Sampling Fish for the Water Framework Directive

A Summary of the Central Fisheries Board's Surveillance Monitoring for Fish in Lakes, Rivers and Transitional Waters 2008

Summary Report 2008

Chairman's Statement

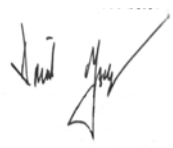
In December 2000, the European Union introduced the Water Framework Directive (WFD) as part of a new standard approach for all countries to manage their water resources and to protect aquatic ecosystems. The fundamental objectives of the WFD, which was transposed into Irish Law in December 2003, are 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 status by 2015. The Water Framework Directive staff in the Central Fisheries Board work closely with other sister agencies, national and international organisations, academic institutions and our parent Department, the Department of Communications, Energy and Natural Resources.

2008 was a very challenging and rewarding year for the scientists working on the Water Framework Directive. It was one of the wettest summers in almost 50 years, which hampered the ability to conduct field research, yet despite this, the project proceeded and met the key goals and objectives. This report summarises achievements against these key objectives delivered by the WFD staff of the Research and Development Division of the Central Fisheries Board.

The Board are equally delighted and proud to have such committed, experienced and highly qualified scientists working across all research disciplines within inland fisheries. However, without the support and commitment of the management and staff in the Regional Fisheries Boards, it would not be possible to undertake many of the key objectives reported in this document.

The Board is delighted to provide research and development services to the Regional Fisheries Boards, other state agencies and our parent Department, and in keeping with our core belief of continuous improvement, and taking due cognisance of the current economic climate, the Research and Development Division has been restructured to provide a more project focused and goal orientated approach to our work, which will allow us to deliver even higher standards in 2009 and subsequent years.

On my own behalf and on behalf of my fellow Board members I would like to congratulate all who have contributed to the significant level of work which was undertaken in 2008 under the Water Framework Directive, the key elements of which are reported in this document and wish them continued success in 2009.



David Mackey,
Chairman

Central Fisheries Board,
May 2009

Foreword

Welcome to the Central and Regional Fisheries Board (CFB & RFB) Water Framework Directive (WFD) Surveillance Monitoring for Fish Summary Report 2008.

The Directive (2000/60/EC) and Irish National Legislation (S.I. No. 722 of 2003) came into force in 2000 and 2003, respectively. A principal aim of this legislation is to preserve existing ecosystems where water quality is currently at high or good status and to restore to good status those waters which are currently impaired. The Directive specifies that monitoring of a variety of elements (including fish) in rivers, lakes and transitional waters shall commence in 2007. The CFB has been assigned the responsibility by the Environmental Protection Agency (EPA), in accordance with the above legislation, of delivering the fish monitoring requirements of the WFD.

Each Member State in the EU is required to implement certain corrective measures to preserve waters in high and good status and to restore waters which are at risk of not achieving good status by 2015. Fish are amongst the elements the legislation specifies shall be measured at specific locations selected for surveillance monitoring. These sites are set out in the WFD Monitoring Programme published by the EPA in 2006.

The WFD fish surveillance monitoring programme in 2008 has been extensive, and 83 river sites, 32 lakes and 42 transitional water bodies were successfully surveyed nationwide. A team of scientists were recruited by the Research and Development section of the CFB to carry out the monitoring surveys.

Approximately 80,000 fish have been recorded during the surveys and all fish have been identified, counted and a representative sample has been measured, weighed and had scales removed for aging purposes. Some fish were retained for further analysis in the CFB laboratory. Work on the programme in the field finished in early November and staff spent the winter months processing the large volume of fish samples taken over the sampling period.

I believe this new national monitoring programme for the WFD will provide up to date accurate information on fish species in our waters for decision makers, angling clubs and owners and will establish a baseline ecological status for these waters. The information from the monitoring programme will be used to evaluate the effectiveness or otherwise of the control measures in the WFD River Basin Management Plans. All lakes, rivers and transitional waters surveyed for WFD up to 2008 have been assigned an ecological status class (high, good, moderate, poor, bad) and results have been submitted to the draft river basin management plans. These plans were published by the River Basin Districts in December 2008.

Preliminary reports are available to read on the WFD fish website (www.wfdfish.ie). A more comprehensive report and interactive maps giving information on fish stocks for each of the waters surveyed is planned for the website in 2009.

It is important that I pay tribute to the support and expertise received from our colleagues in the Regional Fisheries Boards (RFBs); it is in coordination with these colleagues that the success in the WFD Surveillance Monitoring was delivered. We work hand in hand with the staff of the RFBs in delivery of national research projects and also in addressing their regional research requirements.

The year ahead offers many challenges both environmental and managerial; we continue to see rapid changes in our natural aquatic environment, with climate change, water quality and the potential threats from invasive species a continued focus. We must also be cognisant of the changed economic climate. With this in mind we have focused strongly on ensuring that our business and project management functions are robust in order to deliver the required research while ensuring quality and value for money. Lastly, I would like to thank all the WFD CFB and RFB staff for their support and hard work in 2008 and wish them every success for the year ahead.

Dr Cathal Gallagher,
Director of Research & Development

Central Fisheries Board,
May 2009

Executive Summary

In December 2000, the European Union introduced the Water Framework Directive (WFD) (2000/60/EC) - as part of a standard approach for all countries 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, 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 status by 2015.

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 of all biological elements including fish is the main tool used to classify the status (high, good, moderate, poor and 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, monitoring then helps to track the effectiveness of measures needed to clean up water bodies and achieve good status.

The responsibility for monitoring fish has been assigned to the Central and Regional Fisheries Boards. A national fish stock surveillance monitoring programme has been initiated at specified locations in a 3 year rolling cycle. 73 lakes, 180 sites in rivers and 70 estuaries are being surveyed for fish in the first three year cycle. The WFD fish surveillance monitoring programme in 2008 has been extensive and 83 river sites, 32 lakes and 42 transitional water bodies were successfully surveyed nationwide.

This report summarizes the main findings of the fish stock surveys in the waterbodies (lakes, rivers and transitional waters) surveyed during 2008 and reports the current status of the fish stocks in each of these. The surveys were conducted using a suite of European standard methods; electric fishing is the main survey method used in rivers and various netting techniques are being used in lakes and estuaries. Survey work was conducted between June and November, which is the optimum time for sampling fish in Ireland.

Thirty-two lakes were surveyed for fish in 2008. A total of 16 fish species and three types of hybrids were recorded using a multi-method sampling approach. Water chemistry samples were taken at each lake to assist in the classification of each lake. Eels were the most common fish species recorded in lakes followed by brown trout, perch, pike and roach. In general salmonids dominated lakes in the north-west, west and south west and were absent from lakes in the Cavan, Monaghan and midland regions. Sea trout were recorded in five lakes in the northwest and southwest. Salmon were recorded in six lakes and char in five lakes. The native Irish lake fauna has been augmented by the introduction of a large number of non-native species and have become established in the wild, these include roach, rudd, bream, etc. The status of these species varies widely throughout the country but were most common in the midland and Cavan/Monaghan/Sligo lakes.

An essential step in the WFD monitoring process is the classification of the status of lakes. A new WFD fish classification tool has been developed for the island of Ireland (Ecoregion 1) using Republic of Ireland and Northern Ireland data generated during the North South Share Fish in Lakes project (Kelly *et al*, 2008). Using this tool and expert opinion on non-native/alien species all lake waterbodies surveyed during 2008 have been assigned an ecological status for fish. Four lakes were classified as high status, 11 classified as good, 15 classified as moderate, one as poor and one as bad. The northwest and southwest were mainly dominated by lakes classified as high or good status and many of the midland and border counties failed to reach good ecological status for fish.

Eighty-three of the 120 river sites scheduled were sampled during 2008, the remaining sites were deferred to 2009 as the unseasonably high water levels during August and September prevented monitoring. A total of 15 fish species (including sea trout) and one type of hybrid were captured using boat based and hand-set electric fishing gear. Physical habitat variables were measured at each sample site. Brown trout were the most widespread fish species and were only absent from three of the sites surveyed, this was followed by eels, salmon, 3-spined stickleback, juvenile lamprey, stoneloach, minnow and gudgeon. Fish species richness ranged from one species to a maximum of ten species. Eels were absent on a number of river sites where there are large dams present downstream, e.g. Shannon, Lee, Erne and Clady catchments. The distribution of juvenile salmon was patchy throughout the sites surveyed with abundances appearing better in the northwest, southwest and southeast. Sea trout, as expected, were only recorded in sites close to the coast and in rivers that allow their access upstream. Irish rivers are similar to lakes in relation to stocks on non-native fish species which have become established in the wild in certain river catchments. The distribution and abundance of these varies throughout the country.

Forty-two transitional (estuaries and lagoons) water bodies were sampled during 2008. A total of 61 fish species (including sea trout) were recorded using a multi-method sampling approach. Salinity samples were measured at each beach seine site. The three most frequently encountered fish species recorded in the transitional waters were flounder, common goby and eel, accounting for 90%, 76% and 76% respectively. Species richness ranged from one species to a maximum of 31 species. Six estuaries recorded 20 or more fish species. Five species of angling importance were recorded during the surveys, i.e. flounder, pollack, mullet (thick-lipped and golden grey) and bass. Eels were recorded in 32 waterbodies. Three fish species listed in the Irish red Data book and labelled as "species threatened in Ireland" and internationally important species (i.e. smelt, river lamprey and salmon) were recorded in four, two and ten estuaries respectively. Dace, an invasive species, was recorded in three waterbodies. A fish classification tool for certain types of transitional waters has been developed and status assigned.

A new draft classification tool (Transitional Fish Classification Index or TFCI) for fish in estuaries has been developed by the Northern Ireland Environment Agency using Data from Northern Ireland and the Republic of Ireland. Using this tool all 42 waterbodies surveyed during 2008 have been assigned

ecological status for fish. One waterbody was classified as High, 19 were classified as Good, 11 as Moderate, 10 as Poor and one was classified as Bad ecological status for fish.

Project Personnel

This report was written and researched by Dr. Fiona Kelly, Ms. Lynda Connor, Mr. Glen Wightman, Dr. Ronan Matson, Ms. Emma Morrissey, Ms. Roisin O'Callaghan, Mr. Rory Feeney, Ms. Grainne Hanna and Mr. Kieran Rocks, Central Fisheries Board (CFB), under the direction of Dr. Cathal Gallagher, Director of Research and Development as part of the Water Framework Directive (WFD) Fish Surveillance Monitoring Programme, 2007 to 2009.

Acknowledgements

The authors wish to gratefully acknowledge the help and co-operation of the CEOs, ACEOs and their staff from the seven Regional Fisheries Boards (Eastern Regional Fisheries Board, Northern Regional Fisheries Board, Northwestern Regional Fisheries Board, Southern Regional Fisheries Board, Southwestern Regional Fisheries Board and the Western Regional Fisheries Board). The authors would also like to gratefully acknowledge the help and cooperation from all their colleagues in the Central Fisheries Board. Staff from the CFB's large patrol vessel, An Cosantóir Brádan provided support during the Shannon estuary surveys and their help is gratefully acknowledged.

Mr. Trevor Champ, Senior Research Officer with the Central Fisheries Board, who retired in November 2008, championed the use of fish communities in the ecological classification of rivers and lakes for the WFD. He worked on the WFD programme since the 1990s and was heavily involved in guiding, implementing and acquiring funding for the programme and his hard work is sincerely acknowledged.

Many angling clubs also kindly supported the surveys (including the Glenbeg Angling Club in County Kerry and the Lough Owel anglers) and their help is also gratefully acknowledged. Mr. Peter Mantle from Delphi Fishery, Co. Mayo and Mr. Roderick Perceval, Templehouse, Co. Sligo provided access to their respective fisheries and their help is gratefully acknowledged. The authors would also like to thank National Parks and Wildlife service (NPWS) and their staff in Glenveagh and Killarney National Parks for facilitating access and providing assistance during the Lough Beagh, Lough Leane and Upper Lake Killarney surveys.

We would also like to thank Dr. Martin O' Grady (CFB) and No. 3 Operational Wing, Irish Air Corps (Aer Chór na hÉireann) for the aerial photographs.

The authors would also like to acknowledge the funding provided for the project from the Department of Communication, Energy and Natural resources (DCENR) for 2008.

About the Central and Regional Fisheries Boards

The Central Fisheries Board (CFB) is a statutory body with responsibility for inland fisheries and sea angling operating under the aegis of the Department of Communications, Energy and Natural Resources and was established under the Fisheries Act 1980.

The principal functions of the CFB are to advise the Minister for Communications, Energy and Natural Resources on policy relating to the conservation, protection, management, development and improvement of inland fisheries and sea angling, to support, co-ordinate and provide specialist services to the Regional Fisheries Boards, and to advise the Minister on the performance by the Regional Fisheries Boards of their functions.

The Boards mission is to "ensure that the valuable resources of inland fisheries and sea angling are conserved, managed, developed and promoted in their own right and to support sustainable economic activity, job creation and recreational amenity".

The seven Regional Fisheries Boards have primary responsibility for fisheries management in their Regions. The role of the Regional Fisheries Boards is to conserve, protect, develop manage and promote inland fisheries. The Boards are also responsible for developing and promoting sea angling and protecting molluscs.

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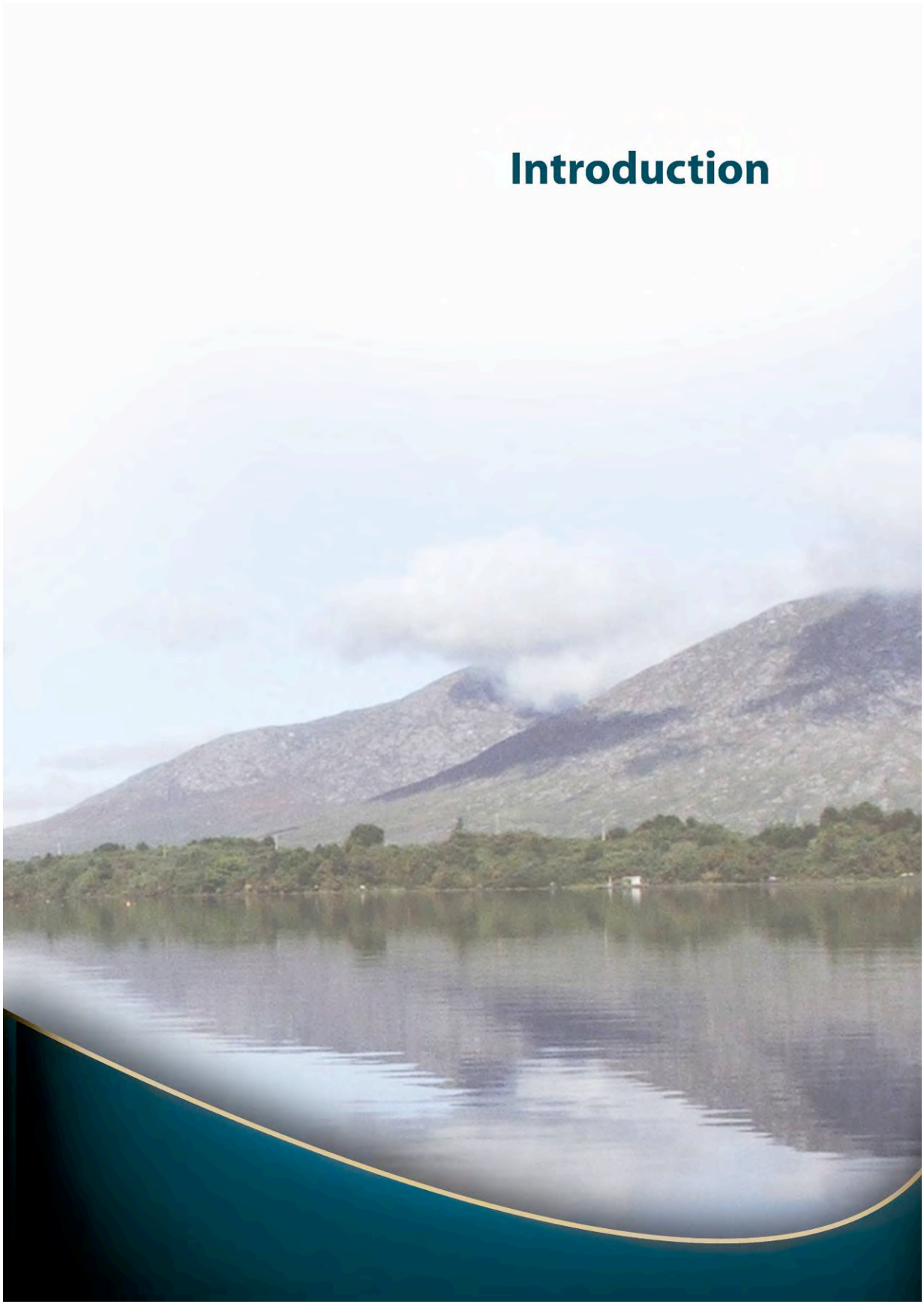


1. INTRODUCTION

In December 2000, the European Union introduced the Water Framework Directive (WFD) (2000/60/EC) as part of a new standard approach for all countries 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, 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 status by 2015. Many pollution reduction measures already in place as part of existing directives and national legislation will be evaluated, modified, and coordinated under the WFD to achieve these objectives. The WFD is being administered and managed at local level by River Basin Districts (RBDs). In accordance with national legislation (Water Regulations S.I. 722 / 2003), the Environmental Protection Agency published, in 2006, a programme of monitoring to be carried out in Ireland in order to meet the legislative requirements of the WFD.

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 and 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, monitoring then helps to track the effectiveness of measures needed to clean up water bodies and achieve good status.

Water quality in Ireland has been assessed for many years by the Environmental Protection Agency (EPA) principally on the basis of water chemistry and aquatic creatures such as insects, snails and shrimps. In the year 2000, the OECD criticised Ireland for placing too much emphasis on water quality and not enough on ecosystem quality. 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 the Central and Regional Fisheries Boards. A national fish stock surveillance monitoring programme has been initiated at specified locations in a 3 year rolling cycle. 73 lakes, 180 sites in rivers and 70 estuaries are being surveyed for fish in the first three year cycle. This research will provide new information on the status of fish species present at these sites as well as on their abundance, growth patterns, and population demographics.

In 2005 and 2006 as part of an Interreg funded project for the WFD (North South Share Fish in Lakes Project), the staff of the Central and Regional Fisheries Boards carried out fish stock surveys on 53 lakes in the border counties (Kelly *et al.*, 2008b). The Boards began surveillance monitoring for the WFD assisted by fishery owners and angling clubs during 2007. During this initial period 15 lakes in 4 Regional Fisheries Board areas were successfully surveyed. Transitional waters in the Barrow, Nore

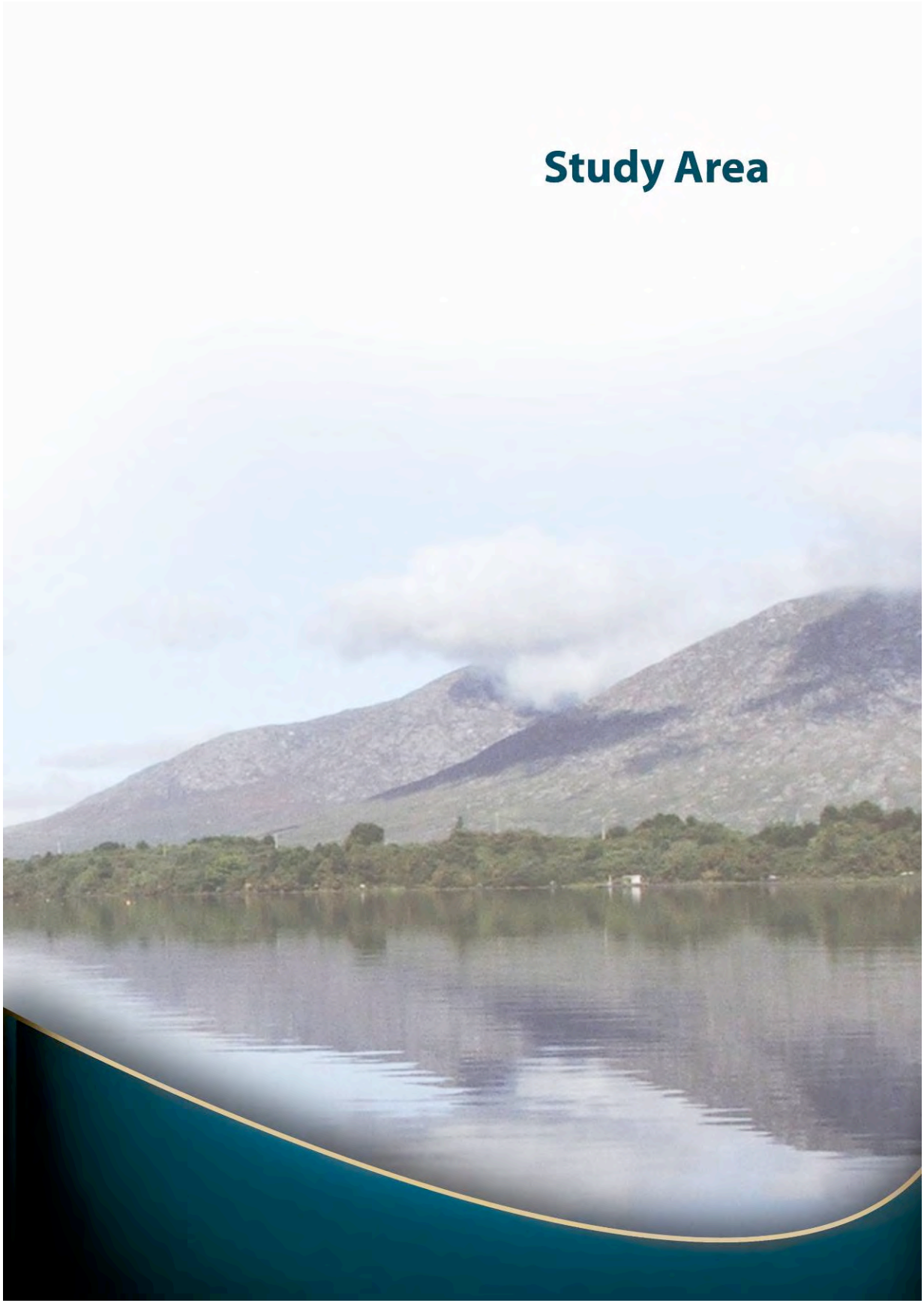
and Suir estuaries and Waterford Harbour were also surveyed with the assistance of the Southern Regional Fisheries Board. No rivers were surveyed during the 2007 surveillance monitoring period.

The WFD fish surveillance monitoring programme in 2008 has been extensive and 83 river sites, 32 lakes and 42 transitional water bodies were successfully surveyed nationwide. A team of scientists were recruited by the Research and Development section of the Central Fisheries Board to carry out the monitoring surveys. As many as four Central and Regional Fisheries Board WFD monitoring teams were deployed simultaneously to work in the field. The surveys were conducted using a suite of European standard methods; electric fishing is the main survey method used in rivers and various netting techniques are being used in lakes and estuaries. Survey work was conducted between June and November, which is the optimum time for sampling fish in Ireland. Sampling in rivers was frustrated by poor weather, higher than average rainfall and water levels. Due to the stresses of weather the surveying and monitoring of some river sites planned for 2008 have been deferred until 2009.

This report summarises the main findings of the fish stock surveys in the waterbodies (lakes, rivers and transitional waters) surveyed during 2008 and reports the current status of the fish stocks in each of these. One of the main objectives of the WFD monitoring programme is to assign ecological status to each waterbody and results from selected lakes and transitional waters are also presented here.

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

Study Area



2. STUDY AREA

2.1 Lakes

Thirty two lake waterbodies, ranging in size from 24.5ha (Lough Brin) to 11519.9ha (Upper Lough Corrib), were surveyed in six Regional Fisheries Board areas during 2008, as part of the programme for sampling fish for the Water Framework Directive (Fig. 2.1). A range of lake types (11 WFD designated typologies) (EPA, 2005) and trophic levels were surveyed (Table 2.1).

Eight lakes were surveyed in the Northern Regional Fisheries Board (NRFB) (Corglass Lake, Derrybrick Lough, Lough Egish, Lough Barra, Kiltooris Lough, Lough Beagh, Lough Fern and Lough Melvin) ranging in area from 36ha (Derrybrick Lough) to 2252.9ha (Lough Melvin) (Fig. 2.1), five were surveyed in the North Western Regional Fisheries Board (NWRFB) (Carrowmore Lake, Lough Gill, Lough Easky, Lough Talt and Templehouse Lake) ranging in size from 96.9ha (Lough Talt) to 1375.3ha (Lough Gill) (Fig. 2.1), three were surveyed in the Western Regional Fisheries Board (WRFB) (Glencullin Lough, Lower and Upper Lough Corrib), eight in the South Western Regional Fisheries Board (SWRFB) (Lough Acoose, Lough Caragh, Lough Allua, Glenbeg Lough, Lough Leane, Inniscarra resevoir, Upper Lake and Lough Brin) ranging in area from 24.5ha (Lough Brin) to 1944.3ha (Lough Leane), seven in the Shannon Regional Fisheries Board (ShRFB) (Lough Sheelin, Lough O'Flynn, Cavetown Lake, Lough Owel, Lough Nanoge, Lough Meelagh and Annaghmore Lake) ranging in area from 45.9ha (Lough Nanoge) to 1808ha (Lough Sheelin) and one in the Eastern Regional Fisheries Board (ERFB) (Upper Lough Skeagh) between June and October 2008 (Table 2.1).

Table 2.1: List of lakes surveyed for WFD surveillance monitoring, June to October 2008. Details of area (ha), mean depth (m) and max depth (m) are included

Lake name	Catchment	Easting	Northing	WFD Typology	Area (ha)	Mean depth (m)	Max depth (m)
NRFB							
Corglass	Erne	234842	308823	9	34.3	1.6	6
Melvin	Drowes	189530	353752	8	2197	7.8	40
Barra	Gweebarra	193447	411876	4	62.3	4.4	12
Kiltooris	Coastal	167183	396339	5	43.3	<4	14
Egish	Erne	277884	312744	10	117	3.3	10
Beagh	Lackagh	202074	421485	4	259	9.2	46.5
Fern	Leannan	218292	424349	6	181	2	3
Derrybrick	Erne	234514	312044	9	36.2	2.1	5
NWRFB							
Carrowmore	Owenmore	83597.466	327913.364	6	911.2	<4	2.5
Gill	Garavogue	175363	333545	8	1375.3	>4	31
Easky	Easky	144396	323036	2	118.7	3	10.5
Talt	Moy	139683	315172	8	96.9	>4	40
Templehouse	Ballysadare	161565	317148	10	118.6	2.6	5.3
WRFB							
Glencullin	Bundorragha	81952	269647	1	34.1	<4	13
Lough Corrib upr	Corrib	127105	236016	12	5042	>4	42
Lough Corrib lwr	Corrib	113819	248676	10	11519	<4	6.8

Table 2.1 contd.: List of lakes surveyed for WFD surveillance monitoring, June to October 2008. Details of area (ha), mean depth (m) and max depth (m) are included

Lake name	Catchment	Easting	Northing	WFD Typology	Area (ha)	Mean depth (m)	Max depth (m)
SWRFB							
Acoose	Caragh	75602	85287	2	66.3	>4	19
Caragh	Caragh	71986	90432	4	488.7	11	39
Allua	Lee	118989	65591	4	135.9	4.0	28.4
Glenbeg	Coastal	70632	53003	4	66.2		32
Leane	Laune	93171	88660	8	1944.3	13	60
Upper Lake Killarney	Laune	90931	82113	4	166.7	14.5	36
Brin	Blackwater	78334	77451	3	24.5	5.9	13
Inniscarra*	Lee	147703	279690	8	489	7.4	35.4
ShRFB							
Sheelin	Inny	244291	283941	12	1808.2	4.4	15
O' Flynn	Suck	158361	279690	10	136.9	4.5	14.5
Cavetown	Shannon Upr	183228	297430	10	64	<4	20
Owel	Inny	240155	258633	8	1017.6	>4	22
Nanoge	Shannon Upr	150461	290247	11	45.9	4.5	11
Meelagh	Shannon Upr	189093	312025	6	115.7	<4	14
Annaghmore	Shannon Upr	189942	283670	10	52.9	<4	16
ERFB							
Upper L. Skeagh	Boyne	265083	301342	6	61	2.2	4.9

Note: Lake typology is described in Appendix 1
Note: *Inniscarra was surveyed jointly by WFD and CFB coarse fish section

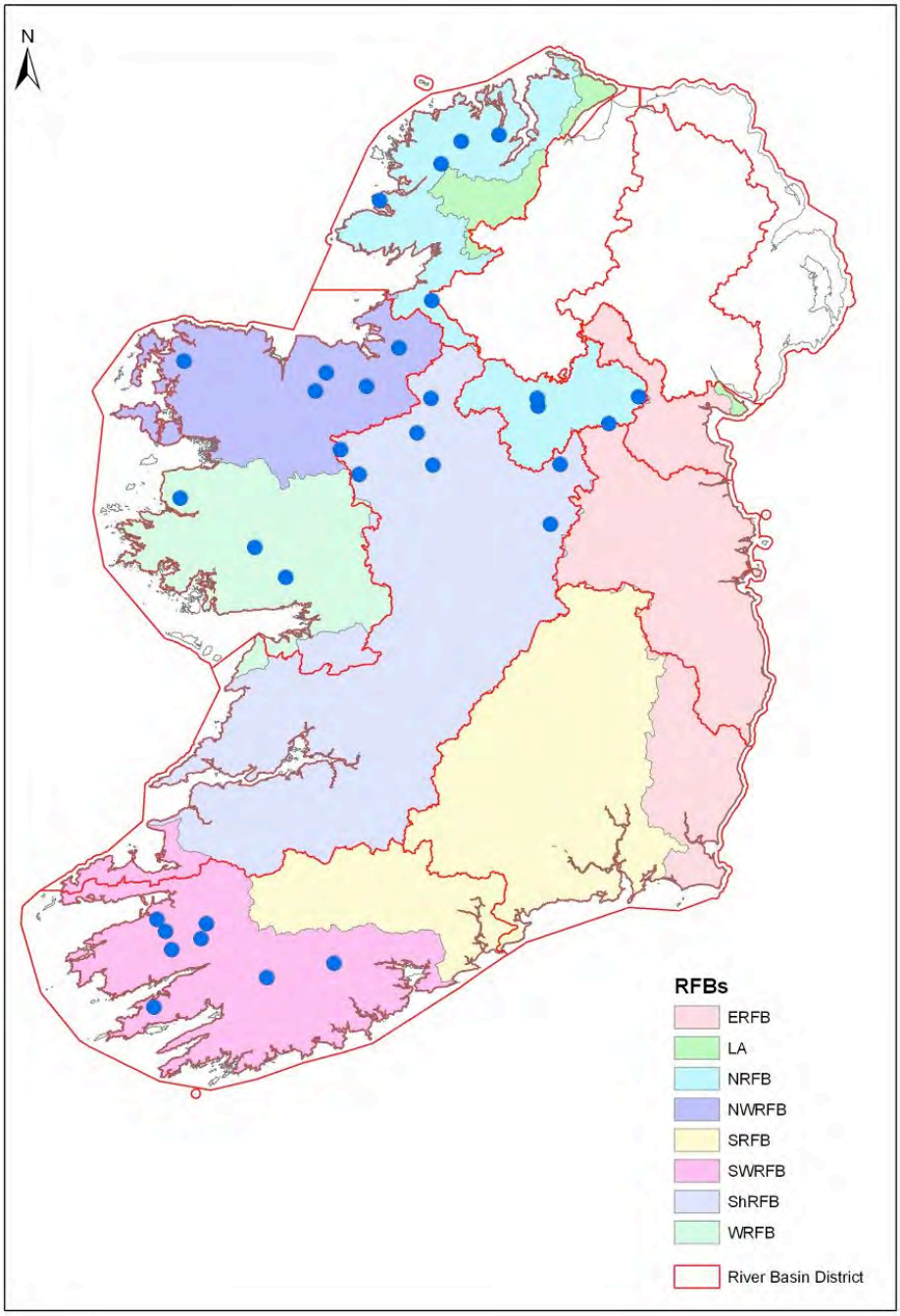


Fig. 2.1: Location map indicating the 32 lake waterbodies surveyed as part of the WFD surveillance monitoring programme, June to October 2008

2.2 Rivers

Fish stock surveys were carried out at 83 river sites (in four catchment size classes - <10km^2, <100km^2, <1000km^2 and <10000km^2) between July and early October 2008 by staff from the Central Fisheries Board and the seven Regional Fisheries Boards, as part of the programme for sampling fish for the Water Framework Directive (Table 2.2 and Fig. 2.2).

Eleven river sites, in six catchments, were surveyed in the Eastern Regional Fisheries Board. Sites ranged in surface area from 387.5m^2 (Douglas river) to 8680m^2 (Liffey river at Kilcullen) (Fig. 2.2 and Table 2.2). A total of twelve river sites in five river catchments were surveyed in the Southern Regional Fisheries Board ranging in area from 361.67m^2 (Nuenna River) to 2464m^2 (Colligan River) (Fig. 2.2 and Table 2.2). Nine river sites in five catchments were surveyed in the South Western Regional Fisheries Board; these ranged in area from 202.5m^2 (Tyshe river) to 7440m^2 (Flesk River). The Bunowen River (2520m^2) was the only river site surveyed in the Western Regional Fisheries Board during 2008. Nine river sites in four catchments were surveyed in the North Western Regional Fisheries Board ranging in area from 319.65m^2 (Tobercurry) to 5943m^2 (Deel river at Crossmolina). A total of 29 river sites were surveyed in the Shannon Regional Fisheries Board during 2008, they ranged in area from 171m^2 (Little River) to 20916m^2 (Shannon River - Battle Bridge). Twelve river sites, in eight river catchments, were surveyed in the Northern Regional Fisheries Board area, ranging in area from 177m^2 (Ballyhallan River) to 5587m^2 (Erne River at Belturbet) (Fig. 2.2 and Table 2.2).

Table 2.2: List of river sites surveyed for WFD surveillance monitoring, July to October 2008. Details of catchment area (km^2), wetted width, surface area (m^2), mean depth (m) and max depth (m) are included

EPA code	Site	Catchment	Easting	Northing	Catchment size (km^2)	Width (m)	Area (m^2)	Mean depth (m)	Max depth (m)
ERFB Hand-set sites									
11B020300	Banoge	Owenavorragh	315948	156340	<100	6.46	646.00	0.22	0.45
12C030200	Clody	Slaney	289742	154970	<100	7.77	776.67	0.32	0.50
09D010900	Dodder	Liffey	317704	231128	<1000	11.40	570.00	0.36	0.65
12D030200	Douglas	Slaney	284445	163946	<100	3.88	387.50	0.22	0.55
13D010350	Duncormick	Coastal	291366	110626	<100	4.72	471.67	0.34	0.63
12U010200	Urrin	Slaney	287055	144031	<100	5.95	535.50	0.37	0.59
09R010400	Rye Water	Liffey	294686	238556	<1000	6.38	638.33	0.26	0.54
ERFB Boat sites									
03B010800	Blackwater (Newmills Br.)	Blackwater (Ulster)	271921	338773	<1000	11.20	2968.00	0.42	0.95
09L010700	Liffey (Kilcullen)	Liffey	284110	209964	<1000	24.80	8680.00	0.77	1.40
11O010500	Owenavorragh	Owenavorragh	315104	154291	<100	8.00	1280.00	0.50	1.00
10V010300	Vartry	Vartry	328823	196717	<1000	7.40	1110.00	0.51	0.82
SRFB Hand-set sites									
15B010200	Ballyroan	Nore	242178	185122	<100	4.88	439.50	0.31	0.51
16D030100	Duag	Suir	192040	112667	<100	4.14	372.60	0.19	0.33
15G010200	Glory	Nore	248480	139983	<100	7.40	666.00	0.37	0.58
16N010100	Nier	Suir	219922	112908	<100	15.60	702.00	0.31	0.70
15N020100	Nuenna	Nore	236349	163731	<100	5.17	361.67	0.31	0.58

Table 2.2 contd.: List of river sites surveyed for WFD surveillance monitoring, July to October 2008. Details of catchment area (km^2), wetted width, surface area (m^2), mean depth (m) and max depth (m) are included

EPA code	Site	Catchment	Easting	Northing	Catchment size (km^2)	Width (m)	Area (m^2)	Mean depth (m)	Max depth (m)
SRFB Boat sites									
16A020600	Anner	Suir	231304	135343	<100	8.80	1760.00	0.47	0.95
17C010250	Colligan	Colligan	223215	95223	<100	11.20	2464.00	0.49	1.15
17M010350	Mahon	Mahon	242264	101091	<100	10.20	1836.00	0.48	1.30
16M021100	Multeen	Suir	200706	140185	<1000	14.00	2100.00	0.48	0.80
15N010300	Nore (Quakers Br.)	Nore	221293	186978	<100	7.80	1560.00	0.96	1.70
16S020200	Suir (Knocknageragh)	Suir	213094	172414	<100	5.80	614.80	0.49	0.69
19W011300	Womanagh	Womanagh	198381	72632	<100	6.00	618.00	0.66	0.93
SWRFB Hand-set sites									
19G010200	Glashaboy	Glashaboy	166998	84251	<100	4.03	363.00	0.32	0.54
19M010600	Martin	Lee	159943	75433	<100	6.83	307.35	0.30	0.76
22S010100	Shanowen	Maine	101250	109130	<100	7.33	623.33	0.26	0.50
23T020500	Tyshe	Tyshe	76025	122380	<100	4.50	202.50	0.47	0.67
SWRFB Boat sites									
22F020300	Flesk*	Laune	96920	89392	<1000	24.80	7440.00	0.73	1.40
22G061200	Gweestin	Laune	83810	94979	<100	8.40	1092.00	0.44	0.80
19L030100	Lee	Lee	114647	66603	<100	10.40	2080.00	0.45	0.72
22M010700	Maine	Maine	89124	104806	<1000	16.40	5248.00	0.48	0.90
22O030400	Owenreagh*	Laune	88398	82121	<100	23.00	10580.00	0.79	1.90
WRFB Boat sites									
32B030100	Bunowen*	Bunowen	81981	277734	<100	12.60	2520.00	0.69	1.40
NWRFB Hand-set sites									
33B010100	Ballinglen	Ballinglen	110251	334201	<100	6.73	471.33	0.25	0.68
34C050030	Clydagh	Moy	114364	296515	<10	5.18	466.50	0.19	0.35
32G030100	Glennamong	Srahmore	94724	302350	<100	7.68	691.50	0.31	0.90
34M020050	Moy	Moy	152241	319249	<100	7.32	658.50	0.10	0.31
34T020200	Tobercurry	Moy	147543	311356	<100	3.55	319.65	0.16	0.29
NWRFB Boat sites									
34B080400	Behy	Moy	128756	318151	<100	6.72	806.00	0.66	1.12
34C010200	Castlebar	Moy	117089	292029	<100	6.32	632.00	0.32	0.48
34D010400	Deel (Crossmolina)	Moy	117974	318579	<1000	18.40	5943.20	1.00	1.90
33G010100	Glenamoy	Glenamoy	89384	333757	<100	10.60	2183.60	0.35	0.55
ShRFB Hand-set sites									
26B071100	Boor	Shannon Upr	209753	234942	<100	4.80	460.80	0.51	1.11
25B100100	Bow	Shannon Lwr	166601	186922	<100	5.47	492.30	0.27	0.61
27B020300	Broadford	Bunratty	160845	172127	<100	3.60	288.00	0.48	0.60
25G210010	Glenfelly	Shannon Lwr	220199	201371	<10	3.06	274.95	0.21	0.52
27G020600	Gourna	Bunratty	148253	164353	<100	3.78	340.50	0.31	0.53
25G040025	Graney	Shannon Lwr	155530	190009	<100	5.43	434.53	0.26	0.45
26I010100	Inny (Oldcastle)	Inny	254918	279257	<100	2.87	258.00	0.42	0.67
25L010200	Little	Shannon Lwr	206305	217768	<100	3.80	171.00	0.30	0.53

Table 2.2 contd.: List of river sites surveyed for WFD surveillance monitoring, July to October 2008. Details of catchment area (km^2), wetted width, surface area (m^2), mean depth (m) and max depth (m) are included

EPA code	Site	Catchment	Easting	Northing	Catchment size (km^2)	Width (m)	Area (m^2)	Mean depth (m)	Max depth (m)
ShRFB Boat sites									
25B091100	Brosna (Clonony)	Shannon Lwr	204896	220903	<10000	22.00	8800.00	1.05	2.00
25B090760	Brosna (Pollagh)	Shannon Lwr	219013	225727	<1000	28.00	12432.00	1.32	1.85
26C011000	Camlin	Shannon Upr	209657	277707	<1000	11.21	2801.67	0.87	1.04
25C060500	Clodiagh	Shannon Lwr	225710	225628	<1000	7.60	1200.80	0.65	1.08
26C100400	Cross	Shannon Upr	203693	239201	<1000	6.20	1091.20	1.27	1.90
24D020400	Deel (Newcastlewest)	Shannon Est Sth	132454	128637	<1000	8.60	1720.00	0.60	1.01
23F010500	Feale	Feale	106919	130913	<1000	31.00	9765.00	0.44	1.00
26F020400	Feorish*	Shannon Upr	190029	310567	<100	9.05	17511.75	1.77	2.15
27F010700	Fergus	Fergus	134524	177868	<100	23.20	10068.80	1.86	3.00
26I011350	Inny (Shrule)	Inny	213517	255885	<10000	18.80	7144.00	0.73	1.30
25K010700	Kilcrow	Shannon Lwr	179808	205671	<1000	10.20	2815.20	0.63	0.97
25L020700	Little Brosna	Shannon Lwr	205262	203497	<1000	10.65	2130.00	0.57	0.78
24M010900	Maigue	Shannon Est Sth	147928	144017	<1000	28.40	14682.80	1.19	1.90
26M020500	Mountnugent	Inny	249044	285710	<100	7.54	1372.58	0.67	1.26
26S010300	Scramoge	Shannon Upr	191810	277708	<1000	10.10	2939.10	1.53	2.00
26S020500	Shannon (Battle Br)	Shannon Upr	194824	305035	<1000	33.20	20916.00	0.97	2.00
25S020700	Silver	Shannon Lwr	213810	219891	<1000	7.68	997.75	0.75	1.11
23S020700	Smearlagh	Feale	103052	132839	<1000	15.20	3526.40	0.39	1.07
26S071100	Suck (Ballyforan)	Suck	181589	246423	<10000	35.80	12172.00	0.66	1.04
26S070300	Suck (Cloondacarra)	Suck	167185	278205	<1000	9.20	1922.80	0.58	0.83
25T030400	Tullamore	Shannon Lwr	229267	225275	<1000	6.83	1281.25	0.71	1.05
NRFB Hand-set sites									
40B010200	Ballyhallan	Clonmany	236980	446116	<10	3.93	177.00	0.12	0.20
39B020600	Burnfoot	Burnfoot	237968	423697	<100	4.49	247.04	0.26	0.44
38C060100	Cronaniv Burn	Clady	193084	418695	<10	5.89	265.20	0.18	0.30
39G050100	Glaskeelan	Leannan	205202	417317	<100	5.07	228.30	0.34	0.47
38O060300	Owentocker	Owentocker	173264	390635	<100	9.39	422.70	0.31	0.50
36S010300	Swanlinbar	Erne	219707	327158	<100	7.75	348.75	0.24	0.46
39S020050	Swilly	Swilly	206003	409202	<100	7.13	320.96	0.25	0.58
36W030700	Waterfoot	Erne	208490	365177	<100	8.63	397.13	0.35	0.50
NRFB Boat sites									
36A021400	Annalee	Erne	240252	310333	<1000	16.20	2656.80	0.55	0.72
36D020150	Dromore	Erne	271456	320753	<100	5.34	801.00	0.79	1.05
37E030300	Eany Water	Eany Water	183866	381481	<100	22.31	6023.70	0.72	1.63
36E011400	Erne (Belturbet)	Erne	236083	316934	<10000	19.20	5587.20	0.55	0.82

Note: * indicates that sites will be resurveyed in 2009 (water levels were high in 2008)

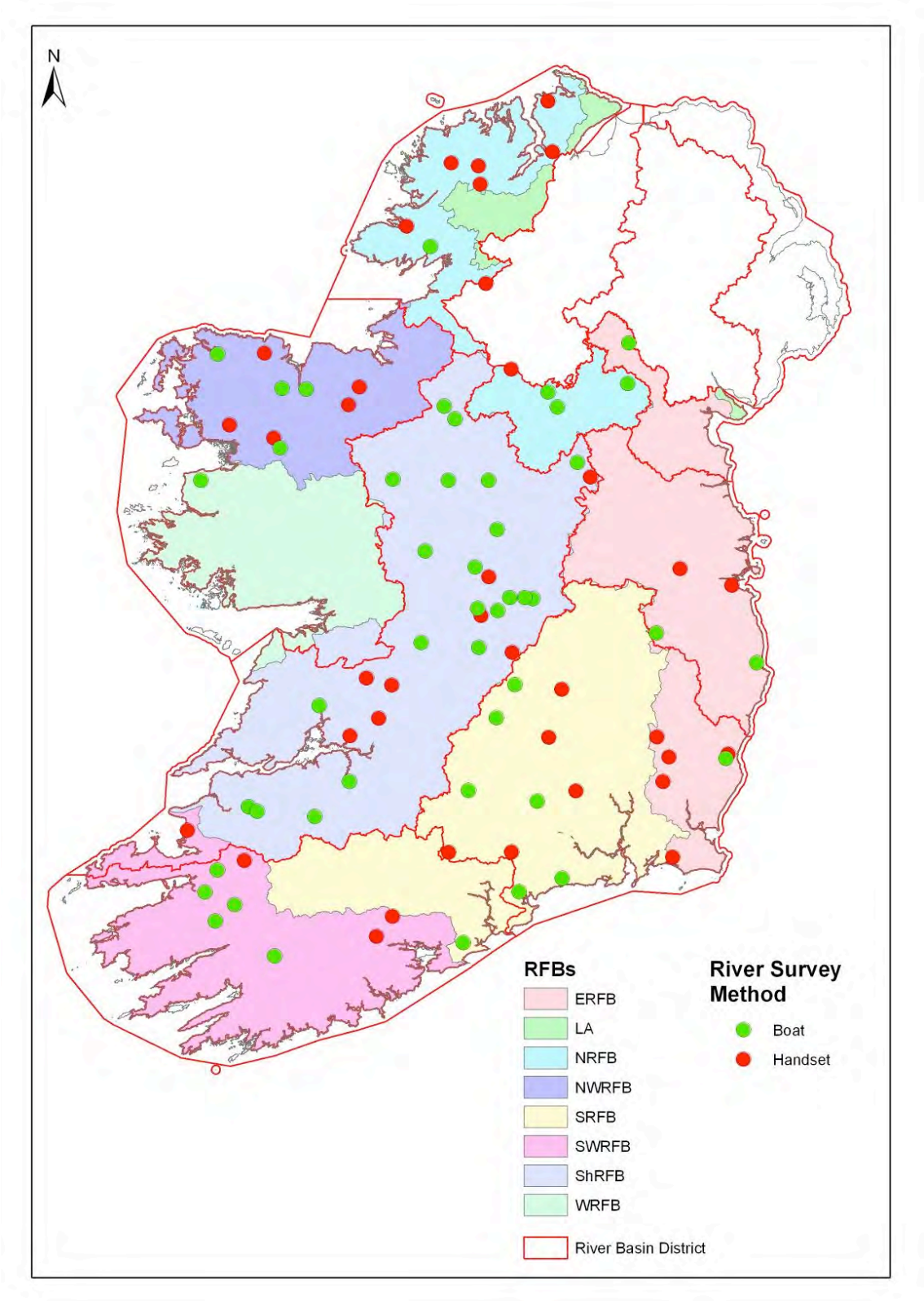


Fig. 2.2: Location map showing the 83 river sites surveyed as part of the WFD surveillance monitoring programme, June to October 2008

2.3 Transitional waters

Fish stock surveys were carried out at sites in 42 transitional water bodies between September and November 2008 by staff from the Central Fisheries Board and six Regional Fisheries Boards (Table 2.3 and Figs. 2.3 to 2.8). Staff from the CFBs large protection vessel, An Cosantóir Bradán, provided support during the Shannon Estuary surveys (Plate 4.1).

Transitional waters ranged in size from 0.08km^2 (Bridge Lough, Knockakilleen in Co. Galway) to 123.08km^2 (Lower Shannon Estuary, Co. Clare, Kerry & Limerick). Seven transitional waters were surveyed in the Eastern Regional Fisheries Board (ERFB) ranging in area from 0.17km^2 (Avoca Estuary) to 4.8km^2 (Lower Liffey Estuary) (Table 2.3 and Fig. 2.3). Six were surveyed in the North Western Regional Fisheries Board (NWRFB) ranging in size from 8.39km^2 (Sruwaddacon Bay) to 17.25km^2 (Tullaghan Bay) (Table 2.3 and Fig. 2.4), eight were surveyed in the Shannon Regional Fisheries Board (ShRFB) ranging from 0.38km^2 (Upper Feale Estuary) to 123.08km^2 (Lower Shannon Estuary) (Table 2.3 and Fig. 2.6), three were surveyed in the Southern Regional Fisheries Board (SRFB) ranging in size from 0.7km^2 (Upper Blackwater Estuary) to 12.07km^2 (Lower Blackwater Estuary) (Table 2.3 and Fig. 2.5), twelve were surveyed in the South Western Regional Fisheries Board (SWRFB) ranging in size from 0.12km^2 (Glashaboy Estuary) to 12.23km^2 (Lough Mahon Estuary) (Table 2.3 and Fig. 2.7), and six were surveyed in the Western Regional Fisheries Board ranging from 0.08km^2 (Bridge Lough, Knockakilleen) to 9.70km^2 (Corrib Estuary) (Table 2.3 and Fig. 2.8) between September and November 2008.

