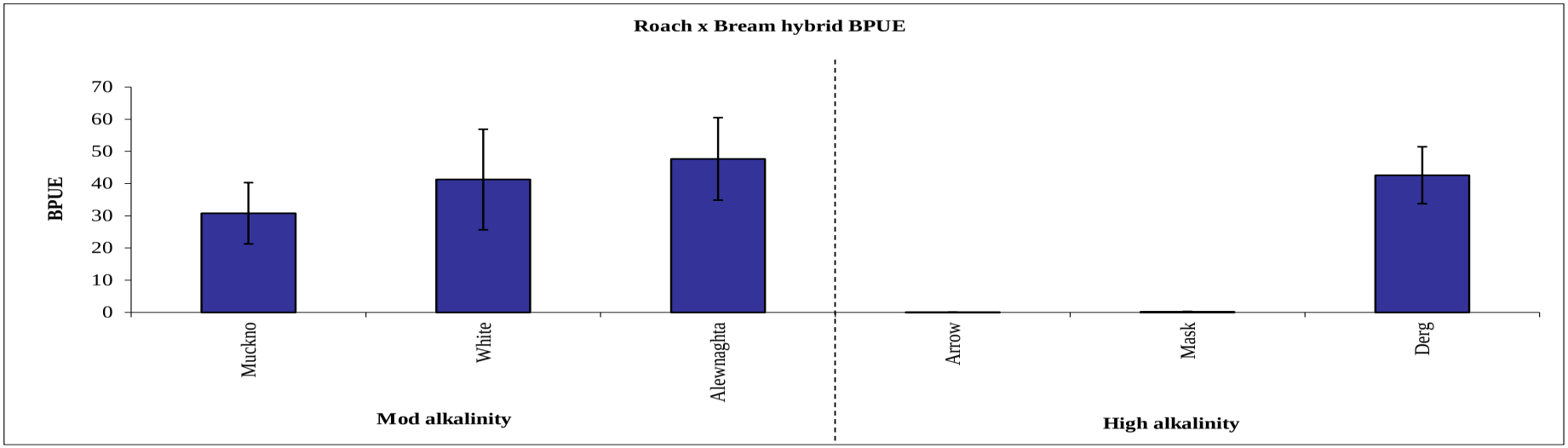

Fig. 4.37 Roach x Bream biomass (BPUE – mean (±SE) weight (g) fish/m net) in lakes surveyed for WFD fish monitoring 2012

4.1.4 Fish Growth

4.1.4.1 Growth of brown trout, perch and roach

Scales from 704 brown trout (16 lakes), 518 roach (seven lakes), 161 rudd (six lakes), otoliths from 22 char (three lakes) and opercular bones from 1,158 perch (14 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. Overall brown trout from Muckanagh Lough and Lough Carra showed the fastest growth at L4 (Fig. 4.38). Perch from Lough Carra and roach from Lough Mask showed the fastest growth rate (Fig. 4.39 and Fig 4.40).

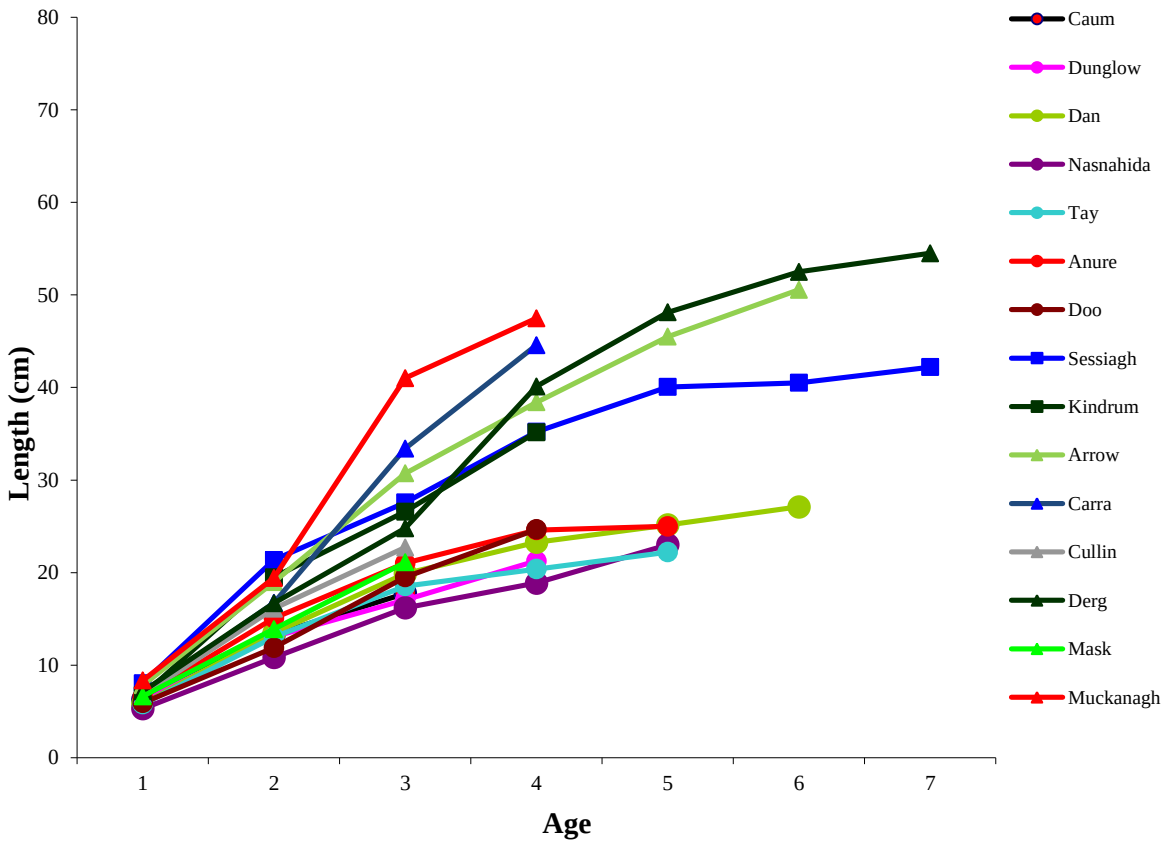

Fig. 4.38. Mean lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2012 (note: circles indicate low alkalinity lakes, squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

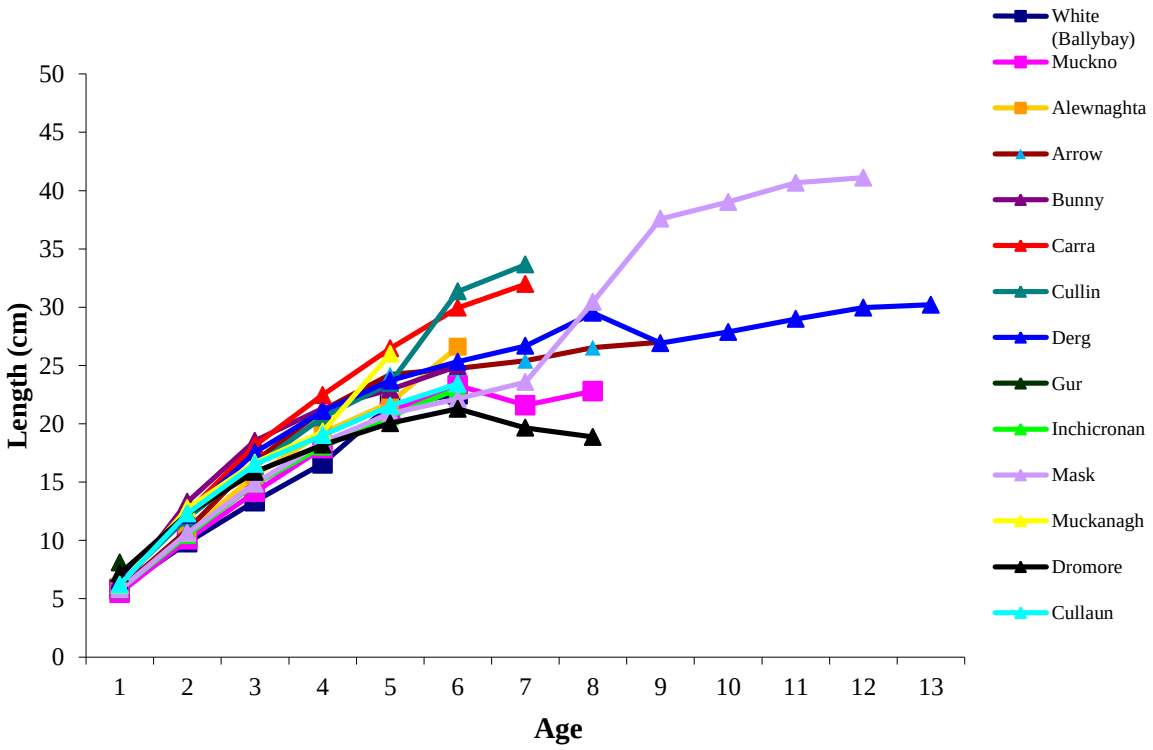

Fig. 4.39. Mean lengths at age of perch in lakes surveyed for WFD fish monitoring 2012 (note: squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

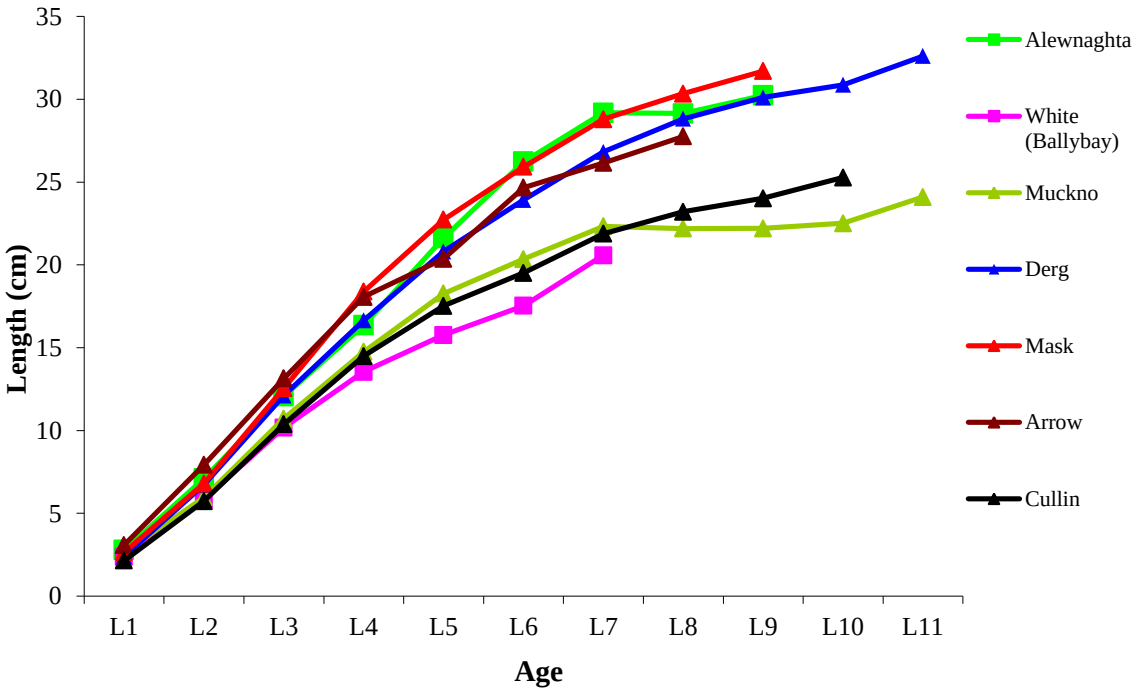

Fig. 4.40. Mean lengths at age of roach in lakes surveyed for WFD fish monitoring 2012 (note: squares indicate moderate alkalinity lakes and triangles indicate high alkalinity lakes)

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

Brown trout from moderate and high alkalinity lakes surveyed during 2012 displayed a significantly faster growth at the end of year 1, 2, 3, 4 and 5 than those from the low alkalinity lakes (Fig. 4.41) (one-way ANOVA, L1 - $F_{2, 14}$=9.727, P<0.05; L2 - $F_{2, 14}$=19.579, P<0.05; L3 - $F_{2, 14}$=7.353, P<0.05; L4 - $F_{2, 11}$=58.883, P<0.05; L5 - $F_{2, 6}$=155.155, P<0.05) (Fig. 4.41) (Appendix 3).

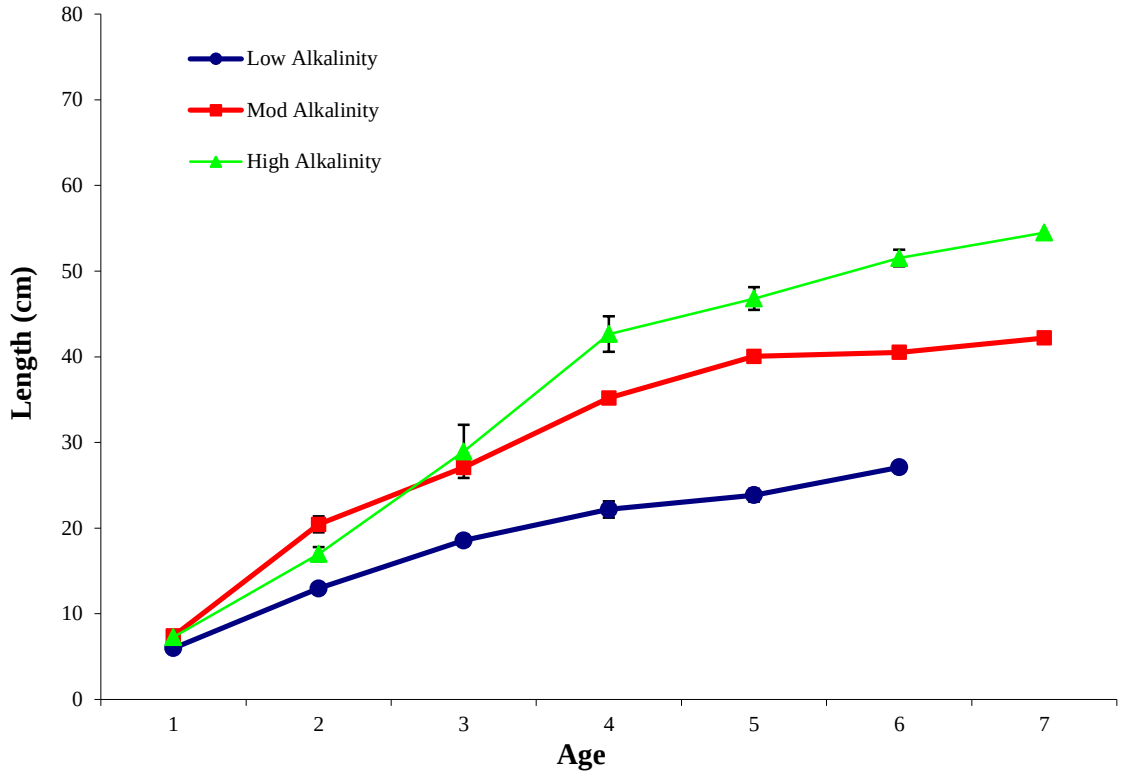

Fig 4.41. Mean (±SE) lengths at age of brown trout in lakes surveyed for WFD fish monitoring 2012

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 nine lakes during 2012; five were classified as very slow and four were classified as very fast (Table 4.3). Trout from Lough Caum, Lough Cullaun, Lough Carra, Lough Cullin, Lough Mask, Lough Nasnahida and Mukanagh Lough were not classified as there were no four year old fish captured on these lakes, or the L4 value was outside Kennedy and Fitzmaurice's range.

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

Very slow	Very fast
Dunglow	Kindrum
Anure	Arrow
Dan	Derg
Tay	Sessiagh
Doo	

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

Both perch and roach were recorded in moderate and high alkalinity lakes only. Overall, the mean length at age of both perch and roach were slightly higher in the high alkalinity lakes than in the moderate alkalinity lakes, however, only perch in high alkalinity lakes displayed a significantly faster growth at the end of year 2 and 3 than those from the moderate alkalinity lakes (one-way ANOVA, L2 – $F_{1, 12}$=9.102, P<0.05; L3 – $F_{1, 12}$=7.983) (Fig. 4.42 and Fig. 4.43). Appendices 4 and 5 give a summary of the mean back calculated lengths at age of perch and roach from the 14 and seven lakes respectively.

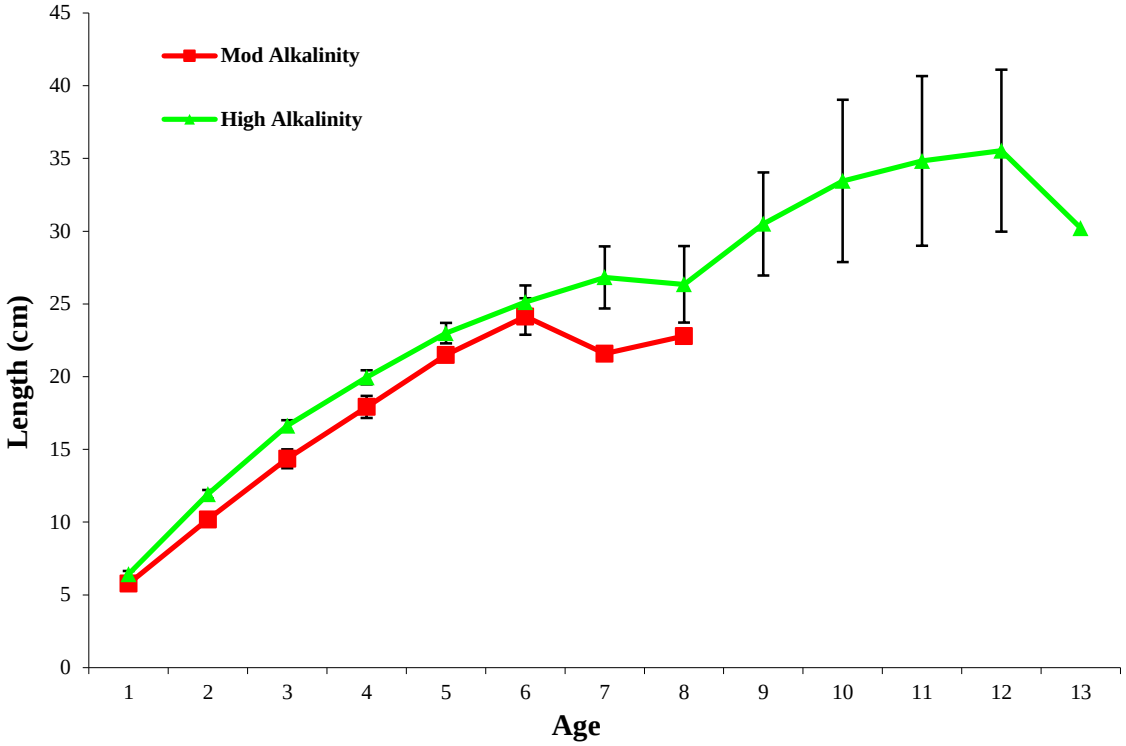

Fig 4.42. Mean (±SE) length at age of perch in lakes surveyed for WFD fish monitoring 2012

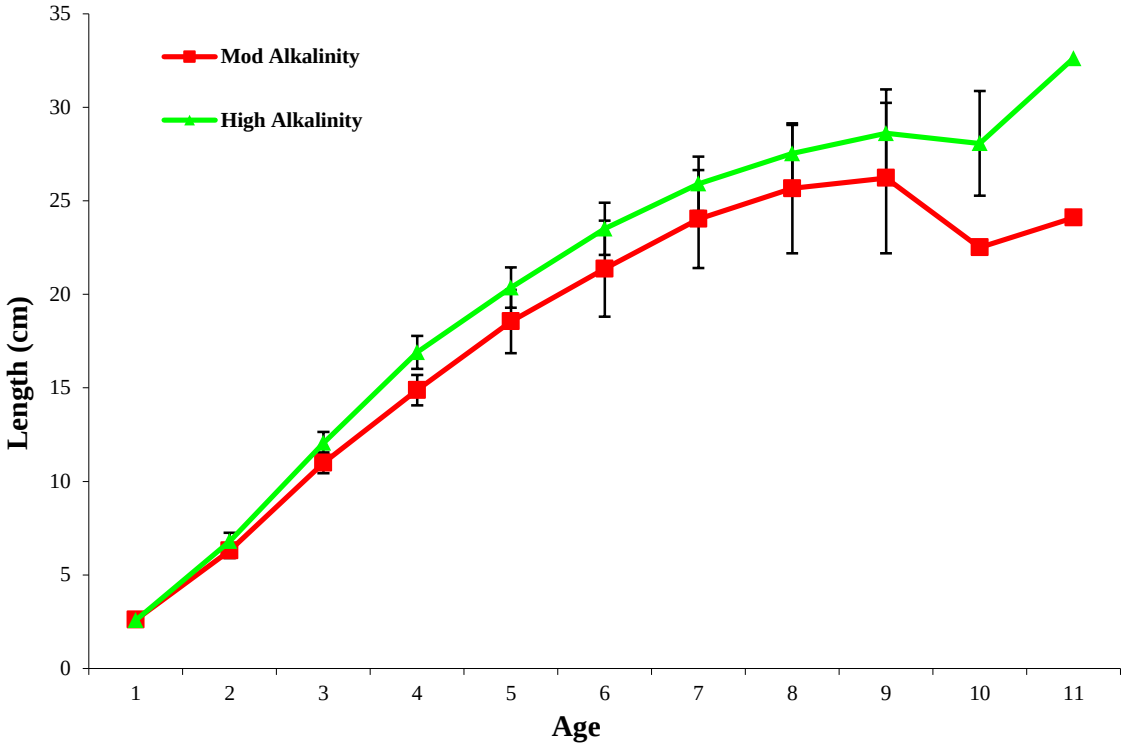

Fig 4.43. Mean (±SE) length at age of roach in lakes surveyed for WFD fish monitoring 2012

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*., 2012b). FIL2 is a further development of the original FIL1 ecological classification tool (Kelly *et. al.*, 2008b) and it has been successfully intercalibrated in a cross Europe exercise. It combines a discriminant analysis model, providing a discrete assessment of status class with an ecological quality ratio (EQR) model, providing WFD compliant quantitative ecological quality ratios between 0 and 1 (Kelly *et al*., 2012b).

All 23 lakes surveyed during 2012 were assigned a draft ecological status class using the FIL2 ecological classification tool, together with expert opinion; ten were classified as High, four were classified as Good, three were classified as Moderate, four were classified as Poor and two were classified as 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)
Anure	1	High
Bunny	3	High
Carra	4	High
Cullaun	4	High
Doo	2	High
Dromore	4	High
Dungloe	1	High
Inchicronan	4	High
Sessiagh	2	High
Tay	2	High
Arrow	4	Good
Dan	2	Good
Nasnahida	1	Good
Mask	4	Good
Cam	1	Moderate
Kindrum	3	Moderate
Muckanagh	4	Moderate
Cullin	3	Poor
Derg	4	Poor
Gur	3	Poor
Muckno	4	Poor
Alewnaghta	3	Bad
White	3	Bad

Ecological status is subject to change upon review

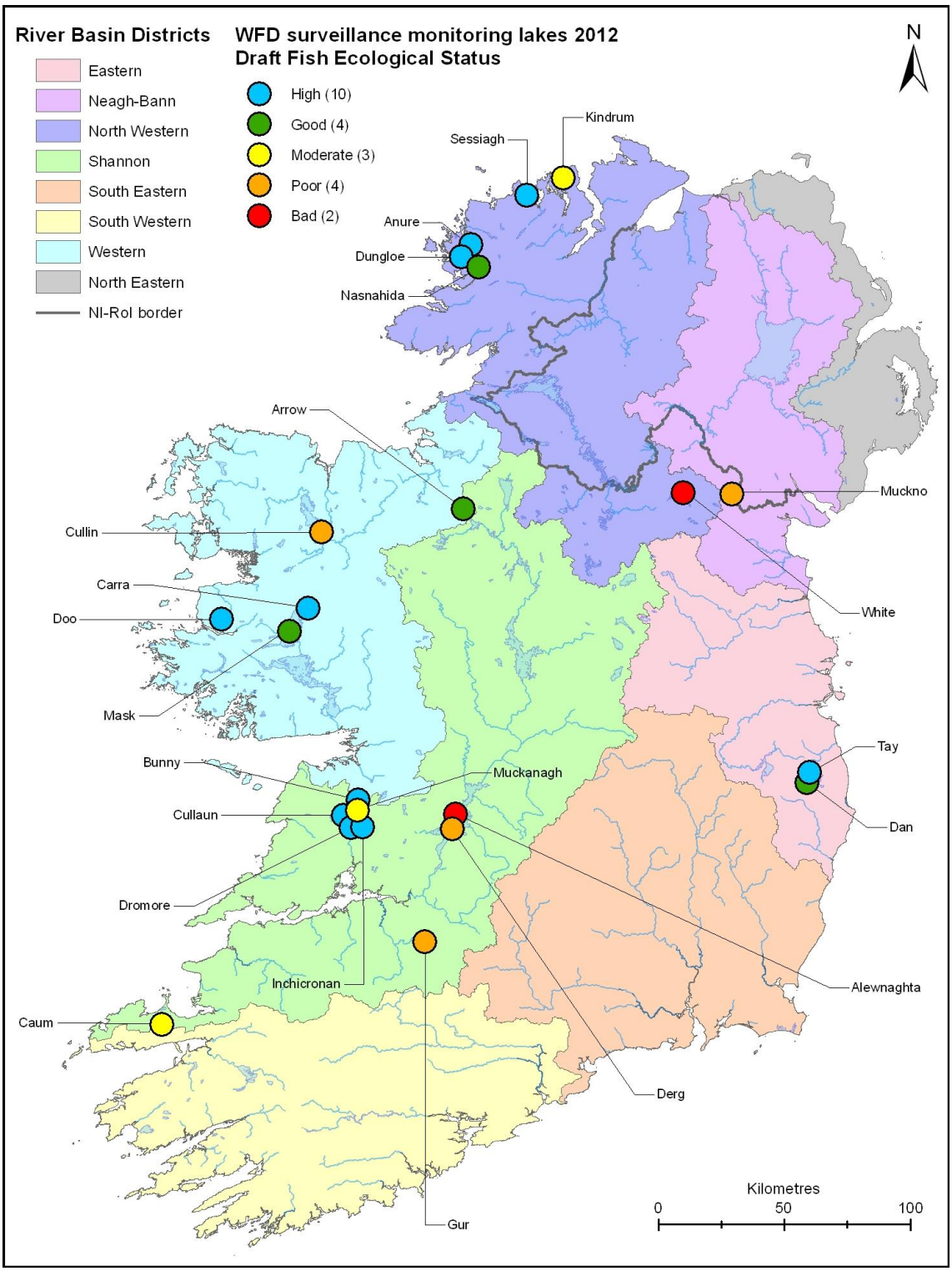

Fig. 4.44. Ecological classification of lakes surveyed during 2012 using the FIL2 ecological classification tool

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 when 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 58 river sites surveyed during 2012 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 58 river sites surveyed during 2012

	Scientific name	Common name	Number of river sites	% river sites
	NATIVE SPECIES			
1	*Salmo trutta*	Brown trout	55	94.83
2	*Gasterosteus aculeatus*	Three-spined stickleback	26	44.83
3	*Anguilla anguilla*	Eel	41	70.69
4	*Salmo salar*	Salmon	45	77.59
5	*Lampetra* sp.	Lamprey sp.	17	29.31
6	*Salmo trutta*	Sea trout *	6	10.34
7	*Platichthys flesus*	Flounder	4	6.90
	NON NATIVE (influencing ecology)			
8	*Barbatula barbatula*	Stone loach	25	43.10
9	*Phoxinus phoxinus*	Minnow	21	36.21
10	*Rutilus rutilus*	Roach	10	17.24
11	*Perca fluviatilis*	Perch	10	17.24
12	*Leuciscus leuciscus*	Dace	10	17.24
13	*Esox lucius*	Pike	8	13.79
14	*Rutilus rutilus x Abramis brama*	Roach x bream hybrid	2	3.45
15	*Abramis brama*	Bream	1	1.72
	NON NATIVE SPECIES (generally not influencing ecology)			
16	*Gobio gobio*	Gudgeon	7	12.07

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

A total of 15 fish species (sea trout are included as a separate "variety" of trout) and one hybrid were recorded in the 58 river sites surveyed during 2012. Brown trout was the most widespread species occurring in 95% of the sites surveyed, followed by salmon (78%), European eel (71%), three-spined stickleback (45%), stone loach (43%), minnow (36%), lamprey sp. (29%), dace (17%), perch (17%), roach (17%), pike (14%), gudgeon (12%) and sea trout (10%). Flounder, roach x bream hybrids, and bream were recorded in less than 10% of the sites surveyed (Table 4.5 and Fig. 4.45).

