Shannon International River Basin District Rivers

Sampling Fish for the Water Framework Directive - Rivers 2009

The Central and Regional Fisheries Boards

ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the help and co-operation of CEO Mr. Eamon Cusack, Assistant CEO Mr. Sean Ryan and the staff of the Shannon Regional Fisheries Board; CEO Mr. Aidan Barry, Assistant CEO Dr. Patrick Buck and the staff of the South Western Regional Fisheries Board; and CEO Dr. Greg Forde, Assistant CEO Ms. Amanda Mooney and the staff of 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.

We would like to thank the landowners and angling clubs that granted us access to their land and respective fisheries.

Furthermore, the authors would like to acknowledge the funding provided for the project from the Department of Communications, Energy and Natural Resources for 2009.

PROJECT STAFF

Project Director/Senior Research officer:	Dr. Fiona Kelly (PM up to November 2009)
Project Manager:	Dr. Andrew Harrison (from November 2009)
Research Officer:	Mrs. Lynda Connor
Research Officer:	Mr. Glen Wightman (up to September 2009)
Research Officer:	Dr. Ronan Matson
Technician:	Ms. Grainne Hanna
Technician	Mr. Rory Feeney
Technician:	Ms. Emma Morrissey
Technician:	Ms. Rosin O' Callaghan
Technician:	Mrs. Ciara Wogerbauer
GIS Officer:	Mr. Kieran Rocks
Fisheries Assistant:	Dr. Brian Hayden (Dec 2009 – Feb 2010)
Fisheries Assistant;	Mr. Trevor Stafford (Dec 2009 – Feb 2010)

TABLE OF CONTENTS

1. INTRODUCTION

Fish stock surveys were undertaken in 54 river sites throughout Ireland during the summer of 2009 as part of the programme of sampling fish for the Water Framework Directive (WFD). These surveys are required by both national and European law, with Annex V of the WFD stipulating that rivers are included within the monitoring programme and that the composition, abundance and age structure of fish fauna are examined (Council of the European Communities, 2000). Sixteen of the 54 surveys were carried out at river sites in the Shannon International River Basin District between July and early September 2009 by staff from the Central Fisheries Board (CFB), Shannon Regional Fisheries Board (ShRFB) (Table 2.1, 2.2 and Fig. 2.1). Although fish survey work has been carried out in Ireland in the past, no project to date has been as extensive as the current on-going monitoring programme in providing data appropriate for WFD compliance. Continued surveying of these and additional river sites will provide a useful baseline and time-series dataset for future monitoring of water quality. This in turn will provide information for River Basin District managers to compile and implement programmes of measures to improve degraded water bodies.

The fisheries service in Ireland is currently undergoing a major organisational transition. This follows the recent government plan for the rationalisation of state agencies outlined in the 2009 budget. The eight separate fisheries organisations, comprising the Central Fisheries Board (CFB) and seven Regional Fisheries Boards (RFBs) are set to merge into one single entity and become Inland Fisheries Ireland (IFI). As a result of these changes, the previous administrative zones, the RFBs, will be realigned along the boundaries of River Basin Districts (RBDs) and will in some cases transcend international boundaries. Previous WFD fish surveys were reported based on the seven different RFBs; however, reporting will now reflect these new administrative changes and will group water bodies according to River Basin Districts.

Up until 2010 the Shannon Regional Fisheries Board (ShRFB) occupied the largest area of any RFB. The Shannon International River Basin District (ShIRBD) covers most of this area but also includes parts of the old South Western Regional Fisheries Board and Western Regional Fisheries Board. It also includes a small part of Co. Fermanagh in Northern Ireland, hence its international status; however, only sites situated within the Republic of Ireland are included in this report.

The ShIRBD (Fig. 2.1) is home to Ireland's longest river and is Ireland's largest RBD, covering a distance from where the River Shannon rises in the Cuilcagh Mountains in County Cavan, as far south as the Dingle peninsula in County Kerry. The vast majority of this region is within the Republic of Ireland but it also contains a small part of County Fermanagh in Northern Ireland. Many counties across all four provinces are wholly or partly contained within this RBD. In Ulster, this includes Cavan and Fermanagh; in Connacht, this includes Galway, Leitrim, Mayo, Roscommon and Sligo; in Leinster, this includes Laois, Longford, Meath, Offaly and Westmeath; and in Munster, this includes

Clare, Cork, Kerry, Limerick and Tipperary. The population of the region is over 670,000, but due to the size of its geographic area, the overall population density is relatively low. The largest urban centre is Limerick City, while a number of other smaller towns also have significant populations, including Ennis, Tralee, Mullingar, Athlone and Tullamore. The Shannon RBD contains a lot of agricultural activity, with dairy and meat production being the most economically important. Peat extraction is also important to the region for power generation, as well as tourism operations involving boating and angling (SHIRBD, 2009).

This report summarizes the main findings of the fish stock surveys in the 16 river water bodies surveyed in the ShIRBD during 2009 and reports the current status of the fish stocks in each.

2. STUDY AREA

Sixteen river sites were surveyed in ten river catchments within the ShIRBD; the Annagh, Bunratty, Caher, Creegh, Feale, Fergus, Shannon Estuary South, Shannon Lower, Shannon Upper and Tyshe catchments. The sites ranged in surface area from 118m^2 for the Glendine River to 34,738m^2 for the Shannon River and were divided into two categories for reporting purposes, i.e. hand-set and boat sites.

Summary details of each site's location and physical characteristics are given in Tables 2.1 and 2.2, and the distribution of sites throughout the ShIRBD is shown in Figure 2.1.

Table 2.1. Location and codes of river sites surveyed for WFD surveillance monitoring, 2009

River	Site name	Catchment	Site Code	Waterbody code
ShIRBD Hand-set sites				
Ballyfinboy	Bridge u/s Lough Derg	Shannon Lower	IE25B020800	SH_25_1853
Bilboa	Bilboa Br.	Shannon Lower	IE25B030080	SH_25_486
Broadford	Bridge u/s of Doon Lough	Bunratty	IE27B020800	SH_27_287
Caher	Bridge 2 km d/s of Formoyle	Caher	IE28C010200	SH_28_106
Dead	Pope's Br.	Shannon Lower	IE25D010100	SH_25_1893
Glendine	Knockloskeraun Br.	Annagh	IE28G020200	SH_28_231
Moyree	Bridge u/s Fergus River	Fergus	IE27M020700	SH_27_1178
Newport	Rockvale Br.	Shannon Lower	IE25N020200	SH_25_320
Owvane	Bridge u/s of Loghill	Shannon Estuary South	IE24O020200	SH_24_878
Owveg	Owveg Br.	Feale	IE23O050200	SH_23_1743
Tyshe	West of Ardfert Friary	Tyshe	IE23T020400	SH_23_427
ShIRBD Boat sites				
Creegh	Drumellihy Br.	Creegh	IE28C021400	SH_28_709
Feorish	Bridge 1.5km SW of Keadue	Shannon Upper	IE26F020400	SH_26_234
Fergus	Poplar Br.	Fergus	IE27F010100	SH_27_181
Nenagh	Ballysoilshaun Br.	Shannon Lower	IE25N010300	SH_25_335
Shannon	Ballyleague Br.	Shannon Upper	IE26S021600	SH_26_4162

Table 2.2. Details of river sites surveyed for WFD surveillance monitoring, 2009

River	Upstream catchment (km^2)	Wetted width (m)	Surface area (m^2)	Mean depth (m)	Max depth (m)
ShIRBD Hand-set sites					
Ballyfinboy	187.24	5.00	225	0.30	0.54
Bilboa	85.13	16.27	618	0.20	0.36
Broadford	34.64	5.07	203	0.53	0.86
Caher	14.91	4.73	232	0.25	0.43
Dead	61.94	5.40	243	0.36	0.70
Glendine	12.31	2.52	118	0.14	0.33
Moyree	62.56	9.62	433	0.29	0.69
Newport	68.67	12.55	502	0.32	0.80
Owvane	74.99	13.70	617	0.24	0.67
Owveg	18.53	5.80	249	0.17	0.63
Tyshe	8.52	2.61	196	0.37	0.65
ShIRBD Boat sites					
Creegh	76.00	7.31	1162	0.33	0.71
Feorish	89.07	7.25	573	2.50	2.50
Fergus	138.70	15.00	4425	2.50	2.50
Nenagh	82.44	7.20	994	0.52	0.90
Shannon	2773.77	87.50	34738	>2.00	0.00

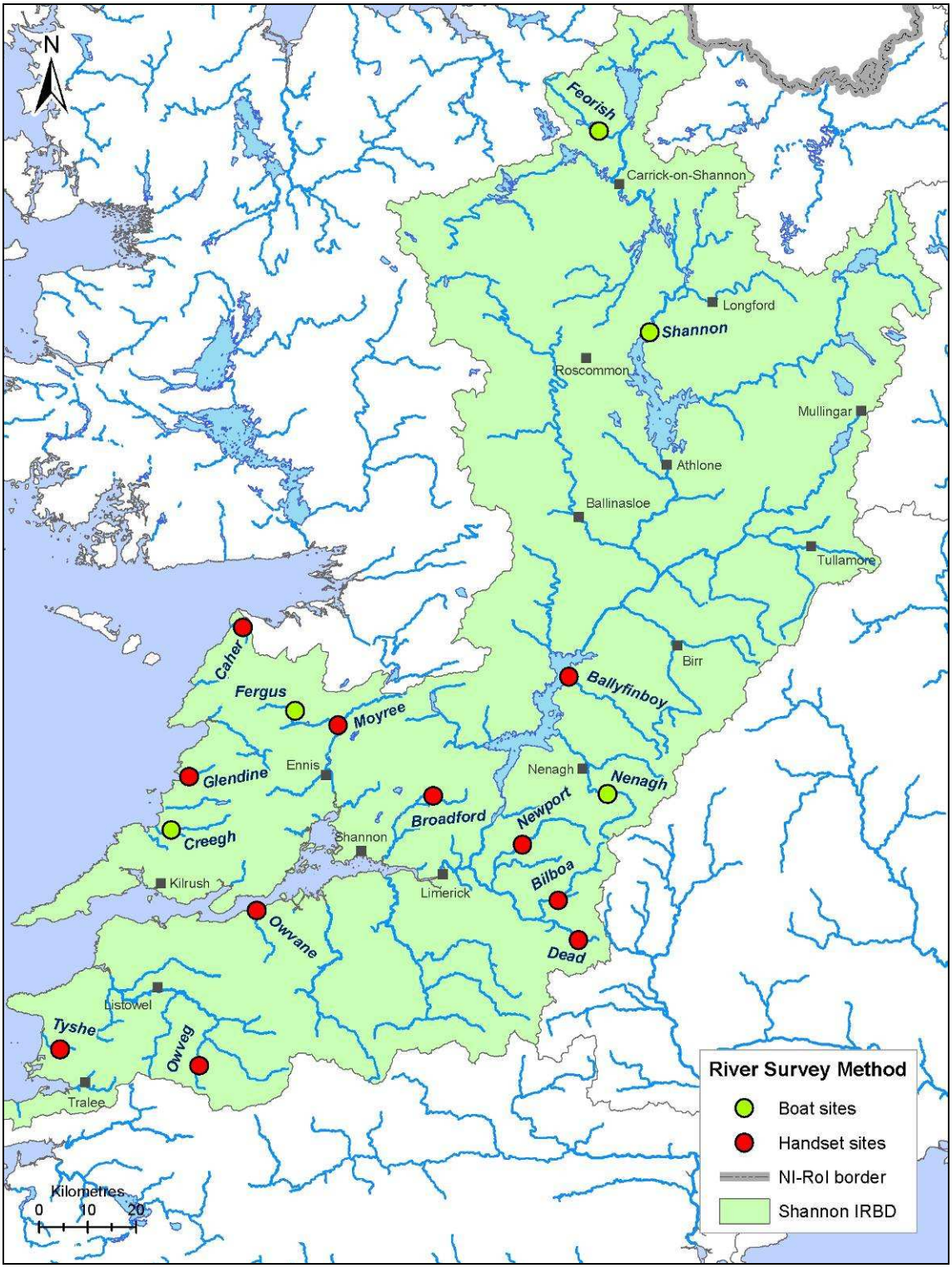

Fig. 2.1. Location map of river sites surveyed throughout the ShIRBD for WFD fish monitoring 2009

3. METHODS

Electric-fishing (Plates 3.1 and 3.2) is the method of choice for surveillance monitoring of fish in rivers to obtain a representative sample of the fish assemblage at each sampling site. This technique complies with European Committee for Standardisation (CEN) guidelines for fish stock assessment in wadeable rivers (CEN, 2003). At each site, the stretch sampled was isolated, where possible, using stop nets, and one to three fishings were carried out using bank-based electric fishing units (hand-sets) or boat-based electric fishing units. Each site ideally included all habitat types; riffle, glide and pool. At each site, a number of physical habitat variables were measured. Water samples for chemical analyses were taken, along with a multi-habitat kick-sample of macroinvertebrates. Macrophyte surveys were carried out on selected wadeable streams.

Fish from each pass were sorted and processed separately. During processing, the species of each fish was identified and its length and weight were measured; sub-samples were measured when large numbers of fish were present. For the purpose of species identification, juvenile river lamprey (*Lampetra fluviatilis*), brook lamprey (*Lampetra planeri*) and sea lamprey (*Petromyzon marinus*) were recorded as 'Lamprey sp.'. Sea trout and brown trout were listed separately. For aging analyses, scales were taken from fish greater than 8.0cm for salmonids and most non-native fish species. These fish were held in a large bin of oxygenated water after processing until they were fully recovered and were then returned to the water. Opercular bones were taken from perch for ageing.

In order to draw comparisons between sites, fish densities were calculated using data from the first fishing pass, as three fishing passes were not possible or practical at all sites. The number captured in the first pass was divided by the total area surveyed to give a minimum population density for each species.

A subsample of the dominant fish species were aged (five fish from each 1cm size class). Fish scales were aged using a microfiche, and opercular bones were aged using an Olympus SZX10 microscope/digital camera system. Growth was determined by back-calculating lengths at the end of each winter (e.g. L1 is the mean length at the end of the first winter, L2 is the mean length at the end of the second winter, etc.).

Plate 3.1. Electric fishing using hand-set units on the Glashaboy River (SWRBD)

Plate 3.2. Electric fishing using boat-based units on the Nenagh River (ShIRBD)

4. RESULTS

4.1 Wadeable hand-set sites

4.1.1 The Ballyfinboy River

Plate 4.1. The Ballyfinboy River upstream of its confluence with Lough Derg, Co. Tipperary

The Ballyfinboy River (Plate 4.1) rises near Moneygall in Co. Offaly. It flows north-westwards through Borrisokane and enters Lough Derg a couple of kilometres north-west of Ballinderry, Co. Tipperary (Fig. 4.1). The Ballyfinboy was once a reasonably good brown trout fishery but has since declined, mainly due to arterial drainage works (O'Reilly, 2009). The survey site, located within a wooded area less than 1km upstream of Lough Derg (Fig. 4.1), borders the Lough Derg North East Shore Special Area of Conservation (SAC). This area on the banks of Lough Derg has six habitats listed on Annex I of the European Union (EU) Habitats Directive, including *Cladium* fens located sporadically along the lake's edge (NPWS, 2003a). Lough Derg itself is a Special Protected Area (SPA) as a breeding and overwintering site for many species of waterfowl. The lake is also of significance as a habitat for river lamprey, which is an EU Habitats Directive Annex II designated species, as well as the location of a population of land-locked sea lamprey (NPWS, 2004).

Three electric-fishing passes were conducted using two bank-based electric fishing units on the 10th of August 2009 along a 45m length of channel. The substrate was predominantly cobble, and the habitat was evenly mixed between riffle, glide and pool. The mean wetted width and mean depth of the surveyed stretch were 5.0m and 20cm respectively. The channel was relatively shaded and as a result was only hospitable to a small number of mosses and liverworts. A total wetted area of 225m^2 was surveyed.

Fig. 4.1. Location of the Ballyfinboy River surveillance monitoring site

A total of four fish species were recorded in the Ballyfinboy River site. Salmon was the most abundant species, followed by stone loach, brown trout and European eel (Table 4.1).

Table 4.1. Density of fish (no./m^2), Ballyfinboy River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.0933	-	0.0933
Barbatula barbatula	Stone loach	-	-	0.0267
Salmo trutta	Brown trout	0.0133	0.0133	0.0267
Anguilla anguilla	European eel	-	-	0.0044
All fish	All fish	-	-	0.1511

Salmon ranged in length from 6.1cm to 9.0cm (Fig. 4.2), with the sample being composed entirely of 0+ fry. Stone loach ranged in length from 5.7cm to 9.0cm.

Brown trout ranged in length from 6.4cm to 24.0cm (Fig. 4.3). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 50%, 30% and 20% of the total brown trout catch respectively. Mean brown trout L1 and L2 were 8.0cm and 15.3cm respectively (Appendix 1). This indicates a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

A single European eel measuring 33.7cm in length was also recorded.

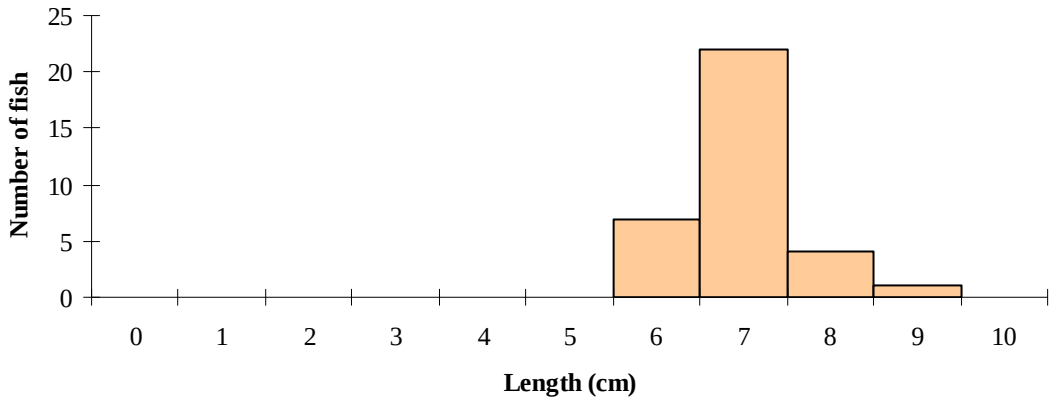

Fig. 4.2. Length frequency distribution of salmon in the Ballyfinboy River, August 2009 (n = 34)

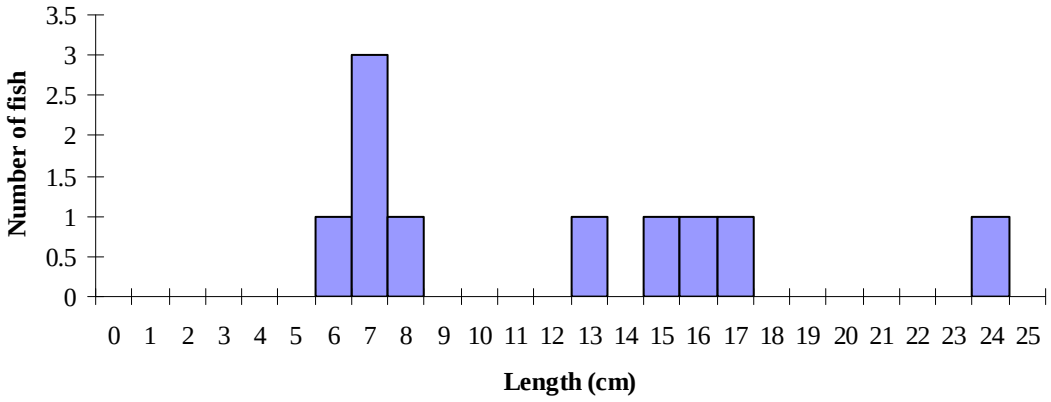

Fig. 4.3. Length frequency distribution of brown trout in the Ballyfinboy River, August 2009 (n = 10)

4.1.2 The Bilboa River

Plate 4.2. The Bilboa River downstream of Bilboa Bridge near Cappamore, Co. Limerick

The Bilboa River (Plate 4.2) is a tributary of the Mulkear River. It rises in the Slieve Felim Mountains in Co. Tipperary and flows in a south-westerly direction towards the Mulkear confluence in Cappamore, Co. Limerick. The Bilboa has good stocks of brown trout and is popular among fly anglers (O'Reilly, 2009). As a tributary of the Mulkear River, the Bilboa River forms part of the Lower Shannon SAC, designated due to the presence of lagoons and alluvial wet woodlands, Annex I habitats assigned by the EU Habitats Directive. Within the Lower River Shannon, many EU Habitats Directive Annex II species are present, including river lamprey, brook lamprey, freshwater pearl mussel, Atlantic salmon and otter. Upstream of the survey site, along the upper reaches of the Bilboa and its tributary, the Gortnageragh River, there are areas of semi-natural broadleaf woodland dominated by native species of trees and shrubs, such as ash, hazel, oak and birch (NPWS, 2005).

The survey site was located immediately downstream of Bilboa Bridge, approximately 4km east of Cappamore (Fig. 4.4). Three electric-fishing passes were conducted using four bank-based electric fishing units on the 13th of August 2009 along a 38m stretch of river channel. The substrate was predominantly cobble, whilst the habitat was an even mix of riffle and glide. The mean wetted width

of the surveyed stretch was 16.3m and the mean depth was 20.0cm. Emergent macrophytes were scattered throughout the channel as well as mosses, liverworts and red algae. Himalayan balsam, a non-native species which is becoming an increasing threat to river bank habitats in Ireland, was also present on the river banks. A total wetted area of 618m^2 was surveyed.

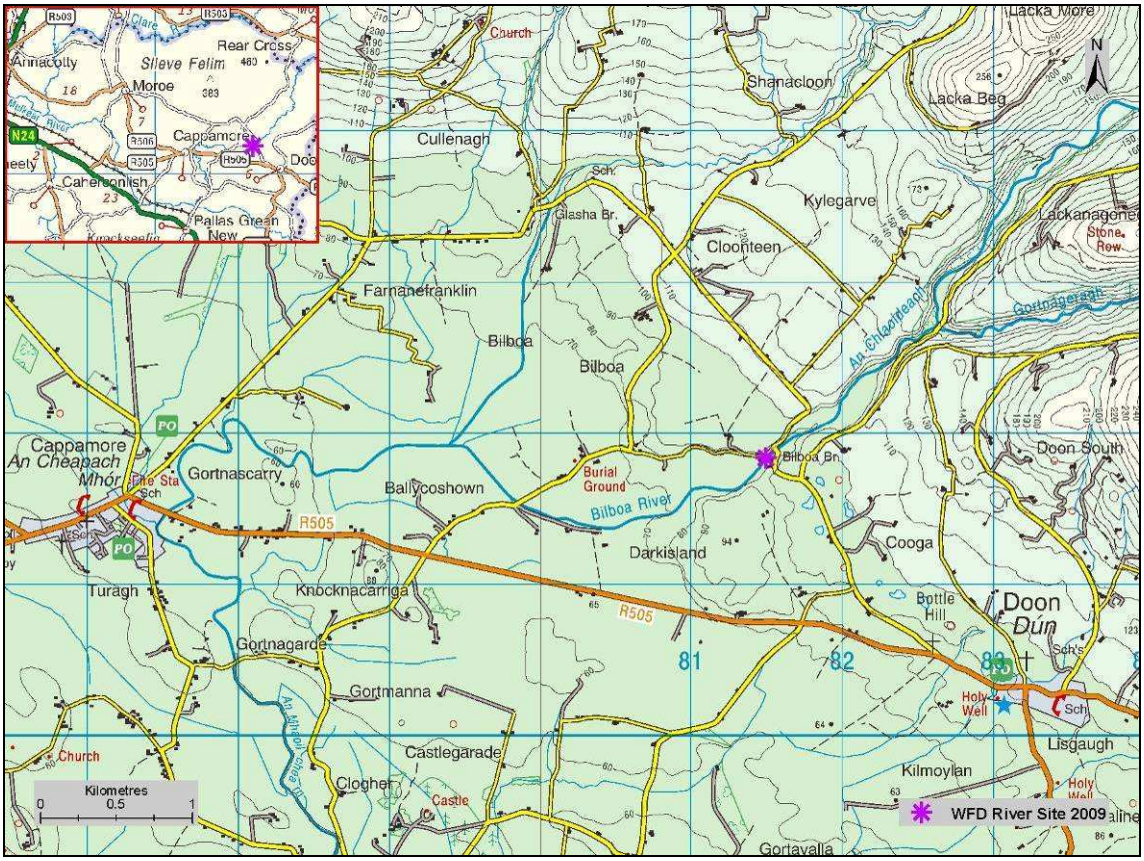

Fig. 4.4. Location of the Bilboa River surveillance monitoring site

A total of five fish species were recorded in the Bilboa River site. Salmon was by far the most abundant species, followed by brown trout, European eel, stone loach and three-spined stickleback (Table 4.2).

Table 4.2. Density of fish (no./m^2), Bilboa River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.3446	0.2330	0.5775
Salmo trutta	Brown trout	0.0259	0.0307	0.0566
Anguilla anguilla	European eel	-	-	0.0016
Barbatula barbatula	Stone loach	-	-	0.0016
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0016
All fish	All fish	-	-	0.6390

Salmon ranged in length from 4.3cm to 16.3cm (Fig. 4.5). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 64%, 33% and 3% of the total salmon catch respectively. Mean salmon L1 and L2 were 4.5cm and 8.6cm respectively (Appendix 2).

Brown trout ranged in length from 4.6cm to 20.7cm (Fig. 4.6). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 48%, 37% and 15% of the total brown trout catch respectively. Mean brown trout L1 and L2 were 6.6cm and 14.2cm respectively (Appendix 1). This indicates a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

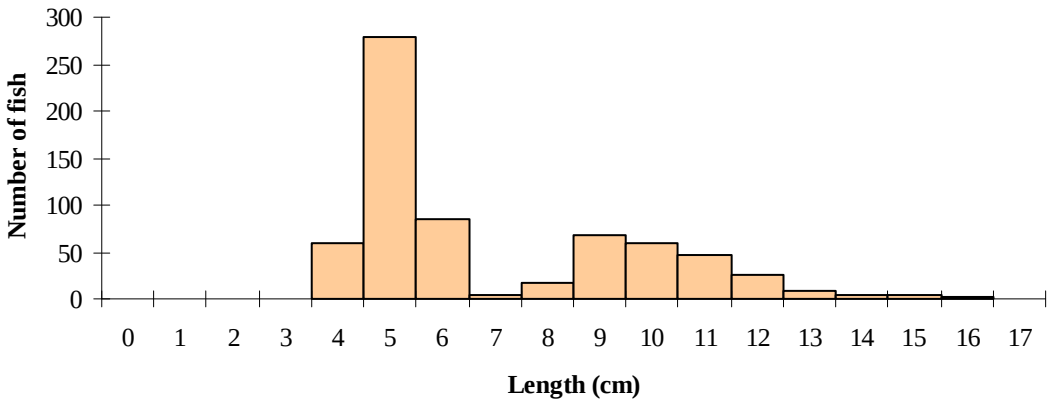

Fig. 4.5. Length frequency distribution of salmon in the Bilboa River site, August 2009 (n = 666)

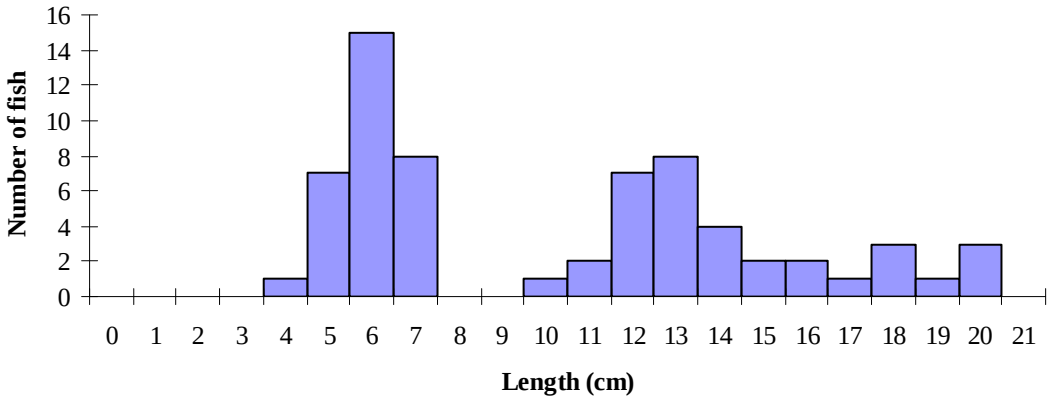

Fig. 4.6. Length frequency distribution of brown trout in the Bilboa River site, August 2009 (n = 65)

4.1.3 The Broadford River

Plate 4.3. The Broadford River at Killaderry Bridge just upstream of Doon Lough, Co. Clare

The Broadford River (Plate 4.3) is a small stream that rises in the Slieve Bearnagh Mountains in south-east Co. Clare. It flows through Doon Lough to join the Anaclare River and later the Owenogarney River, which flows southwards through Sixmilebridge and joins the Shannon Estuary at Bunratty Castle. Tributaries of the Broadford River, joining the main channel upstream of the survey site, flow from the Slieve Bearnagh bog, an area of special significance as the last region of intact open moorland in Ireland (NPWS, 2003b).