Table 2.3: List of Transitional water bodies sampled for WFD fish monitoring between September and November 2008 (FT=freshwater tidal, TW=transitional and L=lagoon)

Transitional Waterbody	MS Code	Type	Area (km^2)	Min Salinity (ppt)	Max Salinity (ppt)
Eastern Regional Fisheries Board					
Broad Lough	EA_130_0100	TW	0.80	10.15	32.9
Avoca Estuary	EA_150_0100	TW	0.17	0.30	1.00
Lower Liffey Estuary	EA_090_0300	TW	4.80	6.35	11.25
Upper Liffey Estuary	EA_090_0400	TW	0.19	0.10	0.10
Tolka Estuary	EA_090_0200	TW	3.58	17.10	20.05
Broadmeadow Water	EA_060_0100	L	3.33	0.55	17.05
Rogerstown Estuary	EA_050_0100	TW	3.05	1.80	26.90
North Western Regional Fisheries Board					
Moy Estuary	WE_420_0300	TW	7.42	0.10	32.45
Garavoge Estuary	WE_470_0100	TW	8.83	1.30	7.45
Ballysadare Estuary	WE_460_0300	TW	8.72	0.00	0.15
Sruwaddacon Bay	WE_400_0200	TW	8.39	26.60	31.00
Tullaghan Bay	WE_390_0100	TW	17.25	1.35	23.75
Newport Bay	WE_350_0200	TW	9.35	0.00	14.90
Shannon Regional Fisheries Board					
Cashen Estuary	SH_060_0100	TW	2.67	0.00	1.50
Upper Feale Estuary	SH_060_0200	FT	0.38	0.00	0.00
Lower Shannon Estuary	SH_060_0300	TW	123.08	11.60	26.8
Upper Shannon Estuary	SH_060_0800	TW	39.51	0.10	7.00
Fergus Estuary	SH_060_1100	TW	64.75	5.25	18.70
Deel Estuary	SH_060_0600	TW	3.02	0.55	10.35
Maigue Estuary	SH_060_0700	TW	3.21	0.20	1.90
Limerick Docks	SH_060_0900	FT	2.4875	0.10	0.10

Table 2.3 contd. List of Transitional water bodies sampled for WFD fish monitoring between September and November 2008 (FT=freshwater tidal, TW=transitional and L=lagoon)

Transitional Waterbody	MS Code	Type	Area (km^2)	Min Salinity (ppt)	Max Salinity (ppt)
Southern Regional Fisheries Board					
Upper Blackwater Estuary	SW_020_0500	FT	0.70	0.00	0.00
Lower Blackwater Estuary	SW_020_0100	TW	12.07	0.00	0.00
Colligan Estuary	SE_140_0100	TW	10.03	21.15	33.05
South Western Regional Fisheries Board					
North Channel Great Island	SW_060_0300	TW	7.96	21.45	29.55
Owenacurra Estuary	SW_060_0400	TW	1.121	2.20	8.65
Lough Mahon	SW_060_0750	TW	12.23	7.00	25.8
Harper's Island	SW_060_0700	TW	2.06	21.1	23.4
Glashaboy Estuary	SW_060_0800	TW	0.12	1.20	3.0
Upper Lee Estuary	SW_060_0950	TW	0.25	0.20	0.20
Lower Lee Estuary	SW_060_0900	TW	0.88	4.85	7.10
Argideen Estuary	SW_090_0200	TW	4.92	8.15	34.60
Kilkeran Lake	SW_110_0100	L	0.18	2.40	3.50
Ilen Estuary	SW_130_0100	TW	9.66	0.05	27.55
Kilmakilloge Harbour	SW_190_0200	TW	5.85	6.55	26.30
Lee (Tralee) Estuary	SH_050_0100	TW	3.06	0.80	4.30
Western Regional Fisheries Board					
Westport Bay	WE_350_0100	TW	5.32	12.30	32.85
Erriff Estuary	WE_310_0100	TW	0.41	1.55	8.85
Corrib Estuary	WE_170_0700	TW	9.70	0.25	22.15
Bridge Lough, Knockakilleen	WE_160_0200	L	0.08	-	-
Loch Tanaí	WE_200_0600	L	0.10	10.4	1050?
Loch an tSáile	WE_200_1100	L	0.90	0.15	0.45

Fig. 2.3: Location map showing the 7 transitional waterbodies in the ERFB surveyed as part of the WFD surveillance monitoring, June to October 2008

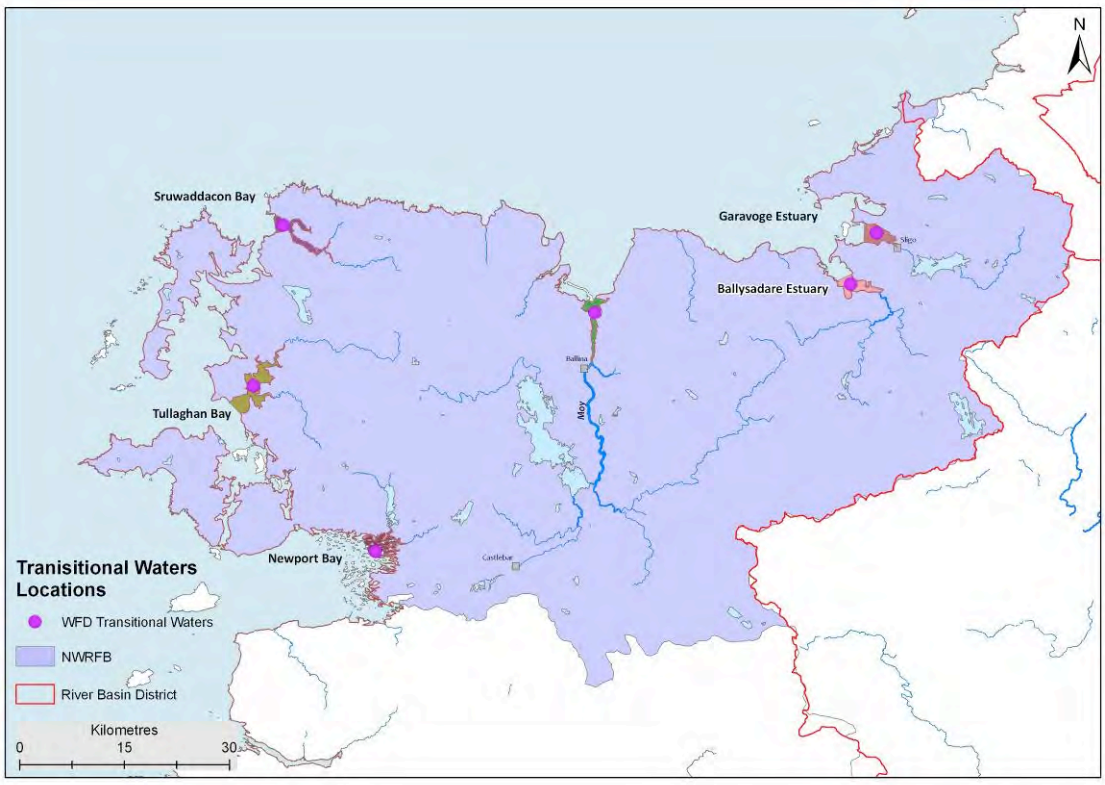


Fig. 2.4: Location map showing the 6 transitional waterbodies in the NWRFB surveyed as part of the WFD surveillance monitoring, June to October 2008

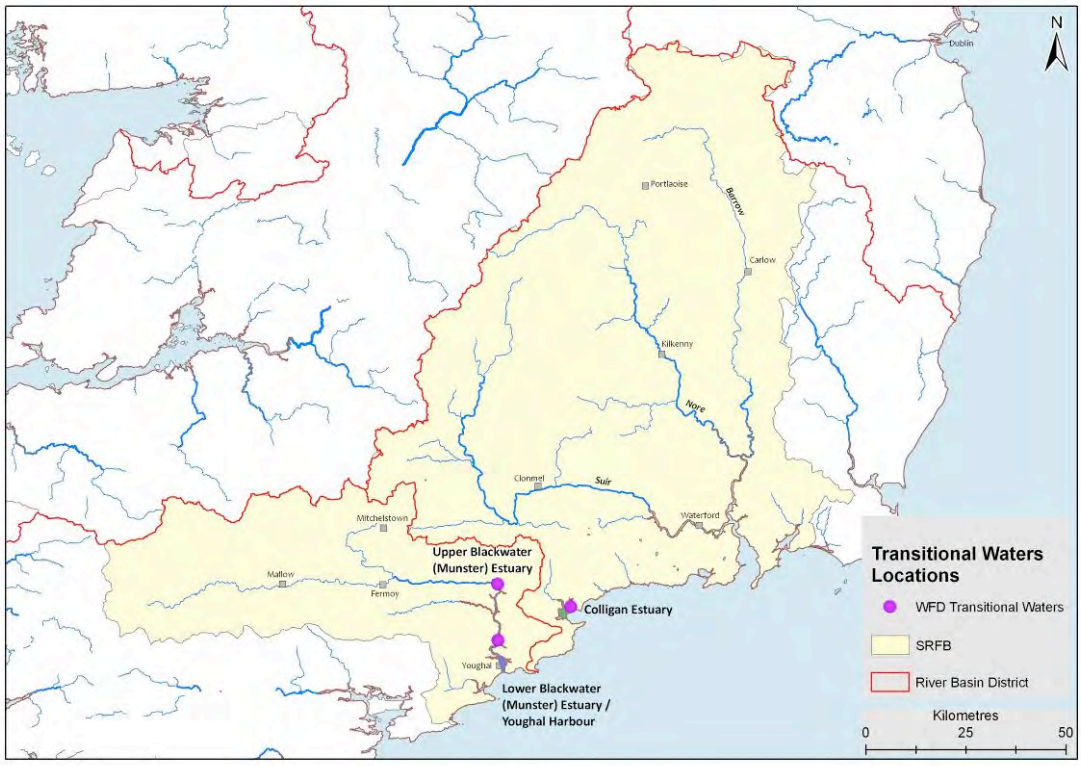


Fig. 2.5: Location map showing the 3 transitional waterbodies in the SRFB surveyed as part of the WFD surveillance monitoring, June to October 2008

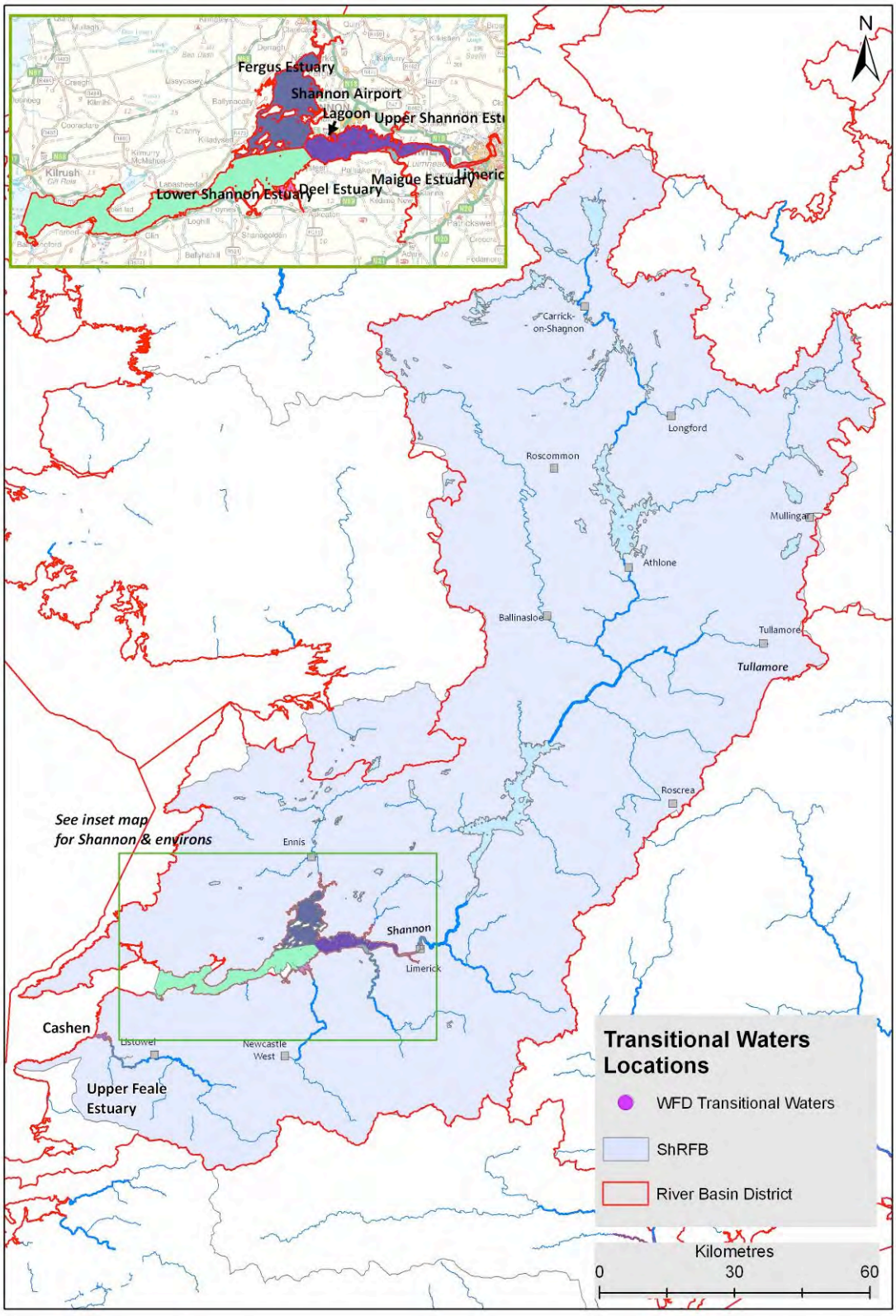


Fig. 2.6: Location map showing the 8 transitional waterbodies in the ShRFB surveyed as part of the WFD surveillance monitoring, June to October 2008

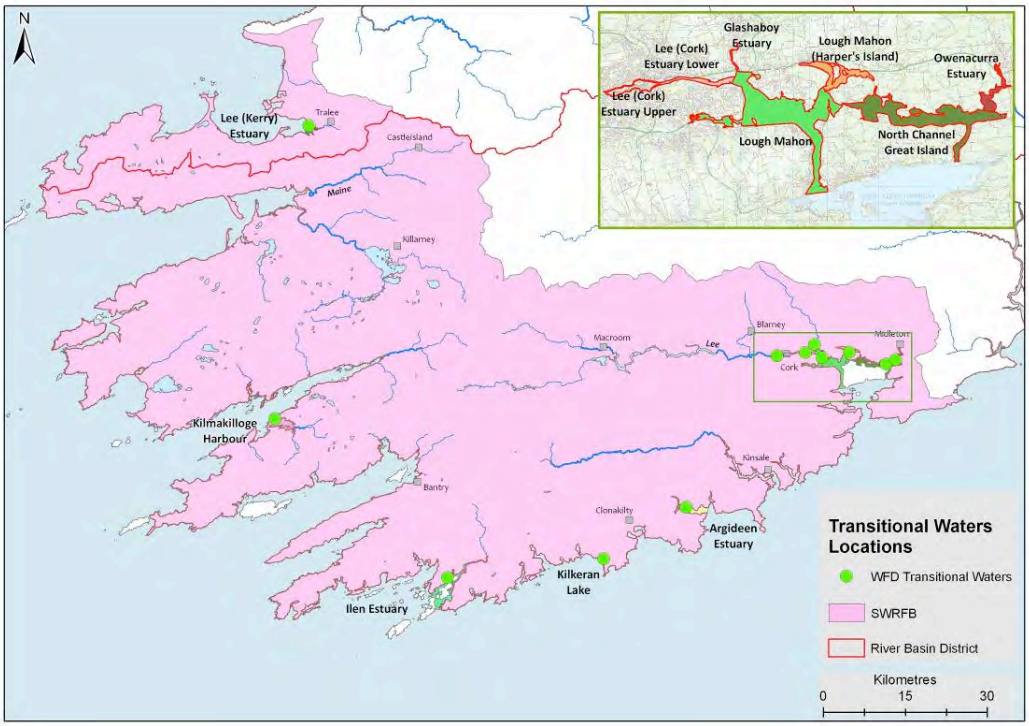


Fig. 2.7: Location map showing the 12 transitional waterbodies in the SWRFB surveyed as part of the WFD surveillance monitoring, June to October 2008

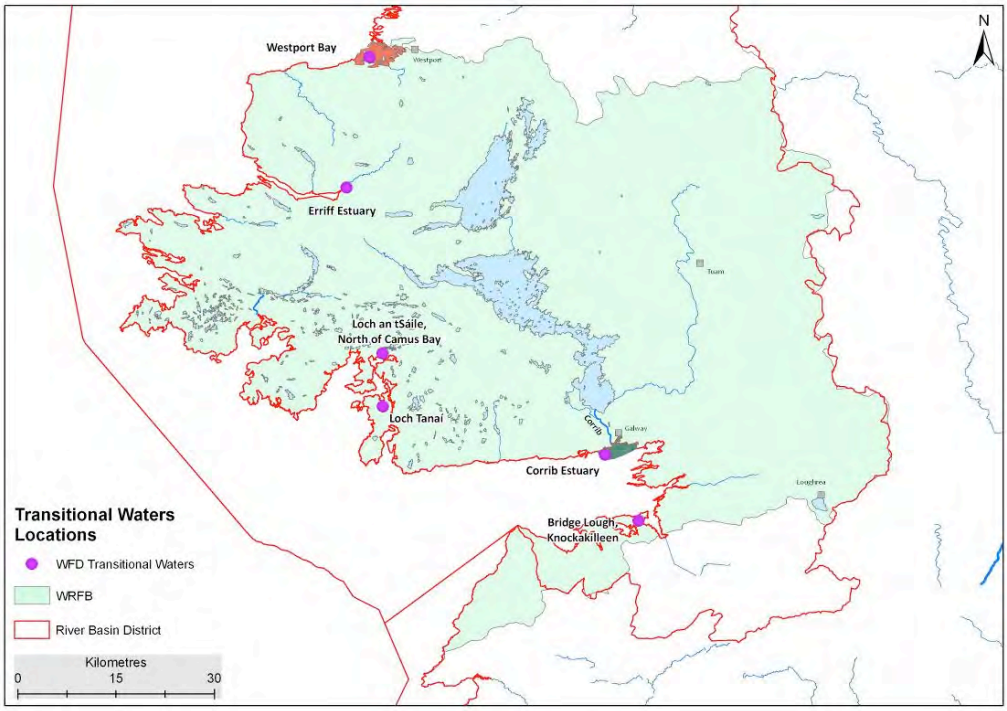
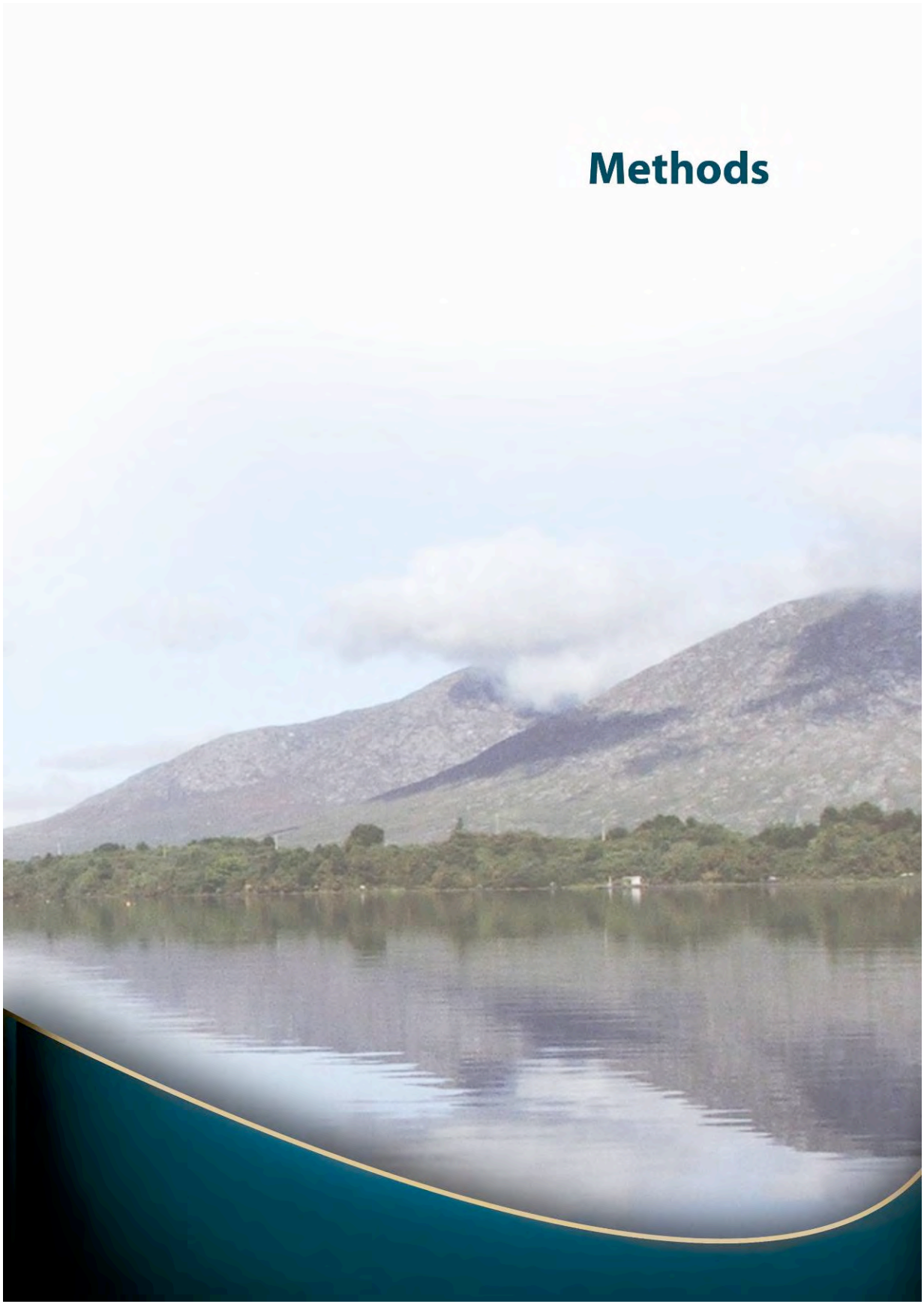


Fig. 2.8: Location map showing the 6 transitional waterbodies in the WRFB surveyed as part of the WFD surveillance monitoring, June to October 2008


Methods

3. METHODS

All surveys were conducted using a suite of European standard methods (CEN, 2003; CEN 2005a; CEN, 2005b); electric fishing is the main survey method used in rivers and various netting techniques are being used in lakes and estuaries.

3.1 Lakes

3.1.1 Fish stock assessment

Thirty two waterbodies were surveyed using a netting method tested and developed during the NS Share Fish in Lakes Project (Kelly *et al*., 2007b and 2008a). Lake surveys were completed between June and September. The gill netting procedure was carried out according to European standard protocols (CEN, 2005b) which were tested during the NS Share fish in lakes project (Kelly, *et al*., 2007b). Standard multimesh monofilament survey gill nets (Plate 3.1(a)) were used to sample the fish populations. The method is based on stratified random sampling and involves each lake being 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). Random sampling is then performed within each depth stratum (CEN, 2005b). Surface floating nets (Plate 3.1(b)), "Dutch" fyke nets (Plate 3.2 and 3.6) and benthic braided single panel (62.5mm mesh knot to knot) gill nets were used to supplement the gillnetting effort.

Survey locations were randomly selected using a grid placed over the map of the lake. Portable GPS instruments were used to mark the precise location of each net. The angle of each survey gill net in relation to the shoreline was randomized. All nets were set between 3 and 6pm, fished overnight and lifted between 10.00am and 12.00 midday in order to ensure that the activity peaks of each fish species were included.

3.1.2 Processing of fish

All fish were counted, measured and weighed on site; scales were removed from salmonids, roach, rudd, tench and pike. Samples of some fish were retained for further analysis, e.g. char otoliths and opercular bones from perch were removed in the CFB laboratory. Catches from each gear type were recorded as the mean number of fish captured per metre of net during the time period (CPUE-catch per unit effort).

3.1.3 Water chemistry

One water sample was collected from the middle of each lake in a plastic two litre bottle and transported to the CFB laboratory for analysis of the following chemical variables: total phosphate, alkalinity, total hardness, total oxidised nitrogen, molybdate reactive phosphate, colour and chlorophyll. Conductivity, temperature, dissolved oxygen and pH were measured on site using a Yellow Spring Instrument (YSI) multiprobe. A Secchi disc was used to measure the clarity of the water in each lake.

Plate 3.1(a): Retrieving a benthic survey gill net on Corglass Lake, Co. Cavan

Plate 3.1(b): Surface floating survey gill net on Lough Allen, Co. Leitrim

Plate 3.2: Setting a fyke net on Lough Doo, Co. Donegal

3.2 Rivers

Electric fishing is the method of choice for WFD surveillance monitoring of fish in rivers to obtain a representative sample of the fish assemblage at each sampling site. A standard methodology was drawn up for the monitoring programme (CFB, 2008a). The technique complies with CEN guidance for fish stock assessment in wadeable rivers (CEN, 2003). The standard methodology includes fish sampling, hydrochemistry sampling, and a physical habitat survey. A macrophyte survey was also carried out at selected sites. Surveys were carried out between July and early October (to facilitate the capture of 0+ salmonids) when stream and river flows were moderate to low.

3.2.1 Fish Stock Assessment

Each site was sampled by depletion electric fishing (where possible) involving one or more anodes, depending on the width of the site. Each sampling area was isolated using stopnets or was clearly delineated by instream hydraulic or physical breakpoints such as well defined shallow riffles or weirs when it wasn't possible to use stop nets. Three fishings were carried out in the contained area.

In small shallow channels (<0.5-0.7m in depth), a portable (bank based) landing net (anode) connected to a control box and portable generator (bank-based) or electric fishing backpack was used to sample in an upstream direction (Plate 3.3). In larger deeper channels (>0.5-1.5m), fishing was carried out from flat-bottomed boat(s) in a downstream direction using a generator, control box and a pair of electrodes (Plate 3.3). All habitats, in wadable and deeper sections, were sampled (i.e. riffle, glide, pool).

Plate 3.3: Electrofishing with bank-based generators (left) in the River Clydagh and boat-based generators on the River Inny (right)

Fish from each pass/fishing were sorted and processed separately. All fish species present were measured for length and weight and scales for age analysis were removed from a subset of samples (Plate 3.4). All fish were held in a large bin of water after processing until they were fully recovered and then returned to the river. Samples of eels were retained for further analysis.

Population estimates were calculated using the three fishing depletion method of Zippin (1958) or Carle and Strub (1978). Minimum densities were calculated where single fishing was carried out or where confidence intervals were high (Crisp, *et al*., 1974).

Plate 3.4: Processing fish for length, weight and scale samples

3.2.2 Environmental/abiotic variables

An evaluation of habitat quality is critical to any assessment of ecological integrity and was performed at each site at the time of biological sampling. Physical characterisation of a stream includes documentation of general land use, description of the stream origin and type, summary of riparian vegetation and measurements of instream parameters such as width, depth, flow and substrate (Barbour *et al*., 1999). A number of habitat variables were measured at each site to complement the species lists (Table 3.1).

At each site the percentage of overhead shade, percentage substrate type and instream cover were visually assessed. Water width was measured at six transects along the reach fished. Water depth was measured at five intervals along each transect. The percentage of riffle, glide and pool was measured over each reach surveyed. Riffles were classified as areas of fast water with a broken-surface appearance; pools were areas of slow deep water with a smooth surface appearance and glides were intermediate in character.

Table 3.1 Selection of environmental/abiotic variables measured or calculated at all river sites, July to October 2008

Environmental variable		Min	Max	Mean	Footnote
River reach sampled					
	Length fished (m)	45	1935	192.7	1
	Mean depth (m)	0.10	1.86	0.54	2
	Max depth (m)	0.20	3.0	0.93	3
	Mean wetted width (m)	2.87	35.8	10.58	4
	Surface area (m^2)	171	20916	2791	1
	Shade due to tree cover (%)	0	<75	-	6
	Instream cover (%)	0	90	8	6
	Landuse	1	6	-	7
	Bank slippage	0	1	-	9
	Bank erosion	0	1	-	9
	Fencing (RHS & LHS)	0	1	-	9
	Trampling (R & L)	0	1	-	9
	Velocity status	1	3	-	10
	Velocity rating	2	5	-	11
Flow type (%)					
	Riffle	0	75	24	12
	Glide	16.67	100	62	12
	Pool	0	67	13	12
Substrate type (%)					
	Bedrock	1	30	10.2	6
	Boulder	2	70	19.3	6
	Cobble	5	90	41.3	6
	Gravel	5	81	29.7	6
	Sand	1.75	50	16.7	6
	Mud/silt	2.5	100	28.7	6

***Footnotes*:**

1. Measured over length of site fished
2. Mean of 30 depths taken at 6 transects through the site
3. Measured at deepest point in stretch fished
4. Mean of 3 widths taken at 3 transects
5. Calculated from length and width data
6. Estimated visually at time of sampling
7. Landuse in the immediate area of the site estimated visually at time of sampling (1 - pasture, 2 - woodland, 3 - tillage, 4 - urban, 5 - bog and 6 - other)
8. GIS using CORINE data
9. Bank slippage, bank erosion, fencing estimated visually at time of sampling (presence or absence recorded as 1 or 0)
10. Velocity status = Water levels-estimated visually at time of sampling - 3 grades (1 - flood, 2 - normal & 3 - low)
11. Velocity rating-estimated visually at time of sampling - 5 ratings given (1 - torrential, 2 - fast, 3 - moderate, 4 - slow, 5 - very slow)
12. Measured at time of sampling (when measuring length of site)

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 open sea. As such, they provide a challenging habitat to survey as nothing remains stable for very long. In every 24 hour period, the tidal level rises and falls twice, subjecting extensive areas to inundation and exposure.

3.3.1 Fish stock assessment

Current work in the UK indicates the need for a multi-method approach, using various netting techniques, to sampling for fish in estuaries. These procedures have been adopted by the Research and Development division of the Central Fisheries Board as the standard method for sampling fish in transitional waters in Ireland for the WFD monitoring programme (CFB, 2008b). 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 (10mm mesh size) was conducted at each site using a four-person team, two staff on shore and two in a boat. Sampling sites were selected to represent the range of habitat types within the estuary, 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, through presence of very soft sediments or obstructions on the estuary bed, were also considered. Some sites were available at particular stages of the tide only.

The standard seine net used in transitional water surveys is 30m in length, 3m deep with guide ropes of 30m attached to each end. 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 for fish.

All beach seine nets were set from a boat (Plate 3.5), with one end or guide rope fixed or held on shore, while the boat followed an arc until the full net was played out. In conditions where there is no influence of tide or flow, the seine nets were allowed to settle while the second guide rope was brought to shore. Each net was drawn into a position where it lay parallel to the shore and was then slowly drawn shoreward (Plate 3.5).

Plate 3.5: Beach seining, setting the net from the boat (left) and hauling on shore by hand

3.3.1.2 Fyke netting

A fyke net is a cylindrical or conical net which is hung around a series of hoops or frames. The net has a number of internal funnel-shaped throats whose tapered ends are directed inwards from the mouth. The closed end where the fish accumulate is called the cod end. The mouth of the fyke net has a leader attached to guide fish into the enclosure.

"Dutch" type fyke nets are the standard fyke nets used to sample fish in the estuaries. These are 15m in length overall with a 0.8m diameter front hoop joined by an 8m leader (Plate 3.2). Fyke nets and leader material are 10mm square mesh. Three "Dutch" fyke nets are joined in a series to form one unit. Each fyke net unit was weighted by two anchors to prevent movement of drift and two marker buoys were attached to either end.

Fyke nets were used at all sites during the transitional water surveys. Nets were deployed overnight to maximise fishing time in different types of habitats, i.e. rocky, sandy and weedy shores. Tide was also a factor when deploying the fykes as they must be submerged at all times to fish effectively. Fyke nets were set and retrieved by hand into a boat and fish were processed (Plate 3.6).

Plate 3.6: Fyke net being hauled aboard a rigid inflatable boat

3.3.1.3 Beam trawl

A beam trawl was used successfully on a limited number of sites and was towed by a large (>4m) Regional Fisheries Board RIB or by a half-deck trawler. This technique uses a 1.5m/2m metal beam trawl and permits sampling of littoral and open waters where the bed type is suitable. A triangular-shaped metal frame (55cm height) is attached to either end of the beam (Plate 3.7). A net is attached to the metal frame; the beam keeps the net open horizontally while the triangular metal frames on each end of the beam keep the net open vertically. The net is attached as a bag, with decreasing mesh size moving back to the bunt.

Trawls are carried out over transects of 100 – 200 m in length with the start and finish recorded on GPS. Trawling must be done over a sand or gravel substrate as trawling over soft sediments can cause the net to foul with mud and make the recovery of the trawl extremely difficult. After each haul the trawl was taken aboard and the fish were processed.

Plate 3.7: Beam trawl being deployed by a commercial half-decker fishing boat

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, estuary name, grid reference, net information (type), number of each species, length and weights. Once processing was complete the majority of fish were returned to the water alive. Representative sub-samples of a number of fish

species were measured (fork length) to the nearest millimeter. All fish species present were listed and counted and a species list was compiled. Any fish species that could not be identified on site were preserved in 50% ethanol or frozen and taken back to the CFB laboratory.

3.3.3 Additional information

Information on bed type and site slope was compiled by visual assessment at each beach seine site, 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 slopes, moderate slopes and steep slopes.

Salinity, oxygen saturation and water temperature were also recorded at all beach seine sampling sites. Portable GPS instruments were used to mark the precise location of each sampling site.

3.4 Aging of fish

A subsample of the dominant fish species were aged (five fish from each 1cm class); fish scales were read using a microfiche, opercular bones were read using an epidioscope and an Olympus microscope (SZX10)/digital camera system and the char otoliths were aged using alcohol and Olympus microscope (SZX10) (Plates 3.8 to 3.10). Ages and back calculated growth rates were determined in the laboratory.

Plate 3.8: Image of an opercular bone from a perch (4+) (top) from River Suck at Cloondacarra Bridge

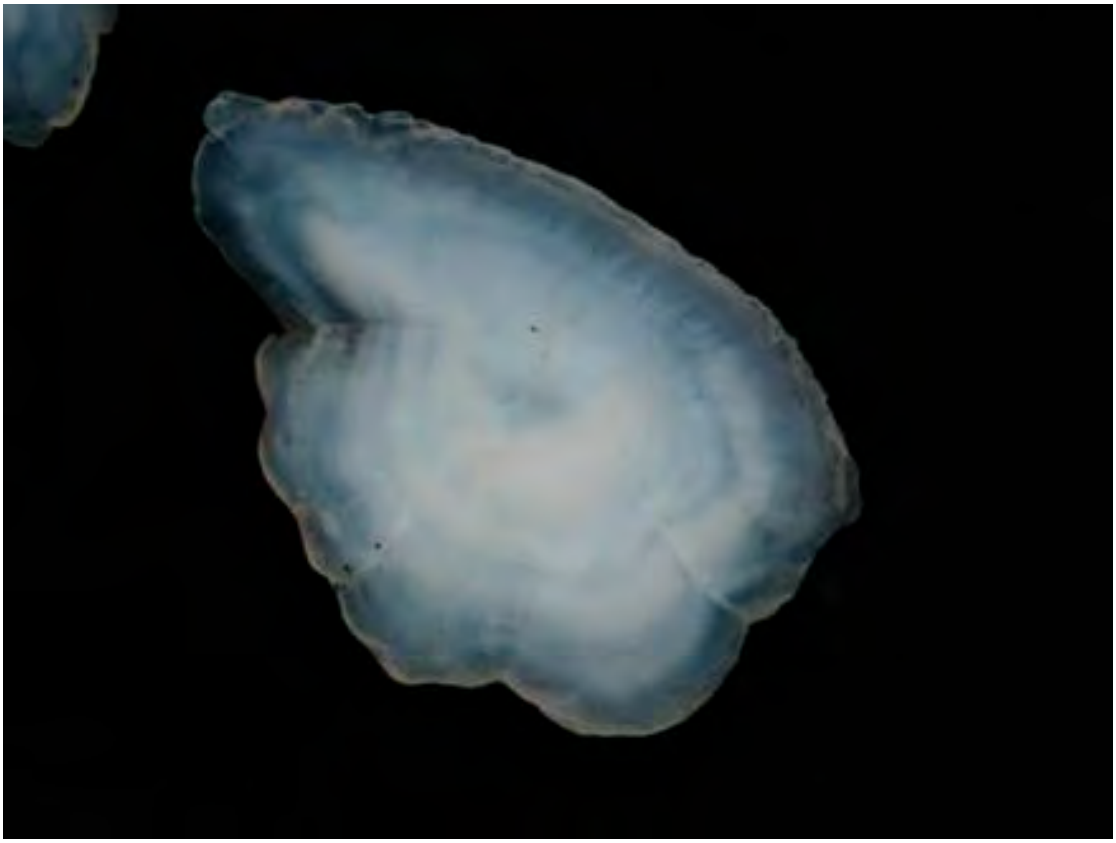


Plate 3.9: Image of an otolith from a char (4+) from Kindrum Lough, Co. Donegal

Plate 3.10: Perch aging inter-calibration exercise between an old epidioscope and the new Olympus microscope with image analysis software

3.5 Quality assurance

CEN (2005b) recommends that all activities in the fish sampling method (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 project. All WFD staff have been trained in electric fishing techniques, fish identification, sampling methods, data analyses, off road driving and personal survival techniques.

There is a need for quality control for fish identification by operators, particularly in relation to hybrids of coarse fish. Samples of each fish species (from the three water body types) were retained when the operative was in any doubt in relation to the identity of the species, e.g. rudd and/or roach hybrids. Staff working in transitional waters attended a training course on identification of fish in estuaries in Millport, Scotland hosted by the Environment Agency of England and Wales.

There is also a need for quality control when aging fish; therefore every tenth scale or bone from each species was checked in the laboratory by a second biologist experienced in age analysis techniques. New equipment and imaging software, for aging fish, was introduced during 2008 and early 2009 to support this exercise.

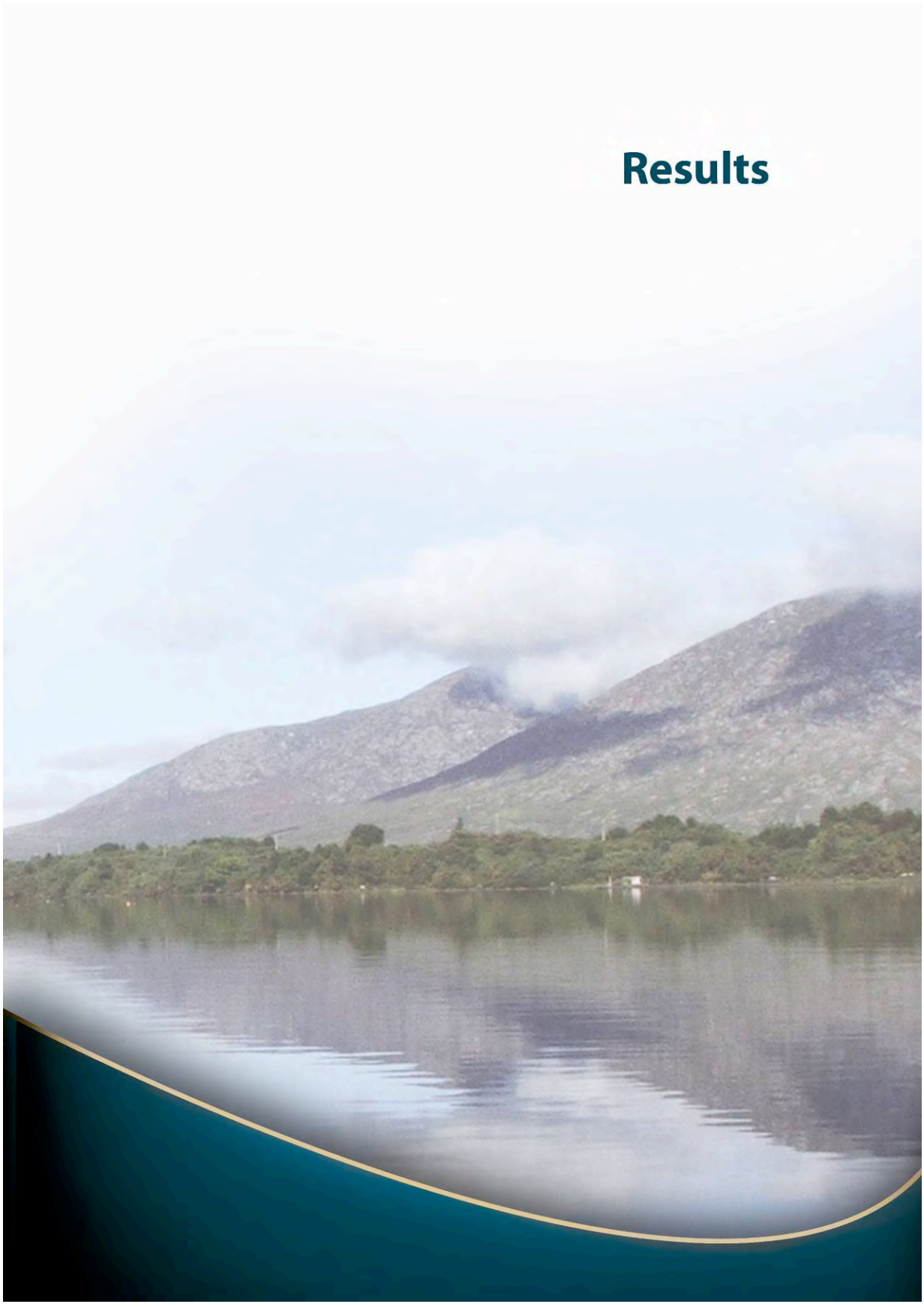
Further quality control measures will be implemented during 2009 in relation to standardising data analyses, database structure and reporting.

All classification tools for fish will continue to be developed during 2009 and 2010 and outputs from these will be intercalibrated across Europe.

3.6 Disinfection and decontamination procedures

One of the main concerns when carrying out WFD surveillance monitoring is to consider the changes which may occur to the biota as a consequence of the unwanted spread of biota, such as the zebra mussel, from waterbody to waterbody and to develop standard operating procedures for disinfection of equipment in order to prevent dispersal of alien species and other organisms to uninfected waters. A standard operating procedure was produced by the "NS Share Fish in Lakes" project for disinfection of survey equipment (Kelly and Champ, 2006) and this is followed diligently by staff in the Fisheries Boards when moving between waterbodies.

Results



4. RESULTS

Ireland has a depauperate freshwater fish community (only 29 species) compared with the rest of Europe (FAME CONSORTIUM, 2004) and Britain (Maitland and Campbell, 1992) and broadly consists of two distinct groups, the salmonids, which require low temperatures and high oxygen, and the cyprinids, which prefer higher temperatures and display a range of tolerances to low oxygen.

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 by a panel of fishery experts (Kelly *at al*., 2008b) (Table 4.1). 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. native species are the only species present in the lake) (Kelly *at al*., 2008b) (Table 4.1). A list of fish species recorded in the 32 lakes during 2008 is shown in Table 4.1. The percentage of lakes in which each fish species occurred is shown in Table 4.1 and Figure 4.1.

Table 4.1: List of fish species recorded in the 32 lakes surveyed during 2008

	Scientific names	Common names	Number of lakes	% lakes
	NATIVE SPECIES			
1	*Salmo salar* Linnaeus, 1758	Juvenile salmon	1	3.1
		Adult salmon	6	18.8
2	*Salmo trutta* Linnaeus, 1758	Brown trout	24	75.0
3	*Salmo trutta* Linnaeus, 1758	Sea trout*	5	15.6
4	*Salvelinus alpinus (Linnaeus, 1758)*	Char	5	15.6
5	*Gasterosteus aculeatus* (L.)	Three-spined stickleback	8	25.0
6	*Platichthys flesus* (Duncker)	Flounder	1	3.1
7	*Anguilla anguilla* (L.)	Eel	31	96.8
8	*Alosa fallax killarnensis*	Killarney shad	1	3.1
	NON NATIVE SPECIES (influencing ecology)			
9	*Esox lucius* (L.)	Pike	17	53.1
10	*Rutilus rutilus* (L.)	Roach	17	53.1
11	*Perca fluviatilis* (L.)	Perch	21	65.6
12	*Abramis brama* (Linnaeus, 1758)	Bream	12	37.5
13	*Phoxinus phoxinus* (L.)	Minnow	2	6.3
14	*Barbatula barbatula*	Stoneloach	1	3.11
	NON NATIVE SPECIES (generally not influencing ecology)			
15	*Tinca tinca* (Linnaeus, 1758)	Tench	6	18.8
19	*Gobio gobio* (L.)	Gudgeon	2	6.3
17	*Scardinius erythropthalmus (Linnaeus, 1758)*	Rudd	8	25.0
	Hybrids			
	Roach x bream hybrid		12	37.5
	Roach x rudd hybrid		5	15.6
	Rudd x bream hybrid		1	3.1

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

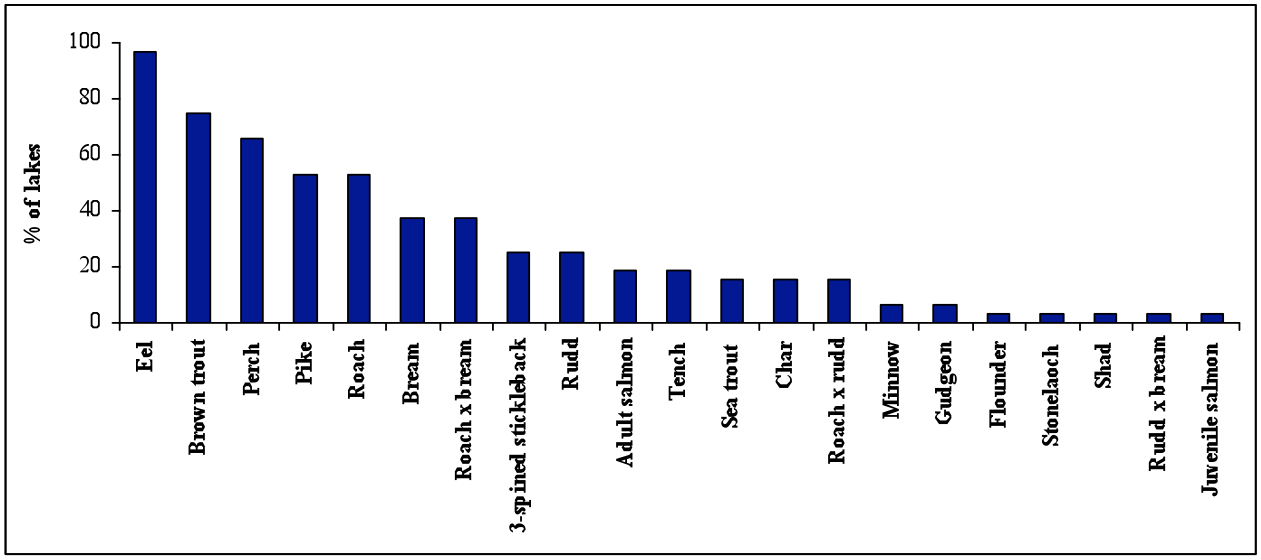


Fig. 4.1: Fish species present at lakes (% of lakes) surveyed for WFD SM monitoring 2008

Overall, a total of seventeen (sea trout are included as a separate "variety" of trout) species of fish and three types of hybrids were recorded from a total of 32 lakes surveyed during 2008 (Table 4.1). Eels were the most common fish species, occurring in 96.8% of lakes surveyed, followed by brown trout (75%), perch (65.6%), pike (53.1%), roach (53.1%), bream (37.5%), roach x bream hybrids (37.5%), 3-spined stickleback (25%), rudd (25%), adult salmon (18.8%), tench (18.8%) sea trout (15.6%), char (15.6%) and roach x rudd hybrids (15.6%). Minnow, gudgeon, flounder, stoneloach, shad, rudd x bream hybrids and juvenile salmon were present in less than 10% of the lakes surveyed (Table 4.1 and Fig. 4.1).

Fish species richness (excluding hybrids) ranged from two species at two lakes (Glenbeg Lough and Lough Easky) to a maximum of eleven species at one lake (Inniscarra Resevoir) (Table 4.2, Fig. 4.2). Lough Leane recorded the highest number of native species (i.e. 5 species). Native species were absent from one lake (Skeagh Upper) (Table 4.2). Non-native species (group 2 and 3) were present in 23 lakes (Table 4.2), group 2 species in 23 lakes and group 3 species in 10 lakes (Table 4.2).

Table 4.2: Species richness at each lake surveyed between June to October 2008

Lake	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Inniscarra	11	4	4	3
Owel	8	3	3	2
Leane	8	5	1	2
Corrib Lwr	7	3	4	0
Corrib Upr	7	3	4	0
Gill	7	2	4	1
Meelagh	7	2	4	1
Allua	7	1	4	2
Upper Lake Killarney	7	3	2	2
Templehouse	7	2	4	1
Sheelin	6	2	4	0
Melvin	6*	4	1	1

Table 4.2 contd: Species richness at each lake surveyed between June to October 2008

Lake	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
Annaghmore	6	1	3	2
O'Flynn	5	2	3	0
Corglass	4	1	4	0
Talt	5	4	1	0
Derrybrick	5	1	4	0
Carrowmore	4	4	0	0
Cavetown	4	1	3	0
Glencullin	4	4	0	0
Beagh	4	4	0	0
Nanoge	4	1	3	0
Caragh	4	3	1	0
Egish	4	1	3	0
Brin	4	3	1	0
Fern	4	4	0	0
Skeagh Upper	4	0	4	0
Barra	3	3	0	0
Kiltooris	3	3	0	0
Acoose	3	3	0	0
Glenbeg	2	2	0	0
Easky	2	2	0	0

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

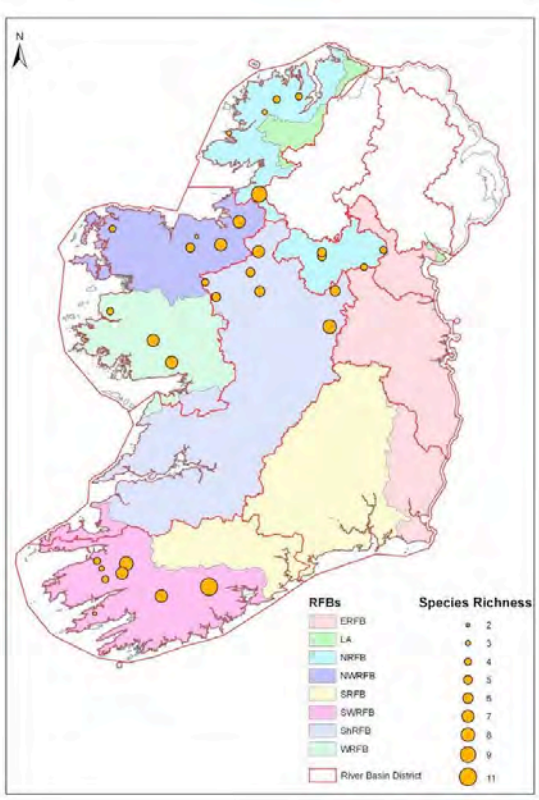


Fig 4.2 Fish species richness in 32 lakes surveyed for WFD SM monitoring 2008

4.1.2 Fish species distribution in the 32 lakes surveyed during 2008

Eels were widely distributed (Fig. 4.3); they were absent from only one lake (Upper Lough Skeagh). In general salmonids dominated lakes in the north-west, west and south-west area and were absent from lakes in the Cavan/Monaghan and midlands area (Figs. 4.4 to 4.7). The pattern for brown trout distribution was to dominate lakes in the north-west, west and south-west area and to be absent from lakes in the Cavan, Monaghan and midland areas (Fig. 4.4). Sea trout were only present in three lakes in the north-west (Glencullin Lough, Lough Beagh and Carrowmore Lake) and two lakes in the south-west area (Inniscarra Reservoir and Lough Brin) (Fig. 4.5). Salmon were recorded at 6 lakes (Lough Melvin, Lough Barra, Lough Leane, Upper Lake, Lough Talt and Inniscarra Reservoir). Adult salmon were recorded in 5 lakes and juvenile salmon in one lake, i.e. Lough Barra (Fig. 4.6). Char were recorded in five lakes in the Donegal, Sligo and Kerry areas (Fig. 4.7). Three-spined stickleback were present in 8 lakes (in the west and north-west and Lough Owel) (Fig. 4.8).

The native Irish lake fish fauna has been augmented by the introduction of a large number of non-native species which were stocked 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. These include, roach, rudd, bream, etc. The status of these non-native species varies throughout Ireland and these species have not been translocated to many areas in the north-west and areas in the west and south-west of Ireland as yet (Figs. 4.9 to 4.16). Perch were the most widely distributed of the non-native species in the 2008 surveillance monitoring area, i.e. they were present in 21 out of 32 lakes surveyed (Fig. 4.9). Roach were captured in 17 lakes (two in the south-west area, Inniscarra Reservoir and Lough Allua, with the rest in the Cavan/Monaghan/Sligo and midlands areas) (Fig. 4.10), rudd were present in 8 lakes (four lakes in the south-west and Lough Melvin was the most northerly population found) (Fig. 4.11) and pike were recorded in 17 lakes (mainly in the Cavan/Monaghan/Sligo area and the midlands) (Fig. 4.16). Roach x rudd hybrids were present in 5 lakes, roach x bream hybrids were present in 12 lakes and rudd x bream hybrids were recorded in 1 only lake (Lough Allua). Bream were recorded in 12 lakesand tench were captured in 6 lakes (Figs. 4.12 to 4.15).