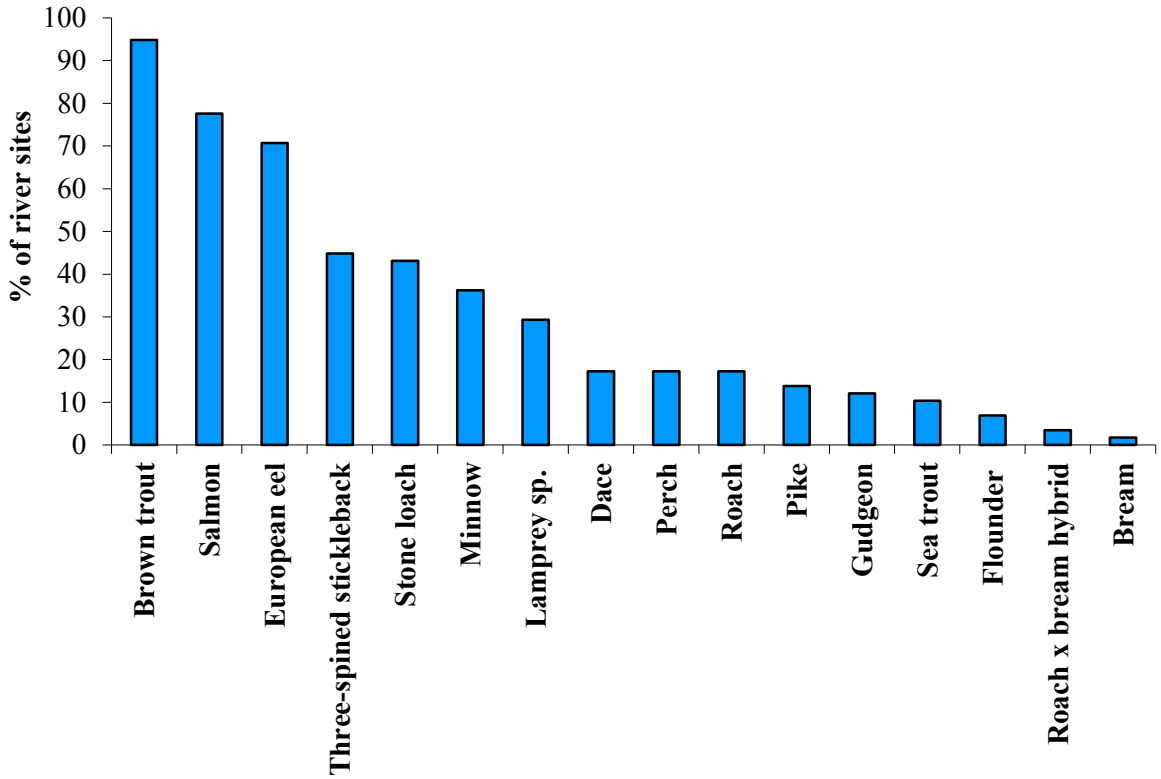

Fig. 4.45. Percentage of sites where each fish species was recorded (total of 58 river sites surveyed) during WFD surveillance monitoring 2012

Fish species richness ranged from one species in the Glenealo River and Tully Stream, Site A, to a maximum of 13 species in the River Barrow at Pass Br. (Table 4.6 and Figs. 4.46 and 4.47). Native species were present in all of the sites surveyed. Twenty-six of the 58 sites contained exclusively native species (45%). The maximum number of native species captured in any site was six and this was recorded in the River Nanny in Co. Meath (Table 4.6). Group 2 species (non-native species influencing ecology) were present at 32 sites. The maximum number of non-native species recorded at any one site was six, recorded in three of the River Barrow sites at Dunleckny, Graiguenamanagh and Ballykeenan. Only one Group 3 species (gudgeon) was present among the river sites surveyed, recorded at seven sites (Table 4.6).

Table 4.6. Species richness in each river site surveyed for WFD fish monitoring 2012

Site	RBD	Species richness	No. native species (Group 1)	No. of Non-native species (Group 2)	No. of non-native (Group 3)
Wadeable sites					
Greese (Br. NE of Belan House_A)	SERBD	9*	5	4	0
Greese (Br. NE of Belan House_B)	SERBD	8	5	3	0
Nanny (Meath) (Br. at Julianstown_A)	ERBD	8	6	2	0
White (Louth) (Ballymageragh_A)	NBIRBD	7	5	2	0
Athboy (Br. nr Clonleasan Ho._B)	ERBD	6	3	3	0
Burren (Ullard Br._A)	SERBD	6	5	1	0
Dead (Pope's Bridge_B)	SHIRBD	6	5	1	0
Argideen (Ballinoroher Weir_A)	SWRBD	6	4	2	0
Burren (Ullard Br._B)	SERBD	5	4	1	0
Dead (Pope's Bridge_A)	SHIRBD	5	4	1	0
Dinin (Dinin Br._A)	SERBD	5	3	2	0
Owvane (Limerick) (Br. u/s (SE of) Loghill_A)	SHIRBD	5	5	0	0
Athboy (Br. nr Clonleasan Ho._A)	ERBD	4	3	1	0
Gowlan (Track west of Lough Black_B)	SERBD	4	4	0	0
Lerr (Prumplestown Br._A)	SERBD	4	3	1	0
Clady (Donegal) (Bryan's Br._A)	NWIRBD	4	4	0	0
Glenamoy (Glenamoy Village_A)	WRBD	4	4	0	0
Owenbrin (Br. u/s L. Mask_A)	WRBD	4	3	1	0
Tully Stream (Soomeragh Br_B)	SERBD	3	3	0	0
Adrigole (0.5km d/s of Glashduff confl._A)	SWRBD	3	3	0	0
Black (Shrule) (Br. at Kilshanvy_A)	WRBD	3	3	0	0
Black (Shrule) (Br. at Kilshanvy_B)	WRBD	3	3	0	0
Gowlan (Track west of Lough Black_A)	SERBD	3	3	0	0
Bunowen (Louisburgh) (Tully Br._A)	WRBD	3	3	0	0
Dunneill (Donaghintraine Br._A)	WRBD	3	3	0	0
Glencree (Br. u/s Dargle confl_A)	ERBD	3	3	0	0
Bilboa (Br u/s Blackboy Br - Bilboa Br._A)	SHIRBD	3	2	1	0
Tyshe (West br. Ardfert at Friary_A)	SHIRBD	2	2	0	0
Tyshe (West br. Ardfert at Friary_B)	SHIRBD	2	2	0	0
Ballyfinboy (Ballinderry Br._A)	SHIRBD	2	2	0	0
Big (Louth) (Ballygoly Br._A)	NBIRBD	2	2	0	0
Caher (Br. 2 km d/s Formoyle_A)	SHIRBD	2	2	0	0
Dargle (Bahana_A)	ERBD	2	2	0	0
Dunneill (Dromore West_A)	WRBD	2	2	0	0
Owveg (Kerry) (Owveg Br._B)	SHIRBD	2	2	0	0
Glenealo (Br. d/s Upper Lake_A)	ERBD	2	2	0	0
Tully Stream (Soomeragh Br_A)	SERBD	1	1	0	0
Glenealo (Behind Upper Lake car park shop_A)	ERBD	1	1	0	0

* Roach x bream hybrids included in this table

Table 4.6 ctn. Species richness in each river site surveyed for WFD fish monitoring 2012

Site	RBD	Species richness	No. native species (Group 1)	No. of Non-native species (Group 2)	No. of non-native (Group 3)
Non-wadeable sites					
Barrow (Pass Br._A)	SERBD	13*	5	7	1
Barrow (Bagenalstown (Slipway to lock)_A)	SERBD	11	3	7	1
Barrow (Dunleckny (Swimming pool)_A)	SERBD	11	4	6	1
Barrow (Graiguenamanagh Br._A)	SERBD	11*	4	6	1
Barrow (Ballykeenan Lock_A)	SERBD	10	4	6	0
Barrow (Upper Tinnahinch Lock_A)	SERBD	10	4	5	1
Kilcrow (Ballyshrule Br._A)	SHIRBD	9	3	5	1
Barrow (Leighlinbridge Lord Bagenal Hotel_A)	SERBD	7	4	3	0
Maigue (Castleroberts Br._A)	SHIRBD	7	5	2	0
Moy (u/s Ardnaree Br._A)	WRBD	7	5	2	0
Bride (Waterford) (Footbr. N of Ballynella_A)	SWRBD	6	5	1	0
Deel (Crossmolina) (Bridge at Castle Gore_A)	WRBD	6	3	3	0
Awbeg (Buttevant) (Kilcummer Br._A)	SWRBD	5	4	1	0
Creegh (Drumellihy Br._A)	SHIRBD	5	5	0	0
Nenagh (Ballysoilshaun Br._A)	SHIRBD	5	3	2	0
Tullamore (Br. SW of Ballycowen br._A)	SHIRBD	5	2	2	1
Liffey (500 m d/s Ballyward Br._A)	ERBD	4	1	3	0
Little Brosna (Riverstown Br._A)	SHIRBD	4	3	1	0
Bride (Waterford) (d/s of Footbr._A)	SWRBD	3	3	0	0
Eany Water (Just d/s Eany Beg/More confl_A)	NWIRBD	3	3	0	0

* Roach x bream hybrids included in this table

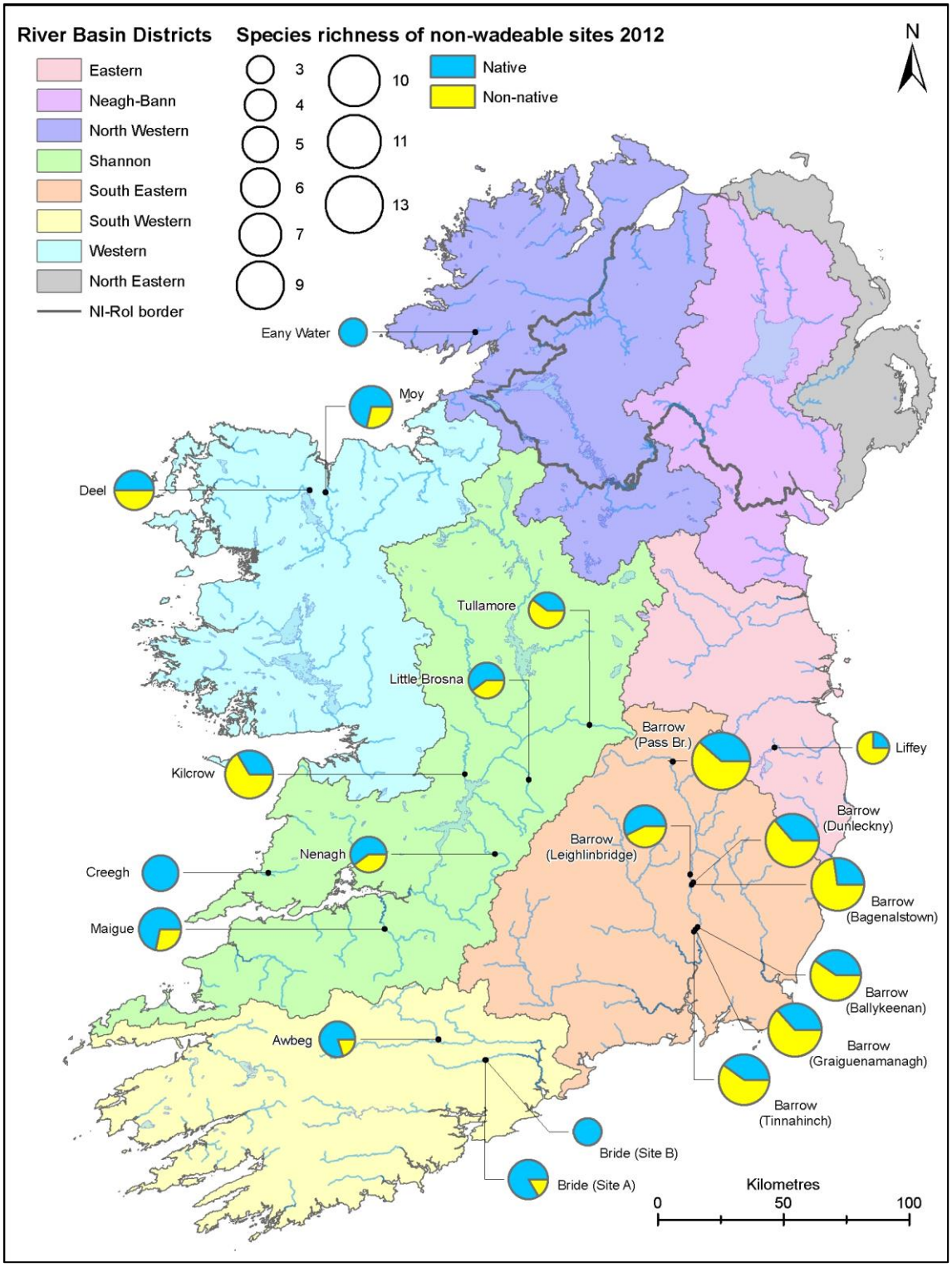

Fig. 4.46. Fish species richness at non-wadeable river sites surveyed using boat based electric-fishing equipment for WFD fish monitoring 2012

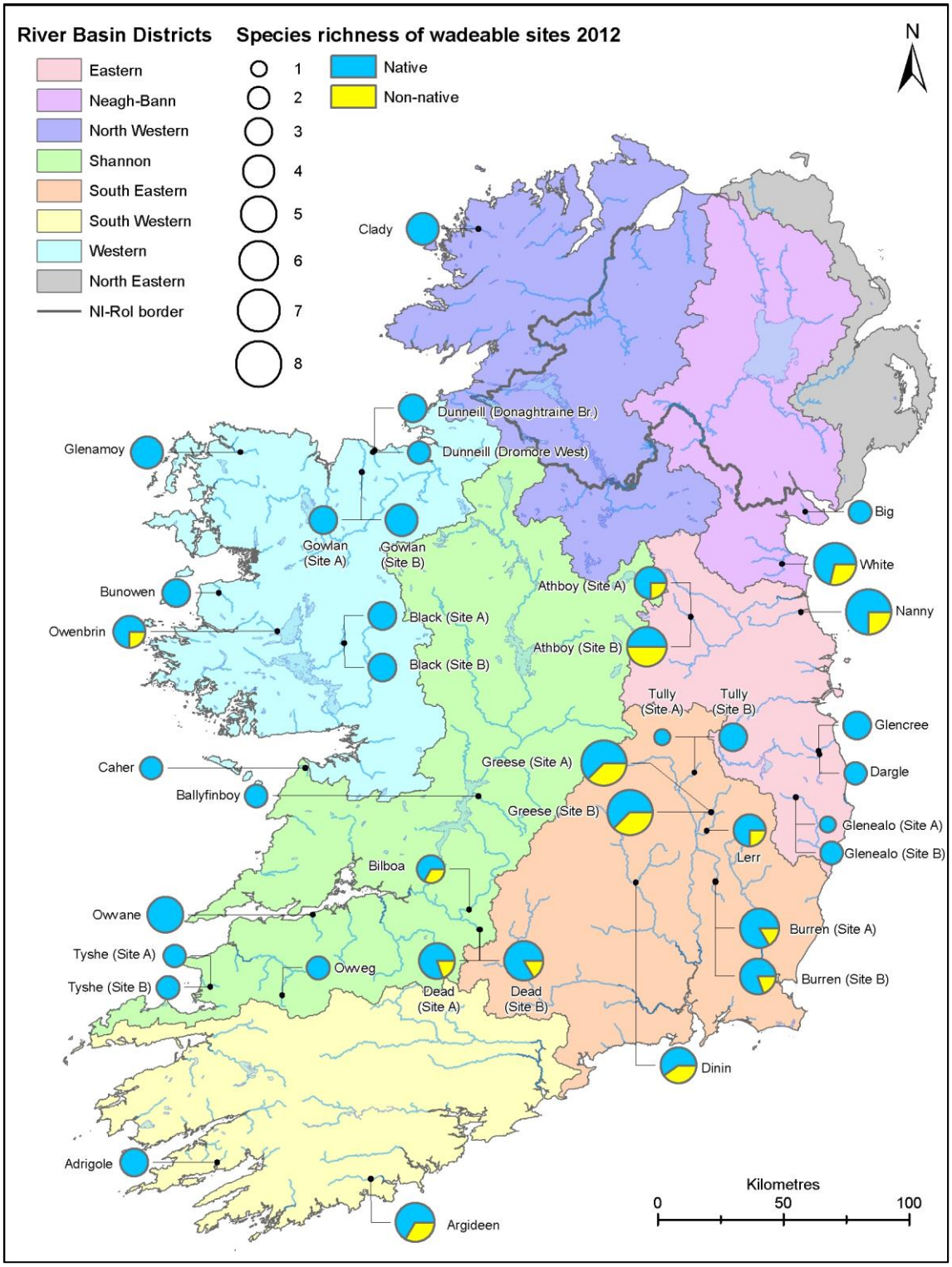

Fig. 4.47. Fish species richness at wadeable river sites surveyed using handset electric-fishing equipment for WFD fish monitoring 2012

4.2.2 Fish species distribution and abundance

Brown trout were the most widely distributed species among sites surveyed in 2012, being recorded in 55 of the 58 sites (Fig. 4.48 to Fig. 4.51). Brown trout fry (0+) were present in 40 sites (Fig. 4.48 and Fig. 4.49), while older brown trout (1+ and older) were encountered in 54 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 (0.006 fish/m^2) and 1+ and older fish (0.057 fish/m^2) were captured in the Creegh River site (ShIRBD) and River Bride (Site B) respectively. In wadeable streams, the highest densities of fry (0.422 fish/m^2) and 1+ and older fish (0.283 fish/m^2) were recorded in the Caher River site (ShIRBD) and Big River site (NBIRBD) respectively.

Sea trout were only recorded in six sites in 2012, with the highest abundance recorded in the River Nanny (ERBD) (0.004 fish/m^2) (Fig. 4.52 and Fig. 4.53).

Salmon were also widely distributed throughout the country, being present in 45 sites. Salmon fry (0+) were captured in 30 sites (Fig. 4.54 and Fig. 4.55), while older salmon (1+ & older) were recorded in 43 sites (Fig. 4.56 and Fig. 4.57). This follows a similar trend to that of brown trout, where fry (0+) densities were generally more abundant in shallow wadeable streams, than in non-wadeable deeper channels, sampled with boat based electric-fishing equipment. For non-wadeable streams, the highest densites of salmon fry (0+) and 1+ and older fish were captured in the River Bride (Site B) (0.007 fish/m^2) and Creegh River (0.021 fish/m^2) (ShIRBD). In wadeable streams, the greatest densities of fry (0+) (0.443 fish/m^2) and 1+ and older fish (0.246 fish/m^2) were both recorded in the Bilboa River.

Eels were present in 41 sites, and their distribution is shown in Fig. 4.58 and Fig. 4.59. The highest eel density was recorded in the Owvane River (0.161 fish/m^2) (ShIRBD). 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 and those locations furthest from the sea.

Flounder were recorded in only four sites located very close to the coast, with their highest density recorded in the River Nanny (0.011 fish/m^2) (ERBD) (Fig. 4.60 and Fig. 4.61).

Three-spined stickleback were distributed throughout the country, being captured in a total of 26 sites. (Fig. 4.62 and Fig. 4.63). Their highest density (0.41 fish/m^2) was recorded in the Tyshe River (Site B) (SWRBD).

Juvenile lamprey were recorded in 17 river sites, with their highest density (0.019 fish/m^2) recorded in the Burren River (SERBD) (Fig. 4.64 and Fig. 4.65). Stone loach were recorded in 25 sites throughout the country. Their highest density was recorded in the River Nanny (0.033 fish/m^2)

(ERBD) (Fig. 4.66 and Fig. 4.67). Minnow were recorded in 21 river sites, with their greatest density (0.298 fish/m^2) in the Owenbrin River (WRBD) (Fig. 4.68 and Fig. 4.69).

Dace were captured in ten sites, all of which were (SERBD) (Fig. 4.70 and Fig. 4.71). Their highest density was recorded in the Lerr River (0.093fish/m^2).

Roach were recorded in 10 river sites, including all of those surveyed in the River Barrow (Fig. 4.72 and Fig. 4.73). The greatest density of roach recorded (0.013 fish/m^2) was in the Deel River (WRBD). Only one bream was caught during all surveys in 2012. This individual was recorded in the River Barrow at Bagenalstown (SERBD). Roach x bream hybrids were only recorded at two sites, both on the River Barrow. The highest abundance was present at the Pass Br. Site.

Perch were recorded in 10 sites, (Fig. 4.74 and Fig. 4.75). Their highest density (0.007 fish/m^2) was recorded in the Kilcrow River (ShIRBD).

Pike were captured at eight river sites during 2012 (Fig. 4.76 and Fig. 4.77). The Kilcrow River site within the ShIRBD had the highest density (0.002 fish/m^2).

Gudgeon were recorded in seven river sites, all within either the SERBD or ShIRBD (Fig. 4.78 and Fig. 4.79). The highest recorded density of gudgeon (0.010 fish/m^2) was observed in the River Barrow, Pass Br. Site (SERBD).

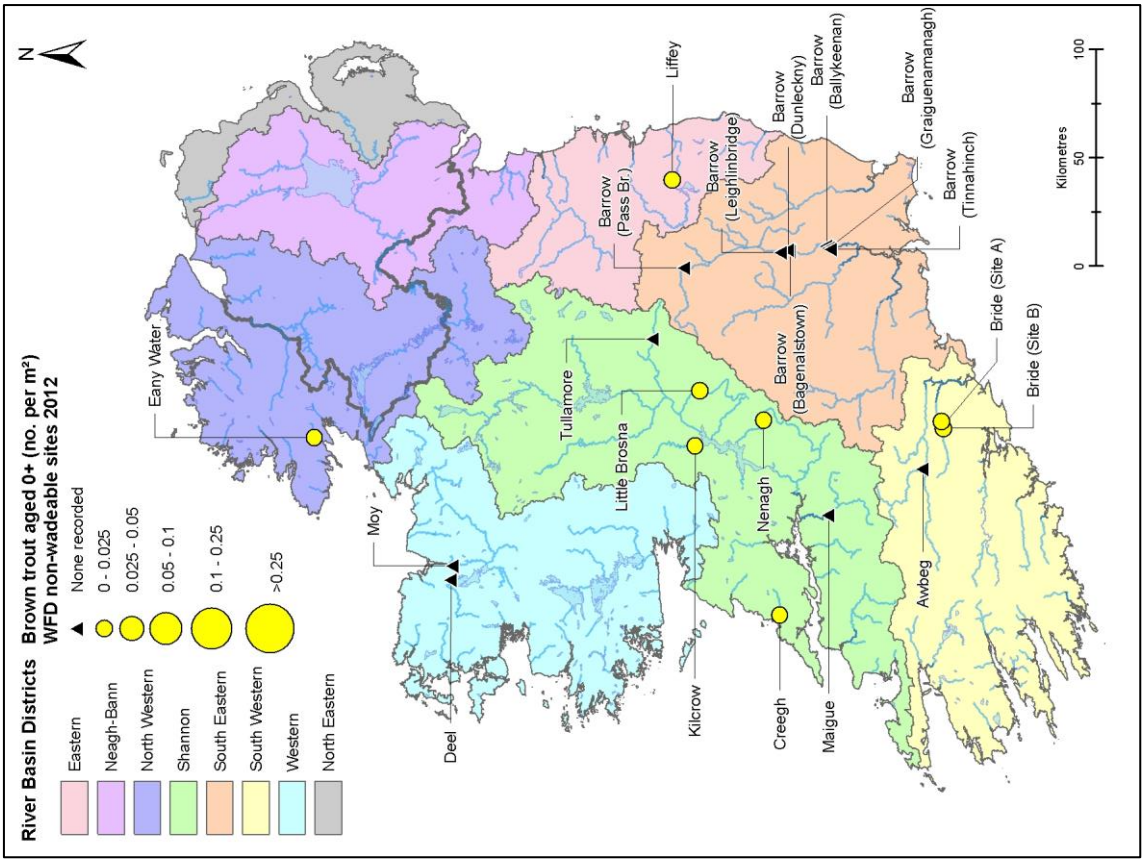

Fig. 4.49. Distribution and abundance of 0+ brown trout at non-wadeable river sites surveyed for WFD fish monitoring 2012

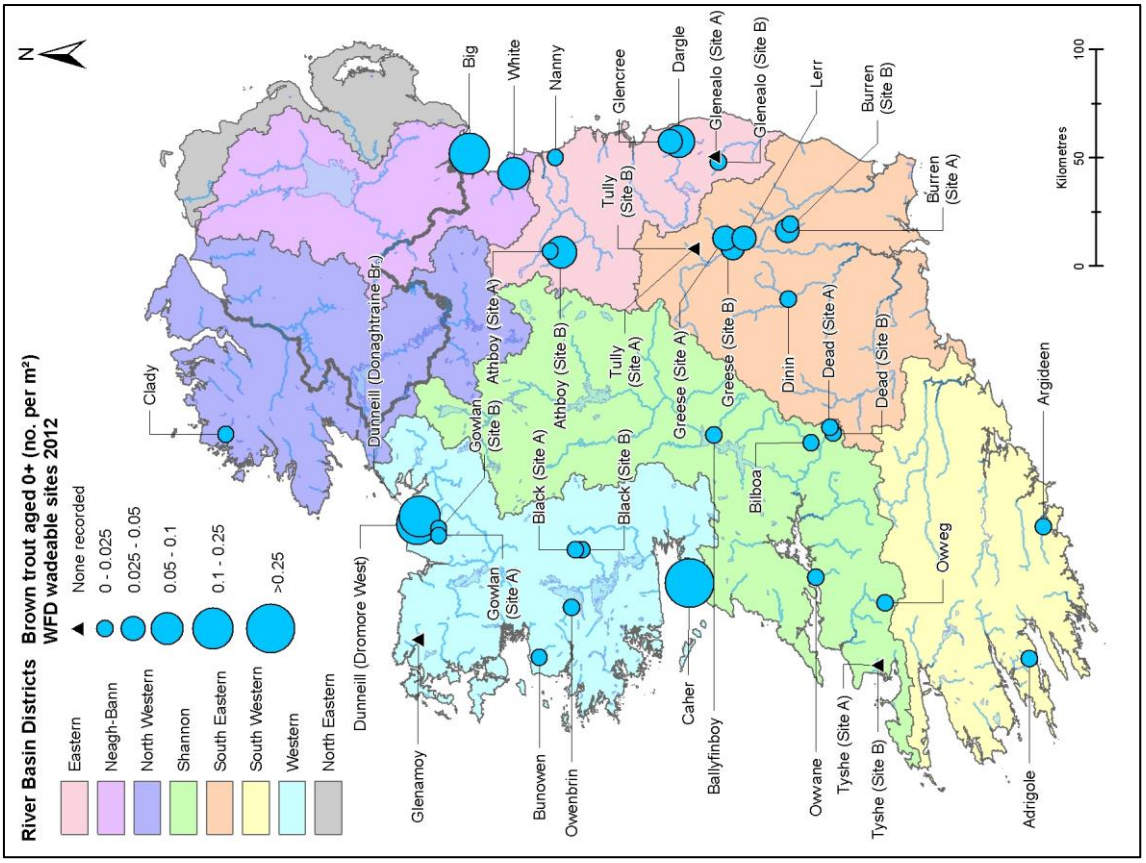

Fig. 4.48. Distribution and abundance of 0+ brown trout at wadeable river sites surveyed for WFD fish monitoring 2012

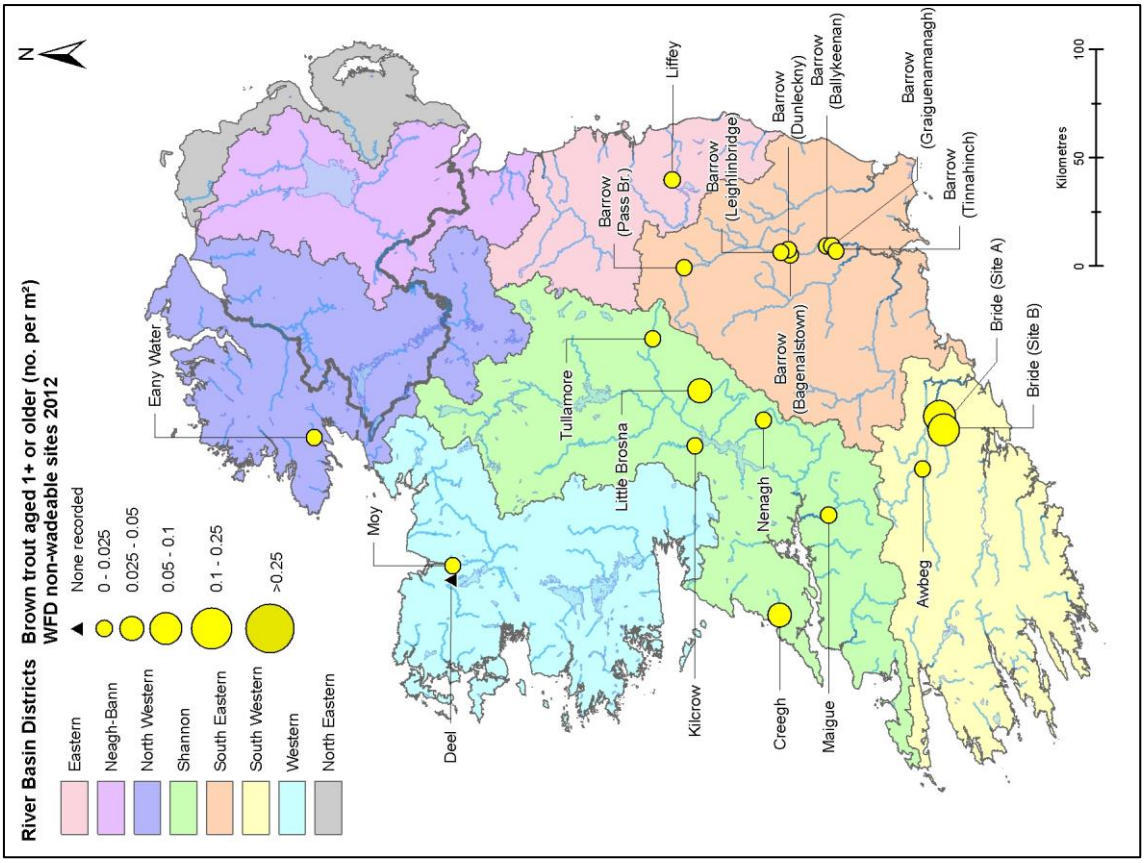

Fig. 4.51. Distribution and abundance of 1+ or older brown trout at non-wadeable river sites surveyed for WFD fish monitoring