The survey site was located approximately 0.5km upstream of Lough Doon at Killaderry Bridge (Fig. 4.7). Three electric-fishing passes were conducted using two bank-based electric fishing units on the 12th of August 2009 along a 40m stretch of river channel. Although all three habitat types (glide, riffle and pool) were represented in the channel, glide was the most prevalent. The substrate consisted mainly of fine material, including gravel, sand and silt. The mean wetted width of the stretch surveyed was 5.1m and the mean depth was 53.0cm. Vegetation present included a number of emergent species as well as various mosses and liverworts. Himalayan balsam, a non-native species

which is becoming an increasing threat to river bank habitats in Ireland, was also present on the river banks. A total wetted area of 203m^2 was surveyed.

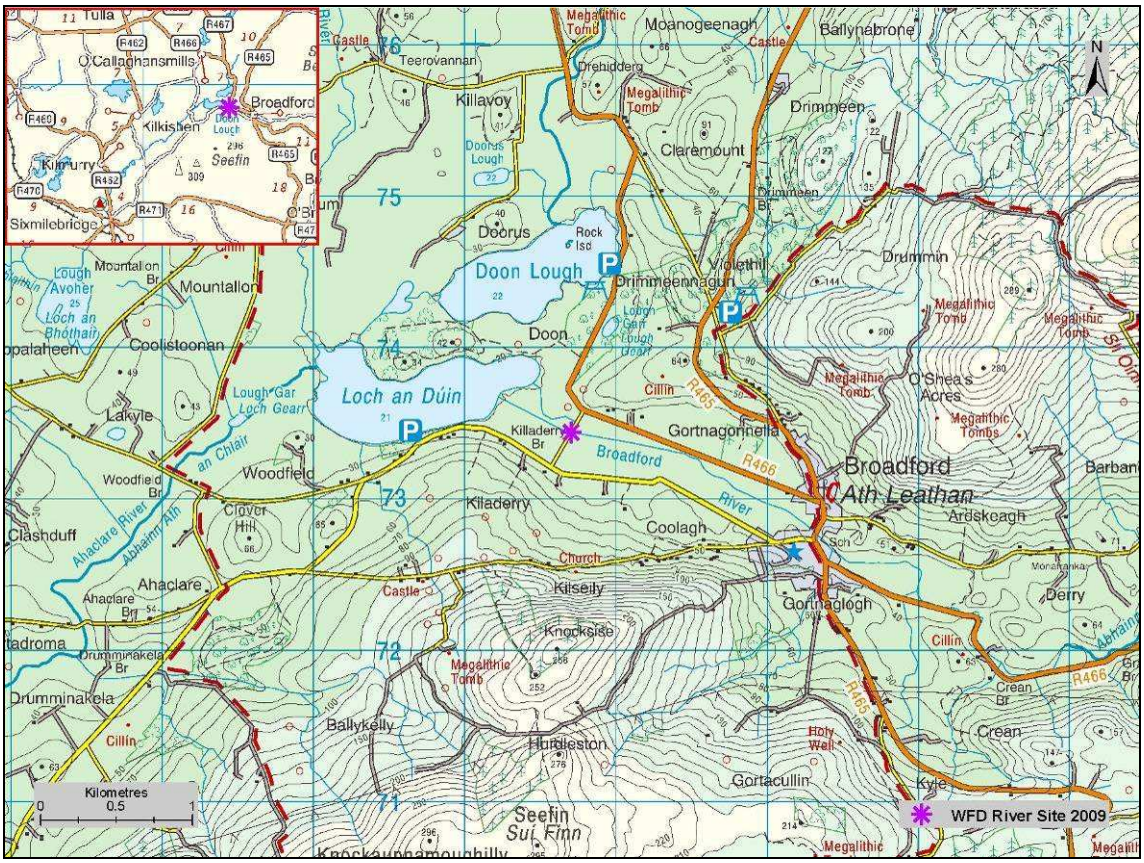

Fig. 4.7. Location of the Broadford River surveillance monitoring site

A total of five fish species were recorded in the Broadford River site. Gudgeon was the most abundant species, followed by salmon, European eel, three-spined stickleback and brown trout (Table 4.3).

Table 4.3. Density of fish (no./m^2), Broadford River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Gobio gobio	Gudgeon	-	-	0.1480
Salmo salar	Salmon	0.0493	0.0592	0.1086
Anguilla anguilla	European eel	-	-	0.0247
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0099
Salmo trutta	Brown trout	0.0099	-	0.0099
All fish	All fish	-	-	0.3010

Gudgeon ranged in length from 5.7cm to 11.1cm (Fig. 4.8). Salmon ranged in length from 5.1cm to 12.8cm (Fig. 4.9). Two age classes (0+ and 1+) were present, accounting for approximately 55% and 45% of the total salmon catch respectively. Mean salmon L1 was 5.3cm (Appendix 2).

European eels ranged in length from 15.2cm to 46.9cm. Brown trout ranged in length from 5.7cm to 7.1cm.

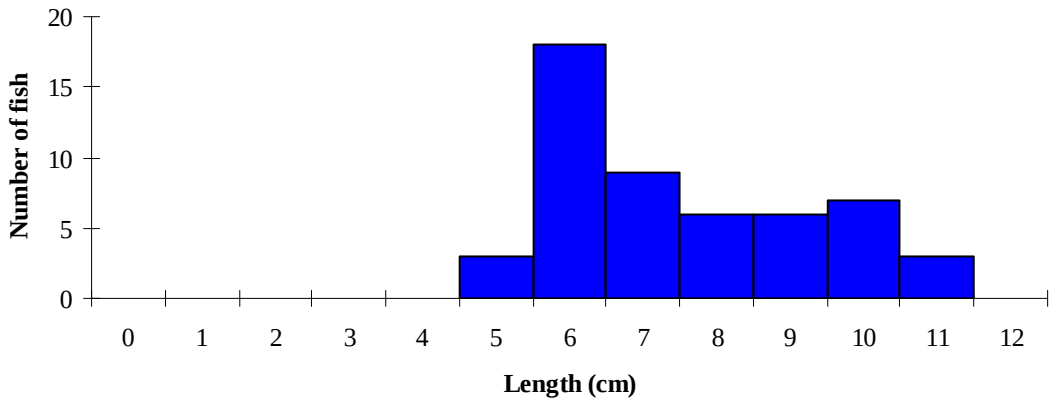

Fig. 4.8. Length frequency distribution of gudgeon in the Broadford River, August 2009 (n = 52)

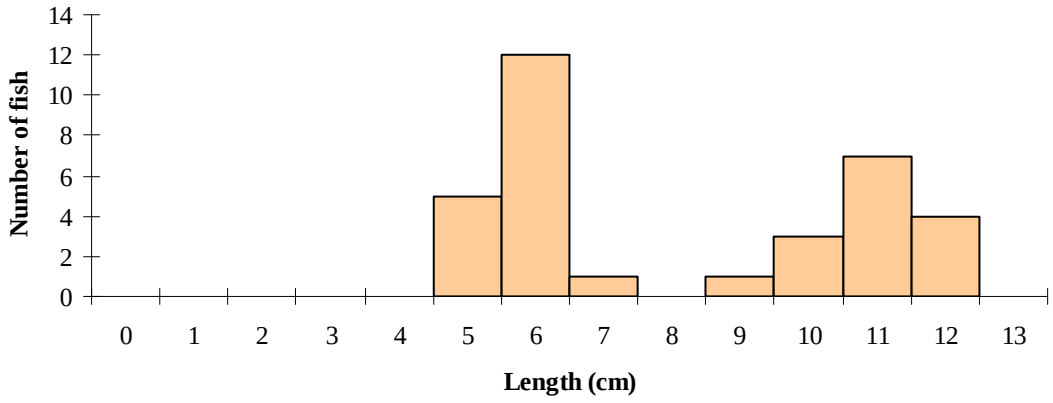

Fig. 4.9. Length frequency distribution of salmon in the Broadford River, August 2009 (n = 33)

4.1.4 The Caher River

Plate 4.4. The Caher River at Carna Bridge near Fanore, Co. Clare

The Caher River (Plate 4.4) is a small stream located in the Burren in north-west Co. Clare. It winds its way in a north-westerly direction for approximately 7km before joining the sea at Fanore (Fig. 4.1). The Caher is a relatively small and shallow river and as a result does not contain enough large fish to interest the angler. The survey site, located near a fulacht fiadh (burnt mound) archaeological site beside Carna Bridge, Co. Clare (Fig. 4.10), is inside the Black Head-Poulsallagh SAC of the Burren. This area is particularly noted for its excellent representatives of Burren habitats; karst limestone pavements and limestone heaths (NPWS, 2002).

Three electric-fishing passes were conducted using two bank-based electric fishing units on the 7th of August 2009 along a 49m stretch of river channel. A good mix of each habitat type was present at the site, with gravel as the dominant substrate. The mean wetted width of the stretch surveyed was 4.7m, and the mean depth was 25.0cm. Macrophyte vegetation consisted mainly of mosses and liverworts, which are common in shallow rocky streams. A total wetted area of 232m^2 was surveyed.

Fig. 4.10. Location of the Caher River surveillance monitoring site

A total of two fish species were recorded in the Caher River site. Brown trout was the most abundant species, followed by European eel (Table 4.4).

Table 4.4. Density of fish (no./m^2), Caher River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo trutta	Brown trout	0.1811	0.0733	0.2544
Anguilla anguilla	European eel	-	-	0.0043
All fish	All fish	-	-	0.2587

Brown trout ranged in length from 4.4cm to 18.5cm (Fig. 4.11). Two age classes (0+ and 1+) were present, accounting for approximately 74% and 26% of the total brown trout catch respectively. Mean brown trout L1 was 8.8cm (Appendix 1).

Only two eels were captured, measuring 31.5cm and 35.9cm.

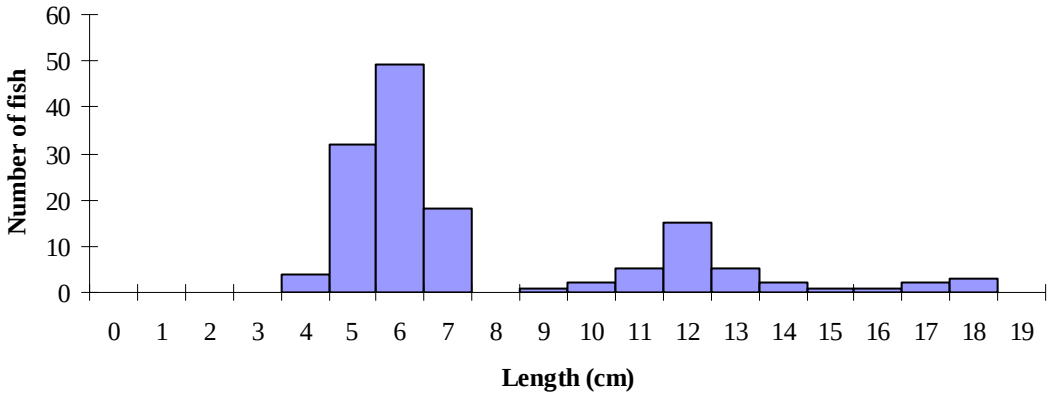

Fig. 4.11. Length frequency distribution of brown trout in the Caher River, July 2009 (n = 140)

4.1.5 The Dead River

Plate 4.5. The Dead River at Pope's Bridge near Limerick Junction, Co. Tipperary

The Dead River (Plate 4.5) is a tributary of the Mulkear River. Two main tributaries, the Cauteen River and the Pope's River, join together in Co. Tipperary to form the Dead River, which then flows north-westwards into Co. Limerick. The Dead River later joins with the Mulkear River before reaching the River Shannon in Limerick City. Although brown trout in the Dead River tend to be larger than in the Mulkear River, its 'canal-like features' have made it a less popular place to fish (O'Reilly, 2009). As a major tributary of the Mulkear, the Dead River is included within the Lower River Shannon SAC. Within the Lower Shannon catchment, EU Habitats Directive Annex I priority habitats such as alluvial wet woodlands and lagoons can be found, along with the following Annex II species; Atlantic salmon, sea lamprey, river lamprey, brook lamprey, bottle-nosed dolphin, freshwater pearl mussel and otter (NPWS, 2005).

The survey site was located upstream of Pope's Bridge, approximately 4km north-east of Oola, Co. Tipperary (Fig. 4.12). Three electric-fishing passes were conducted using two bank-based electric-fishing units on the 7th of August 2009 along a 45m stretch of river channel. Glide dominated the channel at this location, which contained a substrate of mainly cobble. Macrophyte vegetation present

included common species of moss and grass. The mean wetted width of the stretch surveyed was 5.4m and mean depth was 36.0cm. A total wetted area of 243m^2 was surveyed.

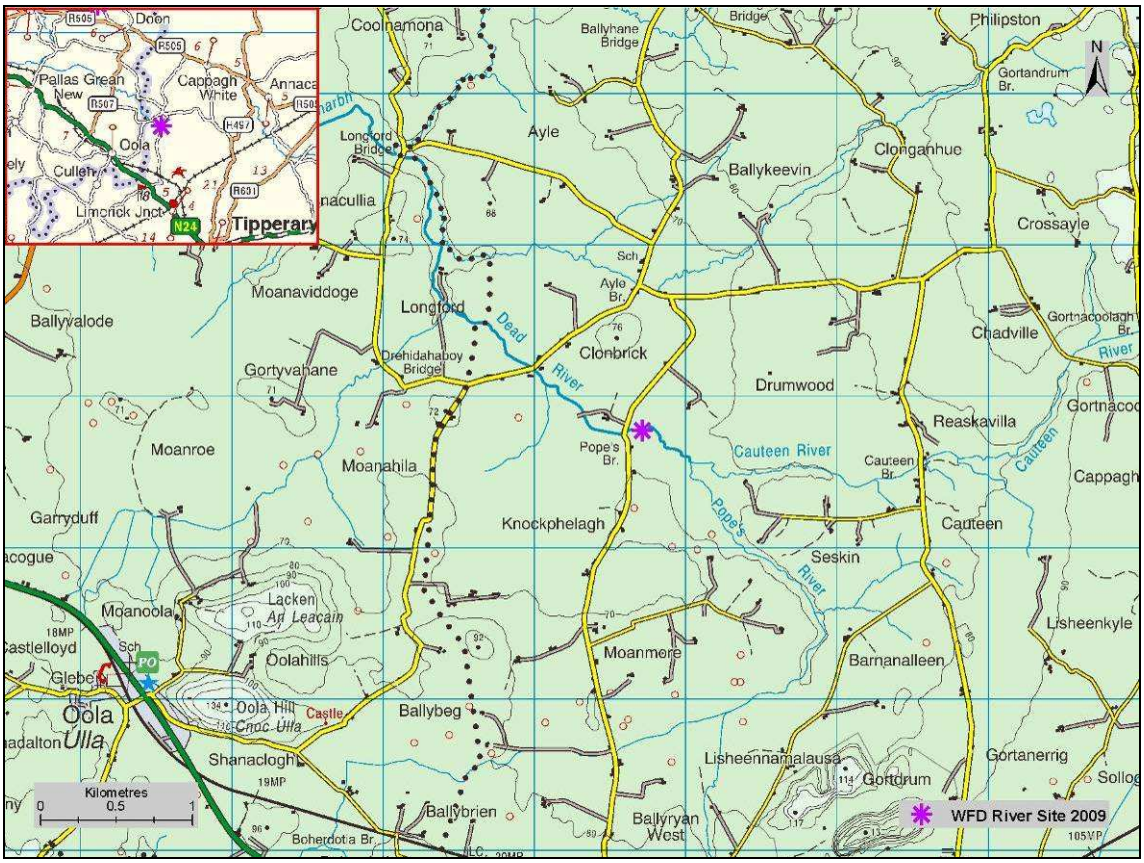

Fig. 4.12. Location of the Dead River surveillance monitoring site

A total of five fish species were recorded in the Dead River site. Salmon was the most abundant species, followed by brown trout, juvenile lamprey, European eel and stone loach (Table 4.5).

Table 4.5. Density of fish (no./m^2), Dead River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.0782	0.0412	0.1193
Salmo trutta	Brown trout	-	0.1152	0.1152
	Lamprey sp.	-	-	0.0123
Anguilla anguilla	European eel	-	-	0.0082
Barbatula barbatula	Stone loach	-	-	0.0082
All fish	All fish	-	-	0.2634

Salmon ranged in length from 6.0cm to 16.2cm (Fig. 4.13). Two age classes (0+ and 1+) were present, accounting for approximately 61% and 39% of the total salmon catch respectively. Mean salmon L1 was 6.1cm (Appendix 2).

Brown trout ranged in length from 15.7cm to 30.4cm (Fig. 4.14). Three age classes (1+, 2+ and 3+) were present, accounting for approximately 25%, 58% and 18% of the total brown trout catch respectively. Mean brown trout L1, L2 and L3 were 8.2cm, 18.2cm and 23.7cm respectively (Appendix 1). This indicates a fast rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

European eels ranged in length from 25.7cm to 48.0cm, and juvenile lamprey ranged in length from 7.5cm to 13.0cm. Stone loach ranged in length from 7.0cm to 10.8 cm.

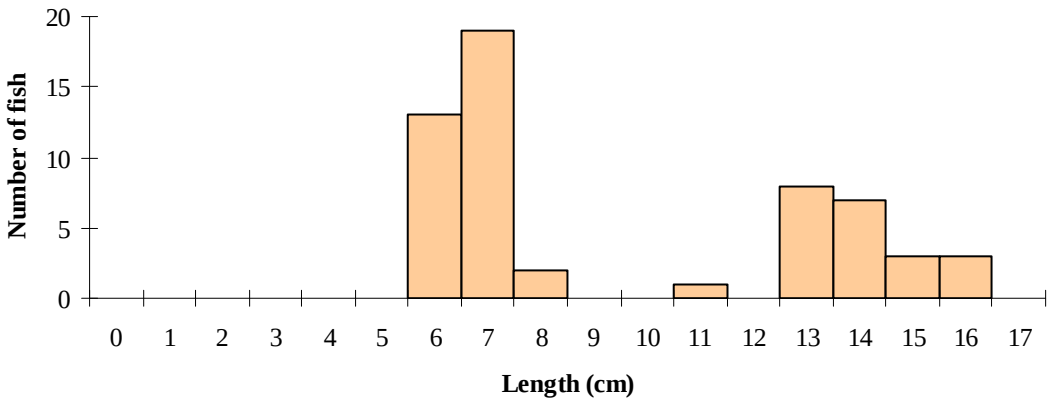

Fig. 4.13. Length frequency distribution of salmon in the Dead River, August 2009 (n = 56)

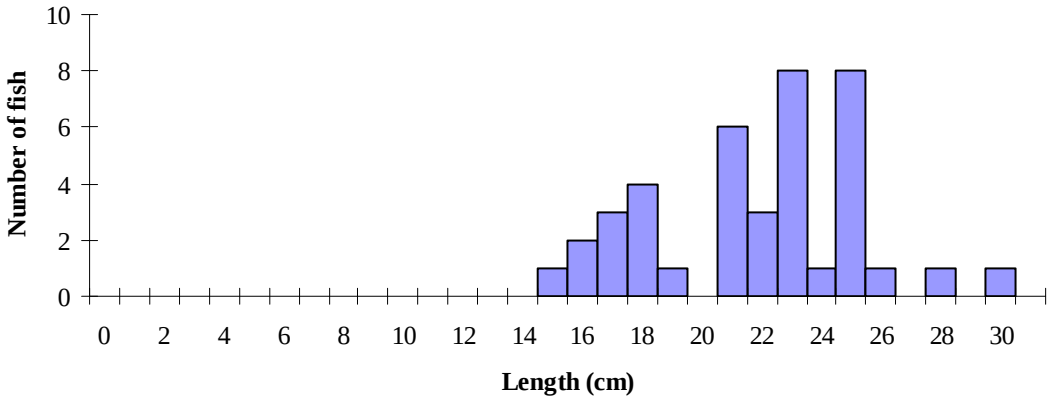

Fig. 4.14. Length frequency distribution of brown trout in the Dead River, August 2009 (n = 40)

4.1.6 The Glendine River (Clare)

Plate 4.6. The Glendine River at Knockloskeraun Bridge near Miltown Malbay, Co. Clare

The Glendine River (Plate 4.6) is a small stream located in Co. Clare. It rises in the hills west of Milltown Malbay and flows for approximately 9km before reaching the sea just south of Spanish Point. Although the Glendine River survey site itself is not located within a special area of conservation, the river outflow joins the sea at the Carrowmore Point to Spanish Point and Islands SAC.

The survey site was located upstream of Knockloskeraun Bridge, approximately 1.5km south of Milltown Malbay, Co. Clare (Fig. 4.15). Three electric-fishing passes were conducted using one bank-based electric-fishing unit on the 8th of July 2009 along a 47m length of river channel. Although pools dominated the stretch, riffles and glides were also present within the channel surveyed. Cobble was the dominant substrate, followed by gravel and sand. A layer of algae covered most of the substrate within this stretch. The mean wetted width of the stretch surveyed was 2.5m and the mean depth was 14.0cm. Vegetation present included various common emergent and riparian species, typical of this type of stream (slow flowing with fine substrates). A total wetted area of 118m^2 was surveyed.

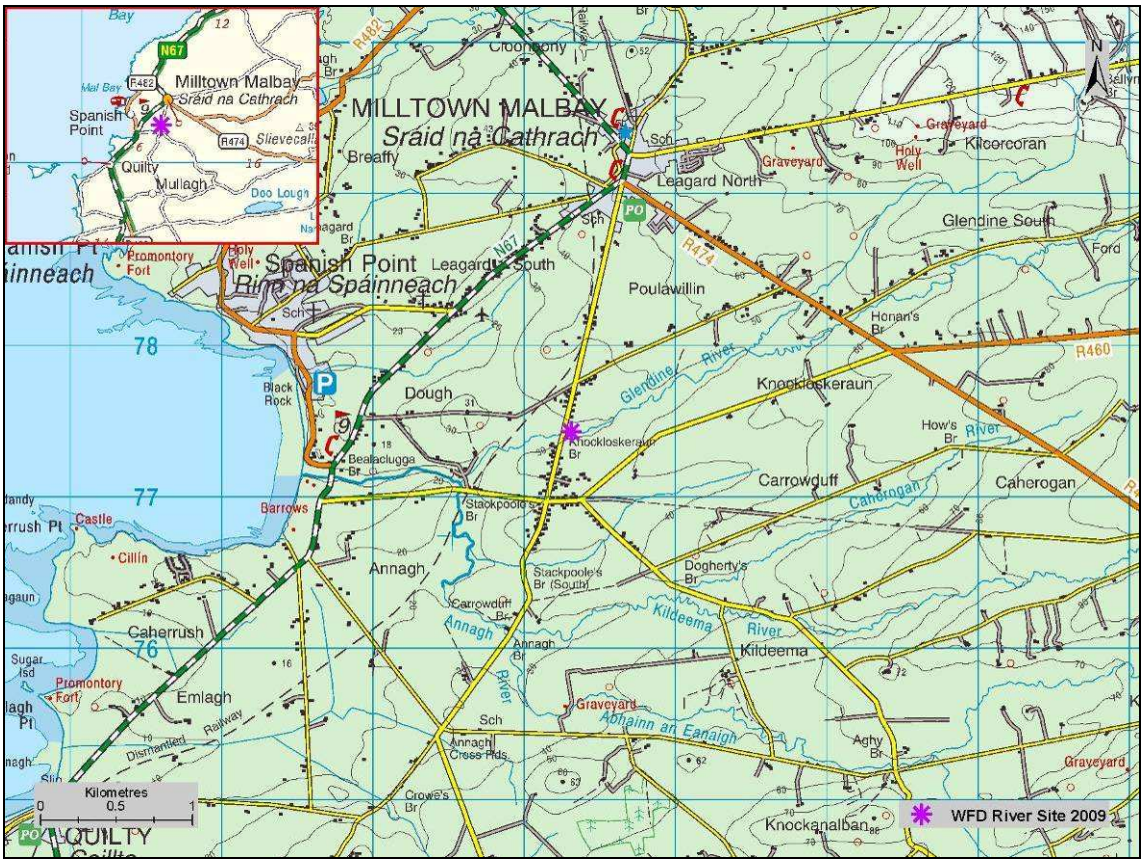

Fig. 4.15. Location of the Glendine River surveillance monitoring site

A total of three fish species were recorded in the Glendine River site. Brown trout was the most abundant species, followed by European eel and salmon (Table 4.6).

Table 4.6. Density of fish (no./m^2), Glendine River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo trutta	Brown trout	0.3974	0.0338	0.4312
Anguilla anguilla	European eel	-	-	0.0676
Salmo salar	Salmon	-	0.0085	0.0085
All fish	All fish	-	-	0.5073

Brown trout ranged in length from 5.0cm to 21.6cm (Fig. 4.16). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 91%, 3% and 6% of the total brown trout catch respectively. Mean brown trout L1 and L2 were 7.2cm and 13.5cm respectively (Appendix 1). This indicates a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

European eels ranged in length from 10.9cm to 36.4cm. A single salmon measuring 15.1cm and aged 1+ was also recorded.

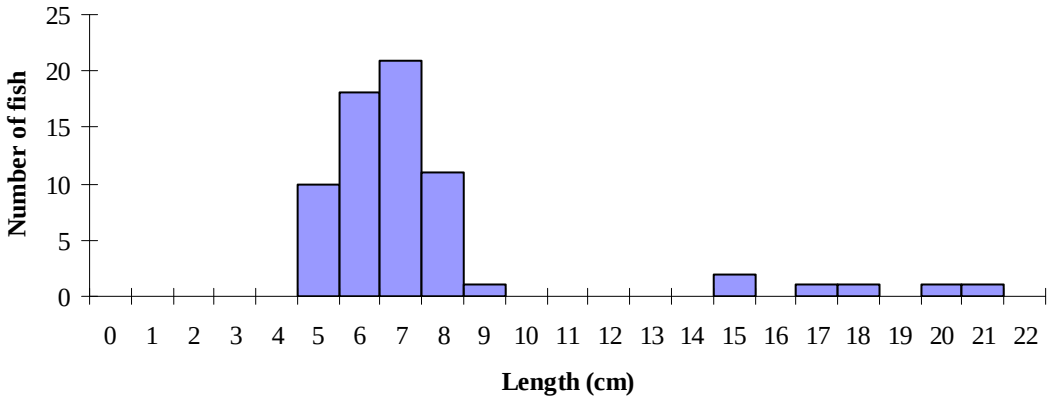

Fig. 4.16. Length frequency distribution of brown trout in the Glendine River site, July 2009 (n = 67)

4.1.7 The Moyree River

Plate 4.7. The Moyree River just upstream of its confluence with the River Fergus near Crusheen, Co. Clare

The Moyree River (Plate 4.7) is a tributary of the River Fergus. It rises in the Maghera Mountains in Co. Clare and flows westwards draining several small lakes. It continues in a southerly direction, joining the River Fergus near Addroon Bridge. Anglers tend to give more attention to the River Fergus itself than to this small tributary. The Moyree River has been designated as an SAC on account of its extensive colony of lesser horseshoe bats, an EU Habitats Directive Annex II species, and the presence of several examples of Annex I priority habitats; floating vegetation, caves, alkaline fen and floating limestone (NPWS, 2001).