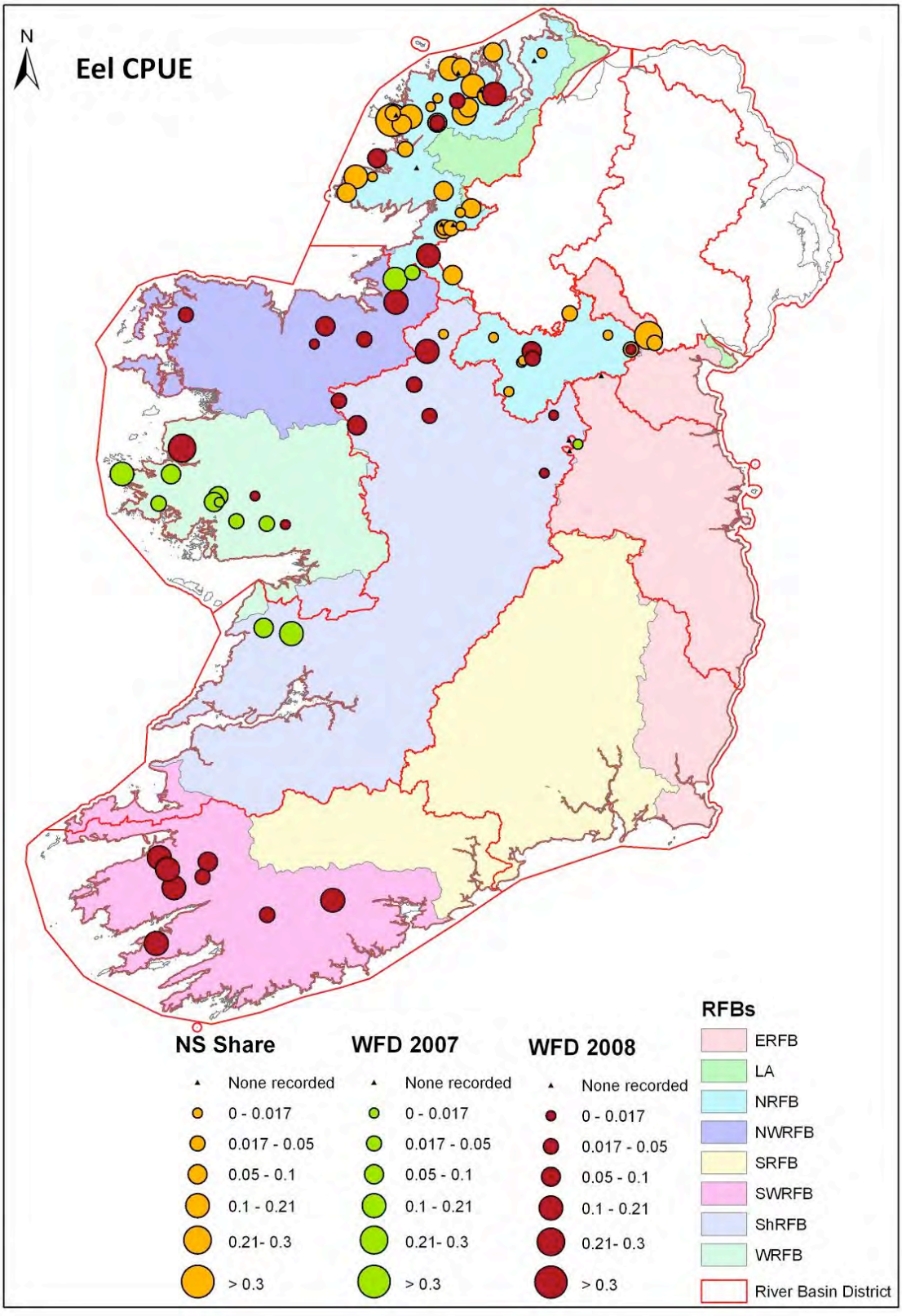


Fig. 4.3: Eel distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

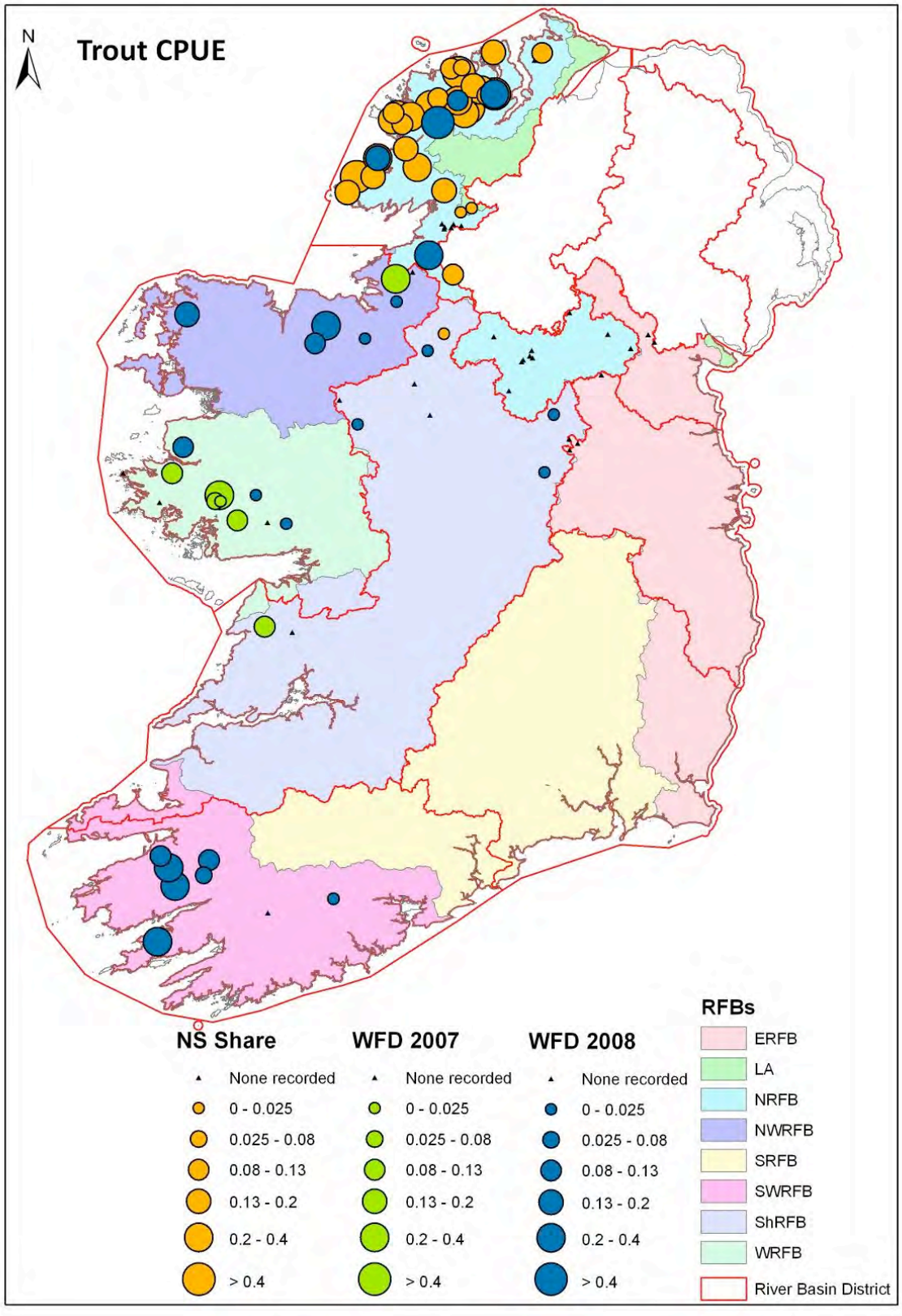


Fig. 4.4: Brown trout distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

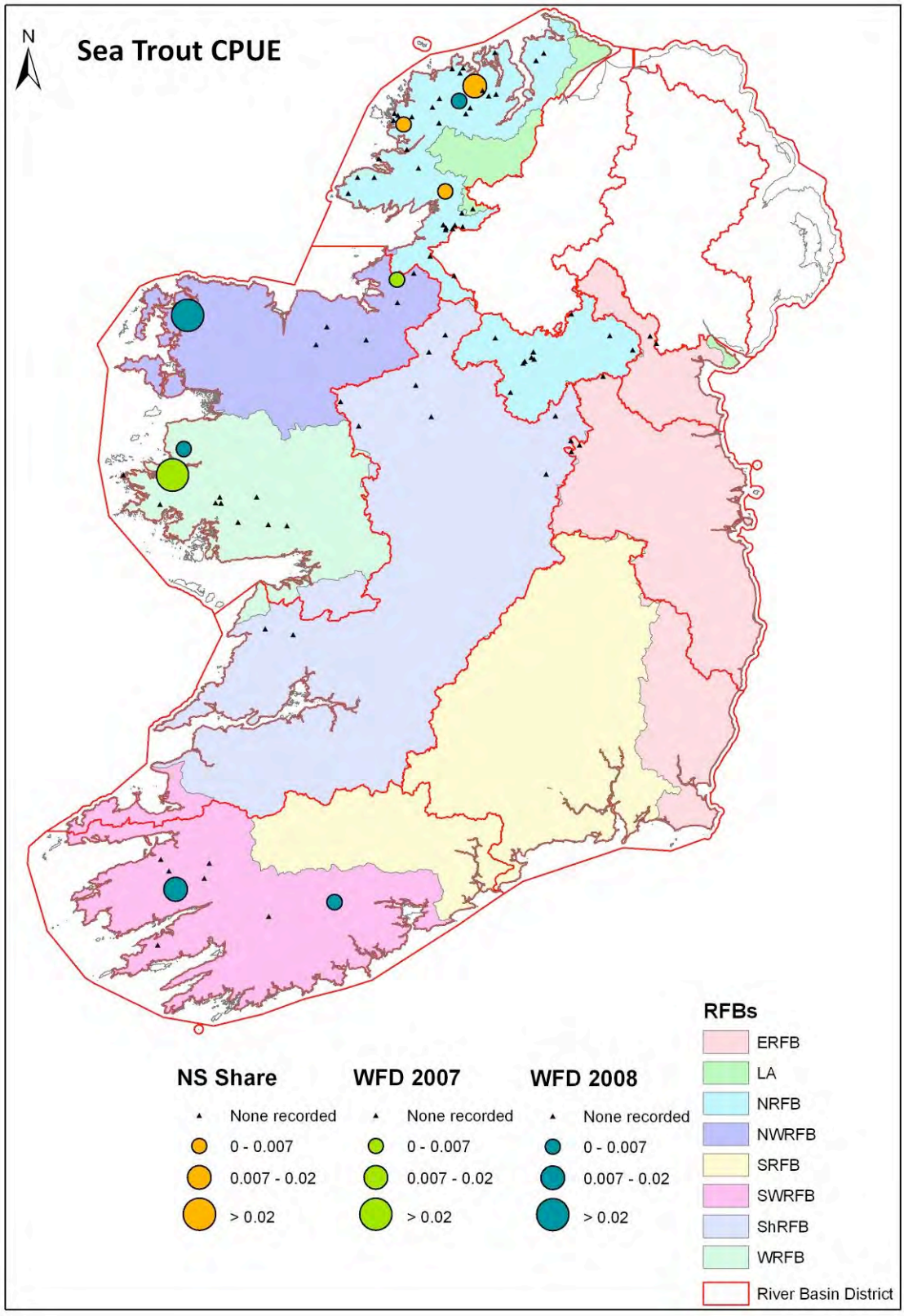


Fig. 4.5: Sea trout distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

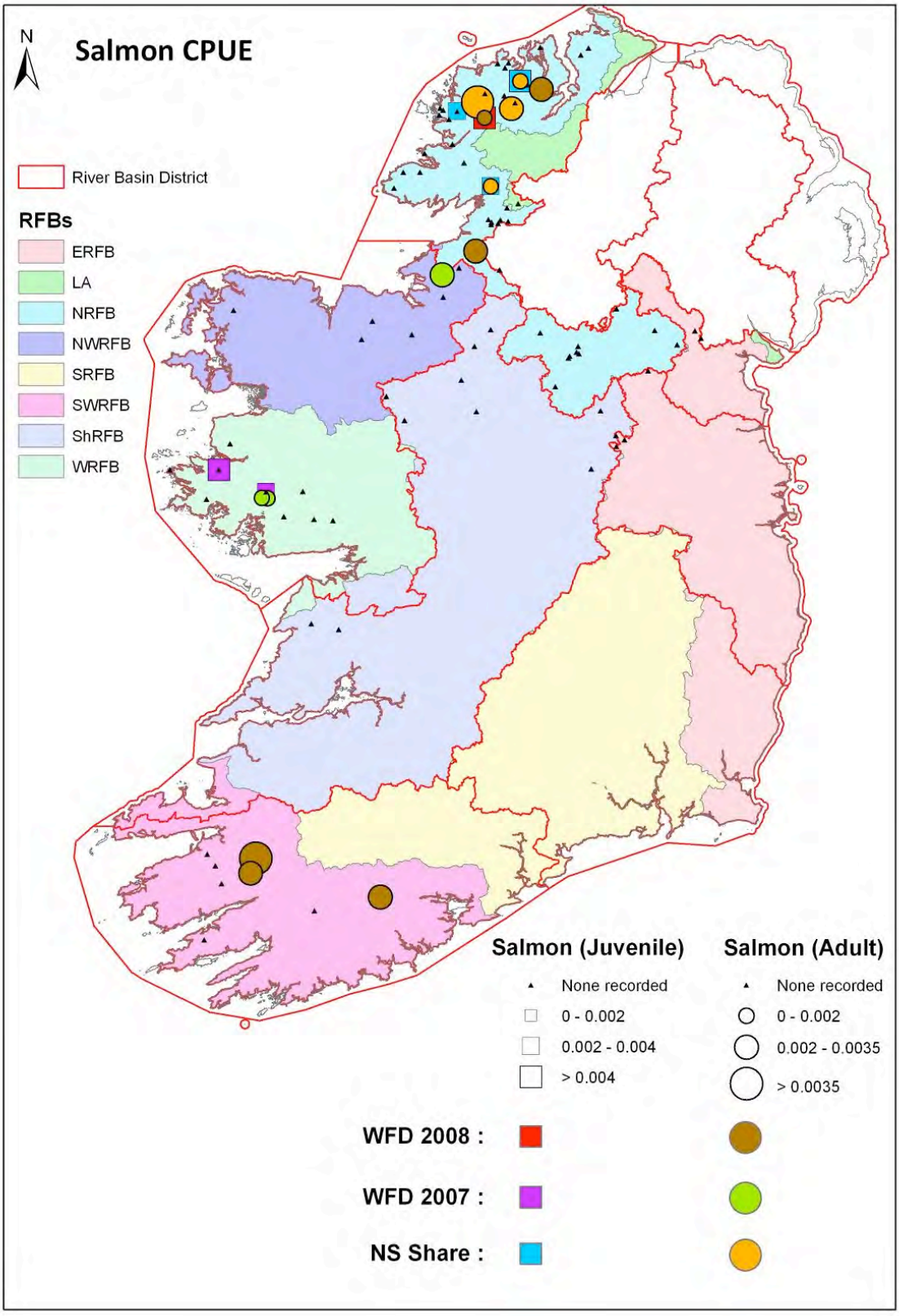


Fig. 4.6: Salmon (adult and juvenile) distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

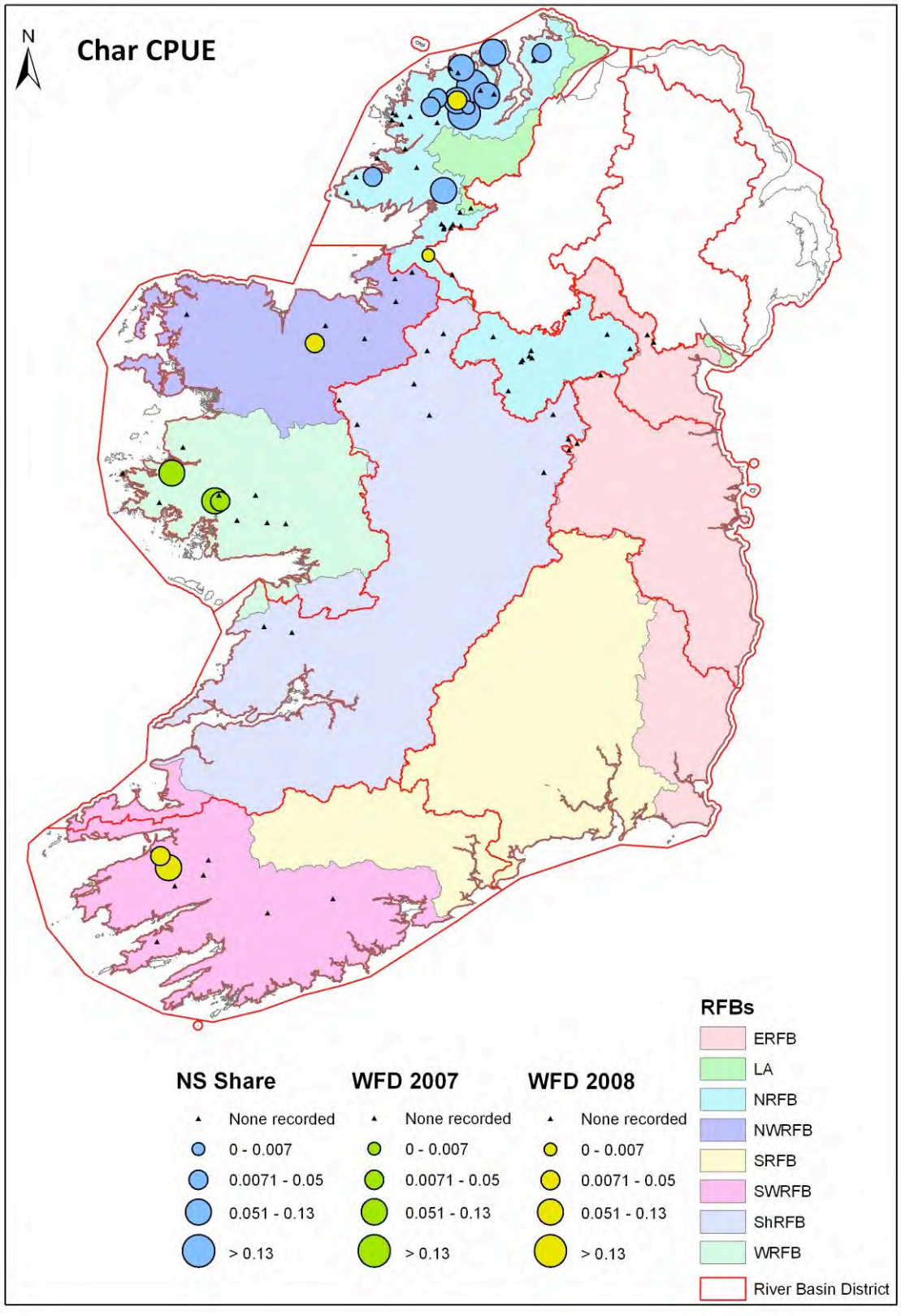


Fig. 4.7: Char distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

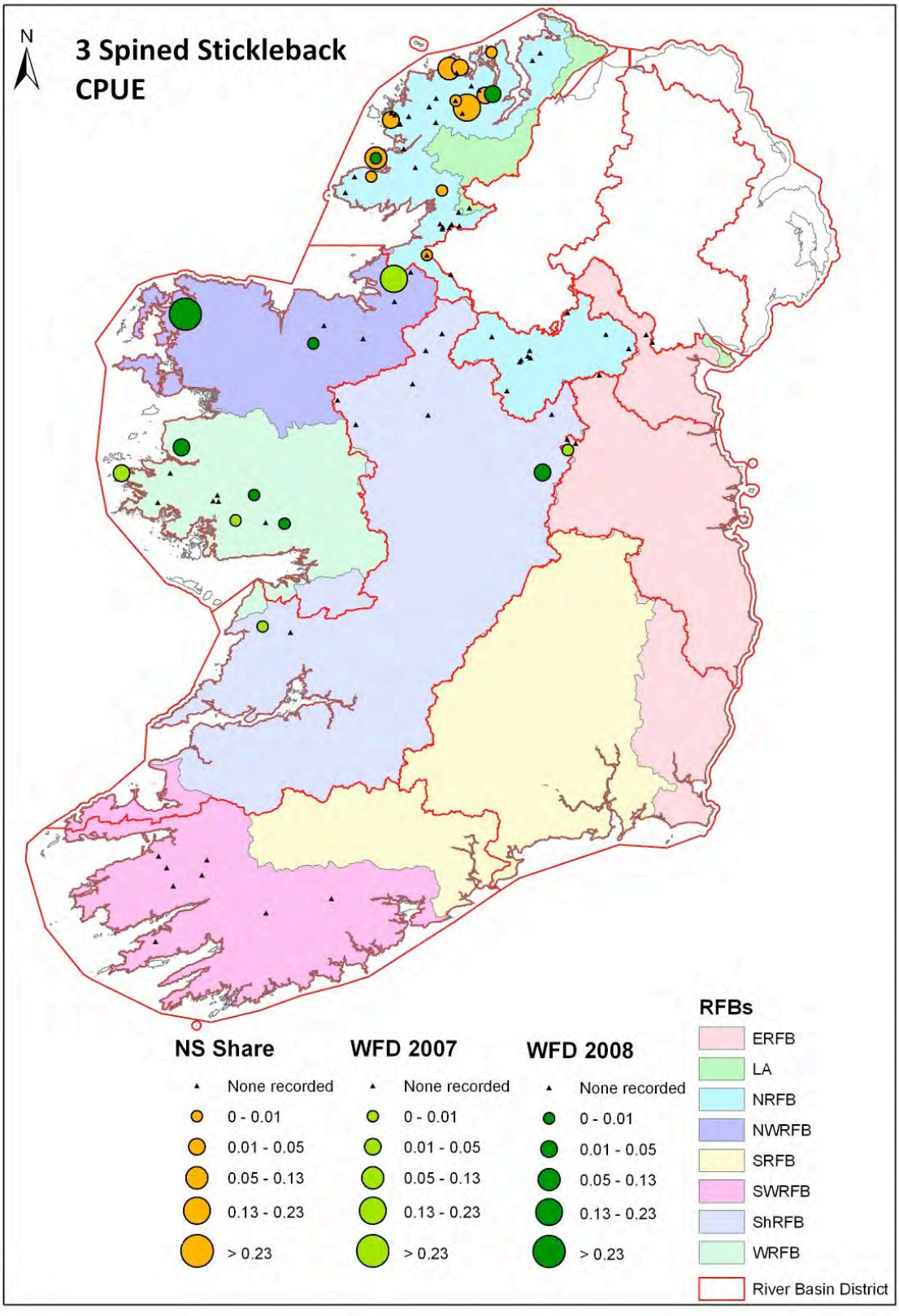


Fig. 4.8: 3-spined stickleback distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

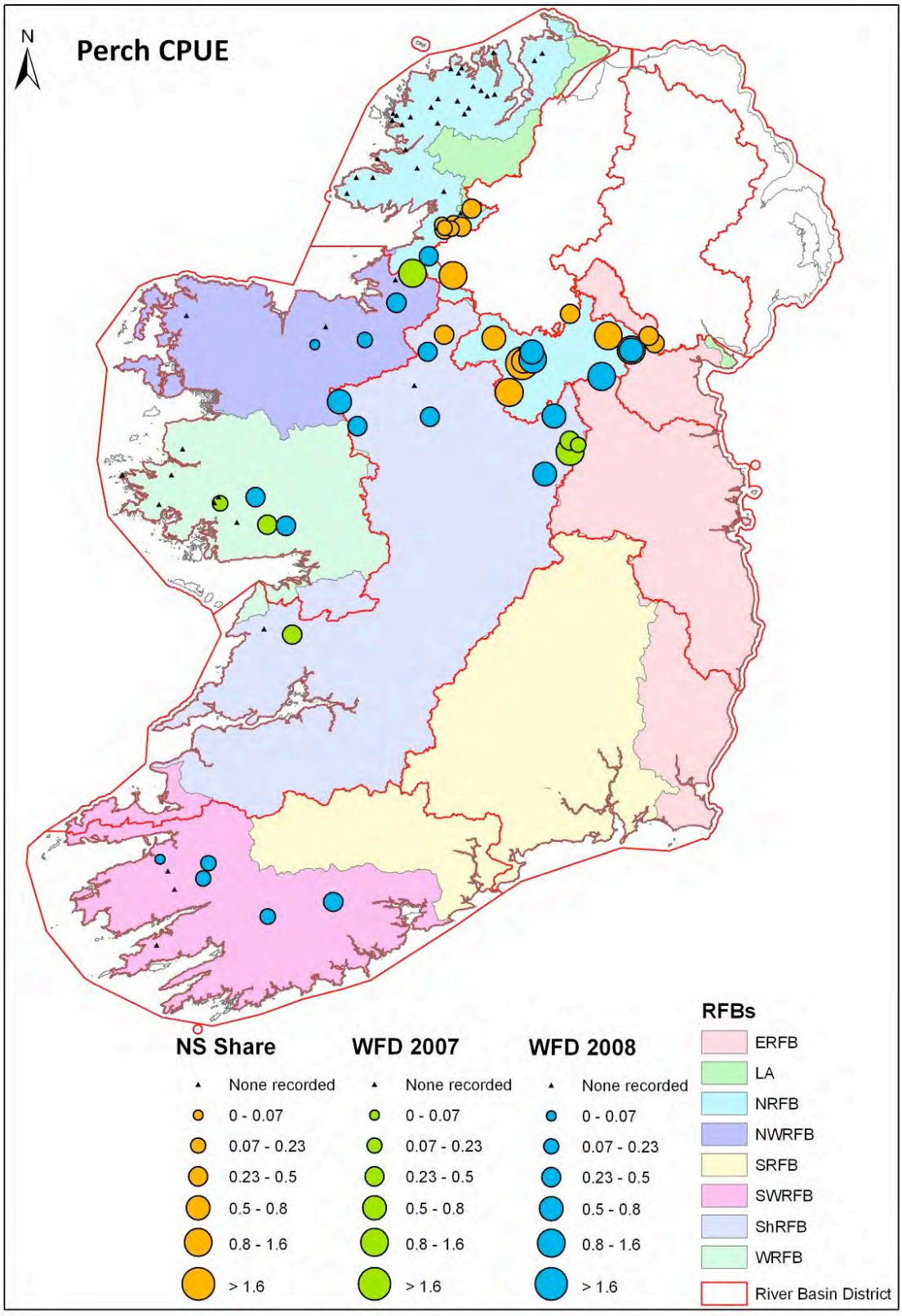


Fig. 4.9: Perch distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

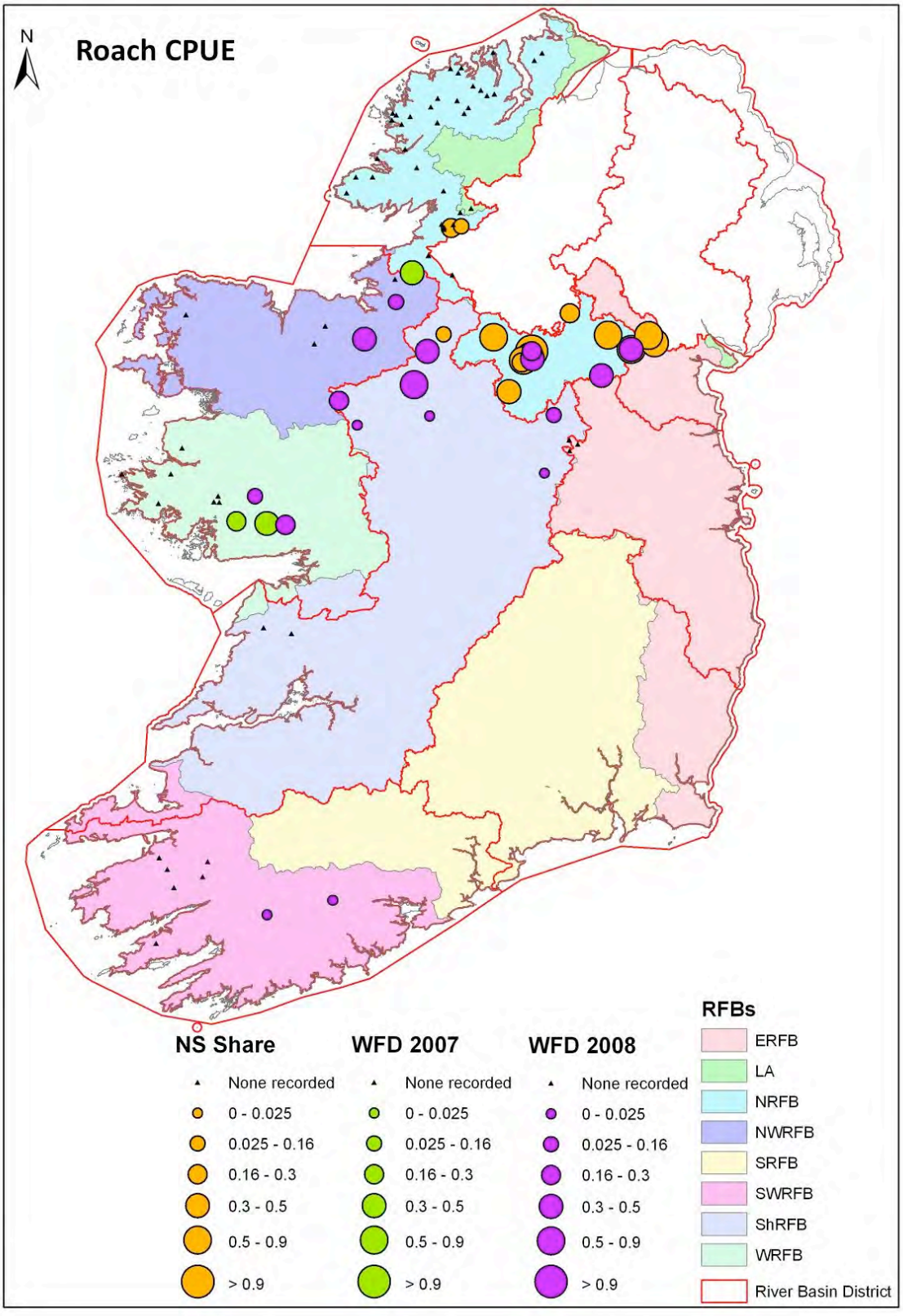


Fig. 4.10: Roach distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

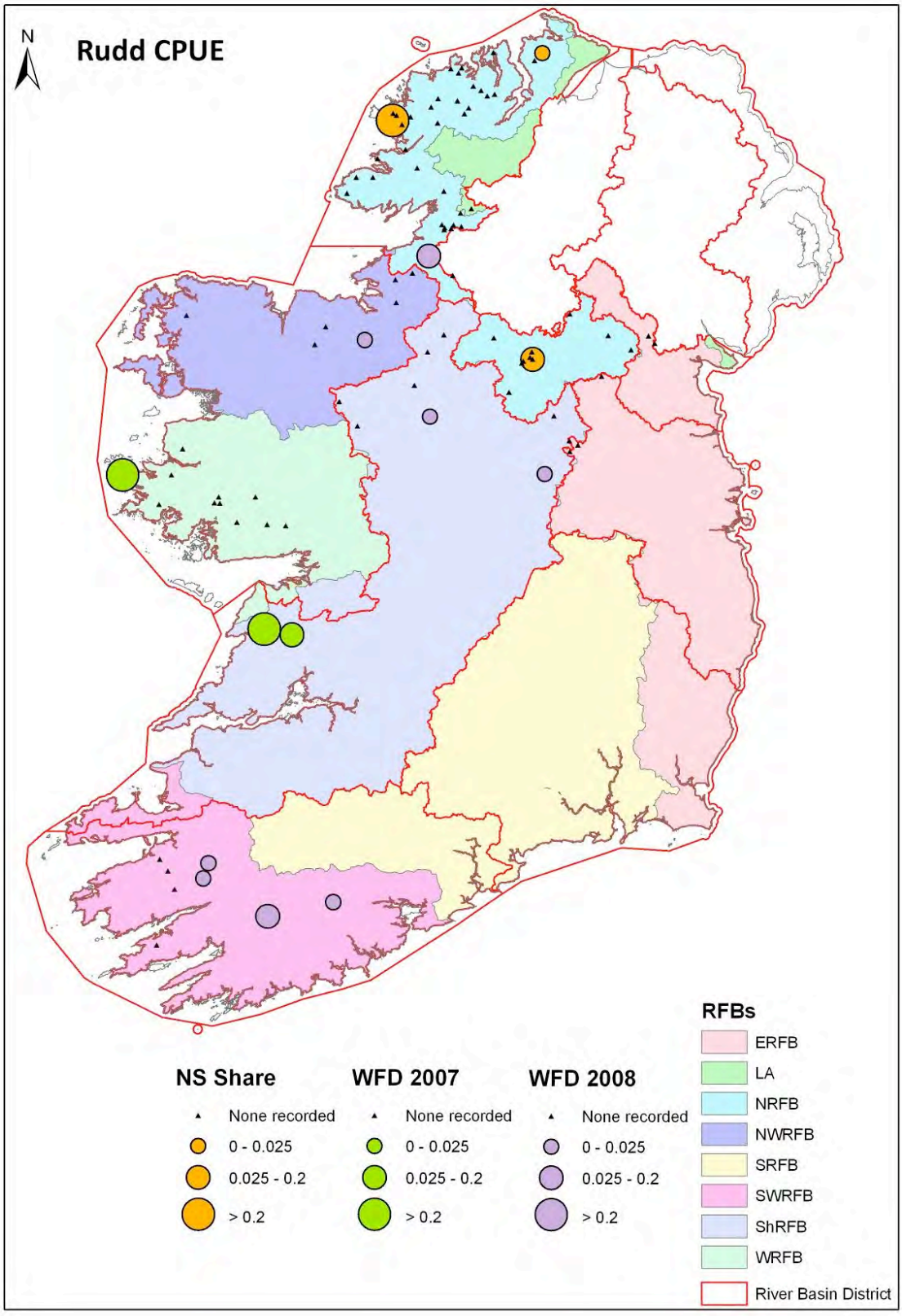


Fig. 4.11: Rudd distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

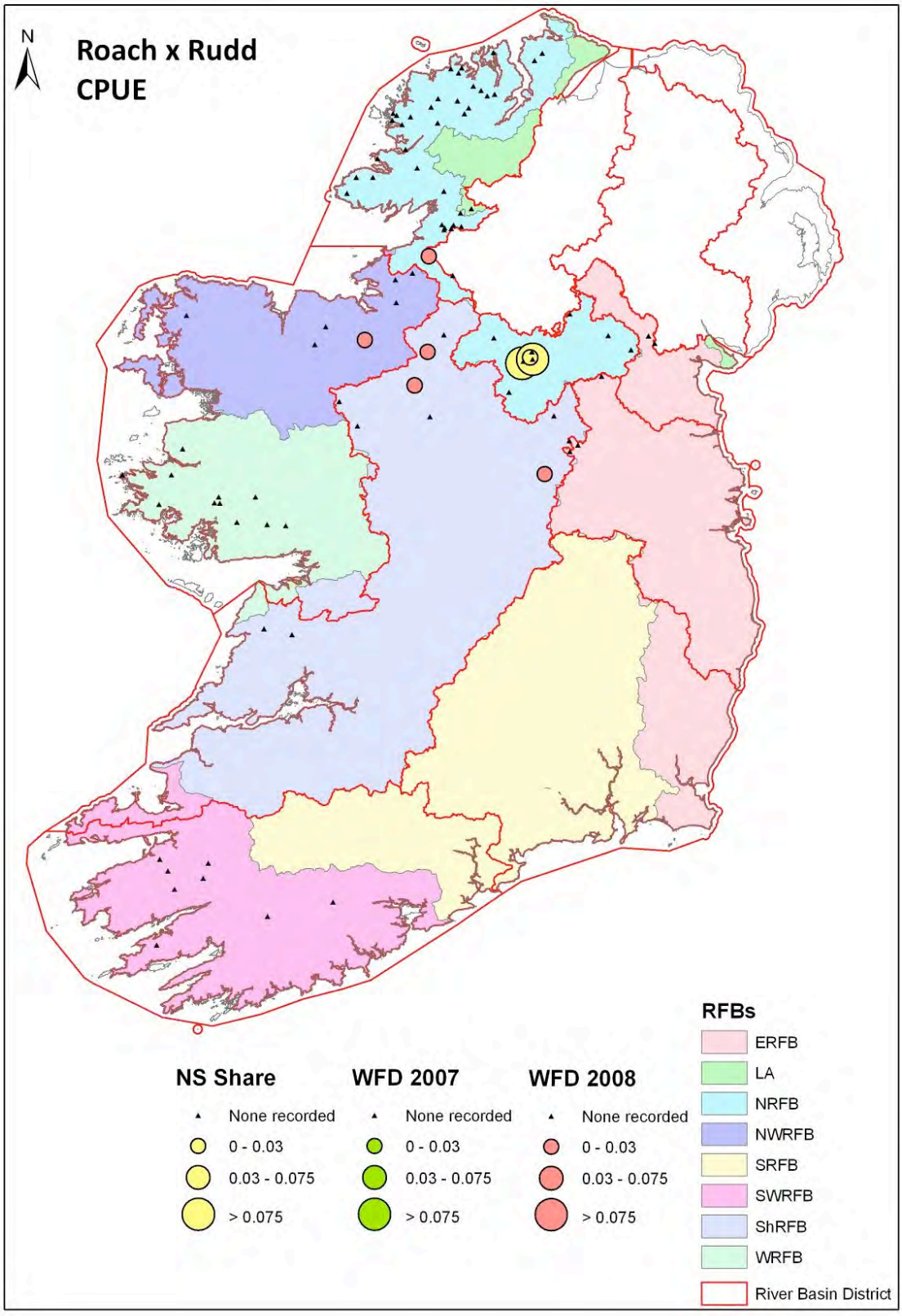


Fig. 4.12: Roach x rudd hybrid distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

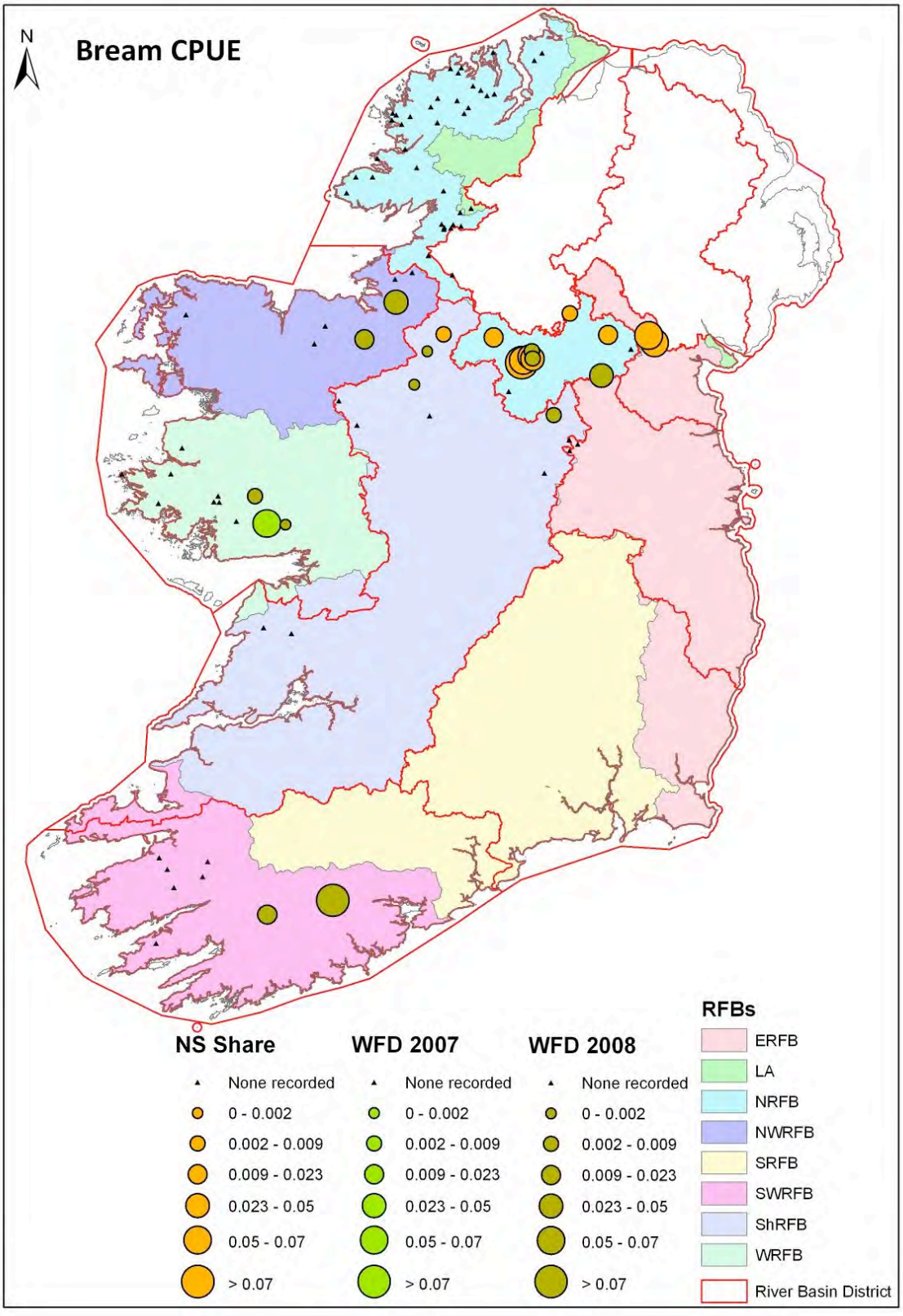


Fig. 4.13: Bream distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

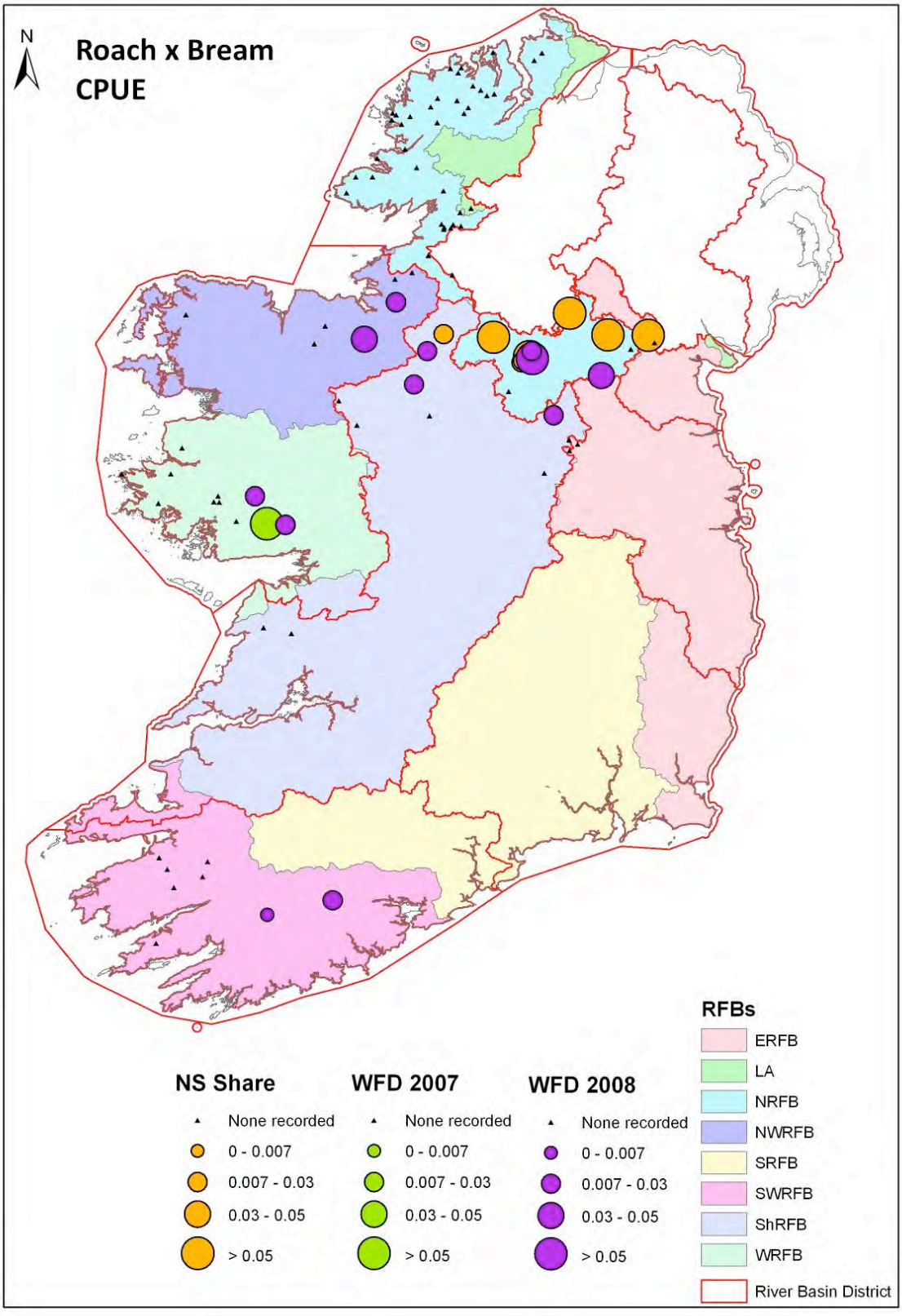


Fig. 4.14: Roach x bream hybrid distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

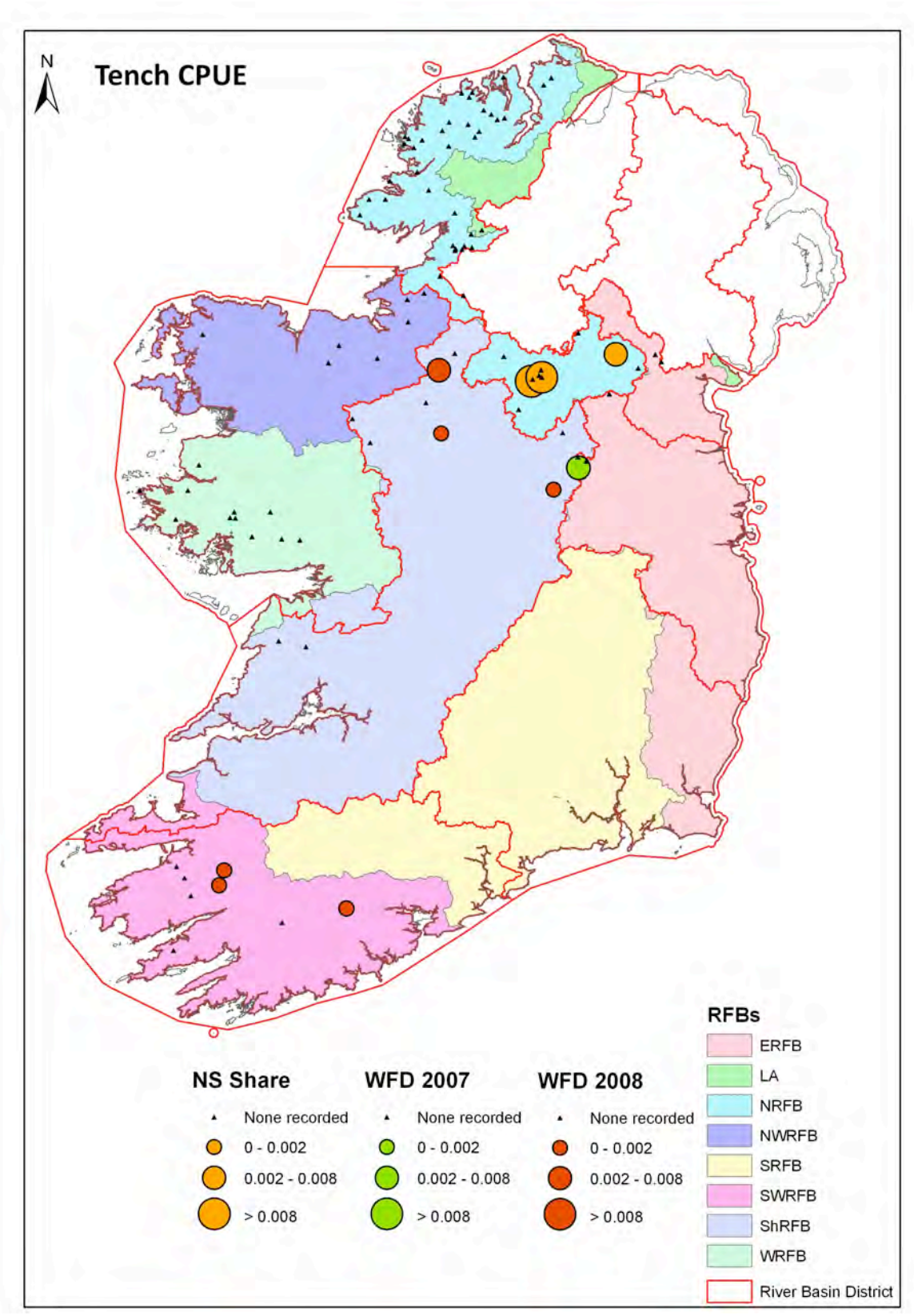


Fig. 4.15: Tench distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

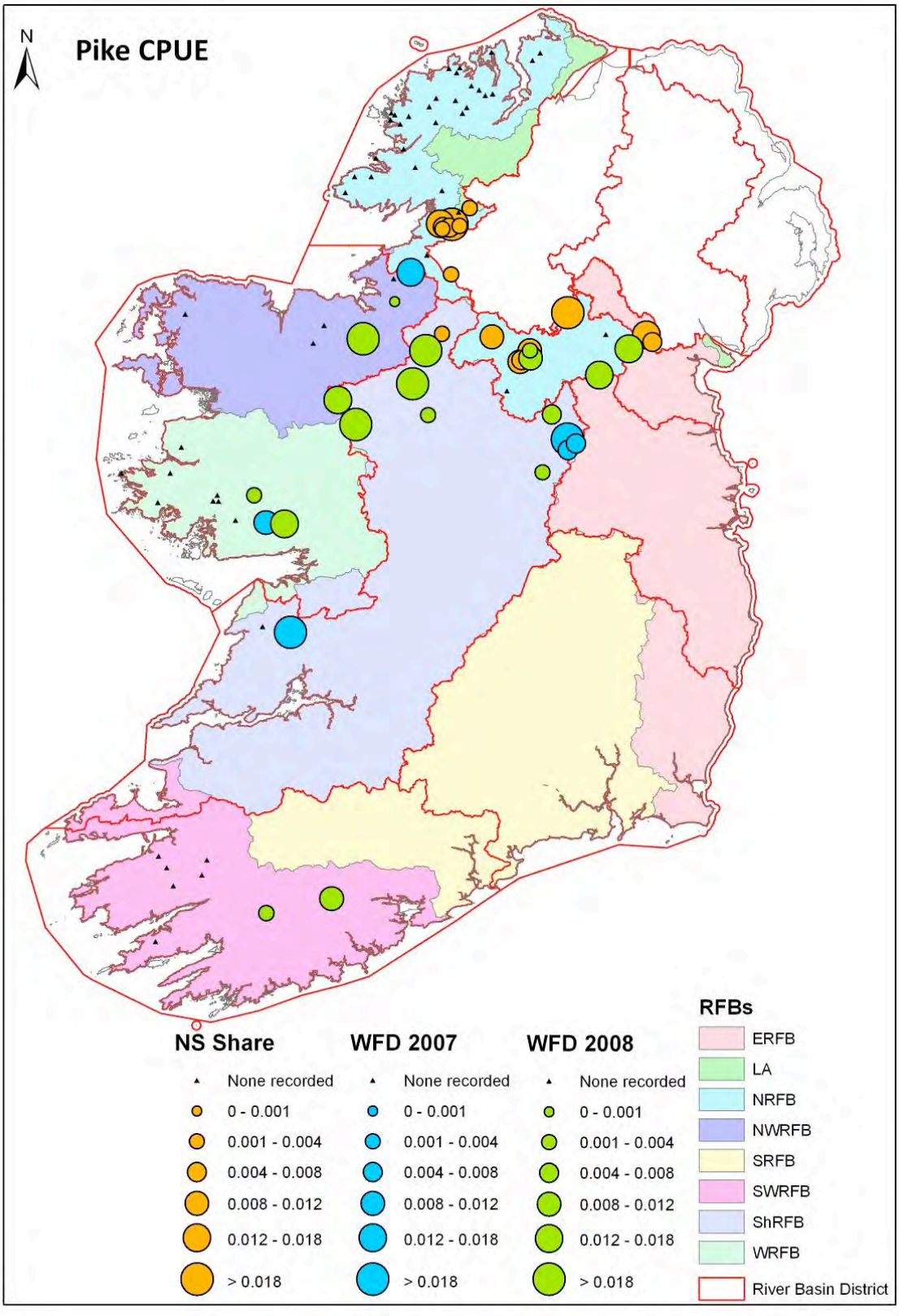


Fig. 4.16: Pike distribution and abundance (CPUE/m net) in the 2008 SM area (CPUE data from the WFD 2007 and the NS Share lake surveys (2005 and 2006) are also shown)

4.1.3 Fish abundance and biomass in 32 lakes surveyed for WFD surveillance monitoring 2008

The abundance and biomass (as indicated by mean CPUE (mean number of fish/m net) and BPUE (mean weight (g) of fish/m of net) respectively) of the principal fish species recorded in lakes during the course of the project is shown in Figures 4.17 to 4.36. Eel abundance and biomass for 31 lakes surveyed during 2008 is shown in Figures 4.17 and 4.18. Glenbeg Lough, Lough Brin and Glencullin Lough recorded the highest abundance of eels in the low alkalinity lakes, Lough Melvin, Lough Fern and Lough Gill recorded the highest in the moderately alkaline lakes and Annaghmore Lake, Lough O'Flynn and Derrybrick Lough recorded the highest abundance in the high alkalinity lakes. Glenbeg Lough and Glencullin Lough recorded the highest biomass of eels in the low alkalinity lakes, Inniscarra Reservoir and Lough Meelagh recorded the highest biomass in the moderately alkaline lakes and Annaghmore Lake and Lough O'Flynn had the highest biomass of eels in the high alkalinity lakes. Overall Glencullin Lough recorded the highest abundance and Lough Meelagh recorded the highest biomass of eels of the 32 lakes surveyed in 2008 (Figs. 4.17 and 4.18).

Trout were recorded in 24 lakes in the 2008 SM area (Figs. 4.19 and 4.20). Overall the highest mean abundance of trout of all the lakes was recorded on Lough Barra, a low alkalinity lake in Co. Donegal (Fig. 4.19), whereas the highest mean biomass of trout in all lakes surveyed was recorded on Lough Fern (moderate alkalinity), also in County Donegal (Fig. 4.20). Lough Barra also recorded the highest abundance of trout in the low alkalinity lakes, Lough Melvin had the highest abundance in the moderately alkaline lakes and Lower Lough Corrib recorded the highest abundance of trout in the high alkalinity lakes (Fig. 4.19). Lough Brin recorded the highest biomass of trout in the low alkalinity lakes, Lough Fern recorded the highest in the moderately alkaline lakes and Lower Lough Corrib had the highest biomass of trout in the high alkalinity lakes (Fig. 4.20).

Sea trout were only recorded at five lakes in the 2008 SM area (Figs. 4.21and 4.22) with the highest abundances in Lough Brin (low alkalinity) and Carrowmore Lake (moderate alkalinity) and the highest biomass in Glencullin Lough (low alkalinity) and Carrowmore Lake (moderate alkalinity).

Char were present in five lakes in the 2008 SM area (Figs. 4.23 and 4.24) with Lough Acoose (low alkalinity) recording the highest abundance and the highest biomass of char. Lough Talt recorded the highest abundance and the highest biomass of char in the moderate alkalinity lakes, where char were captured. No char were captured in any of the high alkalinity lakes surveyed.

Perch were recorded in 21 lakes in the 2008 SM area (Figs. 4.25 and 4.26). Lough Allua recorded the highest abundance of perch in the low alkalinity lakes, Lough Skeagh Upper recorded the highest abundance of perch in the moderate alkalinity class and Corglass Lake recorded the highest abundance of perch in the high alkalinity lakes (Fig. 4.25). Lough Allua, Lough Caragh and Upper Lake Killarney recorded a similar low biomass of perch in the low alkalinity lakes. Lough Owel and Lough Egish recorded the highest biomass of perch in the moderate and high alkalinity lakes respectively (Fig. 4.26).

The majority of roach occurred in the moderate and high alkalinity lakes with only one low alkalinity lake recording roach (Lough Allua) (Figs. 4.27 and 4.28). Lough Meelagh recorded the highest abundance and the highest biomass of roach in the moderate alkalinity lakes followed by Lough Skeagh Upper. In the high alkalinity lakes Cavetown Lake recorded the highest abundance and Lough Egish recorded the highest biomass (Fig 4.28).

Pike were recorded in 17 lakes with the majority occurring in the moderate and high alkalinity lakes. Only one low alkalinity lake recorded pike (Lough Allua) (Figs. 4.29 and 4.30). Lough Meelagh recorded the highest abundance and the highest biomass of pike in the moderate alkalinity lakes and Templehouse Lake recorded the highest abundance of pike in the high alkalinity lakes with Lough Corrib Lower recording the highest biomass (Figs. 4.29 and 4.30).

Bream were captured on 12 lakes, with the majority again occurring in the moderate and high alkalinity lakes. Only one low alkalinity lake recorded bream (Lough Allua) (Figs. 4.31 and 4.32). Inniscarra Reservoir recorded the highest abundance and the highest biomass of bream in the moderate alkalinity lakes where bream were captured, followed by Lough Skeagh Upper, Lough Gill and Lough Meelagh. Templehouse Lake recorded the highest abundance of bream in the high alkalinity lakes with Lough Corrib Upper recording the highest biomass.

Rudd were recorded on eight lakes with Lough Allua (low alkalinity), Lough Melvin (moderate alkalinity) and Annaghmore Lake (high alkalinity) showing the highest abundances across the three alkalinities respectively (Figs. 4.33 and 4.34). Lough Allua, Lough Owel and Annaghmore Lake showed the highest rudd biomass across the three alkalinities respectively.

Roach x bream hybrids were captured on 12 lakes in the 2008 SM area. The highest abundance was recorded on Corglass Lake (high alkalinity) and the highest biomass was on Derrybrick Lough (high alkalinity) (Figs. 4.35 and 4.36).