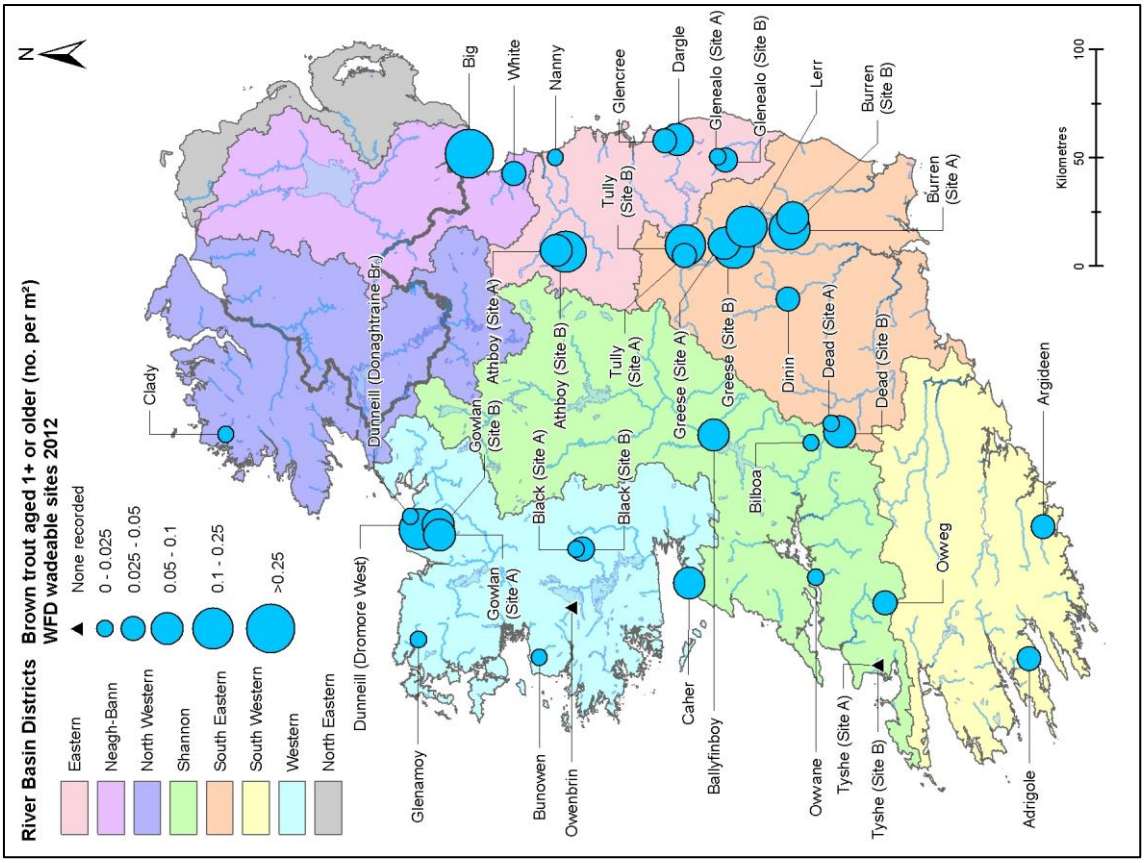

Fig. 4.50. Distribution and abundance of 1+ or older brown trout at wadeable river sites surveyed for WFD fish monitoring 2012

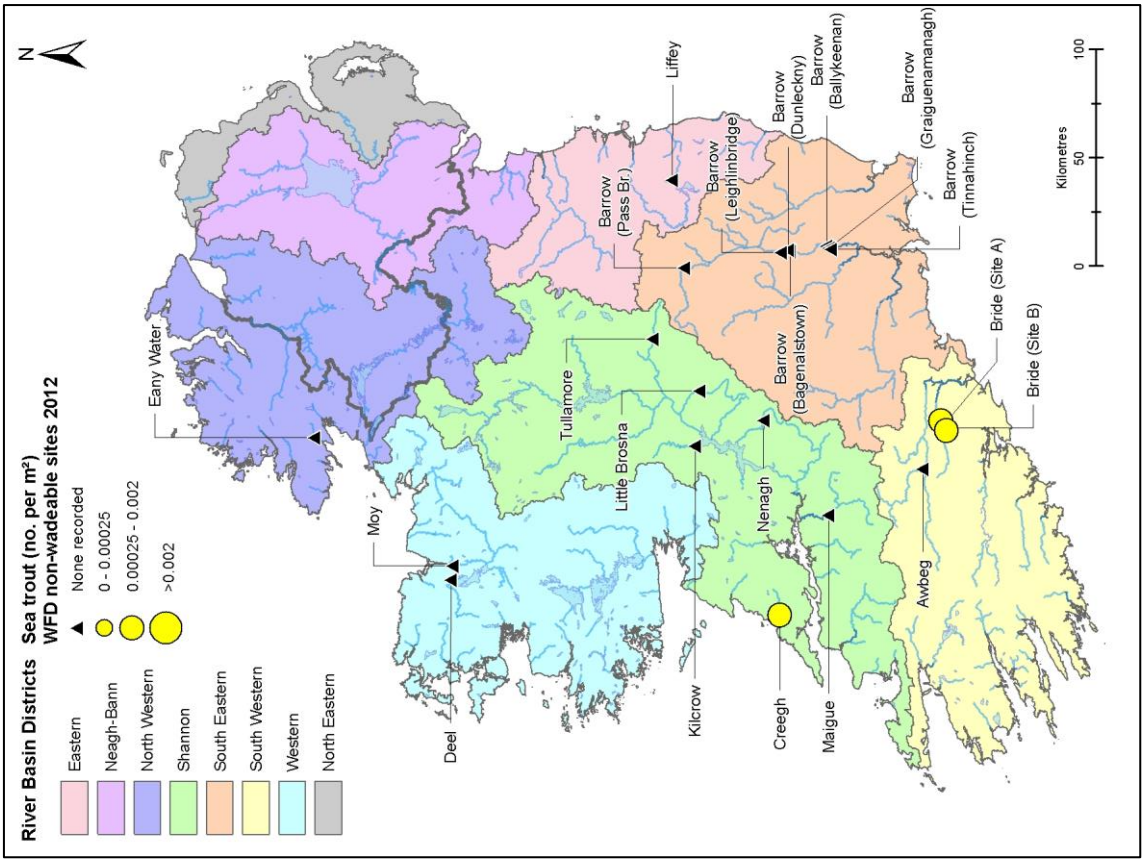

Fig. 4.53. Distribution and abundance of sea trout at non-wadeable river sites surveyed for WFD fish monitoring 2012

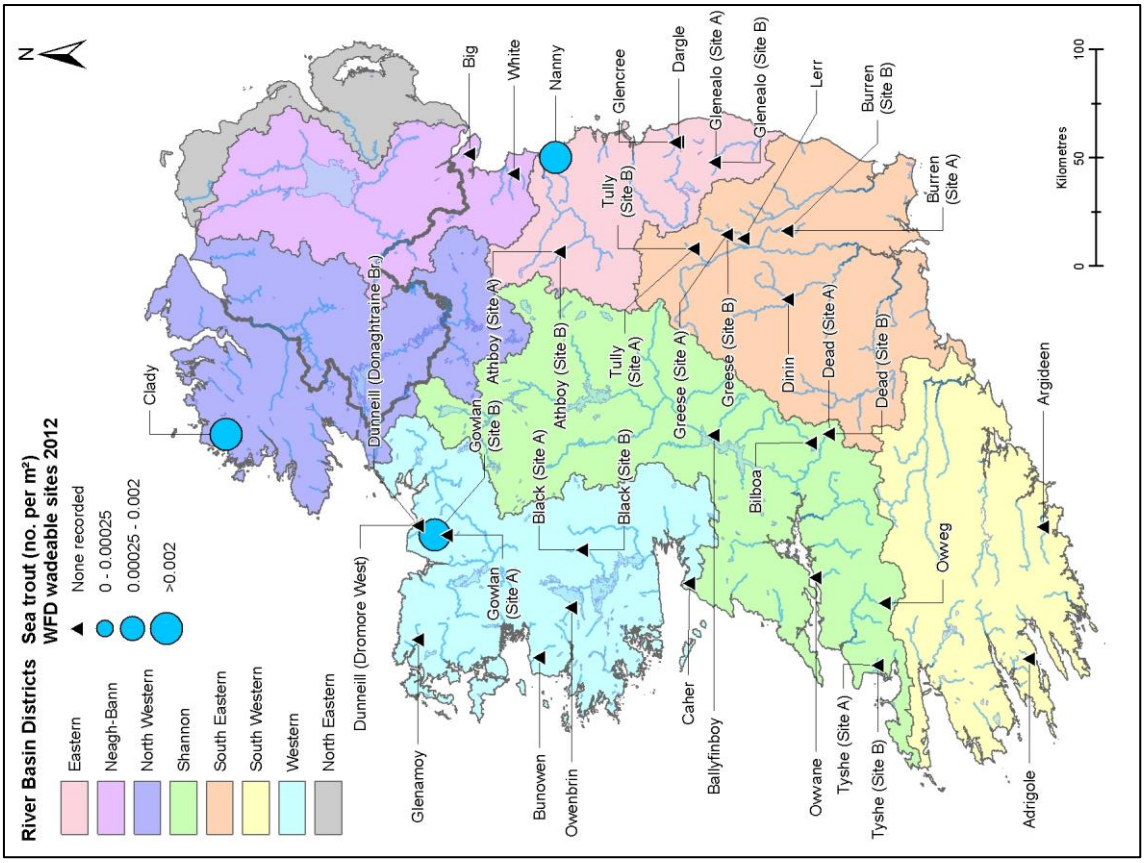

Fig. 4.52. Distribution and abundance of sea trout at wadeable river sites surveyed for WFD fish monitoring 2012

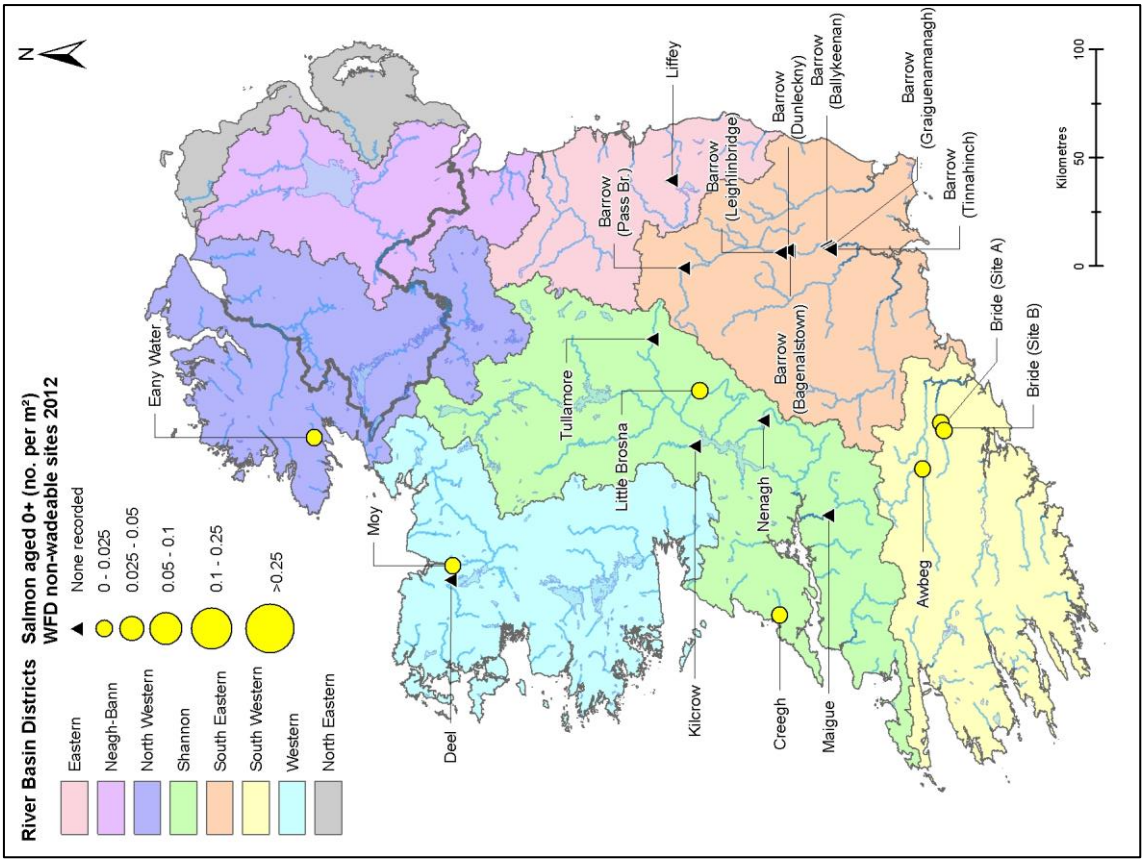

Fig. 4.55. Distribution and abundance of 0+ salmon at non-wadeable river sites surveyed for WFD fish monitoring 2012

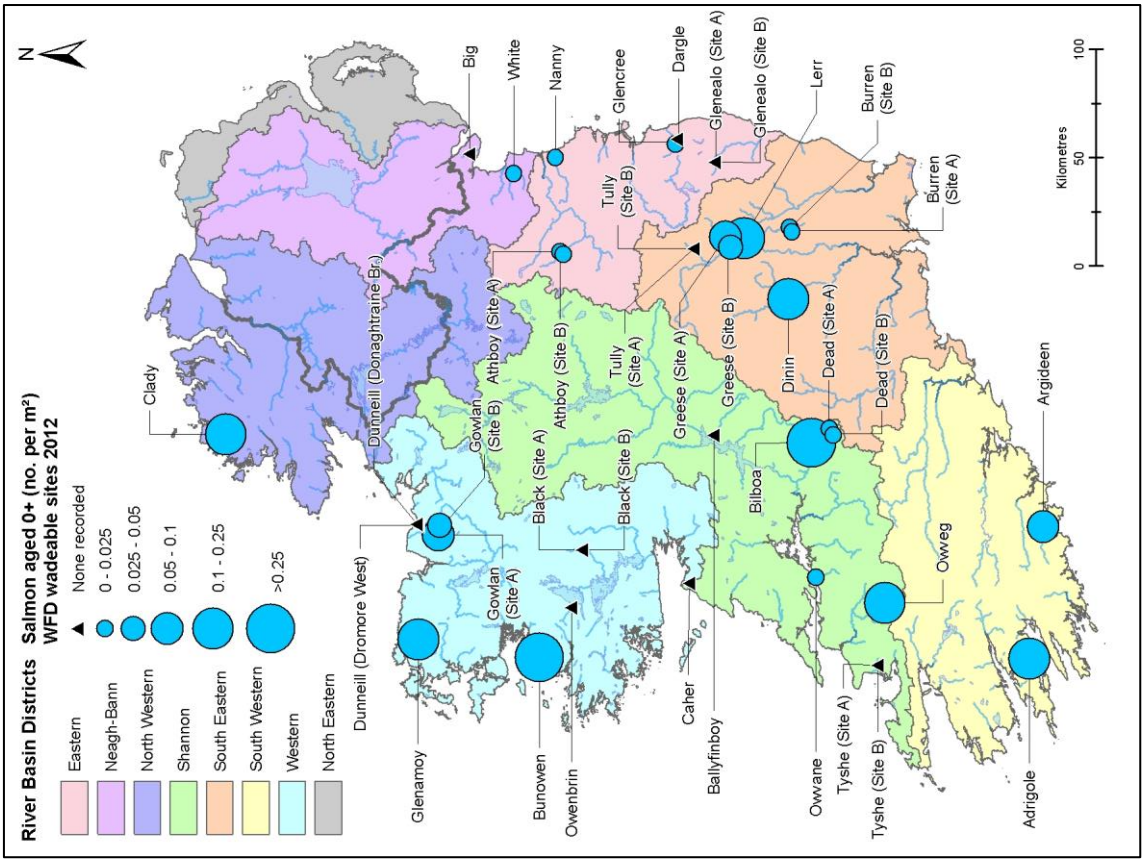

Fig. 4.54. Distribution and abundance of 0+ salmon at wadeable river sites surveyed for WFD fish monitoring 2012

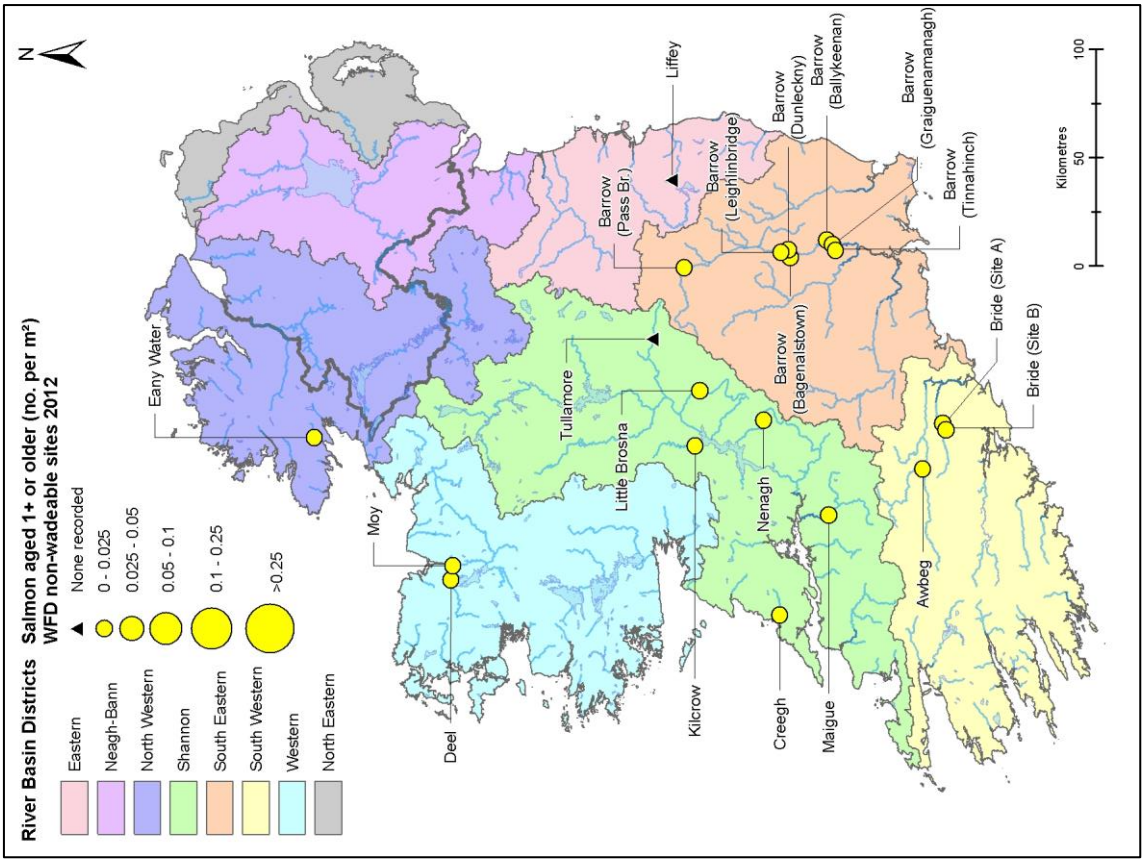

Fig. 4.57. Distribution and abundance of 1+ or older salmon at non-wadeable river sites surveyed for WFD fish monitoring 2012

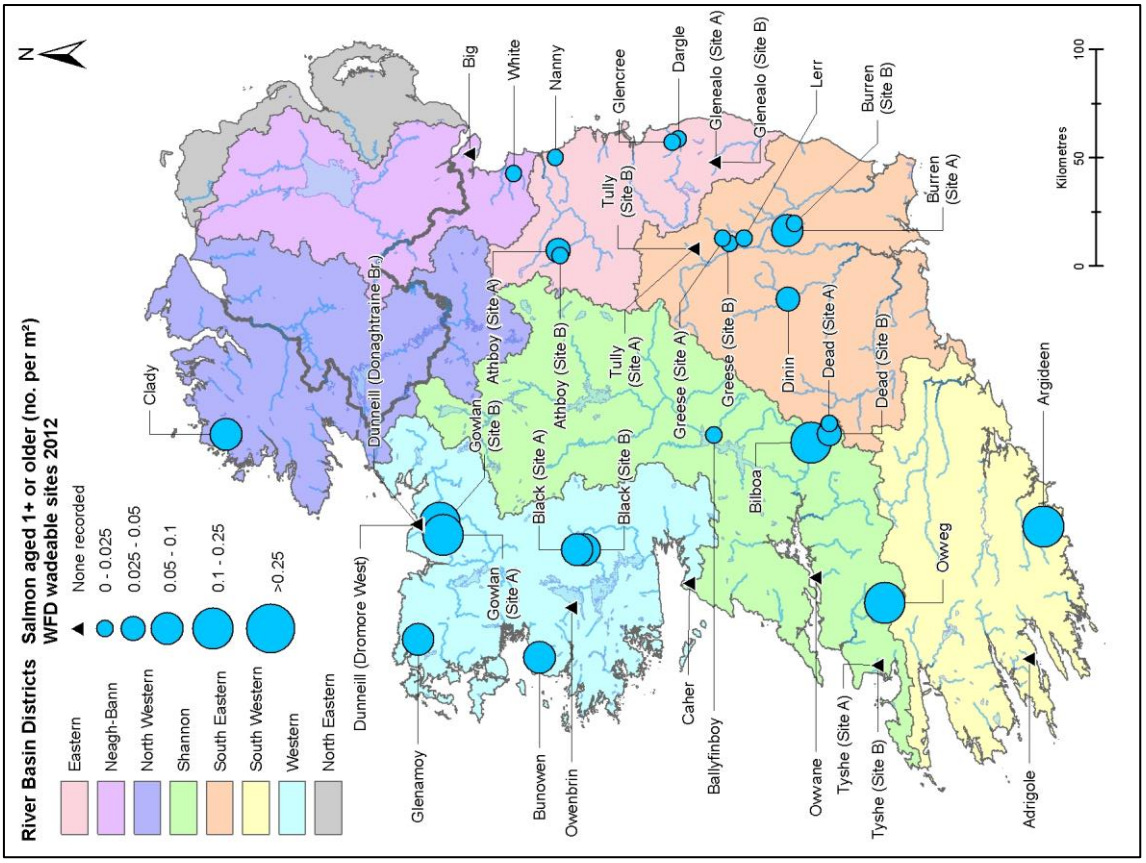

Fig. 4.56. Distribution and abundance of 1+ or older salmon at wadeable river sites surveyed for WFD fish monitoring 2012

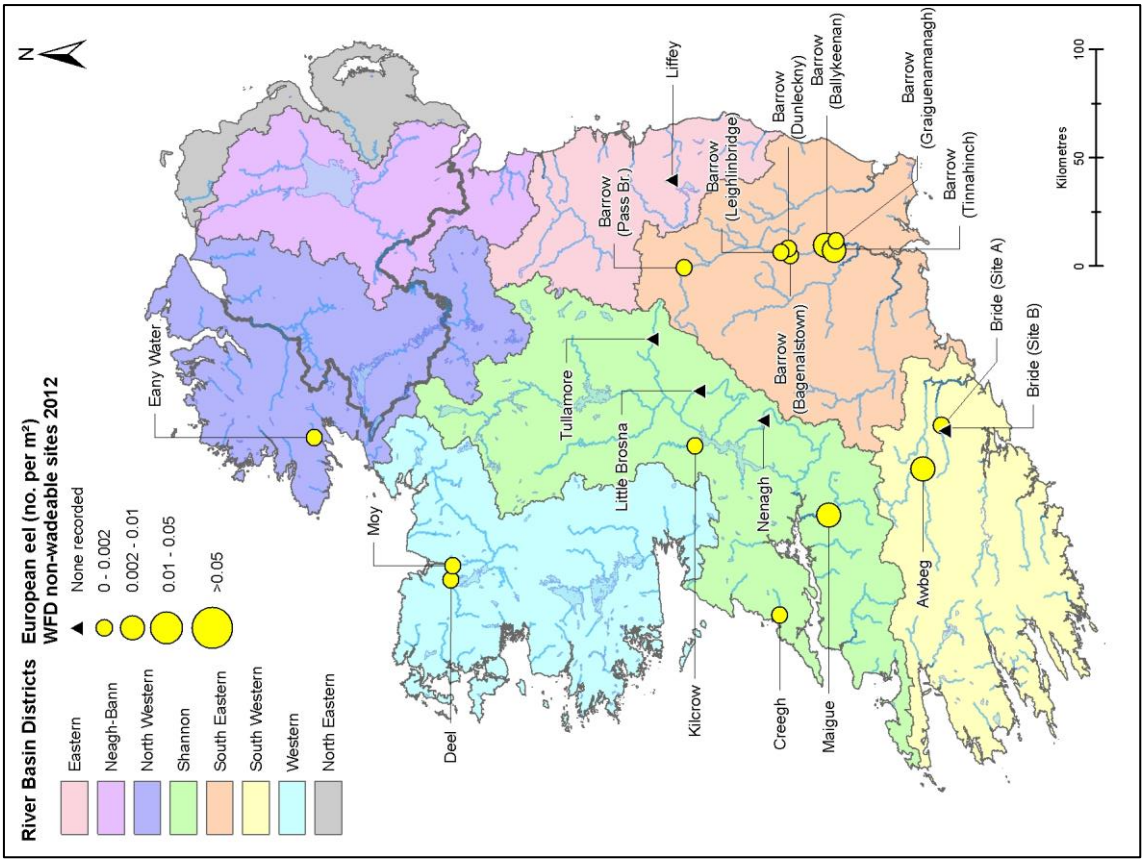

Fig. 4.59. Distribution and abundance of European eel at non-wadeable river sites surveyed for WFD fish monitoring 2012

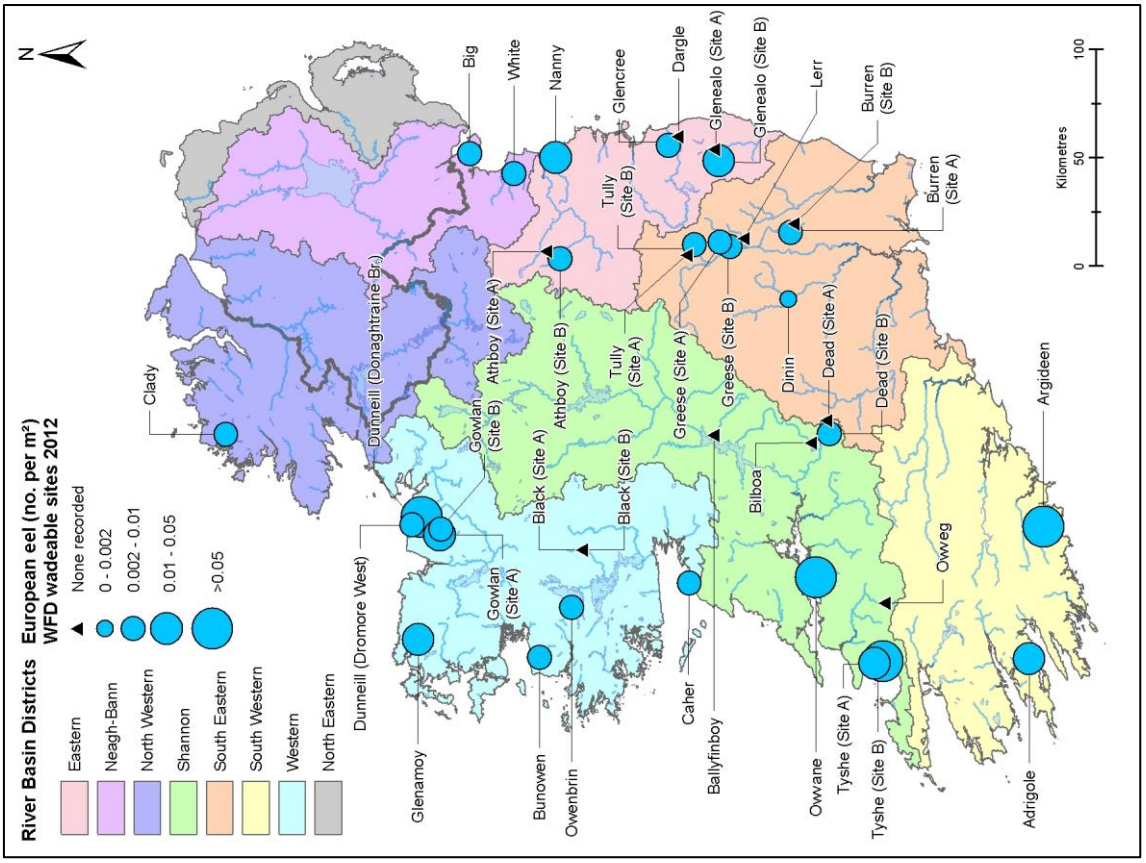

Fig. 4.58. Distribution and abundance of European eel at wadeable river sites surveyed for WFD fish monitoring 2012