The survey site was located on the upstream side of a bridge, just above the River Fergus confluence (Fig. 4.17). Three electric-fishing passes were conducted using two bank-based electric-fishing units on the 11th of August 2009 along a 45m stretch of river channel. Glide and cobble dominated the channel at this location, and the mean wetted width and mean depth of the stretch surveyed were 9.6m and 29.0cm respectively. This site composed two distinct habitats; a shaded stretch which could be easily waded and an open stretch which was thick with vegetation, making it more difficult to wade

through. A wide variety of macrophyte species were recorded, including aquatic mosses and liverworts as well as numerous emergent and floating species. A total wetted area of 433m^2 was surveyed.

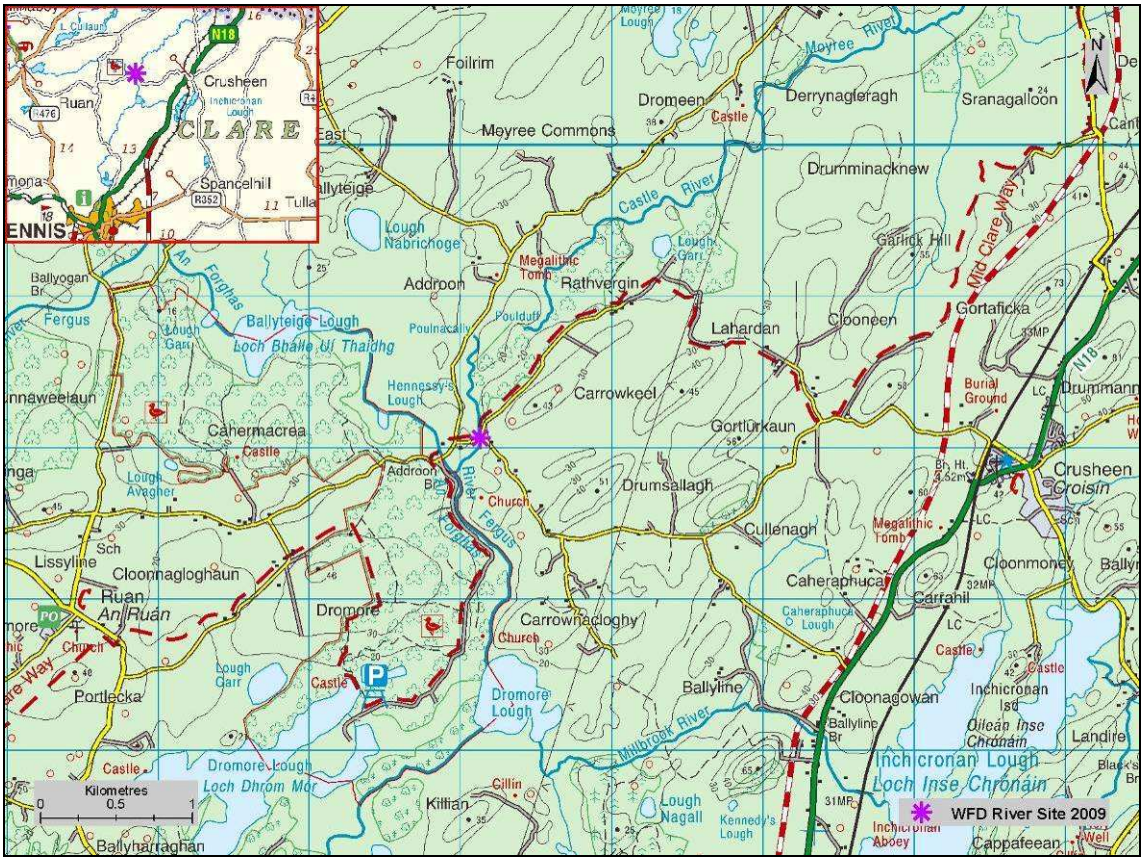

Fig. 4.17. Location of the Moyree River surveillance monitoring site

A total of six fish species were recorded in the Moyree River site. Salmon was the most abundant species, followed by brown trout, European eel, pike, perch and juvenile lamprey (Table 4.7).

Table 4.7. Density of fish (no./m^2), Moyree River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.0601	0.0139	0.0739
Salmo trutta	Brown trout	0.0185	-	0.0185
Anguilla anguilla	European eel	-	-	0.0139
Esox lucius	Pike	-	-	0.0046
Perca fluviatilis	Perch	-	-	0.0046
	Lamprey sp.	-	-	0.0023
All fish	All fish	-	-	0.1179

Salmon ranged in length from 6.5cm to 13.2cm (Fig. 4.18). Two age classes (0+ and 1+) were present, accounting for approximately 85% and 15% of the total salmon catch respectively. Mean salmon L1 was 5.9cm (Appendix 2).

Brown trout ranged in length from 7.0cm to 8.9cm, with the sample being composed entirely of 0+ fry. European eels ranged in length from 19.2cm to 45.6cm, and juvenile lamprey captured ranged from 12.8cm to 14.1cm in length.

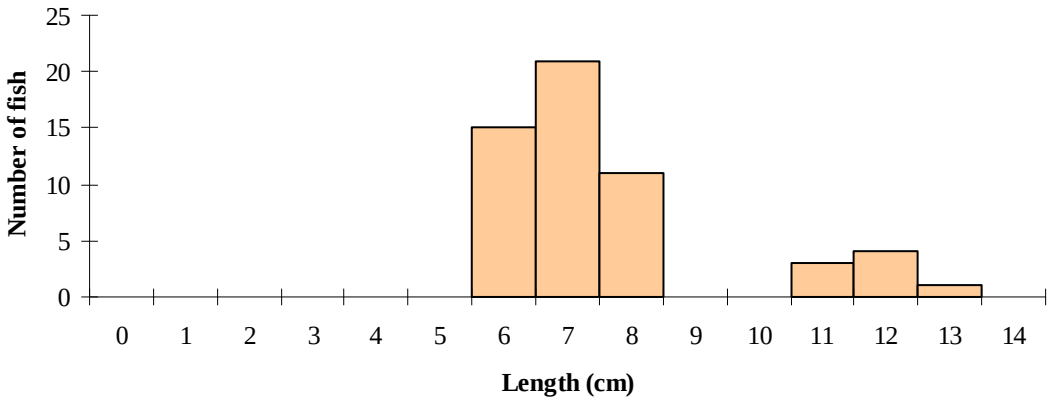

Fig. 4.18. Length frequency distribution of salmon in the Moyree River site, August 2009 (n = 55)

4.1.8 The Newport River

Plate 4.8. The Newport River upstream of Rockvale Bridge near Newport, Co. Tipperary

The Newport River (Plate 4.8) is a tributary of the Mulkear River, located mainly in Co. Tipperary. It rises in the Silvermines Mountains and flows west through the village of Newport, later joining the Annagh to form the Kileengarrif, which joins the Mulkear just south of Barringtonsbridge in Co. Limerick. The Newport River is part of the Mulkear River SAC as discussed in Section 4.1.2 and 4.1.5.

The survey site was located just downstream of the Newport waste-water treatment plant outflow (Fig. 4.19). Two electric-fishing passes were conducted using three bank-based electric-fishing units on the 2nd of September 2009 along a 40m length of river channel. Although glide and boulder dominated the habitat and substrate respectively, there was a good variety of habitat and substrate types present throughout the channel. The mean wetted width of the stretch surveyed was 12.6m and the mean depth was 32.0cm. This was a relatively heavily shaded stretch of river, with bryophytes (mosses and liverworts) featuring most prominently among the flora present. The rocky substrate was also covered with a layer of algae. A total wetted area of 502m^2 was surveyed.

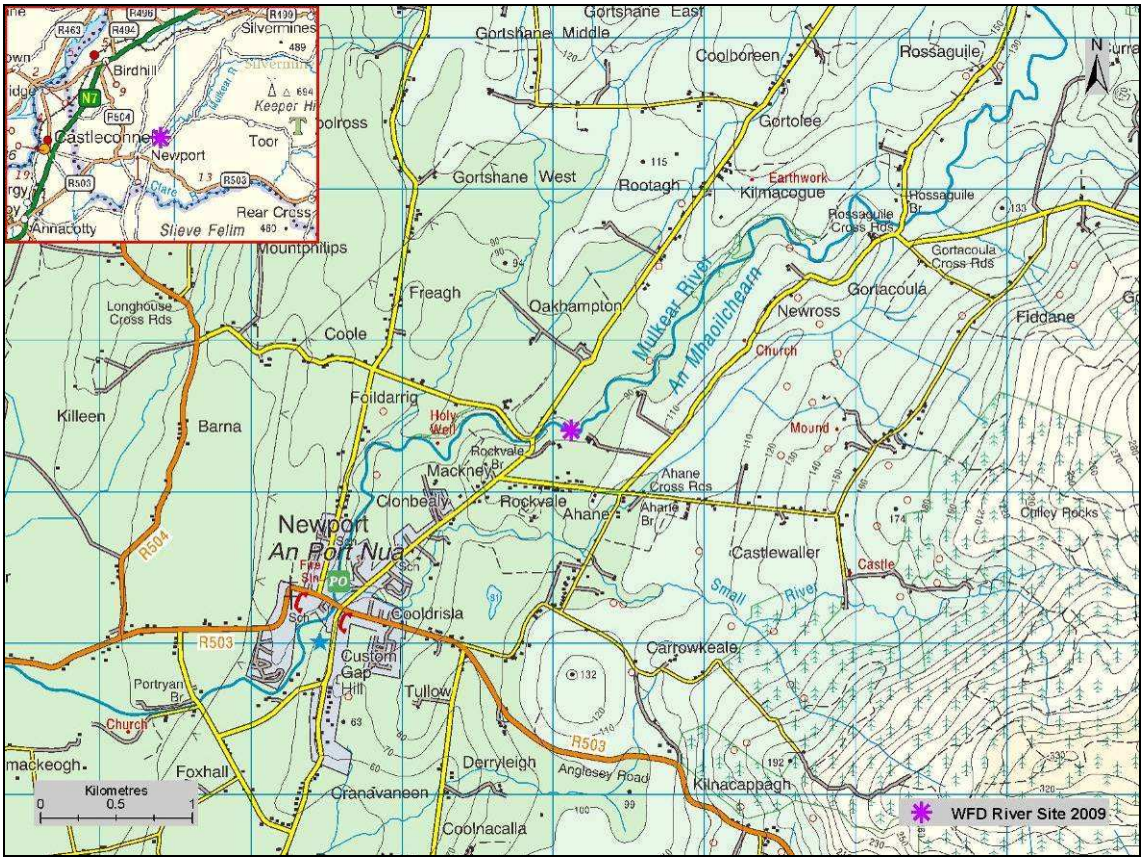

Fig. 4.19. Location of the Newport River surveillance monitoring site

A total of four fish species were recorded in the Newport River site. Salmon was the most abundant species, followed by brown trout, juvenile lamprey and European eel (Table 4.8).

Table 4.8. Density of fish (no./m^2), Newport River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.0339	0.0837	0.1175
Salmo trutta	Brown trout	0.0100	0.0259	0.0359
	Lamprey sp.	-	-	0.0080
Anguilla anguilla	European eel	-	-	0.0040
All fish	All fish	-	-	0.1653

Salmon ranged in length from 4.4cm to 14.2cm (Fig. 4.20). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 37%, 49% and 14% of the total salmon catch respectively. Mean salmon L1 and L2 were 4.0cm and 8.1cm respectively (Appendix 2).

Brown trout ranged in length from 5.2cm to 26.9cm (Fig. 4.21). Four age classes (0+, 1+, 2+ and 3+) were present, accounting for approximately 28%, 7%, 38% and 28% of the total brown trout catch

respectively. Mean brown trout L1, L2 and L3 were 6.0cm, 13.2cm and 15.5cm respectively (Appendix 1). This indicates a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

European eels and juvenile lampreys ranged in length from 24.9cm to 50.7cm and 11.6cm to 12.5cm respectively.

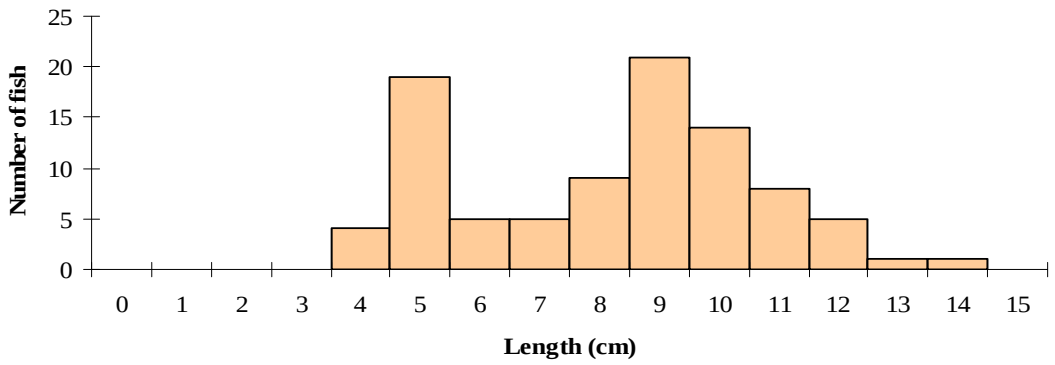

Fig. 4.20. Length frequency distribution of salmon in the Newport River site, September 2009 (n = 92)

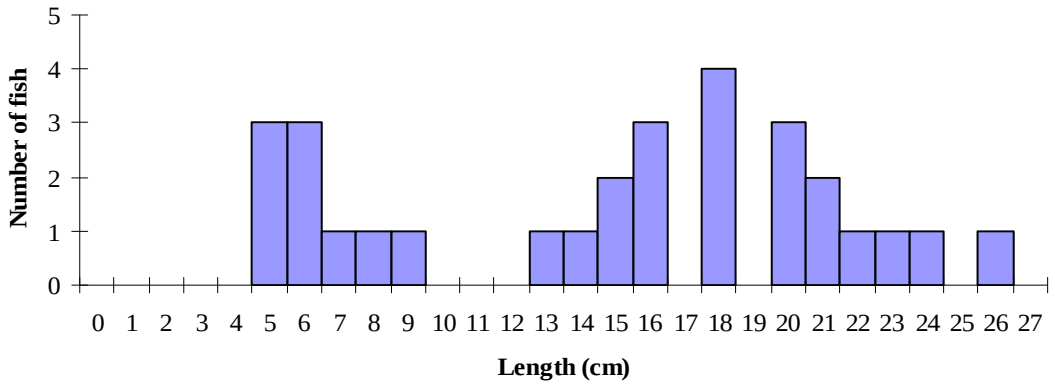

Fig. 4.21. Length frequency distribution of brown trout in the Newport River site, September 2009 (n = 29)

4.1.9 The Owvane River (Limerick)

Plate 4.9. The Owvane River upstream of the bridge in Loghill, Co. Limerick

The Owvane River (Plate 4.9) is located in Co. Limerick. It flows in a northerly direction, joining the Shannon Estuary near the village of Loghill. Salmon and sea trout are both known to be present in this river but have declined in number in recent years and struggled to replenish themselves (O'Reilly, 2009).

The survey site was located just outside Loghill (Fig. 4.22). Three electric-fishing passes were conducted using three bank-based electric-fishing units on the 15th of September 2009 along a 45m length of river channel. Glide and cobble dominated the habitat and the substrate at this site respectively. The mean wetted width of the stretch surveyed was 13.7m, and the mean depth was 24.0cm. Macrophyte species present at this site included various mosses and liverworts, typical of shallow rocky streams. This survey was conducted quite close to the sea and had the common estuarine algae, *Enteromorpha* present, suggesting that the site was in close proximity to the river's upper tidal limits. A total wetted area of 617m^2 was surveyed.

Fig. 4.22. Location of the Owvane River surveillance monitoring site

A total of five fish species were recorded in the Owvane River site. European eel was the most abundant species, followed by salmon, brown trout, flounder and three-spined stickleback (Table 4.9).

Table 4.9. Density of fish (no./m^2), Owvane River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Anguilla anguilla	European eel	-	-	0.0989
Salmo salar	Salmon	0.0811	0.0130	0.0941
Salmo trutta	Brown trout	0.0811	0.0130	0.0697
Platichthys flesus	Flounder	-	-	0.0357
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0130
All fish	All fish	-	-	0.3114

European eels ranged in length from 7.9cm to 35.7cm (Fig. 4.23).

Salmon ranged in length from 6.7cm to 15.1cm (Fig. 4.24). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 87%, 8% and 5% of the total salmon catch respectively. Mean salmon L1 and L2 were 5.2cm and 7.9cm respectively (Appendix 2).

Brown trout ranged in length from 6.9cm to 19.4cm (Fig. 4.25). Two age classes (0+ and 1+) were present, accounting for approximately 69% and 31% of the total brown trout catch respectively. Mean brown trout L1 was 7.4cm (Appendix 1).

Flounder ranged in length from 3.5cm to 9.9cm (Fig. 4.26). Three-spined stickleback ranged in length from 2.4cm to 4.1cm (Fig. 4.27).

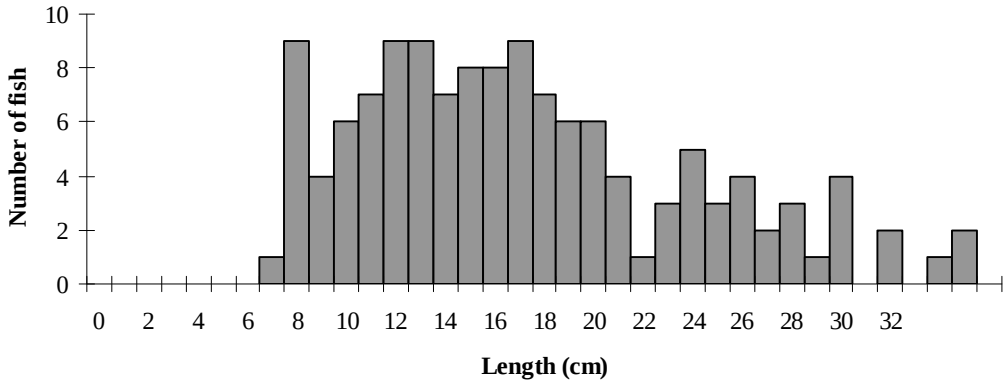

Fig. 4.23. Length frequency distribution of European eels in the Owvane River site, September 2009 (n = 131)

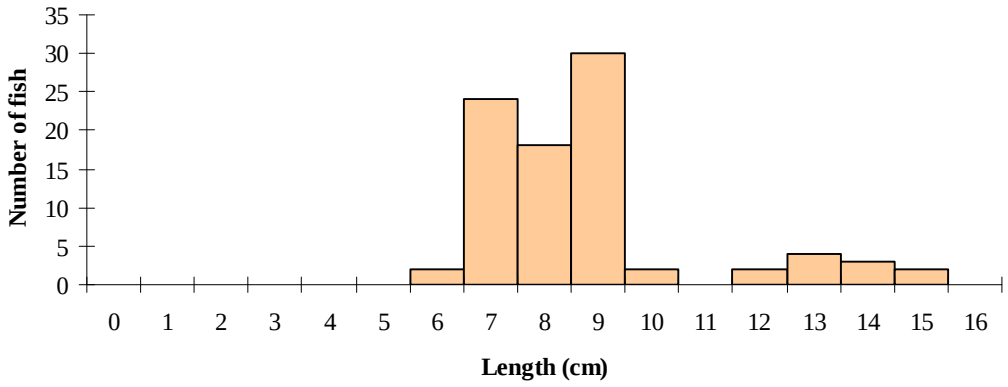

Fig. 4.24. Length frequency distribution of salmon in the Owvane River site, September 2009 (n = 87)

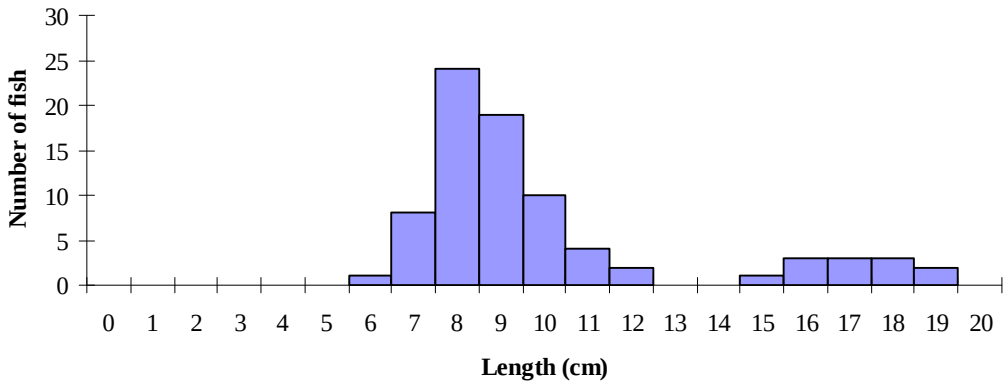

Fig. 4.25. Length frequency distribution of brown trout in the Owvane River site, September 2009 (n = 80)

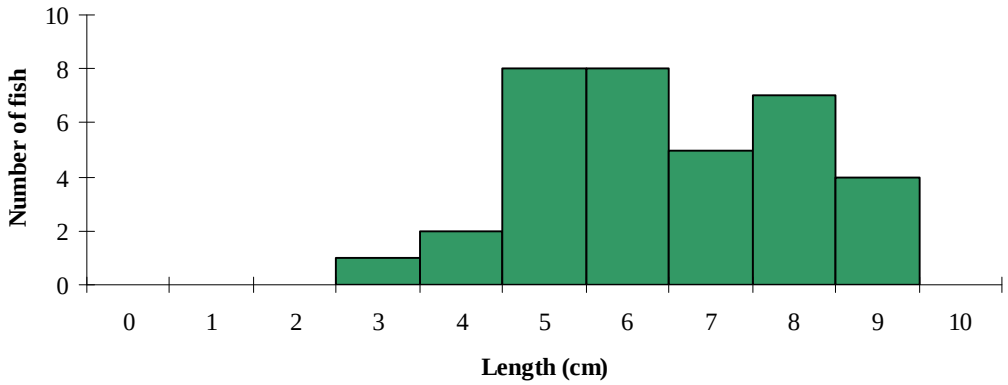

Fig. 4.26. Length frequency distribution of flounder in the Owvane River site, September 2009 (n = 35)

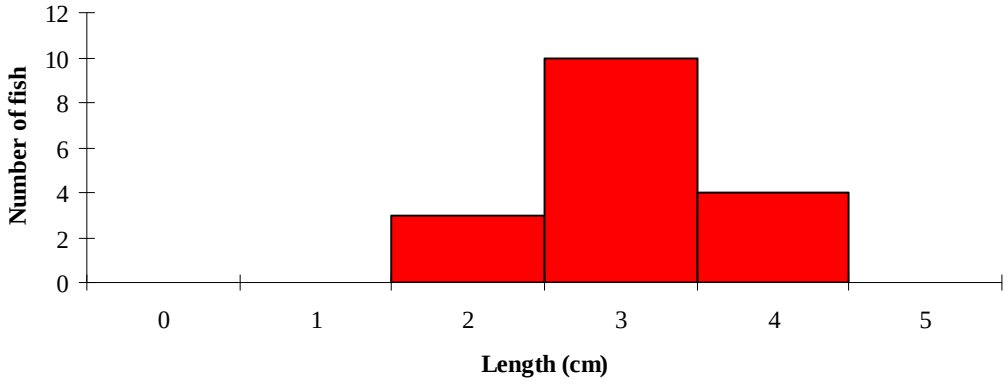

Fig. 4.27. Length frequency distribution of three-spined stickleback in the Owvane River site, September 2009 (n = 17)

4.1.10 The Owveg River (Kerry)

Plate 4.10. The Owveg River at Owveg Bridge near Knocknagashel, Co. Kerry

The Owveg River (Plate 4.10) is a tributary of the River Feale, located in north-east Co. Kerry and flows in a northerly direction, joining the River Feale on the border between Co. Kerry and Co. Limerick. It is a spate river and is known to contain a small number of sea trout (O'Reilly, 2009). The Owveg River is a tributary of the River Feale, which subsequently enters the Lower River Shannon and is thus encompassed within the Lower River Shannon SAC (see Section 4.1.5). The survey site also lies on the border of the Stacks Mountains and the Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA.

The survey site was located downstream of a bridge approximately 3km south-east of Knocknagashel, Co. Kerry (Fig. 4.28). Three electric-fishing passes were conducted using three bank-based electric-fishing units on the 16th of September 2009 along a 43m length of river channel. Glide and riffle dominated the habitat, whilst the substrate consisted mostly of cobble. The mean wetted width of the stretch surveyed was 5.8m and the mean depth was 17.0cm. The shallow water and rocky substrate present at this site provided a good habitat for aquatic mosses and liverworts, which were abundant throughout. A total wetted area of 249m^2 was surveyed.

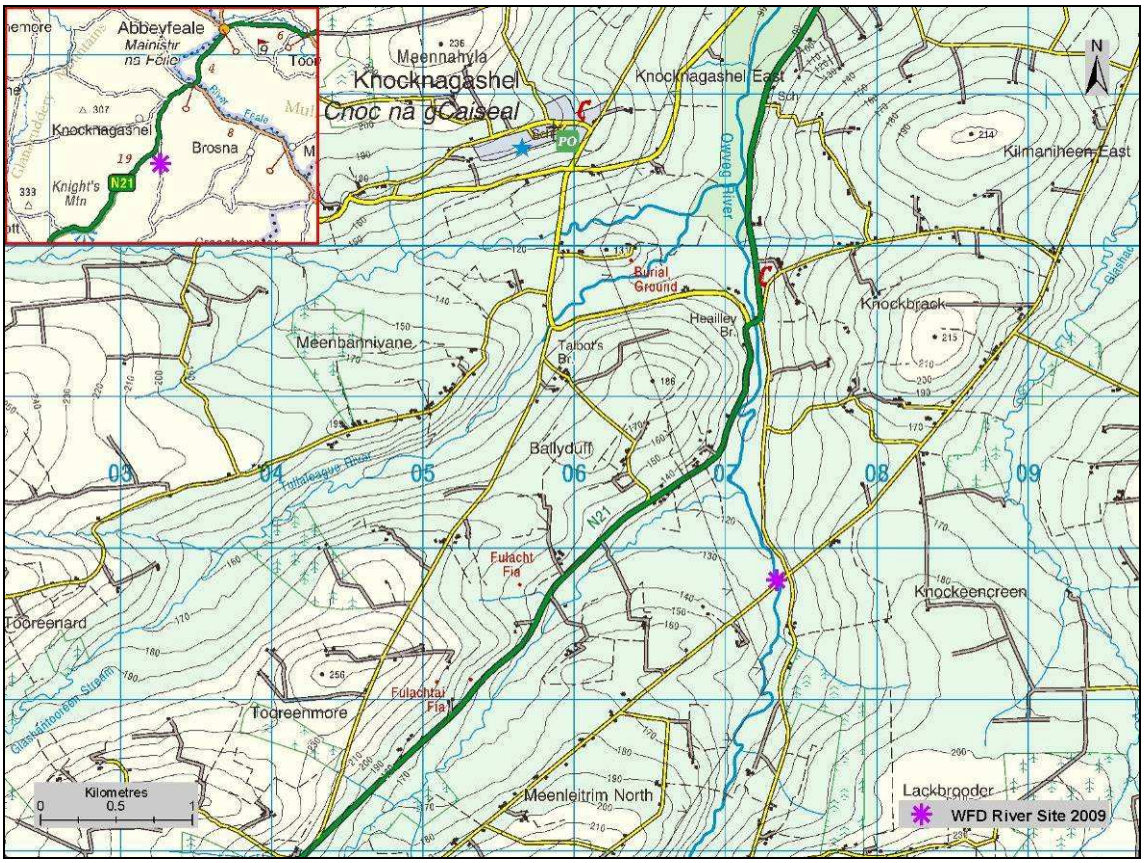

Fig. 4.28. Location of the Owveg River surveillance monitoring site

There were only two fish species recorded in the Owveg River site. Salmon was the most abundant species, followed by brown trout (Table 4.10).