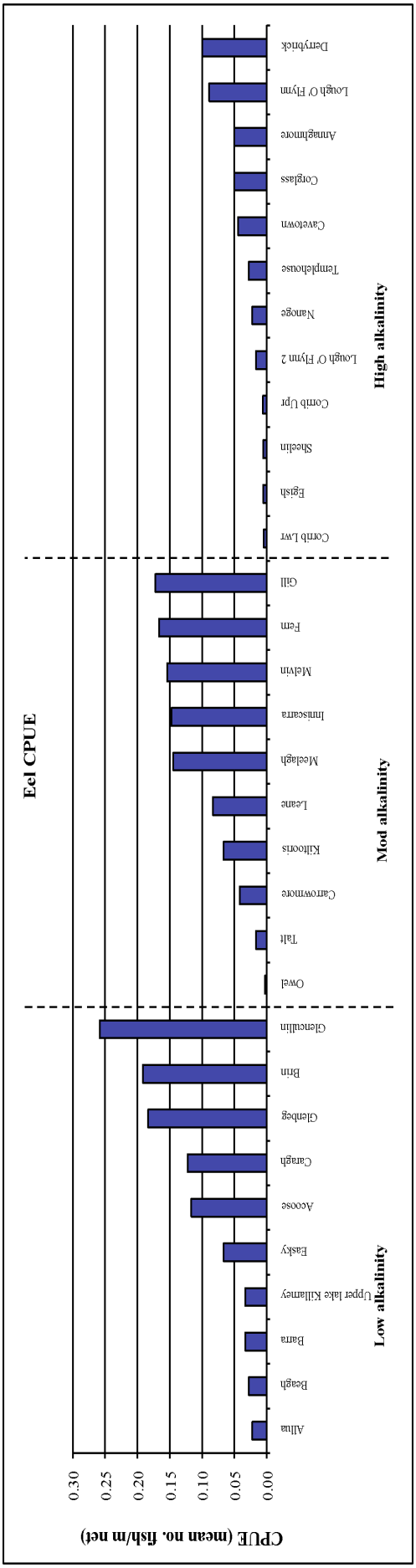


Fig. 4.17: Eel abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

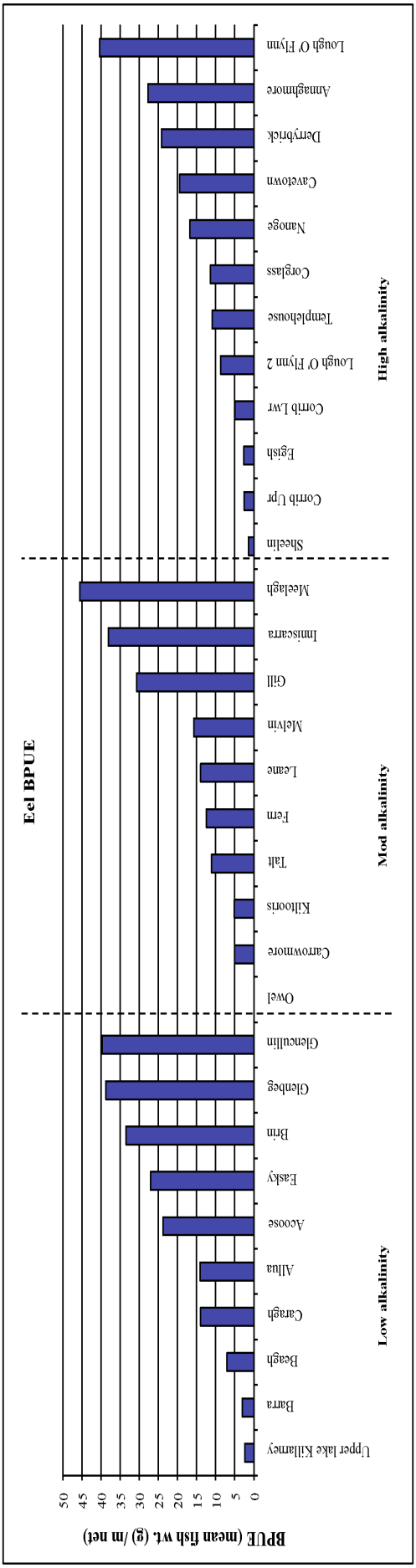


Fig. 4.18: Eel biomass (BPUE – mean weight (g) of fish/m net) in 2008 SM lakes

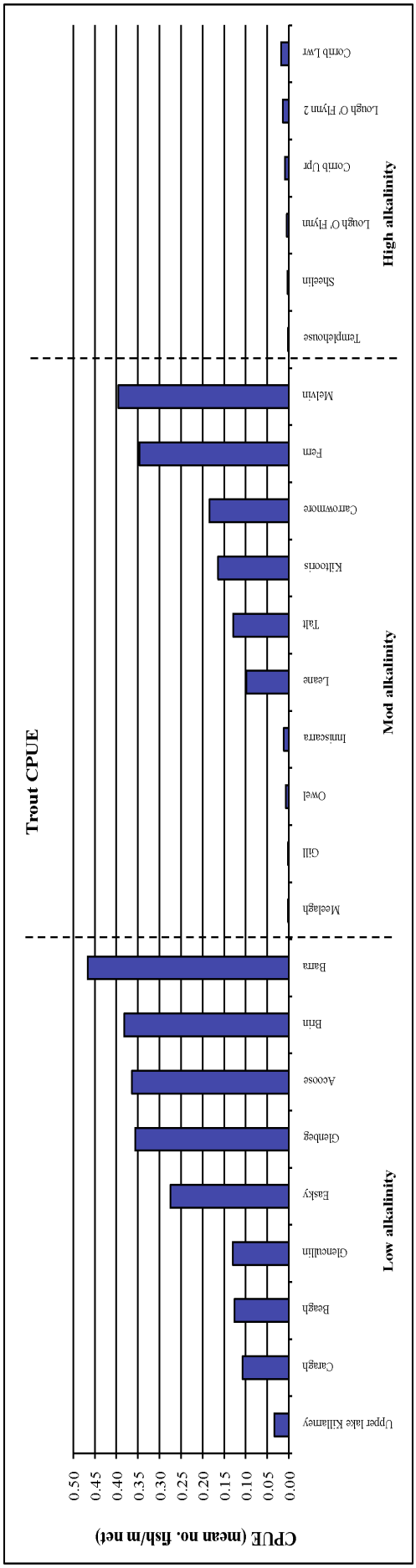


Fig. 4.19: Trout abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

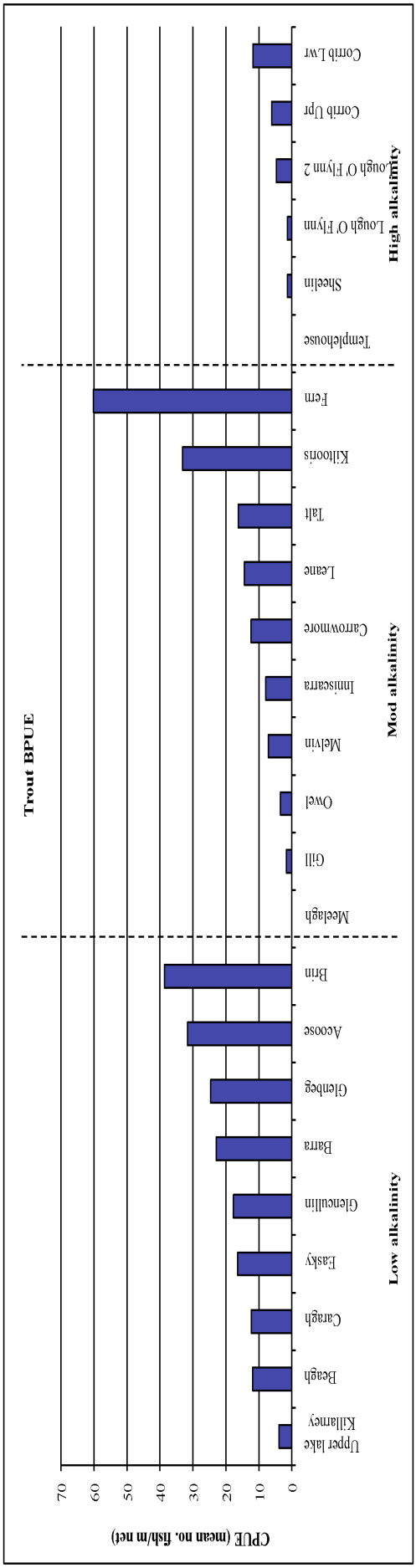


Fig. 4.20: Trout biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

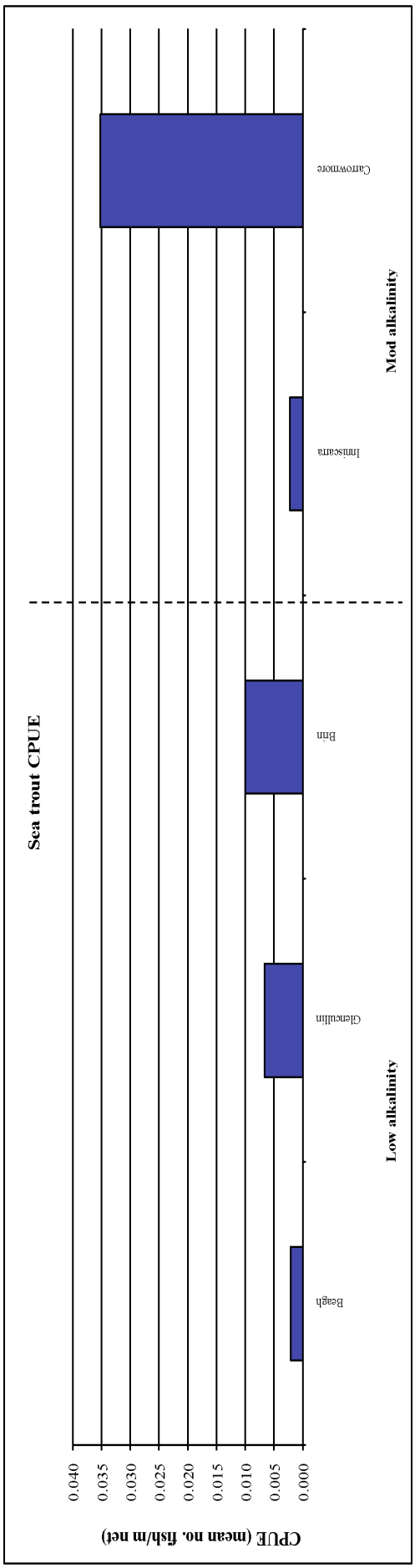


Fig. 4.21: Sea trout abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

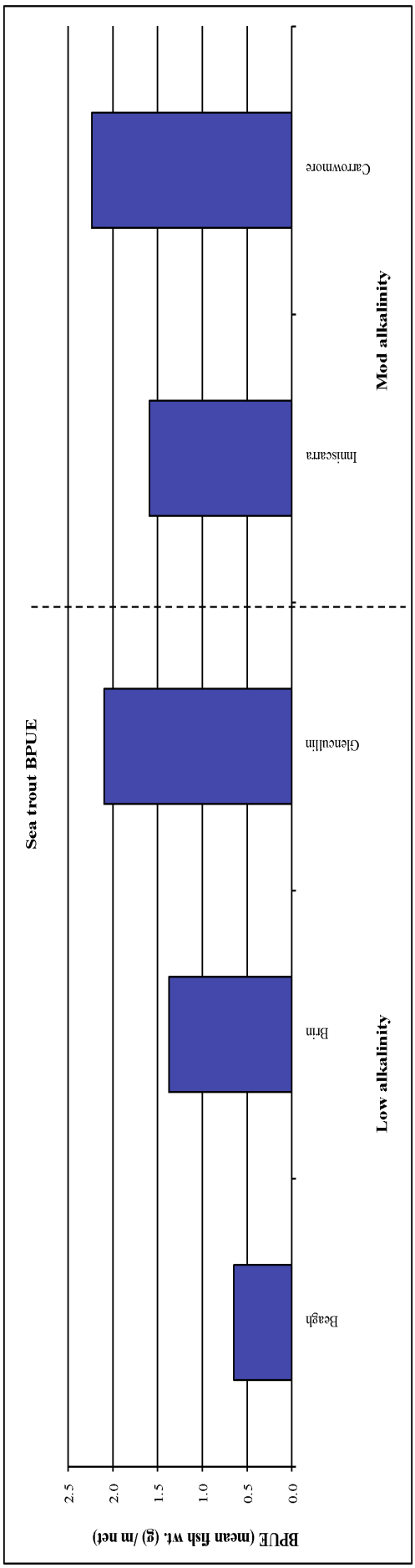


Fig. 4.22: Sea trout biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

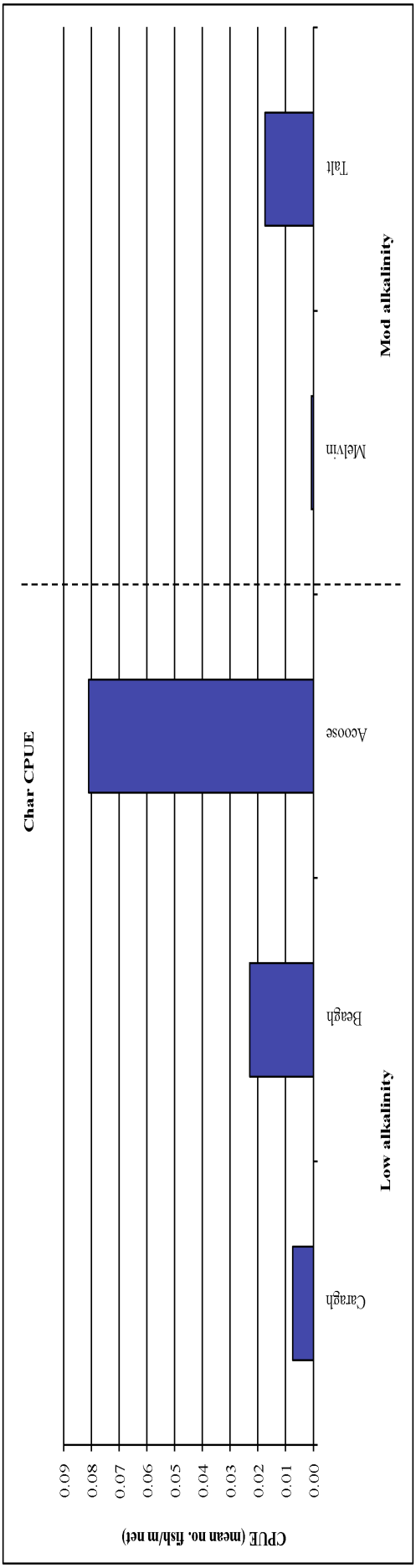


Fig. 4.23: Arctic char abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

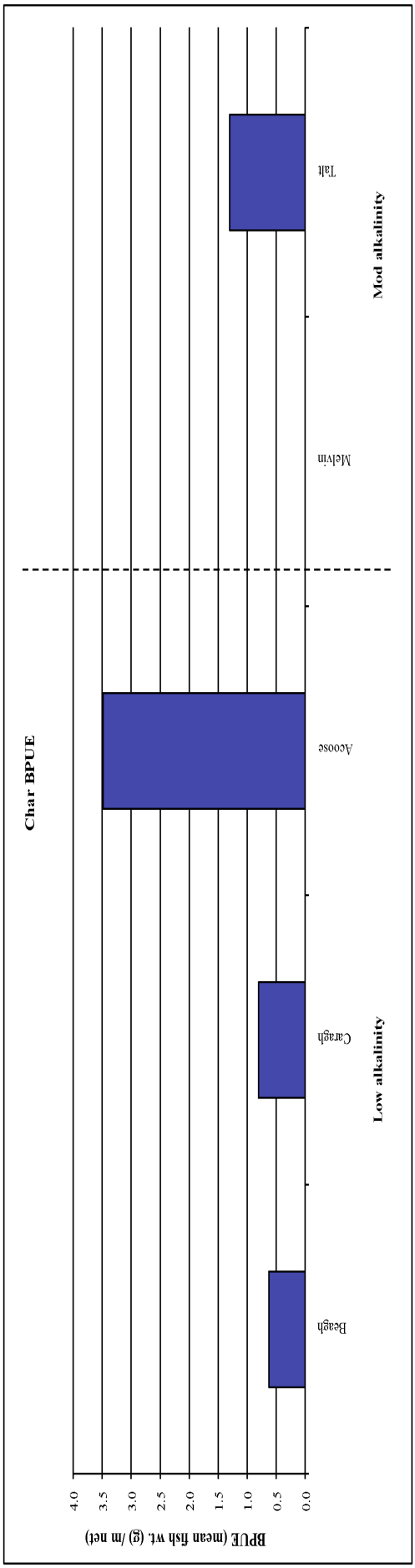


Fig. 4.24: Arctic char biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

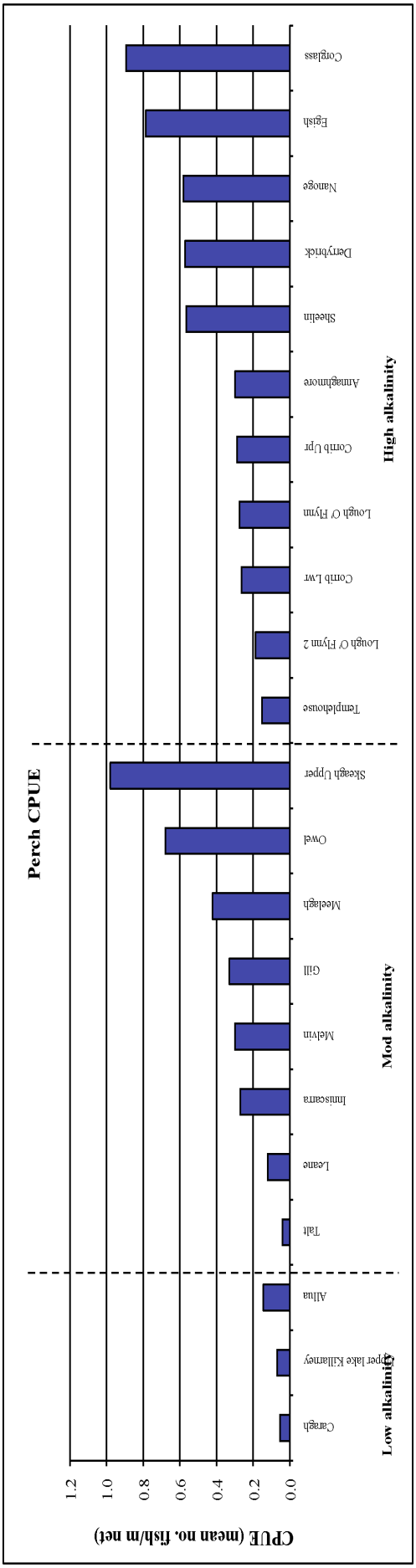


Fig. 4.25: Perch abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

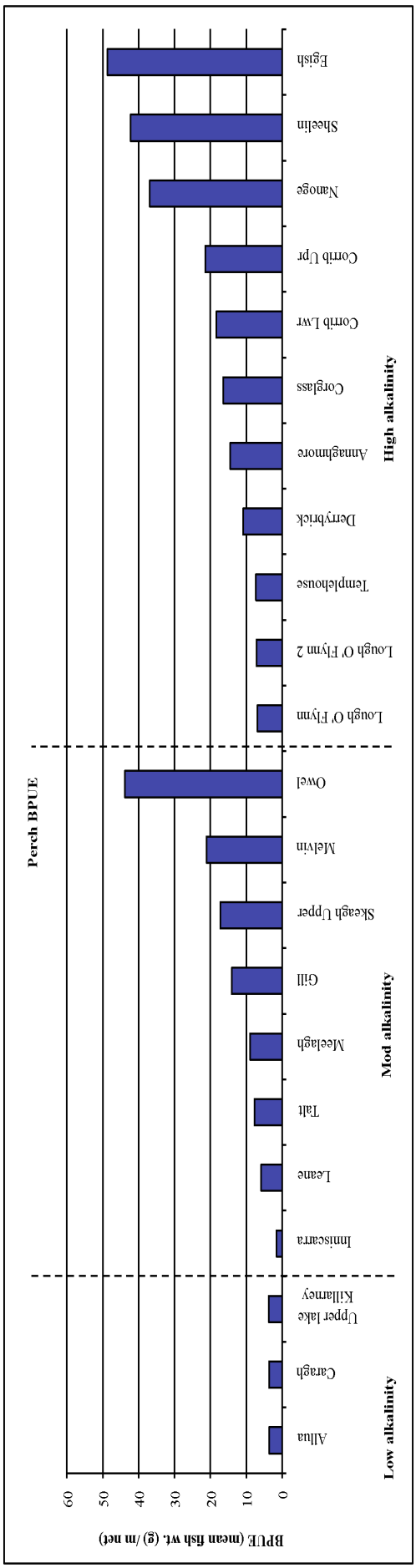


Fig. 4.26: Perch biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

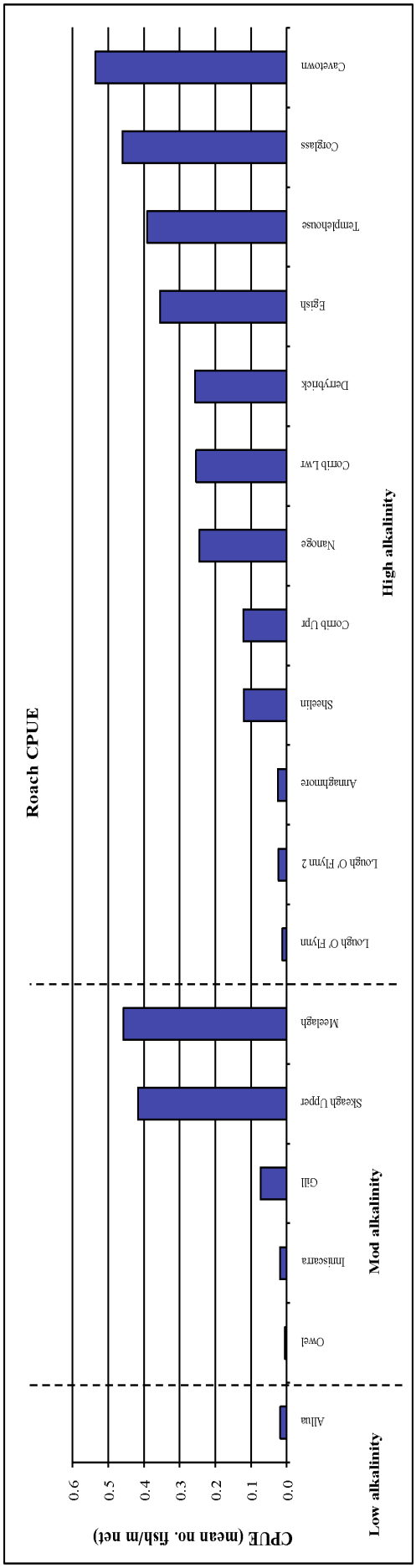


Fig. 4.27: Roach abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

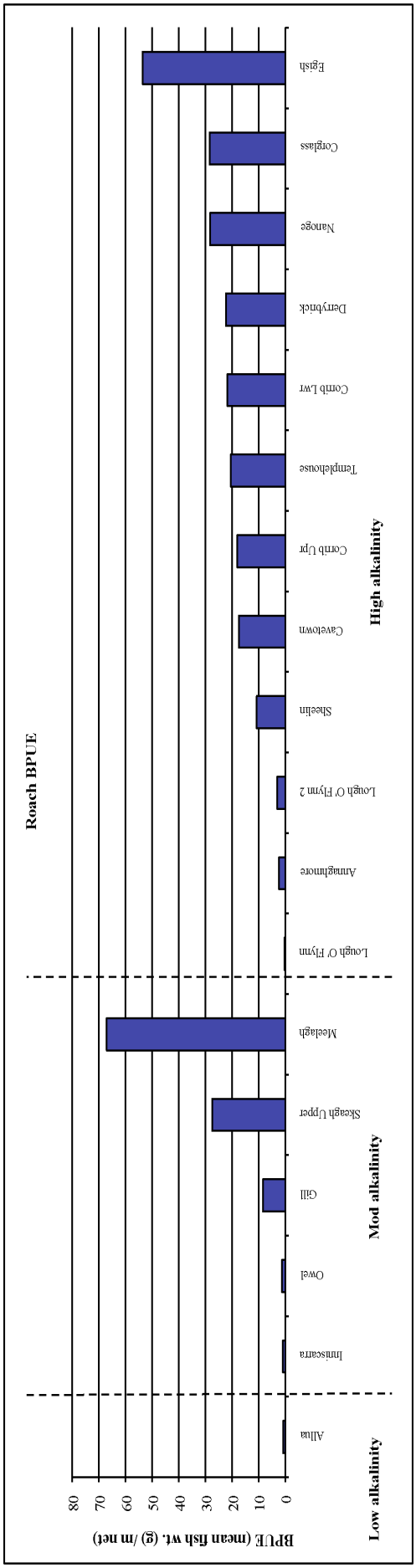


Fig. 4.28: Roach biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

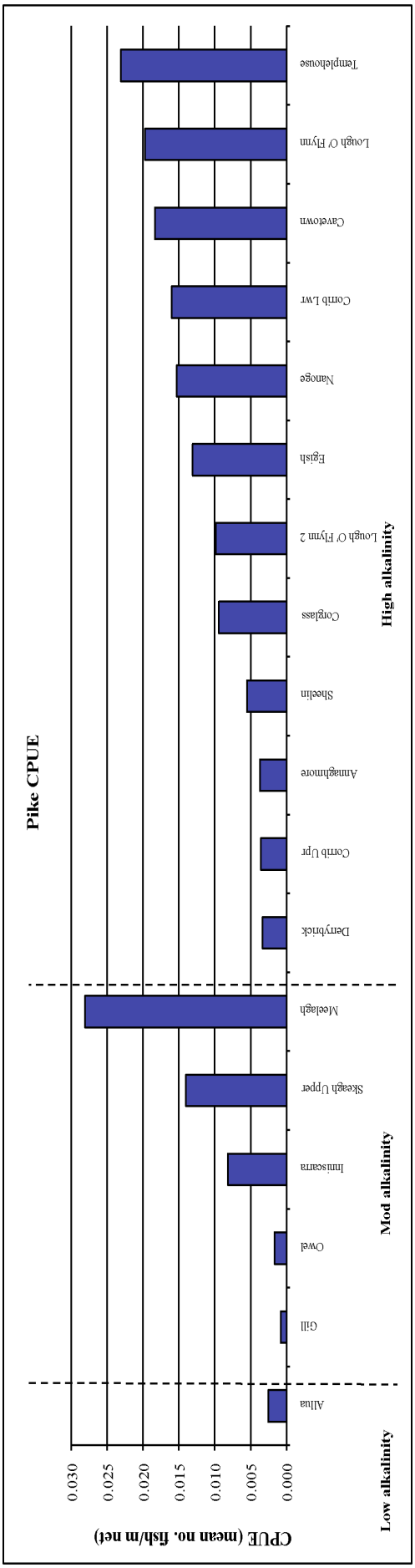


Fig. 4.29: Pike abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

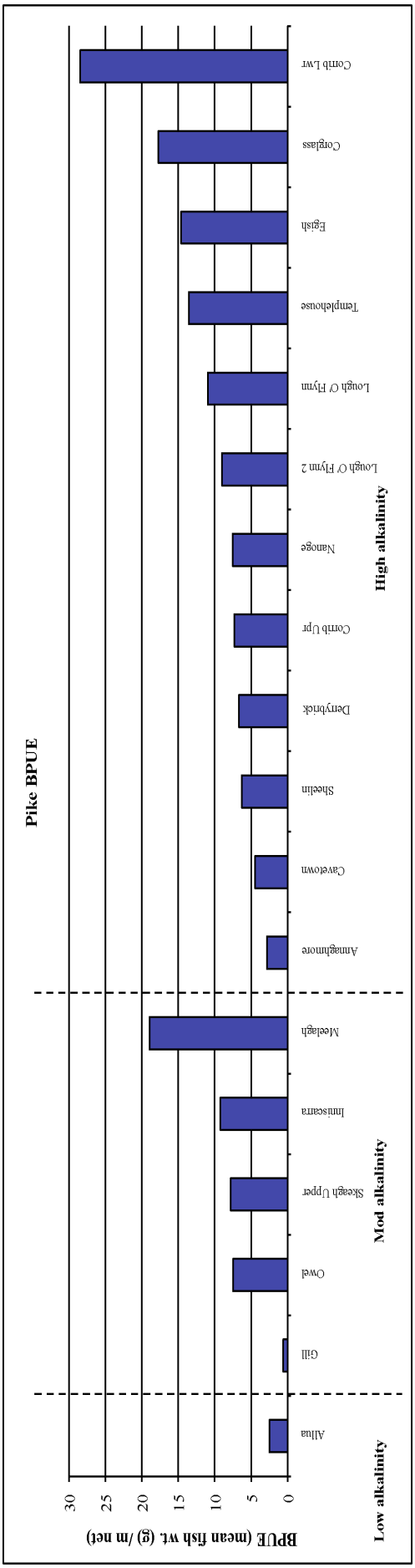


Fig. 4.30: Pike biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

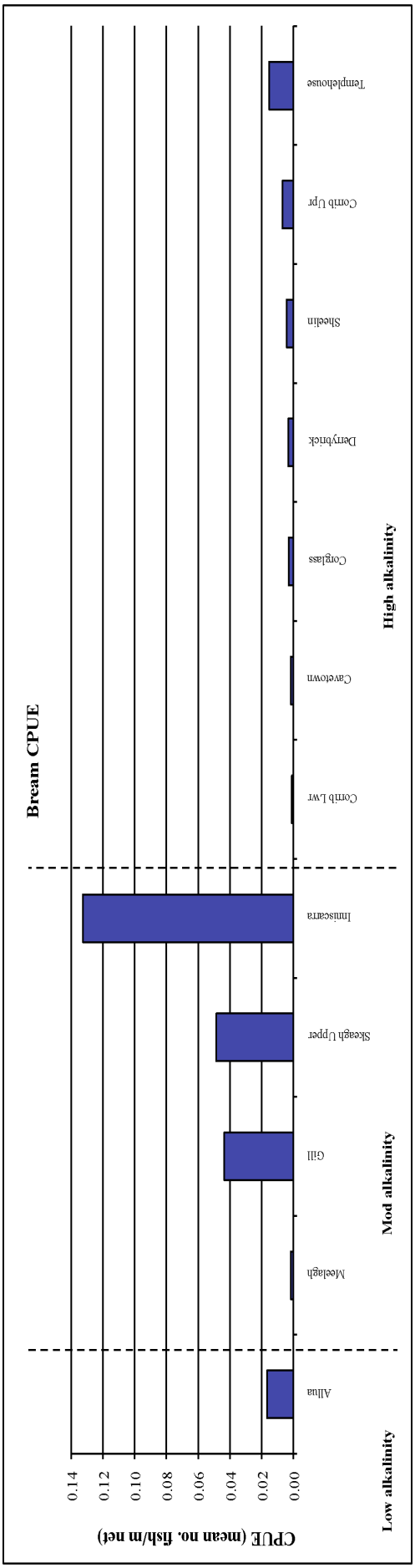


Fig. 4.31: Bream abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

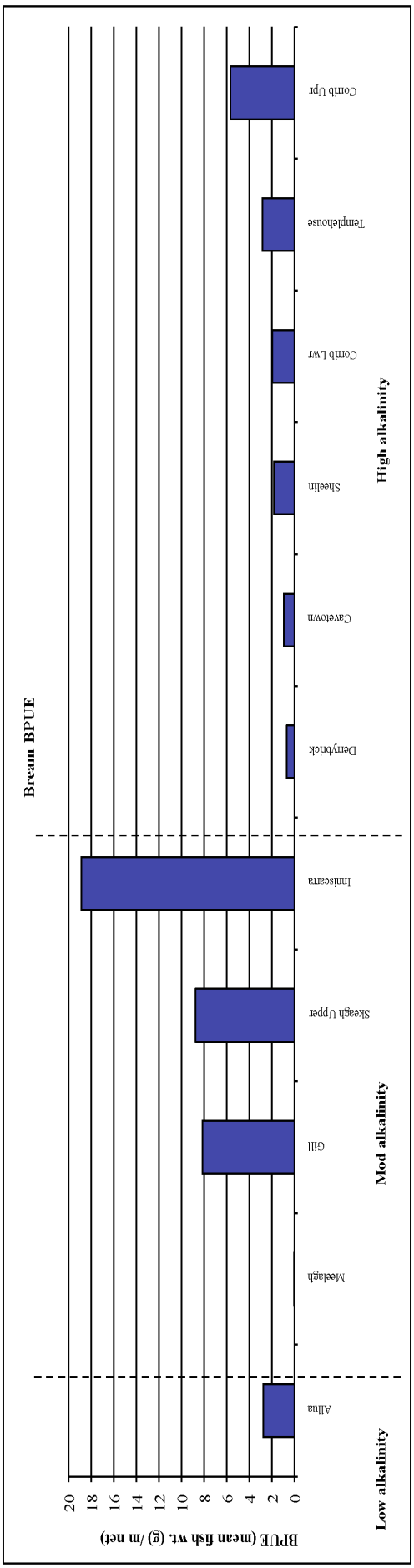


Fig. 4.32: Bream biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

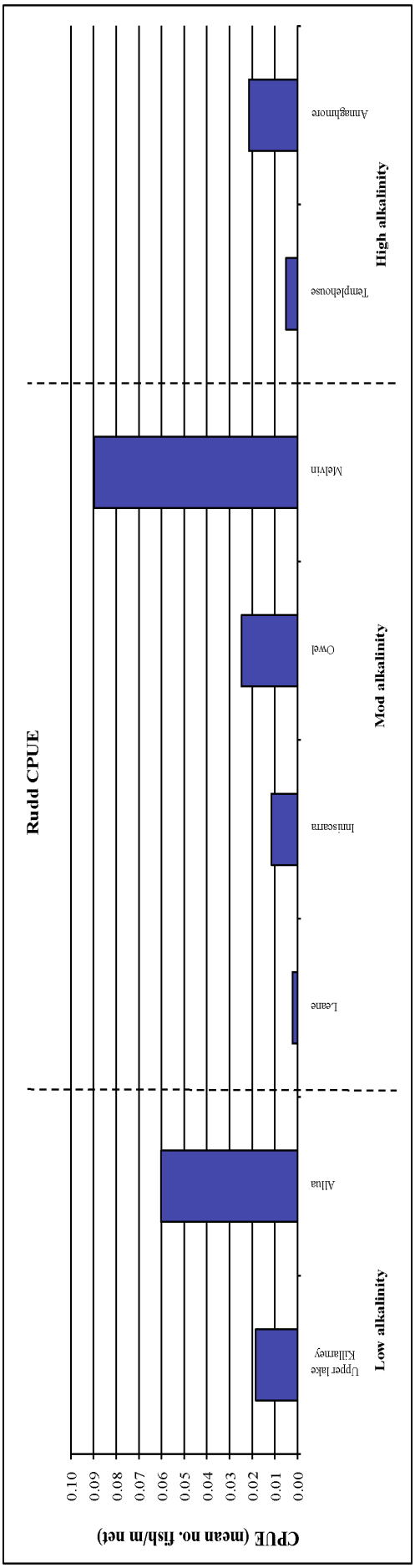


Fig. 4.33: Rudd abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

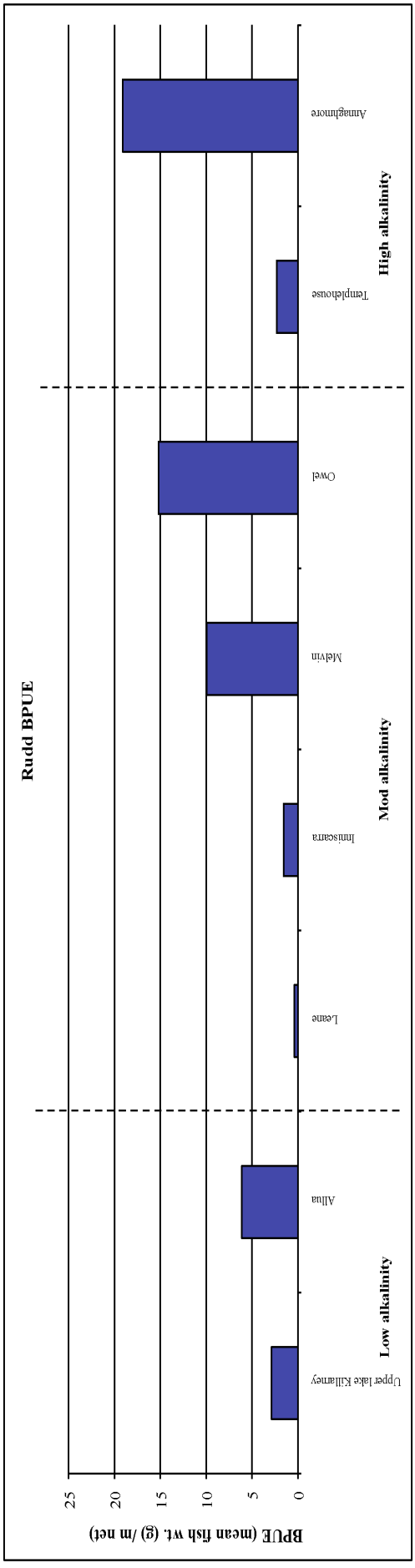


Fig. 4.34: Rudd biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

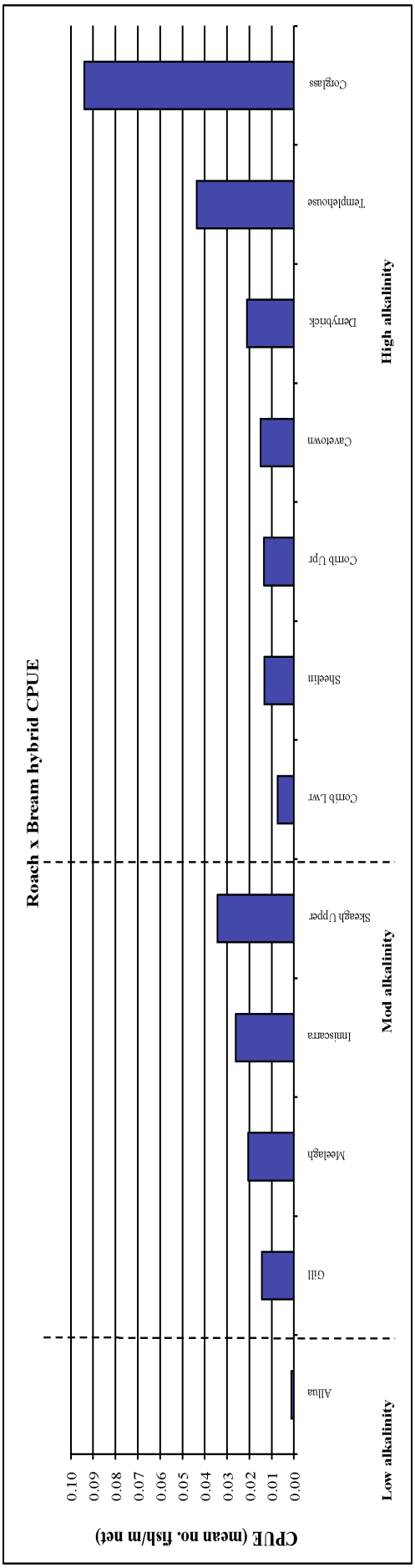


Fig. 4.35: Roach x Bream hybrid abundance (CPUE – mean no. fish/m net) in 2008 SM lakes

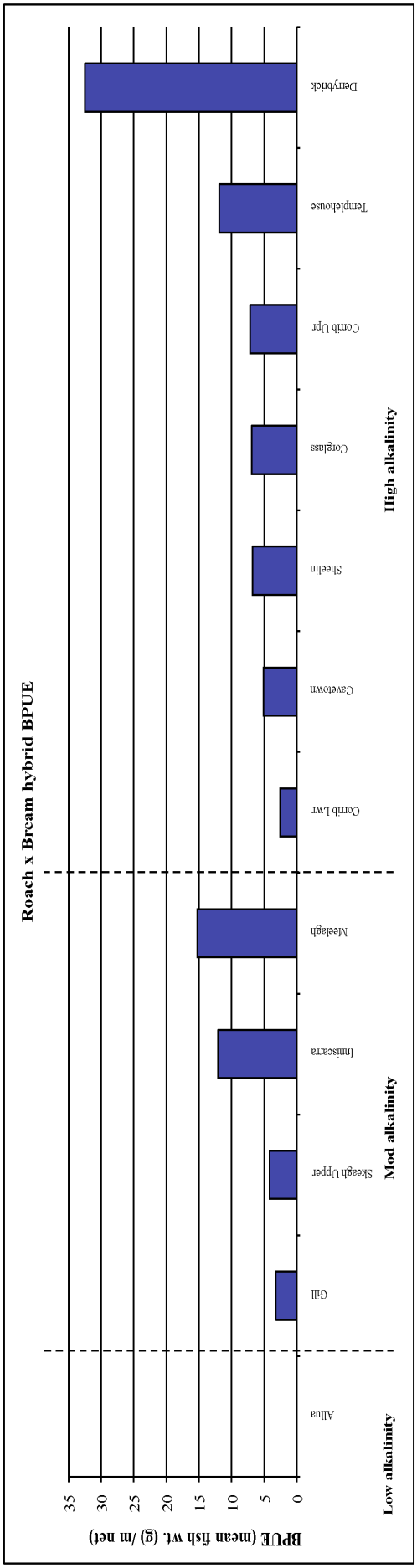


Fig. 4.36: Roach x Bream hybrid biomass (BPUE – mean no. fish/m net) in 2008 SM lakes

4.1.4 Fish growth

Scales from 933 trout (24 lakes), 796 roach (17 lakes), 168 bream (12 lakes), 128 rudd (8 lakes), otoliths from 60 char (4 lakes) and opercular bones from 1,503 perch (21 lakes) were examined for age and growth analysis during the project. Ages were determined from a range of lengths for each fish species, from each lake, comprising a range of age groups (from 0+ to 12+ depending on species). Length at age analyses and growth curves have been constructed for the three dominant species captured during 2008 (i.e. brown trout, perch and roach) (Figs. 4.37 to 4.39). Sub samples of other species in each lake were also aged (eels, pike, tench and hybrids) (Appendix 2).

4.1.4.1 Growth of trout in low, moderate and high alkalinity lakes

Mean back calculated growth curves for trout in lakes surveyed during 2008 are shown in Figure 4.37. Appendix 3 gives a summary of the mean back calculated growth of brown trout in 23 lakes. As expected it can be clearly seen from the graph that the trout from many of the high alkalinity lakes (e.g. Lower Lough Corrib, Upper Lough Corrib and Lough O'Flynn) have the fastest growth rates and trout from the low alkalinity lakes (e.g. Lough Brin, Lough Barra and Glenbeg Lough) have slower growth (Fig. 4.37). Statistical analyses shows that the mean back calculated lengths at the end of year one and year two for trout were significantly higher in high alkalinity lakes when compared to moderate and low alkalinity lakes (One-way Anova, $p<0.001$, LSD Post Hoc $p<0.005$). There was also a statistical difference in trout growth between low and moderate alkalinity lakes (One-way Anova, $p<0.001$, LSD Post Hoc $p<0.005$). Kennedy and Fitzmaurice (1971) related growth rates to alkalinity and classified the growth of lake trout generally into a number of different categories, from:

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 general description was applied to the trout captured in each lake during this project (Table 4.3). Trout from sixteen lakes were classified as being very slow growing, slow growing, fast growing and very fast growing respectively (Table 4.3). Trout from Lough Sheelin, Lough O' Flynn, Lough Acoose, Upper Lake Killarney, Lough Easky, Lough Talt and Templehouse Lake were not classified as there were no four year old fish captured on these lakes.

Table 4.3: Categories of growth of trout in lakes in the 2008 SM area

Very slow	Slow	Fast	Very fast
Carrowmore	Melvin	Fern	Corrib Upper
Barra	Glencullin	Inniscarra	Corrib Lower
Caragh	Kiltooris		Owel
Glenbeg	Beagh		Gill
Brin	Leane		

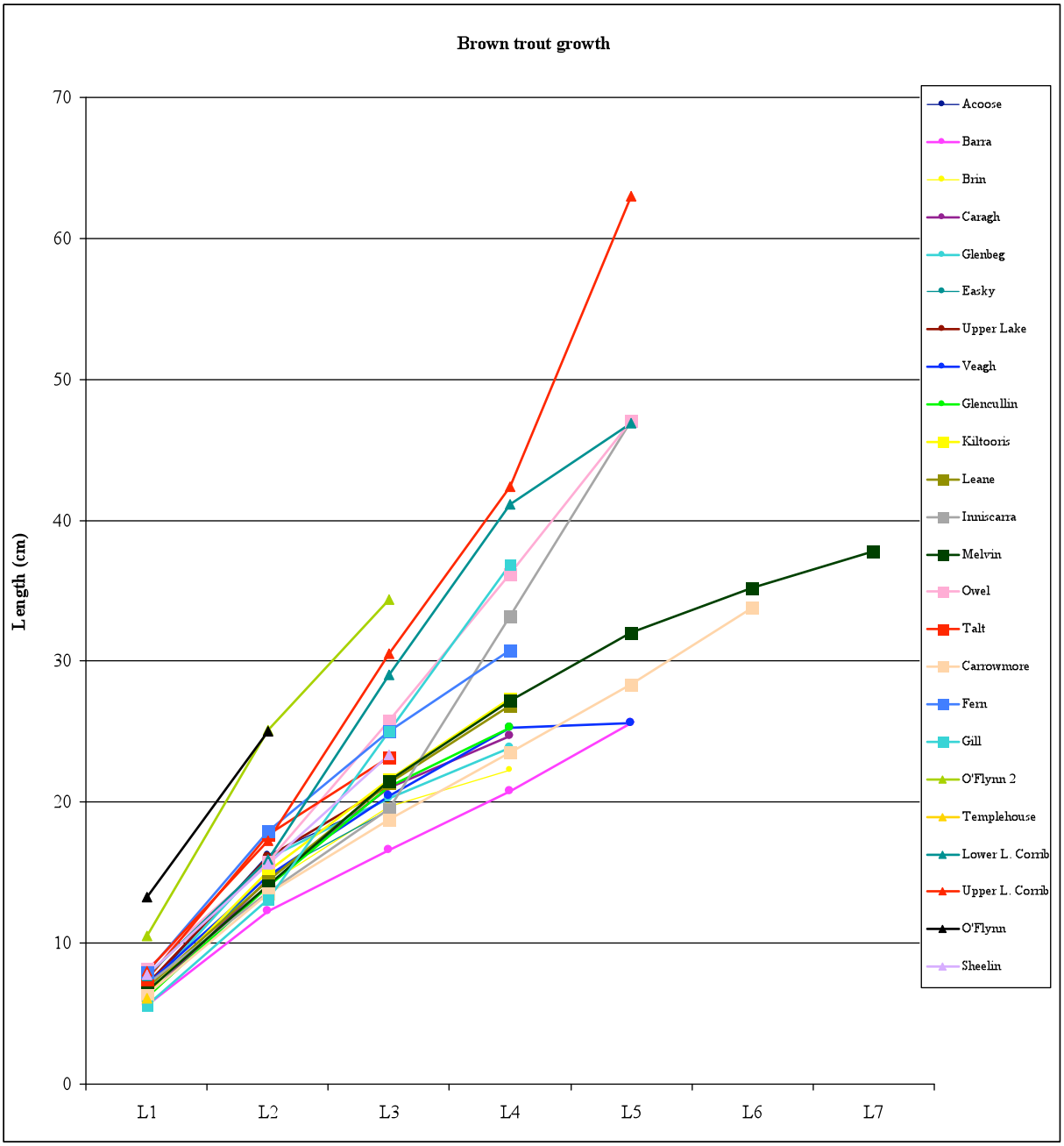


Fig. 4.37: Mean growth rates of trout captured in lakes surveyed for WFD SM monitoring during 2008 (note the round markers indicate low alkalinity lakes, the square markers indicate moderate alkalinity lakes and the triangular markers indicate high alkalinity lakes)

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

Growth curves for perch and roach captured during the project are shown in Figures 4.38 and 4.39. Appendices 4 and 5 give a summaries of the mean back calculated growth of perch and roach from 21 and 17 lakes respectively in the 2008 SM lakes. As for trout above, there is a large variation in growth rates of both perch and roach between lakes.

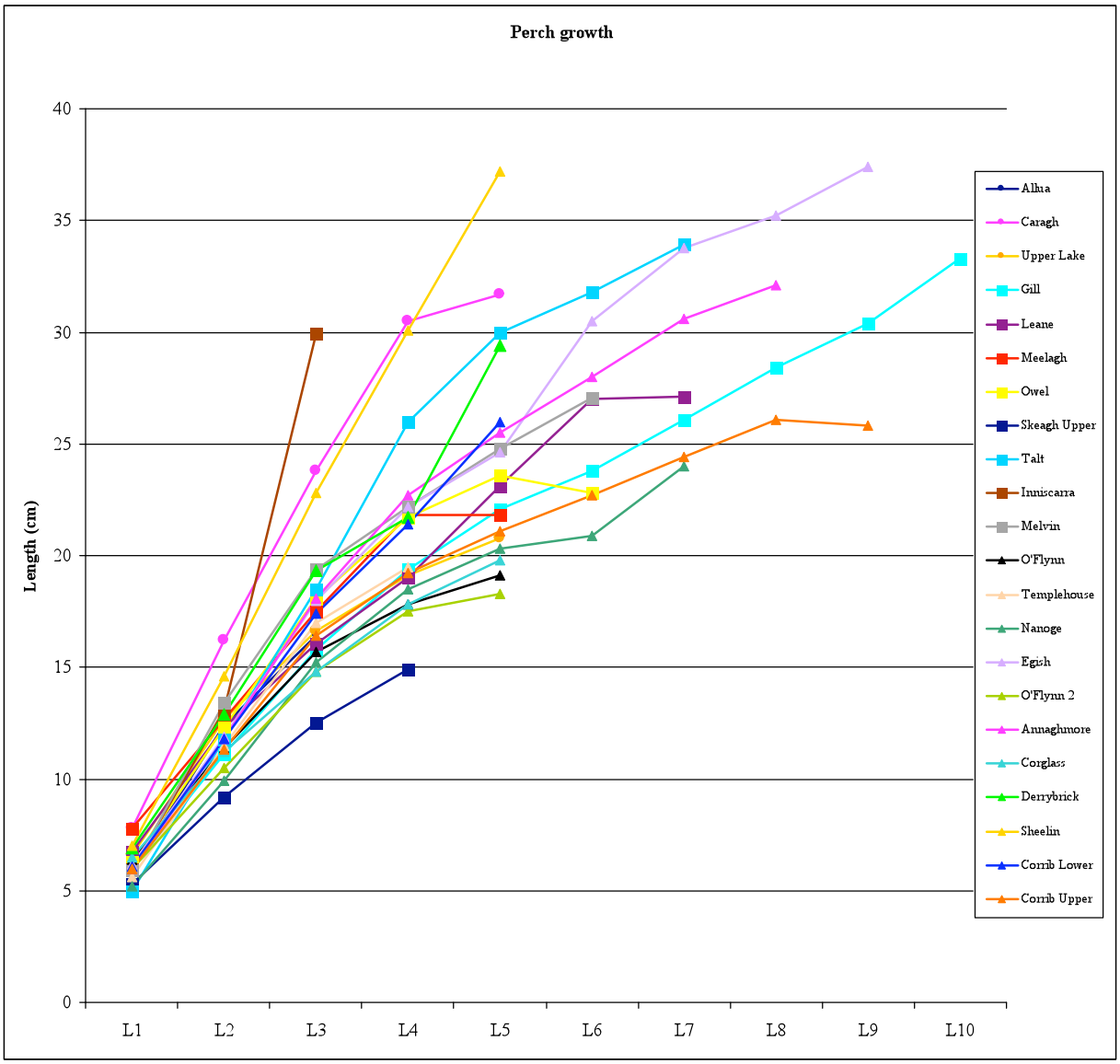


Fig. 4.38: Mean growth rates of perch caught in lakes surveyed for WFD SM monitoring during 2008 (note the round markers indicate low alkalinity lakes, the square markers indicate moderate alkalinity lakes and the triangular markers indicate high alkalinity lakes)

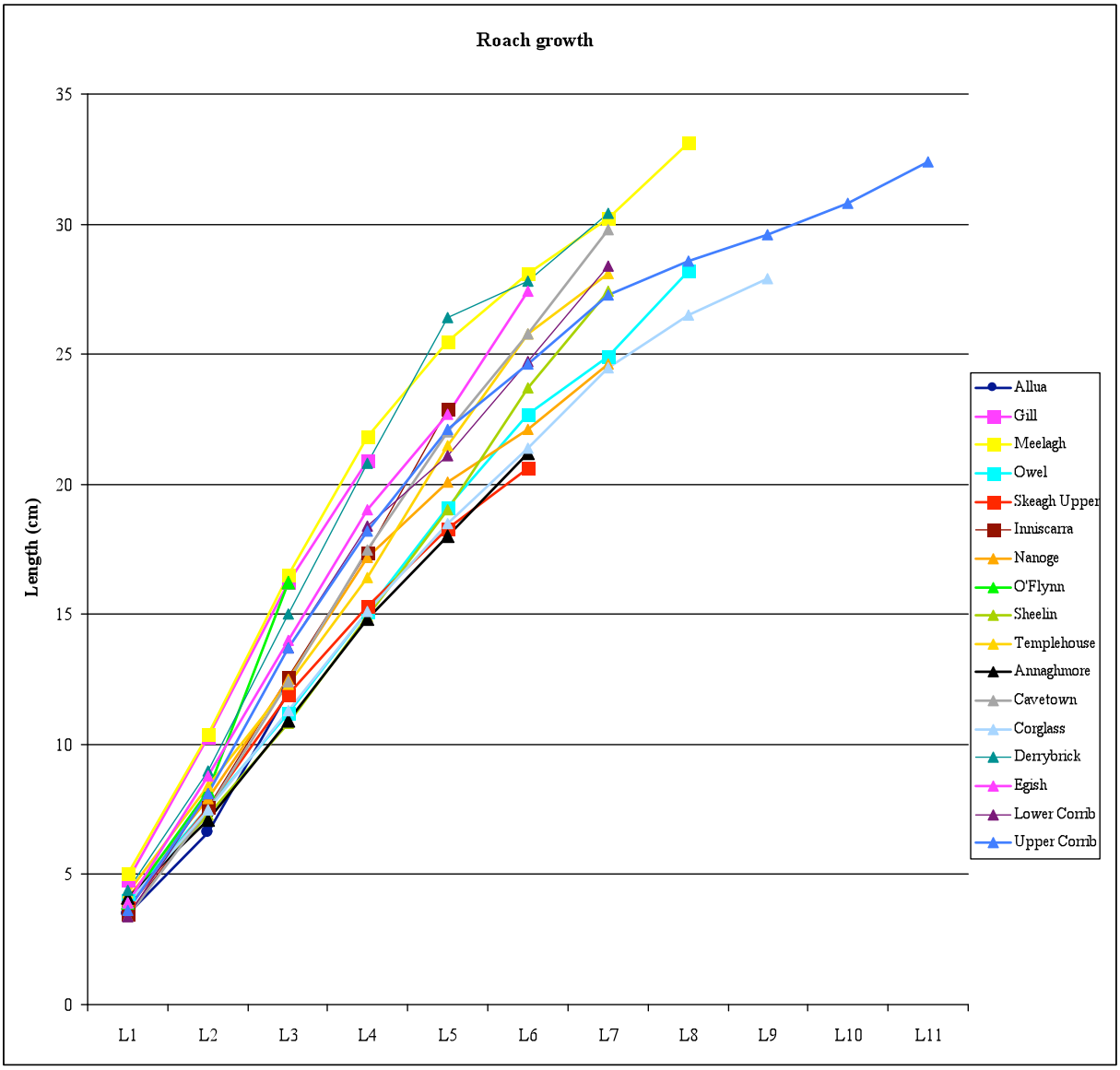


Fig. 4.39: Mean growth rates of roach caught in lakes surveyed for WFD SM monitoring during 2008 (note the round markers indicate low alkalinity lakes, the square markers indicate moderate alkalinity lakes and the triangular markers indicate high alkalinity lakes)

4.1.5 Ecological status - Classification of lakes using the Fish in Lakes (FIL) tool

An essential step in the WFD monitoring process is the classification of the 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 (FIL) ecological classification tool is designed to assign lakes in Ecoregion 17 to ecological status classes ranging from high to bad using fish population parameters relating to abundance, species composition and age structure (Kelly *et.al.*, 2008b). In total, 32 lakes were assigned to an ecological status class using the FIL classification tool together with expert opinion; 4 were classified as High, 11 were classified as Good, 15 were classified as Moderate, 1 was classified as Poor and 1 was classified as Bad ecological status (Figure 4.40). The geographical variation in ecological status reflects the general NW/SW distribution patterns of individual fish species, particularly brown trout and char. The North Western International River Basin District (NWIRBD) and the South West River basin District (SWRBD) are dominated by lakes classified as High or Good ecological status, with a gradual progression to Moderate, Poor and Bad ecological status lakes as we move east through the Shannon International River Basin District (SHIRBD) and Neagh Bann International River Basin District (NBIRBD). This reflects the change in fish communities (mainly salmonids) from upland lakes with little human disturbance to the fish communities (mainly percids and cyprinids) associated with lowland lakes subject to more intensive anthropogenic pressures. The classification of each lake, based on total phosphorous (TP) and using the FIL classification tool, is summarized in Table 4.4.

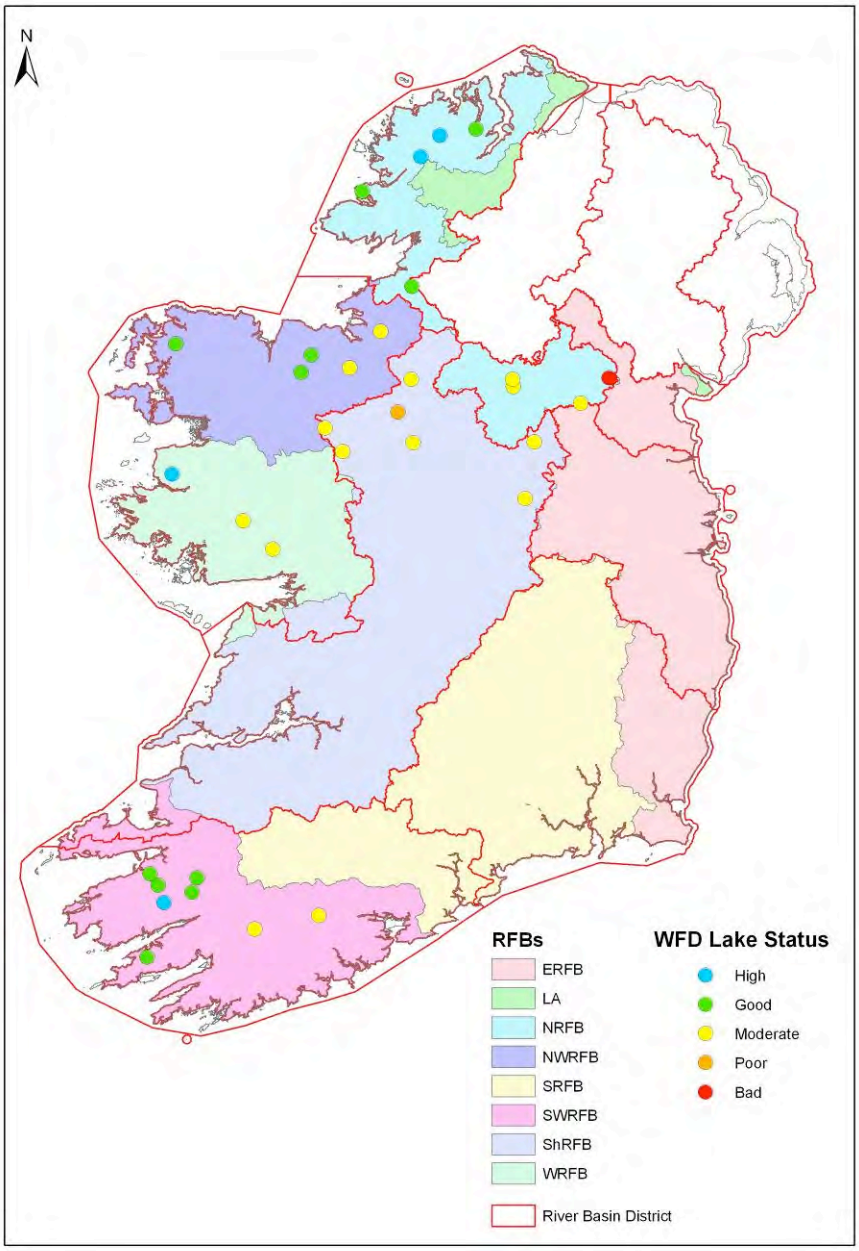


Fig.4.40: Classification of lakes using the Fish in Lakes tool, showing fish ecological status in 2008

Table 4.4: Classification of lakes using the Fish in lakes (FIL) classification tool

Lake	Typology	Fish type	Impact Class (TP)	Impact Class (FIL)	Ecological status (FIL)
Glencullin	1	Salmonids	1	1	High
Barra	4	Salmonids	1	1	High
Beagh	4	Salmonids	1	2	High
Brin	3	Salmonids	1	1	High
Carrowmore	6	Salmonids	2	1	Good
Melvin	8	Salmonids	2	2	Good
Kiltooris	5	Salmonids	1	2	Good
Acoose	4	Salmonids	2	2	Good
Caragh	4	Salmonids	1	2	Good
Glenbeg	4	Salmonids	?	2	Good
Leane	8	Salmonids	2	1	Good
Upper Lake Killarney	4	Salmonids	1	1	Good
Fern	6	Salmonids	2	2	Good
Easky	2	Salmonids	1	2	Good
Talt	8	Salmonids	1	2	Good
Corrib Lwr	10	Salmonids	2	3	Moderate
Corrib Upr	12	Salmonids	2	3	Moderate
Sheelin	12	Salmonids	2	3	Moderate
O' Flynn	10	Salmonids	2	3	Moderate
Owel	8	Salmonids	2	3	Moderate
Gill	8	Salmonids	2	2	Moderate
Templehouse	10	Salmonids	3	3	Moderate
Inniscarra	4	Salmonids	2	3	Moderate
Corglass	9	Perch	2	2	Moderate
Nanoge	11	Perch	2	2	Moderate
Allua	4	Perch	1	2	Moderate
Annaghmore	10	Perch	1	2	Moderate
Derrybrick	9	Perch	2	3	Moderate
Skeagh Upper	6	Perch	3	2	Moderate
Egish	10	Perch	5	5	Bad
Meelagh	6	Roach	2	1	Moderate
Cavetown	10	Roach	2	4	Poor

4.2 Rivers

Trout, salmon and eels are ubiquitous in Ireland and occur in all waters to which they were able to gain access. Irish freshwaters contain only 11 truly native fish species comprising four salmonids, European eel, one shad, two sticklebacks and three lampreys (Kelly *et al*., 2007c). In the absence of major human disturbance a river fish community is considered to be in reference state (in relation to fish) if the population is dominated by salmonids (or euryhaline species with an arctic marine past) (i.e. native fish species are the only species present in the river) (Kelly *et al*., 2007c). A list of fish species recorded in the 83 river sites during the project is shown in Table 4.5. The percentage of river sites in which each fish species occurred is shown in Figure 4.41.