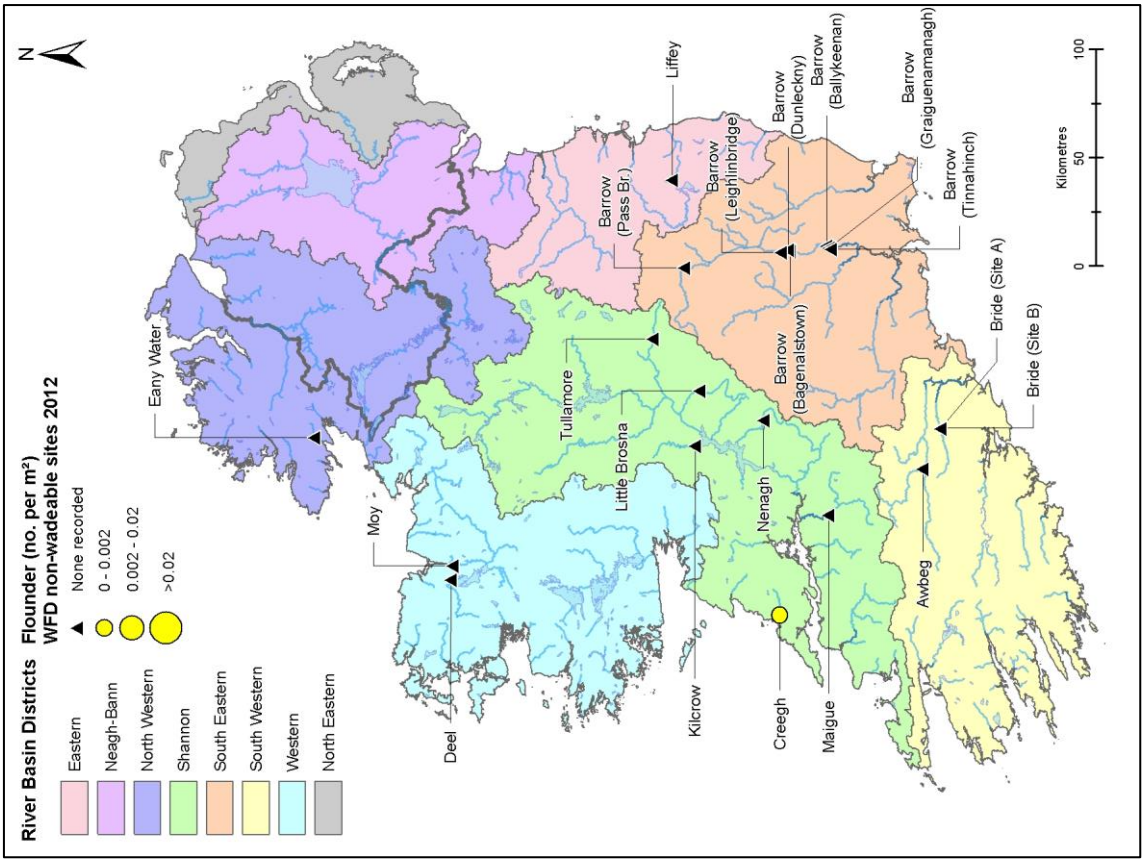

Fig. 4.61. Distribution and abundance of flounder at non-wadeable river sites surveyed for WFD fish monitoring 2012

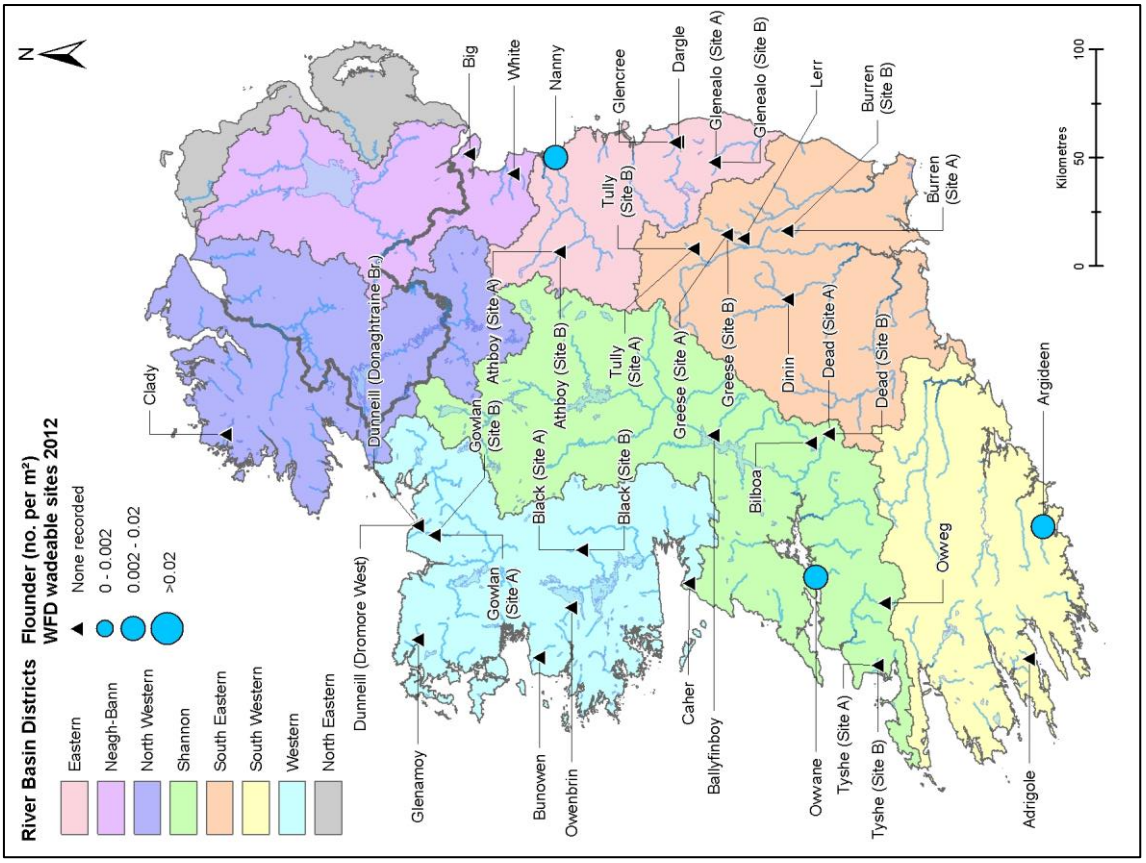

Fig. 4.60. Distribution and abundance of flounder at wadeable river sites surveyed for WFD fish monitoring 2012

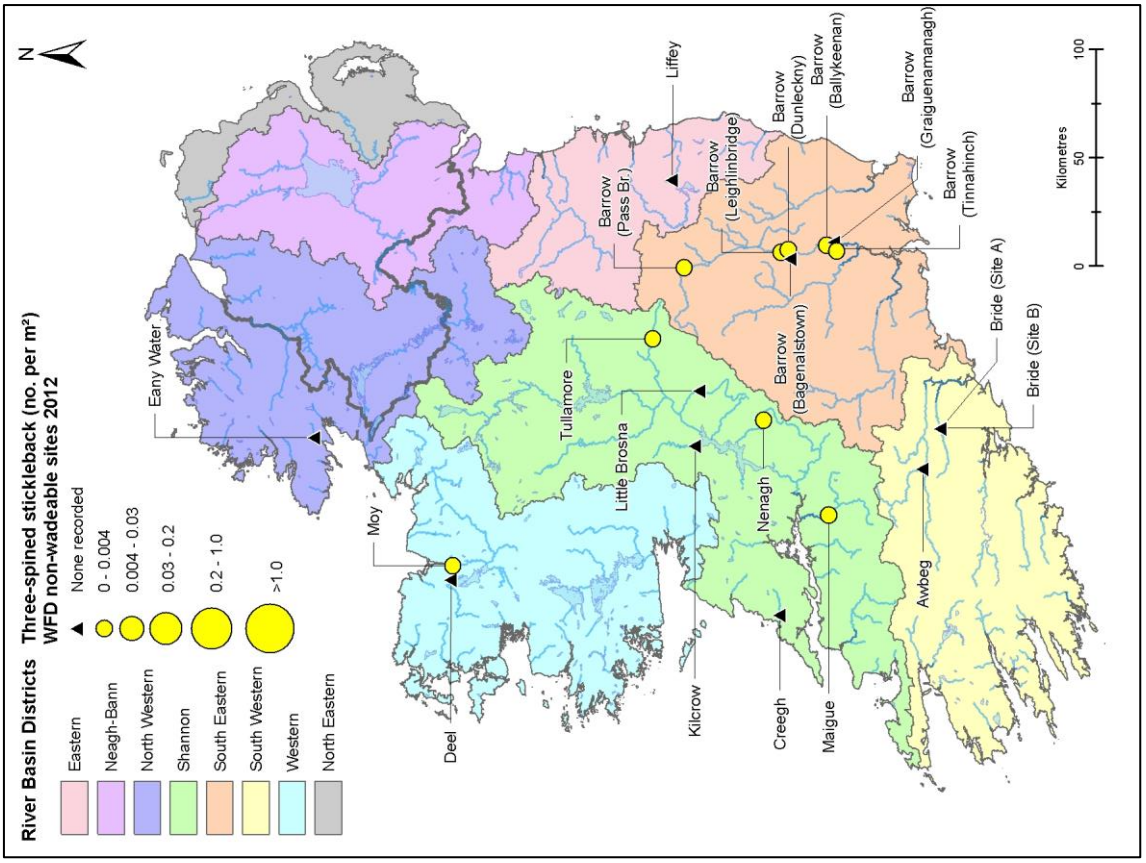

Fig. 4.63. Distribution and abundance of three-spined stickleback at non-wadeable river sites surveyed for WFD fish monitoring

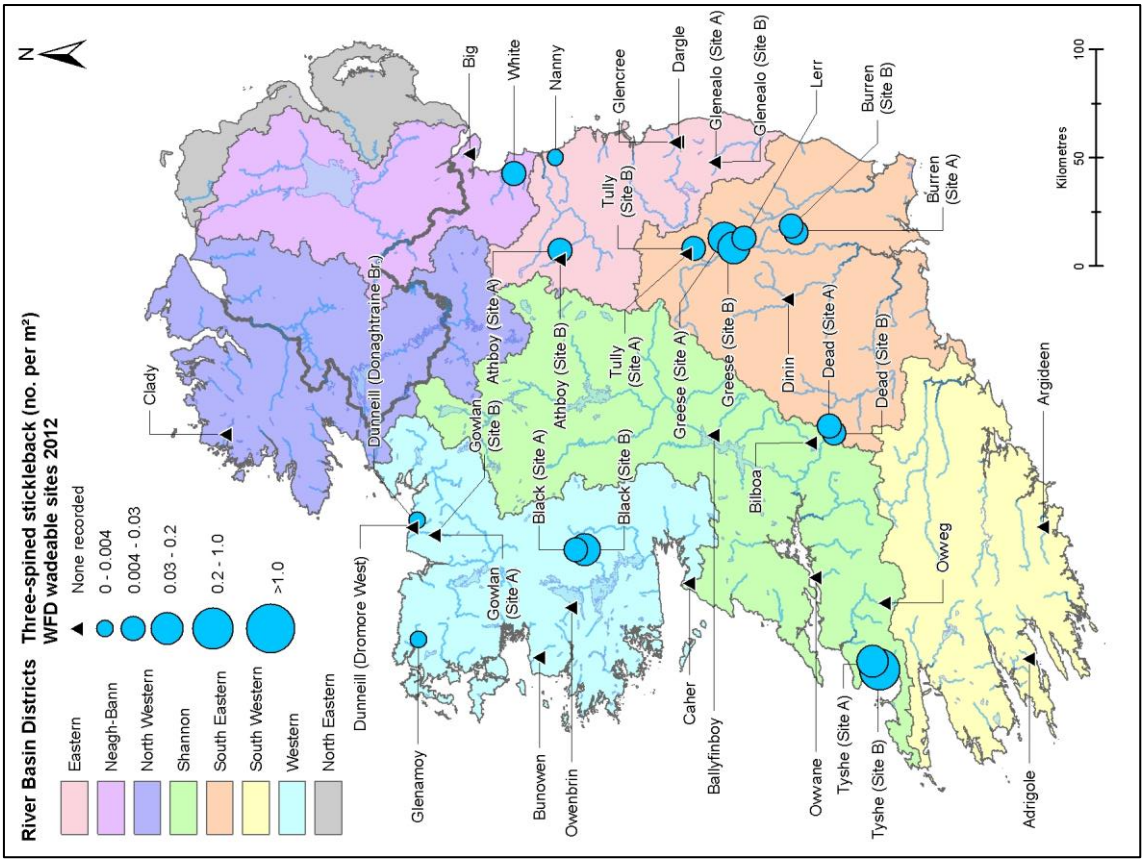

Fig. 4.62. Distribution and abundance of three-spined stickleback at wadeable river sites surveyed for WFD fish monitoring 2012

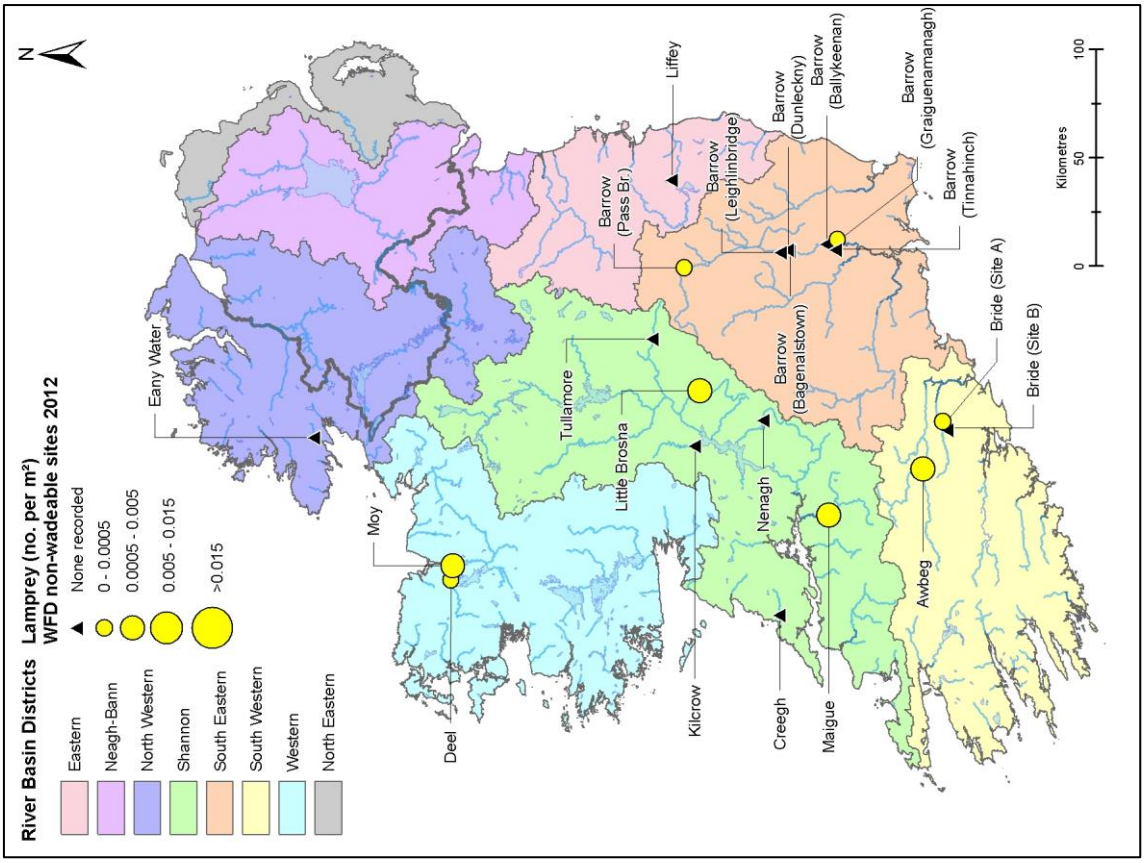

Fig. 4.65. Distribution and abundance of lamprey at non-wadeable river sites surveyed for WFD fish monitoring 2012

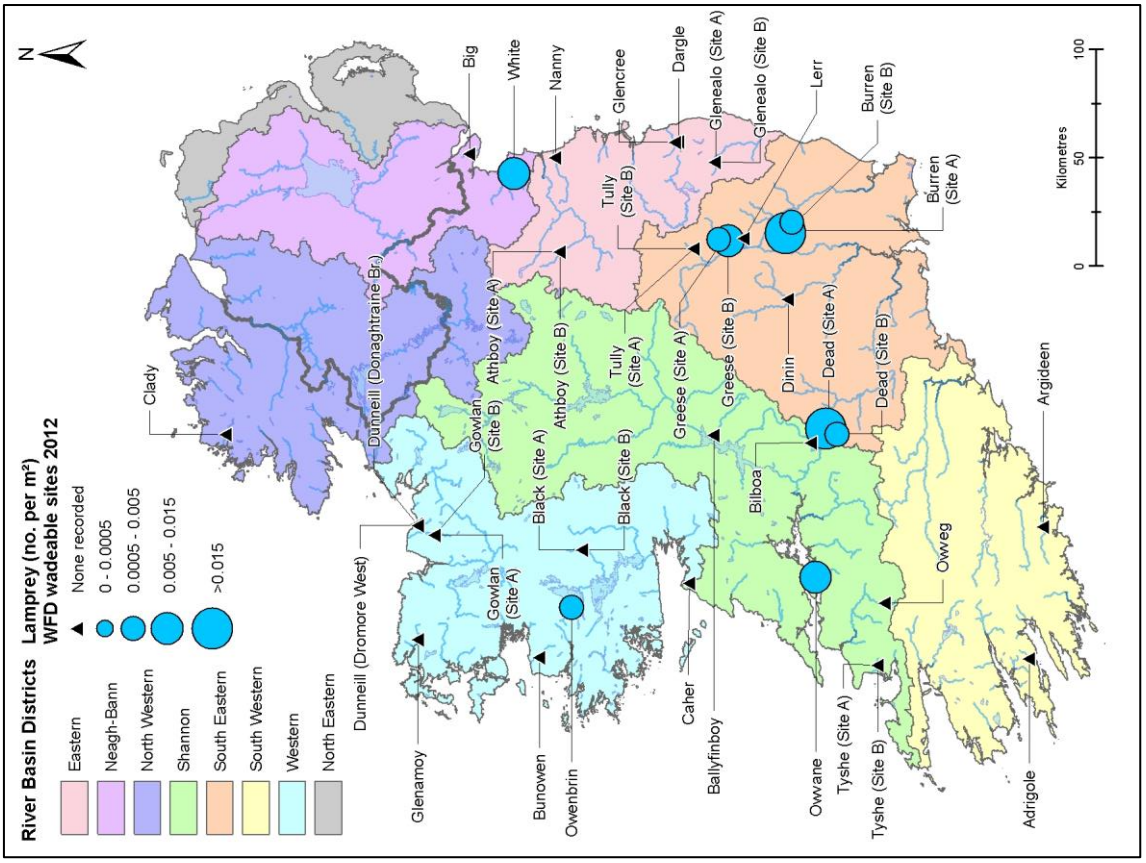

Fig. 4.64. Distribution and abundance of lamprey at wadeable river sites surveyed for WFD fish monitoring 2012

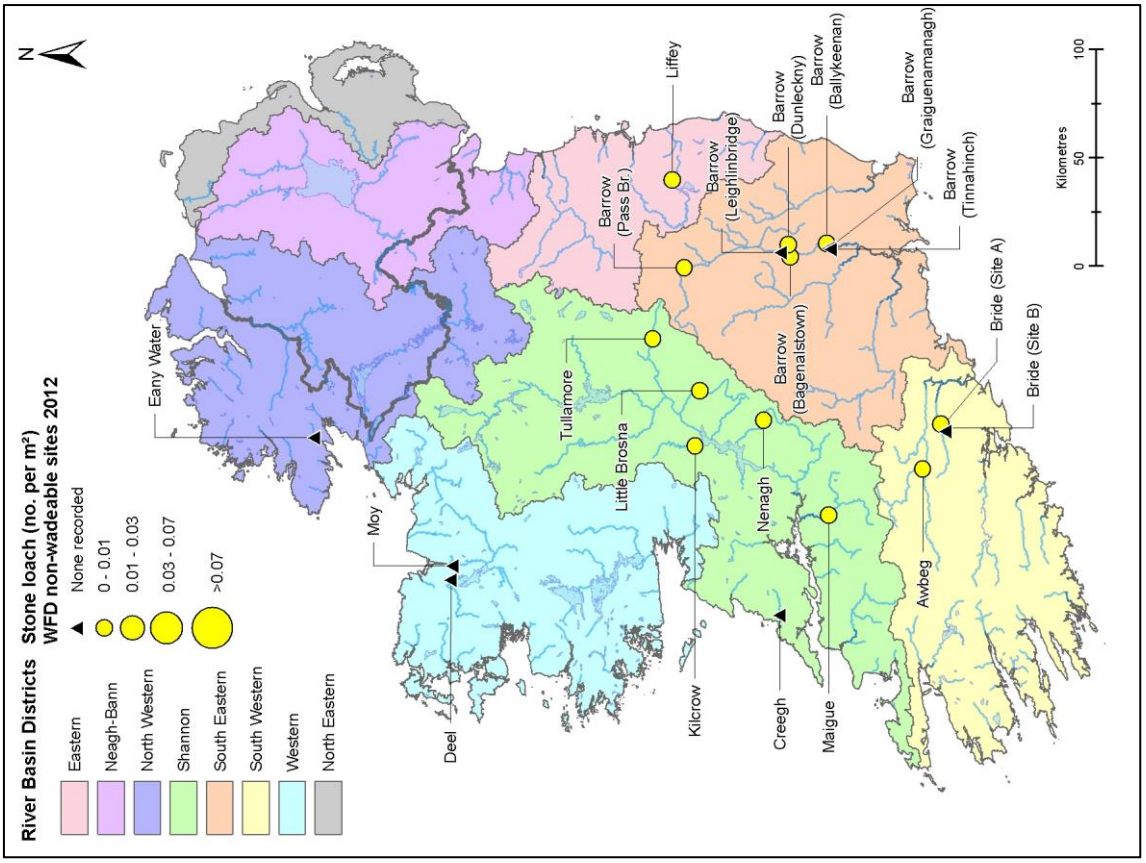

Fig. 4.67. Distribution and abundance of stone loach at non-wadeable river sites surveyed for WFD fish monitoring 2012

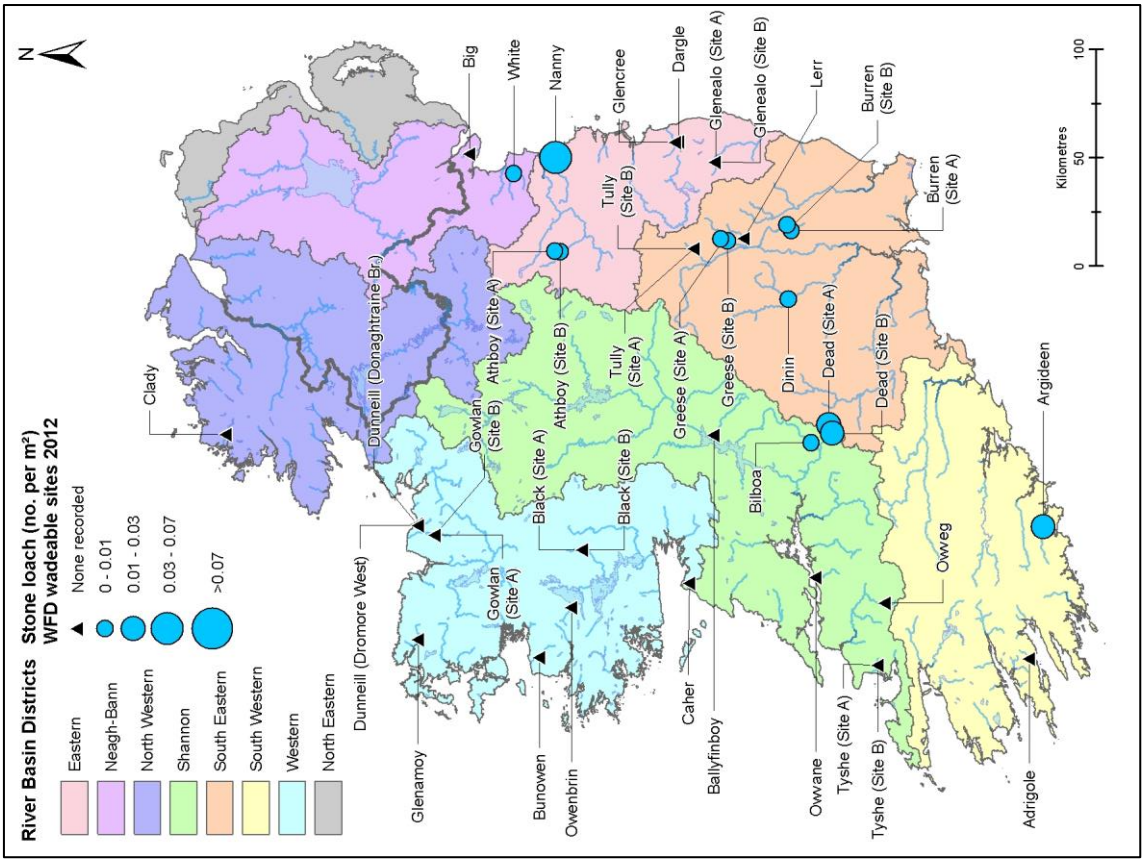

Fig. 4.66. Distribution and abundance of stone loach at wadeable river sites surveyed for WFD fish monitoring 2012

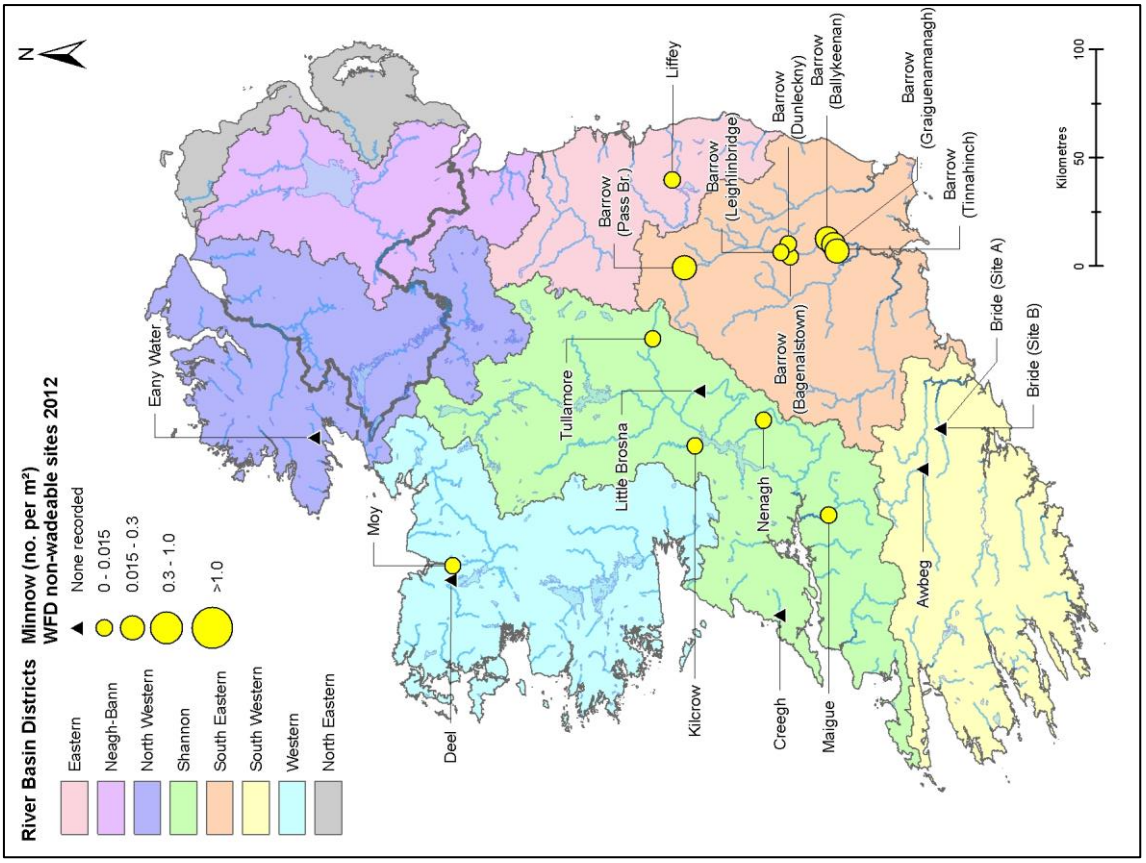

Fig. 4.69. Distribution and abundance of minnow at non-wadeable river sites surveyed for WFD fish monitoring 2012