Table 4.10. Density of fish (no./m^2), Owveg River (Kerry) site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo salar	Salmon	0.1443	0.1163	0.2606
Salmo trutta	Brown trout	0.0481	0.0321	0.0802
All fish	All fish	-	-	0.3408

Salmon ranged in length from 4.1cm to 15.7cm (Fig. 4.29). Two age classes (0+ and 1+) were present, accounting for approximately 66% and 34% of the total salmon catch respectively. Mean salmon L1 was 4.5cm (Appendix 2).

Brown trout ranged in length from 5.9cm to 20.2cm (Fig. 4.30). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 53%, 43% and 3% of the total brown trout catch

respectively. Mean brown trout L1 and L2 were 5.9cm and 20.2cm respectively (Appendix 1). This indicates a fast rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

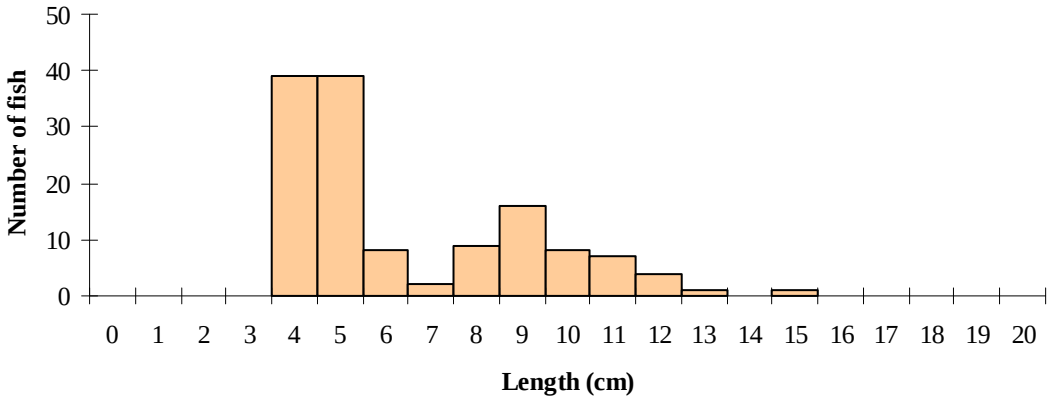

Fig. 4.29. Length frequency distribution of salmon in the Owveg River site, September 2009 (n = 134)

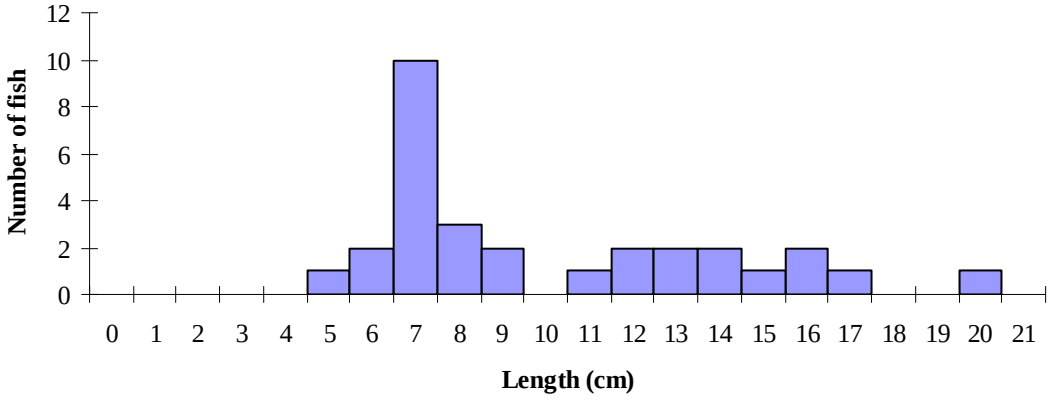

Fig. 4.30. Length frequency distribution of brown trout in the Owveg River site, September 2009 (n = 30)

4.1.11 The Tyshe River (Ardfert)

Plate 4.11. The Tyshe River just outside Ardfert, Co. Kerry

The Tyshe River (Plate 4.11) is located in north Co. Kerry, rising a few kilometres east of Ardfert. It flows westwards for approximately 10km, draining farmland until it joins the sea at Banna Strand.

The survey site was located near Ardfert in a field downstream of the monastic ruins in the village (Fig. 4.31). Three electric-fishing passes were conducted using one bank-based electric-fishing unit on the 9th of July 2009 along a 75m length of river channel. The mean wetted width of the surveyed stretch was only 2.6m and the mean depth was 37.0cm. The survey stretch consisted primarily of glide, although riffle and pool were also present. The dominant substrates were mud and silt. Macrophyte vegetation at the site mainly consisted of emergent marginal species but also contained a submerged moss species tolerant of poor quality water. A total wetted area of 196m^2 was surveyed.

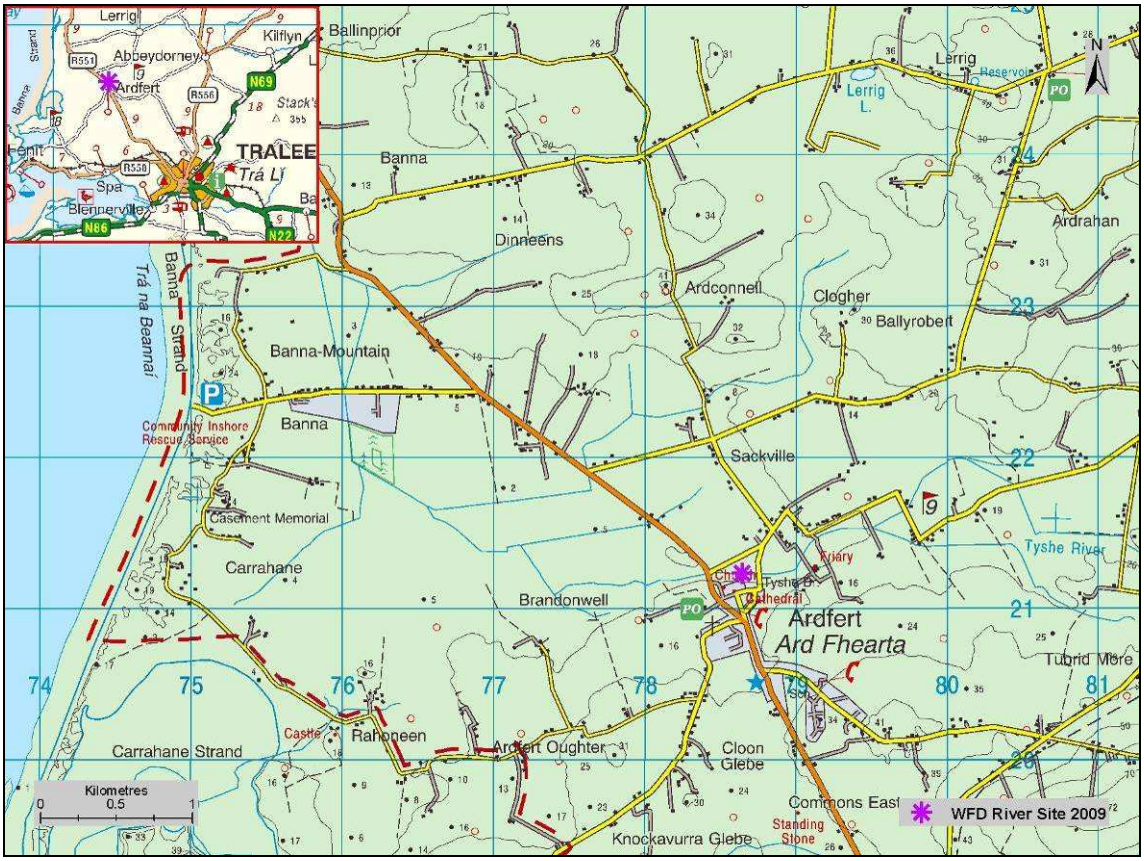

Fig. 4.31. Location of the Tyshe River surveillance monitoring site

Two fish species were recorded in the Tyshe River site. European eel was the most abundant species, followed by three-spined stickleback (Table 4.11).

Table 4.11. Density of fish (no./m^2), Tyshe River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Anguilla anguilla	European eel	-	-	0.2812
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0767
All fish	All fish	-	-	0.3578

European eels ranged in length from 8.2cm to 34.6cm (Fig. 4.32). Three-spined stickleback ranged in length from 4.0cm to 6.1cm (Fig. 4.33).

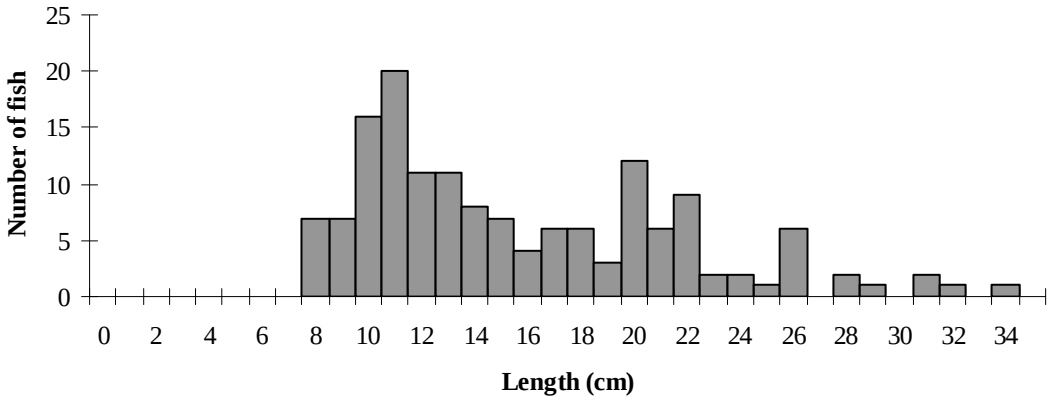

Fig. 4.32. Length frequency distribution of European eels in the Tyshe River site, July 2009 (n = 151)

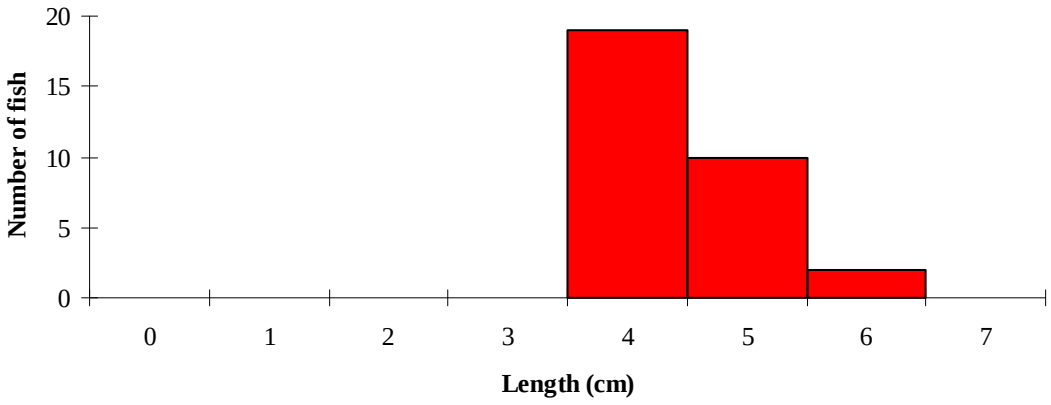

Fig. 4.33. Length frequency distribution of three-spined stickleback in the Tyshe River site, July 2009 (n = 31)

4.2 Boat sites

4.2.1 The Creegh River

Plate 4.12. The Creegh River at Drumellihy Bridge downstream of Creegh, Co. Clare

The Creegh River (Plate 4.12) is located in south-west Co. Clare. It enters the sea at Carrowmore Dunes, approximately 1km north-east of Doonbeg, between Rinnagonnaght Strand and White Strand. Despite being a relatively small river and frequently in spate, the Creegh is known for good stocks of sea trout and small runs of salmon during floods in early summer.

The survey site was located upstream of Drumellihy Bridge (Fig.4.34). Three electric-fishing passes were conducted using one boat-based electric fishing unit on the 14th of September 2009 along a 159m stretch of river channel. Glide was the most abundant habitat present, whilst cobble and gravel dominated the substrate. The mean wetted width and mean depth of the stretch surveyed were 7.3m and 33.0cm respectively. Macrophyte vegetation present included various mosses as well as submerged and emergent species. A total wetted area of 1,162m^2 was surveyed.

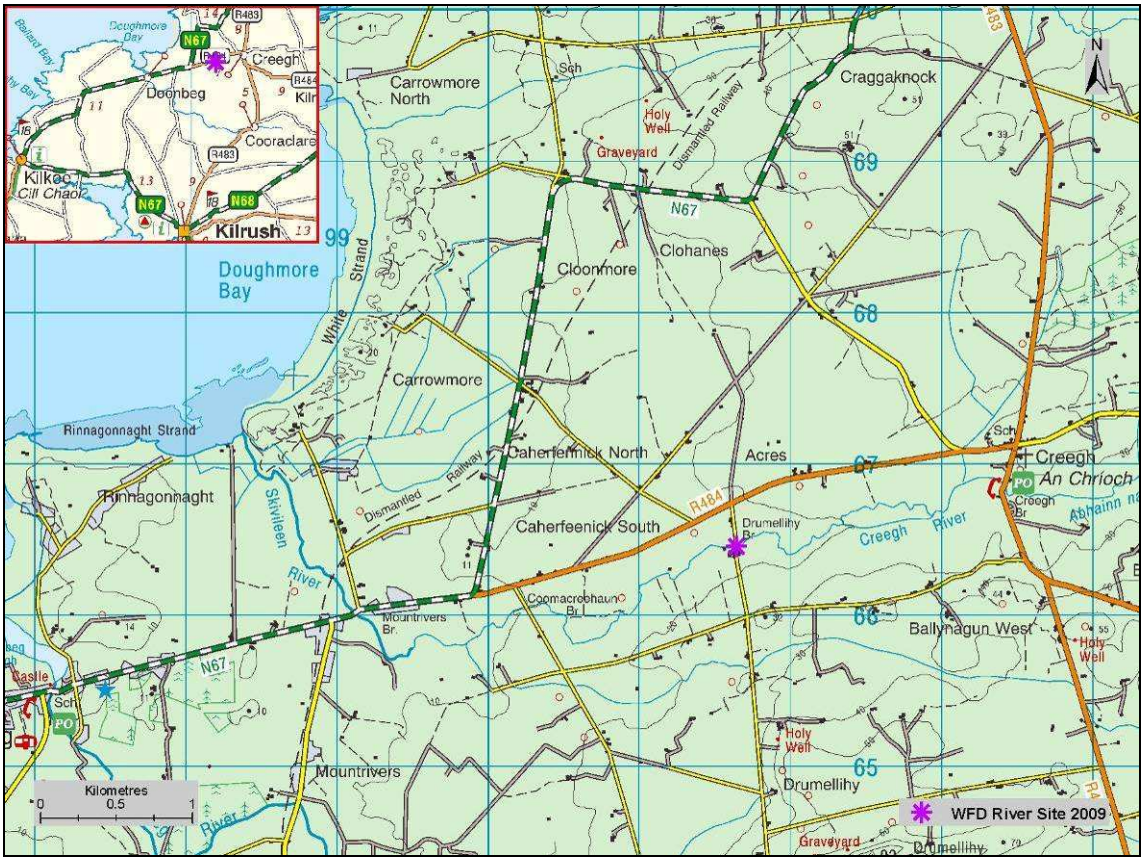

Fig. 4.34. Location of the Creegh River surveillance monitoring site

A total of five fish species were recorded in the Creegh River site. Brown trout was the most abundant species, followed by salmon, flounder, European eel and three-spined stickleback (Table 4.12).

Table 4.12. Density of fish (no./m^2), Creegh River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo trutta	Brown trout	0.0009	0.0275	0.0284
Salmo salar	Salmon	0.0017	0.0215	0.0215
Platichthys flesus	Flounder	-	-	0.0017
Anguilla anguilla	European eel	-	-	0.0009
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0009
All fish	All fish	-	-	0.0534

Brown trout ranged in length from 7.4cm to 29.6cm (Fig. 4.35). Five age classes (0+, 1+, 2+, 3+and 4+) were present, accounting for approximately 6%, 38%, 40%, 15% and 2% of the total brown trout catch respectively. Mean brown trout L1, L2, L3 and L4 were 8.2cm, 14.5cm, 19.1cm and 22.8cm

respectively (Appendix 1). This indicates a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

Juvenile salmon ranged in length from 6.0cm to 15.9cm, and a single adult salmon measuring 62.6cm in length was also captured; the length frequency distribution in Fig. 4.36 shows only the juvenile salmon. Three age classes of juvenile salmon (0+, 1+ and 2+) were present, accounting for approximately 7%, 86% and 6% of the total salmon catch respectively. Mean salmon L1 and L2 were 5.9cm and 9.1cm respectively (Appendix 2).

European eels ranged in length from 17.1cm to 34.5cm. A single three-spined stickleback measuring 3.8cm was captured. Flounder ranged in length from 10.2cm to 19.0cm.

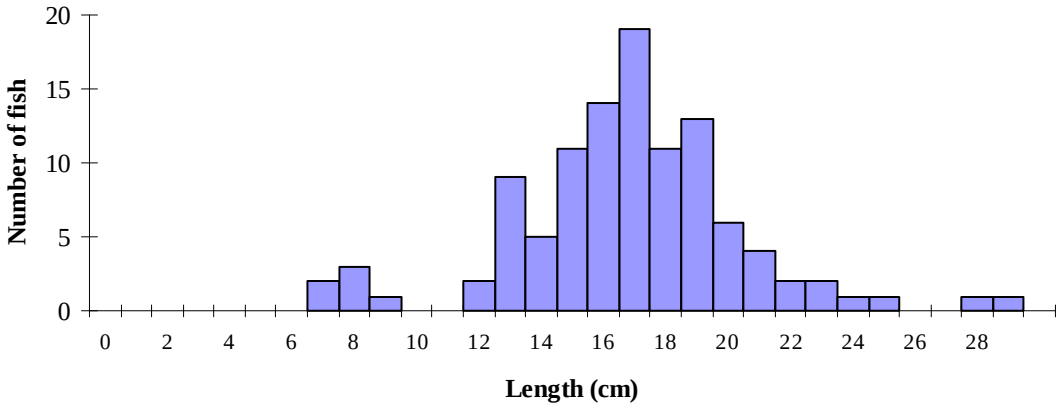

Fig. 4.35. Length frequency distribution of brown trout in the Creegh River, September 2009 (n = 108)

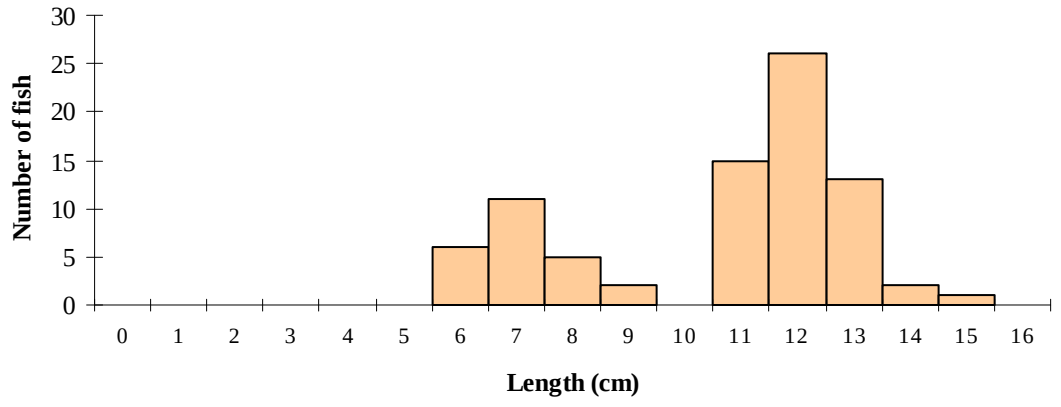

Fig. 4.36. Length frequency distribution of juvenile salmon in the Creegh River, September 2009 (n = 81)

4.2.2 The Feorish River (Ballyfarnon)

Plate 4.13. The Feorish River at Leiterra Bridge near Keadew, Co. Roscommon

The Feorish River (Plate 4.13) is a tributary of the River Shannon, located in Co. Sligo and Co. Roscommon. It rises in the hills north of Ballyfarnon and drains two lakes, Lough Skean and Lough Meelagh, before flowing eastwards to join the River Shannon approximately 3km east of Keadew, Co. Roscommon. Brown trout stocks have been reported as generally good within this river, particularly within pooled areas (O'Reilly, 2009). The Feorish River was previously surveyed in 2008, but high water levels and adverse weather conditions at the time were unfavourable for sampling; consequently, the river was included in the 2009 sampling programme.

The survey site was located upstream of Leiterra Bridge (Fig. 4.37). Two electric-fishing passes were conducted using one boat-based electric-fishing unit on the 18th of September 2009 along a 79m stretch of channel. The mean wetted width of the stretch surveyed was 7.3m and the mean depth was estimated to be between 200cm and 250cm. The depth and turbidity of the water prevented a visual assessment of substrate type being conducted; however regular probing indicated a mainly hard substrate. The habitat was composed entirely of glide. Macrophyte vegetation recorded consisted of

emergent and riparian species typical of slow moving and deep channels. A total wetted area of 573m^2 was surveyed.

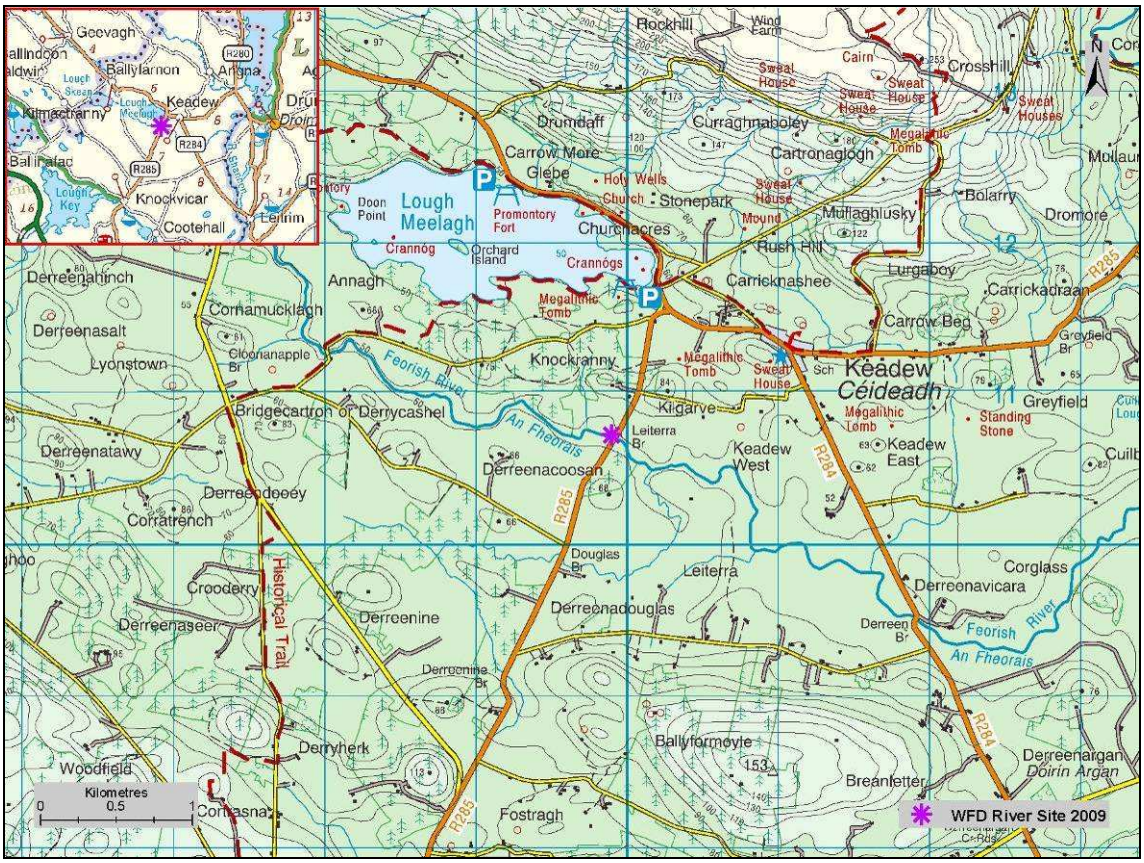

Fig. 4.37. Location of the Feorish River surveillance monitoring site

Only a single fish was captured in the Feorish River site (Table 4.13); a pike measuring 20.7cm, captured in the first pass.

Table 4.13. Density of fish (no./m^2), Feorish River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Esox lucius	Pike	-	-	0.0017
All fish	All fish	-	-	0.0017

4.2.3 The River Fergus

Plate 4.14. The River Fergus at Poplar Bridge near Corrofin, Co. Clare

The River Fergus (Plate 4.14) is located in Co. Clare. It rises near the village of Kilfenora and loops its way in a south-easterly direction through a number of lakes, including Inchiquin Lough and Lough Atedaun near Corrofin. It flows southwards through the town of Ennis before entering the Shannon Estuary. Brown trout and salmon angling are both well documented on the River Fergus; however, its popularity as a salmon fishery has declined in recent years (O'Reilly, 2009). The survey site was located upstream of Poplar Bridge, approximately 3km north-west of Corrofin, Co. Clare (Fig. 4.38).

One electric-fishing pass was conducted using two boat-based electric-fishing units on the 22nd of September 2009 along a 295m length of river channel. The mean wetted width of the stretch surveyed was 15m, and the mean depth estimated to be between 200 and 250cm. Glide was by far the most dominant habitat, although some pools were also present. There was a range of macrophyte species present; mosses and liverworts were abundant in shallower and faster sections, whilst the deeper, slower areas contained more submerged and floating species. A total wetted area of 4,425m^2 was surveyed.

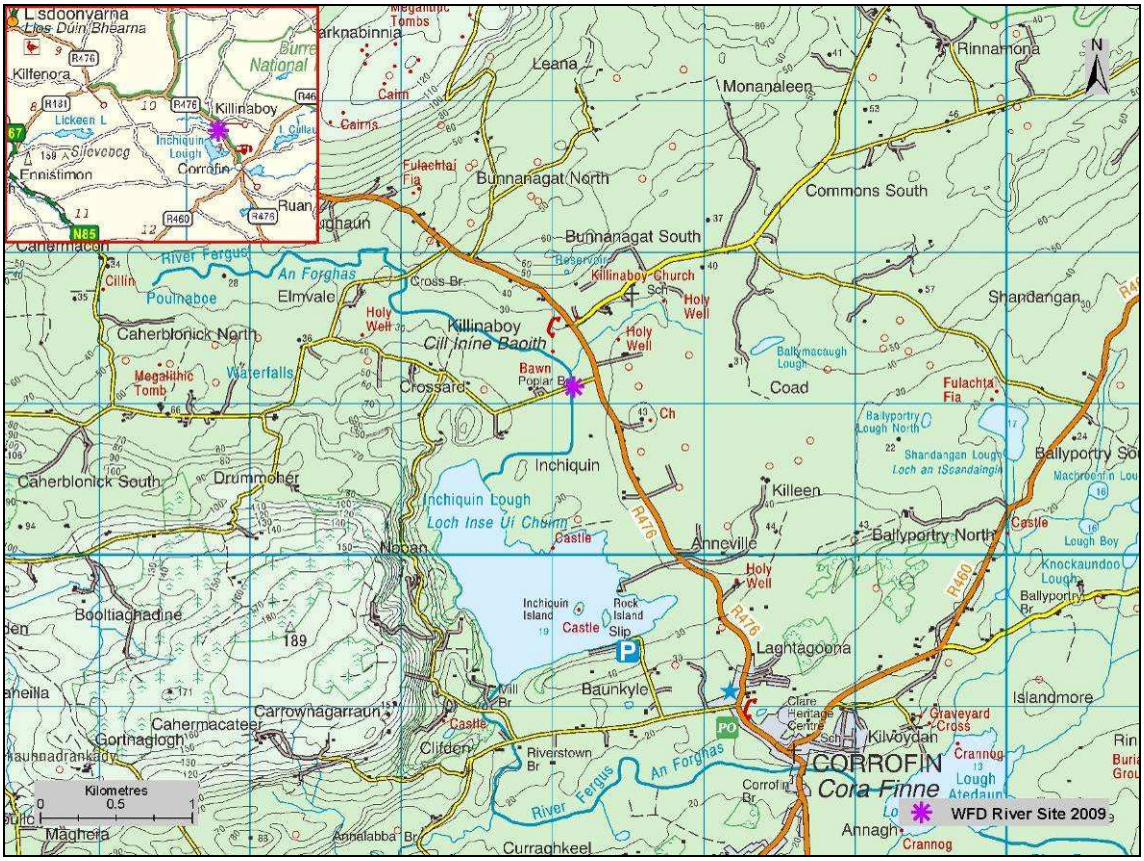

Fig. 4.38. Location of the River Fergus (Poplar Bridge) surveillance monitoring site

A total of five fish species were recorded in the River Fergus site. Brown trout was the most abundant species, followed by pike, three-spined stickleback, European eel and perch (Table 4.14).