Table 4.5: List of fish species recorded in the 83 river sites surveyed for WFD monitoring, July to October 2008

	Scientific names	Common names	Number of river sites	% river sites
	NATIVE SPECIES			
1	*Salmo salar* Linnaeus, 1758	Salmon	58	70
2	*Salmo trutta* Linnaeus, 1758	Brown trout	80	96
	Salmo trutta Linnaeus, 1758	Sea trout*	12	14
3	*Gasterosteus aculeatus* (L.)	Three-spined stickleback	35	42
4	*Lampetra sp.*	Juvenile lamprey	32	39
5	*Platichthys flesus* (Duncker)	Flounder	7	8
6	*Anguilla anguilla* (L.)	Eel	63	76
	NON NATIVE SPECIES (influencing ecology)			
7	*Esox lucius* (L.)	Pike	20	24
8	*Rutilus rutilus* (L.)	Roach	20	24
9	*Perca fluviatilis* (L.)	Perch	18	22
10	*Abramis brama* (Linnaeus, 1758)	Bream	3	4
11	*Phoxinus phoxinus* (L.)	Minnow	26	31
12	*Barbatula barbatula*	Stoneloach	30	36
13	*Leuciscus cephalus (*Linnaeus, 1758)	Chub	1	1
	NON NATIVE SPECIES (generally not influencing ecology)			
14	*Gobio gobio* (L.)	Gudgeon	21	25
	Hybrids			
	Roach x bream hybrid	Roach x bream hybrid	2	2

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

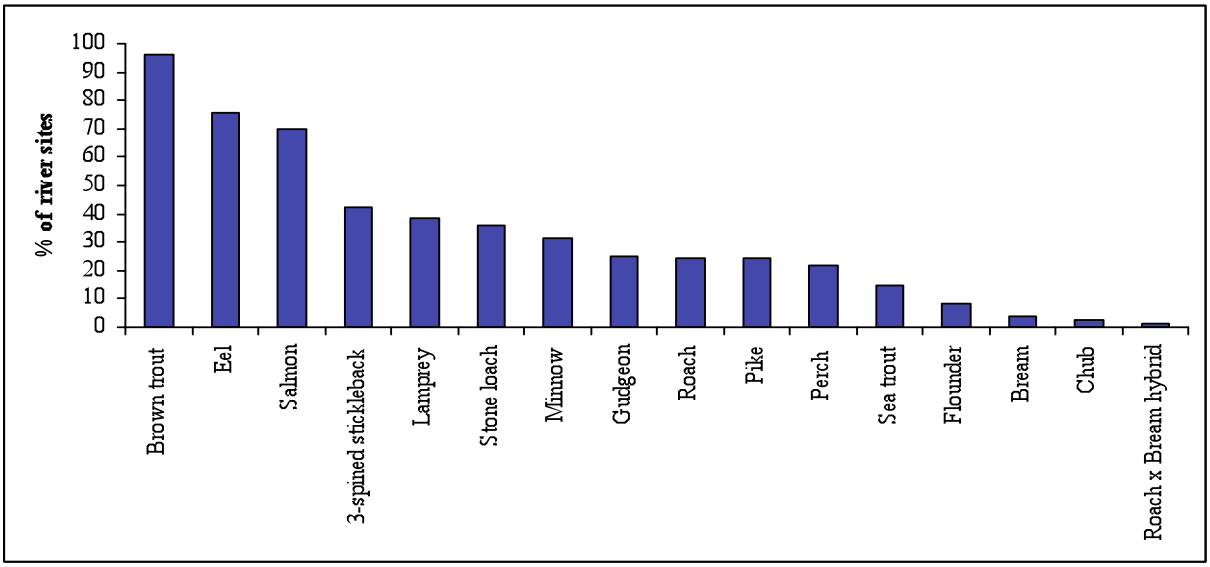


Fig. 4.41: Percentage of sites where each fish species was recorded (total of 83 river sites surveyed) during WFD surveillance monitoring 2008

Overall, a total of 15 fish species (sea trout are included as a separate variety of trout) and one type of hybrid were recorded in the 83 sites surveyed during 2008. Brown trout were the most widespread species occurring in 96% of the sites surveyed, followed by eels (76%), salmon (70%), 3-spined stickleback (42%), juvenile lamprey (39%), stoneloach (36%), minnow (31%), gudgeon (25%), roach (24%), pike (24%), perch (22%) and sea trout (14%). Flounder, bream and chub were present in less than 10% of the river sites surveyed (Table 4.5 and Fig. 4.41).

Fish species richness (excluding hybrids) ranged from one species at one river site (Glenfelly stream in the ShRFB) to a maximum of ten species at one site (Brosna at Clonony in the ShRFB) (Table 4.6 and Fig. 4.42). In general, sites in the Shannon catchment recorded the highest species richness, mainly due to the presence of group 2 and group 3 species. Native species were present at all sites surveyed; however, native species were exclusively present at just 31 of those sites (Table 4.6). Two river sites, the Maine in the SWRFB and the Colligan in the SRFB recorded the highest number of native species (i.e. 7 species) (Table 4.6). Group 2 species (i.e. non native species influencing ecology) were present at 52 sites and the maximum number of non native species recorded at any one site was 6 species (i.e. 3 sites in the ShRFB - Brosna at Clonony, Inny at Shrule Bridge and the Suck at Ballyforan Bridge). Gudgeon was the only group 3 species (i.e. non natives benign – generally not influencing ecology) present in the river sites surveyed and this species was recorded at 21 sites (Table 4.6).

Table 4.6: Species richness at each river site surveyed, July to October 2008

Site	Region	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
		BOAT SITES			
Brosna (Clonony)	ShRFB	10	3	6	1
Nore (Quakers bridge)	SRFB	9	5	3	1
Kilcrow	ShRFB	9	3	5	1
Suck (Ballyforan)	ShRFB	9	2	6	1
Inny (Shrule)	ShRFB	9	2	6	1
Maine	SWRFB	8	7	1	0
Owenavorragh	ERFB	8	6	2	0
Fergus (Clonroad)	ShRFB	8	6	2	0
Suck (Cloondacarra)	ShRFB	8	3	5	0
Annalee	NRFB	8	3	4	1
Colligan	SRFB	7	7	0	0
Clodiagh (Tullamore)	ShRFB	7	5	2	0
Blackwater (Monaghan)	ERFB	7	4	2	0
Glenamoy	NWRFB	6	6	0	0
Feale	ShRFB	6	5	1	0
Gweestin	SWRFB	6	5	1	0
Smearlagh	ShRFB	6	5	1	0
Maigue	ShRFB	6	4	2	0
Deel (Crossmolina)	NWRFB	6	3	3	0
Deel (Newcastlewest)	ShRFB	6	3	2	1
Shannon (Battle Bridge)	ShRFB	6	2	3	1
Dromore	NRFB	6	2	3	1
Erne (Belturbet)	NRFB	6	2	3	1
Tullamore	ShRFB	6	2	3	1
Brosna (Pollagh)	ShRFB	6	1	4	1
Vartry	ERFB	5	5	0	0
Mahon	SRFB	5	5	0	0
Anner	SRFB	5	4	1	0
Lee (Inchinossig)	SWRFB	5	3	2	0
Suir (Knocknageragh)	SRFB	5	2	2	1
Camlin	ShRFB	5	1	3	1
Cross	ShRFB	5	1	3	1
Womanagh	SWRFB	4	4	0	0
Moy (Cloonbaniff)	NWRFB	4	4	0	0
Castlebar	NWRFB	4	3	1	0
Owenreagh	SWRFB	4	3	1	0
Liffey (Kilcullen)	ERFB	4	3	1	0
Multeen	SRFB	4	3	1	0
Silver	ShRFB	4	2	1	1
Feorish	ShRFB	4	1	2	1
Mountnugent	ShRFB	4	1	2	1
Bunowen	WRFB	3	3	0	0
Flesk	SWRFB	3	3	0	0
Eany Water	NRFB	3	3	0	0
Behy	NWRFB	3	3	0	0
Little Brosna	ShRFB	3	2	1	0

Table 4.6 contd.: Species richness at each river site surveyed, July to October 2008

Site	Region	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
		HAND SET SITES			
Boor	ShRFB	8	4	3	1
Rye Water	ERFB	7	4	3	0
Duncormick	ERFB	6	5	1	0
Glory	SRFB	6	5	1	0
Gourna	ShRFB	6	5	1	0
Martin	SWRFB	6	5	1	0
Dodder	ERFB	6	4	2	0
Tobercurry	NWRFB	6	4	2	1
Douglas (Ballon)	ERFB	6	4	2	0
Little (Cloghan)	ShRFB	6	3	2	1
Duag	SRFB	5	5	0	0
Ballyroan	SRFB	5	5	0	0
Burnfoot	NRFB	5	5	0	0
Swanlinbar	NRFB	5	5	0	0
Shanowen	SWRFB	5	5	0	0
Graney	ShRFB	5	4	1	0
Banoge	ERFB	5	4	1	0
Waterfoot	NRFB	5	4	1	0
Bow	ShRFB	5	3	2	0
Urrin	ERFB	4	4	0	0
Broadford	ShRFB	4	4	0	0
Swilly	NRFB	4	4	0	0
Glashaboy	SWRFB	4	3	1	0
Scramoge	ShRFB	4	1	3	0
Glennamong	NWRFB	3	3	0	0
Clydagh	NWRFB	3	3	0	0
Clody	ERFB	3	3	0	0
Ballyhallan	NRFB	3	3	0	0
Nier	SRFB	3	3	0	0
Ballinglen	NWRFB	3	3	0	0
Owentocker	NRFB	3	3	0	0
Tyshe	SWRFB	3	3	0	0
Cronaniv Burn	NRFB	2	2	0	0
Glaskeelan	NRFB	2	2	0	0
Nuenna	SRFB	2	2	0	0
Inny (Oldcastle)	ShRFB	2	2	0	0
Glenfelly	ShRFB	1	1	0	0

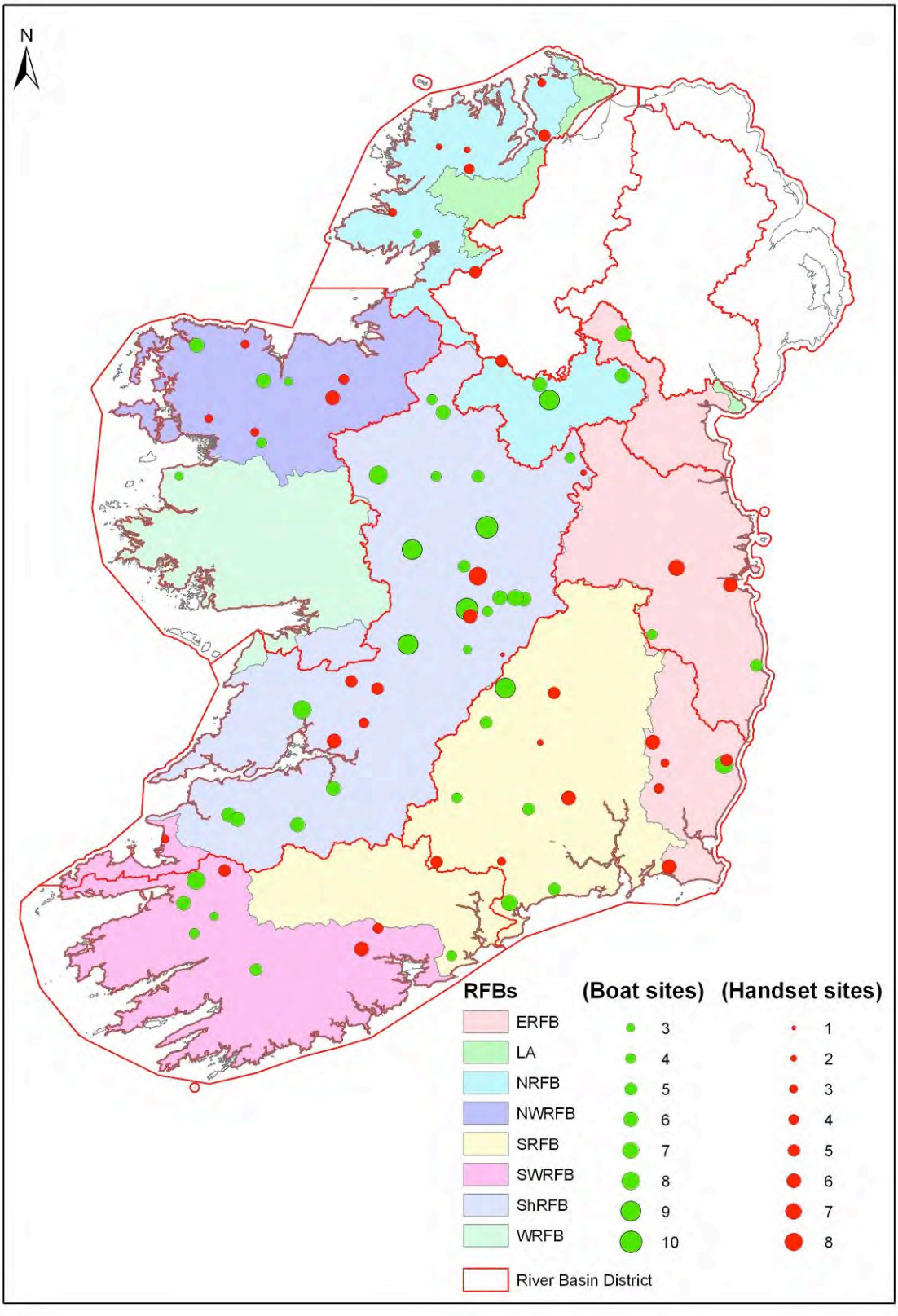


Fig. 4.42: Fish species richness at boat and handset river sites, July to October 2008

4.2.1 Fish species distribution and abundance at the 83 river sites surveyed during 2008

The following figures (Figs 4.43 to 4.57) show the distribution and abundance of each fish species from the 83 river sites surveyed between July and October 2008.

Brown trout were widely distributed throughout the sites surveyed and were absent from only three sites: the Tyshe (SWRFB), the Scramoge (ShRFB) and the Brosna (Pollagh) (ShRFB). The Inny (Oldcastle) (ShRFB) (0.64 fish/m^2) and Glashaboy (SWRFB) (0.43 fish/m^2) hand set sites recorded the highest densities of 0+ brown trout (Fig. 4.43). Brown trout fry (0+) densities were consistently lower at the boat sites; the Owenavorragh (ERFB) (0.038 fish/m^2) recorded the highest densities of at the boat sites, and these fish were not recorded at 23 boat sites (Fig. 4.43). 1+ and older brown trout were more widely distributed at many of the sites surveyed than the 0+ age group (Fig. 4.44). Abundances of 1+ and older brown trout were also consistently higher at many sites than the 0+ age group (Fig. 4.44). The Burnfoot (NRFB) (0.44 fish/m^2), the Glashaboy (SWRFB) (0.40 fish/m^2) and the Bow (0.17 fish/m^2) sites recorded the highest densities of 1+ and older brown trout at the hand set sites, while the Suir (Knocknageragh) (SRFB) (0.25 fish/m^2) and the Deel (Newcastlewest) (ShRFB) (0.15 fish/m^2) recorded the highest densities of 1+ and older brown trout at the boat sites (Fig. 4.44).

Eels were well distributed throughout all the sites surveyed; however, they were absent at a number of sites where there are large dams present downstream, e.g. at 11 sites in the Shannon catchment, one site in the Lee catchment, one in the Erne and one in the Clady catchment (Fig. 4.45). Abundance of eels was also relatively low in comparison to some other fish species such as trout. In general, sites around the coastline recorded higher abundances of eel, e.g. Tyshe (SWRFB) and Banoge (ERFB) than those farther inland (Fig. 4.45).

The distribution of salmon (fry and parr) throughout the sites surveyed was patchy (Fig. 4.46 and 4.47), with abundances appearing better in the northwest, southwest and southeast. Their distribution was quite poor in the Shannon catchment, particularly the upper Shannon (Fig. 4.46 and 4.47). The Tobercurry handset site (NWRFB) (1.28 fish/m^2) recorded the highest abundance of 0+ salmon (fry), followed by the Martin (1.12 fish/m^2), Shanowen (0.80 fish/m^2) (SWRFB), Moy (Cloonbaniff) (0.75 fish/m^2) (NWRFB) and Owentocker (0.56 fish/m^2) (NRFB), whereas the highest density of 0+ salmon at the boat sites (Fig. 4.47) was recorded in the Owenavorragh (0.07 fish/m^2) (ERFB). The Owentocker (0.43 fish/m^2) (NRFB), Nier (0.32 fish/m^2) (SRFB), Shanowen (0.307 fish/m^2) and Ballinglen (0.306 fish/m2) sites recorded the highest densities of salmon parr (1+ and older) at the handset sites and the Behy (0.11 fish/m^2) (NWRFB) recorded the highest density of salmon parr at the boat sites (Fig. 4.47).

Sea trout, as expected, were only recorded in sites close to the coast and in rivers that allow their access upstream and they are generally well scattered around the country (Fig. 4.48). The Smearlagh (ShRFB), Glenamoy (NWRFB) and the Mahon (SRFB) recorded the highest densities of the 12 sea

trout sites (Fig. 4.48). Flounder, like sea trout, were also restricted to sites that are close to the coast and were recorded at only seven of the sites surveyed (Fig. 4.49).

Three-spined stickleback were well distributed throughout the sites surveyed. Relatively high densities were recorded on the Broadford and Gourna (ShRFB) and the Tyshe (SWRFB) sites (Fig. 4.50).

Juvenile lamprey displayed a good distribution in the southern half of the country but were quite sparse at sites in the upper Shannon catchment and in County Mayo (Fig. 4.51).

Irish rivers are similar to lakes in relation to the stocks of non-native fish species which have become established in the wild in certain river catchments. These include roach, pike and bream. The distribution and abundance of these species varies throughout the country (Figs. 4.52 to 4.57). Stoneloach were well distributed throughout the entire country, except for perhaps the most western locations (Fig. 4.52). Minnow were generally well distributed in the SWRFB, ShRFB and ERFB but were relatively rare elsewhere (Fig. 4.53). Roach (present at 20 sites), perch, (18 sites), pike (20 sites) and gudgeon (21 sites) displayed a similar geographical distribution and were recorded most commonly within the ShRFB and the southern part of the NRFB (Figs. 4.54 to 4.57). The River Deel (Crossmolina) which has no connections to the Shannon also recorded a notable abundance of roach, perch and pike (Figs. 4.54 to 4.56). Perch and roach were also present in the Lee catchment (Figs. 4.54 and 4.55). Bream and roach x bream hybrids were also recorded during the surveys but were poorly distributed (3 and 2 sites respectively). Chub, an invasive non-native species in Ireland were recorded at one site on the River Inny at Shrule Bridge (ShRFB).

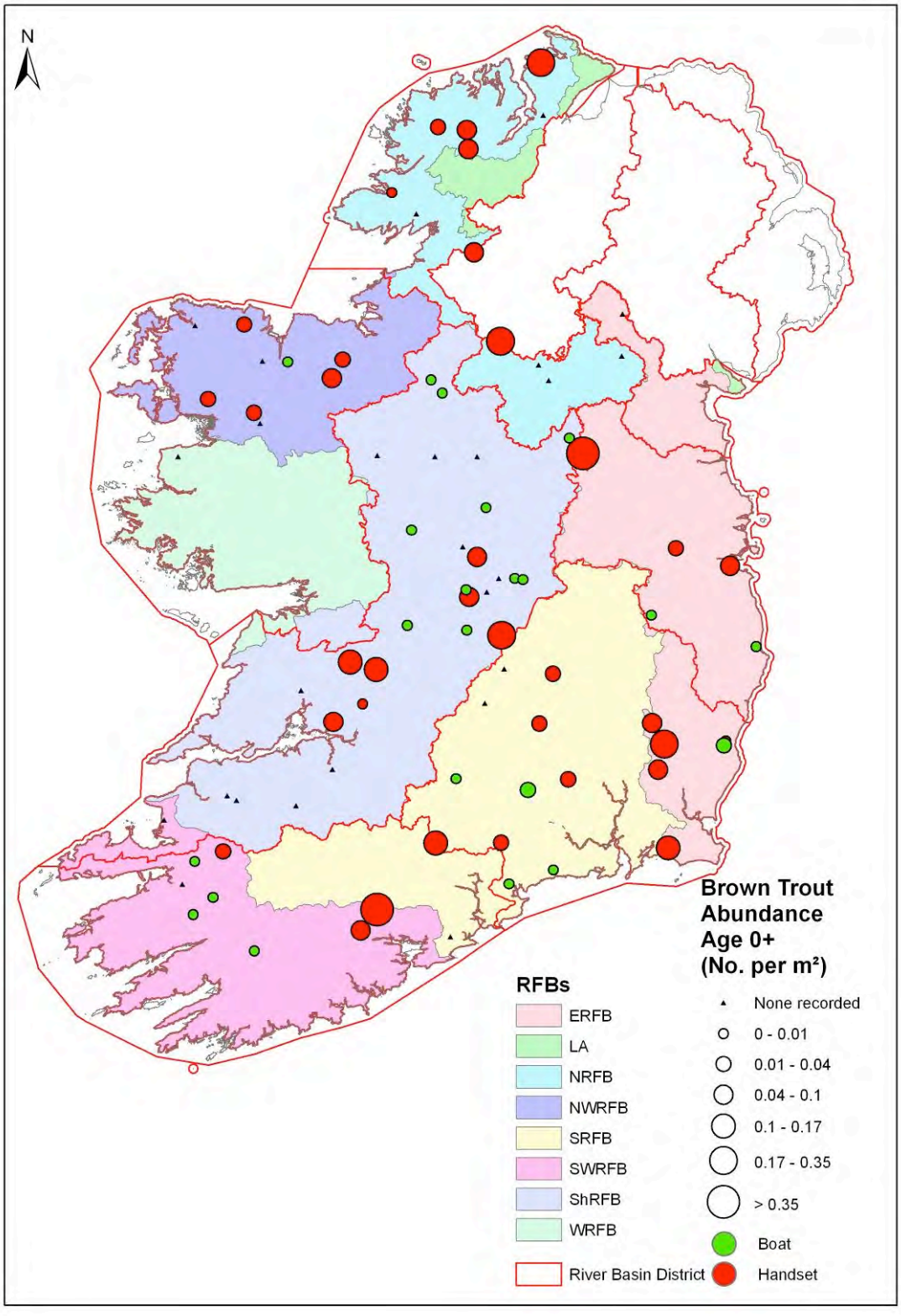


Fig. 4.43: Distribution and abundance of 0+ brown trout at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

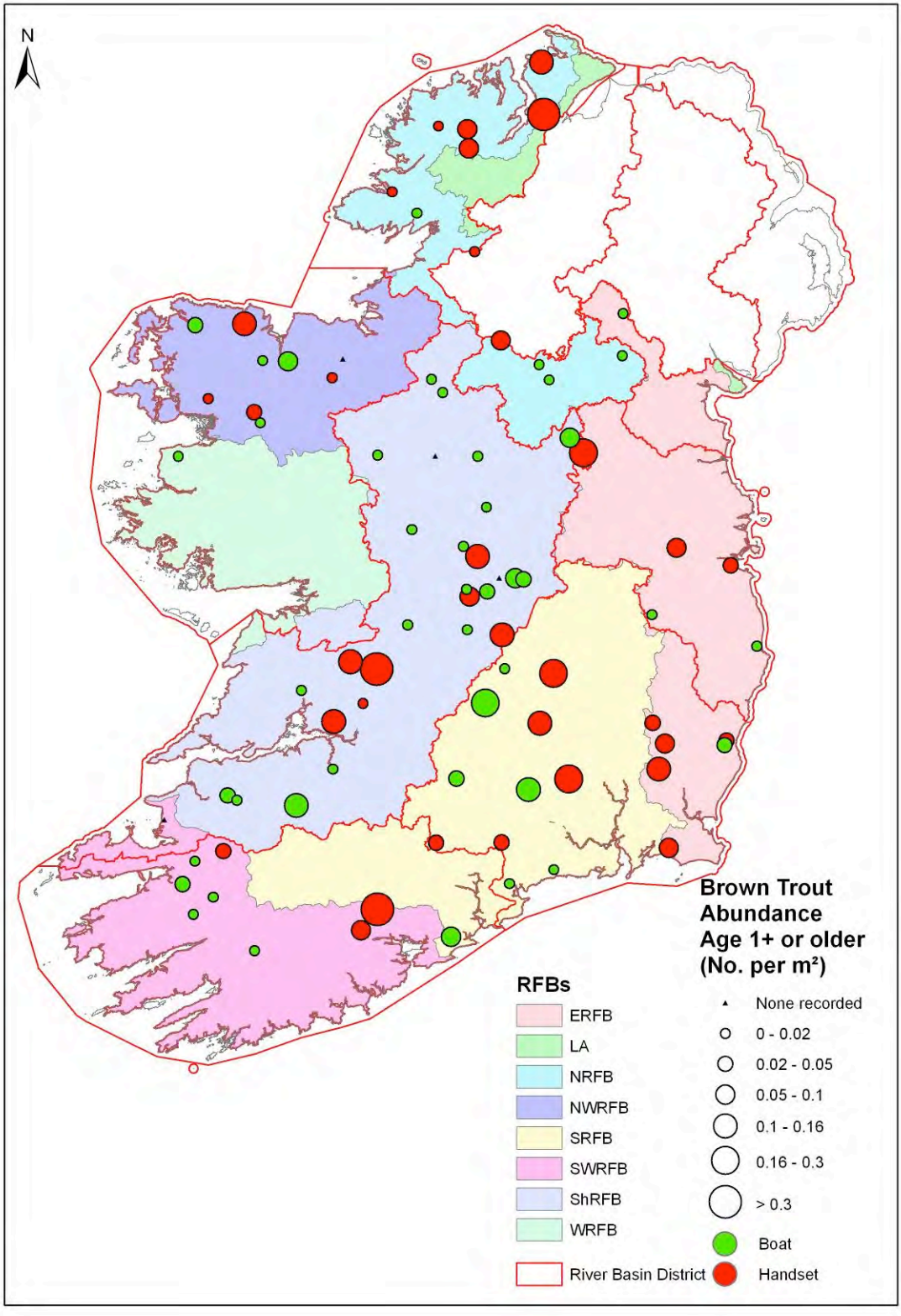


Fig. 4.44: Distribution and abundance of 1+ & older brown trout at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

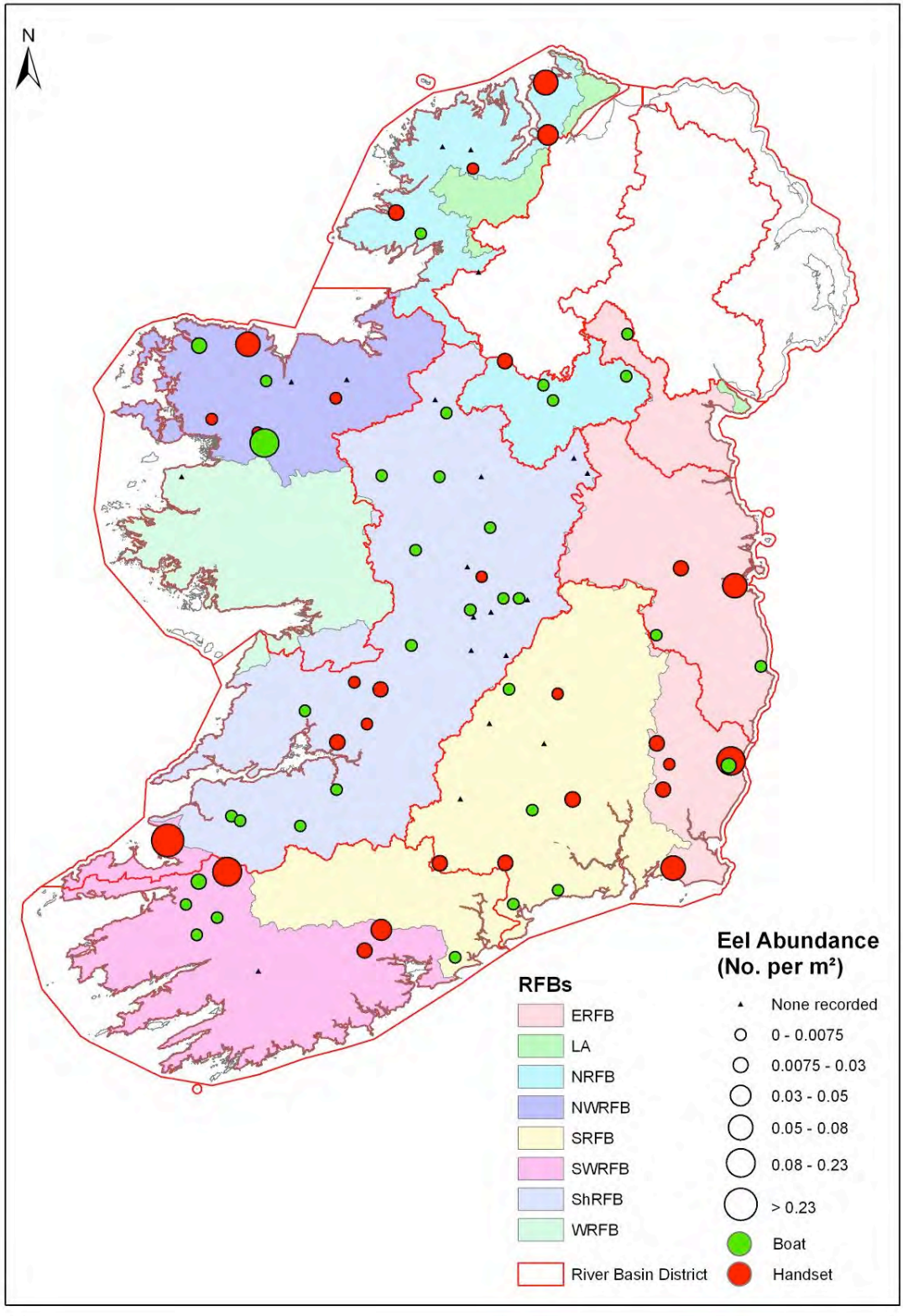


Fig. 4.45: Distribution and abundance of eels at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

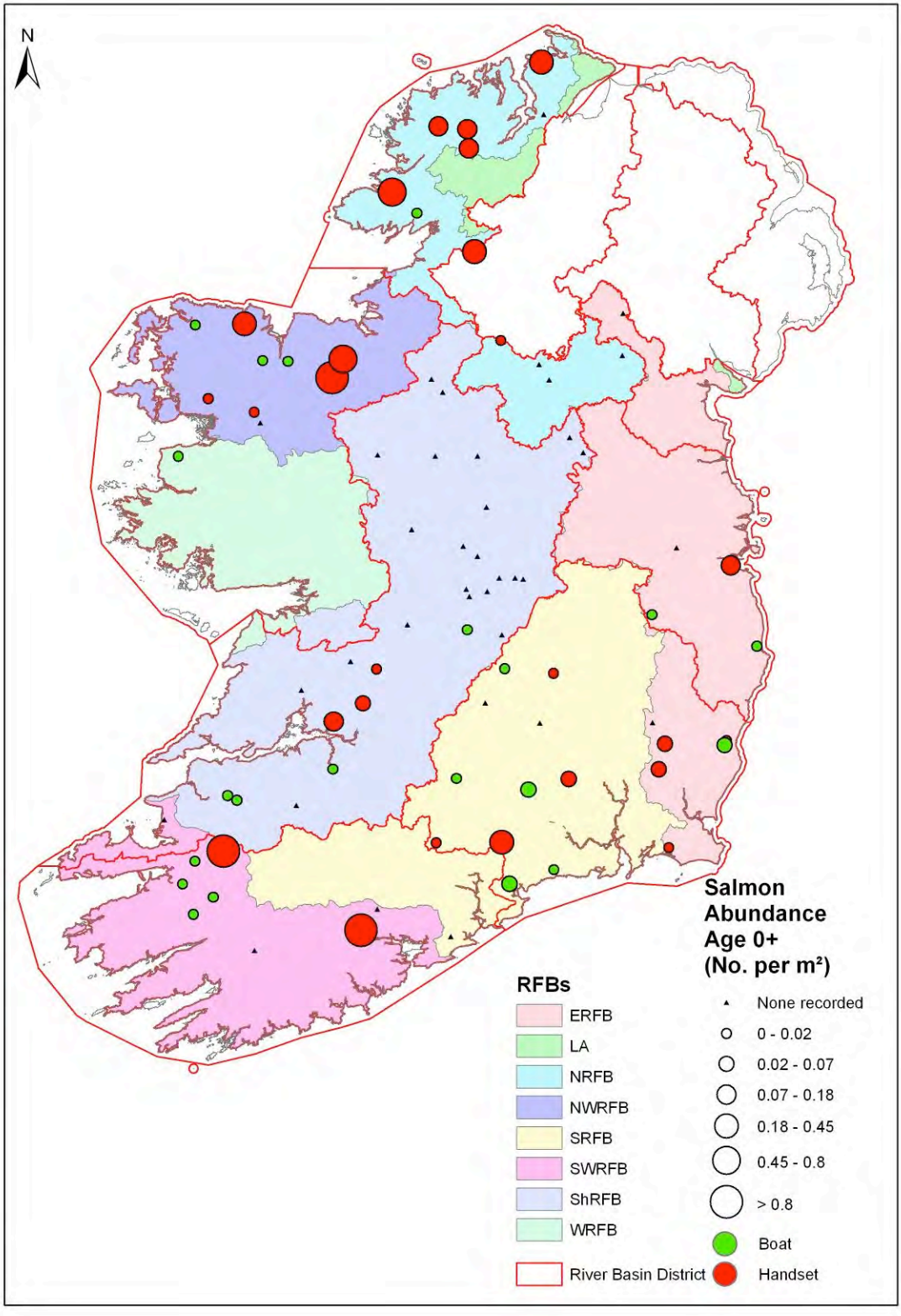


Fig. 4.46: Distribution and abundance of salmon fry (0+), at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

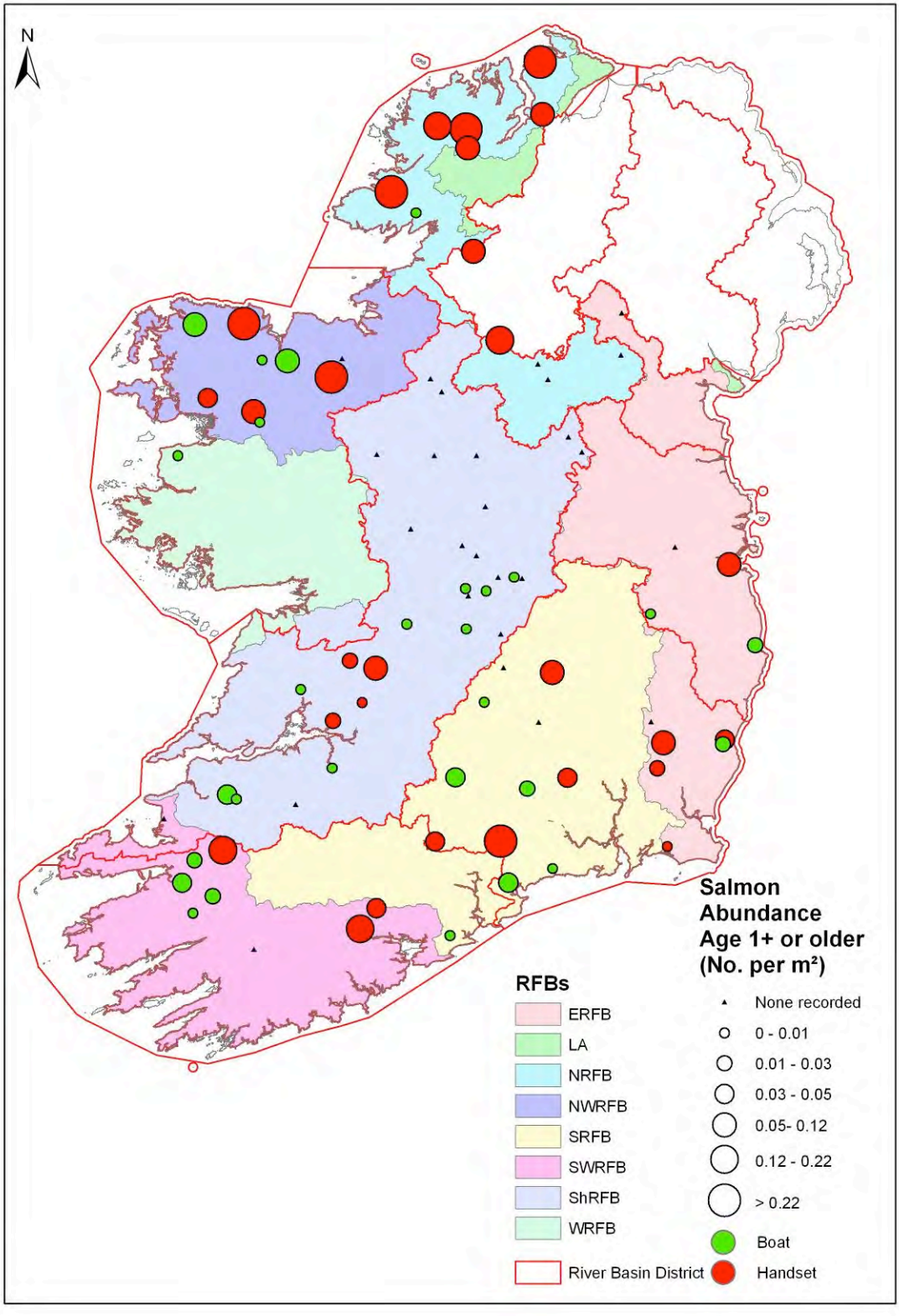


Fig. 4.47: Distribution and abundance of salmon parr (1+ & older) at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

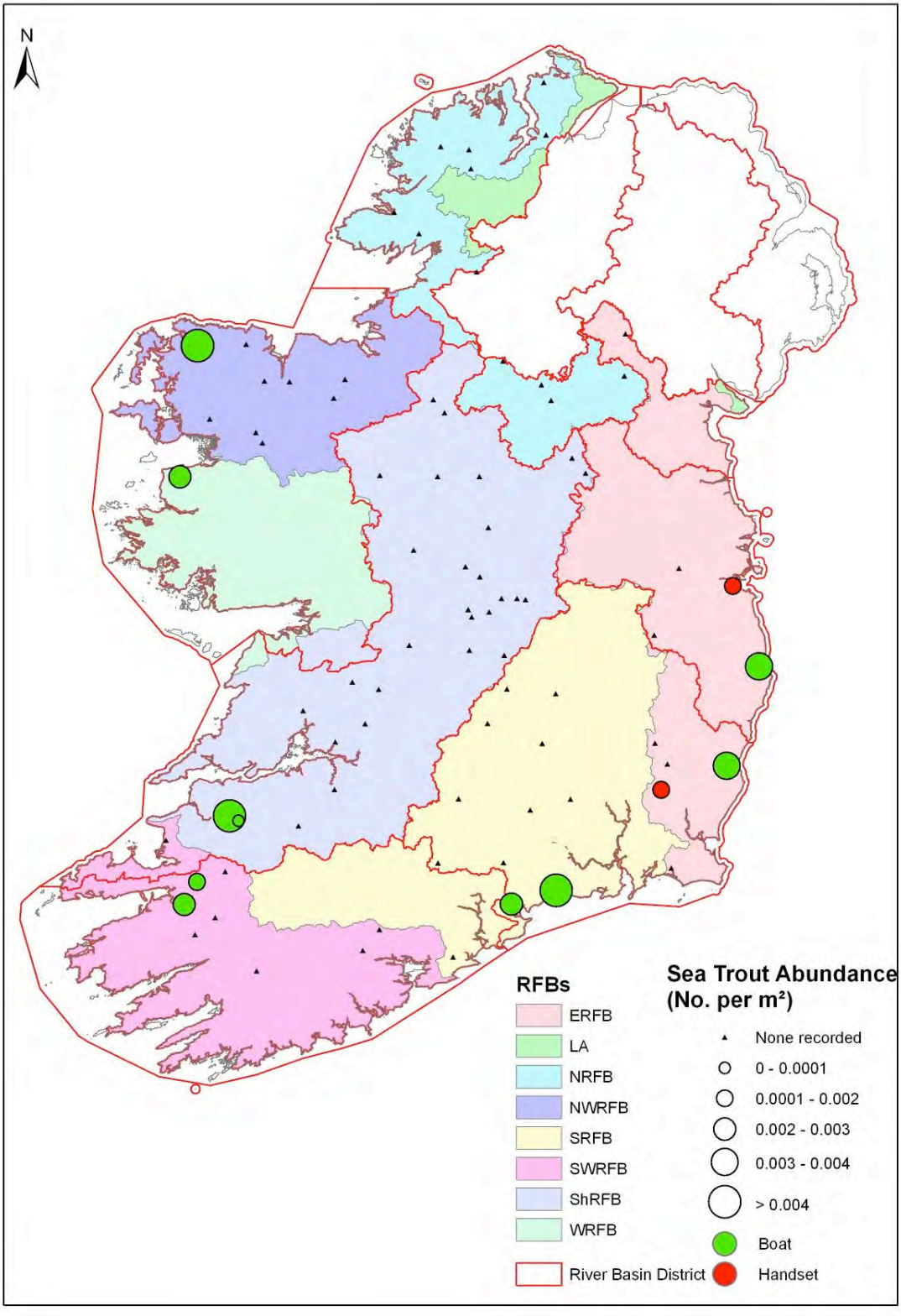


Fig. 4.48: Distribution and abundance of sea trout at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

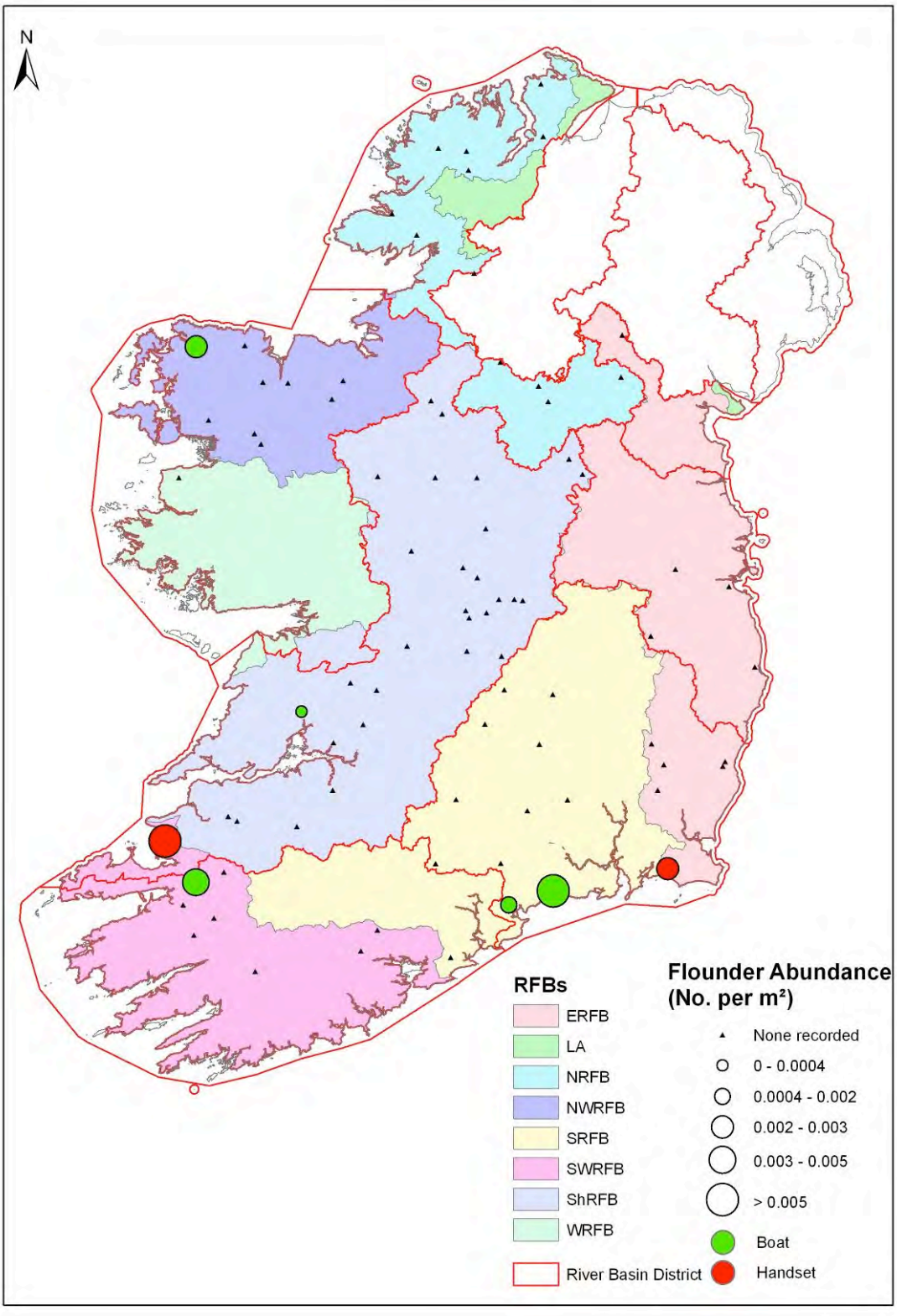


Fig. 4.49: Distribution and abundance of flounder at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

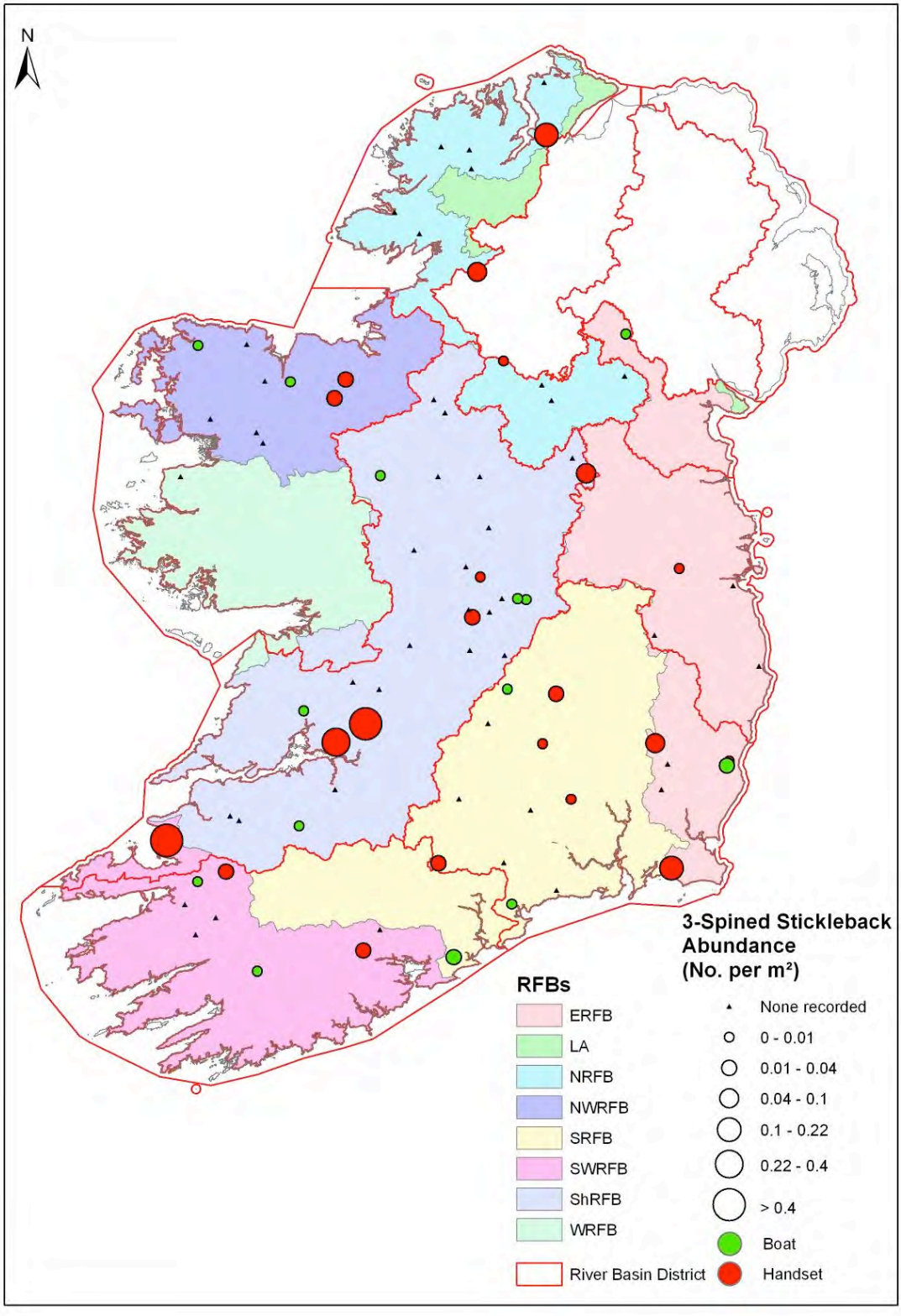


Fig. 4.50: Distribution and abundance of 3-spined stickleback at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

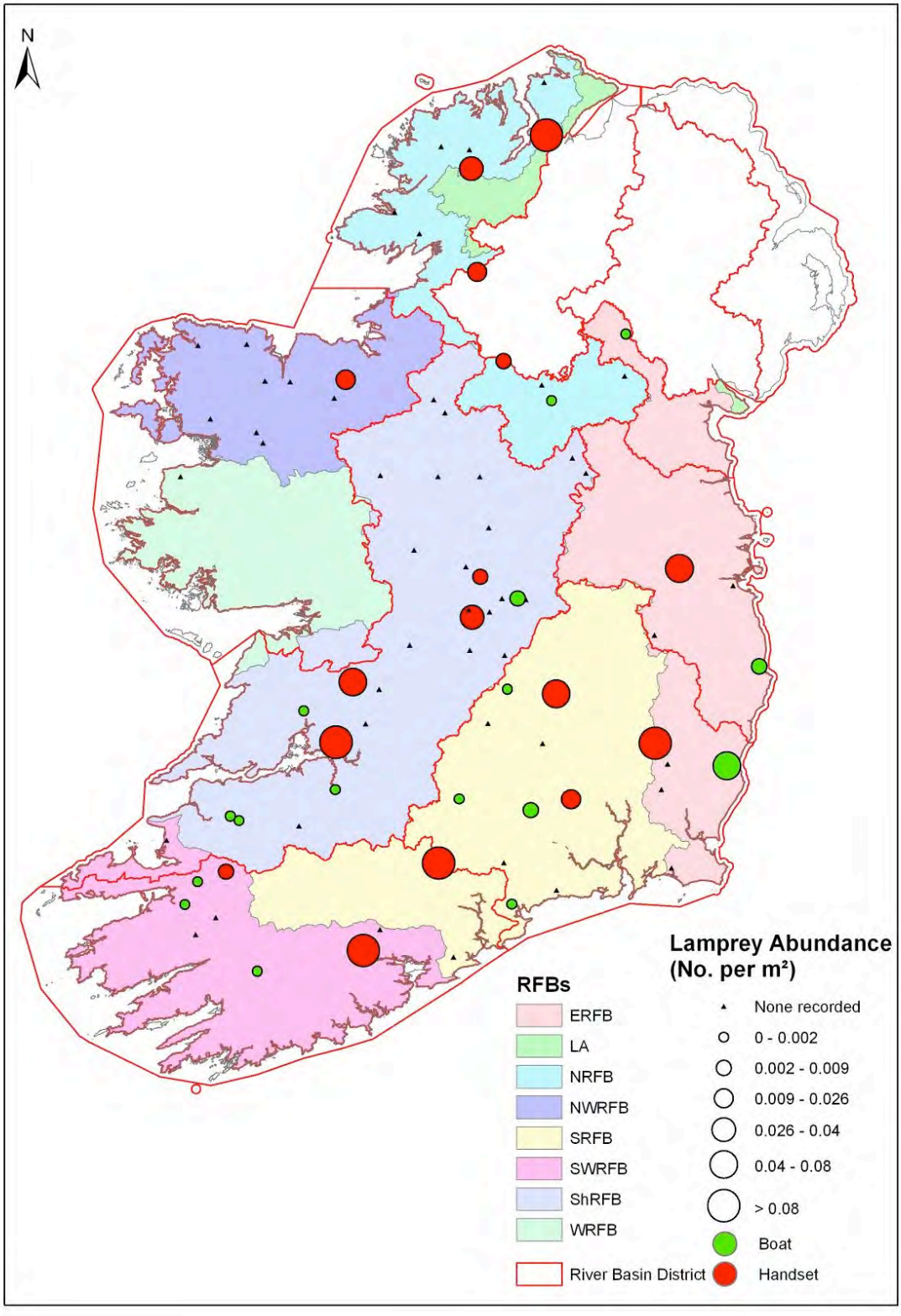


Fig. 4.51: Distribution and abundance of juvenile lamprey at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