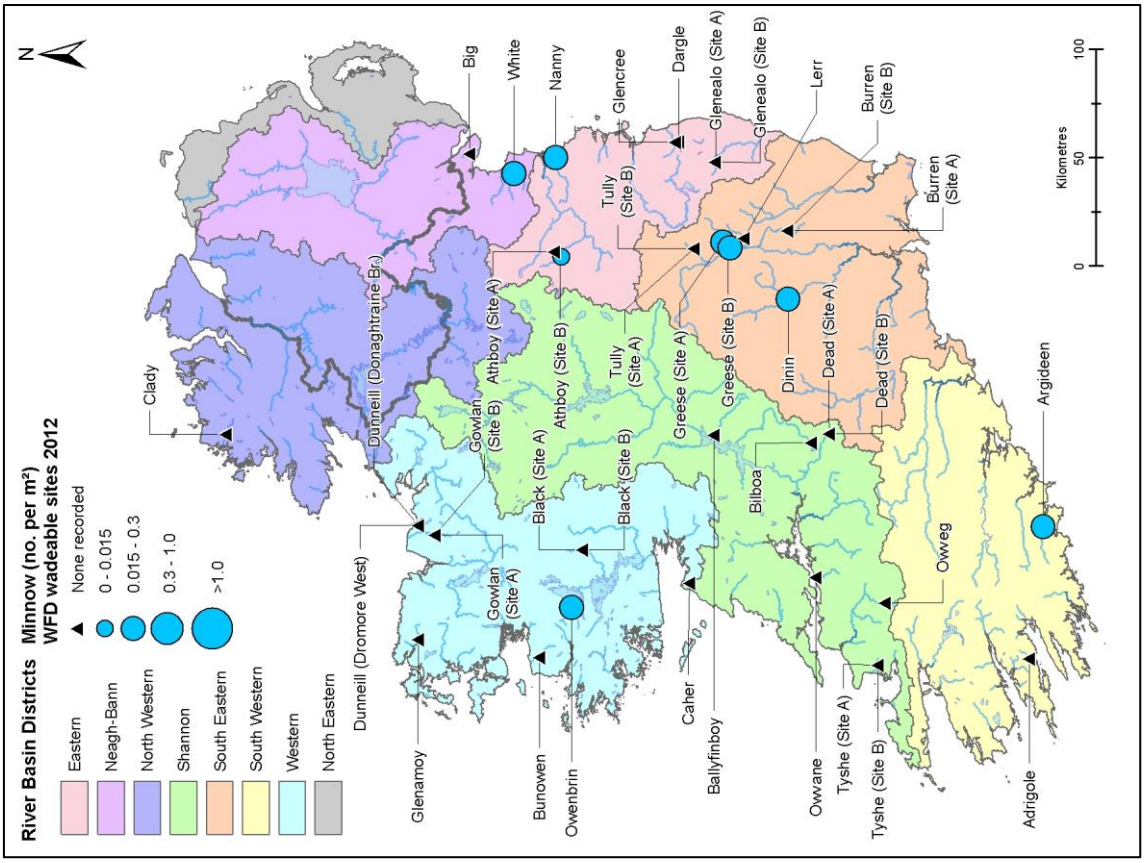

Fig. 4.68. Distribution and abundance of minnow at wadeable river sites surveyed for WFD fish monitoring 2012

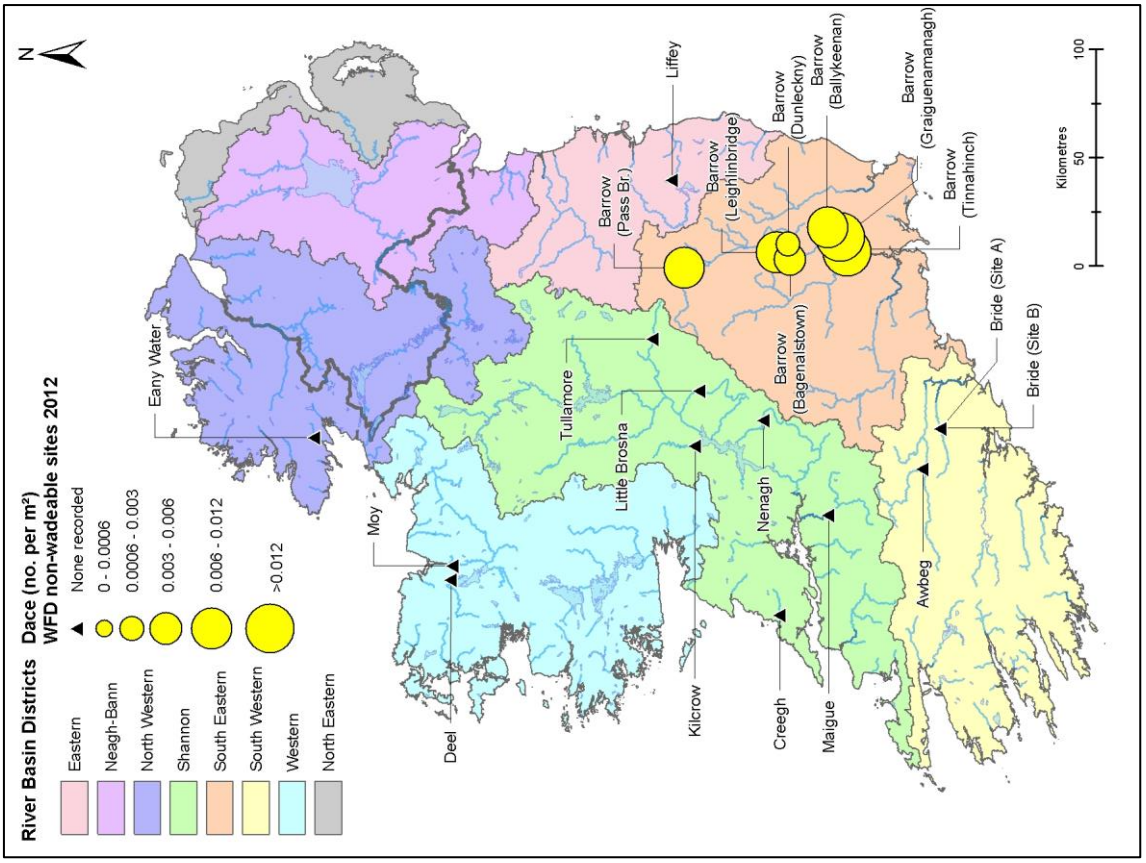

Fig. 4.71. Distribution and abundance of dace at non-wadeable river sites surveyed for WFD fish monitoring 2012

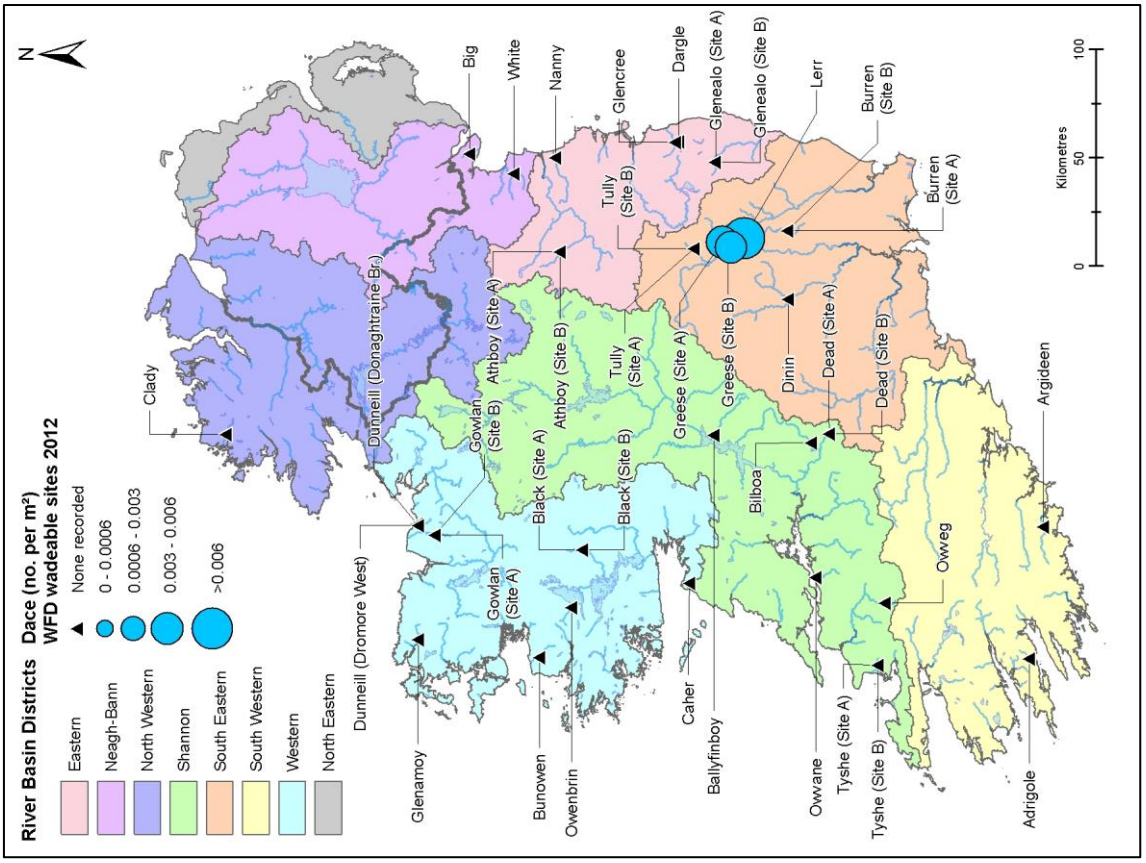

Fig. 4.70. Distribution and abundance of dace at wadeable river sites surveyed for WFD fish monitoring 2012

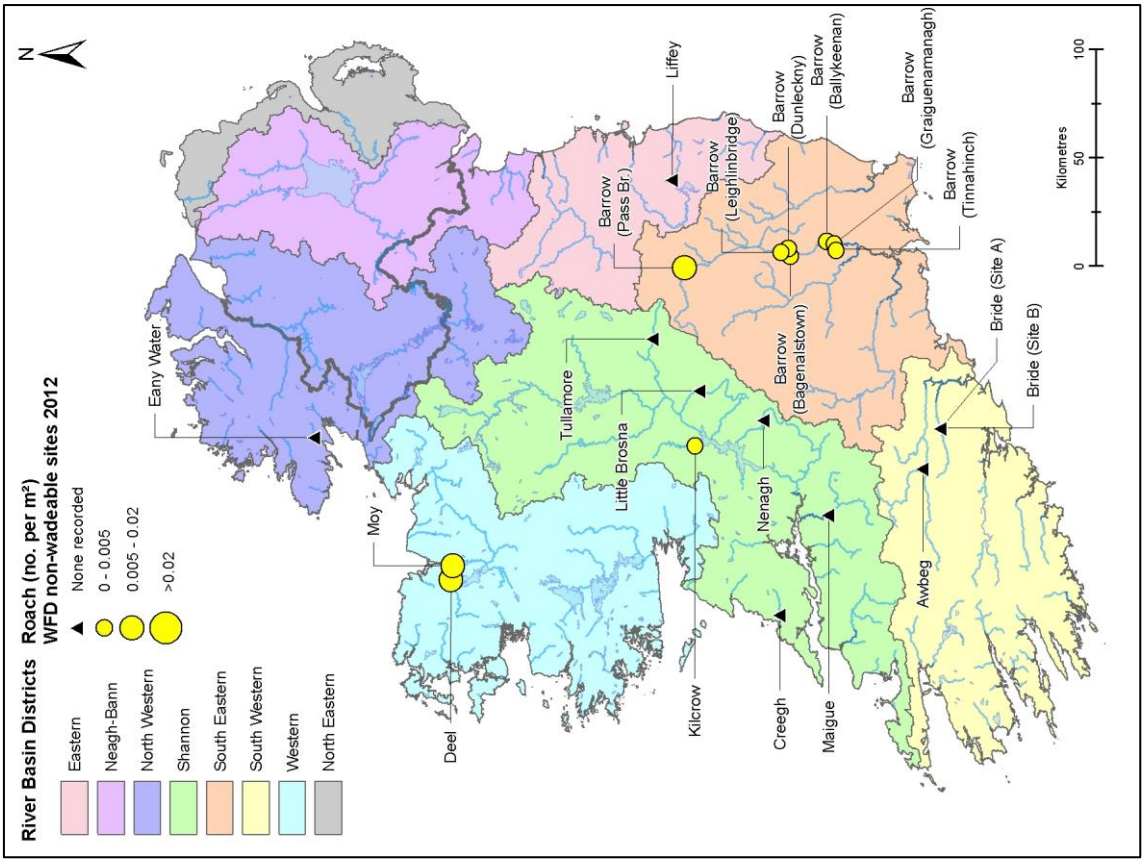

Fig. 4.73. Distribution and abundance of roach at non-wadeable river sites surveyed for WFD fish monitoring 2012

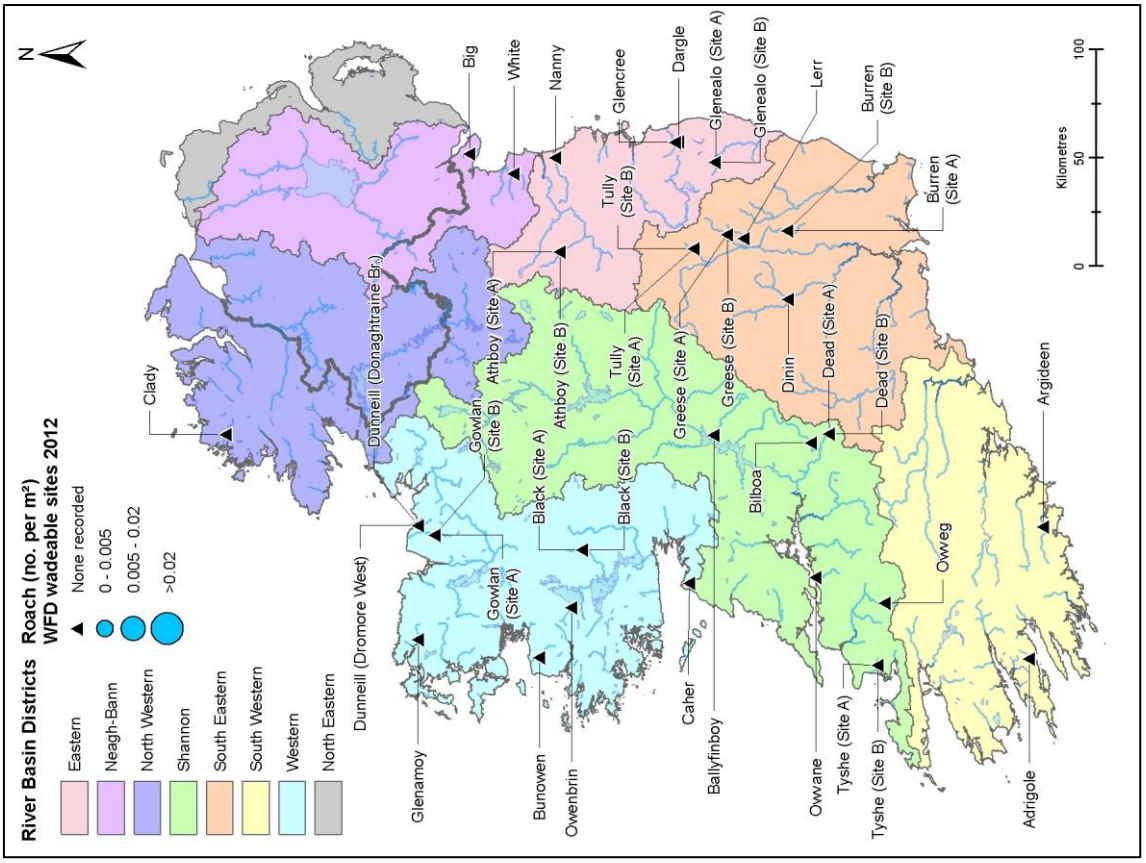

Fig. 4.72. Distribution and abundance of roach at wadeable river sites surveyed for WFD fish monitoring 2012

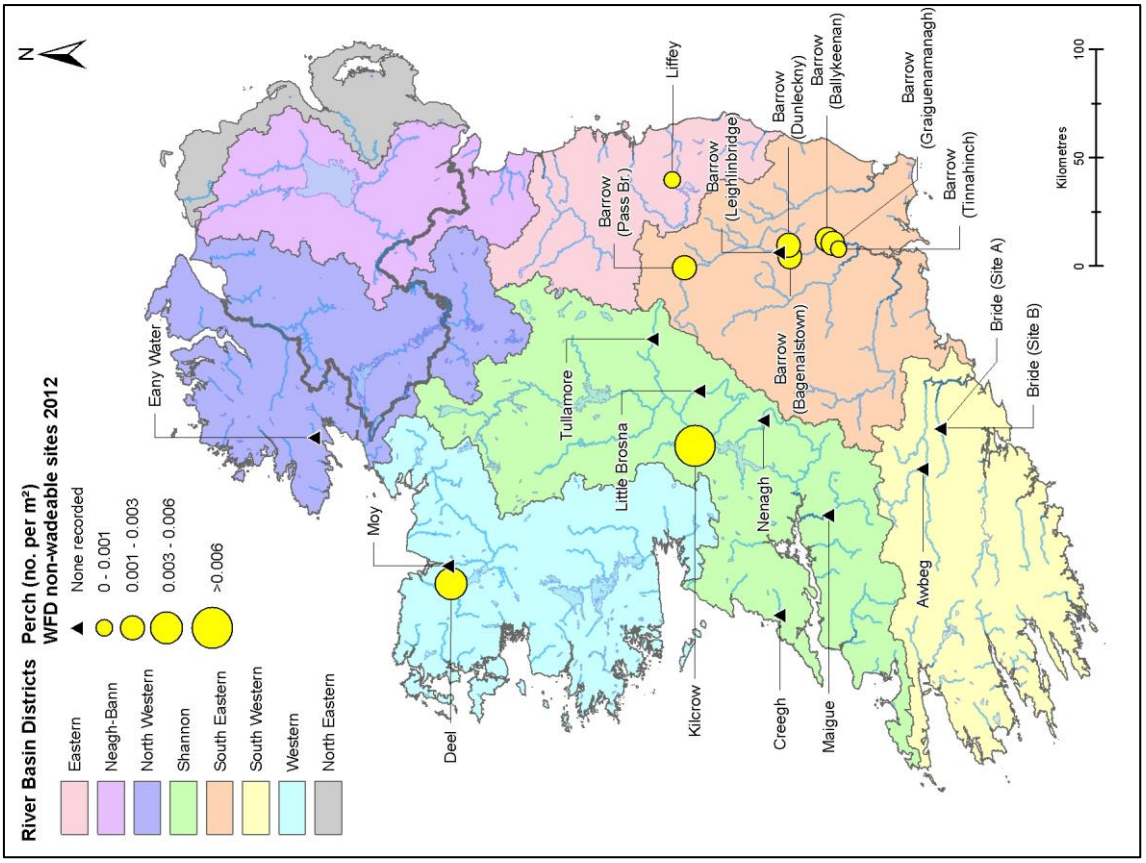

Fig. 4.75. Distribution and abundance of perch at non-wadeable river sites surveyed for WFD fish monitoring 2012

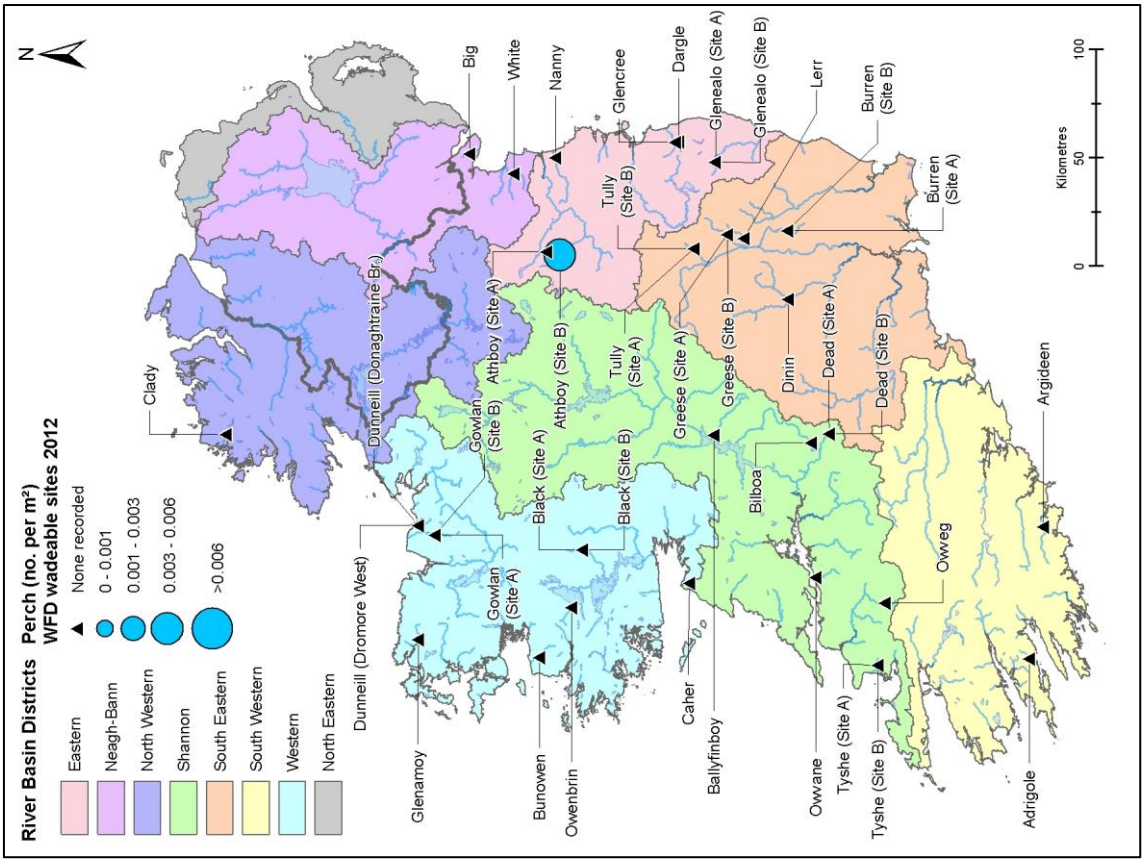

Fig. 4.74. Distribution and abundance of perch at wadeable river sites surveyed for WFD fish monitoring 2012

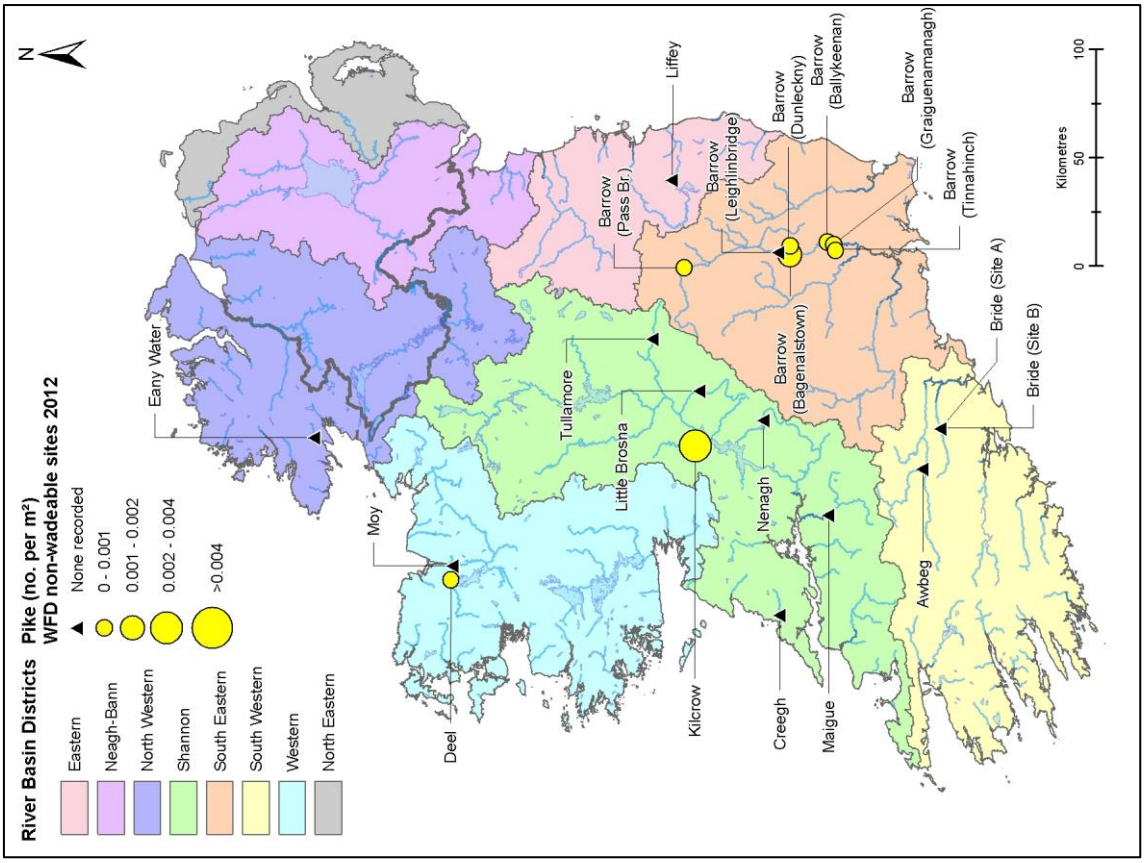

Fig. 4.77. Distribution and abundance of pike at non-wadeable river sites surveyed for WFD fish monitoring 2012

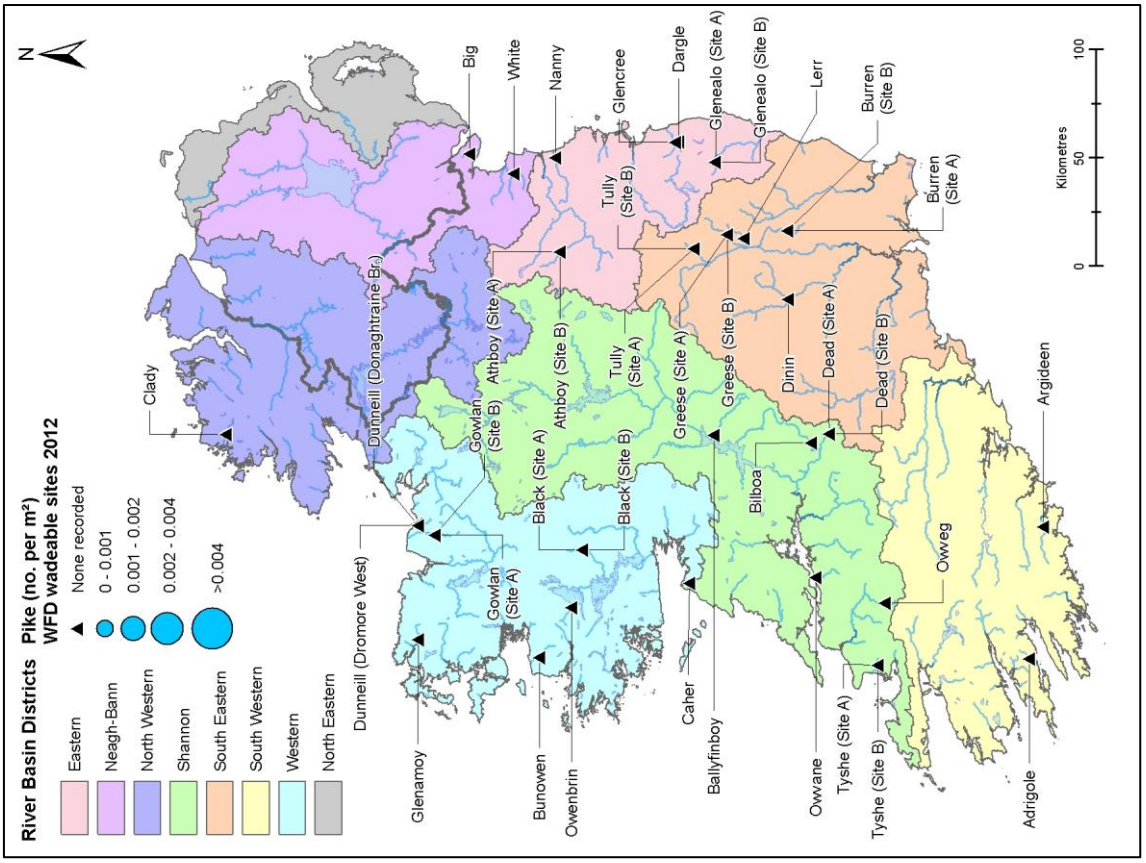

Fig. 4.76. Distribution and abundance of pike at wadeable river sites surveyed for WFD fish monitoring 2012