Table 4.14. Density of fish (no./m^2), River Fergus (Poplar Bridge site) (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo trutta	Brown trout	0.0036	0.0088	0.0124
Esox lucius	Pike	-	-	0.0005
Gasterosteus aculeatus	Three-spined stickleback	-	-	0.0005
Anguilla anguilla	European eel	-	-	0.0002
Perca fluviatilis	Perch	-	-	0.0002
All fish	All fish	-	-	0.0138

Brown trout ranged in length from 7.1cm to 31.9cm (Fig. 4.39). Three age classes (0+, 1+ and 2+) were present, accounting for approximately 29%, 64% and 7% of the total brown trout catch respectively. Mean brown trout L1 and L2 were 8.0cm and 22.1cm respectively (Appendix 1). This indicates a very fast rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

A single eel measuring 38.0cm in length was also recorded.

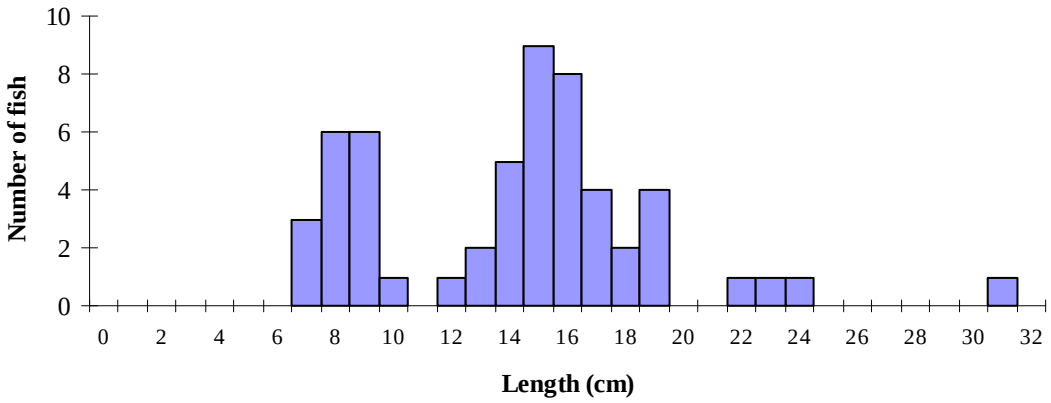

Fig. 4.39. Length frequency distribution of brown trout in the River Fergus, September 2009 (n = 55)

4.2.4 The Nenagh River

Plate 4.15. The Nenagh River at Ballysollshaun Bridge near Nenagh, Co. Tipperary

The Nenagh River (Plate 4.15) rises in the Silvermines Mountains in Co. Tipperary. It loops in a north-westerly direction and continues through the town of Nenagh until it joins Lough Derg at Dromineer. Although there are stocks of salmon within the Nenagh River, it is better known for its plentiful supplies of brown trout, with individual catches of over 2kg possible (O'Reilly, 2009).

The survey site was located upstream of Ballysollshaun Bridge, approximately 7km south-east of Nenagh (Fig. 4.40). Three electric-fishing passes were conducted using one boat-based electric-fishing unit on the 6th of August 2009 along a 138m length of river channel. The habitat was primarily composed of glide, although areas of riffle and pool were also present. The most abundant substrate was cobble, with gravel, boulder and sand also present is lesser quantities. The mean wetted width of the stretch surveyed was 7.2m and the mean depth was 52.0cm. Submerged vegetation was abundant throughout the stretch as well as emergent species in the shallower areas along the margins. A total wetted area of 994m^2 was surveyed.

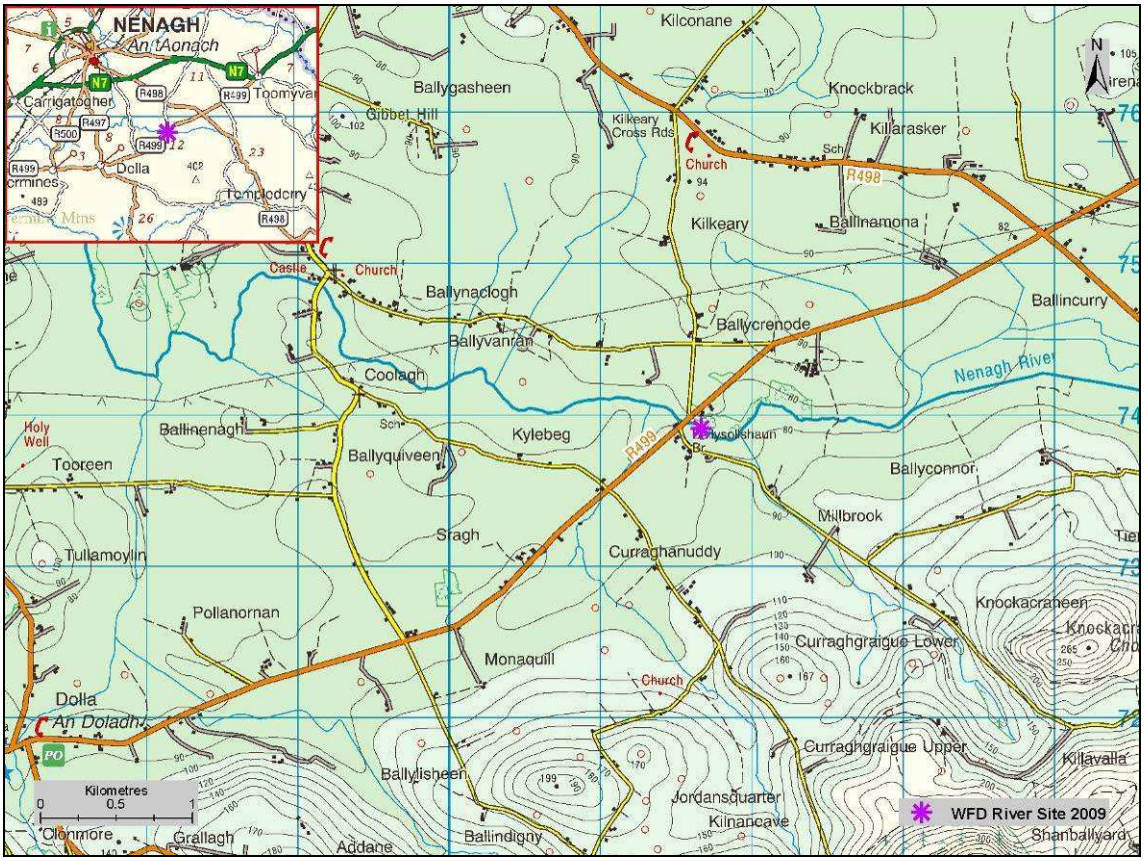

Fig. 4.40. Location of the Nenagh River surveillance monitoring site

A total of five fish species were recorded in the Nenagh River site. Brown trout was the most abundant species, followed by minnow, stone loach, salmon and European eel (Table 4.15).

Table 4.15. Density of fish (no./m^2), Nenagh River site (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Salmo trutta	Brown trout	0.0141	0.0674	0.0815
Phoxinus phoxinus	Minnow	-	-	0.0231
Barbatula barbatula	Stone loach	-	-	0.0030
Salmo salar	Salmon	0.0020	0.0020	0.0020
Anguilla anguilla	European eel	-	-	0.0010
All fish	All fish	-	-	0.1107

Brown trout ranged in length from 6.5cm to 37.4cm (Fig. 4.41). Five age classes (0+, 1+, 2+, 3+ and 4+) were present, accounting for approximately 18%, 53%, 20%, 7% and 2% of the total brown trout catch respectively. Mean brown trout L1, L2, L3 and L4 were 7.0cm, 14.2cm, 19.8cm and 24.3cm

respectively (Appendix 1). This indicated a slow rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971).

Minnow ranged in length from 3.5cm to 7.4cm (Fig. 4.42) and stone loach ranged in length from 7.7cm to 9.6cm.

Salmon ranged in length from 8.3cm to 15.7cm. Two age classes (0+ and 1+) were present, accounting for approximately 22% and 78% of the total salmon catch respectively. Mean salmon L1 was 6.5cm (Appendix 2).

A single eel measuring 29.5cm in length was also recorded.

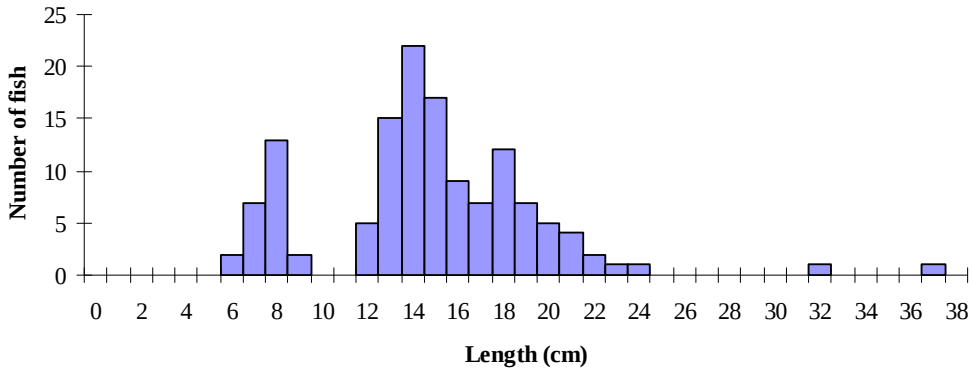

Fig. 4.41. Length frequency distribution of brown trout in the Nenagh River site, August 2009 (n = 133)

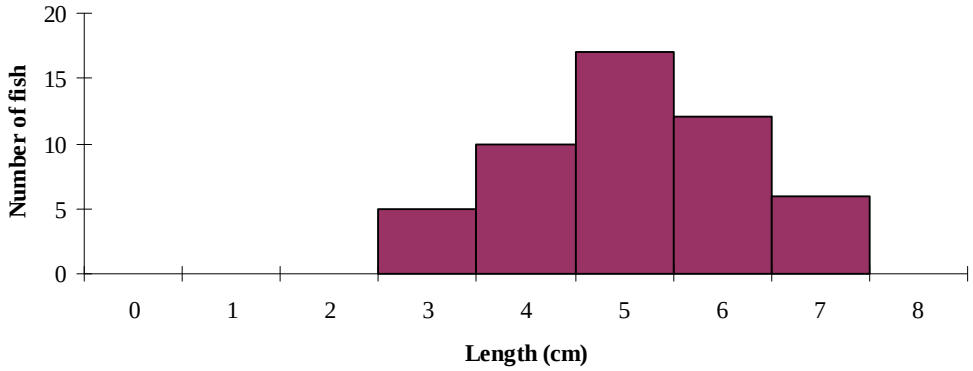

Fig. 4.42. Length frequency distribution of minnow in the Nenagh River site, September 2009 (n = 50)

4.2.5 The River Shannon (Ballyleague Bridge)

Plate 4.16. The River Shannon downstream of the bridge in Lanesborough, on the border of Counties Longford & Roscommon

The River Shannon (Plate 4.16) is Ireland's longest river, flowing for approximately 260km. It rises in the Cuilcagh Mountains in Co. Cavan and flows through three large lakes, Lough Allen, Lough Derg and Lough Ree before entering the sea at Limerick. The Shannon is historically an important navigation route and is connected to many other waterways by a series of canals, including the Royal Canal, the Grand Canal and the Shannon–Erne Waterway, which connects to the River Erne system. Together with its tributaries, the Shannon encompasses a massive catchment area. As the largest river in Ireland, it is no surprise that the Shannon is a great mixed fishery. The main channel itself contains good stocks of brown trout and also supports a good coarse fishery, whereas the tributaries of the lower catchment are better known for their game fishing (O'Reilly, 2009). Lanesborough itself is very popular among coarse anglers due to the "Hot Water Stretch" downstream of the power station outflow. There are several barriers that hinder the migration of fish upstream, including a weir at O'Briensbridge below Lough Derg, the hydro-electric power station at Ardnacrusha and a number of locks used for navigation.

The survey site was located at Ballyleague Bridge in Lanesborough, just upstream of Lough Ree on the border between Co. Roscommon and Co. Longford (Fig. 4.43).

One electric-fishing pass was conducted using four boat-based electric-fishing units on the 16th of September 2009 along a 397m length of river channel. The habitat was entirely composed of glide, and the substrate could not be determined due to the depth. The mean wetted width of the stretch surveyed was 87.5m, and the mean depth was estimated to be somewhere between 200cm and 400cm. A total wetted area of 34,738m^2 was surveyed.

Due to the large nature of this site, and the resultant relatively low number of fish captured, this site will be repeated in 2010 using high-voltage electric-fishing gear.

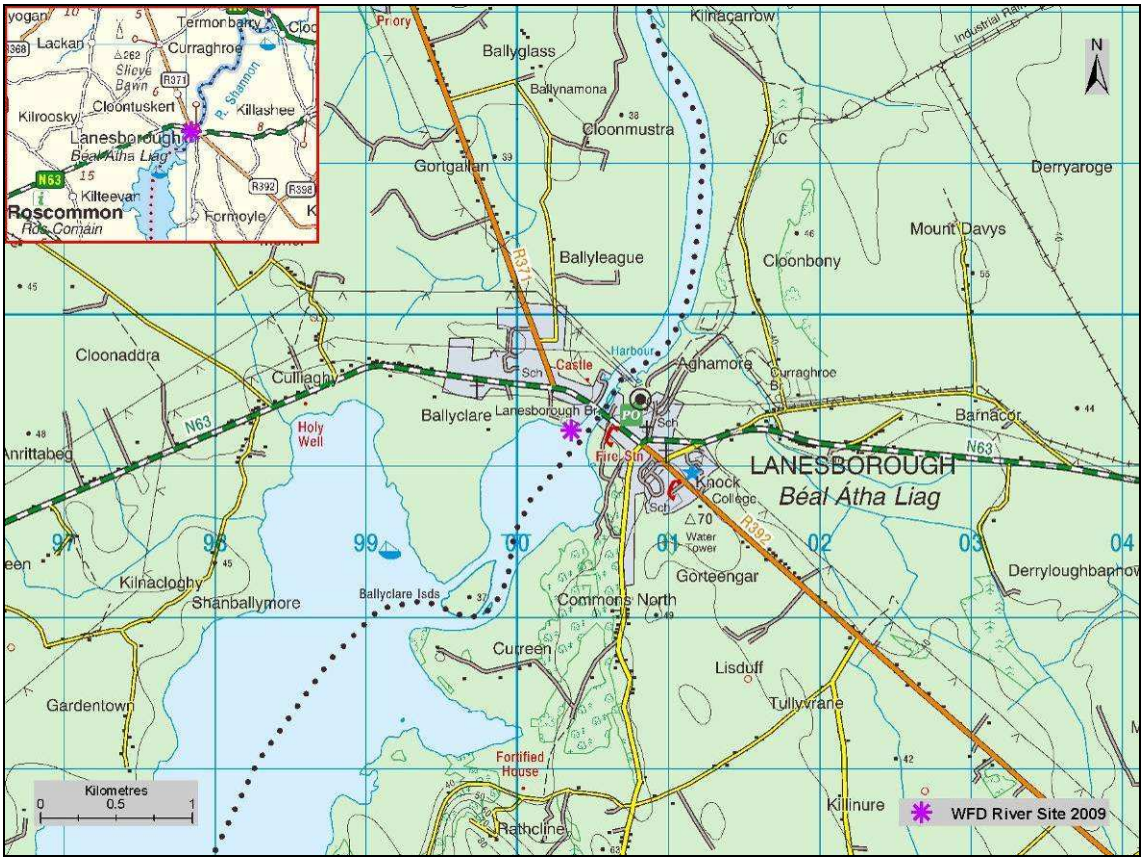

Fig. 4.43. Location of the River Shannon (Ballyleague Bridge) surveillance monitoring site

A total of four fish species were recorded in the River Shannon at Lanesborough. Roach was the most abundant species, followed by perch, European eel and pike (Table 4.16).

Table 4.16. Density of fish (no./m^2), River Shannon (Ballyleague Bridge) (fish density has been calculated as minimum estimates based on the first fishing)

Species name	Common name	0+	1+ & older	Total minimum density
Rutilus rutilus	Roach	-	-	0.0007
Perca fluviatilis	Perch	-	-	0.0005
Anguilla anguilla	European eel	-	-	0.0001
Esox lucius	Pike	-	-	0.0001
All fish	All fish	-	-	0.0014

Roach ranged in length from 3.3cm to 27.6cm (Fig. 4.44). Six age classes (0+, 1+, 2+, 3+, 4+ and 5+) were present, accounting for approximately 56%, 13%, 4%, 4%, 4% and 17% of the total roach catch respectively.

Perch ranged in length from 3.3cm to 27.6cm (Fig. 4.45). Five age classes (0+, 1+, 2+, 4+ and 5+) were present, accounting for approximately 28%, 39%, 22%, 6% and 6% of the total perch catch respectively.

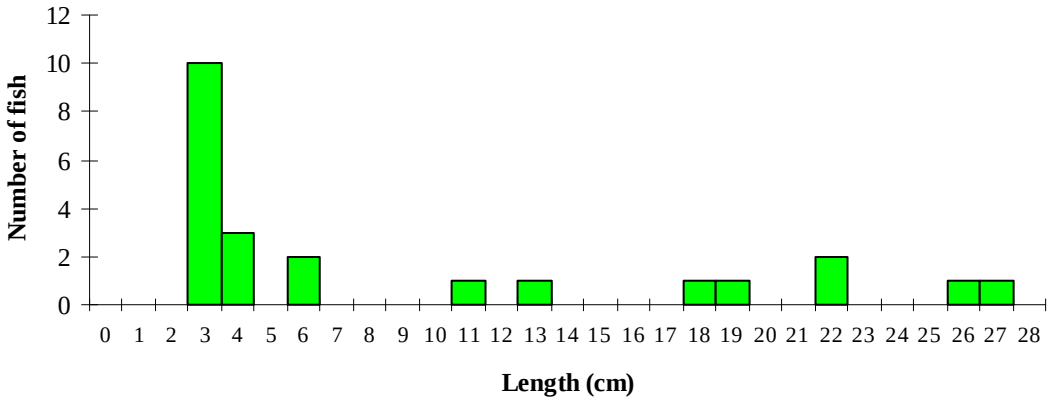

Fig. 4.44. Length frequency distribution of roach in the River Shannon (Ballyleague Bridge), September 2009 (n = 32)

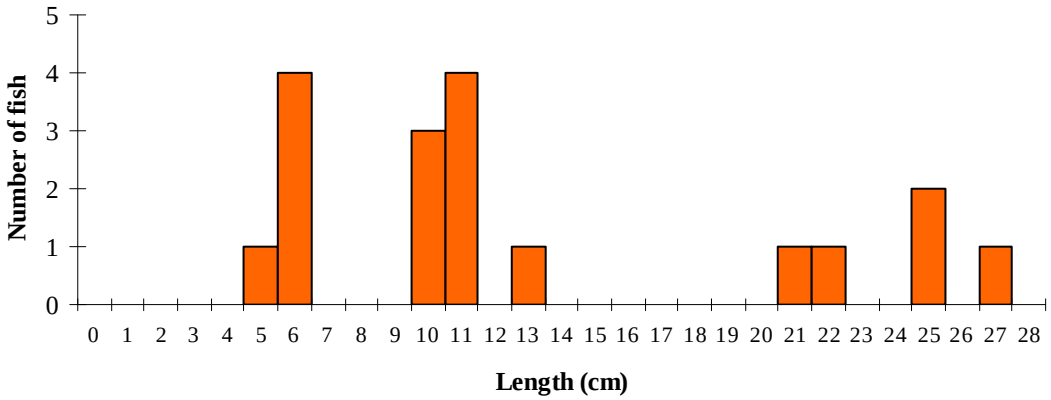

Fig. 4.45. Length frequency distribution of perch in the River Shannon (Ballyleague Bridge), September 2009 (n = 18)

4.3 Community structure

4.3.1 Species richness and composition

A total of twelve fish species were recorded within the 16 ShIRBD sites surveyed during 2009 (Fig. 4.46). European eel (88%), followed by brown trout (81%) and salmon (69%) were the most widespread fish species recorded (Fig. 4.46).

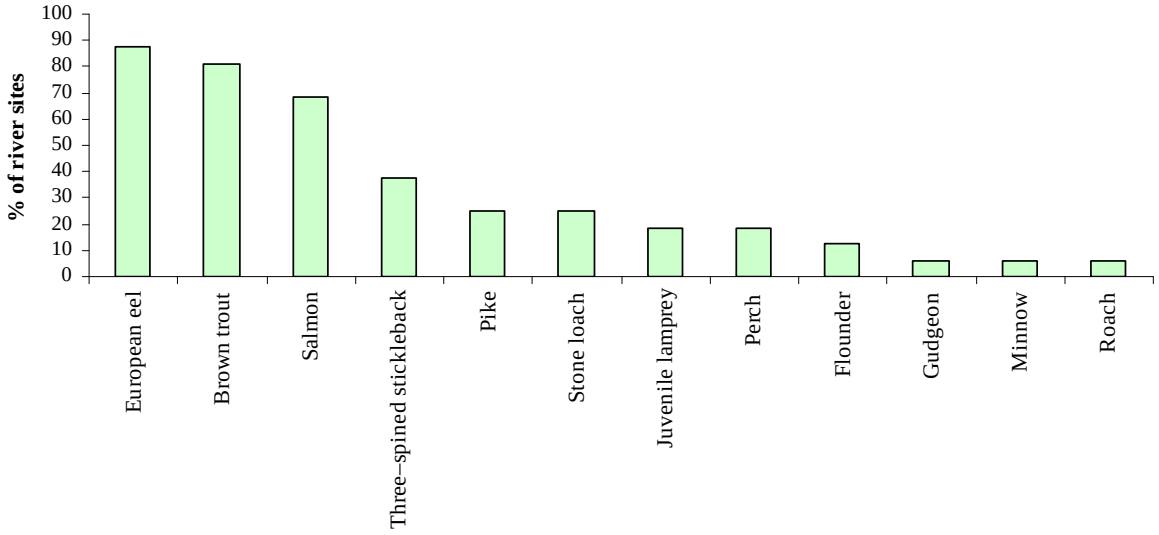

Fig. 4.46. Percentage of sites where each fish species was recorded in the ShIRBD for WFD SM monitoring 2009

Species richness ranged from one species in the Feorish River to six species in the Moyree River (Table. 4.17). Kelly *et al*., (2008) classified fish species in Ireland into three groups. Group 1 – native species (e.g. salmonids, three-spined stickleback, lamprey, eel and flounder) were present in all but one of the sites surveyed. Group 2 – non-native species that influence ecology (e.g. pike, perch, roach, minnow, stoneloach) were recorded in nine of the sites and Group 3 – non-native species that generally don't influence ecology (e.g. gudgeon) were recorded in one site.

Table 4.17. Species richness at each river site surveyed in the ShIRBD, July to October 2009

Site	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
		HAND-SET SITES		
Moyree	6	4	2	0
Bilboa	5	4	1	0
Broadford	5	4	0	1
Dead	5	4	1	0
Owvane (Limerick)	5	5	0	0
Ballyfinboy	4	3	1	0
Newport	4	4	0	0
Glendine (Clare)	3	3	0	0
Caher	2	2	0	0
Owveg (Kerry)	2	2	0	0
Tyshe (Ardfert)	2	2	0	0
		BOAT SITES		
Creegh	5	5	0	0
Fergus	5	3	2	0
Nenagh	5	3	2	0
Shannon (Ballyleague Bridge)	4	1	3	0
Feorish (Ballyfarnon)	1	0	1	0

4.3.2 Species abundance and distribution

Abundance and distribution maps for the most common fish species recorded within the ShIRBD are shown below in Figures 4.47 to 4.74. Recorded fish densities are generally much higher in surveys using hand-set electric-fishing gear than in those conducted with boat-based electric-fishing gear. This is primarily due to the tendency for younger trout and salmon to utilise shallow, riffle areas as nursery habitat and may also be due to the difference in sampling efficiency of the two methods. As such, population densities recorded for each species using the two methods are displayed on separate maps. For comparative purposes, densities from surveys conducted during 2008 are also displayed.

Brown trout were present in 13 of the 16 ShIRBD sites surveyed. The highest density of both brown trout fry (0+) and 1+ and older brown trout amongst boat sites was in the Nenagh River (0.01 fish/m^2 and 0.07 fish/m^2 respectively, Fig. 4.47 and 4.49). The highest density of brown trout fry (0+) recorded amongst the hand-set sites was in the Glendine River (0.40 fish/m^2, Fig. 4.48), whilst the Dead River had the highest density of 1+ and older brown trout amongst hand-set sites (0.12 fish/m^2, Fig. 4.50). No sea trout were captured in any of the ShIRBD sites surveyed during 2009.

Salmon fry (0+) and parr (1+ and older) were recorded in eleven sites within the ShIRBD. Amongst the boat sites, the Nenagh River contained the highest density of 0+ salmon (0.002 fish/m^2, Fig. 4.51), whilst 1+ and older salmon were found in their highest density in the Creegh River (0.02 fish/m^2, Fig. 4.53). Rivers in the southern part of the ShIRBD were rich in salmon, with the highest densities of

both fry (0.35 fish/m^2) and parr (0.23 fish/m^2) amongst hand-set sites being recorded in the Bilboa River (Fig. 4.52 and 4.54).

European eel were also well distributed throughout the ShIRBD, occurring in 14 of the 16 sites surveyed during 2009 (Fig. 4.55 and 4.56). They were absent only from the Owveg and Feorish Rivers. The highest eel densities were encountered in some of the sites closest to the coast. The Tyshe River had by far the greatest abundance of European eels (0.28 fish/m^2) amongst the hand-set sites, whilst the Nenagh River had the highest density of European eels amongst the boat sites, (0.001 fish/m^2).

Lamprey were only captured at three locations, the Dead River, the Moyree River and the Newport River (Fig. 4.57 and Fig. 4.58). Flounder were recorded in two sites, the Owvane and the Creegh Rivers, both of which are close to the coast (Fig. 4.59 and Fig. 4.60). Three-spined stickleback were captured in six sites (Fig. 4.61 and 4.62), with the Tyshe River holding the highest density. Stone loach (Fig. 4.63 and 4.64) were recorded in four sites - the Ballyfinboy, Dead, Nenagh and Bilboa Rivers, all of which were located east of the River Shannon. Perch were recorded in three rivers - the River Fergus, the Moyree River and the River Shannon (Fig. 4.65 and Fig. 4.66), while pike were found in these same three rivers as well as in the Feorish River in the far north of the region (Fig. 4.67 and Fig. 4.68). Minnow, gudgeon and roach were each recorded in only one site in the ShIRBD during WFD surveillance monitoring in 2009 (Fig. 4.69 to Fig. 4.74).