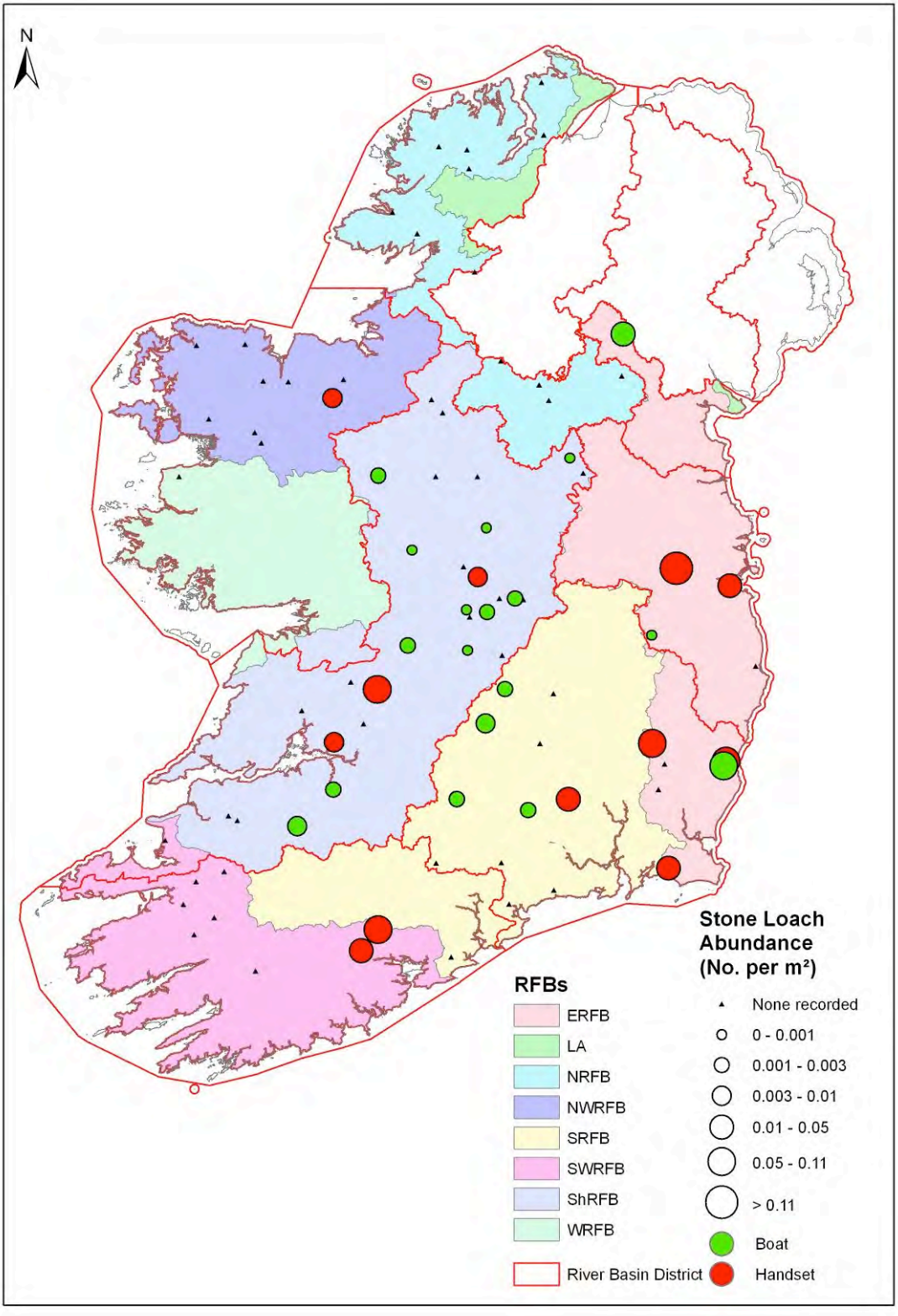


Fig. 4.52: Distribution and abundance of stoneloach at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

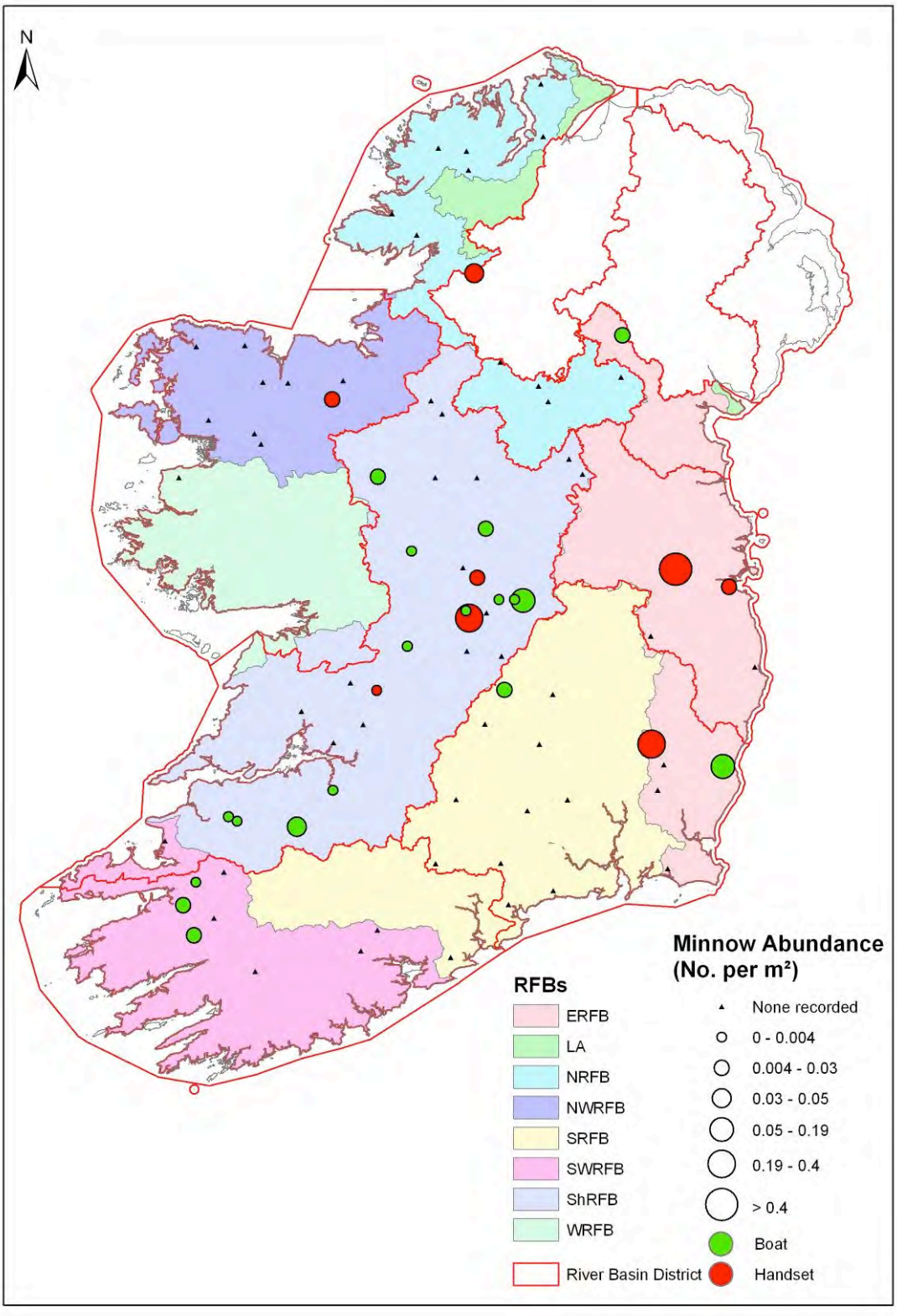


Fig. 4.53: Distribution and abundance of minnow at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

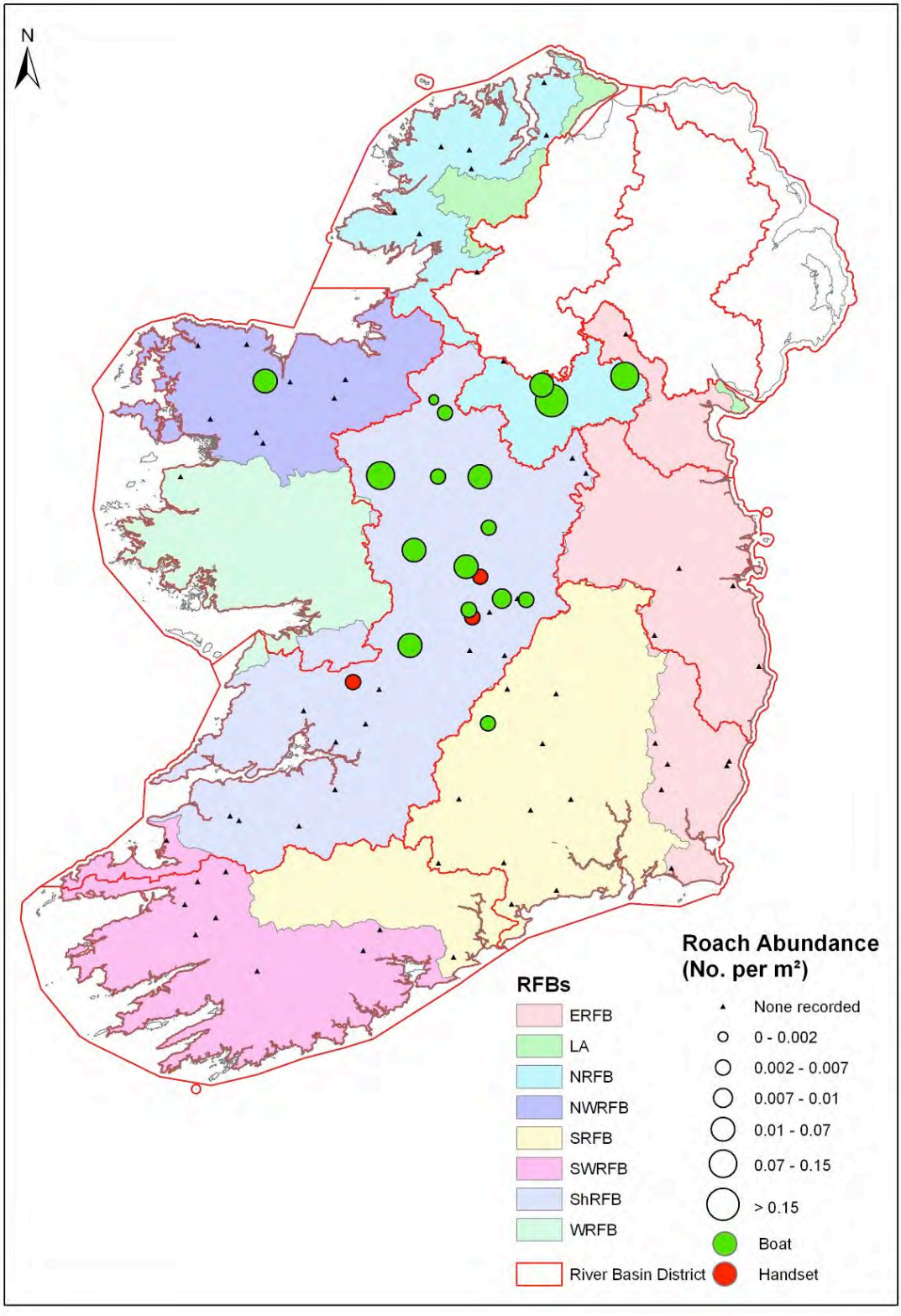


Fig. 4.54: Distribution and abundance of roach at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

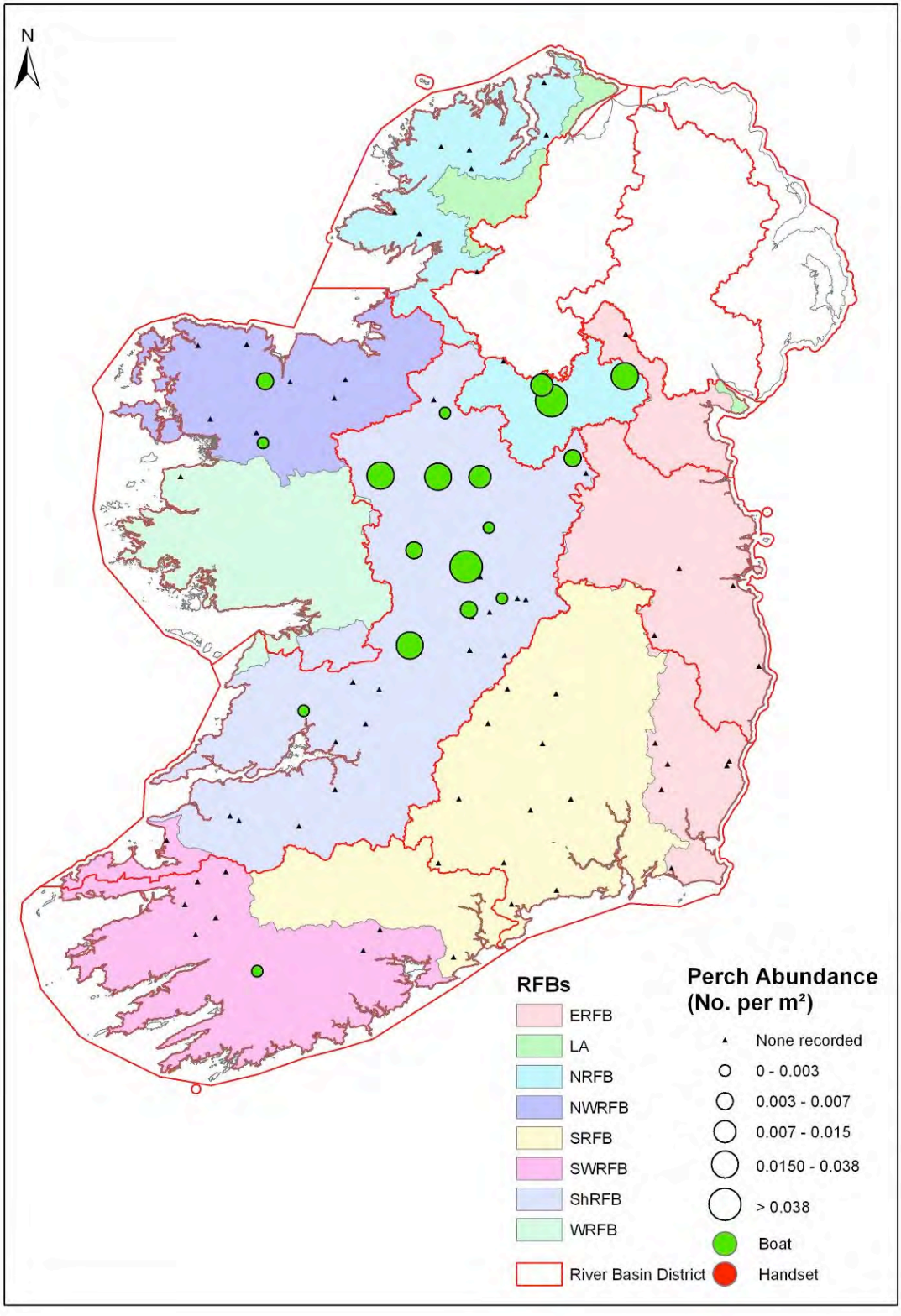


Fig. 4.55: Distribution and abundance of perch at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

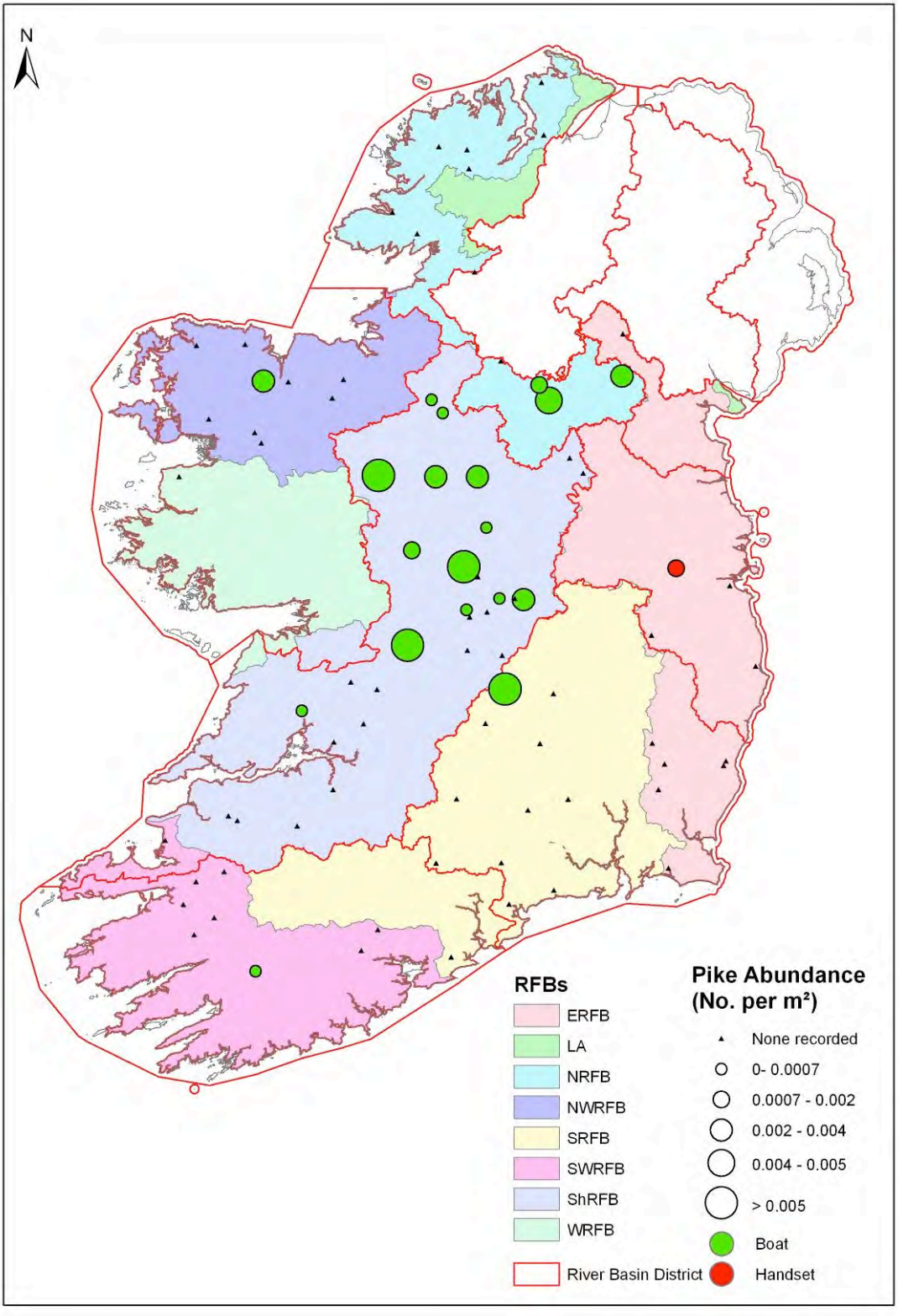


Fig. 4.56: Distribution and abundance of pike at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

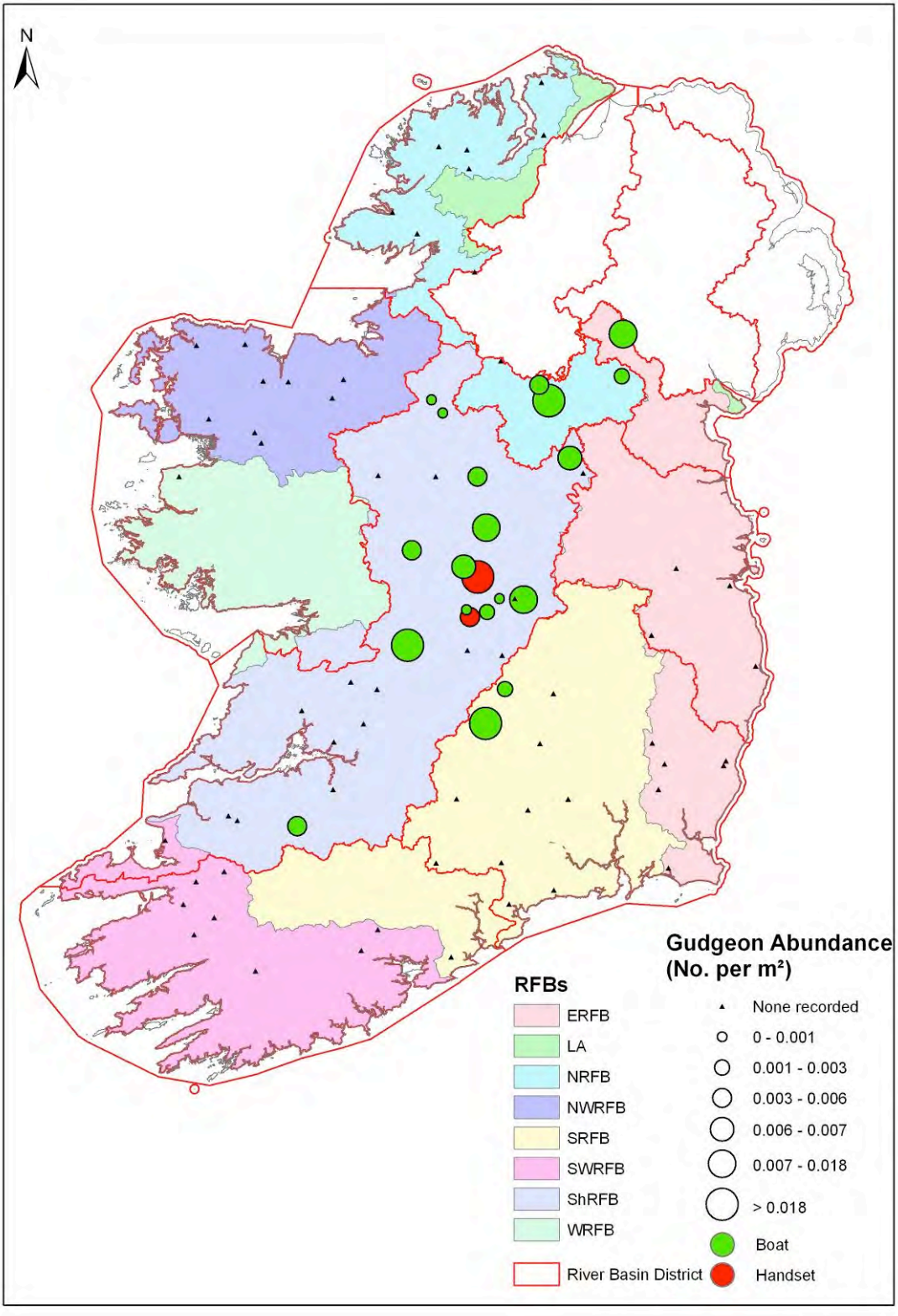


Fig. 4.57: Distribution and abundance of gudgeon at river sites surveyed for WFD monitoring 2008 (different dot sizes represent different abundance levels)

4.2.2 Fish growth in rivers

Scales from 2,593 trout (78 river sites), 1,202 salmon (57 river sites), 79 sea trout (12 river sites), 646 roach (18 river sites), 162 pike (19 river sites), 12 bream (3 river sites), 2 roach x bream hybrids (2 river sites) and 1 chub (1 river site), and opercular bones from 348 perch (14 river sites) were examined for age and growth analysis during the project. Ages were determined from a range of lengths for each fish species, from each river site, comprising a range of age groups (from 0+ to 9+, with the maximum age depending on species). Length at age analyses and growth curves are presented for brown trout, the most widespread species found among sites surveyed during 2008 (Fig. 4.58).

Brown trout ages ranged from 0+ to 6+, the most common ages were 0+ and 1+; however, the older age groups (4+ to 6+) were rare. Single specimens of 5+ and 6+ brown trout were recorded at the Fergus and Mountnugent (ShRFB) boat sites respectively. As expected larger brown trout were usually found at the wider deeper boat sites, while the smaller age classes were more numerous in the shallower hand-set sites. The largest brown trout recorded during the survey was a 3+ fish which was captured in the Mountnugent River in the Inny catchment (ShRFB) and measured 59.9cm in length and weighed 2.08kg. Appendix 6 provides a summary of the mean back-calculated growth of brown trout in 78 rivers.

Salmon fry (0+) and parr (1+ and 2+) were the most common age groups recorded during the surveys. Forty six (one hand set site and five boat sites) adult salmon were recorded during the survey. The largest individual salmon recorded during the survey was recorded in the Maigue River (length 75.2cm and weight 5.05kg). Appendix 7 provides a summary of the mean back-calculated growth of salmon in 56 rivers.

Roach ranged in age from 0+ to 9+. The oldest roach recorded was a single 9+ fish captured in the Annalee River in Co. Cavan. Only a few rivers recorded individuals older than 6+. Perch older than 5+ were only found in two rivers and those older than 4+ were rare. The oldest perch was aged 8+ and was recorded in the River Suck at Ballyforan. The largest pike recorded was caught in the Brosna River (Pollagh), measured 90cm and weighed 6.43kg. This was one of only three pike aged 6+ caught in the whole survey. The others were caught in the River Suck (Ballyforan) and River Erne. No Pike older than this were recorded. Appendix 8 provides a summary of the mean back-calculated growth of roach in 16 rivers.

4.2.2.1 Growth of trout in rivers

Mean back calculated growth curves for trout in the rivers surveyed during 2008 are shown in Figure 4.58. The brown trout population of each river was assigned to growth categories described by Kennedy and Fitzmaurice (1971), who examined the relationship between alkalinity and growth of trout in Irish streams and rivers. For each river, the mean length of trout at L2, L3 and L4 (L2 = back calculated length at the end of the second winter, etc.) were compared to the back-calculated mean

lengths described by Kennedy and Fitzmaurice (1971), as shown in Table 4.7 and Appendix 6. In addition, alkalinity was also considered for rivers for which data were available.

This general description was applied to the trout captured in each river during this project. Trout were classified as being "very slow" growing at 17 sites, "slow" growing at 26 sites, "fast" growing at 24 sites and "very fast" growing at 5 sites (Table 4.8). Trout from the Banoge, the Broadford, the Camlin, the Castlebar, the Deel (Crossmolina), and the Tobercurry were not assigned growth categories because not enough age classes or too few brown trout were captured in these rivers.

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

Growth category	Mean lengths (cm)			Alkalinity (mEq l^{-1}) (Range observed in the current report)
	L2	L3	L4	
Very slow	12	15–16	17–18	0.2–0.4 (0.2–0.4)
Slow	13–14	18–19	20–21	0.5–2.0 (0.8–1.3)
Fast	18–20	24–25	29–30	0.5–2.8 (1.5–2.8)
Very fast	20	30	35–40	>3.0 (>3.0)

Table 4.8: Categories of growth of trout in the WFD river sites 2008

Very slow	Slow	Fast	Very fast
Clody	Dodder	Blackwater (Monaghan)	Maigue
Urrin	Douglas	Liffey (Kilcullen Br)	Mountnugent
Nuenna	Duncormick	Owenavorragh	Suck (Cloondacarra Br)
Womanagh	Vartry	Rye Water	Kilcrow
Bow	Colligan	Anner	Dromore
Glenfelly Stream	Duag	Ballyroan	
Graney	Glory	Multeen	
Inny (Oldcastle)	Mahon	Nore (Quakers' Br)	
Ballinglen	Nier	Suir (Knocknageeragh Br)	
Glenamoy	Glashaboy	Flesk	
Glennamong	Lee (Inchinossig Br)	Gweestin	
Ballyhallan	Martin	Maine	
Burnfoot	Boor	Owenreagh	
Cronaniv Burn	Gourna	Shanowen	
Glaskeelan	Inny (Shrule Br)	Brosna (Clonony Br)	
Swilly	Little	Clodiagh	
Waterfoot	Silver	Cross	
	Tullamore	Deel (Newcastlewest)	
	Bunowen	Feale	
	Behy	Fergus (Clonroad Br)	
	Clydagh	Little Brosna	
	Annalee	Shannon (Battle Br)	
	Eany Water	Smearlagh	
	Erne (Belturbet)	Suck (Ballyforan Br)	
	Owentocker		
	Swanlinbar		

Rivers for which water chemistry data were available were assigned to three categories defined in the Irish rivers typology: low alkalinity rivers (<35 mg $CaCO_3$ l^{-1}), moderate alkalinity rivers (35–100 mg $CaCO_3$ l^{-1}) and high alkalinity rivers (>100 mg $CaCO_3$ l^{-1}). One-way ANOVA ($p<0.001$) and post hoc least-significant-difference tests ($p<0.001$) of rivers for which alkalinity data where available showed that the mean back-calculated lengths at the end of the first winter (L1) and the second winter (L2) for trout were significantly higher in high alkalinity rivers compared with moderate and low alkalinity rivers; however, the difference in back-calculated L1 and L2 lengths between low and moderate alkalinity rivers was not significant.

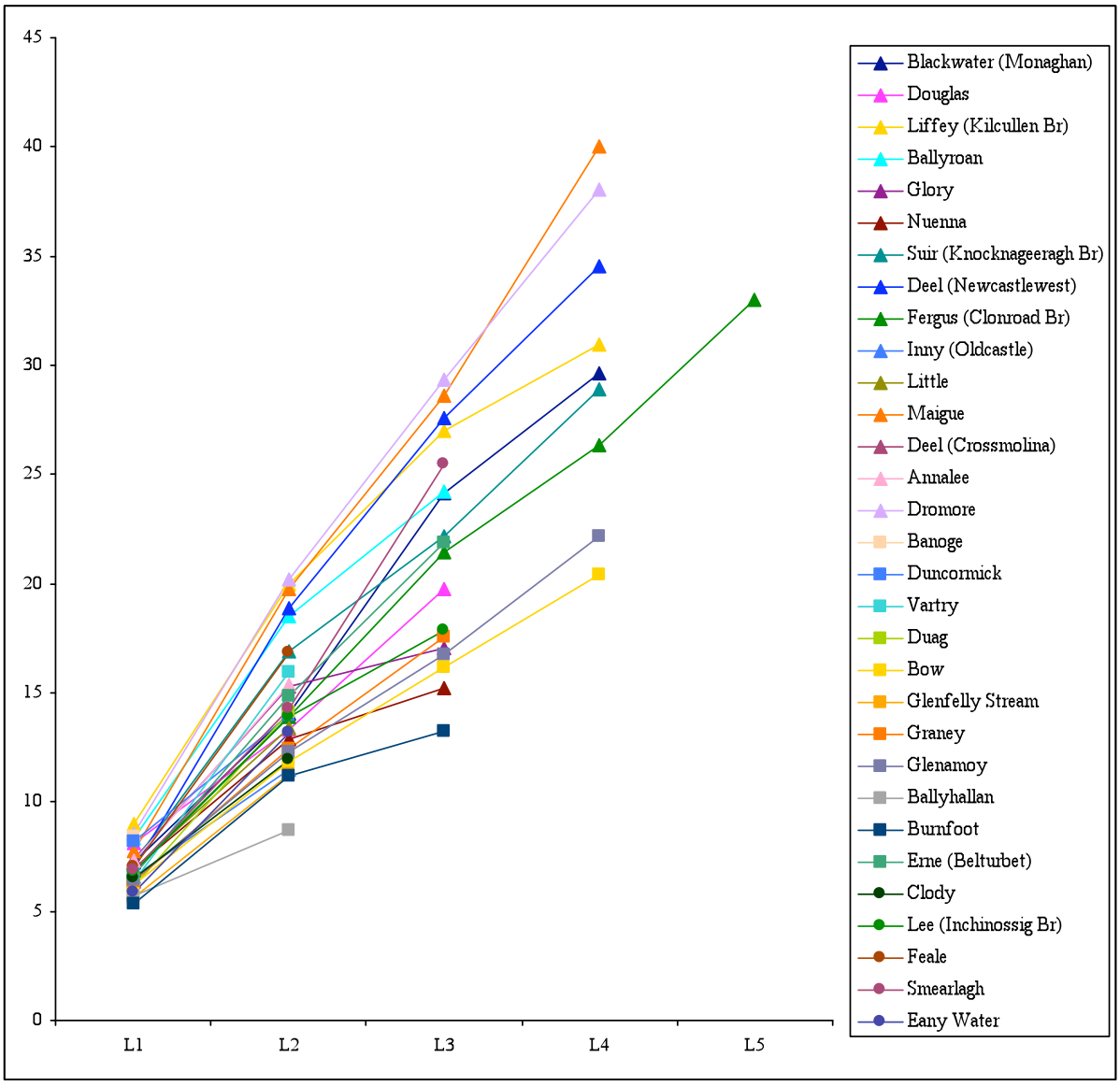


Fig. 4.58: Mean growth rates of trout captured in rivers for which alkalinity was measured as part of WFD surveillance monitoring during 2008 (note the round markers indicate low alkalinity rivers, the square markers indicate moderate alkalinity rivers and the triangular markers indicate high alkalinity rivers)

4.3 Transitional waters

4.3.1 Fish species composition and richness

WFD requires that information be collected on the composition and abundance of fish species in Transitional Waters. Estuaries have also been exploited by fish over a long evolutionary period. Many fish species avail of the highly productive nature of estuaries for all or part of their life cycle. Some fish species are migratory, travelling through estuaries from the sea to reach spawning grounds in freshwater, such as salmon and lamprey, while others, such as eels, migrate down through estuaries as adults to spawn at sea.

Overall, a total of 61 fish species (sea trout are included as a separate "variety" of trout) were recorded from a total of 42 transitional waterbodies surveyed during 2008 (Table 4.9). The list of fish species for each individual estuary can be found in the detailed reports (see the dedicated website www.wfdfish.ie). The percentage of transitional waterbodies in which each fish species occurred is shown in Figure 4.59. The list comprised of a number of types of fish species (euryhaline, diadromous, estuarine, marine and freshwater).

The three most frequently encountered species recorded during the 2008 surveys were flounder (90%) followed by common goby (76%) and eel (76%). The percentage of transitional waterbodies in which the 24 most common fish species occurred is shown in Figure 4.59. Flounder were the most common fish species, occurring in 90% of transitional waterbodies surveyed, followed by common goby (76%), eel (76%), 5-bearded rockling (57%), thick-lipped grey mullet (55%), 3-spined stickleback (55%), sprat (55%), plaice (50%), pollack (45%), sand goby (40%), long-spined sea scorpion (36%), sand smelt, (36%), 15-spined stickleback (33%), 2-spotted goby (31%), greater pipefish (31%) and whiting (31%) (Table 4.9 and Fig. 4.59). Twenty five fish species were present in 10 to 30% of the waterbodies and the remaining twenty species were recorded in less than 10% of the waterbodies (Table 4.9 and Fig. 4.59).

Table 4.9: Species presence in transitional water bodies sampled between September and November 2008

	Scientific names	Common names	Number of transitional waterbodies	% transitional waterbodies
1	*Platichthys flesus*	Flounder	38	90
2	*Pomatoschistus microps*	Common Goby	32	76
3	*Anguilla anguilla*	Eel	32	76
4	*Ciliata mustela*	5-Bearded Rockling	24	57
5	*Chelon labrosus*	Thick-Lipped Grey Mullet	23	55
6	*Gasterosteus aculeatus*	3-Spined Stickleback	23	55
7	*Sprattus sprattus*	Sprat	23	55
8	*Pleuronectes platessa*	Plaice	21	50
9	*Pollachius pollachius*	Pollack	19	45
10	*Pomatoschistus minutus*	Sand Goby	17	40
11	*Taurulus bubalis*	Long Spined Sea Scorpion	15	36

Table 4.9 contd.: Species presence in transitional water bodies sampled between September and November 2008

	Scientific names	Common names	Number of transitional waterbodies	% transitional waterbodies
12	*Atherina presbyter*	Sand Smelt	15	36
13	*Spinachia spinachia*	15-Spined Stickleback	14	33
14	*Gobiusculus flavescens*	2-Spotted Goby	13	31
15	*Syngnathus acus*	Greater Pipefish	13	31
16	*Merlangius merlangus*	Whiting	13	31
17	*Ammodytes tobianus*	Lesser Sandeel	12	29
18	*Salmo trutta*	Brown Trout	12	29
19	*Salmo salar*	Atlantic Salmon*	10	24
20	*Dicentrarchus labrax*	Bass	10	24
21	*Symphodus melops*	Corkwing Wrasse	10	24
22	*Salmo trutta*	Sea Trout***	9	21
23	*Gobius niger*	Black Goby	9	21
24	*Gadus morhua*	Cod	9	21
25	*Labrus bergylta*	Ballan Wrasse	8	19
26	*Conger conger*	Conger Eel	7	17
27	*Entelurus aequoreus*	Snake Pipefish	7	17
28	*Perca fluviatilis*	Perch	6	14
29	*Trisopterus minutus*	Poor Cod	6	14
30	*Agonus cataphractus*	Pogge	6	14
31	*Limanda limanda*	Dab	6	14
32	*Scyliorhinus canicula*	Lesser Spotted Dogfish	6	14
33	*Pholis gunnellus*	Gunnel	6	14
34	*Liza aurata*	Golden-Grey Mullet	5	12
35	*Myoxocephalus scorpius*	Short-Spined Sea Scorpion	5	12
36	*Hyperoplus lanceolatus*	Greater Sandeel	4	10
37	*Pollachius virens*	Coalfish	4	10
38	*Syngnathus typhle*	Deep Snouted Pipefish	4	10
39	*Rutilus rutilus*	Roach	4	10
40	*Callionymus lyra*	Dragonet	4	10
41	*Osmerus eperlanus*	Smelt*	4	10
42	*Gaidropsarus vulgaris*	3-Bearded Rockling	3	7
43	*Leuciscus leuciscus*	Dace**	3	7
44	*Phoxinus phoxinus*	Minnow	3	7
45	*Syngnathus rostellatus*	Nillson's Pipefish	3	7
46	*Esox lucius*	Pike	2	5
47	*Scyliorhinus stellaris*	Bull-Huss	2	5
48	*Lampetra fluviatilis*	River Lamprey*	2	5
49	*Scophthalmus rhombus*	Brill	2	5
50	*Solea solea*	Common Sole	2	5
51	*Cyclopterus lumpus*	Lumpsucker	1	2
52	*Lipophrys pholis*	Blenny	1	2
53	*Microstomus kitt*	Lemon Sole	1	2
54	*Sparus aurata*	Gilt-Head Bream	1	2
55	*Ctenolabrus rupestris*	Goldsinny	1	2
56	*Echiichthys vipera*	Lesser Weever	1	2
57	*Gobio gobio*	Gudgeon	1	2
58	*Liparis liparis*	Sea Snail	1	2
59	*Labrus bimaculatus*	Cuckoo Wrasse	1	2
60	*Psetta maximus*	Turbot	1	2
61	*Trisopterus luscus*	Pouting	1	2

Note: * indicates Red Data Book species, ** indicates invasive species and ***sea trout are included as a separate "variety" of trout

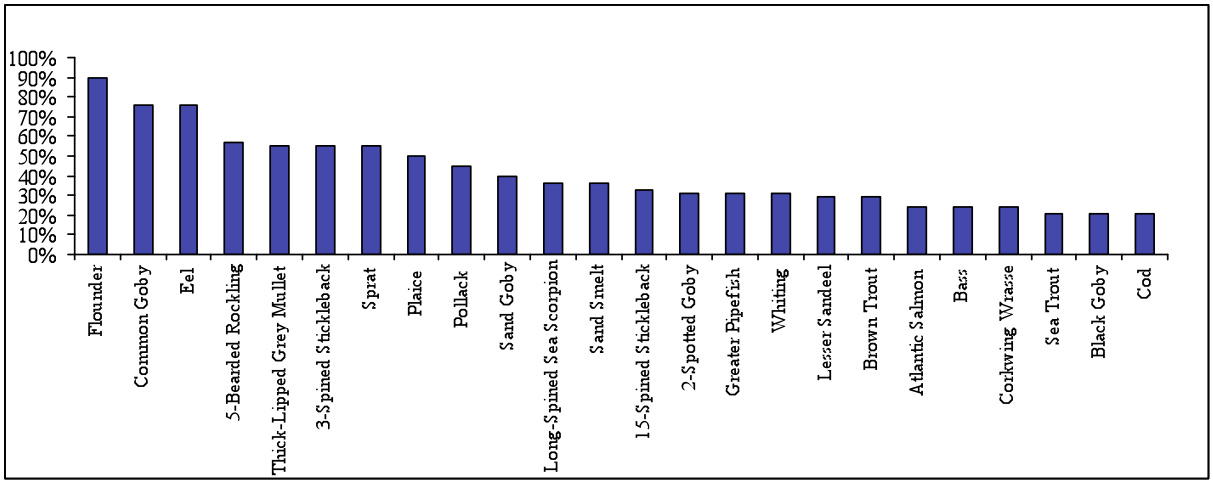


Fig. 4.59: Fish species present at transitional waters (% of transitional waters) surveyed for WFD fish monitoring, September to October 2008

Species richness ranged from one species on Bridge Lough lagoon to a maximum of 31 species on the Lower Shannon Estuary (Fig. 4.60). Six estuaries recorded 20 or more fish species (Ilen - 24, Lower Blackwater - 24, Westport Bay - 24, Sruwaddacon - 23 and North Channel Great Island - 20 species), whereas 13 estuaries recorded less than ten species (i.e. Limerick Docks, Upper Feale, Harper's Island, Lower Lee, Owenacurra, Upper Liffey, Loch an tSáile, Loch Tanaí, Glashaboy, Lee (Tralee), Kilmakilloge Harbour, Upper (Cork) Lee and Bridge Lough (Fig. 4.60).

Plate 4.1: An Cosantóir Bradán and WFD staff from the CFB and the ShRFB

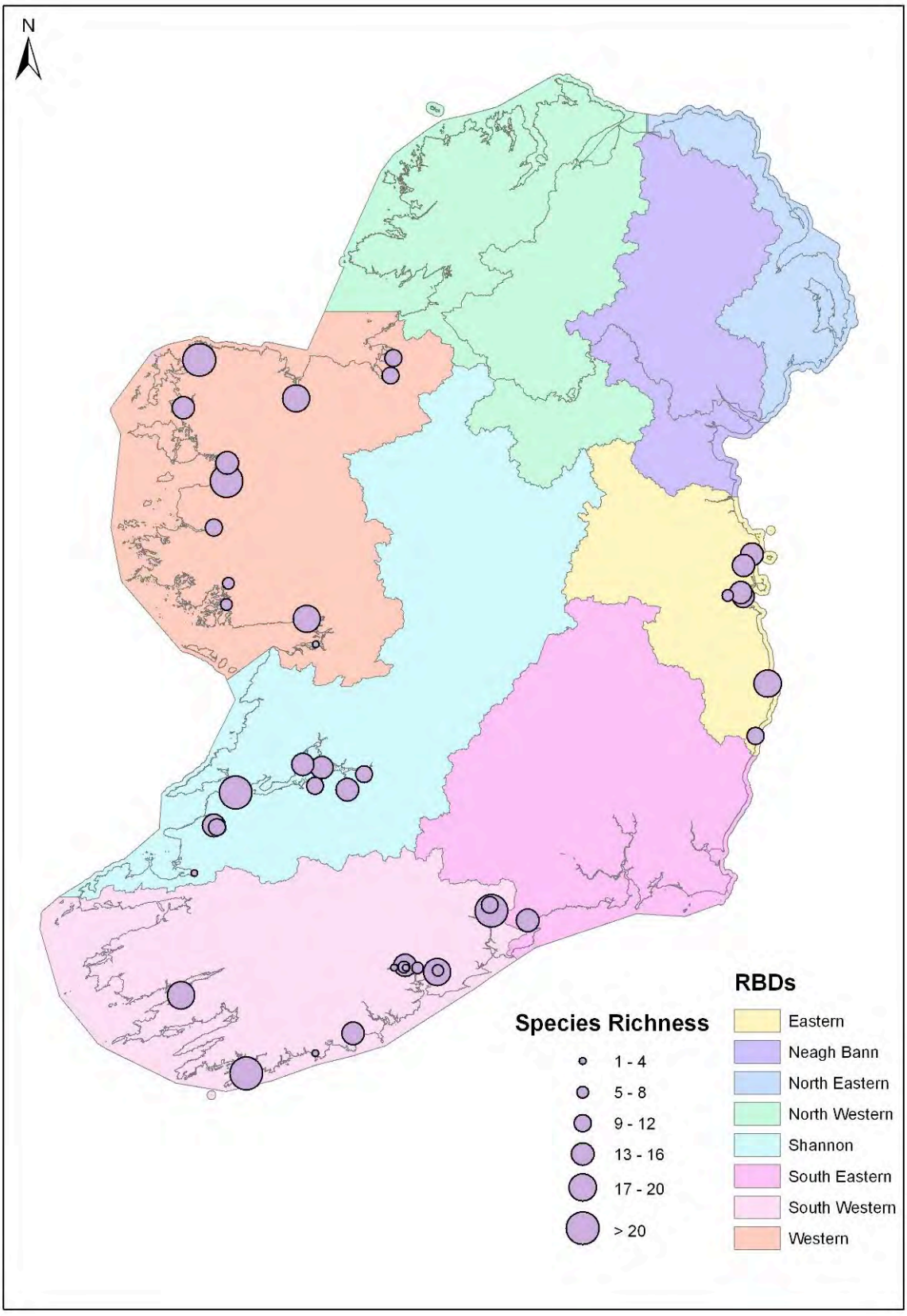


Fig. 4.60: Species richness at 42 transitional waterbodies, September to November 2008

4.3.2 Fish species distribution

A large number of juvenile and immature fish of a range of species were taken within the various waters surveyed indicating the important nursery function of many of the waterbodies. Five species of angling importance were recorded during the surveys, i.e. flounder (38 waterbodies), pollack (19 waterbodies), mullet (thick-lipped mullet (Plate 4.3) at 23 waterbodies and golden-grey mullet at five waterbodies) and bass (10 waterbodies, Plate 4.2) in sizeable numbers at particular sites (Fig. 4.61 to 4.64).

Plate 4.2: Bass (captured in the Lower Shannon Estuary; measuring 64.5cm in length and 3.67kg in weight)

Plate 4.3: Thick-lipped grey mullet (captured in the Avoca Estuary; measuring 54.0cm in length)

Plate 4.4: Golden grey mullet (captured in the Lower Blackwater Estuary; 41.5cm in length)

In addition to the required fish metrics (fish species composition and abundance); WFD also requires status reports on indicator species. The diadromous or migratory fish species such as eel, salmon, sea trout, lamprey, smelt and shad are particularly significant in this latter category. Thirty five of the waterbodies surveyed during 2008 comprise part of the series of Special Areas of Conservation (SACs) designated nationally. The legal basis on which SACs are selected and designated is the EU Habitats Directive, transposed into Irish law in the European Union (Natural Habitats) Regulations, 1997 as amended in 1998 and 2005. The Directive lists certain habitats and species that must be protected within SACs. These habitats in the transitional waterbodies are the coastal lagoons (code 1150) and estuaries (code 1130). The protected species that can occur in transitional waterbodies are river lamprey, sea lamprey, Atlantic salmon and twaite shad. During the survey, eels were regularly taken in fyke nets (recorded in 32 waterbodies) (Fig. 4.65), while smelt, considered an indicator of good water quality, were regularly taken in beach seines (Fig. 4.66). Three species listed in the Irish Red Data Book (Whilde, 1993) and labelled as "species threatened in Ireland" (i.e. smelt and river lamprey) and "internationally important species (i.e. salmon) were recorded in four (Fergus, Lower Blackwater (Munster), Maigue and Upper Shannon estuaries), two (Avoca and Maigue) and ten estuaries (Avoca, Cashen, Lower and Upper Munster Blackwater, Lower Liffey, Tolka, Newport, Loch Tanaí, upper Blackwater, Shannon and Upper Feale) respectively (Figs. 4.66 to 4.68). Dace, an invasive species in Ireland was also recorded in three estuaries (Lower and Upper Munster Blackwater and Maigue) (Fig. 4.69).

A number of freshwater species (pike, roach, perch) were also recorded during the surveys in 2008, which is unusual, but were probably washed into the estuaries by the unseasonal floods during August and September 2008. Two unusual species were recorded during the surveys; one specimen of a juvenile gilt head bream was recorded in Broad Lough and one lumpsucker was recorded in North Channel Great Island waterbody.

Gilthead bream are common in the Mediterranean but are also found off the coast of northern France and the south coast of England. Preliminary observations suggest that gilt head bream are beginning to colonise the Irish coast line and have been recorded off the south coast of Ireland mainly by anglers. The presence of this species off the east coast of Ireland suggests that it is spreading quite rapidly. This is the furthest north they have been documented on the east coast of Ireland (Dr. Willie Roche, CFB, pers. comm.) (Plate 4.5).

One fish species rarely recorded in estuary surveys, lumpsucker (*Cyclopterus lumpus),* 3.3cm in length, was captured during the survey. Lumpsucker are common all around the coast of Ireland but have rarely been recorded during transitional water surveys. Adults of breeding age live on the sea bottom amongst rocks from shallow water to depths of at least 200m, whereas non-breeding adults can also live in deep open water. Juveniles of the species can be found in low tide rock pools (Dipper, 2001).