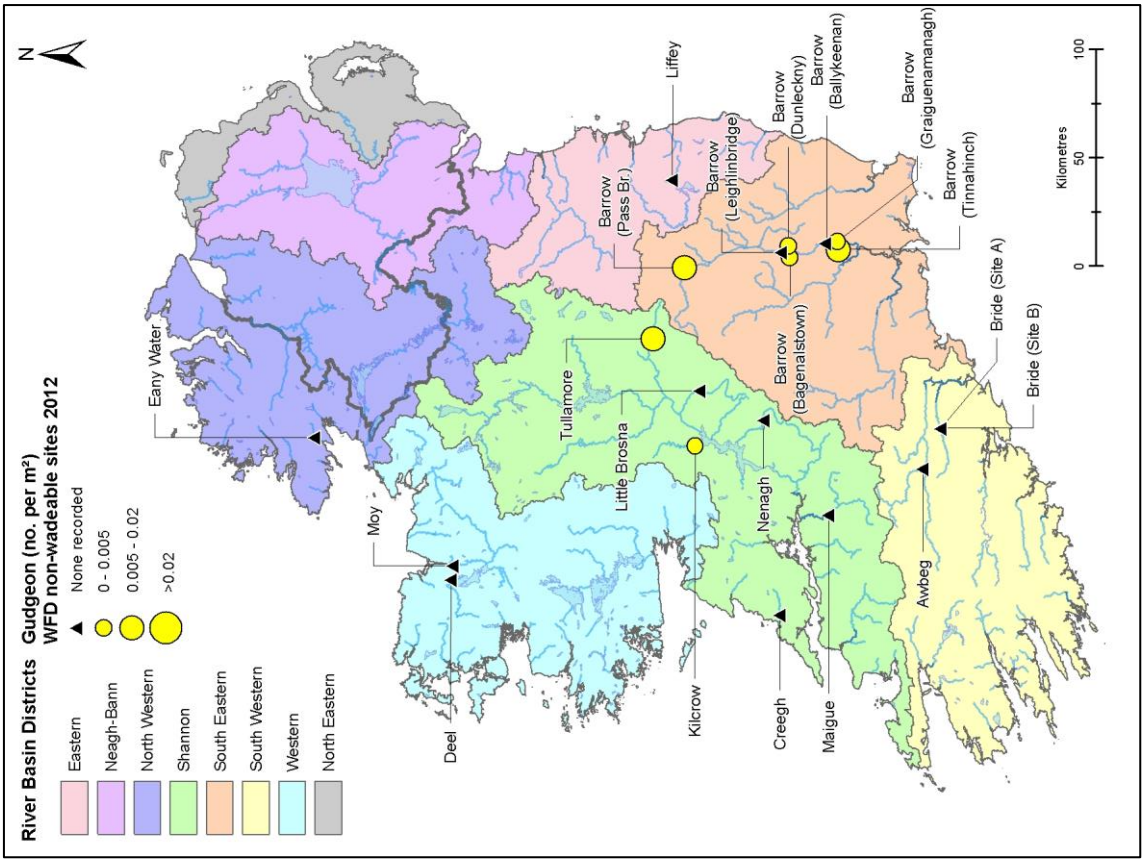

Fig. 4.79. Distribution and abundance of gudgeon at non-wadeable river sites surveyed for WFD fish monitoring 2012

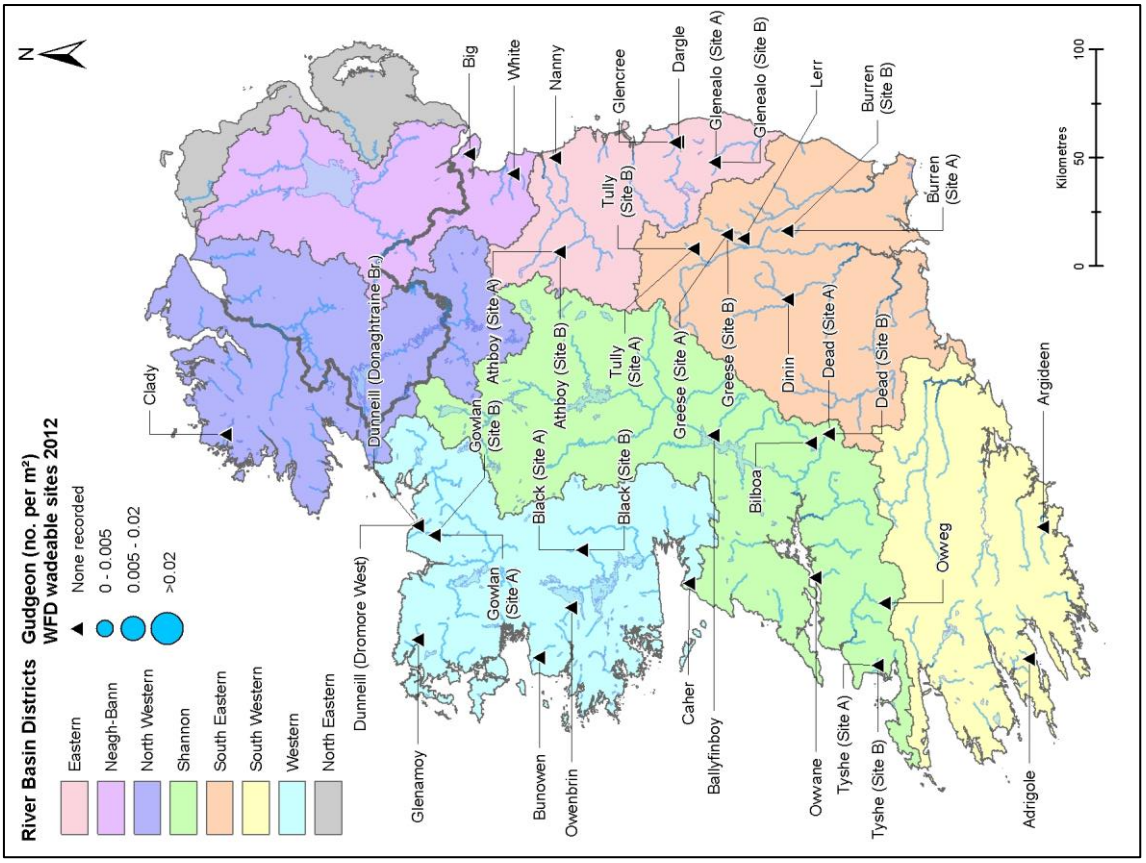

Fig. 4.78. Distribution and abundance of gudgeon at wadeable river sites surveyed for WFD fish monitoring 2012

4.2.3 Fish Growth

Scales from a total of 1,025 brown trout (54 sites), 525 salmon (43 sites), 12 sea trout (six sites), 164 roach (10 sites), 39 pike (eight sites), 296 dace (10 sites), four roach x bream hybrids (two sites) and one bream were examined for age and growth analysis. Where large numbers of any species were captured at a site, scales were analysed from a sub-sample of five fish within each 1cm size class.

Brown trout ages ranged from 0+ to 5+. Fry (0+) made up 15% of the fish for which scales were examined, 42% were aged 1+ and 33% were aged 2+. Older fish were relatively rare and accounted for only 9% 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 Kilcrow River (ShIRBD), measured 44.1cm and weighed 940g. It was not aged as there were no readable scales. Appendix 7 provides a summary of the mean back-calculated lengths at age of brown trout in the sites surveyed.

A range of sea trout ages were recorded during the 2012 surveys and are explained below. A one year old smolt, spent one full year at sea and returned to the river the following year with no spawning mark present, known as a 1sw (sea winter) maiden, (1.1+, total age 2+) (one individual). A 2-year smolt, that returned to freshwater after only a few months at sea, also known as a "finnock" (2.0+, total age 2+) (three individuals). A 2-year smolt that went to sea for a few months, returned to the river to spawn (finnock spawner), went out to sea again and was captured on its freshwater return later that year. (2.0+1 SM+, total age 3+) (one individual). A 2-year old smolt with additional spring growth from estuarine feeding prior to going to sea (denoted by the "B") for a few months (finnock, 2B.0+, total age 2+) (one individual). A 3-year old smolt that returned to freshwater after only a few months at sea (finnock, 3.0+, total age 3+) (five individuals). A 3-year old smolt that returned to freshwater after only a few months at sea but also displays some secondary growth from estuarine feeding prior to going to sea (finnock, 3B.0+, total age 3+) (one individual). In total, one sea winter maiden, one finnock spawner and 10 finnock sea trout were recorded in 2012.

Salmon ages ranged from 0+ to 3+. Fry (0+) made up 17.5% of the fish for which scales were examined, and the remaining fish examined were composed of juveniles aged 1+ and 2+, which accounted for 75% and 7.5% of the population respectively. Only a single individual aged 3+ was recorded. The capture of adult salmon was avoided during these surveys. The largest juvenile salmon recorded was a smolt measuring 19.7cm in length and 99g in weight, captured in the Little Brosna. Appendix 8 shows a summary of the mean back-calculated length at age data for salmon in the sites surveyed.

Roach ranged in age from 0+ to 7+, with the largest roach recorded measuring 26.9cm in length, weighing 429g and aged 7+. It was caught in the River Barrow at Dunleckny. The largest pike

recorded was an individual measuring 70.0cm, weighing 2.6kg and aged 4+. It was caught in the River Barrow at upper Tinnahinch Lock.

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 58 river sites surveyed during 2012 is shown in Appendix 7. Brown trout from three river sites were classed as very slow, 14 were classed as slow and nine were classed as 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 2012 using Kennedy and Fitzmaurice (1971)

Very slow	Slow	Fast
Clady River (Donegal)	Adrigole River	Athboy River (Site A)
Dunneill River (Dromore West)	Awbeg River (Buttevant)	Athboy River (Site B)
Gowlan River (Site B)	Bilboa River	Bride (Site A)
	Barrow, River (Leighlinbridge)	Bride (Site B)
	Barrow, River (Pass Br.)	Greese, River (Site A)
	Burren River (Site B)	Liffey, River
	Creegh River	Little Brosna River
	Dinin River	Nenagh River
	Glencree River	Tullamore River
	Gowlan River (Site A)	
	Greese, River (Site B)	
	Kilcrow River	
	Tully Stream (Site A)	
	Tully Stream (Site B)	

River sites containing 1+ and older brown trout were divided into three categories based on their alkalinity; these were low = <35 mg$CaCO_3$ l^{-1}, moderate = 35 - 100 mg$CaCO_3$ l^{-1}, and high > 100 mg$CaCO_3$ l^{-1}. Eleven river sites were characterised as low alkalinity, eleven as moderate alkalinity and 32 as high alkalinity. The mean length at age data for each alkalinity category is shown in Fig. 4.80. Statistical analysis (Kruskal-Wallis tests) revealed that there was a significant difference in the mean L1 of brown trout among the three alkalinity groups ($H=7.768$, $df = 2$, $p<0.05$). Using Mann-Whitney *post-hoc* tests, significant differences were found between the low and moderate and low and high alkalinity categories. There was also a significant difference in mean L2 among alkalinity groups ($H=8.695$, $df=2$, $p<0.05$). Mann-Whitney *post-hoc* tests showed significant differences between the low and high alkalinity rivers. Finally, no significant difference was found for L3 between the alkalinity groups. Insufficient data was available to test differences between L4 in each alkalinity type.

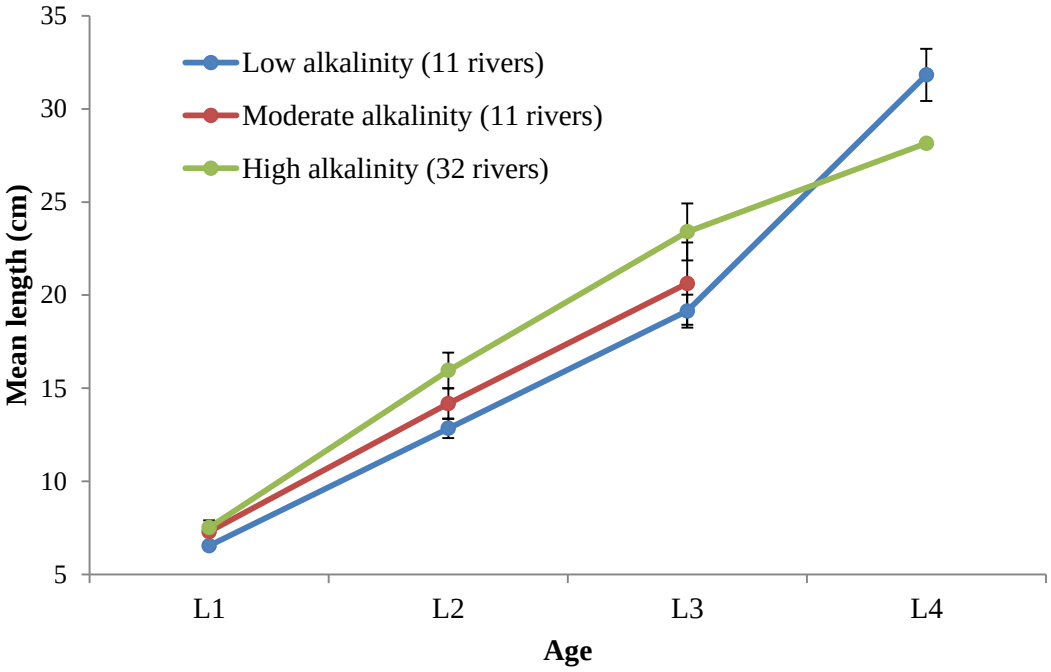

Fig. 4.80. Mean (±S.E.) back calculated lengths at age for brown trout in rivers within each alkalinity class

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

An ecological classification tool for fish in rivers (FCS2 Ireland) has recently been developed for Ecoregion 17 (Republic of Ireland and Northern Ireland), along with a separate version for Scotland to comply with the requirements of the WFD (SNIFFER, 2011). Agencies throughout each of the three regions contributed data which was used in the model development. The tool works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) conditions using a geo-statistical model based on Bayesian probabilities. The resulting output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range, corresponding to the five ecological status classes of High, Good, Moderate, Poor and Bad. Confidence levels are assigned to each class and represented as probabilities. This tool has successfully completed the recent EU wide intercalibration exercise in order to standardise results across Europe. FCS2 Ireland has been used, along with expert opinion, to classify 56 of the 58 river sites surveyed during 2012; three river sites were classified as High (5.4%), 34 as Good (60.7%), 15 as Moderate (26.8%), and four as Poor (7.1%) (Table 4.9, Fig. 4.81). The River Moy and River Barrow at Bagenalstown were not classified due to river conditions during the time of the survey being inappropriate for the collection of reliable data.

Table 4.9. Ecological status of river sites surveyed for fish in 2012 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site Code	Site name	Previous ecological status	Ecological status 2012
ERBD Wadeable sites				
Athboy	07A010100A	Br. nr Clonleasan Ho_A	Good (2009)	Good (54%)
Athboy	07A010100B	Br. nr Clonleasan Ho_B	N/A	Moderate (80%)
Dargle	10D010005A	Bahana_A	N/A	Good
Glencree	10G010200A	Br. u/s Dargle R confl_A	Good (2009) (98%)	Good (52%)
Glenealo	10G050200A	Br. d/s Upper Lake_A	Moderate (2009)	Moderate
Glenealo	10G050200B	Br. d/s Upper Lake_B	N/A	Moderate (53%)
Nanny (Meath)	08N010700A	Br. at Julianstown_A	Moderate (2009)	Moderate (58%)
ERBD Non-Wadeable sites				
Liffey	09L010250A	500 m d/s Ballyward Br._A	Good (2009)	Good
NBIRBD Wadeable sites				
Big (Louth)	06B010100A	Ballygoly Br._A	Good (2009) (73%)	Good (86%)
White (Louth)	06W010500B	Coneyburrow Br._B	Moderate (2009)	Poor
NWIRBD Wadeable sites				
Clady (Donegal)	38C040150A	Bryan's Br._A	Good (2009) (72%)	High (100%)
NWIRBD Non-Wadeable sites				
Eany Water	37E030300A	Just d/s Eany Beg/More confl_A	Good (2008)	Good
SERBD Wadeable sites				
Burren	14B050100A	Ullard Br._A	Moderate (2009)	Moderate
Burren	14B050100B	Ullard Br._B	N/A	Moderate (82%)
Dinin	15D020800A	Dinin Br._A	Good (2009) (57%)	Good
Greese	14G040350A	Br. NE of Belan House_A	Moderate (2009)	Good
Greese	14G040350B	Br. NE of Belan House_B	N/A	Good
Lerr	14L010200A	Prumplestown Br._A	N/A	Moderate (61%)
Tully Stream	14T020390A	Soomeragh Br._A	Moderate (2009) (98%)	Poor (98%)
Tully Stream	14T020390B	Soomeragh Br._B	Moderate (2009) (83%)	Moderate (99%)
SERBD Non-Wadeable sites				
Barrow	14B012870A	Bagenalstown (Slipway to lock)_A	N/A	N/A
Barrow	14B013440A	Ballykeenan Lock_A	N/A	Good (54%)
Barrow	14B012820A	Dunleckny (Swimming pool)_A	N/A	Good (63%)
Barrow	14B013500A	Graiguenamanagh Br._A	N/A	Good (54%)
Barrow	14B012690A	Leighlinbridge Lord Bagenal Hotel_A	N/A	Moderate (87%)
Barrow	14B011000B	Pass Br._B	N/A	Good
Barrow	14B013510A	Upper Tinnahinch Lock_A	N/A	Good (62%)

Ecological status is subject to change upon review

Table 4.9 ctn. Ecological status of river sites surveyed for fish in 2012 using the FCS2 Ireland classification tool (confidence in class is included in brackets)

River	Site Code	Site name	Previous ecological status	Ecological status 2012
ShIRBD Wadeable sites				
Ballyfinboy	25B020750A	Ballinderry Br._A	N/A	Moderate
Bilboa	25B030080A	Br. u/s Blackboy Br. Bilboa Br_A	High (2009) (99%)	High
Caher	28C010200A	Br. 2 km d/s Formoyle_A	Good (2009) (65%)	Good
Dead	25D010100A	Pope's Bridge_A	Moderate (2009)	Moderate (90%)
Dead	25D010100B	Pope's Bridge_B	N/A	Good (100%)
Owvane (Limerick)	24O020200A	Br. u/s (SE of) Loghill_A	Good (2009)	Good (65%)
Owveg (Kerry)	23O050200B	Owveg Br._B	N/A	Good
Tyshe	23T020400A	West br. Ardfert at Friary_A	Poor (2009)	Poor
Tyshe	23T020400B	West br. Ardfert at Friary_B	Poor (2009)	Poor
ShIRBD Non-Wadeable sites				
Creegh	28C021500A	Drumellihy Br._A	Good (2009) (76%)	Good
Kilcrow	25K010700A	Ballyshrule Br._A	Moderate (2008)	Moderate (100%)
Little Brosna	25L020700A	Riverstown Br._A	Good (2008)	Good (95%)
Maigue	24M010900A	Castleroberts Br._A	Moderate (2008) (62%)	Moderate
Nenagh	25N010300A	Ballysoilshaun Br._A	Good (2009) (86%)	Good
Tullamore	25T030400A	Br. SW of Ballycowen Br._A	Moderate (2008) (98%)	Moderate (81%)
SWRBD Wadeable sites				
Adrigole	21A010150A	0.5km d/s of Glashduff_A	N/A	Good (71%)
Argideen	20A020150B	Ballinoroher Ford_B	N/A	Good
SWRBD Non-Wadeable sites				
Awbeg (Buttevant)	18A051300A	Kilcummer Br._A	Good (2009)	Good (98%)
Bride (Waterford)	18B050500A	Footbr. N of Ballynella_A	Good (2009) (97%)	Good (92%)
Bride (Waterford)	18B050500B	Footbr. N of Ballynella_B	N/A	Good (94%)
WRBD Wadeable sites				
Black (Shrule)	30B020100A	Br. at Kilshanvy_A	Good (2009)	Good
Black (Shrule)	30B020100B	Br. at Kilshanvy_B	N/A	Good (71%)
Bunowen (Louisburgh)	32B030100A	Tully Br._A	Good	Good (88%)
Dunneill	35D060200A	Donaghintraine Br._A	Good (2009)	Good
Dunneill	35D060170A	Dromore West_A	N/A	Good
Glenamoy	33G010075A	Glenamoy Village_A	N/A	Good (56%)
Gowlan	35G030050A	Track west of Lough Black_A	Good (2009)	High (78%)
Gowlan	35G030050B	Track west of Lough Black_B	Good (2009)	Good (94%)
Owenbrin	30O010200A	Br. u/s L. Mask_A	Good (2008)	Good
WRBD Non-Wadeable sites				
Deel (Crossmolina)	34D010400A	Bridge at Castle Gore_A	Moderate (2008)	Moderate
Moy	34M021020A	U/s Ardnaree Br._A	N/A	N/A

Ecological status is subject to change upon review

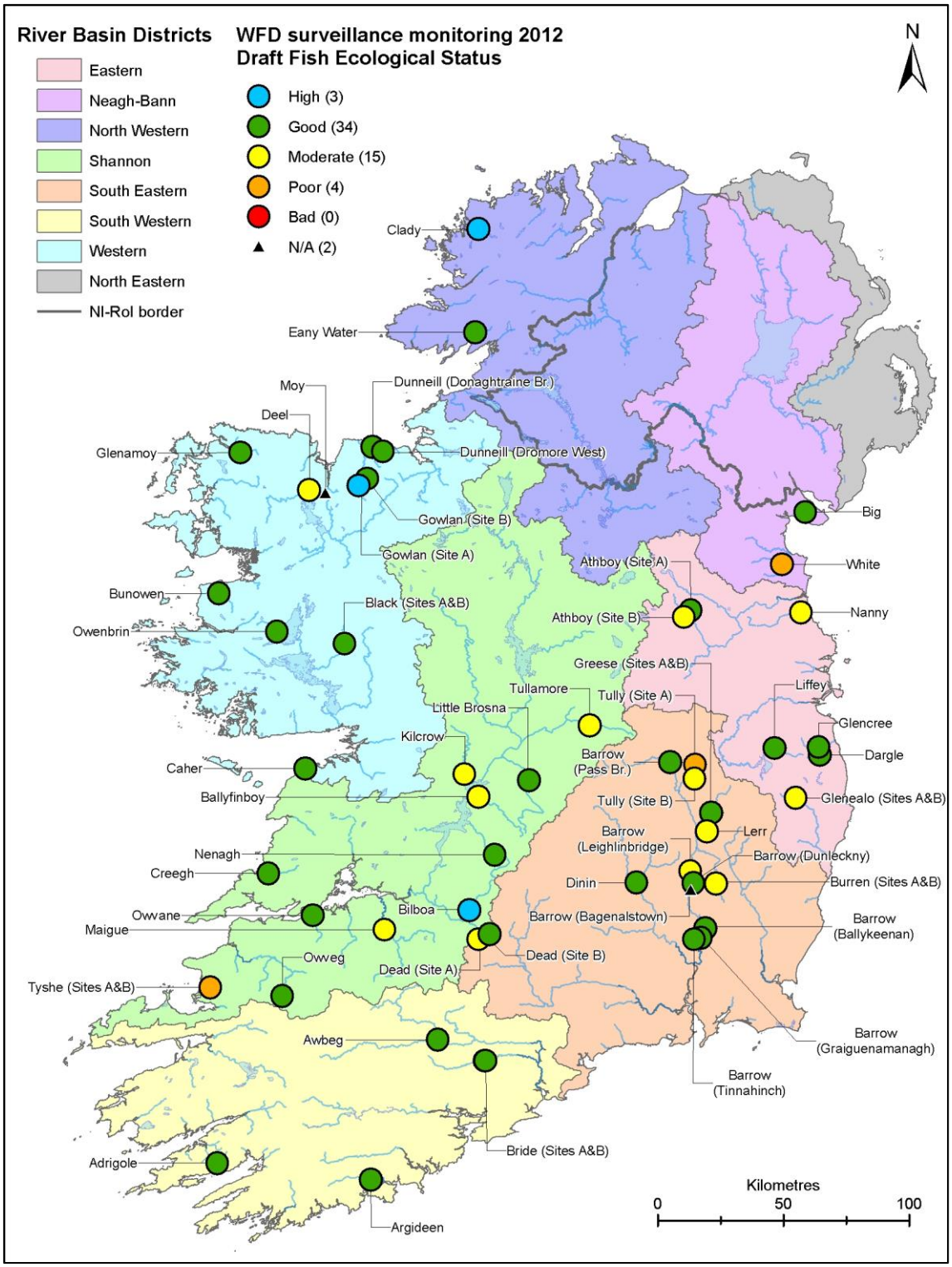

Fig. 4.81.Classification of river sites using the FCS2 Ireland classification tool

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 three transitional water bodies surveyed during 2012 (Table 4.10).

In total, 23, 10 and 14 species of fish were captured in the Boyne, Erne and Gweebarra Estuaries respectively, with six species (five-bearded rockling, flounder, lesser sandeel, pollack, sand goby and three-spined stickleback) recorded in all three water bodies. Other commercially important fish recorded included brown trout, sea trout, flounder, pollack, salmon and cod.

Table 4.10. Fish species recorded in each estuary surveyed during October 2012

Scientific name	Common name	Boyne total fish	Erne total fish	Gweebarra total fish
Salmo trutta	Brown trout	12	-	5
Gadus morhua	Cod	46	-	-
Anguilla anguilla	European eel	32	-	17
Spinachia spinachia	Fifteen-spined stickleback	1	-	3
Ciliata mustela	Five-bearded rockling	31	8	3
Platichthys flesus	Flounder	164	68	90
Syngnathus acus	Greater pipefish	1	-	2
Pholis gunnellus	Gunnel (Butterfish)	3	-	-
Ammodytes tobianus	Lesser sandeel	1159	12	2
Taurulus bubalis	Long-spined sea scorpion	5	-	1
Phoxinus phoxinus	Minnow	829	-	-
Perca fluviatilis	Perch	-	1	-
Pleuronectes platessa	Plaice	8	-	13
Agonus cataphractus	Pogge	1	1	-
Pollachius pollachius	Pollack	2	1	1
Rutilus rutilus	Roach	1	-	-
Salmo salar	Salmon	13	-	-
Pomatoschistus minutus	Sand goby	66	408	473
Salmo trutta	Sea trout*	5	-	-
Myoxocephalus scorpius	Short-spined sea scorpion	1	-	-
Sprattus sprattus	Sprat	5	-	-
Barbatula barbatula	Stone loach	1	-	-
Chelon labrosus	Thick-lipped grey mullet	-	15	-
Gasterosteus aculeatus	Three-spined stickleback	17	6	1
Psetta maxima	Turbot	-	2	1
Gobiusculus flavescens	Two-spotted goby	5	-	2

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 were captured within the three sites surveyed, indicating the essential nursery function of these transitional water bodies e.g. thick lipped grey mullet and flounder.

Important angling species were also recorded across the three water bodies, including, brown trout, sea trout, salmon, pollack and cod.

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 three waterbodies surveyed during 2012 are incorporated in the series of Special Areas of Conservation (SACs), designated nationally. The European eel, which is considered "critically endangered" and Atlantic salmon, listed as "vulnerable" in the Red List for Amphibians, Reptiles and Fish (King *et al*., 2011), 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 2012, eels were present in low numbers in both the Gweebarra and the Boyne transitional waterbodies, no eels were recorded in the Erne Estuary. Data from these WFD surveys is also used to support the National Eel Management Plan (O' Leary *et al.*, 2012).

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

An essential step in the WFD monitoring process is the classification of the status of transitional waters, which in turn will assist in identifying the objectives that must be set in the individual River Basin Management Plans. IFI has completed 149 transitional water fish surveys in 83 water bodies to date. 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 (Boyne Estuary) was classified as Good and two waterbodies (Erne Estuary and Gweebarra Estuary) were classified as Moderate (Table 4.11, Fig. 4.82). Both the Erne and Gweebarra estuaries showed a decline in status from 2009.

Table 4.11. Draft fish Ecological Status Classification of transitional water bodies surveyed during 2012 using the Transitional Fish Classification Index (TFCI)

Water body	Type	Status 2009	Status 2012
Boyne Estuary	Transitional	Good	Good
Erne Estuary	Transitional	Good	Moderate
Gweebarra Estuary	Transitional	Good	Moderate

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

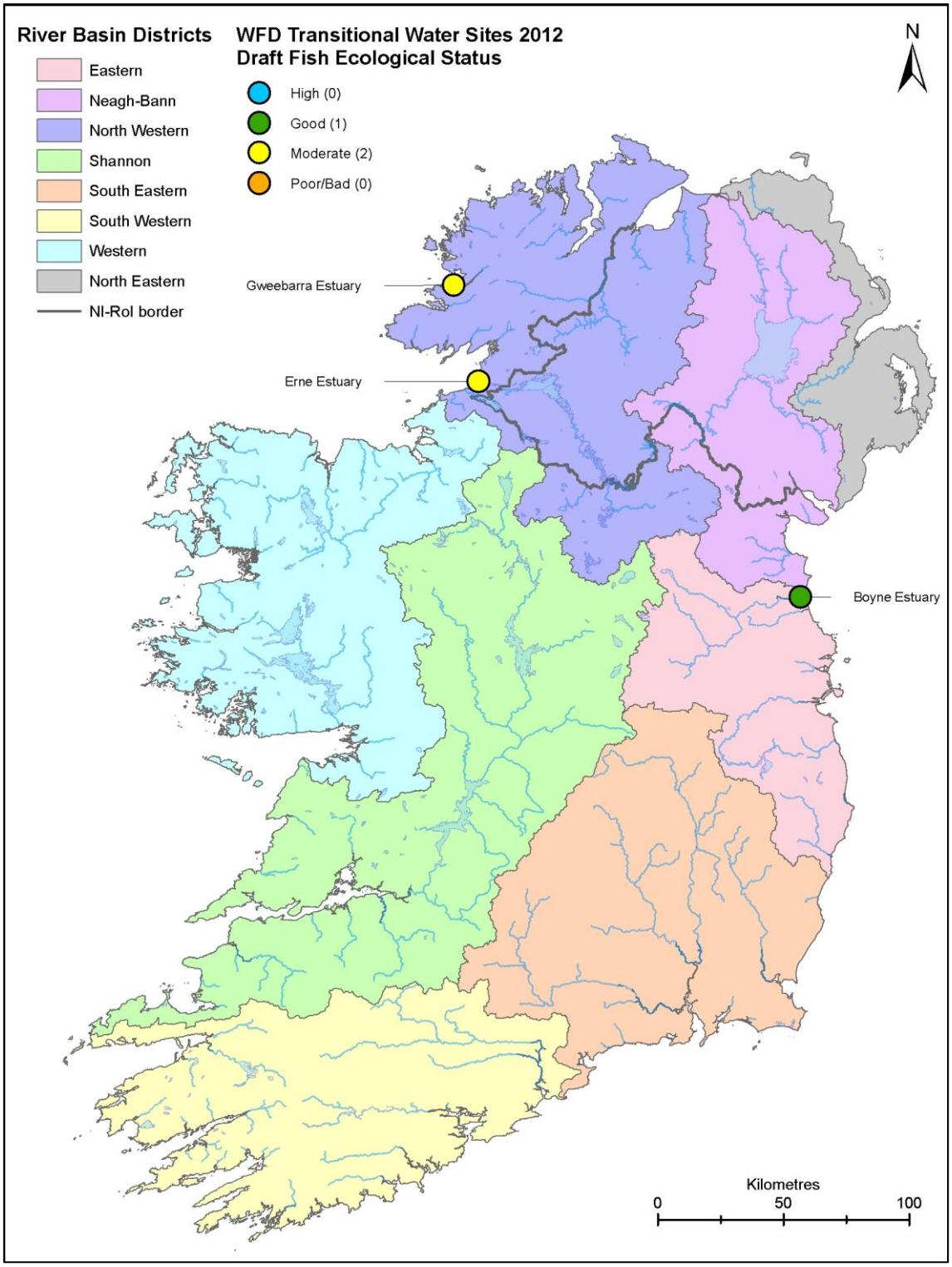

Fig. 4.82 Draft fish Ecological Status Classification of transitional water bodies surveyed during 2012 using the Transitional Fish Classification Index (TFCI)

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 species. Two (Twaite shad and smelt) are predominantly marine species that enter freshwater to spawn near the upstream limit of the tidal influence and the remaining three (Allis shad, sturgeon and flounder) are principally marine or estuarine species, entering freshwater for variable periods (Kelly *et al*., 2007c; Champ *et al*., 2009).