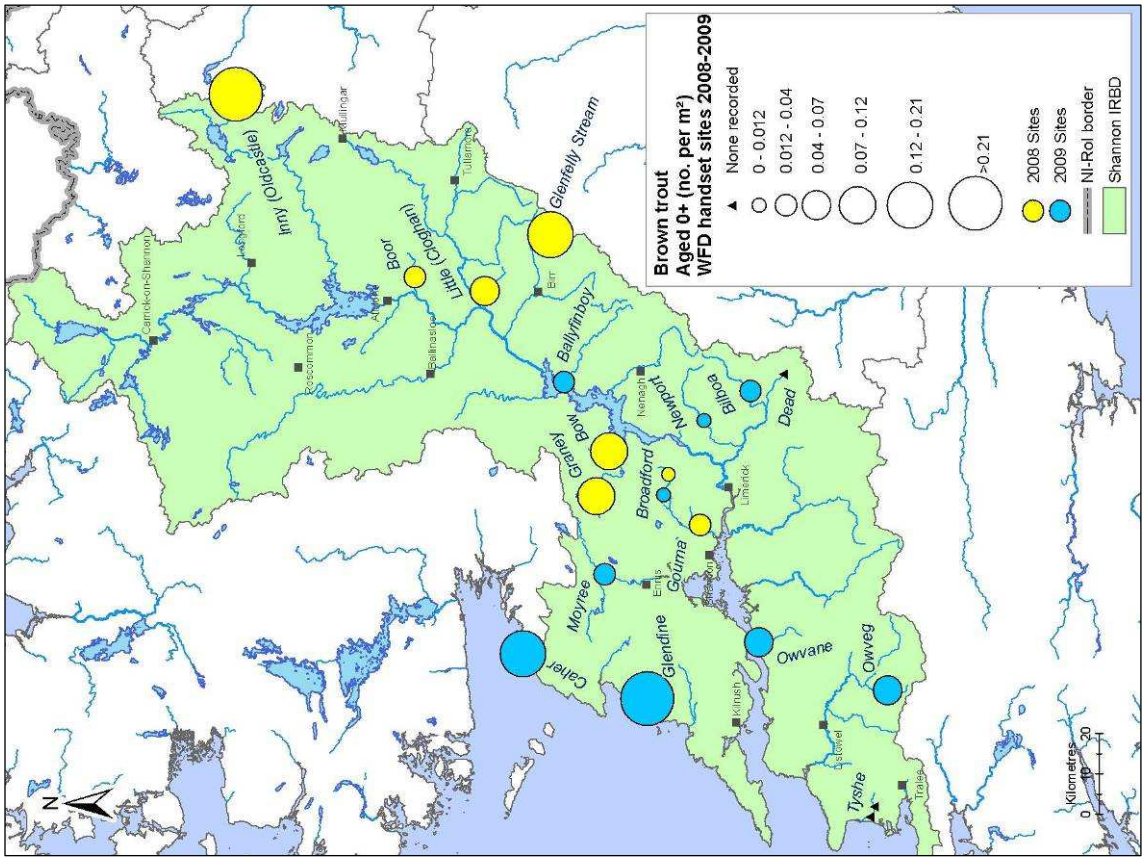

Fig. 4.48. Distribution map of 0+ brown trout in ShIRBD hand-set sites surveyed for WFD monitoring 2008–2009

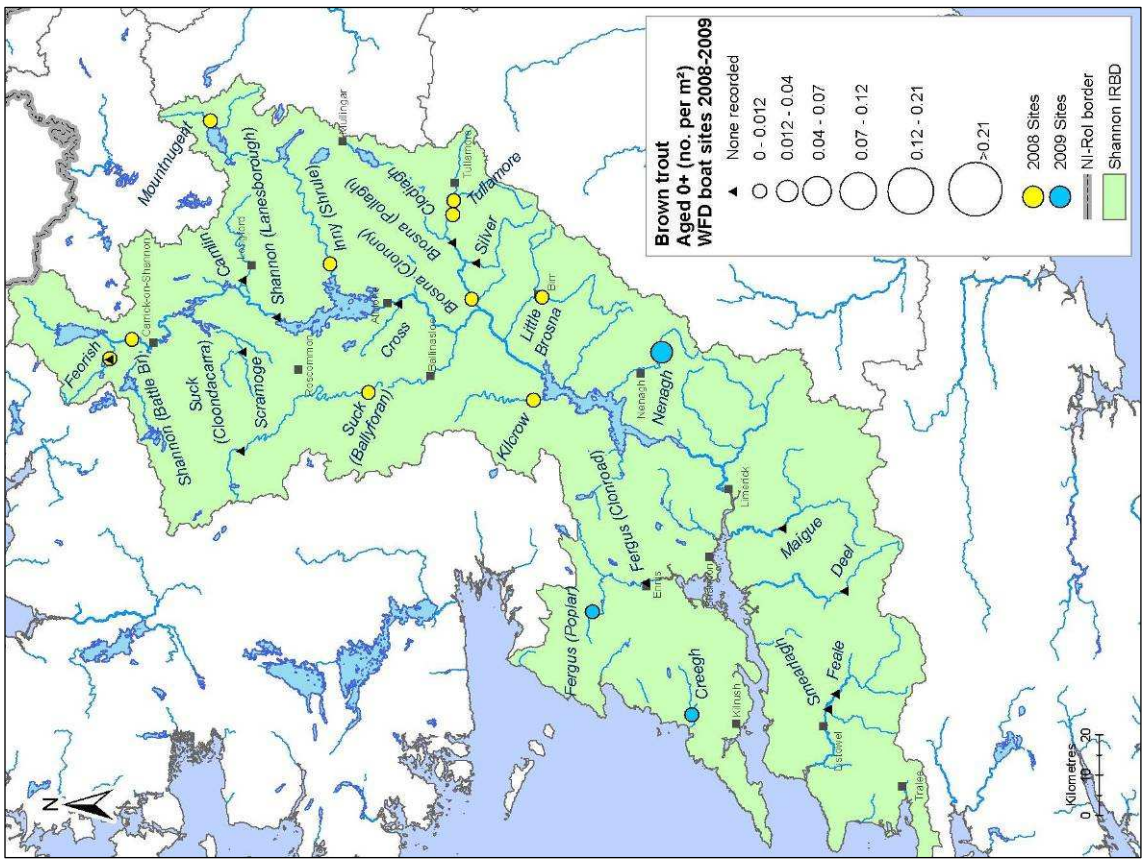

Fig. 4.47. Distribution map of 0+ brown trout in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

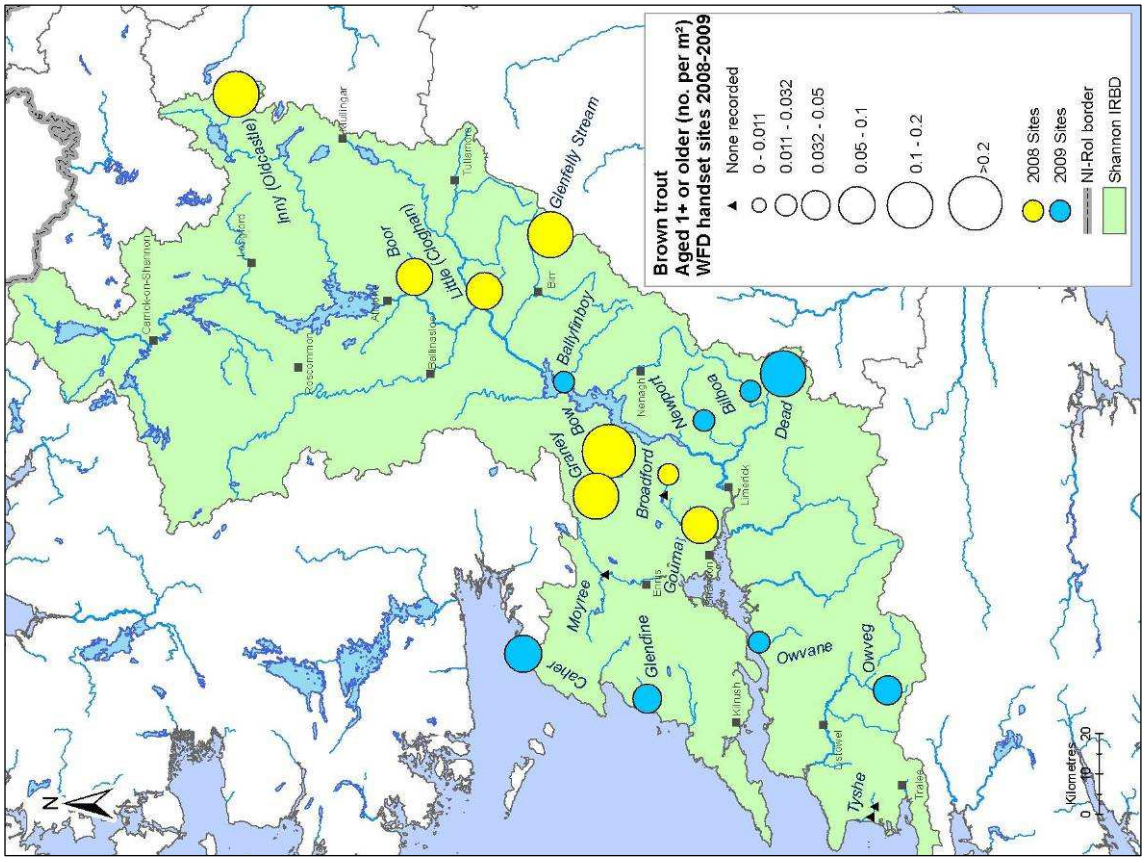

Fig. 4.50. Distribution map of 1+ or older brown trout in ShIRBD hand-set sites surveyed for WFD monitoring 2008–2009

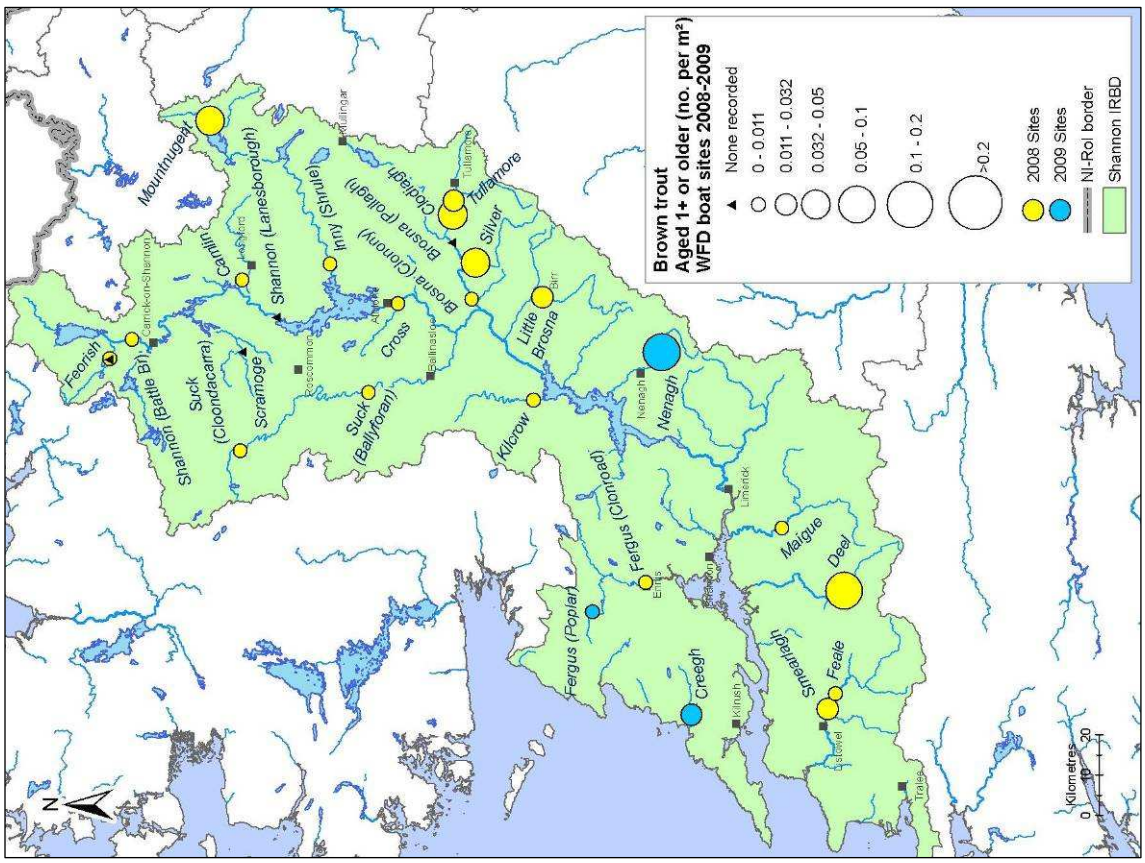

Fig. 4.49. Distribution map of 1+ or older brown trout in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

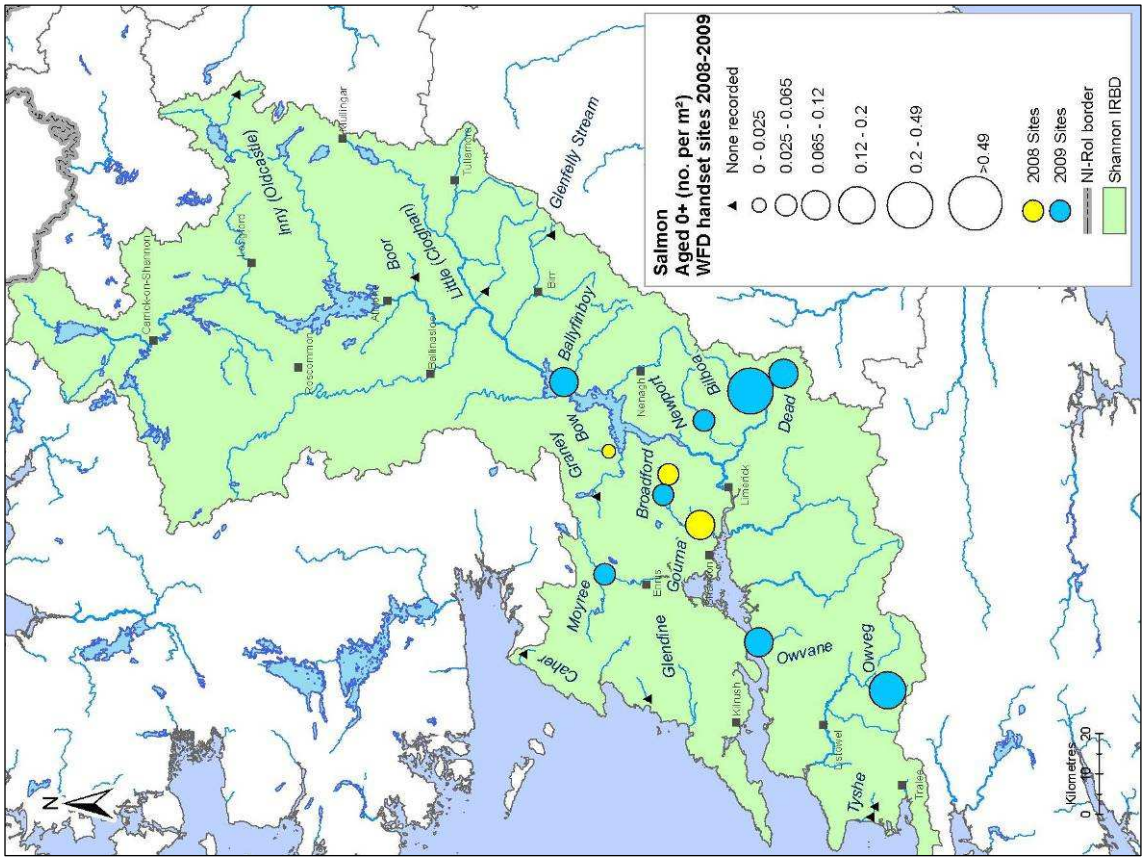

Fig. 4.52. Distribution map of 0+ salmon in ShIRBD hand-set sites surveyed for WFD monitoring 2008–2009

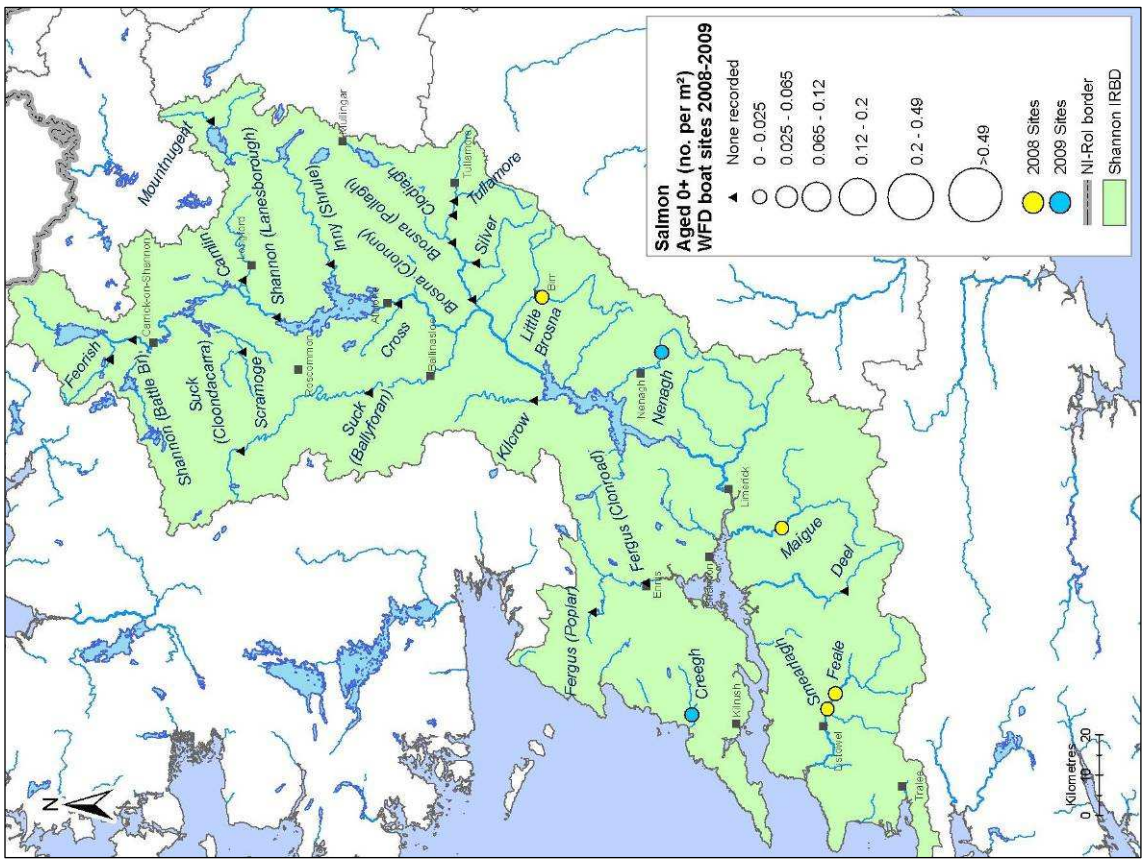

Fig. 4.51. Distribution map of 0+ salmon in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

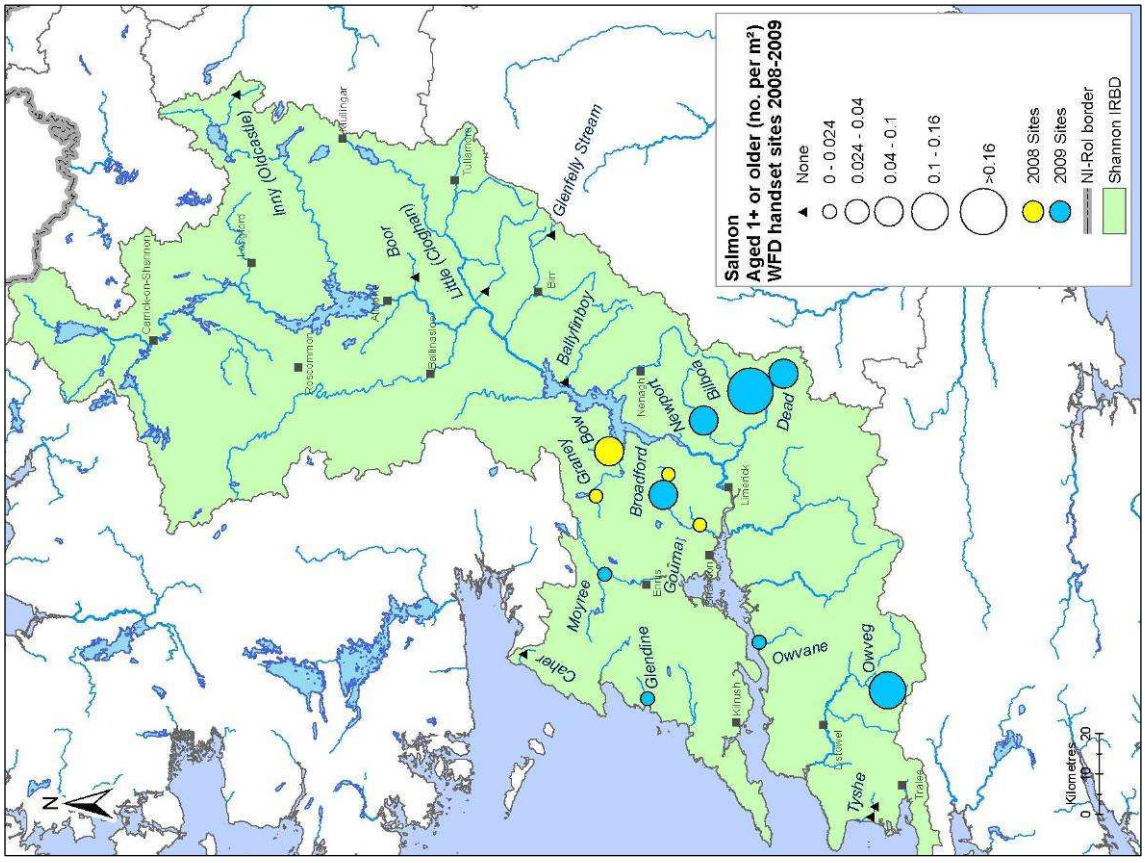

Fig. 4.54. Distribution map of 1+ or older salmon in ShIRBD hand-set sites surveyed for WFD monitoring 2008–2009

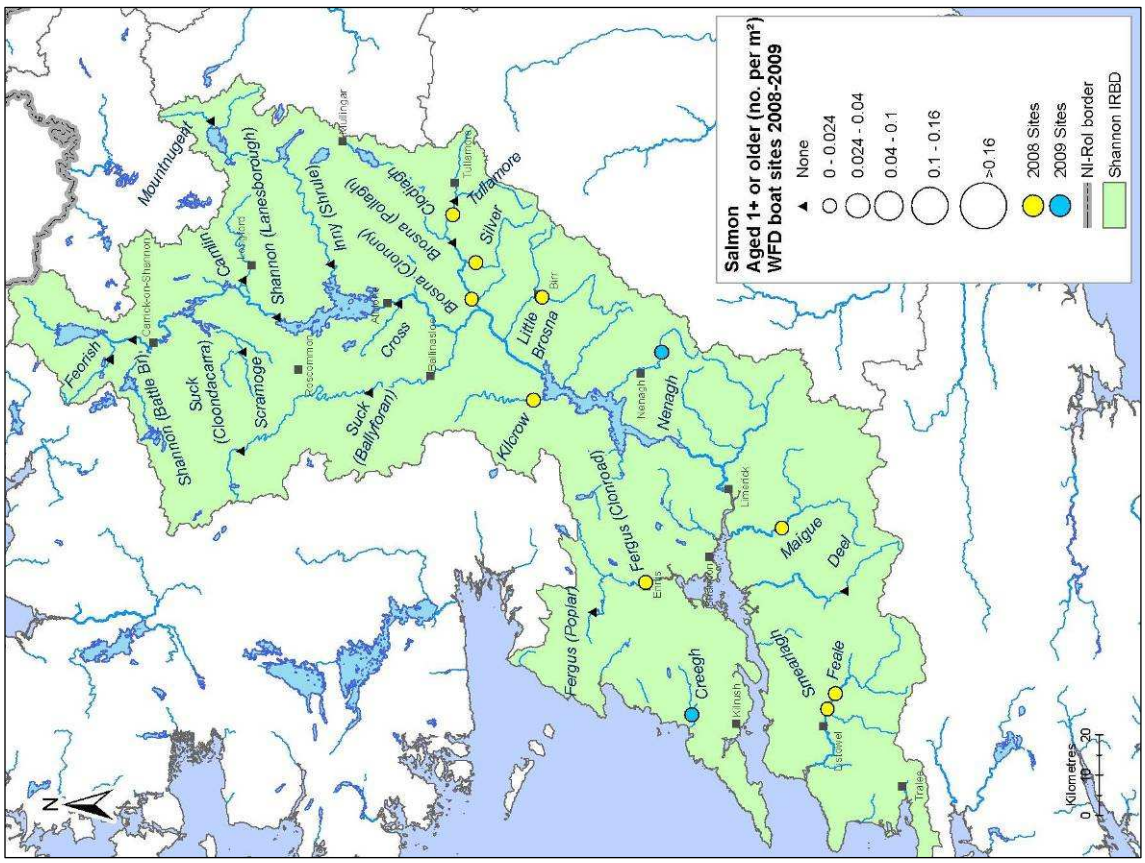

Fig. 4.53. Distribution map of 1+ or older salmon in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

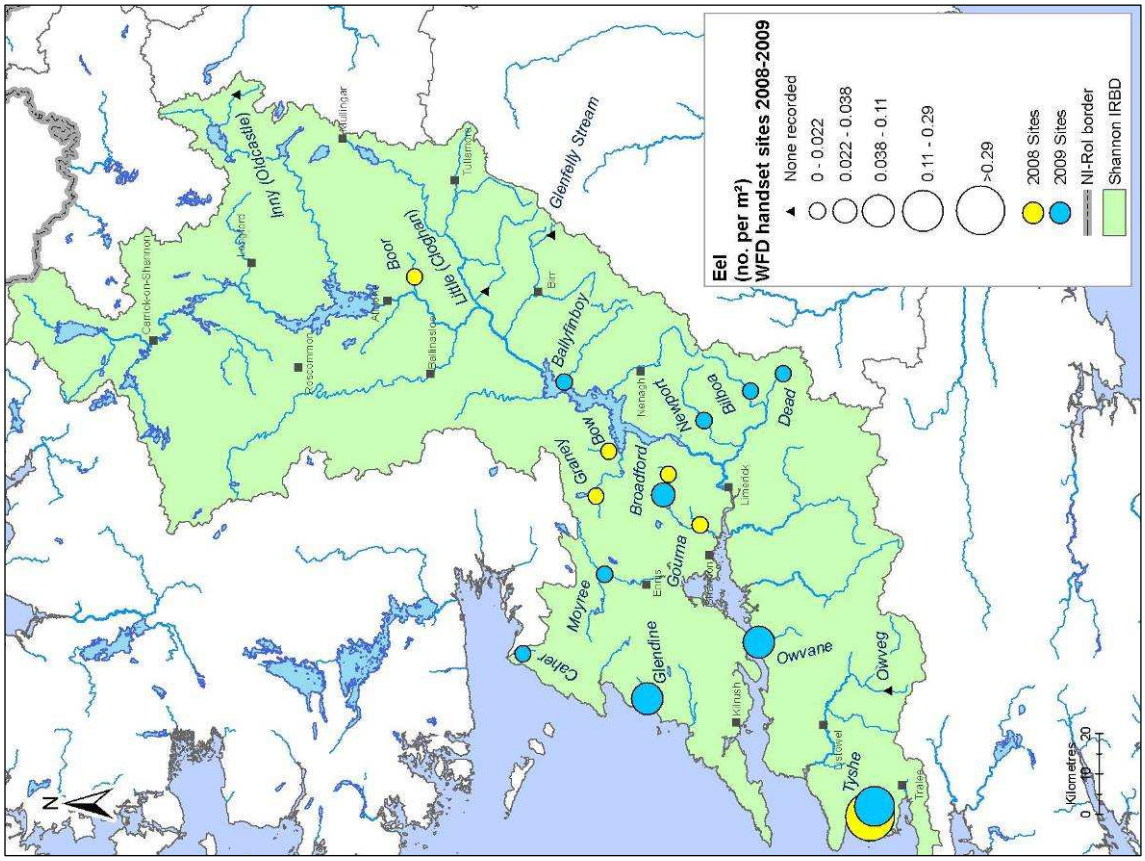

Fig. 4.56. Distribution map of European eel in ShIRBD hand-set sites surveyed for WFD monitoring 2008–2009