Plate 4.5: Gilthead bream

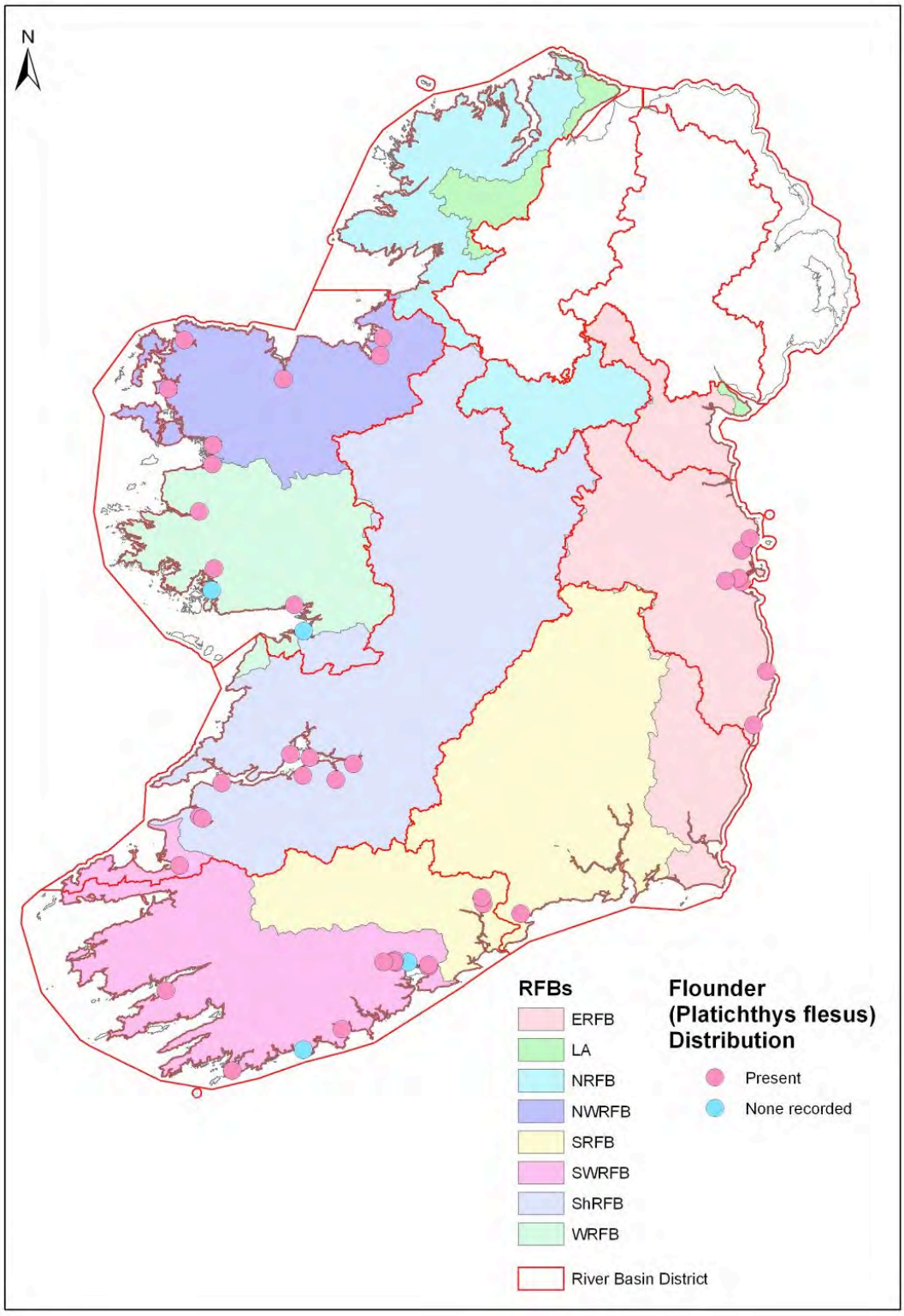


Fig. 4.61: Flounder distribution in transitional waters surveyed for WFD monitoring 2008

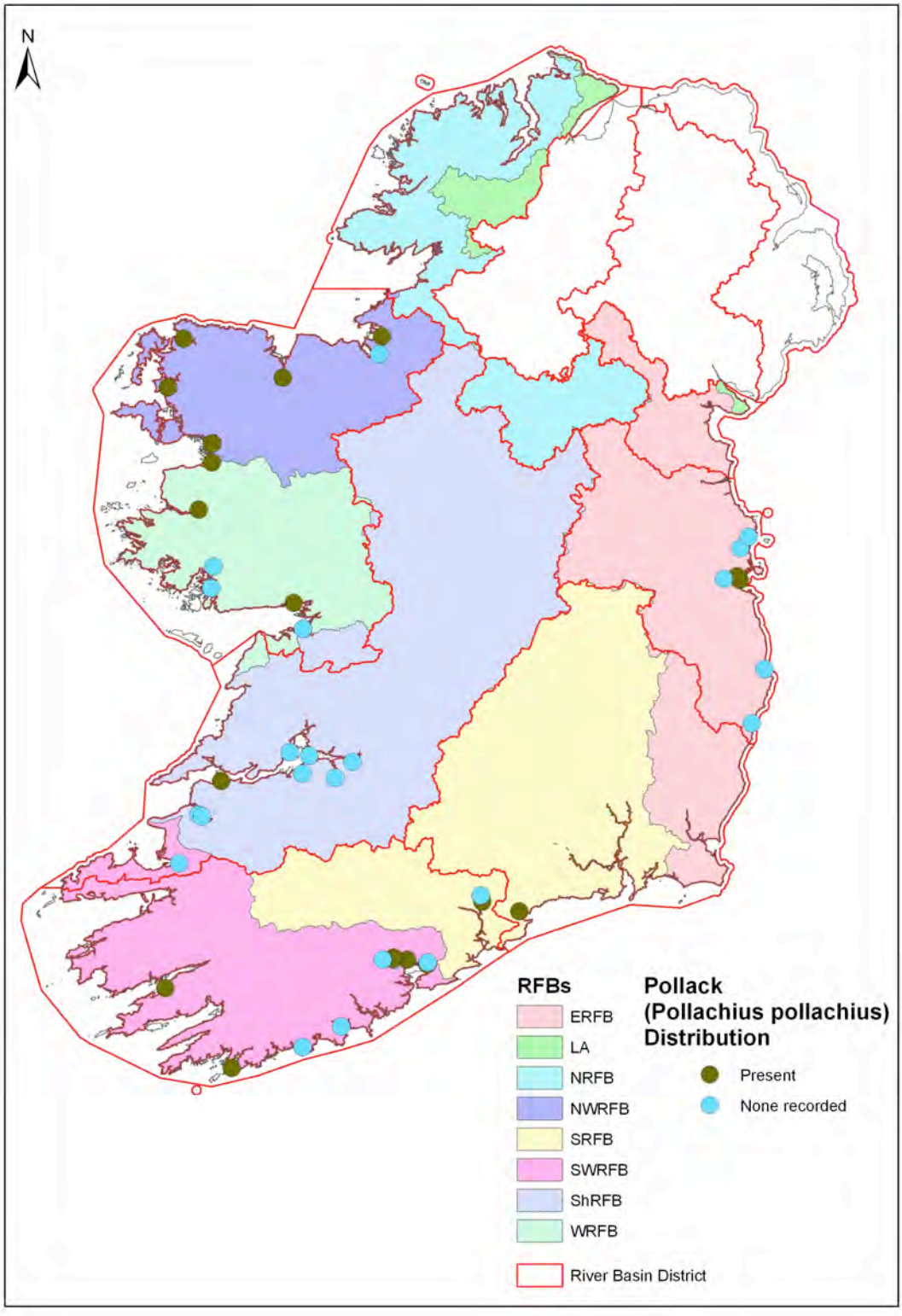


Fig. 4.62: Pollack distribution in transitional waters surveyed for WFD monitoring 2008

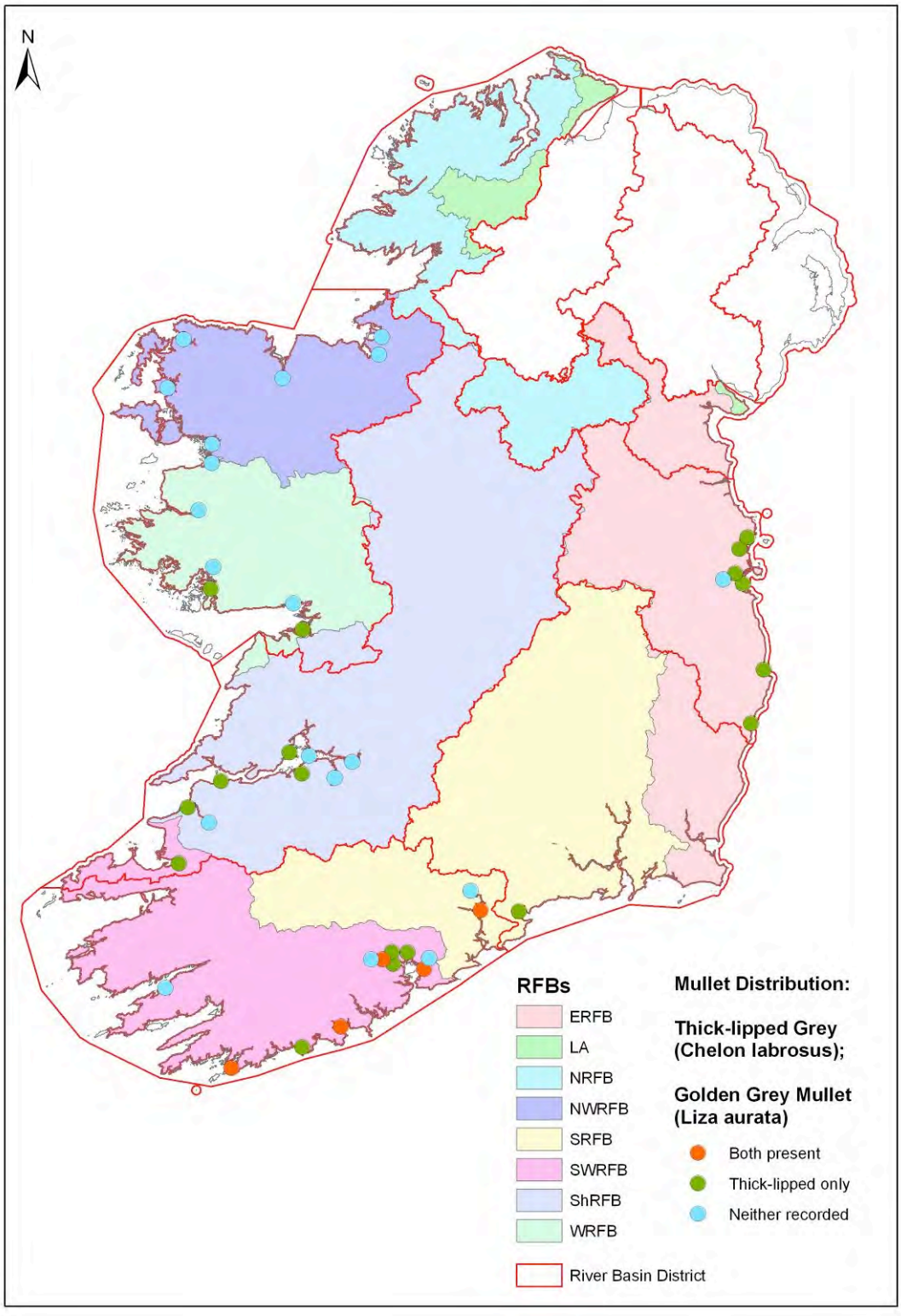


Fig. 4.63: Thick-lipped and golden-grey mullet distribution in transitional waters surveyed for WFD monitoring 2008

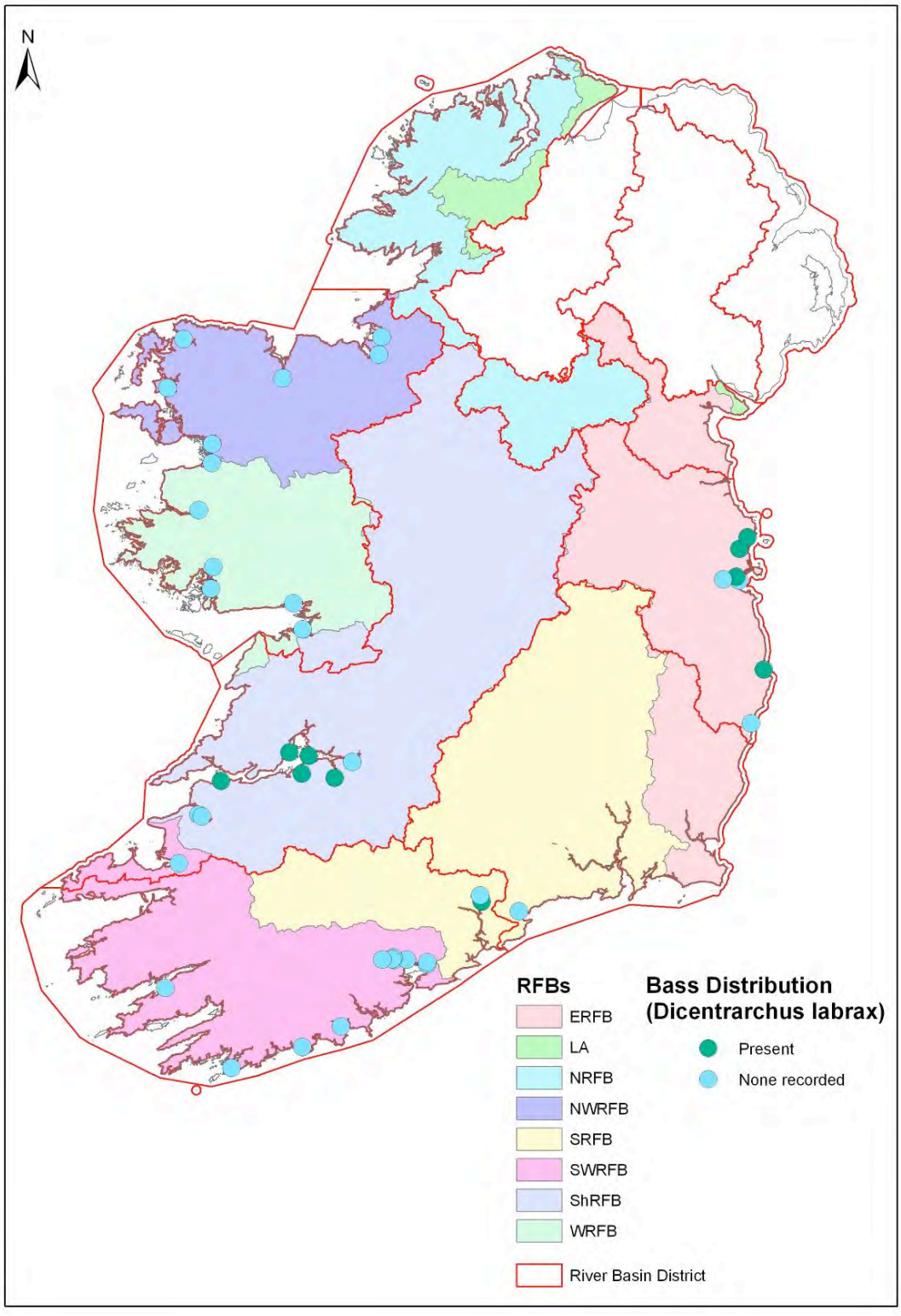


Fig. 4.64: Bass distribution in transitional waters surveyed for WFD monitoring 2008

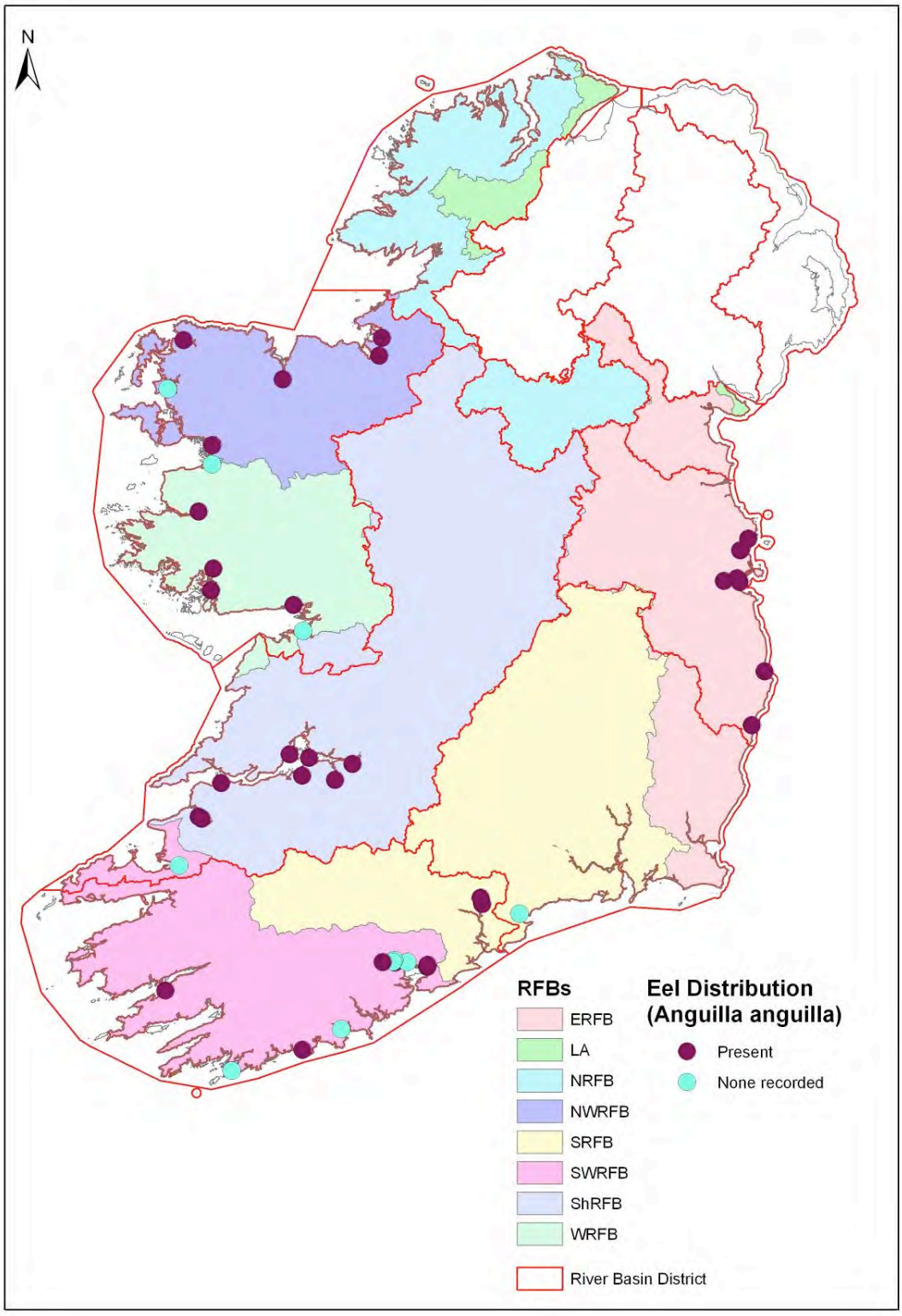


Fig. 4.65: Eel distribution in transitional waters surveyed for WFD monitoring 2008

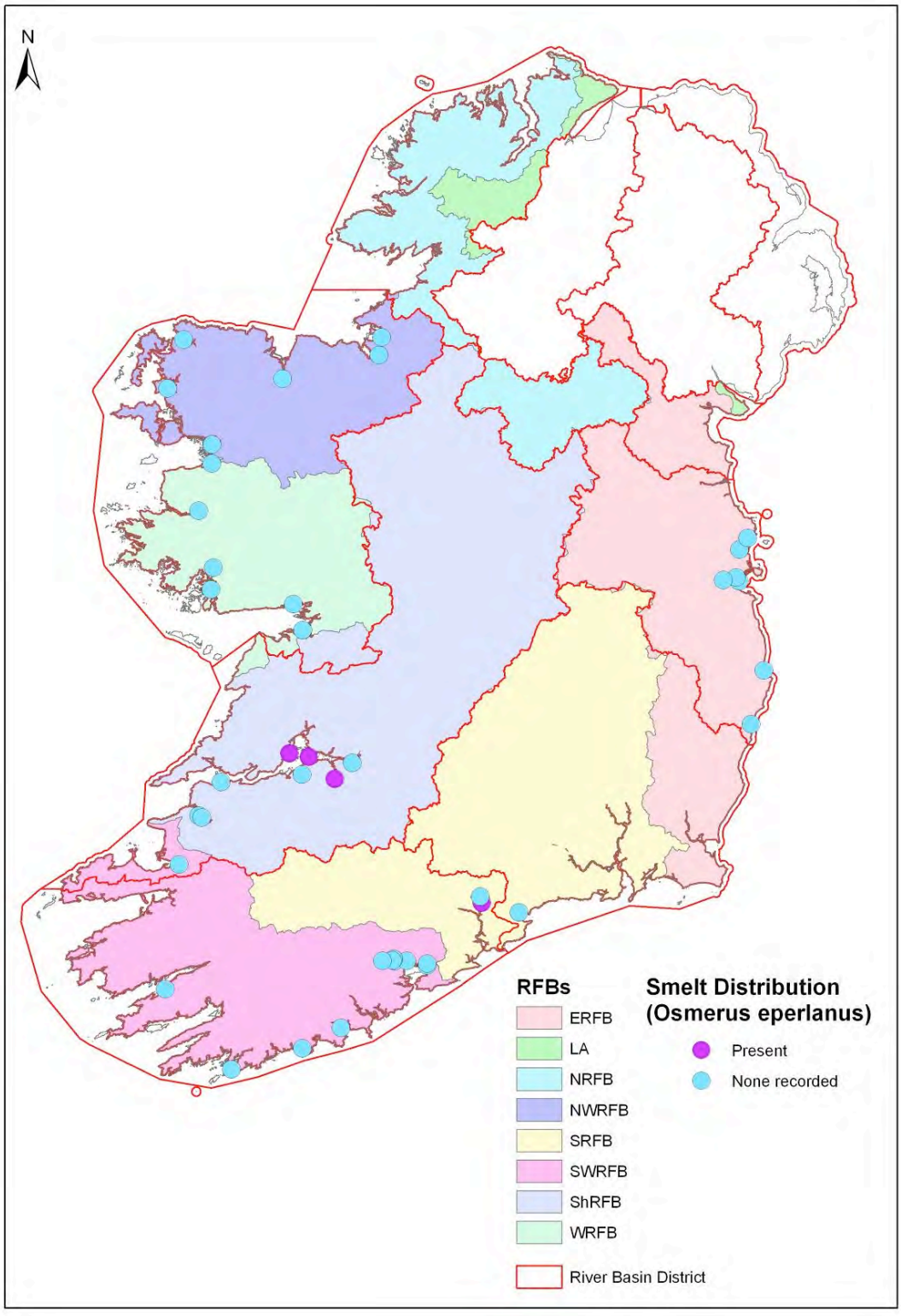


Fig. 4.66: Smelt distribution in transitional waters surveyed for WFD monitoring 2008

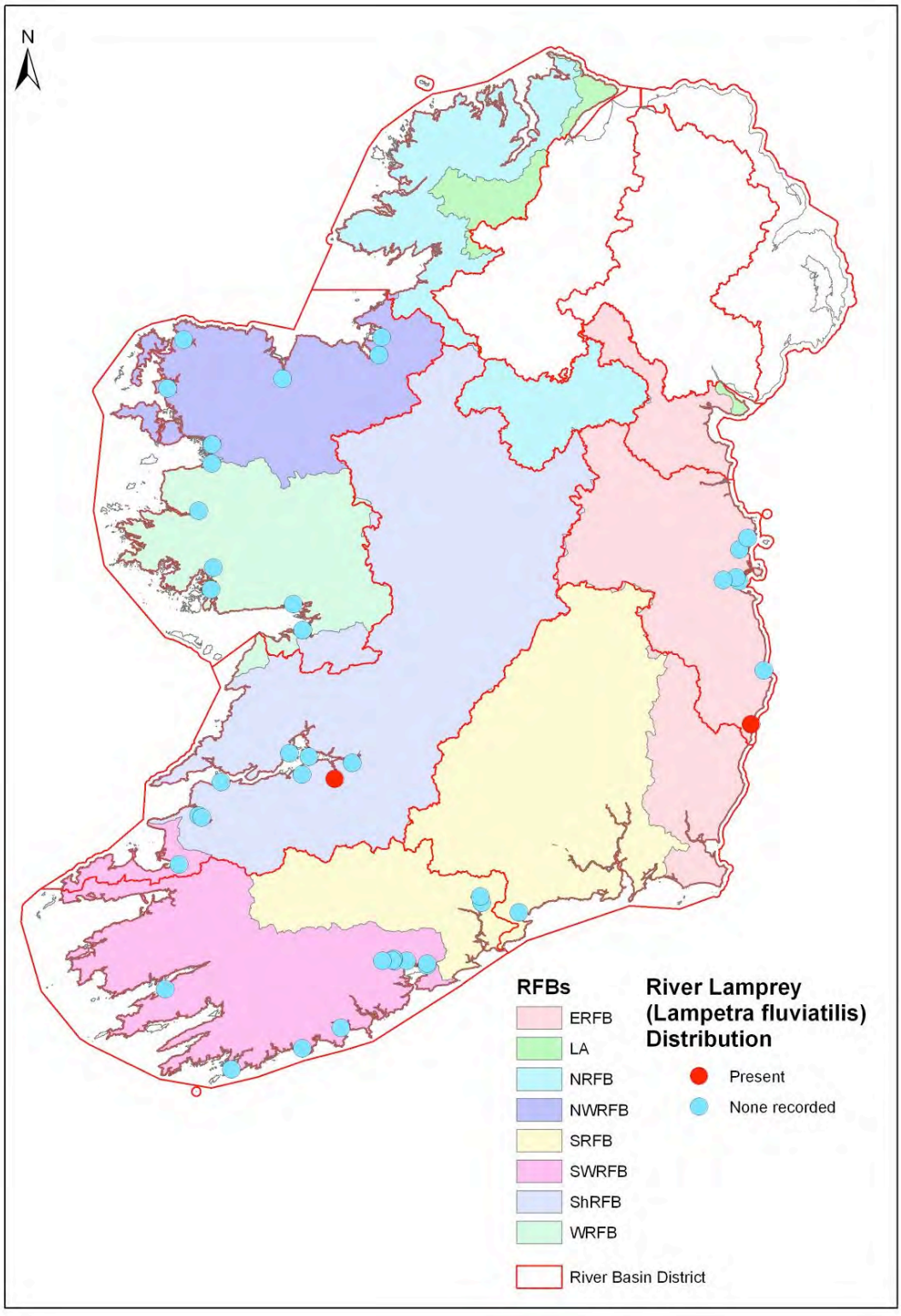


Fig. 4.67: River lamprey distribution in transitional waters surveyed for WFD monitoring 2008

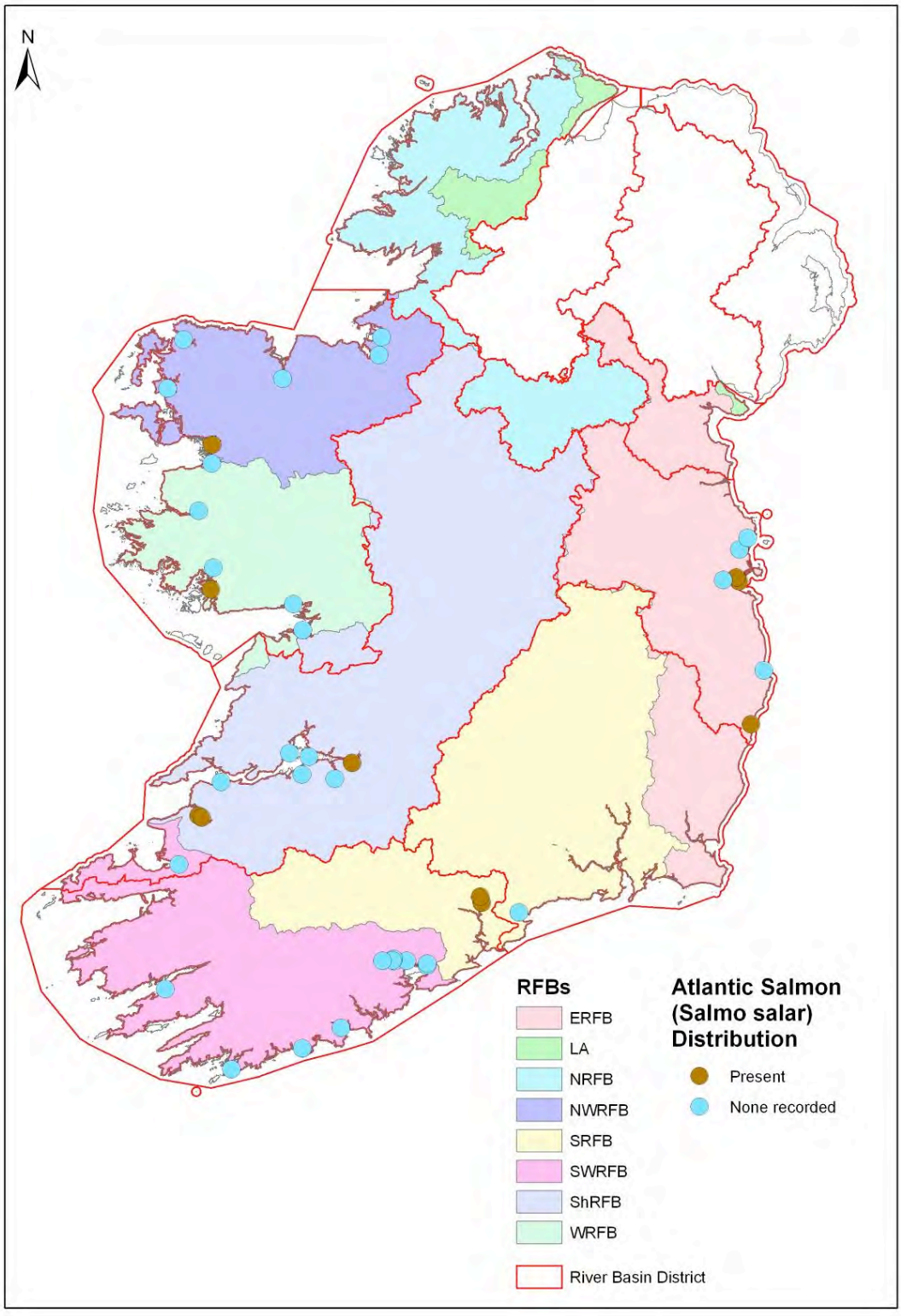


Fig. 4.68: Atlantic salmon distribution in transitional waters surveyed for WFD monitoring 2008

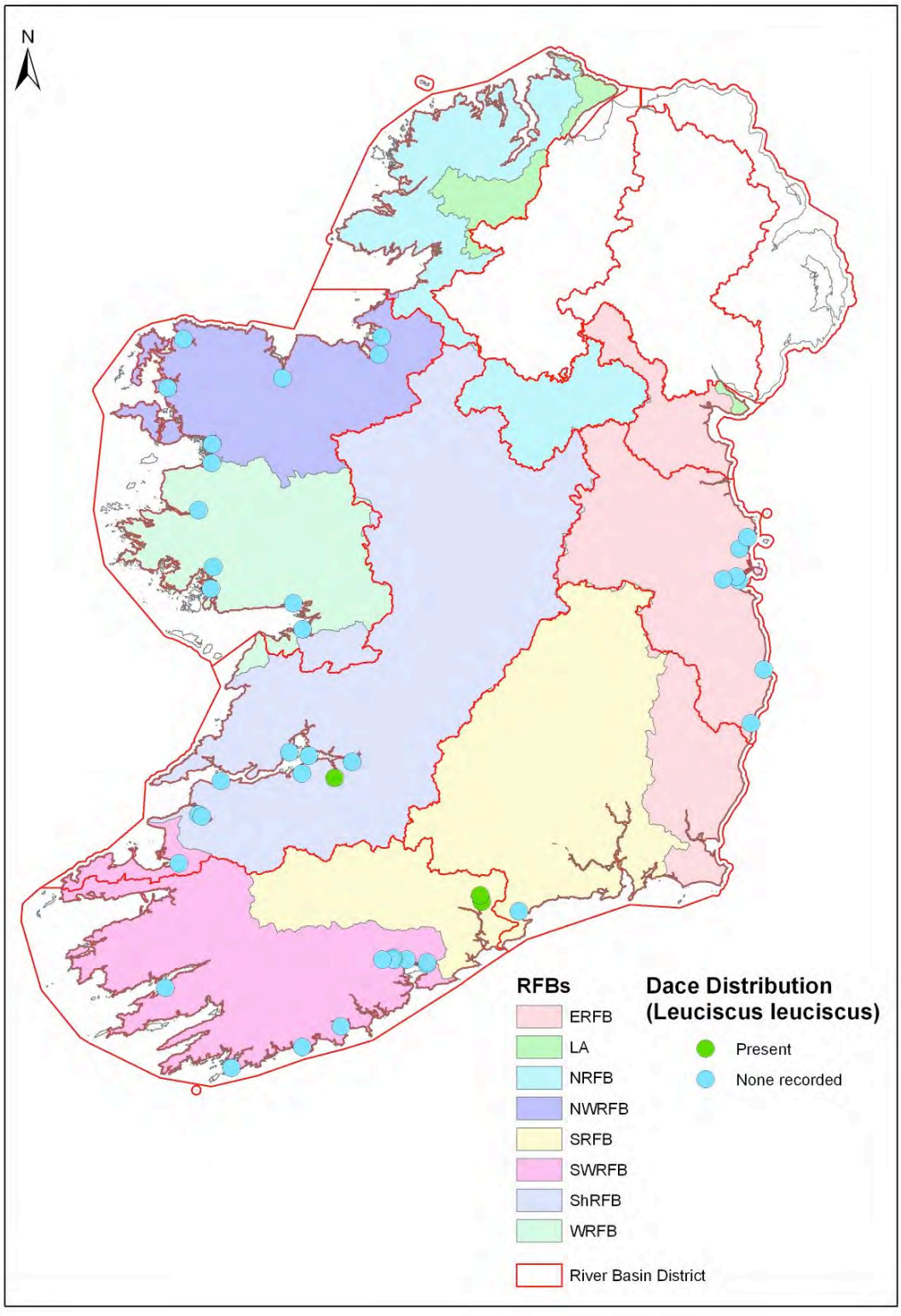


Fig. 4.69: Dace distribution in transitional waters surveyed for WFD monitoring 2008

4.3.3 Ecological status - Classification of transitional waters using the METRIC tool

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. The considerable amount of data compiled during the METRIC project (EPA 2008) and thereafter in the CFB national WFD monitoring programme (2007 and 2008) has been submitted to the Northern Ireland Environment Agency (NIEA). This material has been analysed to develop a draft classification tool "Transitional Fish Classification Index or TFCI" using the Index of Biotic Integrity (IBI) approach broadly based on that developed for South African waters and in the UK (Harrison and Whitfield, 2004; Coates *et al*., 2007).

In total, 42 transitional waterbodies were assigned to a draft ecological status class using the new METRIC classification tool; one waterbody was classified as "High", 19 were classified as "Good", 11 were classified as "Moderate", 10 were classified as "Poor" and one was classified as "Bad" ecological status (Figure 4.70).

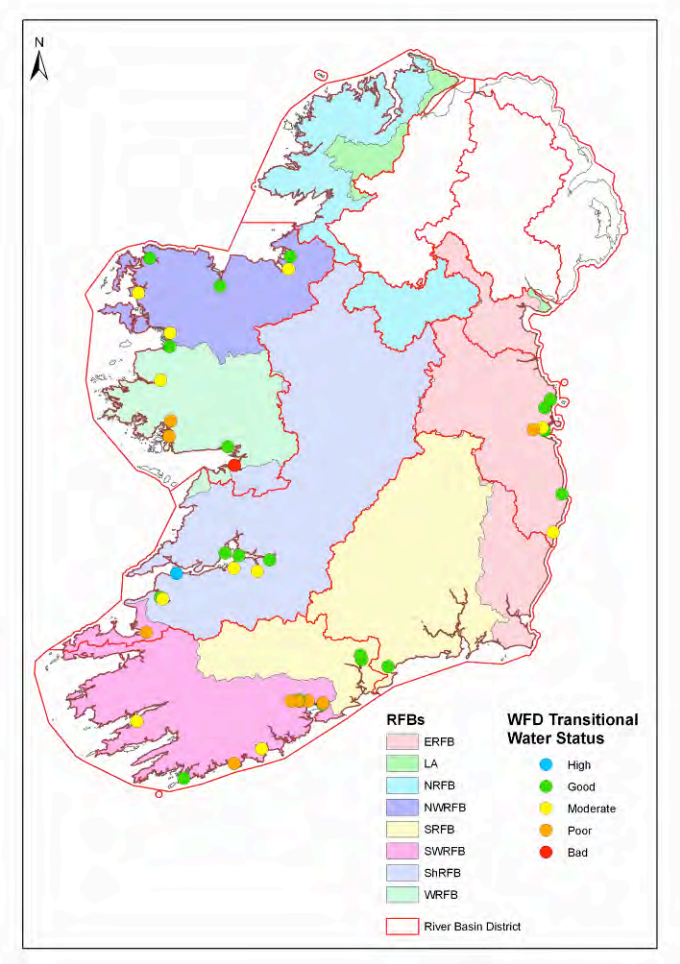
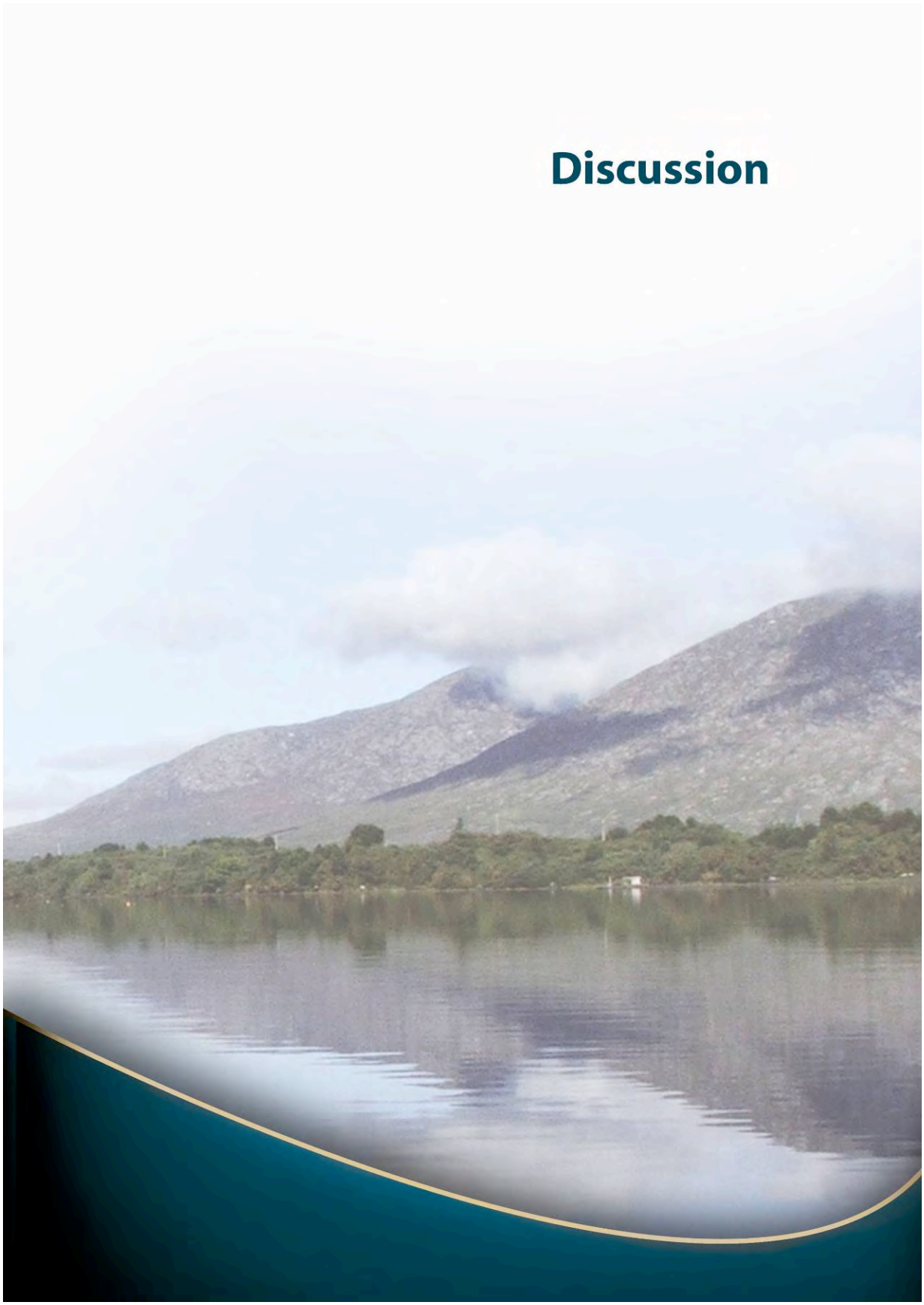


Fig. 4.70: Draft Ecological Classification of transitional water bodies using the Transitional Waters Fish Classification Tool

Discussion



5. DISCUSSION

5.1 Species richness

A total of seventeen and fifteen fish species (including sea trout) were recorded in lakes and rivers respectively during the WFD surveys in 2008. Fish species composition and richness data in lakes demonstrated that eels and brown trout followed by perch were the three most widely distributed fish species encountered during the 2008 surveillance monitoring programme. The maximum number of fish species recorded in any one lake was eleven (Inniscarra Reservoir). This was due to the presence of a number of salmonid and coarse fish species in the lake. Brown trout, salmon and eels were the most widely distributed fish species encountered in rivers during the 2008 surveillance monitoring programme. The highest number of fish species recorded in any one river was ten (the River Brosna, Clonony), again due to the presence of a mixture of salmonid and coarse fish species. In the transitional waters, flounder and sand goby followed by eels were the most widely distributed fish species. The maximum number of fish species recorded in any one waterbody was 31 (Lower Shannon Estuary).

Similar studies to the WFD programme have also recorded up to 16 fish species in rivers and lakes surveyed (Kelly *et al*., 2007a, Kelly *et al*., 2007c and Kelly *et al*., 2008b). Ireland has a depauperate fish community compared with the rest of Europe. Maitland and Campbell (1992) estimate that *circa* 215 freshwater fish species occur in Europe generally, of which about 80 species exist in the north-western part; they identify 55 species in Britain of which only 31 occur in Ireland. There are 13 species of native freshwater fish in Ireland, including euryhaline species entering freshwater, and a further estimated 12 or more introductions, some of which, such as pike (*Esox lucius),* were probably introduced in medieval times (Kelly *et al*., 2008a).

5.2 Distribution of native species

The native fish community of Irish lakes and rivers in the absence of anthropogenic influences is one dominated by salmonids. The glacial relicts Arctic Char and Pollan are present in some lakes (Kelly *et al*., 2008). 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.

Brown trout occur in almost every rivulet, brook, stream and river in Ireland (Kennedy and Fitzmaurice, 1971). Brown trout were recorded in 75% and 80% of the lakes and rivers surveyed respectively and this is similar to previous work carried out in Irish lakes and rivers (Kelly *et al*., 2007a and c and Kelly *et al*., 2008a and b). They were absent in many lakes where non-native coarse fish dominated the population. Salmon and eels occur in every waterbody in Ireland to which they can gain access (McGinnity *et al.,* 2003; Moriarty and Dekker, 1997). Eels were recorded in 96.8% of lakes and only 63% of rivers. Salmon were recorded in only 19% of lakes and 70% of river sites surveyed. Eels and

salmon were not recorded in many of the catchments where there are large hydroelectric dams present downstream, e.g. Shannon catchment. This agrees with work carried out during previous surveys (Kelly *et al*., 2007a and c and Kelly *et al*., 2008b). Four large catchments (Shannon, Erne, Liffey and Lee) no longer have self sustaining populations of salmon and efforts are underway to stock juvenile salmon to increase stocks (Gargan, P., CFB, *pers*. *comm*.). Char were recorded in 5 lakes during the survey. The survey confirmed that this species is no longer present in Lough Corrib. A number of char populations have become extinct over the last 30 years and this has been related mainly to deterioration in water quality, for example Lough Corrib and Lough Conn. Water abstraction is an additional pressure which can effect the status of char populations (Igoe, F., ICCG, *pers. comm*.). The absence of these native species in specific catchments is particularly related to deterioration in water quality and to the presence of an impoundment preventing fish passage. The WFD sets out three main objectives to be achieved by 2015, i.e. to preserve, protect and restore the quality of the aquatic environment; therefore the absence of these native species at specific locations around the country must be addressed in the Draft River Basin Management Plans. 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 supports ecological standards (ShIRBD, 2008).

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. pike, dace, bream, tench, roach, rainbow trout), introduced either deliberately, accidentally or through careless management, e.g. angling activities, aquaculture and the aquarium trade. A non-native species is one that has been either intentionally or accidently 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. roach, rudd and bream.

Data analysis illustrates that non-native fish species were present in 23 of the 32 lakes surveyed during 2008. Overall, the majority of moderate and high alkalinity lakes (parts of the south-west, midlands and west) recorded higher species richness than low alkalinity lakes, reflecting the presence of non-native species in these lakes. Non-native species were present in 52 of the 83 river sites surveyed. Overall, the majority of river sites in the Shannon Region recorded higher species richness and this reflected the presence of non-native species that occurred in 26 out of the 29 rivers sampled. Non-native species were present in 10 of the 42 transitional waterbodies surveyed.

Perch, roach and pike are three of the most common non-native fish species recorded in Irish waters. These species were recorded in a cluster of lakes mainly in the Cavan/Monaghan/Sligo area and the midlands, whilst they were present in river sites mainly in the Shannon Region and interconnecting parts of the Northern Region linked via the Shannon-Erne Waterway. The Shannon-Erne Waterway probably facilitates their movement between the two Regions, resulting in their gradual spread.

Records of these species in other catchments were rare, however they were recorded in parts of the country with no access to the Shannon and Erne catchments (e.g. River Moy, River Lee, Rye Water, Lough Allua and Inniscarra resevoir). Non-native fish recorded in the transitional waters were freshwater species, captured in low salinity areas in the upper tidal limits of estuaries. These estuaries are typically fed by large rivers that sweep the fish downstream during flood events.

The presence of abundant populations of non-native fish species is also an indication of ecosystem health. Researchers have found that there is a general trend for species richness to increase in relation to deterioration in water quality in lakes and rivers; this trend only changes when a lake reaches a hypertrophic state (Kelly *et al*., 2007a and c and Kelly *et al*., 2008b). Salmonids were the dominant fish species in ultraoligo/oligotrophic lakes, and this dominance decreases and changes to a population dominated by coarse fish (Group 2) species as trophic status increases across the range of lakes in this study (Kelly *et al*., 2008b). Stoneloach and minnow were most prevalent at river sites during 2008 where the water quality status was classified as moderate or worse. This agrees with previous research carried out on Irish rivers (Kelly *et al*., 2007c).

The status of these non-native species varies throughout Ireland. Data collected during the 2008 WFD surveys and previous surveys such as the 2005 to 2008 NS Share Fish in lakes project and WFD SM lake fish survey 2007 confirms that the Northwest, West and Southwest are the last areas in the country to which many of these non-native species have not been translocated to as yet and every effort must be made to preserve this status.

The national policy of the Fisheries Boards in Ireland is to preserve indigenous and naturalised fishes and to prohibit the introduction of non-native and potentially invasive species. The Fisheries Boards also implement regulations relating to the use of live bait and the transfer of fish between waters and adopt a proactive approach in order to minimise the potential impact of cultured fish on wild populations (Lowry, 2009).

Article 22 (b) of the EU Habitats Directive 92/43/EEC states that contracting parties shall ”ensure that the deliberate introduction into the wild of any species which is not native to their territory is regulated so as not to prejudice natural habitats within their natural range or the wild native fauna and flora and, if they consider it necessary, prohibit such introduction”.

5.4 Effects of non-native species on the 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 absent from four lakes during the survey (Lough Skeagh Upper, Annaghmore Lough, Lough Allua and Lough Egish). 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 to 66.6% of pike

stomachs contained trout in Lough Corrib. A similar trend was evident in river sites, with salmonid abundances generally reduced in rivers where pike were present.

Roach were present in 17 out of 32 lakes surveyed during 2008, while they were recorded in 20 out of the 83 rivers and were especially abundant in the Shannon and Erne catchments. Roach, introduced to Ireland in 1889 (Went, 1950), have been distributed to many waters, mostly by anglers (Fitzmaurice, 1981) and have been introduced to many lakes and rivers in Ireland over the last 40 years. Roach is a species which has been shown to affect salmonid production and cause the decline of brown trout fishing (Fitzmaurice, 1984). Within a few years of being introduced into a waterbody they can become the dominant species. They displace brown trout and rudd stocks disappear almost to the point of extinction (Fitzmaurice, 1981). Fertile hybrids between roach, bream and rudd are produced and with back crossing roach become the dominant species (Fitzmaurice, 1984).

Dace were recorded during three transitional waterbody surveys (Lower and Upper Munster Blackwater and Maigue). Dace, introduced with roach to the Munster Blackwater in 1889 (Went, 1950) have developed populations since 1975 in the River Nore, Co. Kilkenny and the Bunratty River, Co. Clare, a tributary of the Shannon (Moriarty and Fitzmaurice, 2000). This species has recently also been identified in the Shannon at Castleconnell and its tributary the Mulcaire River, occurring upstream and downstream of the weir at Annacotty. Dace now also occur in the River Barrow (J. Caffrey, *pers. comm*.) and the Doon Lakes in east Co. Clare.

Waterbodies with non-native fish species will not meet high status for WFD purposes due to the presence of these species and any new introductions will lead to a downgrading of the status of a waterbody.

5.5 "Exotic" and invasive species

Occasional occurrences of 'exotic' non-native species have been recorded from Irish freshwaters; e.g. catfish (*Octalurus melas)* Fitzmaurice (1984) and huchen *(Hucho hucho)* (Moriarty and Fitzmaurice, 2000) but there is no evidence to suggest that either species have become established. In 2000, live cruscian carp *(Carassius carrassius)* were confiscated from a group of French anglers fishing the River Fergus at Clarecastle (M. Fitzsimmons, *pers.comm*.). These tourist anglers brought the fish to Ireland as 'live bait'. Recently (April 2009) tourist anglers were again found by Officers of the ShRFB, to be using carp as live bait in Killaloe, Co. Clare.

Invasive alien species are recognised as one of the leading threats to biodiversity and also impose enormous costs on agriculture, forestry, fisheries and other human enterprises (Wittenberg and Cock, 2001). There are numerous alien invertebrate, fish and plant species that are being introduced through various pathways and are causing significant damage to coastal and freshwater ecosystems and to the economies that depend on them (ICAIS, 2009). In 2001 and 2004, chub (*Leuciscus cephalus*), allegedly were captured on the River Inny. In 2005 a number of live, angler caught, chub were caught from this

river and formally identified (Caffery *et al*. 2008). During 2006, an electrofishing survey was undertaken on a section of the River Inny to ascertain the status of the chub population (after positive confirmation of the species the previous year), resulting in 17 chub being captured (ages from 3+ to 10+). The species is thought not to be present elsewhere in Ireland. In the 2008 survey, a single specimen of chub was captured in the River Inny at Shrule Bridge. The presence of chub in any river in Ireland could have a major impact on biodiversity and can cause significant irreversible environment and socioeconomic impacts at genetic, species and ecosystem levels (CFB, 2007 and Caffrey *et al*., 2008).

A juvenile gilt-head bream was captured in the 2008 survey of the Broad Lough Estuary, County Wicklow. This species is common in the Mediterranean but is also found off the coast of northern France and the south coast of England. Preliminary observations suggest that gilt head bream are beginning to colonise the Irish coast line and have been recorded off the south coast of Ireland mainly by anglers (Dr. Willie Roche, CFB, *pers. comm*.). The presence of the species off the east coast of Ireland suggests that it is spreading quite rapidly. This is the furthest north they have been documented on the east coast of Ireland. Rising temperatures have seen the extension of the zone of habitation of non-native species northward. This is a natural biogeographical expansion in response to increasing coastal water temperatures (Met Éireann).

Damage from invasive species can range from the displacement of native plants and/or animals as a result of competition for space, light and food to a more direct effect where some introduced species prey on local wildlife (Barton and Heard, 2005). The native island fauna of Ireland is under increasing threat from unwelcome introductions. With the removal of internal boundaries ("relaxation" of customs) within the EU and modern roll-on/roll-off facilities it is becoming more difficult to intercept illegal importation of non-native species. There is a continuing threat from ill-informed anglers bringing non-native species into Ireland to stock their "favourite" water. In addition to new introductions into Ireland, previously introduced "naturalised" species are still spreading largely through illegal translocations to new catchments. As a consequence, more unique indigenous aquatic systems are under particular threat from alien species (Buckley, 2005).

An All-Ireland review of invasive species was jointly commissioned by National Parks and Wildlife Service in the Republic of Ireland and the Environment and Heritage Service in Northern Ireland in 2004. This resulted in the "Invasive Species in Ireland" report, which recommended 10 key actions to both Governments. The key actions aim to reduce the risk of invasions, control and manage established and new invasive species, monitor impacts, raise public awareness, improve legislation and address international obligations (Anon, 2004).

It is imperative that fisheries authorities implement extra measures to stop the importation and further spread of non-native/exotic species in Ireland, particularly in the northwest where many waterbodies are

in reference state in terms of fish species and free from non-native introductions. One example of this is the recent publication of a Biosecurity Plan for Lough Mask (Lowry, 2009). The report identifies current threats, vectors and pathways, presents a risk assessment and makes recommendations for the prevention of biosecurity threats.

5.6 Age and growth

Statistical analysis has shown that the mean length at age of trout in high alkalinity lakes is significantly higher than in low and moderate alkalinity lakes. There was also a statistical difference in trout growth between low and moderate alkalinity lakes, with moderate alkalinity lakes having higher growth rates. Trout from the lake surveys were classified into three growth categories, i.e. very slow, slow and fast. Growth of trout in Irish lakes is 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 influences the ecology of a river or lake. 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. In Irish lakes there appear to be few exceptions to the rule that the more alkaline the water the faster the trout growth. The average size of 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 trout (Kennedy and Fitzmaurice, 1971). There is some evidence to suggest that in low alkalinity lakes, growth is better when the conductivity is high (usually because of maritime influence) than where the conductivity is very low (Kennedy and Fitzmaurice, 1971). In the less productive lakes, trout are slow growing, relatively short-lived and less selective in their feeding than in richer waters.

Stock density (overstocking) is another factor which can effect growth of 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 trout in lakes. In the biological sense it is a waste of energy for trout to seek foods which are small, scarce and hard to catch (Kennedy and Fitzmaurice,

1971). If fish are to grow well they must be able to obtain large amounts of suitable food organisms of suitable sizes with the minimum of searching. This is possible when there are large standing crops of suitable foods which are never fully grazed (Kennedy and Fitzmaurice, 1969).

In rivers, the range of age classes differed to that of lakes, reflecting life cycle stage. Lakes had lower numbers of juvenile salmonid age classes when compared to rivers as most spend one or two years in nursery streams, before migrating downstream into larger rivers or lakes. Salmon and brown trout fry (0+) were also more abundant in small rivers than in larger channels. Brown trout ranged in age from 0+ to 6+ in rivers; however, the dominant age classes were 0+ and 1+.

5.7 Ecological status

An essential step in the WFD process is the 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. A preliminary classification tool for fish in lakes was developed during the NS SHARE "Fish in Lakes" Project. This tool is designed to assign lakes in ecoregion 17 to ecological status classes ranging from high to bad (Kelly *et al*., 2008b); however, the tool is in an early stage of development, therefore an element of expert opinion is also used in relation to recent introductions or extinctions. Of the 32 lake waterbodies surveyed during 2008, four lakes were classified as High, 11 were classified as Good, 15 were classified as Moderate, one was classified as Poor and one was classified as Bad. The geographical variation in ecological status reflects the change in fish communities (mainly salmonids) from upland lakes with little human disturbance to the fish communities (mainly percids and cyprinids) associated with lowland lakes subject to more intensive anthropogenic pressures. Eight lakes classified in 2005 and 2006 were again assigned status in 2008. The ecological status remained the same for all lakes apart from Lough Kiltooris where the status dropped from High in 2005 to Good in 2008 and Lough Barra where the status improved from Good in 2005 to High in 2008 (Champ *et al*., accepted for publication). Also Derrybrick Lake changed from being a roach dominant lake in 2006 (Kelly *et al*., 2007a) to a perch dominant lake in 2008; however, this has not affected its classification.

There is currently no WFD compliant classification tool for fish in rivers in Ireland. The Environment Agency (EA) in England and Wales is currently developing a new WFD compliant model (FCS2) and a new desk project (WFD68) has been initiated through Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) to prepare and process the river fish data for a new rivers fish classification tool for ROI, NI and Scotland, based on the EA FCS2 model. The Irish rivers fish database has been provided for processing in Swedish and Finnish models as part of a pilot regional intercalibration exercise (Beier *et al.* 2007) to evaluate the suitability of these models for possible application in Ecoregion 17. An amended database has also been forwarded to CEMAGREF for inclusion and testing in the common intercalibration metric (EFI+) which is due to be published shortly.

A new WFD fish classification tool, Transitional Fish Classification Index or TCFI, has been developed for the island of Ireland (Ecoregion 1) using NIEA and CFB data. This is a multi-metric tool based on similar tools developed in South Africa and the UK (Harrison and Whitfield, 2004; Coates *et al.,* 2007). All transitional waterbodies surveyed for fish in 2008 have been assigned a draft classification using this tool. Twenty estuaries (48%) were classified as either High (one waterbody) or Good (19 waterbodies) status while 22 (52%) (11 Moderate, 10 Poor and 1 Bad) were less than Good status. However, the tool is still under development and needs some refinement, particularly for freshwater tidal zones and for lagoons. Lagoons in their nature don't have a strong connection to the ocean and thus have a different species composition when compared with other estuaries.

The classifications for transitional waters were compared to the EPA's draft classification of the waterbodies. These matched in 13 cases (31%), whilst in 14 cases (33%) the TCFI classification was higher than the EPA classification based on general physico-chemical elements, phytoplankton and macroalgal growths. In 15 instances (36%) the EPA classification was higher. The final classification, which will include all biological elements, will be available in December.

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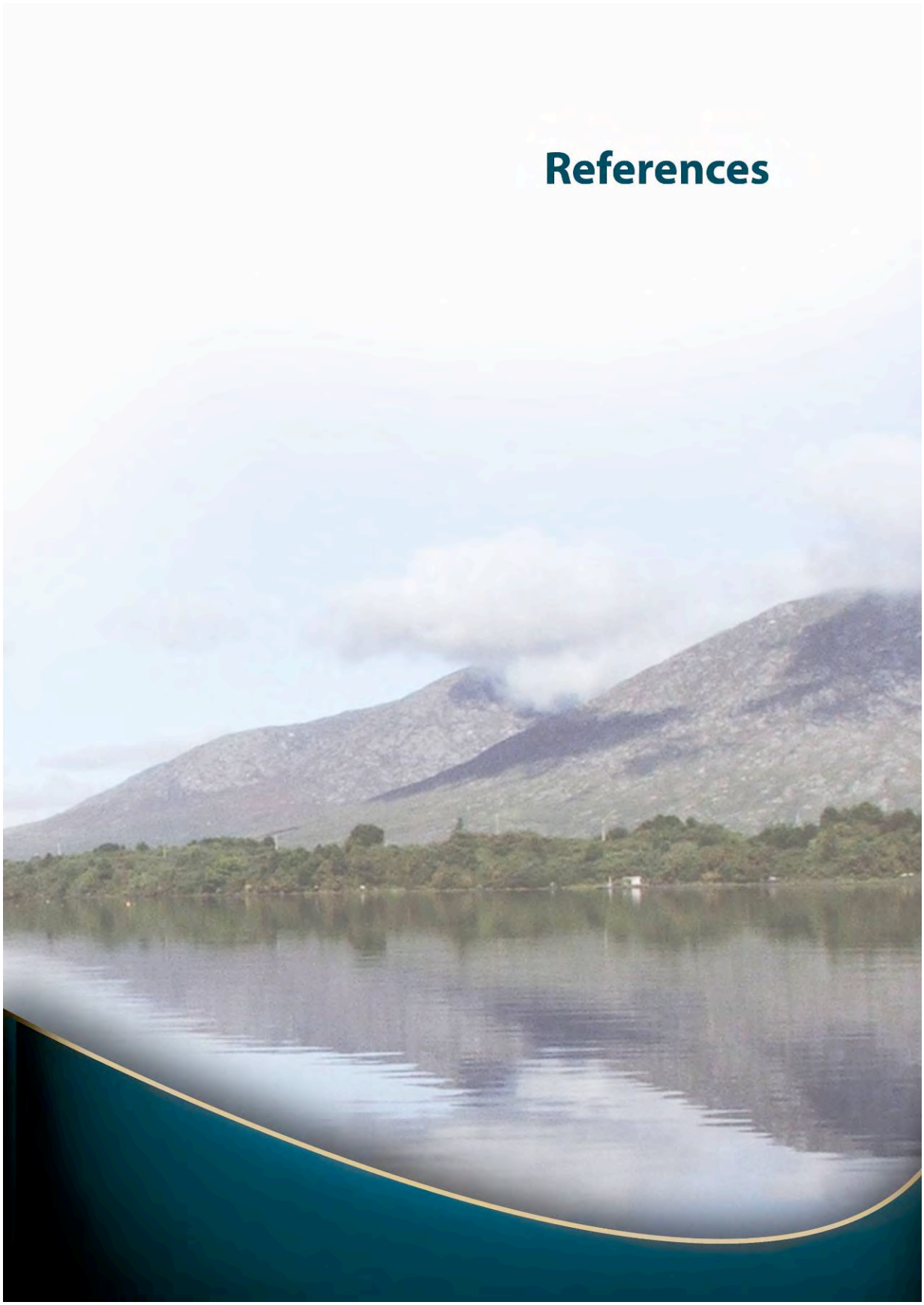

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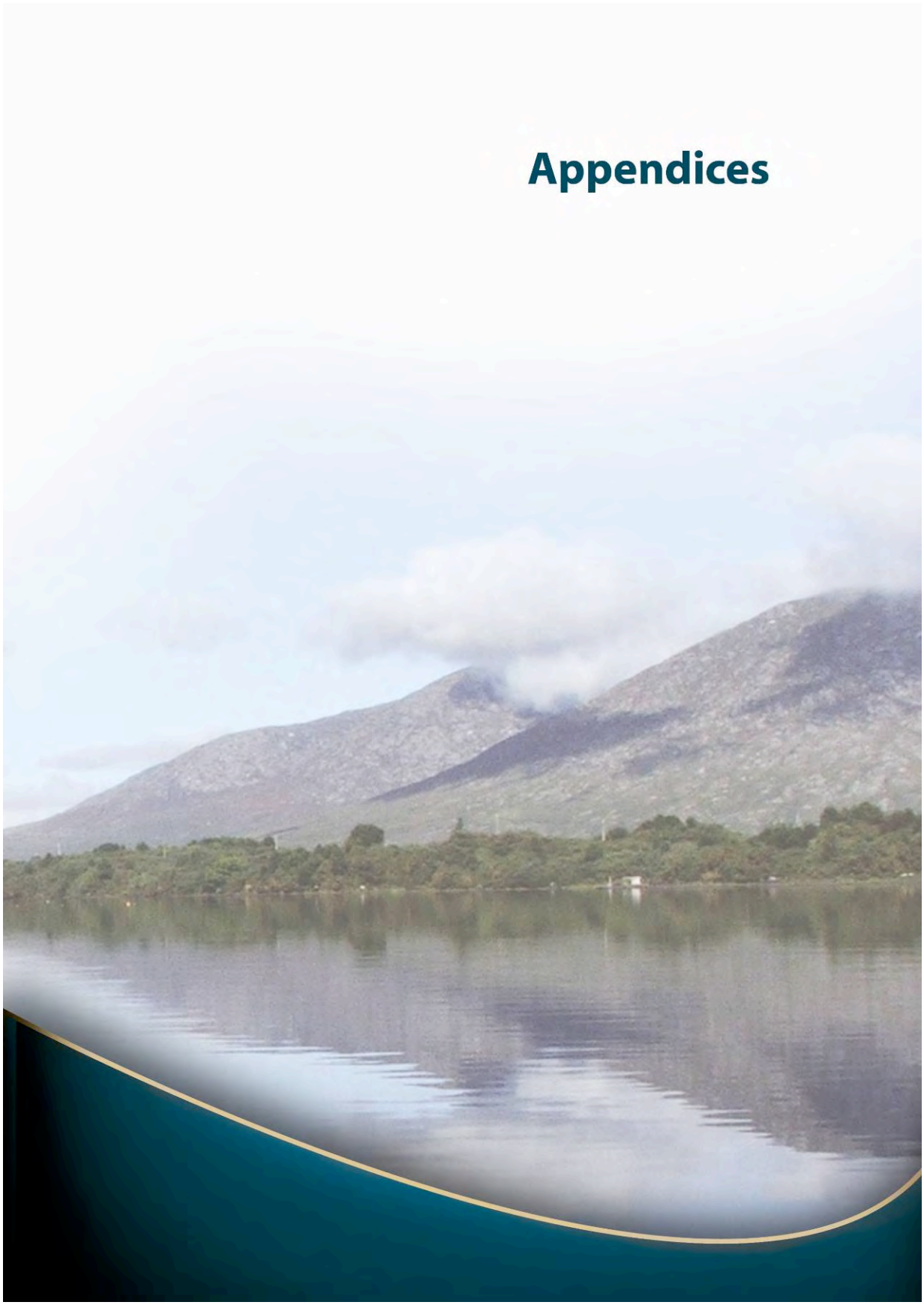
Appendices



APPENDIX 1

Biologically verified typology for lakes in the Republic of Ireland (Free *et al*., 2005).