A total of 16 fish species (sea trout are included as a separate "variety" of trout) were recorded in the 23 lakes surveyed during the 2012 WFD surveillance monitoring season. Roach x bream 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), 17 fish species captured during 2010 (Kelly *et al*., 2011) and 17 fish species captured during 2011 (Kelly *et al*., 2012a). European eels, followed by brown trout and perch were the three most widely distributed species recorded during 2012. The maximum number of fish species recorded in any one lake was eight (Lough Arrow, WRBD), with a mixture of native and non-native fish species being captured in this lake.

A total of 15 fish species (sea trout are included as a separate "variety" of trout) and one hybrid were recorded in the 58 river sites surveyed during the 2012 WFD surveillance monitoring season. This compares with 15 fish species recorded in 2008 (Kelly *et al*., 2009), 16 recorded during 2009 (Kelly *et al*., 2010), 17 recorded in 2010 (Kelly *et al*., 2011) and 14 in 2011 (Kelly *et al*., 2012a). Brown trout, salmon and European eels were the most widely distributed fish species recorded during 2012. The maximum number of fish species recorded in any one river site was 12 (plus one hybrid) in the River Barrow (Pass Br.), which included a mixture of native and non-native species.

A total of 26 fish species were recorded in the three transitional waters surveyed during the 2012 WFD surveillance monitoring season. This compares with 61, 31, 55 and 26 species recorded during 2008, 2009, 2010 and 2011 respectively (Kelly *et al*., 2009, 2010, 2011 and 2012a).

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 2012 fish surveillance monitoring programme for rivers, in which 95% 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, 2011 and 2012).

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 71% of river sites. Salmon were recorded in 78% 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. Three large river 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).

Arctic char were recorded in four lakes during 2012 (Kindrum Lough, Lough Sessiagh, Doo Lough and Lough Mask), however, numbers were low in some of them. Although historically present in Lough Derg, Lough Dan and Lough Tay, no char specimens were captured in 2012 in these lakes, suggesting the likely local extinction of the species. 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 in Lough Dan (Igoe *et al.*, 2005). Water abstraction is an additional pressure which can affect the status of char populations due to the potential exposure of spawning beds (Igoe, F., ICCG, *pers. comm.*).

The absence of native species such as trout, salmon and char within specific catchments is related to various factors, including deterioration in water quality, the presence of impoundments preventing fish passage, drainage and modification of river morphology, habitat deterioration and translocation and competition from non-native species. The WFD sets out three main objectives; to preserve, protect and restore the quality of the aquatic environment. The WFD does not specifically refer to the prevention of fish passage by impoundments; however, Member States must ensure that the physical condition of surface waters (e.g. those affected by drainage schemes) supports ecological standards

(ShIRBD, 2009). Measures are being introduced to rectify this, e.g. IFI's Environmental River Enhancement Programme (EREP) conducted on behalf of the Office of Public Works (OPW).

5.3 Distribution of non-native fish species

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

Non-native fish species were present in 17 out of the 23 lakes surveyed during 2012. 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 32 out of the 58 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 2012. Non-native freshwater species were also present in two of the three transitional water bodies surveyed, minnow and roach were captured in the Boyne Estuary and perch were present in the Erne Estuary.

Pike, perch and roach are three of the most common non-native fish species recorded in Irish waters. In 2012, these species were recorded in a cluster of lakes mainly in counties Clare, Mayo, Monaghan/Cavan and Tipperary/Limerick, whilst they were present in river sites mainly in SERBD, upper ShIRBD and WRBD. 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 2012 with no access to the Shannon and Erne catchments (e.g. Deel River (Crossmolina), River Moy, Lough Arrow, Lough Carra, Lough Cullin, Lough Mask and Lough Muckno), 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 among tolerant non-native species to increase in relation to a 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 of the country to which these non-native species have not yet been translocated. Every effort must be made to preserve the status of the native fish populations, whilst preventing the introduction of non-native species to these areas as this may affect the ecological status of the 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 six lakes surveyed during 2012 (Lough Alewnaghta, Lough Bunny, Dromore Lough, Lough Gur, Inchicronan Lough and White Lough). 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 seven out of the 23 lakes surveyed during 2012, and 10 out of the 58 river sites surveyed (mostly in the River Barrow catchment. Roach, accidentally introduced to Ireland in 1889 (Went, 1950), have been translocated to many waters, mostly by anglers (Fitzmaurice, 1981), over the last 60 years. Roach is a species which has been shown to affect salmonid production and cause a decline in brown trout angling catches (Fitzmaurice, 1984). Within a few years of being introduced into a water body they can become the dominant species due to their high fecundity. They usually displace brown trout 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 2012 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 and moderate alkalinity lakes were significantly higher than those in low alkalinity lakes at the end of year 1, 2, 3, 4 and 5. Overall, the mean length at age of both perch and roach were slightly higher in the high alkalinity lakes than in the moderate alkalinity lakes, however, only perch in high alkalinity lakes displayed a significantly faster growth at the end of year 2 and 3 than those from the moderate alkalinity lakes.

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

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

Growth of brown trout in Irish lakes 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 size and with a minimum search effort. This is possible when there are large standing crops of suitable foods which are never fully grazed (Kennedy and Fitzmaurice, 1969).

5.6 Ecological status classifications

An essential step in the WFD process is the ecological classification of the status of lakes, rivers and transitional waters, which in turn will assist in identifying the objectives that must be set in the individual River Basin District Management Plans. During 2010 the "Fish in Lakes" ecological classification tool developed during the NS SHARE "Fish in Lakes" Project (Kelly *et al*., 2008b) was improved using additional data to make it fully WFD compliant (Kelly *et al*, 2012). 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 23 lakes surveyed during 2012, ten were classified as High, four were classified as Good, three were classified as Moderate, four were classified as Poor and two were classified as 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) ('FCS2 Ireland'), along with a separate version for Scotland to comply with the requirements of the WFD in early 2011 (SNIFFER, 2011). The tool works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) conditions using a geo-statistical model based

on Bayesian probabilities. The resulting output is an Ecological Quality Ratio (EQR) between 1 and 0, with five class boundaries defined along this range corresponding to the five ecological status classes of High, Good, Moderate, Poor and Bad. Confidence levels are assigned to each class and represented as probabilities. The tool has been successfully intercalibrated in a project to standardise ecological status classifications across Europe. FCS2 Ireland has been used to classify 56 of the 58 river sites surveyed during 2012; three river sites were classified as High, 34 as Good, 15 as Moderate and four as Poor.

A new preliminary WFD fish classification tool, Transitional Fish Classification Index or TCFI, has also been developed for the island of Ireland (Ecoregion 1) using Northern Ireland Environment Agency (NIEA) and IFI data. This is a multi-metric tool based on similar tools developed for transitional waters in South Africa and the UK (Harrison and Whitfield, 2004; Coates *et al.,* 2007). The three transitional waterbodies surveyed in 2012 were assigned a draft ecological classification of Good status (Boyne Estuary), Moderate status (Erne Estuary) and Moderate status (Gweebarra Estuary). The TFCI has been successfully intercalibrated in a Europe-wide exercise, however it will undergo further development 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 2012

Lake	Three-spined stickleback	Sea trout	Char	Salmon	Pollan	Brown Trout	Eel	Minnow	Perch	Pike	Roach	Bream	Gudgeon	Tench	Rudd	Roach x Bream	Rainbow trout
Alewnaghta							x		x	x	x	x				x	
Anure				x		x	x	x									
Arrow	x					x	x		x	x	x	x			x	x	
Bunny							x		x	x					x		
Cam						x	x										x
Carra	x					x	x		x	x							
Cullaun						x	x		x	x					x		
Cullin	x					x	x		x		x			x			
Dan						x	x	x									
Derg					x	x	x		x	x	x	x				x	
Doo	x	x	x	x		x	x										
Dromore							x		x	x					x		
Dunglow		x		x		x	x										
Gur							x		x	x					x		
Inchicronan							x		x	x					x		
Kindrum	x		x			x	x										
Mask			x			x	x		x	x	x	x				x	
Muckanagh	x					x	x		x	x				x	x		
Muckno						x	x		x	x	x	x	x			x	
Nasnahida						x	x										
Sessiagh	x		x			x	x										
Tay						x											
White							x		x	x	x			x		x	

APPENDIX 3

Lengths at age of brown trout in 15 lakes surveyed during 2012 (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
Caum	Mean	6.3	13.3	17.8						n/a
	n	78	59	13						
	S.D.	1.5	2.0	2.4						
	S.E.	0.2	0.3	0.7						
	Min.	3.5	8.0	13.8						
	Max.	10.9	17.6	22.2						
Dunglow	Mean	6.2	13.1	17.0	21.3					Very slow
	n	21	18	8	2					
	S.D.	1.8	2.4	1.6	0.8					
	S.E.	0.4	0.6	0.6	0.6					
	Min.	3.3	8.5	14.7	20.7					
	Max.	11.0	16.8	19.1	21.8					
Kindrum	Mean	6.7	19.5	26.6	35.2					Very fast
	n	67	51	24	3					
	S.D.	1.7	4.2	3.1	4.2					
	S.E.	0.2	0.6	0.6	2.4					
	Min.	3.3	10.2	21.3	30.4					
	Max.	10.7	27.7	33.0	38.3					
Anure	Mean	6.5	15.1	21.0	24.6	n/a				Very slow
	n	71	59	28	7	1				
	S.D.	1.6	2.5	2.2	2.4	.				
	S.E.	0.2	0.3	0.4	0.9	0.0				
	Min.	3.5	9.0	16.2	22.2	25.0				
	Max.	10.1	19.3	24.4	28.6	25.0				
Arrow	Mean	7.8	19.0	30.7	38.4	45.5	n/a			Very fast
	n	17	13	8	8	4	1			
	S.D.	1.7	5.2	5.5	8.0	0.7	.			
	S.E.	0.4	1.4	1.9	2.8	0.4	0.0			
	Min.	5.7	11.6	20.5	24.6	44.7	50.6			
	Max.	10.7	27.9	39.2	51.8	46.4	50.6			
Carra	Mean	6.9	16.7	33.4	44.6					n/a
	n	28	20	5	3					
	S.D.	1.7	5.3	6.8	5.4					
	S.E.	0.3	1.2	3.0	3.1					
	Min.	3.8	9.1	26.6	38.3					
	Max.	10.7	27.3	42.7	48.0					
Cullin	Mean	6.8	16.1	n/a						n/a
	n	7	6	1						
	S.D.	1.4	6.1	.						
	S.E.	0.5	2.5	0.0						
	Min.	4.7	12.2	22.7						
	Max.	9.5	28.4	22.7						

APPENDIX 3 continued

Lengths at age of brown trout in 15 lakes surveyed during 2012 (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
Dan	Mean	5.8	13.5	19.9	23.3	25.2	n/a			Very slow
	n	87	69	51	16	2	1			
	S.D.	1.2	2.4	2.5	2.3	0.6	.			
	S.E.	0.1	0.3	0.4	0.6	0.4	0.0			
	Min.	3.5	9.3	15.0	18.9	24.7	27.1			
	Max.	8.7	19.5	26.0	26.6	25.6	27.1			
Derg	Mean	7.2	16.7	24.8	40.1	48.1	52.5	n/a		Very fast
	n	26	26	11	4	2	2	1		
	S.D.	1.9	4.6	7.0	7.9	7.3	5.1	.		
	S.E.	0.4	0.9	2.1	3.9	5.2	3.6	0.0		
	Min.	4.1	9.4	17.6	31.6	42.9	48.9	54.5		
	Max.	10.6	30.2	42.4	48.4	53.3	56.1	54.5		
Mask	Mean	6.6	13.9	21.1						n/a
	n	31	20	7						
	S.D.	1.7	2.7	4.6						
	S.E.	0.3	0.6	1.7						
	Min.	3.6	9.9	16.2						
	Max.	10.9	19.6	28.7						
Muckanagh	Mean	8.3	n/a	n/a	n/a					n/a
	n	2	1	1	1					
	S.D.	0.4	.	.	.					
	S.E.	0.3	0.0	0.0	0.0					
	Min.	8.0	19.4	41.0	47.5					
	Max.	8.6	19.4	41.0	47.5					
Nasnahida	Mean	5.3	10.8	16.2	18.9	n/a				n/a
	n	56	52	33	12	1				
	S.D.	1.3	2.3	2.6	1.7	.				
	S.E.	0.2	0.3	0.4	0.5	0.0				
	Min.	3.1	7.0	11.2	16.5	23.0				
	Max.	8.7	18.1	22.8	22.4	23.0				
Tay	Mean	5.8	13.0	18.5	20.4	22.2				Very slow
	n	109	77	51	13	3				
	S.D.	1.2	2.0	2.3	1.9	1.0				
	S.E.	0.1	0.2	0.3	0.5	0.6				
	Min.	3.6	8.5	14.0	17.1	21.5				
	Max.	8.5	18.7	23.2	22.5	23.4				

APPENDIX 3 continued

Lengths at age of brown trout in 15 lakes surveyed during 2012 (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
Sessiagh	Mean	8.1	21.4	27.6	35.2	40.1	n/a	n/a		Very fast
	n	41	30	11	4	3	1	1		
	S.D.	1.8	4.7	4.7	4.1	5.6	.	.		
	S.E.	0.3	0.9	1.4	2.1	3.2	0.0	0.0		
	Min.	4.0	8.9	17.7	31.8	35.9	40.5	42.2		
	Max.	11.4	27.5	34.5	41.1	46.4	40.5	42.2		
Doo	Mean	5.9	11.9	19.5	24.7					Very slow
	n	53	39	9	2					
	S.D.	1.5	2.8	6.1	1.3					
	S.E.	0.2	0.4	2.0	0.9					
	Min.	3.7	7.6	13.2	23.8					
	Max.	10.2	18.7	33.7	25.6					

APPENDIX 4

Lengths at age of perch in 14 lakes surveyed during 2012 (L1=back calculated length of perch at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13
Dromore	Mean	7.2	12.3	15.9	18.2	20.0	21.3	19.6	n/a					
	n	59	41	31	23	14	7	2	1					
	S.D.	0.7	1.4	1.5	1.8	1.8	1.9	2.0	.					
	S.E.	0.1	0.2	0.3	0.4	0.5	0.7	1.4	0.0					
	Min.	5.9	9.5	13.5	15.3	16.5	17.3	18.2	18.9					
	Max.	9.2	16.0	20.7	23.0	22.2	22.7	21.1	18.9					
Cullaun	Mean	6.2	12.3	16.5	19.0	21.5	23.4							
	n	64	38	32	11	7	2							
	S.D.	1.2	1.7	1.9	1.7	1.8	3.3							
	S.E.	0.1	0.3	0.3	0.5	0.7	2.4							
	Min.	3.7	8.9	12.1	16.8	19.9	21.1							
	Max.	8.6	16.8	20.2	21.9	24.0	25.8							
Alewnaghta	Mean	6.0	10.7	15.6	19.2	21.8	26.6							
	n	67	38	19	6	4	2							
	S.D.	1.0	1.4	2.0	1.8	2.0	1.5							
	S.E.	0.1	0.2	0.4	0.7	1.0	1.1							
	Min.	4.6	8.7	12.6	17.3	18.9	25.5							
	Max.	9.8	15.4	19.4	21.6	23.4	27.7							
Arrow	Mean	5.9	10.9	16.8	21.1	24.2	24.7	25.4	26.5	27.0				
	n	149	120	82	43	27	7	5	4	2				
	S.D.	0.7	1.5	2.4	2.1	2.2	2.0	0.9	1.4	1.6				
	S.E.	0.1	0.1	0.3	0.3	0.4	0.7	0.4	0.7	1.1				
	Min.	3.9	7.7	10.5	16.2	19.8	22.0	24.3	25.1	25.9				
	Max.	7.8	14.9	21.3	25.3	28.5	27.4	26.3	28.4	28.1				
Bunny	Mean	5.7	13.3	18.5	21.3	22.9	n/a							
	n	50	25	17	6	4	1							
	S.D.	1.1	1.6	2.1	2.9	1.2	.							
	S.E.	0.1	0.3	0.5	1.2	0.6	0.0							
	Min.	3.3	10.0	13.8	16.5	21.2	24.9							
	Max.	7.8	16.9	21.7	25.6	23.7	24.9							

APPENDIX 4 continued

Lengths at age of perch in 14 lakes surveyed during 2012 (L1=back calculated length of perch at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13
Carra	Mean	6.8	12.4	18.2	22.5	26.5	30.0	32.0						
	n	100	68	48	29	18	8	3						
	S.D.	1.5	1.9	2.5	3.6	4.5	4.7	4.7						
	S.E.	0.1	0.2	0.4	0.7	1.1	1.7	2.7						
	Min.	4.3	9.7	13.5	15.5	18.1	20.2	27.1						
	Max.	11.1	16.6	23.3	29.1	33.3	34.0	36.3						
Cullin	Mean	6.4	12.0	16.4	20.5	23.5	n/a	n/a						
	n	35	29	21	9	5	1	1						
	S.D.	0.9	1.2	1.9	2.5	2.8	.	.						
	S.E.	0.1	0.2	0.4	0.8	1.3	0.0	0.0						
	Min.	5.0	9.9	13.7	17.3	21.6	31.3	33.7						
	Max.	9.6	14.7	20.2	24.7	28.5	31.3	33.7						
Derg	Mean	6.6	12.2	17.6	21.1	23.7	25.3	26.7	29.5	n/a	n/a	n/a	n/a	n/a
	n	112	94	67	43	35	29	7	3	1	1	1	1	1
	S.D.	0.9	1.6	1.9	1.8	1.9	1.9	2.8	3.0	.	.	.	.	.
	S.E.	0.1	0.2	0.2	0.3	0.3	0.4	1.1	1.7	0.0	0.0	0.0	0.0	0.0
	Min.	4.1	8.5	12.5	17.6	20.0	21.7	23.0	26.1	26.9	27.9	29.0	30.0	30.2
	Max.	9.2	15.8	21.5	25.5	27.2	28.5	30.0	31.7	26.9	27.9	29.0	30.0	30.2
Gur	Mean	8.1												
	n	24												
	S.D.	1.5												
	S.E.	0.3												
	Min.	5.6												
	Max.	10.8												
Inchicronan	Mean	5.8	10.5	14.8	18.0	20.6	n/a							
	n	73	51	25	7	3	1							
	S.D.	0.7	1.1	0.9	1.1	1.2	.							
	S.E.	0.1	0.1	0.2	0.4	0.7	0.0							
	Min.	4.4	8.2	13.1	16.5	19.2	23.0							
	Max.	7.9	13.7	16.8	19.6	21.4	23.0							
Mask	Mean	5.8	10.6	14.9	18.4	20.9	22.1	23.6	30.5	n/a	n/a	n/a		
	n	85	77	62	39	28	19	10	2	1	1	1		
	S.D.	0.8	1.4	1.9	2.0	2.4	2.9	3.9	7.7	.	.	.		
	S.E.	0.1	0.2	0.2	0.3	0.4	0.7	1.2	5.5	0.0	0.0	0.0		
	Min.	4.4	7.6	11.8	14.8	16.1	18.8	20.0	25.0	37.6	39.0	40.7		
	Max.	8.5	15.3	22.1	23.3	26.9	29.8	33.7	35.9	37.6	39.0	40.7		
Muckanagh	Mean	6.2	12.8	16.7	19.3	n/a								
	n	55	19	4	2	1								
	S.D.	0.9	1.5	4.5	2.0	.								
	S.E.	0.1	0.3	2.3	1.4	0.0								
	Min.	3.5	9.9	13.7	17.9	26.0								
	Max.	8.0	16.4	23.3	20.8	26.0								
White	Mean	5.8	9.8	13.3	16.6	21.6	n/a							
	n	81	48	28	23	2	1							
	S.D.	0.6	1.0	1.3	1.7	2.2	.							
	S.E.	0.1	0.1	0.2	0.3	1.6	0							
	Min.	4.5	8.2	11.3	14.0	20.0	22.5							
	Max.	7.0	12.5	16.2	20.4	23.2	22.5							
Muckno	Mean	5.5	10.1	14.2	17.9	21.1	23.3	n/a	n/a					
	n	101	73	37	30	20	12	1	1					
	S.D.	0.9	1.2	2.0	2.2	2.6	3.3	.	.					
	S.E.	0.1	0.1	0.3	0.4	0.6	0.9	0.0	0.0					
	Min.	3.7	6.6	8.9	12.3	16.2	17.7	21.6	22.8					
	Max.	9.2	12.6	17.2	22.2	25.3	29.3	21.6	22.8					

APPENDIX 5

Lengths at age of roach in 7 lakes surveyed during 2012 (L1=back calculated length of roach at the end of the first winter etc.)

Lake		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Alewnaghta	Mean	2.8	7.1	12.1	16.4	21.6	26.2	29.2	n/a	n/a		
	n	47	46	27	5	4	2	2	1	1		
	S.D.	0.5	1.3	1.7	2.0	1.8	2.6	3.1	.	.		
	S.E.	0.1	0.2	0.3	0.9	0.9	1.8	2.2	0.0	0.0		
	Min.	1.8	4.7	8.5	13.7	19.6	24.4	27.0	29.1	30.2		
	Max.	4.0	10.5	15.7	19.2	23.9	28.1	31.4	29.1	30.2		
Arrow	Mean	3.1	7.9	13.1	18.1	20.4	24.7	n/a	n/a			
	n	47	32	17	17	7	4	1	1			
	S.D.	0.8	1.4	2.5	2.8	2.6	2.6	.	.			
	S.E.	0.1	0.2	0.6	0.7	1.0	1.3	0.0	0.0			
	Min.	2.0	4.6	6.6	13.7	17.4	21.8	26.2	27.8			
	Max.	5.4	10.8	17.0	23.0	25.0	28.0	26.2	27.8			
Cullin	Mean	2.2	5.7	10.4	14.5	17.5	19.5	21.9	23.2	24.0	25.3	
	n	87	87	75	57	48	44	28	19	7	3	
	S.D.	0.4	1.2	1.7	1.8	1.7	1.6	1.5	1.3	1.3	0.8	
	S.E.	0.0	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.5	0.4	
	Min.	1.4	3.5	7.0	10.9	14.2	15.3	19.0	20.9	21.4	24.6	
	Max.	3.2	8.8	13.6	17.6	20.1	22.8	25.8	25.3	25.5	26.1	
Derg	Mean	2.4	6.7	12.1	16.7	20.8	23.9	26.8	28.8	30.1	30.9	32.6
	n	106	105	101	73	67	60	38	22	16	10	6
	S.D.	0.6	1.7	2.5	2.7	2.8	2.5	2.1	1.9	2.0	0.7	0.7
	S.E.	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.2	0.3
	Min.	1.6	3.2	6.8	11.7	14.7	17.4	22.1	25.3	27.2	29.7	31.6
	Max.	4.3	10.6	17.8	22.9	26.9	27.9	29.7	31.5	33.0	31.9	33.5
Mask	Mean	2.6	6.8	12.6	18.4	22.7	25.9	28.8	30.3	31.7		
	n	74	73	70	65	54	34	10	6	3		
	S.D.	0.8	1.8	2.8	3.0	2.8	2.8	1.8	1.3	2.1		
	S.E.	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.5	1.2		
	Min.	1.5	3.3	6.3	11.0	16.3	20.7	25.5	28.5	29.6		
	Max.	6.0	11.1	19.6	25.6	29.1	31.7	32.3	32.5	33.8		
White	Mean	2.4	5.8	10.2	13.5	15.8	17.5	n/a				
	n	58	56	39	27	21	17	1				
	S.D.	0.6	1.1	1.7	1.7	1.5	1.5	.				
	S.E.	0.1	0.2	0.3	0.3	0.3	0.4	0.0				
	Min.	1.6	3.6	6.9	10.5	12.6	14.3	20.6				
	Max.	4.1	8.7	13.8	17.1	18.9	19.5	20.6				
Muckno	Mean	2.7	6.0	10.7	14.8	18.3	20.3	22.3	22.2	22.2	n/a	n/a
	n	97	86	55	42	31	15	9	3	2	1	1
	S.D.	0.7	1.3	1.5	1.6	2.0	1.8	2.0	3.1	1.1	.	.
	S.E.	0.1	0.1	0.2	0.3	0.4	0.5	0.7	1.8	0.8	0.0	0.0
	Min.	1.4	3.1	7.5	11.5	13.9	16.8	18.5	19.8	21.4	22.5	24.1
	Max.	5.4	9.9	13.5	17.7	21.9	23.1	24.4	25.8	23.0	22.5	24.1

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)
Anure	1	0.817	0.758	0.864	High	High
Bunny	3	0.834	0.682	0.921	High	High
Carra	4	0.783	0.595	0.898	High	High
Cullaun	4	0.860	0.590	0.963	High	High
Doo	2	0.793	0.730	0.845	High	High
Dromore	4	0.816	0.554	0.940	High	High
Dungloe	1	0.786	0.711	0.846	High	High
Inchicronan	4	0.850	0.687	0.936	High	High
Sessiagh	2	0.764	0.687	0.827	High	High
Tay	2	0.794	0.731	0.845	High	High
Arrow	4	0.748	0.535	0.885	Good	Good
Dan	2	0.736	0.628	0.821	Good	Good
Nasnahida	1	0.644	0.567	0.714	Good	Good
Mask	4	0.681	0.451	0.847	Good	Good
Cam	1	0.413	0.314	0.520	Moderate	Moderate
Kindrum	3	0.503	0.291	0.714	Moderate	Moderate
Muckanagh	4	0.423	0.105	0.821	Moderate	Moderate
Cullin	3	0.269	0.183	0.376	Poor	Poor
Derg	4	0.286	0.099	0.594	Poor	Poor
Gur	3	0.202	0.060	0.502	Poor	Poor
Muckno	4	0.136	0.017	0.589	Poor	Poor
Alewnaghta	3	0.041	0.026	0.065	Bad	Bad
White	3	0.083	0.057	0.119	Bad	Bad

Ecological status is subject to change upon review

APPENDIX 7

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

River		L1	L2	L3	L4	Growth Category
Adrigole River	Mean	6.93	14.18			Slow
	S.D.	1.54	1.18			
	S.E.	0.34	0.48			
	n	21	6			
	Min	4.20	11.86			
	Max	9.14	15.02			
Argideen River	Mean	7.27	12.85			n/a
	S.D.	1.35	2.75			
	S.E.	0.36	1.23			
	n	14	5			
	Min	5.70	9.29			
	Max	9.71	16.43			
Athboy River (Site A)	Mean	7.30	18.10	22.88		Fast
	S.D.	1.32	1.84	3.15		
	S.E.	0.28	0.75	2.23		
	n	22	6	2		
	Min	4.99	15.31	20.65		
	Max	9.53	20.20	25.10		
Athboy River (Site B)	Mean	7.07	17.57	22.85		Fast
	S.D.	1.57	2.34	2.18		
	S.E.	0.35	0.67	1.26		
	n	20	12	3		
	Min	3.43	13.84	20.44		
	Max	9.98	21.73	24.70		
Awbeg River (Buttevant)	Mean	7.43	16.25	22.07		Slow
	S.D.	1.70	2.63	0.97		
	S.E.	0.26	0.53	0.44		
	n	44	25	5		
	Min	4.01	10.67	20.90		
	Max	11.00	20.63	23.55		
Ballyfinboy River	Mean	7.6	11.34			n/a
	S.D.	1.75	0.7			
	S.E.	0.42	0.35			
	n	17	4			
	Min	4.27	10.67			
	Max	10.45	12.13			