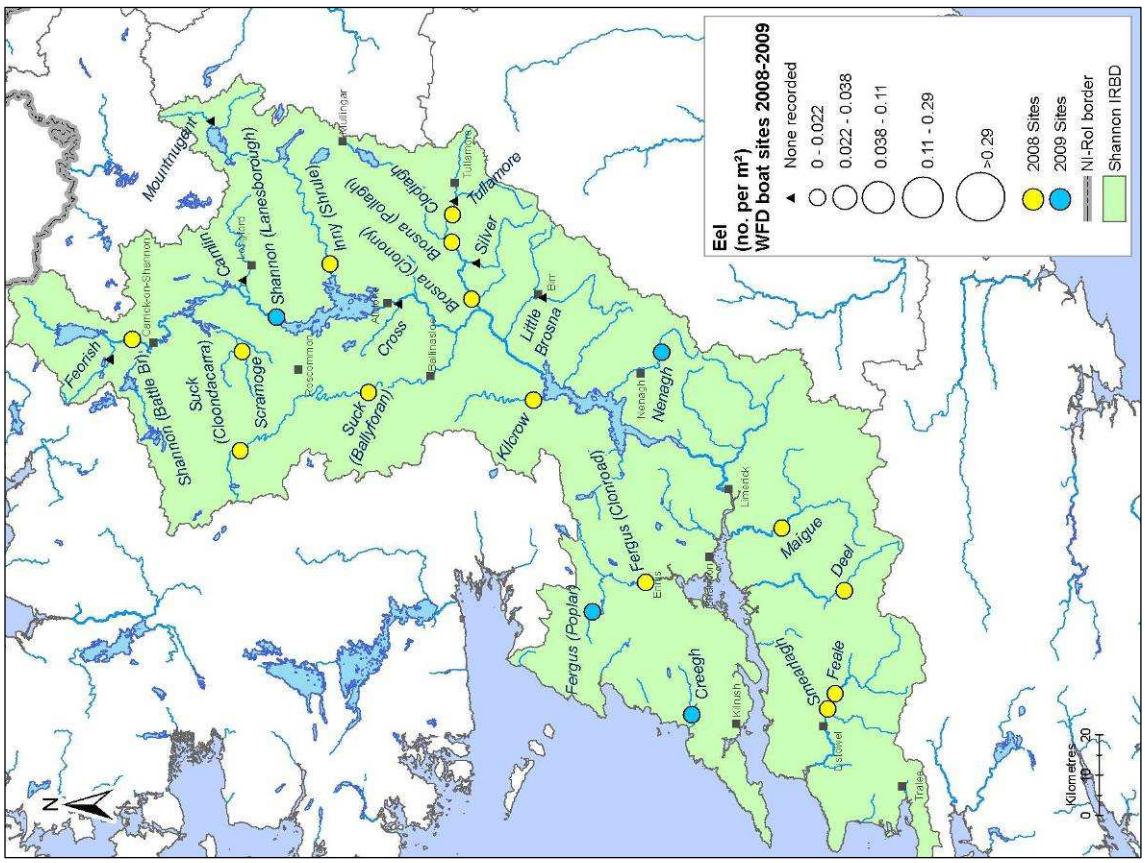

Fig. 4.55. Distribution map of European eel in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

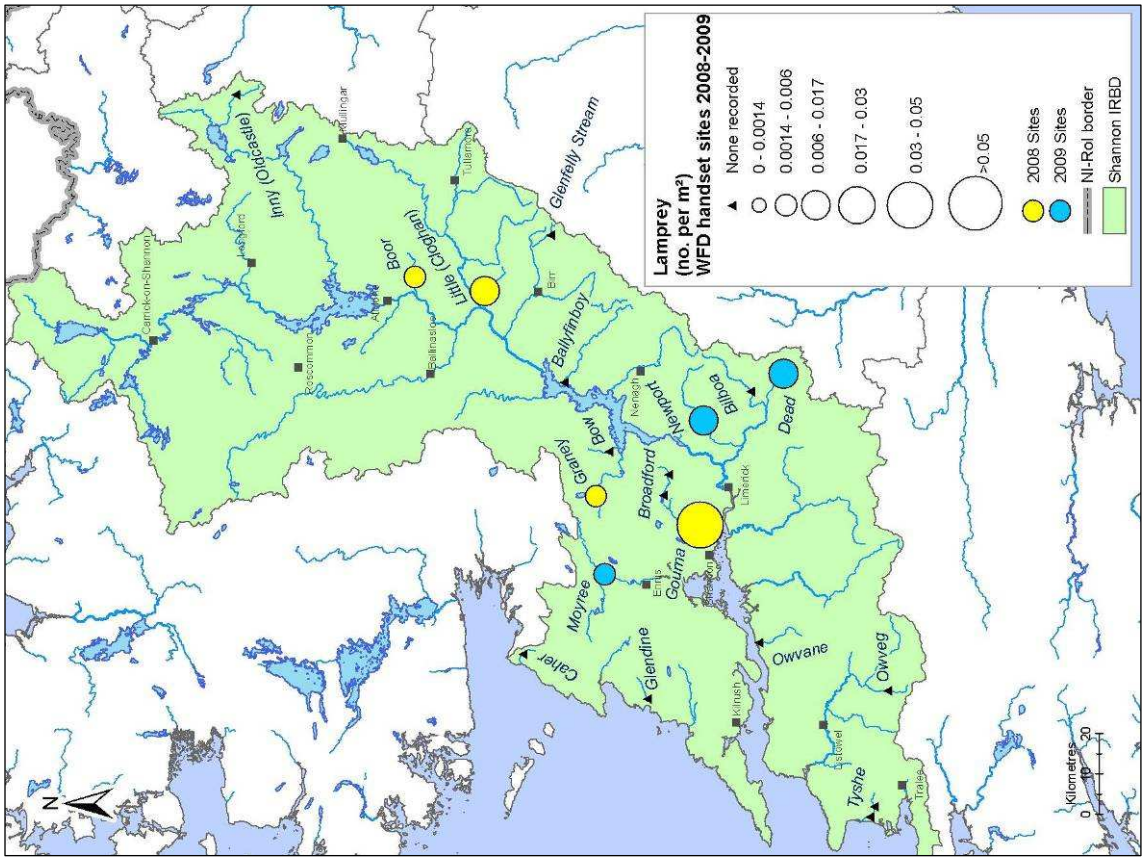

Fig. 4.58. Distribution map of lamprey in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

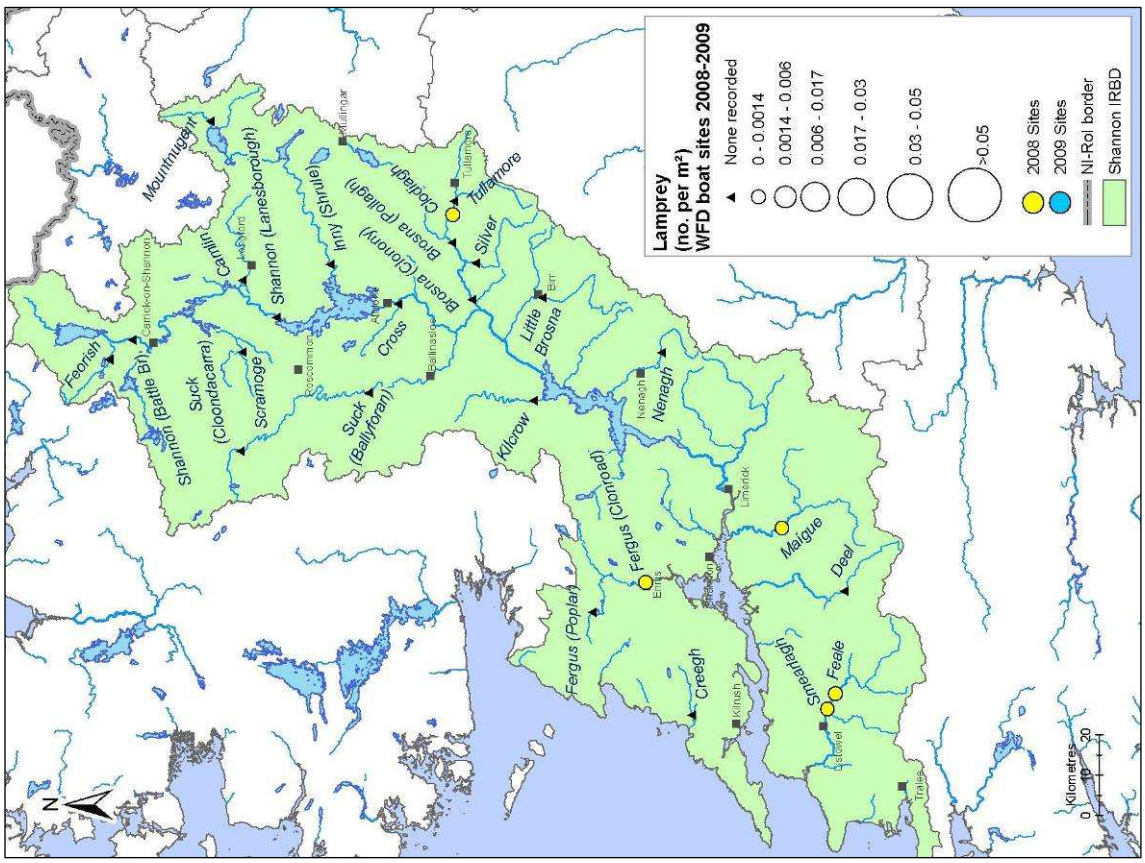

Fig. 4.57. Distribution map of lamprey in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

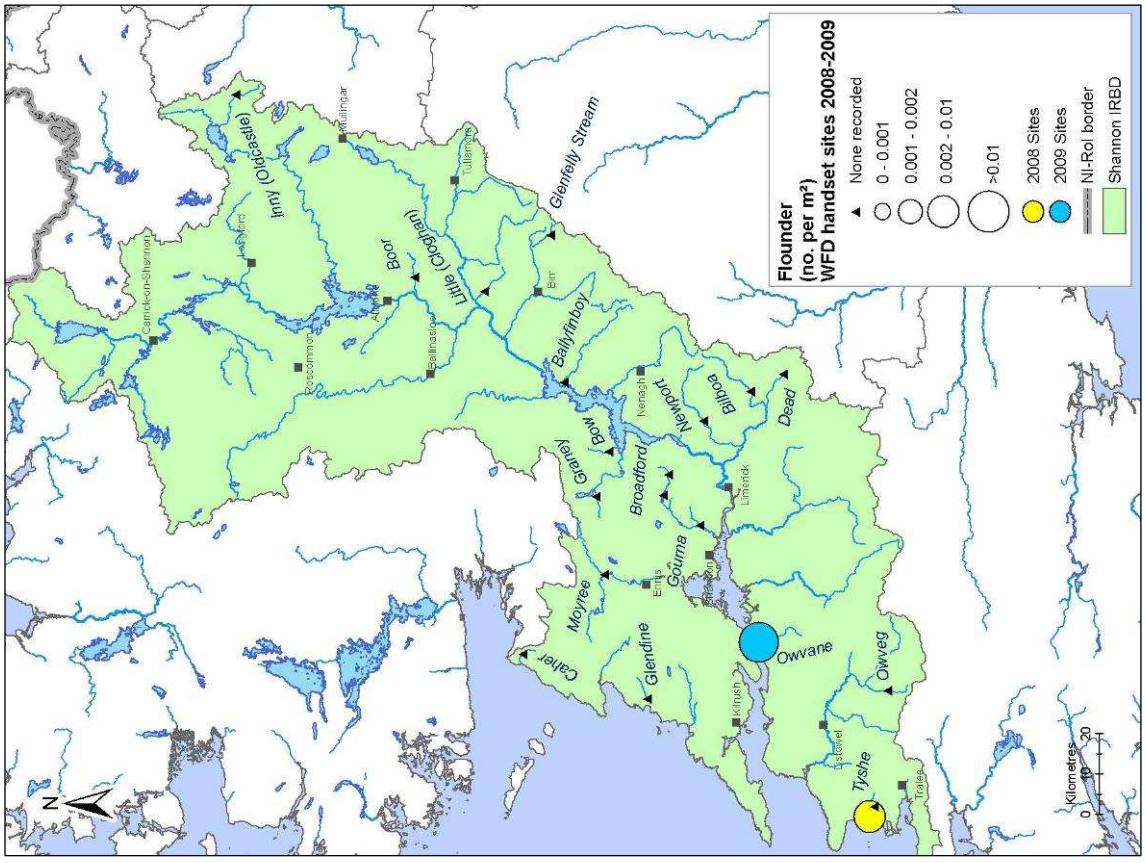

Fig. 4.60. Distribution map of flounder in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

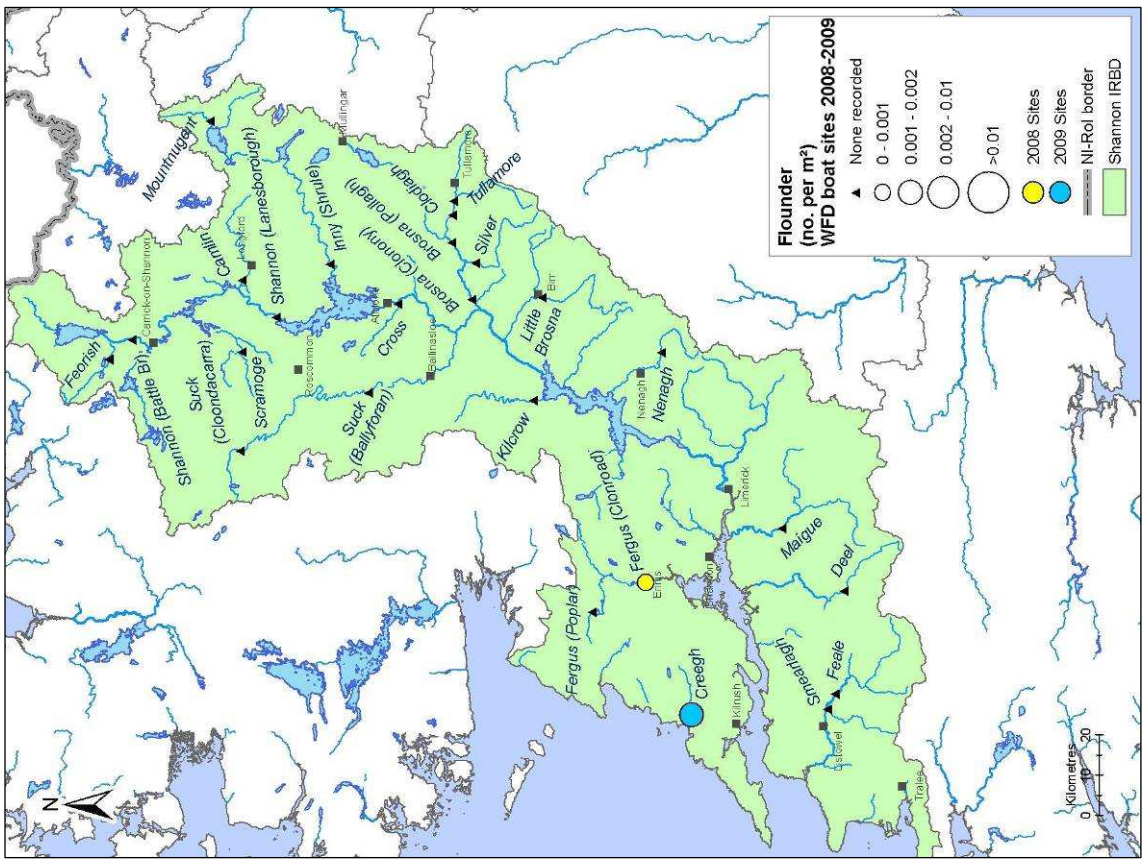

Fig. 4.59. Distribution map of flounder in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

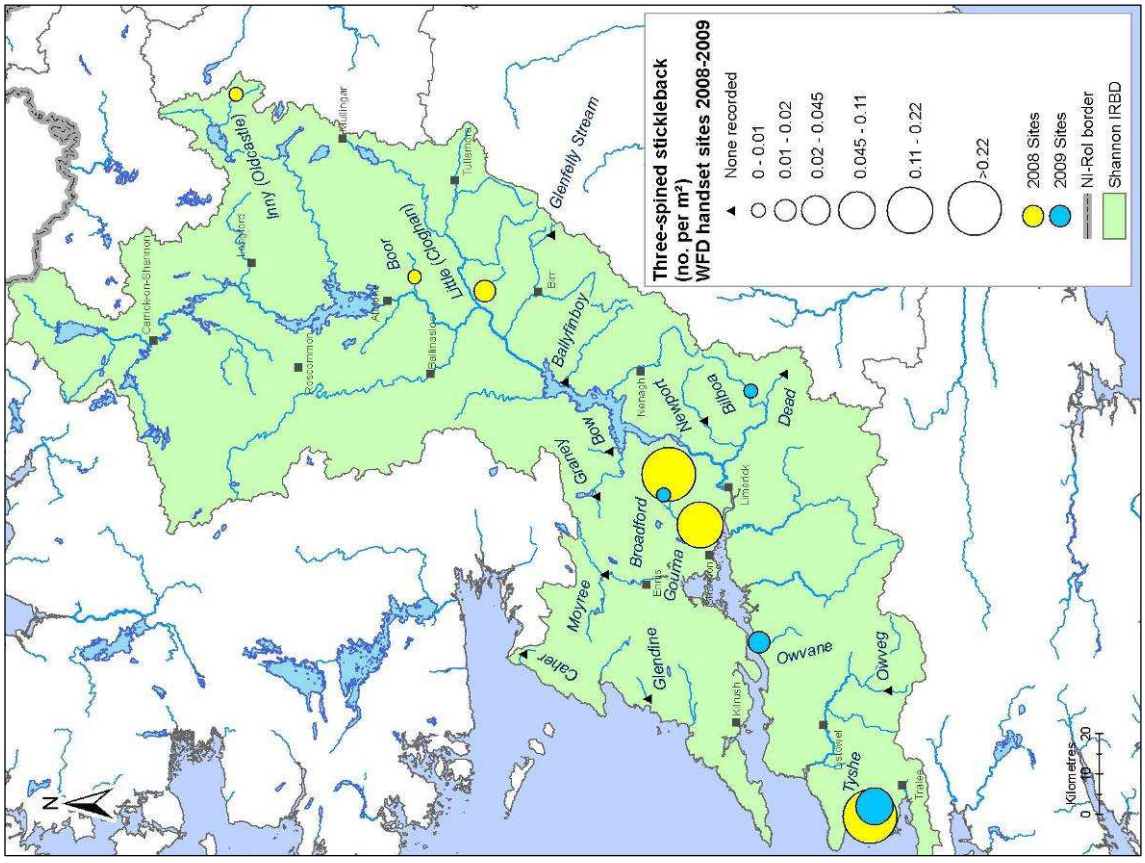

Fig. 4.62. Distribution map of three-spined stickleback in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

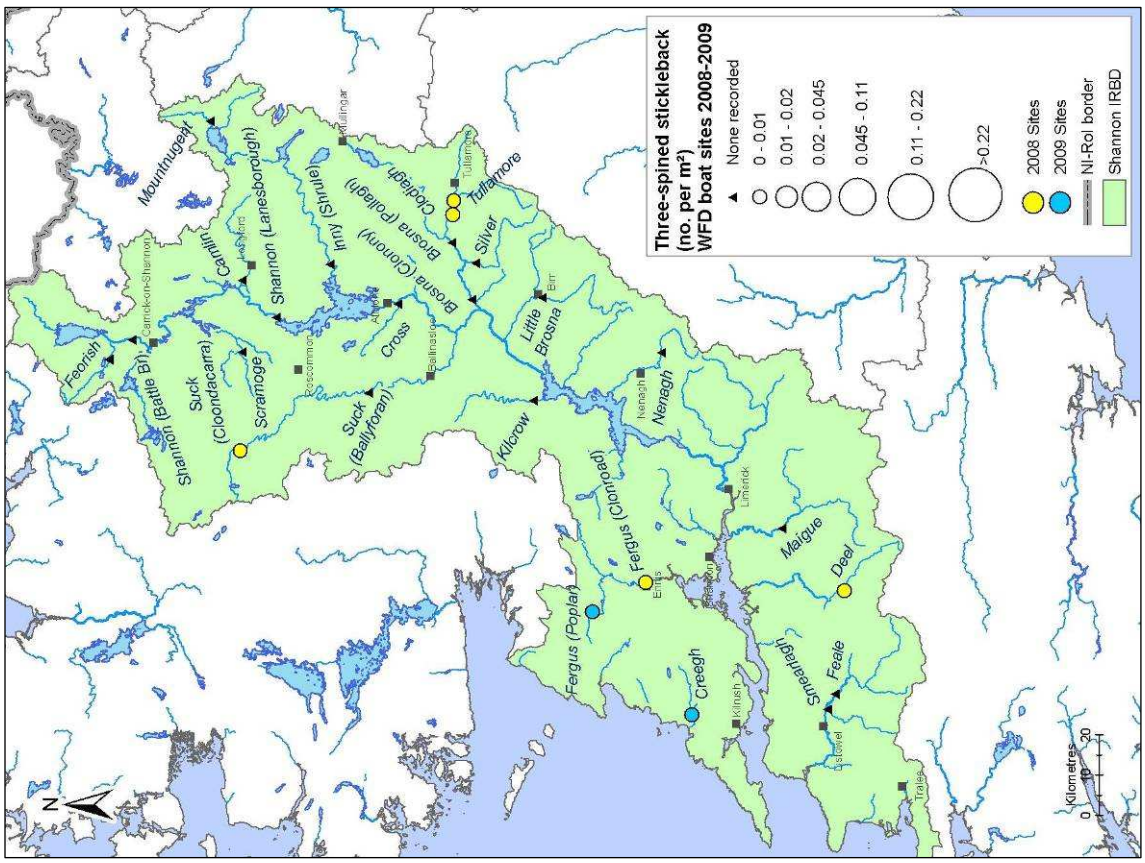

Fig. 4.61. Distribution map of three-spined stickleback in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

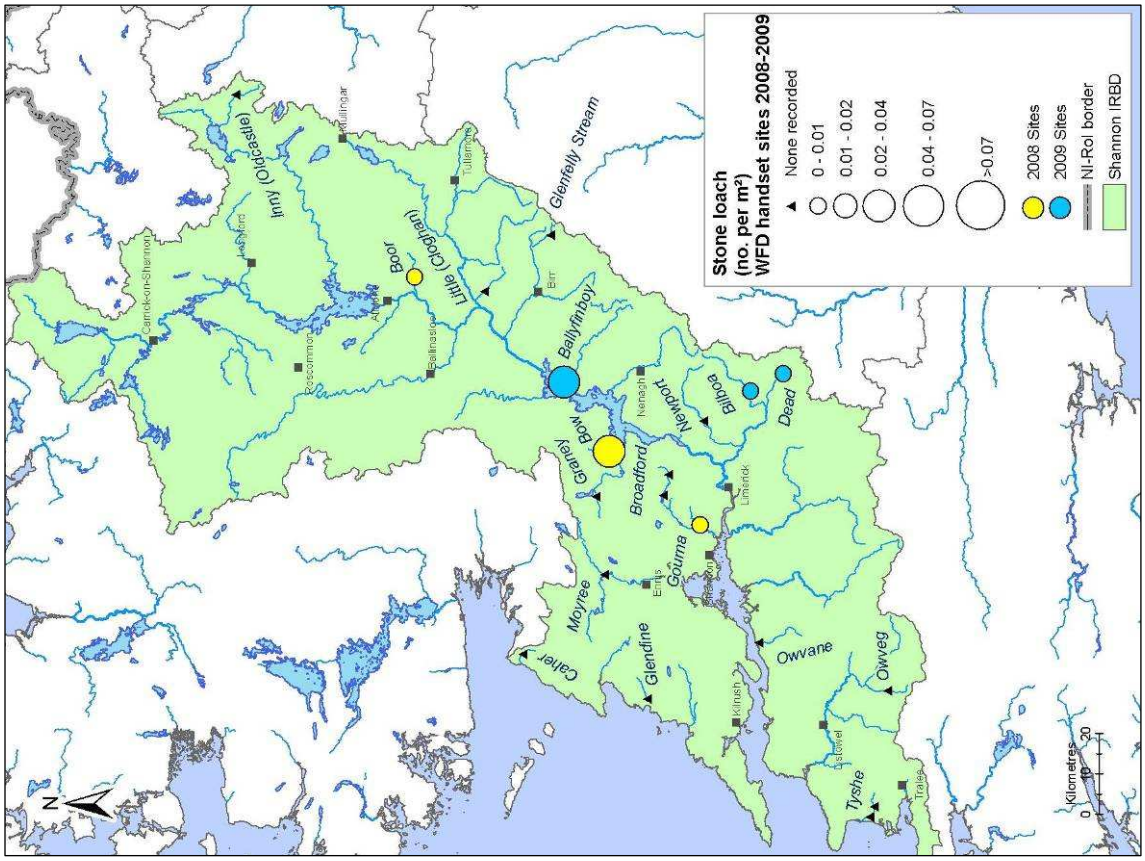

Fig. 4.64. Distribution map of stone loach in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

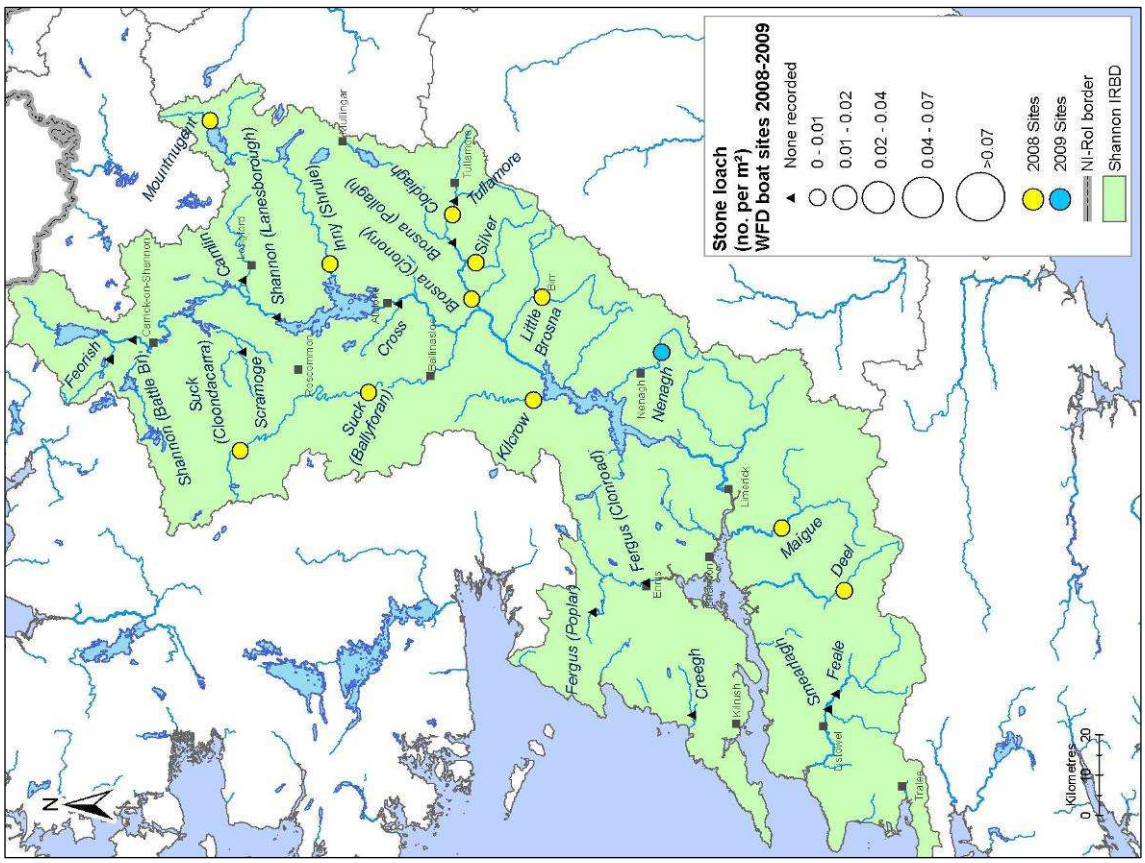

Fig. 4.63. Distribution map of stone loach in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