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 on each lake in the 2008 SM area

Lake Name	Brown trout	Sea trout	Char	Salmon	Shad	3-spined stickleback	Flounder	Eel	Pike	Roach	Perch	Bream	Minnow	Tench	Rudd	Gudgeon	Stoneloach	Hybrids
Carrowmore	X	X				X		X										
Corrib Lwr	X					X		X	X	X	X	X						X
Corrib Upr	X					X		X	X	X	X	X						X
Sheelin	X							X	X	X	X	X						X
O' Flynn	X							X	X	X	X							
Corglass								X	X	X	X	X						X
Cavetown								X	X	X		X						X
Melvin	X		X	X				X			X				X			X
Owel	X					X		X	X	X	X			X	X			X
Gill	X							X	X	X	X	X					X	X
Glencullin	X	X				X		X										
Barra	X			X				X										
Kiltooris	X					X		X										
Beagh	X	X	X					X										
Nanoge								X	X	X	X							
Acoose	X		X					X										
Caragh	X		X					X			X							
Egish								X	X	X	X							
Meelagh	X							X	X	X	X	X		X				X
Allua								X	X	X	X	X			X	X		X
Glenbeg	X							X										
Leane	X			X	X		X	X			X			X	X			
Upper Lake	X			X				X			X		X	X	X			
Brin	X	X						X					X					
Fern	X			X		X		X										
Easky	X							X										
Talt	X		X			X		X			X							
Templehouse	X							X	X	X	X	X			X			X
Annaghmore								X	X	X	X			X	X			
Derrybrick								X	X	X	X	X						X
Skeagh Upp									X	X	X	X						X
Inniscarra	X	X		X				X	X	X	X	X		X	X	X		X

APPENDIX 3

Summary of the growth of brown trout in 23 lakes in the 2008 SM area (L1=back calculated length of trout at the end of the first winter etc.)

Lakename		L1	L2	L3	L4	L5	L6	L7	Growth Category
Acoose	Mean	6.85	16.3	20.3					
	N	54	45	8					
	Std. Deviation	1.594	1.84	1.04					
	Minimum	4.2	12.2	18.9					
	Maximum	11.3	19.8	21.8					
Barra	Mean	5.6	12.3	16.6	20.8	25.6			*Very slow*
	N	54	40	26	3	1			
	Std. Deviation	1.15	1.61	1.07	1.38	.			
	Minimum	3.8	8.7	14.6	19.5	25.6			
	Maximum	8.3	15.2	18.7	22.2	25.6			
Brin	Mean	6.1	14.2	19.7	22.3				*Very slow*
	N	66	48	26	4				
	Std. Deviation	1.32	2.69	1.71	0.95				
	Minimum	4.09	9.5	16.4	21.1				
	Maximum	9.6	19.8	22.2	23.1				
Caragh	Mean	6.16	14.5	21	24.7				*Very slow*
	N	69	59	33	6				
	Std. Deviation	1.29	2.93	2.49	1.25				
	Minimum	3.8	9.5	17.4	23.2				
	Maximum	8.9	19.7	25.7	26.2				
Carrowmore	Mean	6.3	13.5	18.8	23.5	28.4	33.8		*Very slow*
	N	54	47	29	10	4	3		
	Std. Deviation	1.16	2.06	1.92	2.47	4.9	6.6		
	Minimum	4.03	9.8	15.9	21.2	25.4	29		
	Maximum	8.8	18.6	23	27.8	35.8	41.4		
Easky	Mean	6.5	14.8	19.4					
	N	60	41	20					
	Std. Deviation	1.48	1.68	1.9					
	Minimum	3.8	11.8	15.9					
	Maximum	10	17.8	22.6					
Fern	Mean	7.9	17.9	25	30.8				*Fast*
	N	74	48	17	3				
	Std. Deviation	1.61	3.2	2.51	2.31				
	Minimum	4.3	13.3	20.7	29.2				
	Maximum	11.7	23	30	33.5				
Gill	Mean	5.6	13.1	25	36.9				*Very fast*
	N	2	2	2	2				
	Std. Deviation	0.11	0.08	4.05	5.72				
	Minimum	5.59	13	22.2	32.9				

	Maximum	5.75	13.1	27.9	41				
Glenbeg	Mean	6.7	16	20.3	23.9				*Very slow*
	N	58	40	12	2				
	Std. Deviation	1.65	2.38	2.63	2.22				
	Minimum	3.3	9.7	13.4	22.3				
	Maximum	9.9	18.9	22.5	25.5				
Glencullin	Mean	6.2	14	21.1	25.3				*Slow*
	N	30	29	9	3				
	Std. Deviation	1.34	2.75	2.68	1.8				
	Minimum	3.9	9.3	18	23.2				
	Maximum	9.2	19	26.9	26.7				
Kiltooris	Mean	6.4	15.1	21.6	27.4				*Slow*
	N	49	41	24	4				
	Std. Deviation	1.1	2.17	2.29	0.64				
	Minimum	4.6	11.07	18.5	26.6				
	Maximum	9.6	19.8	27.5	28				
Leane	Mean	6.8	14.4	21.4	26.9				*Slow*
	N	60	44	21	6				
	Std. Deviation	0.95	2.7	2.22	3.16				
	Minimum	4.9	9.8	18.3	21.8				
	Maximum	8.9	20.7	26.4	30.8				
Lower L. Corrib	Mean	7.7	15.9	29.01	41.1	46.9			*Very fast*
	N	19	16	9	7	2			
	Std. Deviation	1.28	4	6.5	4.8	4.96			
	Minimum	6.1	11.09	21.2	32.9	43.4			
	Maximum	10.6	26.3	39	47.3	50.4			
Upper L. Corrib	Mean	8	17.3	30.5	42.4	62.95			*Very fast*
	N	14	12	8	8	1			
	Std. Deviation	1.42	4.72	6.6	7.43	.			
	Minimum	6.09	11.1	21.3	31.1	62.95			
	Maximum	10.2	23.6	36.5	51.1	62.95			
Melvin	Mean	6.6	14.07	21.5	27.2	32	35.2	37.8	*Slow*
	N	57	49	33	15	7	3	1	
	Std. Deviation	1.01	2.11	2.43	2.09	2.02	2.03	.	
	Minimum	4.9	9.8	16.4	23.3	29.6	32.9	37.8	
	Maximum	8.4	20.8	27.7	30.2	35.4	36.5	37.8	
O'Flynn	Mean	13.3	25						
	N	3	3						
	Std. Deviation	1.6	1.5						
	Minimum	11.6	23.3						
	Maximum	14.8	26.2						
Sheelin	Mean	7.8	15.6	23.4					
	N	1	1	1					
	Std. Deviation	.	.	.					
	Minimum	7.8	15.6	23.4					
	Maximum	7.8	15.6	23.4					

Owel	Mean	8.2	15.8	25.8	36.2	47.07	*Very fast*
	N	4	4	3	3	1	
	Std. Deviation	0.97	3.45	5.85	5.67	.	
	Minimum	7.2	12.7	19.8	29.7	47.07	
	Maximum	9.5	20.5	31.4	40	47.07	
Talt	Mean	7.4	17.7	23.2			
	N	65	43	27			
	Std. Deviation	1.36	2.23	2.85			
	Minimum	4.3	12.9	18.6			
	Maximum	9.9	21.7	29.8			
Templehouse	Mean	6.1					
	N	1					
	Std. Deviation	.					
	Minimum	6.1					
	Maximum	6.1					
Upper Lake	Mean	7.1	16.1	21.2			
	N	25	21	11			
	Std. Deviation	0.82	1.86	1.97			
	Minimum	5.1	12.6	18.5			
	Maximum	8.8	19.7	24.5			
Veagh	Mean	7.1	14.8	20.4	25.3	25.6	*Slow*
	N	71	56	29	9	2	
	Std. Deviation	1.56	2.29	2.51	3.2	0.13	
	Minimum	3.7	8.9	15.1	21.1	25.5	
	Maximum	9.7	19.4	25.3	32.4	25.6	
Inniscarra	Mean	7.1	13.6	19.5	33.2	47.05	*Fast*
	N	7	7	6	2	1	
	Std. Deviation	1.59	2.59	4.06	7.84	.	
	Minimum	4.2	9.3	13.1	27.7	47.05	
	Maximum	8.8	17.7	25.8	38.8	47.05	
O'Flynn 2	Mean	10.5	25.1	34.4			
	N	11	10	4			
	Std. Deviation	10.02	2.35	3.4			
	Minimum	8.9	19.8	31			
	Maximum	11.8	28.1	38.3			

APPENDIX 4

Summary of the growth of perch in 21 lakes in the 2008 SM area (L1=back calculated length of perch at the end of the first winter etc.)

Lakename		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Annaghmore	Mean	5.97	11.8	18.1	22.7	25.5	28	30.6	32.1			
	N	42	28	16	9	4	1	1	1			
	Std. Deviation	0.97	2.1	1.74	2.51	1.41	.	.	.			
	Minimum	4	8	15.7	19.8	24	28	30.6	32.1			
	Maximum	9	16.9	21.3	27.1	27.3	28	30.6	32.1			
Allua	Mean	5.91	12.4	16.4								
	N	39	21	4								
	Std. Deviation	0.94	1.13	0.71								
	Minimum	4	10.3	15.3								
	Maximum	7.8	14.9	16.9								
Caragh	Mean	7.8	16.2	23.8	30.5	31.7						
	N	37	21	3	1	1						
	Std. Deviation	1.39	1.95	4.26	.	.						
	Minimum	5.69	11.5	20.3	30.5	31.7						
	Maximum	11.47	21.9	28.2	30.5	31.7						
Corglass	Mean	6.5	11.2	14.8	17.8	19.8						
	N	45	28	5	3	1						
	Std. Deviation	0.65	1.58	3.2	0.73	.						
	Minimum	5.4	8.8	10.6	17.1	19.8						
	Maximum	8.2	15	19	18.5	19.8						
Derrybrick	Mean	6.9	12.9	19.3	21.7	29.4						
	N	31	11	6	2	1						
	Std. Deviation	0.68	2.08	2.13	2.81	.						
	Minimum	5.5	10.6	16.3	19.7	29.4						
	Maximum	8.6	16.4	22	23.7	29..4						
Gill	Mean	6.04	11.1	15.8	19.4	22.1	23.8	26.1	28.4	30.4	33.3	
	N	94	75	51	36	24	8	6	3	2	1	
	Std. Deviation	0.93	1.41	1.62	1.76	1.61	1.78	1.86	2.1	2.48	.	
	Minimum	3.8	7.1	13.2	16.3	18.9	20.8	23.1	26.9	28.6	33.3	
	Maximum	9.1	15.1	20.9	24.2	25.2	25.7	28.8	30.8	32.1	33.3	
Leane	Mean	6.77	12.3	16.07	19	23.1	27	27.1				
	N	60	46	22	12	6	3	2				
	Std. Deviation	1.06	1.81	2.49	1.76	3.25	4.43	0.74				
	Minimum	4.8	8.5	12.1	17.1	20.1	24.3	26.5				
	Maximum	9.7	16.6	20.2	21.7	27.4	32.2	27.6				
Meelagh	Mean	7.8	12.7	17.5	21.8	21.8						
	N	60	35	18	13	3						
	Std. Deviation	2.1	2.56	2.61	2.77	1.09						
	Minimum	4.99	8.7	14.5	18.2	20.6						
	Maximum	11.7	18.3	24.6	29.4	22.8						
O'Flynn	Mean	6.4	11.4	15.7	17.8	19.1						
	N	64	42	14	9	4						
	Std. Deviation	1.15	1.58	1.36	1.49	2.38						
	Minimum	4.7	8.5	12.2	16.1	17						

	Maximum	9.8	15.3	17.6	20.3	22.3				
Owel	Mean	6.3	12.3	18.1	21.7	23.6	22.8			
	N	89	65	41	19	7	1			
	Std. Deviation	1.08	1.75	1.72	2.14	3.66	.			
	Minimum	4.2	8.4	15	18.6	20.7	22.8			
	Maximum	10	16.8	22.5	27.2	31.3	22.8			
Skeagh Upper	Mean	5.3	9.2	12.5	14.9					
	N	30	25	17	7					
	Std. Deviation	0.89	0.79	0.62	2.51					
	Minimum	4.1	7.5	11.6	12.7					
	Maximum	8.4	11	13.7	18.9					
Talt	Mean	5	11.8	18.5	26	30	31.8	33.9		
	N	14	8	5	3	3	1	1		
	Std. Deviation	1.01	1.39	3.05	1.27	0.41	.	.		
	Minimum	4	9.6	15.2	24.8	29.5	31.8	33.9		
	Maximum	7.3	14.3	22.5	27.3	30.3	31.8	33.9		
Templehouse	Mean	5.6	11.5	17	19.5					
	N	16	13	11	8					
	Std. Deviation	0.71	1.59	1.88	2.41					
	Minimum	4.8	8.7	14.5	16.3					
	Maximum	7.3	14.1	20.3	23.3					
Upper Lake	Mean	6.6	12.7	16.6	19.1	20.8				
	N	41	34	21	6	5				
	Std. Deviation	1.28	0.98	1.51	2.15	2.96				
	Minimum	4.3	10.8	13.6	16.5	17.4				
	Maximum	10.9	14.9	19.8	21.8	23.7				
Nanoge	Mean	5.2	9.9	15.2	18.5	20.3	20.9	24		
	N	68	54	35	28	8	2	1		
	Std. Deviation	1.04	1.46	1.62	2.24	2.02	0.4	.		
	Minimum	3.1	7.4	12.2	15.2	18	20.6	24		
	Maximum	7.7	13.2	20.6	25	23.3	21.2	24		
Egish	Mean	6.2	11.9	18	22.2	24.6	30.5	33.77	35.2	37.4
	N	99	75	56	21	4	1	1	1	1
	Std. Deviation	0.84	1.29	2.8	3.1	4.2	.	.	.	.
	Minimum	4.7	7.5	12.1	16.7	18.8	30.5	33.77	35.2	37.4
	Maximum	7.7	14.9	26.7	27.6	29	30.5	33.77	35.2	37.4
Inniscarra	Mean	6	13.1	29.9						
	N	15	4	1						
	Std. Deviation	0.98	6.33	.						
	Minimum	4.4	9.7	29.9						
	Maximum	8.5	22.6	29.9						
Sheelin	Mean	7	14.6	22.8	30.1	37.2				
	N	86	61	23	2	2				
	Std. Deviation	0.77	2.31	1.81	1.73	3.15				
	Minimum	5.3	9.4	19.1	28.8	30.4				
	Maximum	8.9	20	26	31.3	34.9				
Melvin	Mean	5.9	13.4	19.4	22.2	24.8	27.06			
	N	100	76	40	30	17	1			
	Std.	0.89	1.73	1.58	1.97	2.82	.			

	Deviation									
	Minimum	4.2	9.1	15.3	17.2	18.7	27.06			
	Maximum	8.7	18.3	24.2	26.9	29.4	27.06			
Lower Corrib	Mean	6.1	11.8	17.4	21.4	26				
	N	83	60	35	21	4				
	Std. Deviation	1.06	1.51	1.79	2.93	4.75				
	Minimum	4.5	9.7	14.4	16.6	19.6				
	Maximum	9.7	16	22.6	26.4	30.7				
Upper Corrib	Mean	5.95	11.3	16.4	19.2	21.1	22.7	24.4	26.1	25.8
	N	107	87	61	43	35	29	27	24	6
	Std. Deviation	0.88	1.54	1.78	1.72	1.88	1.74	2.07	2.13	1.47
	Minimum	4	8.2	13.1	16.2	17.7	19.1	20.5	21.8	23.2
	Maximum	8	15.6	20.5	23.7	26.6	26.8	28.7	30.2	27.4
O'Flynn 2	Mean	6	10.5	14.8	17.5	18.3				
	N	50	43	30	12	1				
	Std. Deviation	0.76	1.25	1.64	1.8	.				
	Minimum	4.4	8.5	10.6	13.5	18.3				
	Maximum	8.4	13.8	18.1	19.6	18.3				

APPENDIX 5

Summary of the growth of roach in 17 lakes in the 2008 SM area (L1=back calculated length of perch at the end of the first winter etc.)

Lake name		L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Annaghmore	Mean	4.1	7.1	10.9	14.8	18	21.2					
	N	10	8	6	6	5	1					
	Std. Deviation	0.39	0.59	1	0.8	0.89	.					
	Minimum	3.4	6.3	9.7	14.3	17	21.2					
	Maximum	4.8	8.3	12.6	16.4	19.4	21.2					
Allua	Mean	3.5	6.6	12								
	N	4	4	4								
	Std. Deviation	0.61	1.5	1.37								
	Minimum	3.1	5.8	10.1								
	Maximum	4.4	8.9	13.1								
Cavetown	Mean	3.4	7.5	12.4	17.5	22	25.8	29.8				
	N	57	52	35	17	9	3	1				
	Std. Deviation	0.58	1.25	2.04	2.1	1.84	1.87	.				
	Minimum	2.2	5.6	9.5	14.5	18.9	23.6	29.8				
	Maximum	4.9	11.2	17.5	21.5	24.2	26..9	29.8				
Corglass	Mean	3.9	7.5	11.3	15.1	18.5	21.4	24.5	26.5	27.9		
	N	49	42	32	27	21	16	6	2	1		
	Std. Deviation	0.42	0.74	1.28	1.19	1	1.21	1.52	0.21	.		
	Minimum	3	6	8.4	13.1	17	19.4	22.5	26.4	27.9		
	Maximum	4.7	8.7	13.4	17.5	19.9	23.9	26.8	26.7	27.9		
Derrybrick	Mean	4.4	9	15	20.8	26.4	27.8	30.4				
	N	35	30	13	7	2	1	1				
	Std. Deviation	0.45	1.15	1.79	2.09	1.51	.	.				
	Minimum	3.1	7.1	11.7	18.7	25.3	27.8	30.4				
	Maximum	5.1	11.5	17	24.3	27.5	27.8	30.4				
Egish	Mean	3.9	8.8	14	19	22.7	27.4					
	N	56	53	37	32	24	6					
	Std. Deviation	0.44	1.02	0.98	1.64	1.41	1.02					
	Minimum	3	6.5	12.1	16.1	19.9	23.1					
	Maximum	4.8	10.8	15.8	22	25.3	25.8					
Gill	Mean	4.8	10.3	16.2	20.9							
	N	35	32	24	3							
	Std. Deviation	0.47	1.04	1.71	1.8							
	Minimum	4	8.3	11.5	18.9							
	Maximum	5.9	12.5	18.8	22.3							
Lower Corrib	Mean	3.4	8.1	13.7	18.4	21.1	24.7	28.4				
	N	114	99	75	45	20	10	1				
	Std. Deviation	0.68	1.7	2.77	2.59	2.08	0.6	.				
	Minimum	2	4.6	9.1	13.6	17.2	23.8	28.4				
	Maximum	5.8	11.3	19.1	22.8	25.5	25.6	28.4				
Upper Corrib	Mean	3.6	8.1	13.7	18.2	22.1	24.6	27.3	28.6	29.6	30.8	32.4
	N	121	110	102	72	47	25	20	13	7	1	1
	Std. Deviation	0.63	1.47	2.12	2.17	2	2.12	2.15	2.27	2.7	.	.
	Minimum	2.3	5.2	9.8	14.6	17.3	19.3	23.4	25.1	26.9	30.8	32.4
	Maximum	5.8	11.7	18.3	22.7	25.7	28.1	30	31.9	33.8	30.8	32.4
Meelagh	Mean	5	10.4	16.5	21.8	25.5	28.1	30.2	33.1			

	N	62	60	45	25	14	12	7	1
	Std. Deviation	1.22	2.09	1.97	1.6	1.33	1.4	1.01	.
	Minimum	3.07	6.1	12.4	19	23.2	25.9	28.8	33.1
	Maximum	8.1	14.4	19.6	24.5	27.6	30.2	31.5	33.1
Nanoge	Mean	4.09	7.9	12.5	17.2	20.1	22.1	24.6	
	N	40	40	34	29	15	7	4	
	Std. Deviation	0.42	0.94	1.28	1.37	1.17	1.06	1.01	
	Minimum	3.2	6.1	9.2	13.7	16.9	20.1	23.3	
	Maximum	4.9	9.6	15	19.4	21.4	23.3	25.7	
O'Flynn	Mean	3.9	8.2	16.2					
	N	3	3	3					
	Std. Deviation	0.29	0.32	0.64					
	Minimum	3.6	7.8	15.7					
	Maximum	4.2	8.4	16.9					
Sheelin	Mean	4	7.3	10.8	14.9	19	23.7	27.4	
	N	63	58	45	25	19	13	6	
	Std. Deviation	0.48	0.67	1.05	1.62	1.84	1.81	1.48	
	Minimum	3	6	9.1	12.8	16.5	20.6	26	
	Maximum	5.3	8.7	12.9	18.9	22.7	26.5	29.3	
Owel	Mean	4	7.6	11.2	15.1	19.1	22.7	24.9	28.2
	N	4	4	4	3	3	2	1	1
	Std. Deviation	0.39	0.64	1.19	1.54	1.55	2.22	.	.
	Minimum	3.5	7	10.1	14.1	17.6	21.1	24.9	28.2
	Maximum	4.5	8.2	12.7	16.9	20.7	24.3	24.9	28.2
Skeagh Upper	Mean	3.7	7.6	11.9	15.3	18.3	20.6		
	N	57	57	44	26	15	5		
	Std. Deviation	0.56	0.68	0.87	0.82	1.07	1.44		
	Minimum	2.1	5.9	9.7	14.1	16.2	18.2		
	Maximum	4.7	8.8	13.1	17	20.3	21.7		
Templehouse	Mean	4.3	8.4	12.3	16.4	21.5	25.8	28.1	
	N	57	50	39	30	7	4	3	
	Std. Deviation	0.42	1.03	1.26	1.68	1.5	0.94	1.23	
	Minimum	3.3	6.3	10.4	14.1	20.2	25	26.9	
	Maximum	5.2	10.7	15.5	21.2	24.2	27	29.4	
Inniscarra	Mean	3.46	7.6	12.6	17.4	22.9			
	N	15	15	6	3	1			
	Std. Deviation	0.71	1.15	0.96	1.05	.			
	Minimum	2.1	6.4	11.7	16.4	22.9			
	Maximum	5	10.2	14.1	18.5	22.9			
O'Flynn 2	Mean	3.9	7.9	13.3	18.6	21.8	23.2		
	N	14	12	12	5	2	1		
	Std. Deviation	0.65	1.03	1.92	2.01	2.26	.		
	Minimum	3.2	6.3	9.3	16.6	20.2	23.2		
	Maximum	5.7	9.4	15.8	21.1	23.4	23.2		

APPENDIX 6

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Annalee	Mean	7.35	15.33					Slow
	SD	1.73	3.12					
	n	20	11					
	Range min.	4.81	9.65					
	Range max.	10.72	19.52					
Anner	Mean	7.45	17.05	24.9				Fast
	SD	1.57	2.6	2.49				
	n	79	38	5				
	Range min.	4.1	11.35	21.58				
	Range max.	10.61	20.59	27.92				
Ballinglen	Mean	7.33	12.74	16.41				Very slow
	SD	1.43	2.00	1.57				
	n	47	23	4				
	Range min.	4.21	9.80	15.10				
	Range max.	10.10	17.05	18.49				
Ballyhallan	Mean	5.73	8.68					Very slow
	SD	0.98	1.11					
	n	23	3					
	Range min.	4.08	7.98					
	Range max.	7.81	9.96					
Ballyroan	Mean	8.33	18.48	24.21				Fast
	SD	2.12	3.12	1.72				
	n	127	39	2				
	Range min.	3.6	10.32	22.99				
	Range max.	15.91	23.87	25.42				
Banoge	Mean	8.44						n/a
	SD	1.34						
	n	21						
	Range min.	5.3						
	Range max.	11.04						
Behy	Mean	6.78	14.07					Slow
	SD	1.08	1.74					
	n	36	11					
	Range min.	5.08	10.67					
	Range max.	8.86	15.92					
Blackwater (Monaghan)	Mean	7.21	14.05	24.18	29.67			Fast
	SD	2.19	3.42	2.48	3.79			
	n	38	24	8	2			
	Range min.	3.78	9.26	20.65	26.99			
	Range max.	12.41	21.11	28.57	32.34			
Boor	Mean	7.17	15.75	20.79				Slow
	SD	1.29	1.67	n/a				
	n	41	25	1				
	Range min.	4.36	12.79	20.79				
	Range max.	10.13	19.08	20.79				

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Bow	Mean	6.24	11.86	16.17	20.40			Very slow
	SD	1.50	1.44	1.25	0.85			
	n	52	29	7	2			
	Range min.	3.62	9.59	14.03	19.79			
	Range max.	10.23	14.93	18.00	21.00			
Broadford	Mean	7.81						
	SD	0.72						
	n	5						
	Range min.	7.20						
	Range max.	8.92						
Brosna (Clonony Br)	Mean	6.87	15.58	20.93	34.67			Fast
	SD	1.83	2.65	4.25	n/a			
	n	56	38	10	1			
	Range min.	3.90	10.29	16.60	34.67			
	Range max.	11.64	21.10	27.39	34.67			
Bunowen (Louisburgh)	Mean	6.06	14.40					Slow
	SD	1.04	1.25					
	n	2	2					
	Range min.	5.32	13.51					
	Range max.	6.79	15.28					
Burnfoot	Mean	5.31	11.22	13.26				Very slow
	SD	0.92	1.11	n/a				
	n	25	5	1				
	Range min.	4.21	9.42	13.26				
	Range max.	7.69	12.40	13.26				
Camlin	Mean	8.55						
	SD	n/a						
	n	1						
	Range min.	8.55						
	Range max.	8.55						
Castlebar	Mean	11.32						
	SD	3.63						
	n	2						
	Range min.	8.75						
	Range max.	13.88						
Clodiagh	Mean	7.88	19.04	27.32				Fast
	SD	1.47	2.96	1.66				
	n	54	29	3				
	Range min.	5.45	11.49	25.78				
	Range max.	11.46	23.30	29.08				
Clody	Mean	6.5	11.95					Very slow
	SD	1.44	1.11					
	n	51	14					
	Range min.	4.03	10.3					
	Range max.	9.69	13.95					

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Clydagh	Mean	7.59	13.17					Slow
	SD	1.67	1.87					
	n	18	6					
	Range min.	3.58	9.68					
	Range max.	9.59	14.37					
Colligan	Mean	6.96	13.57					Slow
	SD	1.23	2.3					
	n	33	9					
	Range min.	4.35	10.54					
	Range max.	9.94	17.56					
Cronaniv Burn	Mean	3.50	11.00					Very slow
	SD	0.83	n/a					
	n	3	1					
	Range min.	2.77	11.00					
	Range max.	4.40	11.00					
Cross	Mean	7.26	17.01	21.95	27.20			Fast
	SD	0.08	3.66	n/a	n/a			
	n	2	2	1	1			
	Range min.	7.21	14.42	21.95	27.20			
	Range max.	7.32	19.60	21.95	27.20			
Deel (Crossmolina)	Mean	6.39						
	SD	n/a						
	n	1						
	Range min.	6.39						
	Range max.	6.39						
Deel (Newcastlewest)	Mean	6.93	18.85	27.60	34.54			Fast
	SD	2.03	4.31	2.67	n/a			
	n	81	46	15	1			
	Range min.	3.58	8.92	23.19	34.54			
	Range max.	12.73	26.57	31.92	34.54			
Dodder	Mean	8.02	15.58					Slow
	SD	1.55	3.53					
	n	19	10					
	Range min.	6.07	11					
	Range max.	10.7	21.68					
Douglas	Mean	8.12	13.3	19.76				Slow
	SD	0.68	1.67	n/a				
	n	10	7	1				
	Range min.	7.24	10.87	19.76				
	Range max.	9.57	15.66	19.76				
Dromore	Mean	8.57	20.17	29.35	38.08			Very fast
	SD	2.49	4.39	7.19	6.86			
	n	9	9	7	5			
	Range min.	5.70	10.85	17.73	33.29			
	Range max.	13.38	27.44	40.15	50.19			

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Duag	Mean	6.14	14.15					Slow
	SD	1.61	4.01					
	n	14	4					
	Range min.	4.03	11.2					
	Range max.	9.55	20.08					
Duncormick	Mean	8.18	14					Slow
	SD	2.02	2.56					
	n	30	7					
	Range min.	5.14	11.45					
	Range max.	11.63	18.75					
Eany Water	Mean	5.86	13.17					Slow
	SD	1.72	2.08					
	n	3	3					
	Range min.	4.04	11.22					
	Range max.	7.46	15.35					
Erne (Belturbet)	Mean	6.63	14.86	21.86				Slow
	SD	1.17	2.75	1.75				
	n	43	39	21				
	Range min.	4.20	10.48	17.97				
	Range max.	8.63	21.18	25.22				
Feale	Mean	7.06	16.84					Fast
	SD	2.38	3.65					
	n	10	7					
	Range min.	4.67	14.02					
	Range max.	11.66	24.42					
Fergus (Clonroad Br)	Mean	6.87	13.88	21.41	26.31	32.98		Fast
	SD	1.87	2.43	2.35	n/a	n/a		
	n	21	16	6	1	1		
	Range min.	4.57	10.09	17.79	26.31	32.98		
	Range max.	11.60	17.89	23.83	26.31	32.98		
Flesk	Mean	8.36	16.08					Fast
	SD	2.73	n/a					
	n	2	1					
	Range min.	6.43	16.08					
	Range max.	10.29	16.08					
Glashaboy	Mean	7.11	13.31	17.25				Slow
	SD	1.34	2.21	0.88				
	n	46	20	5				
	Range min.	4.05	10.36	16.08				
	Range max.	9.57	17.45	18.35				
Glaskeelan	Mean	5.25	10.17	15.71				Very slow
	SD	1.02	1.00	n/a				
	n	13	5	1				
	Range min.	3.59	8.93	15.71				
	Range max.	6.54	11.69	15.71				

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Glenamoy	Mean	6.46	12.29	16.73	22.19			Very slow
	SD	1.24	1.22	0.03	n/a			
	n	35	24	2	1			
	Range min.	4.16	10.20	16.71	22.19			
	Range max.	9.55	14.58	16.75	22.19			
Glenfelly Stream	Mean	5.66	11.30					Very slow
	SD	1.34	0.93					
	n	26	3					
	Range min.	3.89	10.67					
	Range max.	8.08	12.37					
Glennamong	Mean	6.15	12.29					Very slow
	SD	0.89	2.00					
	n	11	4					
	Range min.	4.60	10.25					
	Range max.	7.38	14.76					
Glory	Mean	7.37	15.32	17.04				Slow
	SD	1.76	3.74	2.7				
	n	76	28	5				
	Range min.	4.14	8.07	12.95				
	Range max.	12.38	21.38	20.18				
Gourna	Mean	8.13	14.24	18.16				Slow
	SD	1.47	2.30	n/a				
	n	30	13	1				
	Range min.	4.60	9.96	18.16				
	Range max.	10.49	17.12	18.16				
Graney	Mean	6.36	12.46	17.57				Very slow
	SD	1.32	2.05	n/a				
	n	61	8	1				
	Range min.	3.77	10.30	17.57				
	Range max.	9.32	15.50	17.57				
Gweestin	Mean	7.15	16.46	21.59	29.02			Fast
	SD	1.55	4.45	3.1	n/a			
	n	26	16	5	1			
	Range min.	4.02	8.83	17.61	29.02			
	Range max.	10.3	23.52	25.15	29.02			
Inny (Oldcastle)	Mean	6.57	11.50					Very slow
	SD	1.28	2.49					
	n	34	8					
	Range min.	4.20	7.87					
	Range max.	9.26	14.12					
Inny (Shrule Br)	Mean	8.07	14.22	20.38	24.14			Slow
	SD	2.64	3.59	5.55	1.22			
	n	33	24	7	2			
	Range min.	4.07	6.59	13.40	23.28			
	Range max.	13.81	19.96	28.24	25.00			

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Kilcrow	Mean	10.13	20.97	29.52	35.73			Very fast
	SD	1.34	n/a	n/a	n/a			
	n	3	1	1	1			
	Range min.	9.32	20.97	29.52	35.73			
	Range max.	11.68	20.97	29.52	35.73			
Lee (Inchinossig Br)	Mean	6.8	13.93	17.88				Slow
	SD	1.21	1.69	n/a				
	n	25	19	1				
	Range min.	4.95	11.39	17.88				
	Range max.	9.23	16.69	17.88				
Liffey (Kilcullen Br)	Mean	9.03	19.97	27.02	30.96			Fast
	SD	1.94	2.67	2.79	3.05			
	n	82	44	13	5			
	Range min.	5.12	14.36	22.59	26.87			
	Range max.	14.4	25.54	32.92	34.5			
Little	Mean	6.95	13.37					Slow
	SD	1.85	3.57					
	n	14	8					
	Range min.	4.15	10.02					
	Range max.	9.71	18.32					
Little Brosna	Mean	8.31	16.81	23.12				Fast
	SD	2.05	4.58	2.51				
	n	28	28	4				
	Range min.	4.71	9.16	19.94				
	Range max.	12.94	25.16	25.68				
Mahon	Mean	7.74	13.19					Slow
	SD	2.49	5.63					
	n	13	6					
	Range min.	3.11	8.24					
	Range max.	13.11	23.51					
Maigue	Mean	7.72	19.78	28.64	40.05			Very fast
	SD	1.69	5.83	4.06	n/a			
	n	98	75	25	1			
	Range min.	4.28	10.39	22.08	40.05			
	Range max.	11.71	29.10	36.30	40.05			
Maine	Mean	8.3	16.63	24.44				Fast
	SD	1.56	2.41	n/a				
	n	42	12	1				
	Range min.	4.31	10.88	24.44				
	Range max.	11.39	19.42	24.44				
Martin	Mean	6.71	12.73	18.21				Slow
	SD	1.46	2.44	2.3				
	n	28	18	2				
	Range min.	4.37	9.23	16.58				
	Range max.	9.33	17.62	19.84				

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Mountnugent	Mean	7.39	17.80	28.48	35.22	33.63	40.02	Very fast
	SD	1.57	3.94	5.62	10.38	n/a	n/a	
	n	75	44	21	3	1	1	
	Range min.	3.92	10.65	18.95	27.67	33.63	40.02	
	Range max.	11.51	29.07	42.44	47.05	33.63	40.02	
Multeen	Mean	6.95	15.47	28.79				Fast
	SD	1.73	3.05	0.14				
	n	40	17	2				
	Range min.	3.6	10.45	28.69				
	Range max.	11.06	22.47	28.89				
Nier	Mean	5.93	14.7	20.53				Slow
	SD	1.13	1.58	n/a				
	n	21	5	1				
	Range min.	4.61	12.29	20.53				
	Range max.	8.16	16.72	20.53				
Nore (Quakers' Br)	Mean	7.47	16.12	22.89	29.49			Fast
	SD	1.88	2.53	2.79	n/a			
	n	19	9	5	1			
	Range min.	3.68	12.08	19.04	29.49			
	Range max.	9.92	19.44	26.19	29.49			
Nuenna	Mean	6.93	12.88	15.24				Very slow
	SD	2.54	2.82	2.23				
	n	38	24	3				
	Range min.	3.94	7.53	13.92				
	Range max.	15.91	19.6	17.81				
Owenavorragh	Mean	9.63	20.16					Fast
	SD	2.16	2.74					
	n	38	5					
	Range min.	5.2	16.48					
	Range max.	15.39	23.31					
Owenreagh	Mean	8.53	16.16					Fast
	SD	1.45	0.62					
	n	24	3					
	Range min.	6.7	15.56					
	Range max.	10.86	16.8					
Owentocker	Mean	6.93	14.10	17.74				Slow
	SD	2.09	1.19	n/a				
	n	6	4	1				
	Range min.	4.55	12.73	17.74				
	Range max.	9.60	15.60	17.74				
Rye Water	Mean	8.72	19.77	24.98				Fast
	SD	2.14	3.66	n/a				
	n	33	17	1				
	Range min.	5.77	12.31	24.98				
	Range max.	13.95	24.27	24.98				

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Shannon (Battle Br)	Mean	7.03	15.88	22.99	34.00			Fast
	SD	2.13	4.03	3.24	n/a			
	n	11	7	5	1			
	Range min.	4.68	10.65	19.84	34.00			
	Range max.	11.60	23.20	28.40	34.00			
Shanowen	Mean	8.53	16.16					Fast
	SD	1.45	0.62					
	n	24	3					
	Range min.	6.7	15.56					
	Range max.	10.86	16.8					
Silver	Mean	7.67	15.34	20.35	29.00			Slow
	SD	1.54	3.23	2.68	n/a			
	n	33	13	6	1			
	Range min.	4.41	10.22	17.56	29.00			
	Range max.	10.41	19.57	24.00	29.00			
Smearlagh	Mean	6.90	14.25	25.48				Fast
	SD	1.46	2.64	n/a				
	n	38	20	1				
	Range min.	3.38	11.36	25.48				
	Range max.	9.74	19.65	25.48				
Suck (Ballyforan Br)	Mean	8.48	17.35	25.06				Fast
	SD	n/a	n/a	n/a				
	n	1	1	1				
	Range min.	8.48	17.35	25.06				
	Range max.	8.48	17.35	25.06				
Suck (Cloondacarra Br)	Mean	11.32	22.64					Very fast
	SD	n/a	n/a					
	n	1	1					
	Range min.	11.32	22.64					
	Range max.	11.32	22.64					
Suir (Knocknageragh Br)	Mean	7.28	16.93	22.19	28.88			Fast
	SD	1.77	2.63	1.88	0.91			
	n	71	43	8	3			
	Range min.	4.08	9.85	19.19	27.83			
	Range max.	10.89	20.99	25.26	29.51			
Swanlinbar	Mean	6.68	15.72					Slow
	SD	1.18	1.51					
	n	20	2					
	Range min.	4.47	14.65					
	Range max.	8.99	16.79					
Swilly	Mean	6.62	12.24	20.89				Very slow
	SD	1.38	1.08	n/a				
	n	20	9	1				
	Range min.	3.73	11.03	20.89				
	Range max.	8.60	14.46	20.89				

APPENDIX 6 contd.

Summary of the growth of brown trout in 78 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	Growth category
Tobercurry	Mean	6.08						
	SD	0.40						
	n	2						
	Range min.	5.80						
	Range max.	6.37						
Tullamore	Mean	7.48	14.99	20.44	23.03			Slow
	SD	1.47	2.74	3.34	n/a			
	n	32	29	9	1			
	Range min.	4.38	8.18	15.60	23.03			
	Range max.	9.86	18.97	24.42	23.03			
Urrin	Mean	6.92	12.30	16.82				Very slow
	SD	1.25	1.11	1.02				
	n	48	24	4				
	Range min.	4.15	10.13	15.92				
	Range max.	9.53	14.63	18.24				
Vartry	Mean	6.38	15.98					Slow
	SD	0.8	3.76					
	n	9	4					
	Range min.	4.94	10.77					
	Range max.	7.28	19.63					
Waterfoot	Mean	5.74	9.68					Very slow
	SD	1.10	n/a					
	n	6	1					
	Range min.	4.66	9.68					
	Range max.	7.58	9.68					
Womanagh	Mean	7.36	12.11					Very slow
	SD	1.72	2.16					
	n	34	4					
	Range min.	3.79	10.41					
	Range max.	10.86	15.2					

APPENDIX 7

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Anner	Mean	5.14			
	SD	0.94			
	n	24			
	Range min.	3.48			
	Range max.	6.94			
Ballinglen	Mean	4.97	9.82		
	SD	1.03	0.51		
	n	24	2		
	Range min.	3.34	9.46		
	Range max.	7.00	10.18		
Ballyhallan	Mean	4.51			
	SD	0.73			
	n	23			
	Range min.	3.17			
	Range max.	6.04			
Ballyroan	Mean	5.3			
	SD	1.33			
	n	21			
	Range min.	3.08			
	Range max.	7.93			
Banoge	Mean	6.7			
	SD	1.3			
	n	26			
	Range min.	4.32			
	Range max.	10.05			
Behy	Mean	5.39			
	SD	0.87			
	n	31			
	Range min.	3.87			
	Range max.	6.95			
Bow	Mean	5.04			
	SD	1.18			
	n	15			
	Range min.	3.53			
	Range max.	6.91			
Broadford	Mean	6.27			
	SD	0.02			
	n	2			
	Range min.	6.25			
	Range max.	6.29			
Brosna (Clonony)	Mean	5.03			
	SD	0.24			
	n	5			
	Range min.	4.80			
	Range max.	5.37			

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Bunowen (Louisburgh)	Mean	4.74	7.91		
	SD	0.58	0.18		
	n	12	2		
	Range min.	3.49	7.78		
	Range max.	5.30	8.04		
Burnfoot	Mean	3.60			
	SD	0.39			
	n	4			
	Range min.	3.03			
	Range max.	3.90			
Castlebar	Mean	8.62			
	SD	n/a			
	n	1			
	Range min.	8.62			
	Range max.	8.62			
Clodiagh	Mean	4.66			
	SD	n/a			
	n	1			
	Range min.	4.66			
	Range max.	4.66			
Clody	Mean	5.43			
	SD	0.82			
	n	47			
	Range min.	3.83			
	Range max.	7.44			
Clydagh	Mean	6.30	10.21		
	SD	0.85	3.97		
	n	31	4		
	Range min.	4.47	6.99		
	Range max.	7.70	15.40		
Colligan	Mean	5.05	9.16	36.84	
	SD	0.97	0.06	n/a	
	n	31	2	1	
	Range min.	3.04	9.12	36.84	
	Range max.	7.24	9.2	36.84	
Cronaniv Burn	Mean	3.88	7.12		
	SD	1.26	1.05		
	n	15	11		
	Range min.	2.09	5.91		
	Range max.	6.21	9.77		
Deel (Crossmolina)	Mean	6.14	18.12	37.74	
	SD	2.38	13.08	5.35	
	n	16	13	11	
	Range min.	3.37	9.13	29.40	
	Range max.	9.92	48.13	44.01	

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Dodder	Mean	6.02	9.29		
	SD	0.89	0.55		
	n	21	4		
	Range min.	4.63	8.78		
	Range max.	7.67	9.98		
Duag	Mean	4.8			
	SD	0.79			
	n	17			
	Range min.	3.83			
	Range max.	6.38			
Duncormick	Mean	6.04			
	SD	0.51			
	n	3			
	Range min.	5.45			
	Range max.	6.39			
Eany Water	Mean	4.65	7.70		
	SD	0.89	n/a		
	n	17	1		
	Range min.	3.15	7.70		
	Range max.	5.90	7.70		
Feale	Mean	4.93			
	SD	0.79			
	n	20			
	Range min.	3.45			
	Range max.	6.53			
Fergus	Mean	7.03	15.46	41.42	
	SD	3.95	2.70	5.42	
	n	7	4	4	
	Range min.	4.09	13.11	36.30	
	Range max.	14.52	18.88	49.08	
Flesk	Mean	5.16			
	SD	1.1			
	n	20			
	Range min.	3.31			
	Range max.	6.98			
Glashaboy	Mean	5.98	9.48		
	SD	1.05	n/a		
	n	12	1		
	Range min.	3.55	9.48		
	Range max.	7.43	9.48		
Glaskeelan	Mean	4.65	7.68		
	SD	0.88	1.02		
	n	21	6		
	Range min.	3.11	5.94		
	Range max.	6.14	9.00		

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Glenamoy	Mean	4.67	7.54		
	SD	0.87	0.86		
	n	17	4		
	Range min.	3.27	6.66		
	Range max.	6.59	8.72		
Glennamong	Mean	4.97	8.89		
	SD	0.87	1.56		
	n	32	4		
	Range min.	3.00	7.26		
	Range max.	6.59	10.95		
Glory	Mean	6.33			
	SD	0.85			
	n	23			
	Range min.	4.99			
	Range max.	8.42			
Gourna	Mean	6.24	9.36		
	SD	0.65	n/a		
	n	7	1		
	Range min.	5.59	9.36		
	Range max.	7.34	9.36		
Graney	Mean	4.48			
	SD	0.46			
	n	6			
	Range min.	3.91			
	Range max.	4.98			
Gweestin	Mean	4.33	10.18		
	SD	0.75	0.79		
	n	32	3		
	Range min.	3.02	9.34		
	Range max.	5.79	10.92		
Kilcrow	Mean	4.86			
	SD	n/a			
	n	1			
	Range min.	4.86			
	Range max.	4.86			
Liffey (Kilcullen Br)	Mean	5.53	12.45		
	SD	1.09	1.62		
	n	37	10		
	Range min.	3.44	10.26		
	Range max.	8.32	14.67		
Little Brosna	Mean	5.76	10.45		
	SD	0.93	n/a		
	n	11	1		
	Range min.	3.95	10.45		
	Range max.	7.04	10.45		

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Mahon	Mean	5.47			
	SD	0.95			
	n	14			
	Range min.	4.05			
	Range max.	6.91			
Maigue	Mean	7.74	30.92	48.83	
	SD	2.30	15.48	7.43	
	n	21	17	9	
	Range min.	4.52	10.44	35.09	
	Range max.	11.27	52.08	62.00	
Maine	Mean	5.21	17.09	43.58	55.37
	SD	1.18	11.07	4.08	4
	n	30	9	8	2
	Range min.	3.29	10.29	37.11	52.54
	Range max.	7.91	41.05	50.09	58.19
Martin	Mean	5.38			
	SD	0.82			
	n	26			
	Range min.	4			
	Range max.	7.04			
Multeen	Mean	5.24			
	SD	1.22			
	n	25			
	Range min.	3.27			
	Range max.	7.97			
Nier	Mean	4.37	8.94		
	SD	0.92	1.24		
	n	28	2		
	Range min.	2.9	8.06		
	Range max.	6.73	9.82		
Owenavorragh	Mean	4.79			
	SD	0.98			
	n	15			
	Range min.	3.38			
	Range max.	7.01			
Owenreagh	Mean	3.65			
	SD	0.42			
	n	6			
	Range min.	2.86			
	Range max.	3.97			
Owentocker	Mean	4.46	8.80	32.93	44.02
	SD	0.85	1.84	n/a	n/a
	n	31	13	1	1
	Range min.	3.06	6.51	32.93	44.02
	Range max.	7.25	12.77	32.93	44.02

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Shanowen	Mean	5.71			
	SD	1.22			
	n	20			
	Range min.	3.94			
	Range max.	9.12			
Silver	Mean	6.08			
	SD	n/a			
	n	1			
	Range min.	6.08			
	Range max.	6.08			
Smearlagh	Mean	4.71	8.60		
	SD	0.83	n/a		
	n	20	1		
	Range min.	3.31	8.60		
	Range max.	6.30	8.60		
Suir (Knocknageragh Br)	Mean	6.37			
	SD	n/a			
	n	1			
	Range min.	6.37			
	Range max.	6.37			
Swanlinbar	Mean	4.96			
	SD	1.11			
	n	31			
	Range min.	2.48			
	Range max.	7.11			
Swilly	Mean	4.85			
	SD	0.57			
	n	21			
	Range min.	3.42			
	Range max.	6.31			
Tobercurry	Mean	4.09	10.21		
	SD	0.71	n/a		
	n	22	1		
	Range min.	3.20	10.21		
	Range max.	5.47	10.21		
Urrin	Mean	6.14	9.18		
	SD	0.73	n/a		
	n	16	1		
	Range min.	5.1	9.18		
	Range max.	7.13	9.18		
Vartry	Mean	5.33			
	SD	0.84			
	n	13			
	Range min.	3.47			
	Range max.	6.25			

APPENDIX 7 contd.

Summary of the growth of salmon in 56 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4
Waterfoot	Mean	5.03	8.12		
	SD	1.04	0.48		
	n	19	3		
	Range min.	3.54	7.67		
	Range max.	7.56	8.63		
Womanagh	Mean	6.36			
	SD	0.96			
	n	4			
	Range min.	5.04			
	Range max.	7.09			

APPENDIX 8

Summary of the growth of roach in 16 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9
Annalee	Mean	2.90	6.53	10.93	14.59	17.20	19.50	21.47	24.49	24.75
	SD	0.74	1.39	1.69	1.39	1.42	1.32	1.51	2.10	n/a
	n	84	79	68	41	30	23	14	3	1
	Range min.	2.03	4.09	7.55	10.68	14.71	17.68	18.97	23.16	24.75
	Range max.	5.25	11.00	14.82	17.78	19.96	22.26	24.85	26.90	24.75
Boor	Mean	2.20	7.26	11.88						
	SD	n/a	n/a	n/a						
	n	1	1	1						
	Range min.	2.20	7.26	11.88						
	Range max.	2.20	7.26	11.88						
Brosna (Clonony)	Mean	2.87	6.46	10.39	13.65	15.97	18.04	19.96		
	SD	0.71	1.07	1.31	1.37	0.96	0.57	n/a		
	n	48	48	35	24	12	5	1		
	Range min.	2.00	4.17	8.23	11.85	14.56	17.11	19.96		
	Range max.	4.89	8.59	12.73	16.69	17.38	18.64	19.96		
Brosna (Pollagh)	Mean	2.78	6.56	11.18	15.78	21.20	24.05	28.14		
	SD	0.39	0.83	1.28	1.39	0.92	1.61	n/a		
	n	54	52	47	25	3	2	1		
	Range min.	2.09	4.78	8.76	12.51	20.16	22.91	28.14		
	Range max.	3.97	9.59	14.06	18.64	21.88	25.19	28.14		
Camlin	Mean	2.71	6.51	10.35	13.75	15.46				
	SD	0.59	0.96	1.60	2.76	0.15				
	n	37	32	15	8	2				
	Range min.	2.01	4.33	7.29	10.52	15.36				
	Range max.	4.73	8.93	12.27	17.98	15.57				

APPENDIX 8 contd.

Summary of the growth of roach in 16 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9
Cross	Mean	3.01	6.31	10.60	14.68	17.92	19.36	21.76	23.40	
	SD	0.69	0.93	1.48	1.46	2.32	0.25	n/a	n/a	
	n	36	35	22	21	8	2	1	1	
	Range min.	1.35	4.35	7.61	12.16	15.13	19.18	21.76	23.40	
	Range max.	4.17	7.79	12.58	17.18	22.02	19.54	21.76	23.40	
Dromore	Mean	1.94	4.91	8.72	12.75	16.25				
	SD	0.70	1.19	1.53	1.78	1.69				
	n	46	43	37	19	4				
	Range min.	1.15	3.13	5.54	10.48	14.14				
	Range max.	4.16	8.31	12.26	17.46	17.73				
Erne (Belturbet)	Mean	2.22	5.88	10.73	14.53	17.83	20.91	21.51		
	SD	0.48	1.19	1.75	1.30	1.42	1.70	n/a		
	n	37	36	33	21	11	3	1		
	Range min.	1.37	3.53	7.81	12.17	15.88	19.31	21.51		
	Range max.	3.57	9.21	14.32	17.55	21.19	22.70	21.51		
Graney	Mean	2.42	6.21	12.08						
	SD	n/a	n/a	n/a						
	n	1	1	1						
	Range min.	2.42	6.21	12.08						
	Range max.	2.42	6.21	12.08						
Inny (Shrule)	Mean	3.31	6.92	11.11	15.56	18.40				
	SD	0.95	1.60	1.88	1.66	n/a				
	n	26	20	12	6	1				
	Range min.	2.00	4.66	8.34	12.69	18.40				
	Range max.	5.96	10.16	14.73	17.00	18.40				

APPENDIX 8 contd.

Summary of the growth of roach in 16 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	L5	L6	L7	L8	L9
Kilcrow	Mean	4.00	7.74	11.36						
	SD	0.68	1.14	1.32						
	n	41	27	6						
	Range min.	2.79	6.00	10.01						
	Range max.	5.43	9.58	13.03						
Little (Cloghan)	Mean	3.45	6.44	10.12	13.34	15.64	17.48			
	SD	n/a	n/a	n/a	n/a	n/a	n/a			
	n	1	1	1	1	1	1			
	Range min.	3.45	6.44	10.12	13.34	15.64	17.48			
	Range max.	3.45	6.44	10.12	13.34	15.64	17.48			
Scramoge	Mean	2.69	6.51	11.46	15.43					
	SD	0.48	0.80	1.54	1.56					
	n	18	18	14	7					
	Range min.	2.03	5.26	9.18	13.87					
	Range max.	3.57	7.91	14.10	17.78					
Shannon (Battle Bridge)	Mean	2.83	6.26	10.23	13.68	16.46	19.24	22.29	24.47	
	SD	0.86	1.49	1.55	1.64	1.55	1.28	1.83	n/a	
	n	71	57	42	29	16	6	5	1	
	Range min.	1.50	3.05	7.45	10.60	14.05	17.26	20.06	24.47	
	Range max.	5.11	9.82	15.32	16.36	19.01	20.45	24.35	24.47	
Suck (Ballyforan)	Mean	3.53	6.83	10.52	14.00	16.26	17.86			
	SD	0.57	0.66	0.92	1.11	1.35	0.40			
	n	52	49	34	20	5	2			
	Range min.	2.73	5.23	8.19	11.94	14.19	17.57			
	Range max.	4.94	8.30	12.22	16.22	17.75	18.14			

APPENDIX 8 contd.

Summary of the growth of roach in 16 rivers surveyed in WFD surveillance monitoring 2008 (L1=back calculated length at the end of the first winter etc.)

Suck (Cloondacarra)	Mean	3.89	6.59	9.56	12.67
	SD	0.64	0.81	0.71	1.12
	n	40	28	14	5
	Range min.	2.55	5.11	8.68	11.57
	Range max.	5.03	8.24	10.87	14.19