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Bilboa River	Mean	6.5	14.79			Slow
	S.D.	1.24	2.24			
	S.E.	0.33	0.91			
	n	14	6			
	Min	4.51	11.1			
	Max	7.96	18.12			
Barrow, River (Bagenalstown)	Mean	7.34	24.84	34.39		n/a
	S.D.	0.81	n/a	n/a		
	S.E.	0.40	n/a	n/a		
	n	4	1	1		
	Min	6.30	24.84	34.39		
	Max	8.12	24.84	34.39		
Barrow, River (Ballykeenan)	Mean	7.35	13.23			n/a
	S.D.	3.28	3.14			
	S.E.	1.64	1.81			
	n	4	3			
	Min	3.79	11.37			
	Max	10.28	16.86			
Barrow, River (Dunleckny)	Mean	7.09	15.98	26.66		n/a
	S.D.	0.19	2.94	4.29		
	S.E.	0.14	2.08	3.03		
	n	2	2	2		
	Min	6.95	13.90	23.63		
	Max	7.22	18.06	29.70		
Barrow, River (Graiguenamanagh)	Mean	7.35	14.12			n/a
	S.D.	1.83	3.02			
	S.E.	0.82	1.74			
	n	5	3			
	Min	5.34	10.71			
	Max	8.84	16.46			
Barrow, River (Leighlinbridge)	Mean	6.15	14.92	21.47		Slow
	S.D.	1.99	4.88	3.68		
	S.E.	0.63	1.54	1.39		
	n	10	10	7		
	Min	4.19	8.03	16.92		
	Max	10.40	21.62	27.60		

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Barrow, River (Pass Br.)	Mean	7.01	15.87			Slow
	S.D.	1.26	2.40			
	S.E.	0.32	0.85			
	n	16	8			
	Min	4.80	12.95			
	Max	9.51	20.13			
Barrow, River (Upper Tinnahinch)	Mean	7.06	16.17	21.72		n/a
	S.D.	2.13	3.87	n/a		
	S.E.	0.80	1.93	n/a		
	n	7	4	1		
	Min	4.71	11.19	21.72		
	Max	10.48	19.87	21.72		
Big River (Louth)	Mean	6.6	11.1	14.6		n/a
	S.D.	1.0	1.4	0.5		
	S.E.	0.3	0.7	0.3		
	n	15	4	3		
	Min	5.2	9.5	14.3		
	Max	9.2	12.3	15.2		
Black River (Shrule) (Site A)	Mean	8.53	21.56			n/a
	S.D.	1.36	2.13			
	S.E.	0.55	1.51			
	n	6	2			
	Min	6.48	20.05			
	Max	9.79	23.07			
Black River (Shrule) (Site B)	Mean	8.82				n/a
	S.D.	0.76				
	S.E.	0.23				
	n	11				
	Min	7.10				
	Max	9.65				
Bride (Site A)	Mean	8.60	19.15	28.43		Fast
	S.D.	1.87	2.94	n/a		
	S.E.	0.66	1.04	n/a		
	n	8	8	1		
	Min	6.55	15.34	28.43		
	Max	11.09	25.29	28.43		

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Bride (Site B)	Mean	7.57	16.03	24.36		Fast
	S.D.	1.51	3.86	n/a		
	S.E.	0.21	0.68	n/a		
	n	52	32	1		
	Min	4.51	8.27	24.36		
	Max	10.25	21.96	24.36		
Bunowen River (Louisburgh)	Mean	6.53	13.07	16.04		n/a
	S.D.	1.43	1.38	n/a		
	S.E.	0.58	0.69	n/a		
	n	6	4	1		
	Min	5.12	12.22	16.04		
	Max	8.58	15.14	16.04		
Burren River (Site A)	Mean	7.30	12.33			n/a
	S.D.	1.15	0.52			
	S.E.	0.27	0.26			
	n	18	4			
	Min	6.28	11.82			
	Max	9.95	12.87			
Burren River (Site B)	Mean	6.93	17.17	22.90		Slow
	S.D.	1.48	2.07	0.88		
	S.E.	0.43	0.78	0.62		
	n	12	7	2		
	Min	4.03	13.82	22.28		
	Max	8.97	19.24	23.52		
Caher River	Mean	7.78	12.48			n/a
	S.D.	1.16	0.79			
	S.E.	0.35	0.46			
	n	11	3			
	Min	5.3	11.82			
	Max	9.07	13.36			
Clady River (Donegal)	Mean	5.1	12.0	15.3		Very Slow
	S.D.	0.8	2.5	1.8		
	S.E.	0.2	0.7	1.0		
	n	15	13	3		
	Min	3.9	8.0	13.4		
	Max	6.7	16.0	17.0		

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Creegh River	Mean	8.49	15.22	21.4		Slow
	S.D.	1.67	2.63	1.48		
	S.E.	0.25	0.56	0.6		
	n	46	22	6		
	Min	5.25	9.86	19.13		
	Max	11.73	20.61	23.1		
Dead River (Site A)	Mean	6.41	13.48			n/a
	S.D.	1.45	0.32			
	S.E.	0.73	0.23			
	n	4	2			
	Min	4.69	13.26			
	Max	8.24	13.71			
Dead River (Site B)	Mean	7.32	13.4	16.77		n/a
	S.D.	1.58	3.18	0.32		
	S.E.	0.5	1.42	0.23		
	n	10	5	2		
	Min	5.57	9.75	16.54		
	Max	10.92	17.18	16.99		
Dargle River	Mean	5.96	8.66			n/a
	S.D.	1.28	0.28			
	S.E.	0.32	0.20			
	n	16	2			
	Min	3.38	8.47			
	Max	7.60	8.86			
Dinin River	Mean	7.21	16.00	20.35	24.62	Slow
	S.D.	1.59	2.85	2.27	2.02	
	S.E.	0.29	0.69	0.72	0.76	
	n	31	17	10	7	
	Min	3.42	10.42	15.95	21.79	
	Max	10.39	20.54	22.73	27.13	
Dunneill River (Donaghintraine))	Mean	8.00				n/a
	S.D.	1.62				
	S.E.	0.73				
	n	5				
	Min	5.90				
	Max	10.20				

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Dunneill River (Dromore West))	Mean	7.15	12.65			Very Slow
	S.D.	1.32	1.96			
	S.E.	0.24	0.52			
	n	31	14			
	Min	4.60	9.90			
	Max	10.00	15.30			
Eany Water	Mean	7.5				n/a
	S.D.	1.2				
	S.E.	0.9				
	n	2				
	Min	6.7				
	Max	8.4				
Glenamoy River	Mean	7.10	12.39			n/a
	S.D.	1.00	1.19			
	S.E.	0.32	0.69			
	n	10	3			
	Min	5.20	11.20			
	Max	8.18	13.59			
Glencree River	Mean	6.29	12.54			Slow
	S.D.	1.35	1.69			
	S.E.	0.31	0.60			
	n	19	8			
	Min	4.39	9.79			
	Max	9.60	15.00			
Glenealo River (Site A)	Mean	4.44				n/a
	S.D.	0.95				
	S.E.	0.55				
	n	3				
	Min	3.60				
	Max	5.47				
Glenealo River (Site B)	Mean	5.74	8.53			n/a
	S.D.	1.01	n/a			
	S.E.	0.38	n/a			
	n	7	1			
	Min	4.27	8.53			
	Max	6.72	8.53			

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Gowlan River (Site A)	Mean	6.94	13.16	16.63		Slow
	S.D.	1.73	2.34	2.58		
	S.E.	0.48	0.67	1.49		
	n	13	12	3		
	Min	4.29	9.54	13.67		
	Max	9.86	16.46	18.46		
Gowlan River (Site B)	Mean	6.95	12.81	16.79		Very Slow
	S.D.	1.76	1.47	0.17		
	S.E.	0.38	0.46	0.12		
	n	21	10	2		
	Min	4.54	10.47	16.67		
	Max	10.32	15.15	16.91		
Greese, River (Site A)	Mean	7.96	18.22			Fast
	S.D.	1.52	1.76			
	S.E.	0.35	0.62			
	n	19	8			
	Min	5.34	15.68			
	Max	10.68	20.08			
Greese, River (Site B)	Mean	7.31	15.21	21.92		Slow
	S.D.	1.94	2.87	1.91		
	S.E.	0.38	0.83	1.10		
	n	26	12	3		
	Min	4.19	9.75	19.73		
	Max	10.91	19.29	23.21		
Kilcrow River	Mean	6.54	14.38	23.05	28.7	Slow
	S.D.	1.54	3.14	3.79	n/a	
	S.E.	0.34	0.84	1.43	n/a	
	n	20	14	7	1	
	Min	4.65	10.34	20	28.7	
	Max	9.82	22.24	30.46	28.7	
Lerr River	Mean	7.24	16.52	22.80		n/a
	S.D.	1.48	3.09	n/a		
	S.E.	0.36	1.38	n/a		
	n	17	5	1		
	Min	4.72	13.07	22.80		
	Max	9.87	19.74	22.80		

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Liffey, River	Mean	8.25	17.21	23.21	31.82	Fast
	S.D.	1.88	3.57	2.86	n/a	
	S.E.	0.27	0.65	1.01	n/a	
	n	49	30	8	1	
	Min	5.19	10.69	20.45	31.82	
	Max	14.19	24.91	29.08	31.82	
Little Brosna River	Mean	7.99	17.67	22.25		Fast
	S.D.	2.08	5.26	2.54		
	S.E.	0.3	0.99	1.14		
	n	47	28	5		
	Min	4.09	10.05	18.97		
	Max	12.37	28.85	25.18		
Maigue, River	Mean	9.83	17.3	29.1	31.43	n/a
	S.D.	1.28	1.53	6.64	n/a	
	S.E.	0.45	1.08	4.7	n/a	
	n	8	2	2	1	
	Min	7.13	16.22	24.4	31.43	
	Max	11	18.39	33.8	31.43	
Moy, River (Ardnaree)	Mean	7.89	14.21			n/a
	S.D.	n/a	n/a			
	S.E.	n/a	n/a			
	n	1	1			
	Min	7.89	14.21			
	Max	7.89	14.21			
Nanny (Meath), River	Mean	7.48	19.88			n/a
	S.D.	2.44	n/a			
	S.E.	1.09	n/a			
	n	5	1			
	Min	4.71	19.88			
	Max	10.30	19.88			
Nenagh River	Mean	7.22	14.74	24.63		Fast
	S.D.	1.66	2.98	n/a		
	S.E.	0.26	0.53	n/a		
	n	41	32	1		
	Min	4.35	9.6	24.63		
	Max	10.08	19.65	24.63		

APPENDIX 7 continued

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

River		L1	L2	L3	L4	Growth Category
Owveg River (Kerry)	Mean	6.73	14.19	19.76		n/a
	S.D.	1.09	2.46	n/a		
	S.E.	0.34	1.23	n/a		
	n	10	4	1		
	Min	4.76	10.57	19.76		
	Max	8.05	15.83	19.76		
Tullamore River	Mean	7.13	14.82	25.03		Fast
	S.D.	1.35	3.97	1.98		
	S.E.	0.41	1.78	1.4		
	n	11	5	2		
	Min	4.44	11.09	23.64		
	Max	9.32	20.61	26.43		
Tully Stream (Site A)	Mean	8.19	14.28	22.21		Slow
	S.D.	1.89	2.92	4.92		
	S.E.	0.63	0.97	2.84		
	n	9	9	3		
	Min	5.98	10.27	16.56		
	Max	11.32	17.74	25.53		
Tully Stream (Site B)	Mean	7.92	14.69	20.95	27.83	Slow
	S.D.	1.74	3.28	3.87	1.51	
	S.E.	0.40	0.75	1.17	1.06	
	n	19	19	11	2	
	Min	4.66	9.51	14.45	26.77	
	Max	11.32	20.35	25.83	28.90	
White River (Louth)	Mean	8.2	18.7			n/a
	S.D.	1.3	1.5			
	S.E.	0.4	0.7			
	n	13	4			
	Min	5.4	17.6			
	Max	10.2	20.8			

APPENDIX 8

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

River		L1	L2	L3
Argideen River	Mean	5.35		
	S.D.	1.01		
	S.E.	0.22		
	n	21		
	Min	3.36		
	Max	7.16		
Athboy River (Site A)	Mean	5.57		
	S.D.	1.13		
	S.E.	0.40		
	n	8		
	Min	3.98		
	Max	6.80		
Athboy River (Site B)	Mean	4.83		
	S.D.	0.83		
	S.E.	0.58		
	n	2		
	Min	4.25		
	Max	5.42		
Awbeg River (Buttevant)	Mean	5.55	10.56	
	S.D.	1.22	1.27	
	S.E.	0.24	0.74	
	n	27	3	
	Min	3.98	9.44	
	Max	7.92	11.95	
Ballyfinboy River	Mean	5.18	11.42	
	S.D.	1.9	n/a	
	S.E.	1.1	n/a	
	n	3	1	
	Min	3.53	11.42	
	Max	7.25	11.42	
Barrow, River (Bagenalstown)	Mean	8.73		
	S.D.	n/a		
	S.E.	n/a		
	n	1.00		
	Min	8.73		
	Max	8.73		

APPENDIX 8 continued

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

River		L1	L2	L3
Barrow, River (Ballykeenan)	Mean	5.58		
	S.D.	1.20		
	S.E.	0.85		
	n	2.00		
	Min	4.73		
	Max	6.43		
Barrow, River (Graiguenamanagh)	Mean	5.81		
	S.D.	1.33		
	S.E.	0.67		
	n	4.00		
	Min	4.95		
	Max	7.79		
Barrow, River (Leighlinbridge)	Mean	6.31		
	S.D.	0.89		
	S.E.	0.52		
	n	3.00		
	Min	5.36		
	Max	7.14		
Barrow, River (Pass Br.)	Mean	5.59		
	S.D.	0.96		
	S.E.	0.28		
	n	12.00		
	Min	4.23		
	Max	7.32		
Barrow, River (Tinnahinch)	Mean	5.12		
	S.D.	n/a		
	S.E.	n/a		
	n	1.00		
	Min	5.12		
	Max	5.12		
Bilboa River	Mean	5.7	11.25	
	S.D.	1.58	n/a	
	S.E.	0.31	n/a	
	n	26	1	
	Min	3.5	11.25	
	Max	9.1	11.25	

APPENDIX 8 continued

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

River		L1	L2	L3
Black River (Shrule)	Mean	5.97		
	S.D.	1.12		
	S.E.	0.24		
	n	21		
	Min	4.69		
	Max	8.63		
Black River (Shrule)	Mean	5.80		
	S.D.	0.71		
	S.E.	0.17		
	n	17		
	Min	4.82		
	Max	7.27		
Bride (Site B)	Mean	5.35		
	S.D.	0.79		
	S.E.	0.16		
	n	23		
	Min	4.11		
	Max	7.00		
Bunowen River (Louisburgh)	Mean	5.13	7.42	
	S.D.	1.18	n/a	
	S.E.	0.28	n/a	
	n	18	1	
	Min	3.17	7.42	
	Max	7.78	7.42	
Burren River (Site A)	Mean	4.68		
	S.D.	0.78		
	S.E.	0.24		
	n	11.00		
	Min	3.26		
	Max	5.83		
Burren River (Site B)	Mean	6.65		
	S.D.	n/a		
	S.E.	n/a		
	n	1.00		
	Min	6.65		
	Max	6.65		

APPENDIX 8 continued

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

River		L1	L2	L3
Clady River (Donegal)	Mean	4.5	8.9	10.9
	S.D.	0.8	1.2	n/a
	S.E.	0.2	0.4	n/a
	n	24	10	1
	Min	3.1	6.2	10.9
	Max	5.6	10.1	10.9
Creegh River	Mean	6.76		
	S.D.	1.11		
	S.E.	0.25		
	n	19		
	Min	4.87		
	Max	8.63		
Dargle River	Mean	6.38		
	S.D.	n/a		
	S.E.	n/a		
	n	1		
	Min	6.38		
	Max	6.38		
Dead River (Site A)	Mean	5.99		
	S.D.	0.56		
	S.E.	0.23		
	n	6		
	Min	5.36		
	Max	6.82		
Dead River (Site B)	Mean	5.9		
	S.D.	1.24		
	S.E.	0.44		
	n	8		
	Min	3.95		
	Max	7.33		
Deel River (Crossmolina)	Mean	5.80		
	S.D.	0.48		
	S.E.	0.28		
	n	3		
	Min	5.49		
	Max	6.36		

APPENDIX 8 continued

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

River		L1	L2	L3
Dinin River	Mean	5.42	10.89	
	S.D.	1.01	1.17	
	S.E.	0.21	0.52	
	n	23.00	5.00	
	Min	4.04	9.31	
	Max	7.56	12.35	
Eany Water	Mean	4.0	7.1	
	S.D.	0.8	0.6	
	S.E.	0.2	0.4	
	n	21	3	
	Min	2.7	6.6	
	Max	6.1	7.9	
Glenamoy River	Mean	4.93		
	S.D.	0.81		
	S.E.	0.20		
	n	16		
	Min	3.40		
	Max	6.27		
Glencree River	Mean	5.75		
	S.D.	0.79		
	S.E.	0.30		
	n	7		
	Min	4.63		
	Max	6.78		
Gowlan River	Mean	5.84		
	S.D.	1.49		
	S.E.	0.86		
	n	3		
	Min	4.40		
	Max	7.38		
Gowlan River	Mean	5.87	10.70	
	S.D.	1.06	0.74	
	S.E.	0.24	0.52	
	n	20	2	
	Min	3.84	10.17	
	Max	7.91	11.22	

APPENDIX 8 continued

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

River		L1	L2	L3
Greese, River (Site A)	Mean	5.35		
	S.D.	0.89		
	S.E.	0.52		
	n	3.00		
	Min	4.37		
	Max	6.12		
Greese, River (Site B)	Mean	6.26		
	S.D.	0.74		
	S.E.	0.43		
	n	3.00		
	Min	5.57		
	Max	7.04		
Kilcrow River	Mean	6.25		
	S.D.	1.23		
	S.E.	0.55		
	n	5		
	Min	4.99		
	Max	8		
Lerr River	Mean	5.58		
	S.D.	1.63		
	S.E.	0.94		
	n	3.00		
	Min	4.51		
	Max	7.46		
Little Brosna River	Mean	6.68	12.52	
	S.D.	1.79	1.52	
	S.E.	0.37	0.51	
	n	24	9	
	Min	3.36	8.95	
	Max	10.75	14.05	
Maigue, River	Mean	7.19		
	S.D.	n/a		
	S.E.	n/a		
	n	1		
	Min	7.19		
	Max	7.19		

APPENDIX 8 continued

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

River		L1	L2	L3
Moy, River	Mean	5.27	9.65	
	S.D.	1.23	1.64	
	S.E.	0.26	0.82	
	n	22	4	
	Min	3.01	7.36	
	Max	7.74	11.25	
Nanny (Meath), River	Mean	6.70	13.64	
	S.D.	n/a	n/a	
	S.E.	n/a	n/a	
	n	1	1	
	Min	6.70	13.64	
	Max	6.70	13.64	
Nenagh River	Mean	6.7		
	S.D.	n/a		
	S.E.	n/a		
	n	1		
	Min	6.7		
	Max	6.7		
Owveg River (Kerry)	Mean	4.76		
	S.D.	1.1		
	S.E.	0.26		
	n	18		
	Min	3.2		
	Max	6.89		
White River (Louth)	Mean	7.5		
	S.D.	n/a		
	S.E.	n/a		
	n	1		
	Min	7.5		
	Max	7.5		

APPENDIX 9

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

River		L1	L2	L3
Creegh River	Mean	8.12	15.93	19.82
	S.D.	1.9	0.68	0.79
	S.E.	0.95	0.34	0.46
	n	4	4	3
	Min	5.65	15.12	19.1
	Max	9.85	16.59	20.66
Bride (Waterford) (Site A)	Mean	9.04	22.69	
	S.D.	3.44	6.13	
	S.E.	2.43	4.34	
	n	2	2	
	Min	6.61	18.36	
	Max	11.47	27.03	
Bride (Waterford) (Site B)	Mean	6.67	18.17	22.72
	S.D.	3.12	11.93	n/a
	S.E.	2.20	8.44	n/a
	n	2	2	1
	Min	4.46	9.74	22.72
	Max	8.87	26.61	22.72
Clady (Donegal)	Mean	6.80	12.40	19.20
	S.D.	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a
	n	1	1	1
	Min	6.80	12.40	19.20
	Max	6.80	12.40	19.20
Creegh	Mean	8.12	15.93	19.82
	S.D.	1.90	0.68	0.79
	S.E.	0.95	0.34	0.46
	n	4	4	3
	Min	5.65	15.12	19.10
	Max	9.85	16.59	20.66
Gowlan	Mean	4.81	13.12	17.93
	S.D.	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a
	n	1	1	1
	Min	4.81	13.12	17.93
	Max	4.81	13.12	17.93

APPENDIX 9 continued

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

River		L1	L2	L3
Nanny (Meath)	Mean	6.63	15.33	18.03
	S.D.	0.69	1.98	n/a
	S.E.	0.49	1.40	n/a
	n	2	2	1
	Min	6.15	13.93	18.03
	Max	7.12	16.73	18.03

APPENDIX 10

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

River		L1	L2	L3	L4
Barrow, River (Bagenalstown)	Mean	21.11	32.04	41.92	48.04
	S.D.	5.41	5.51	4.91	7.73
	S.E.	1.80	1.95	1.86	4.46
	n	9.00	8.00	7.00	3.00
	Min	12.94	21.57	35.43	42.18
	Max	27.19	38.13	48.73	56.80
Barrow, River (Ballykeenan)	Mean	29.43			
	S.D.	n/a			
	S.E.	n/a			
	n	1.00			
	Min	29.43			
	Max	29.43			
Barrow, River (Dunleckny)	Mean	20.85	29.45	40.80	
	S.D.	3.94	4.05	n/a	
	S.E.	1.49	2.34	n/a	
	n	7.00	3.00	1.00	
	Min	14.88	25.50	40.80	
	Max	26.40	33.60	40.80	
Barrow, River (Graiguenamanagh)	Mean	24.63	39.35	44.27	
	S.D.	3.02	n/a	n/a	
	S.E.	1.23	n/a	n/a	
	n	6.00	1.00	1.00	
	Min	20.37	39.35	44.27	
	Max	27.94	39.35	44.27	
Barrow, River (Pass Br.)	Mean	13.33	34.33	55.67	
	S.D.	0.37	9.72	n/a	
	S.E.	0.26	6.88	n/a	
	n	2.00	2.00	1.00	
	Min	13.07	27.45	55.67	
	Max	13.59	41.20	55.67	
Barrow, River (Tinnahinch)	Mean	28.55	41.45	57.11	68.16
	S.D.	n/a	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a	n/a
	n	1.00	1.00	1.00	1.00
	Min	28.55	41.45	57.11	68.16
	Max	28.55	41.45	57.11	68.16

APPENDIX 10 continued

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

River		L1	L2	L3	L4
Kilcrow	Mean	14.36	35.14	49.91	
	S.D.	3.93	n/a	n/a	
	S.E.	1.76	n/a	n/a	
	n	5	1	1	
	Min	8.99	35.14	49.91	
	Max	19.96	35.14	49.91	

APPENDIX 11

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

River		L1	L2	L3	L4
Barrow, River (Bagenalstown)	Mean	2.87	7.02	11.98	17.17
	S.D.	0.96	1.74	2.22	1.71
	S.E.	0.18	0.34	0.57	0.49
	n	28	26	15	12
	Min	1.85	4.62	7.93	14.42
	Max	5.71	10.93	16.15	20.31
Barrow, River (Ballykeenan)	Mean	3.54	8.16	12.85	17.26
	S.D.	1.11	1.51	1.72	1.32
	S.E.	0.18	0.31	0.52	0.42
	n	36	24	11	10
	Min	2.11	5.28	10.37	13.95
	Max	6.57	11.24	15.39	18.94
Barrow, River (Dunleckny)	Mean	3.00	6.83	11.87	17.31
	S.D.	0.97	1.67	2.09	0.85
	S.E.	0.24	0.56	0.85	0.38
	n	16	9	6	5
	Min	1.85	3.71	8.58	16.69
	Max	4.55	8.74	14.15	18.73
Barrow, River (Graiguenamanagh)	Mean	3.08	7.46	12.70	17.21
	S.D.	0.94	1.75	1.96	2.08
	S.E.	0.13	0.28	0.42	0.60
	n	54	40	22	12
	Min	1.60	4.60	9.49	12.54
	Max	5.85	11.03	17.09	21.65
Barrow, River (Leighlinbridge)	Mean	3.01	7.21	11.73	14.96
	S.D.	0.82	1.75	1.18	1.46
	S.E.	0.12	0.27	0.25	0.41
	n	49	43	22	13
	Min	2.04	3.72	9.37	12.48
	Max	6.72	12.92	13.54	17.27
Barrow, River (Pass Br.)	Mean	3.90	8.29		
	S.D.	0.69	n/a		
	S.E.	0.17	n/a		
	n	17	1		
	Min	2.76	8.29		
	Max	5.66	8.29		

APPENDIX 11 continued

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

River		L1	L2	L3	L4
Barrow, River (Tinnahinch)	Mean	3.04	7.42	11.73	16.87
	S.D.	0.99	1.38	2.24	1.58
	S.E.	0.16	0.29	0.75	0.60
	n	38	23	9	7
	Min	1.68	5.14	9.12	14.95
	Max	4.84	10.71	14.88	20.00
Greese, River (Site A)	Mean	2.19	7.45	13.59	
	S.D.	n/a	n/a	n/a	
	S.E.	n/a	n/a	n/a	
	n	1	1	1	
	Min	2.19	7.45	13.59	
	Max	2.19	7.45	13.59	
Greese, River (Site B)	Mean	2.38	7.15	13.51	
	S.D.	n/a	n/a	n/a	
	S.E.	n/a	n/a	n/a	
	n	1	1	1	
	Min	2.38	7.15	13.51	
	Max	2.38	7.15	13.51	
Lerr River	Mean	3.16	8.23	12.39	
	S.D.	0.64	1.01	0.29	
	S.E.	0.17	0.26	0.21	
	n	15	15	2	
	Min	2.37	6.49	12.18	
	Max	4.48	9.46	12.59	

APPENDIX 12

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

River		L1	L2	L3	L4
Barrow, River (Bagenalstown)	Mean	2.48	6.15		
	S.D.	0.61	0.93		
	S.E.	0.16	0.42		
	n	15	5		
	Min	1.47	4.55		
	Max	3.64	7.02		
Barrow, River (Ballykeenan)	Mean	2.59	5.28	8.61	11.82
	S.D.	0.83	0.30	n/a	n/a
	S.E.	0.48	0.21	n/a	n/a
	n	3	2	1	1
	Min	2.03	5.07	8.61	11.82
	Max	3.55	5.49	8.61	11.82
Barrow, River (Dunleckny)	Mean	2.58	6.14	12.03	16.05
	S.D.	0.52	1.09	0.86	1.20
	S.E.	0.11	0.38	0.50	0.85
	n	23	8	3	2
	Min	1.63	4.22	11.50	15.20
	Max	3.87	7.11	13.03	16.90
Barrow, River (Graiguenamanagh)	Mean	2.60	6.44	11.12	12.86
	S.D.	0.60	2.24	2.48	1.58
	S.E.	0.14	0.75	1.11	1.12
	n	19	9	5	2
	Min	1.67	3.69	8.73	11.74
	Max	3.55	11.07	15.09	13.97
Barrow, River (Leighlinbridge)	Mean	2.53	6.08		
	S.D.	0.76	0.88		
	S.E.	0.20	0.28		
	n	14	10		
	Min	1.76	4.56		
	Max	4.29	6.97		
Barrow, River (Pass Br.)	Mean	2.96	5.45	9.53	13.63
	S.D.	0.89	1.29	1.59	1.03
	S.E.	0.15	0.34	0.71	0.46
	n	35	14	5	5
	Min	1.85	3.33	7.26	12.36
	Max	5.81	7.23	11.00	14.83

APPENDIX 12 continued

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

River		L1	L2	L3	L4
Barrow, River (Tinnahinch)	Mean	2.50			
	S.D.	0.29			
	S.E.	0.15			
	n	4			
	Min	2.12			
	Max	2.74			
Deel River (Crossmolina)	Mean	2.21	5.62	10.74	
	S.D.	0.63	0.99	2.28	
	S.E.	0.14	0.28	1.14	
	n	21	12	4	
	Min	1.09	3.92	7.84	
	Max	4.24	7.27	13.29	
Kilcrow River	Mean	2.26	6.48	8.31	
	S.D.	0.46	1.35	n/a	
	S.E.	0.14	0.43	n/a	
	n	10	10	1	
	Min	1.6	4.39	8.31	
	Max	3.21	8.6	8.31	
Moy, River	Mean	2.52	4.82		
	S.D.	0.42	0.36		
	S.E.	0.11	0.18		
	n	15	4		
	Min	1.82	4.55		
	Max	3.17	5.32		

APPENDIX 13

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

River		L1	L2	L3	L4
Barrow, River (Bagenalstown)	Mean	4.61	7.97	12.58	20.55
	S.D.	n/a	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a	n/a
	n	1	1	1	1
	Min	4.61	7.97	12.58	20.55
	Max	4.61	7.97	12.58	20.55

APPENDIX 14

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

River		L1	L2	L3	L4
Barrow, River (Graiguenamanagh)	Mean	2.10	6.69	9.94	14.33
	S.D.	n/a	n/a	n/a	n/a
	S.E.	n/a	n/a	n/a	n/a
	n	1	1	1	1
	Min	2.10	6.69	9.94	14.33
	Max	2.10	6.69	9.94	14.33
Barrow, River (Pass Br.)	Mean	2.05	5.25	8.76	15.73
	S.D.	0.12	0.99	1.90	3.10
	S.E.	0.07	0.57	1.10	1.79
	n	3	3	3	3
	Min	1.94	4.11	7.26	12.17
	Max	2.18	5.95	10.90	17.84

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