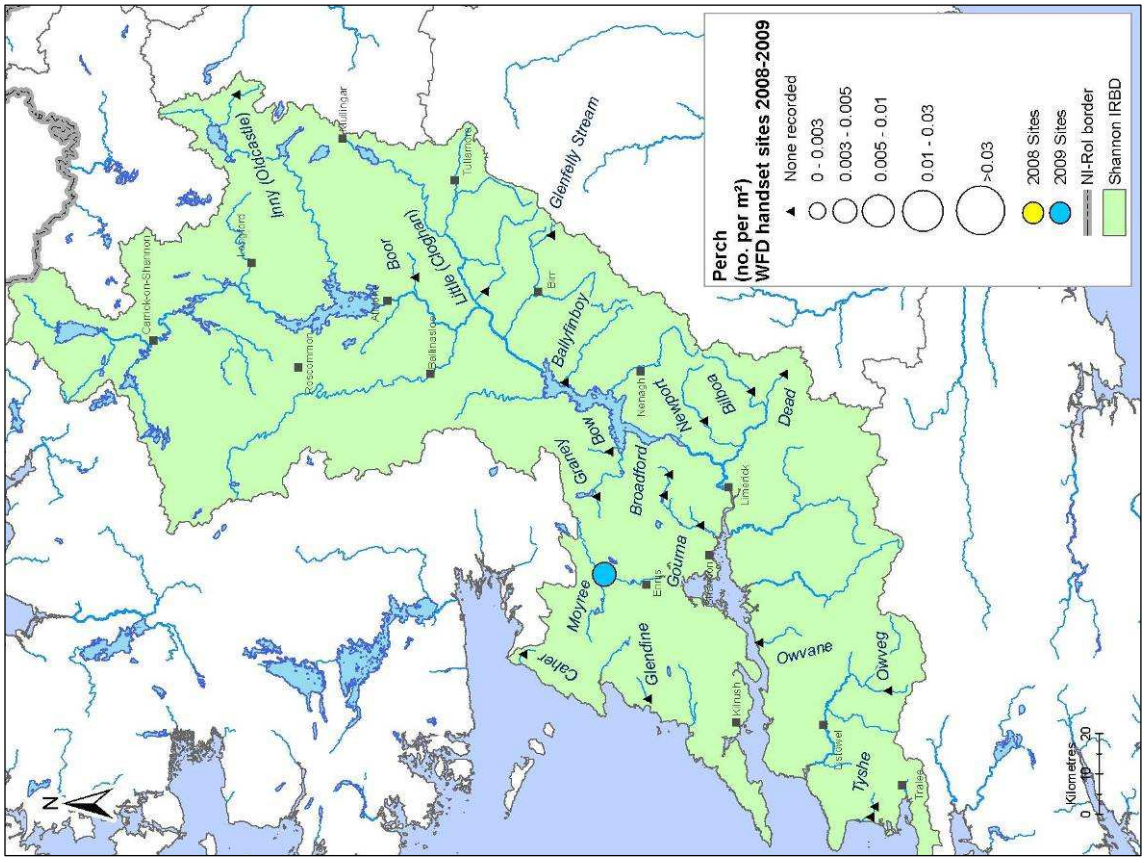

Fig. 4.66. Distribution map of perch in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

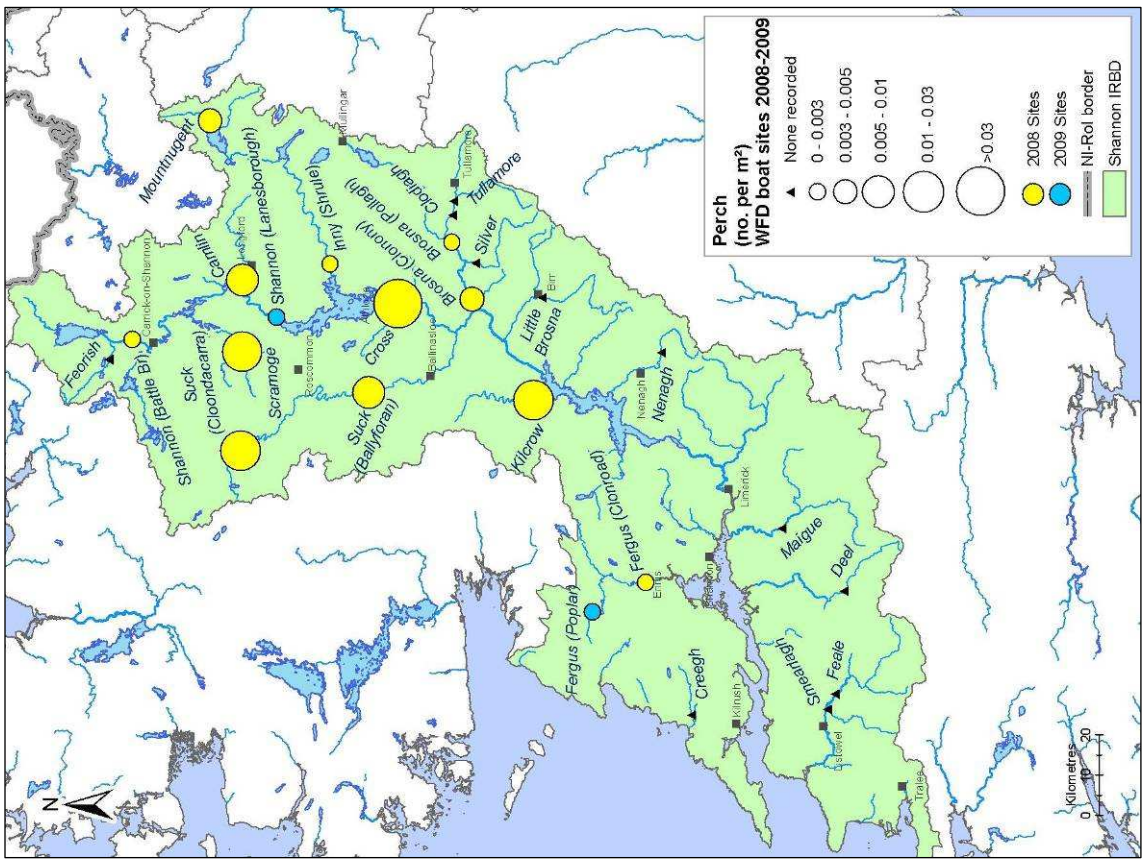

Fig. 4.65. Distribution map of perch in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

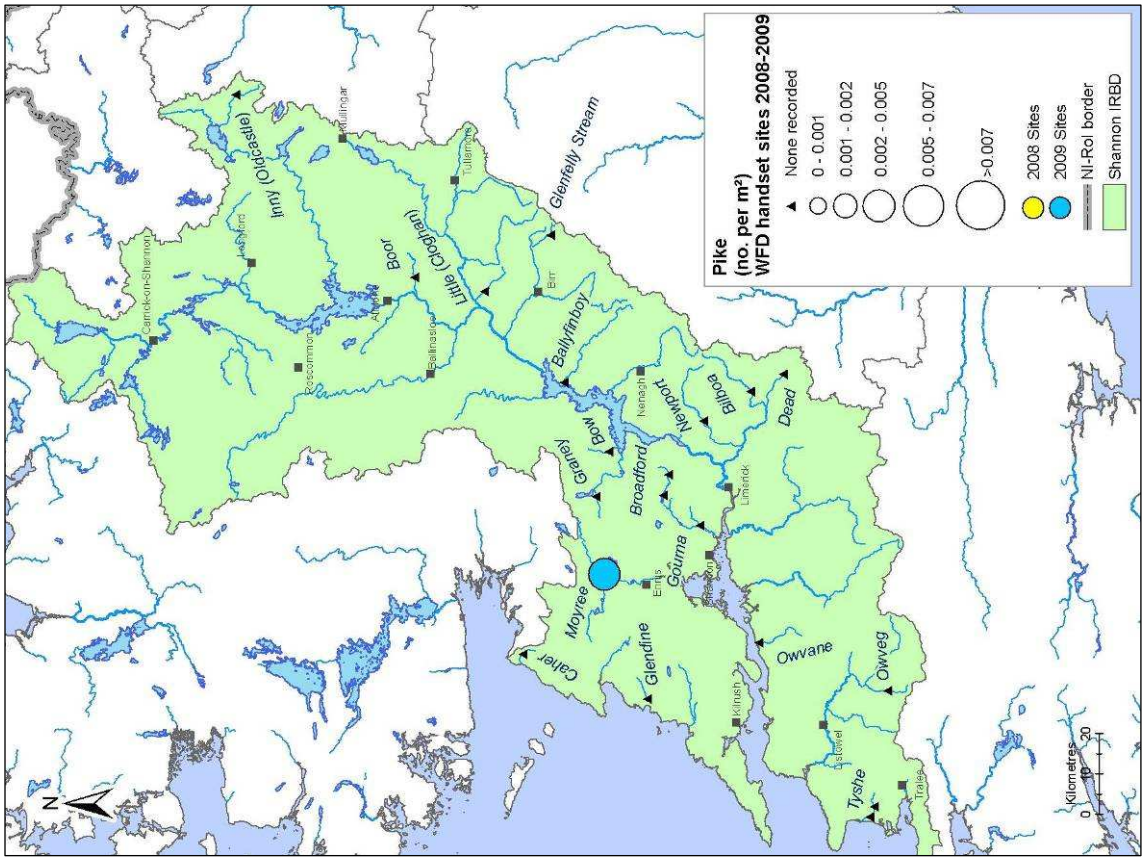

Fig. 4.68. Distribution map of pike in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

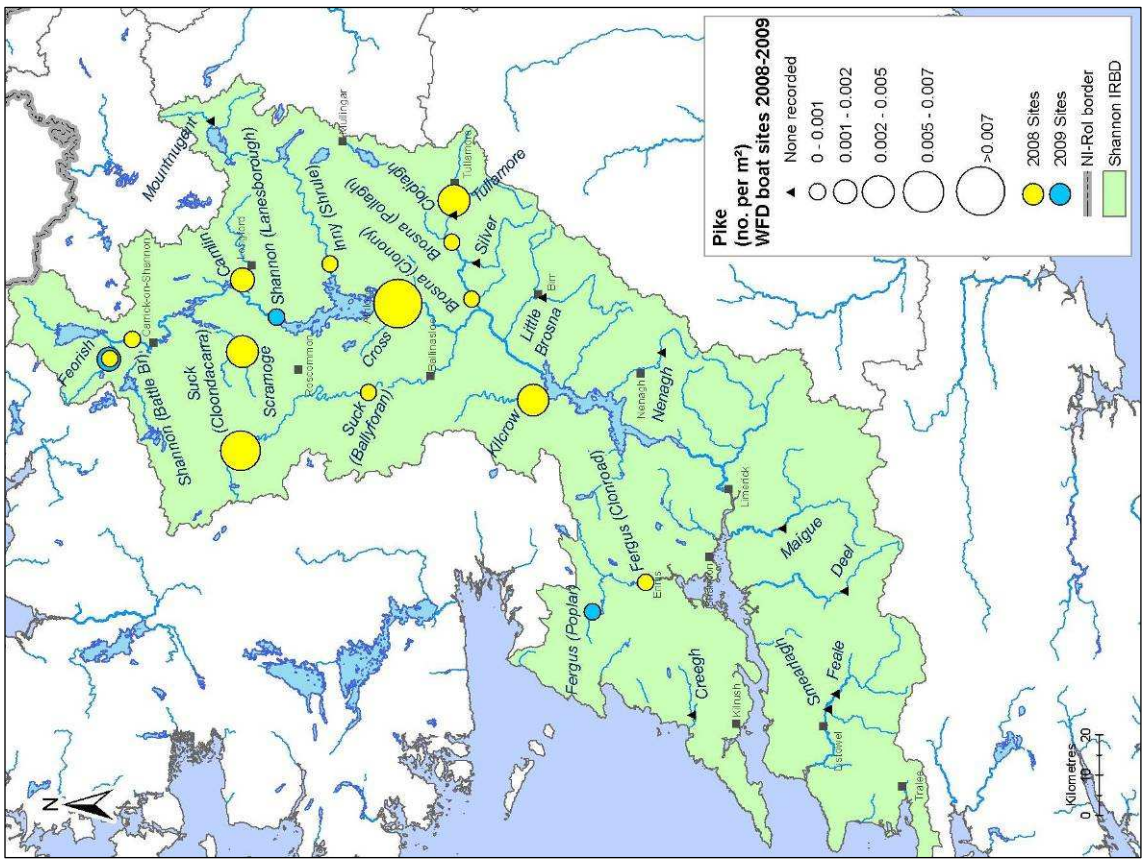

Fig. 4.67. Distribution map of pike in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

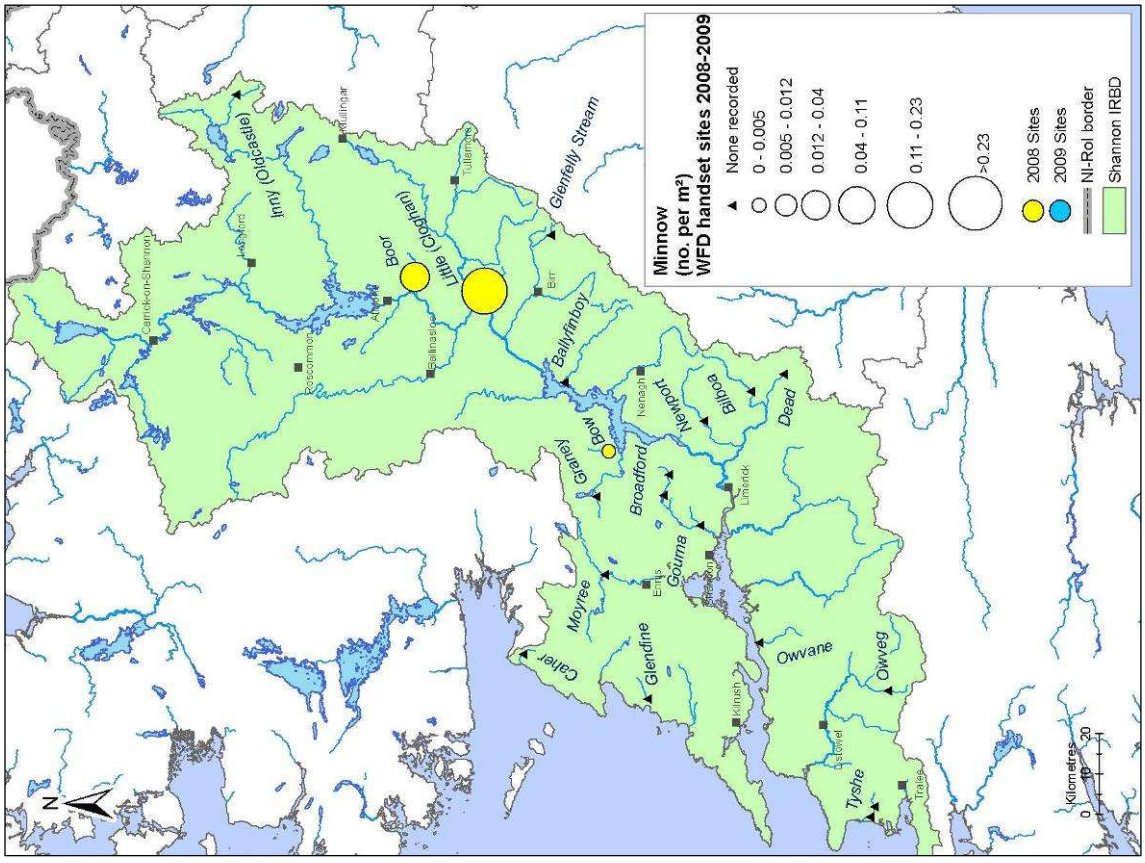

Fig. 4.70. Distribution map of minnow in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

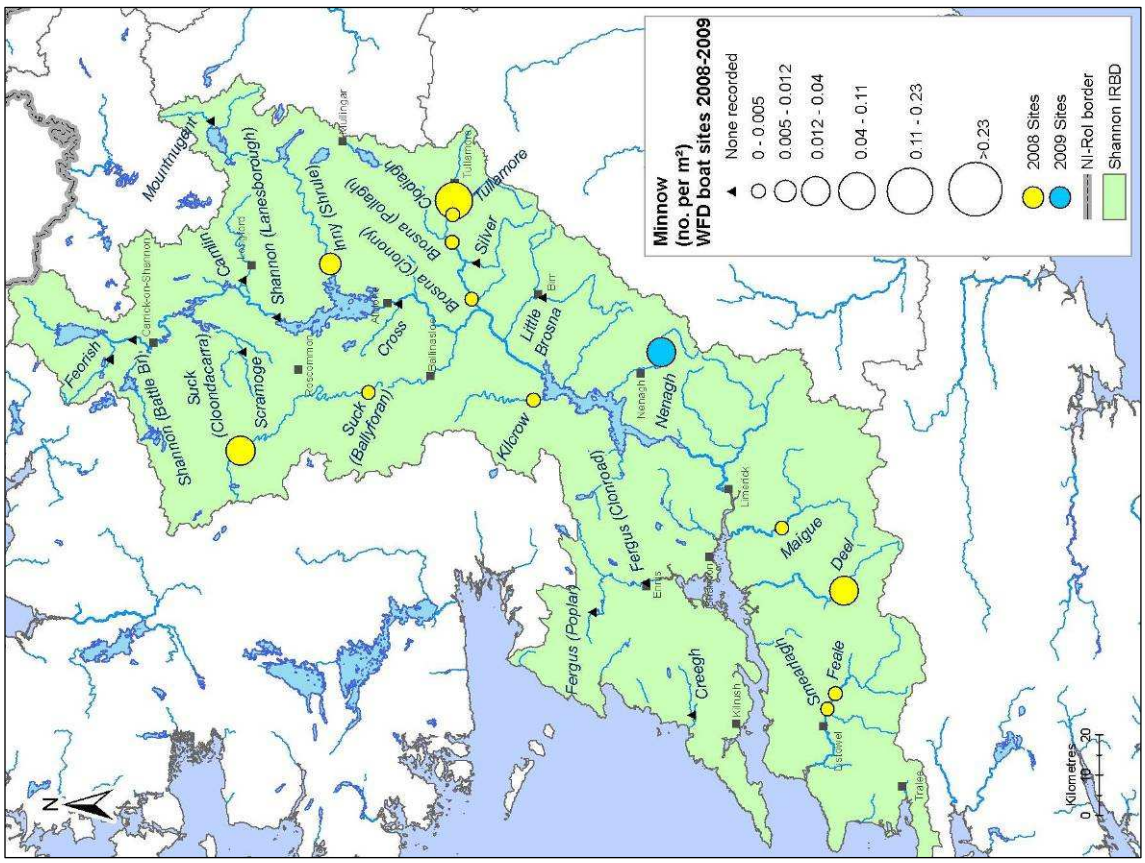

Fig. 4.69. Distribution map of minnow in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

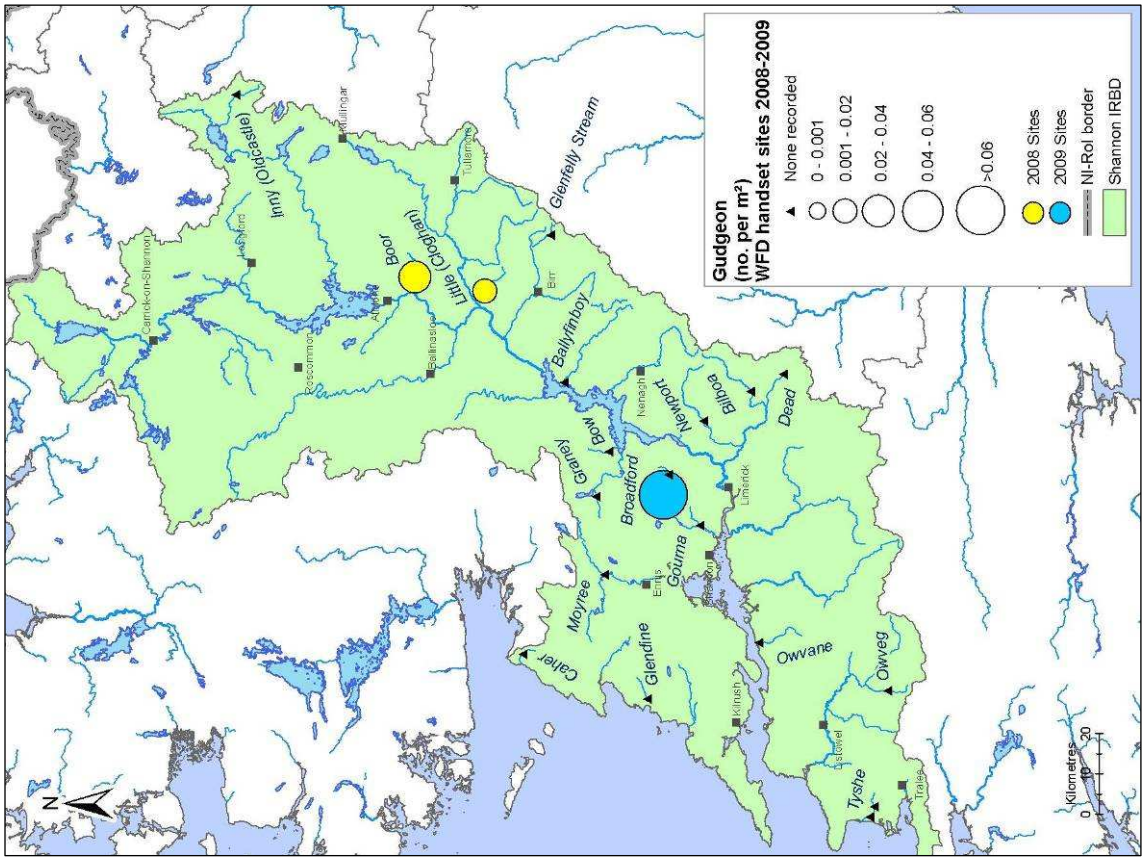

Fig. 4.72. Distribution map of gudgeon in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

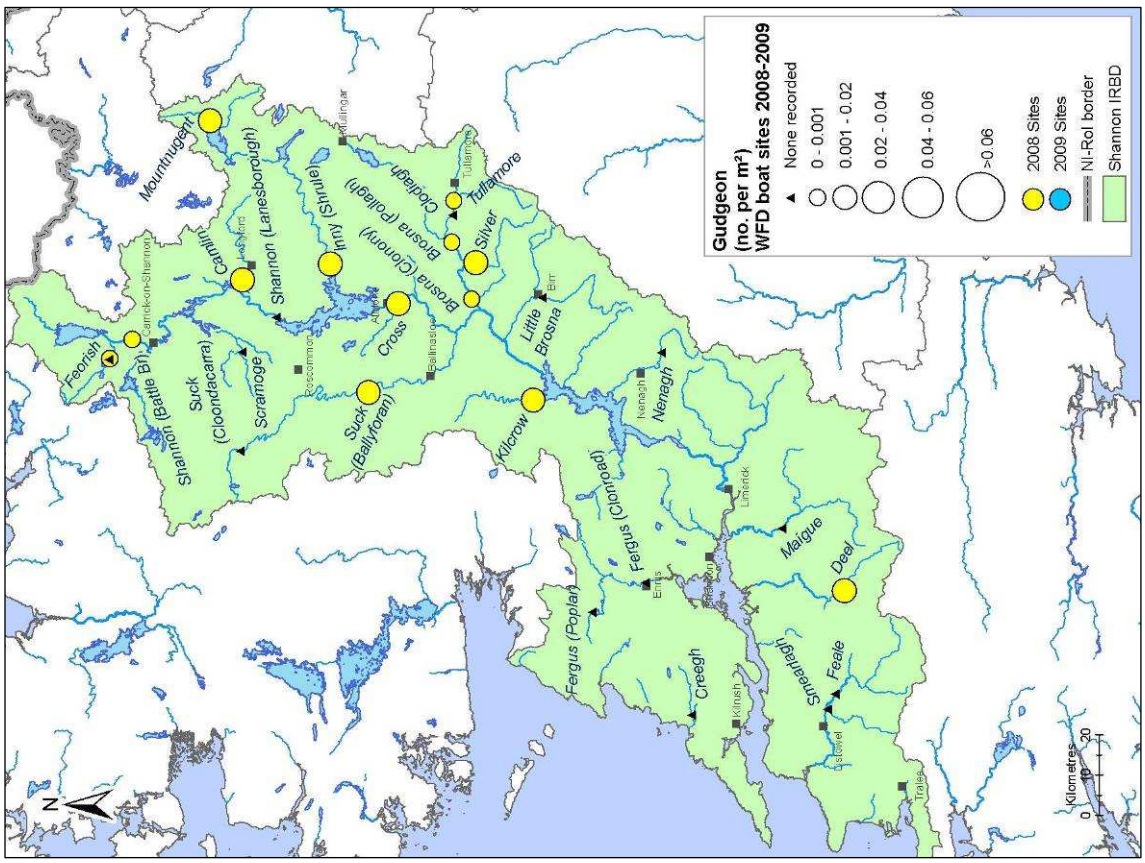

Fig. 4.71. Distribution map of gudgeon in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

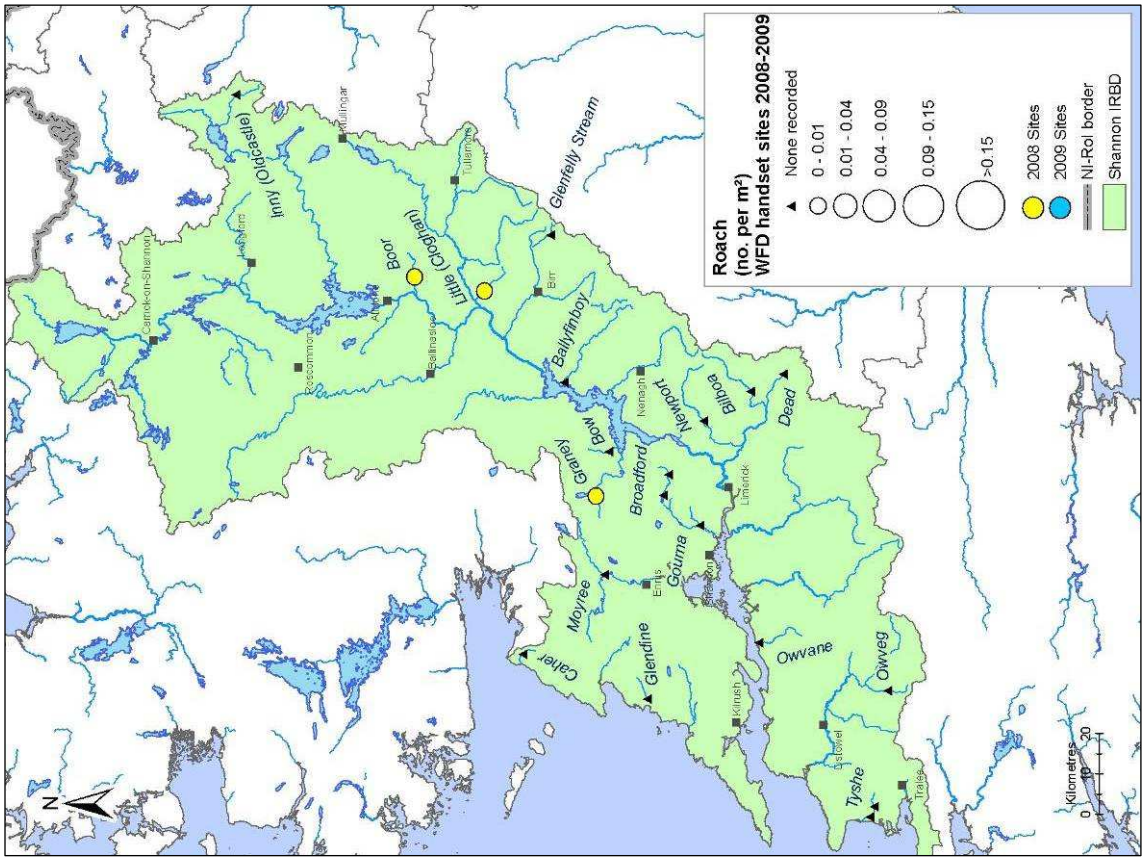

Fig. 4.74. Distribution map of roach in ShIRBD handset sites surveyed for WFD monitoring 2008–2009

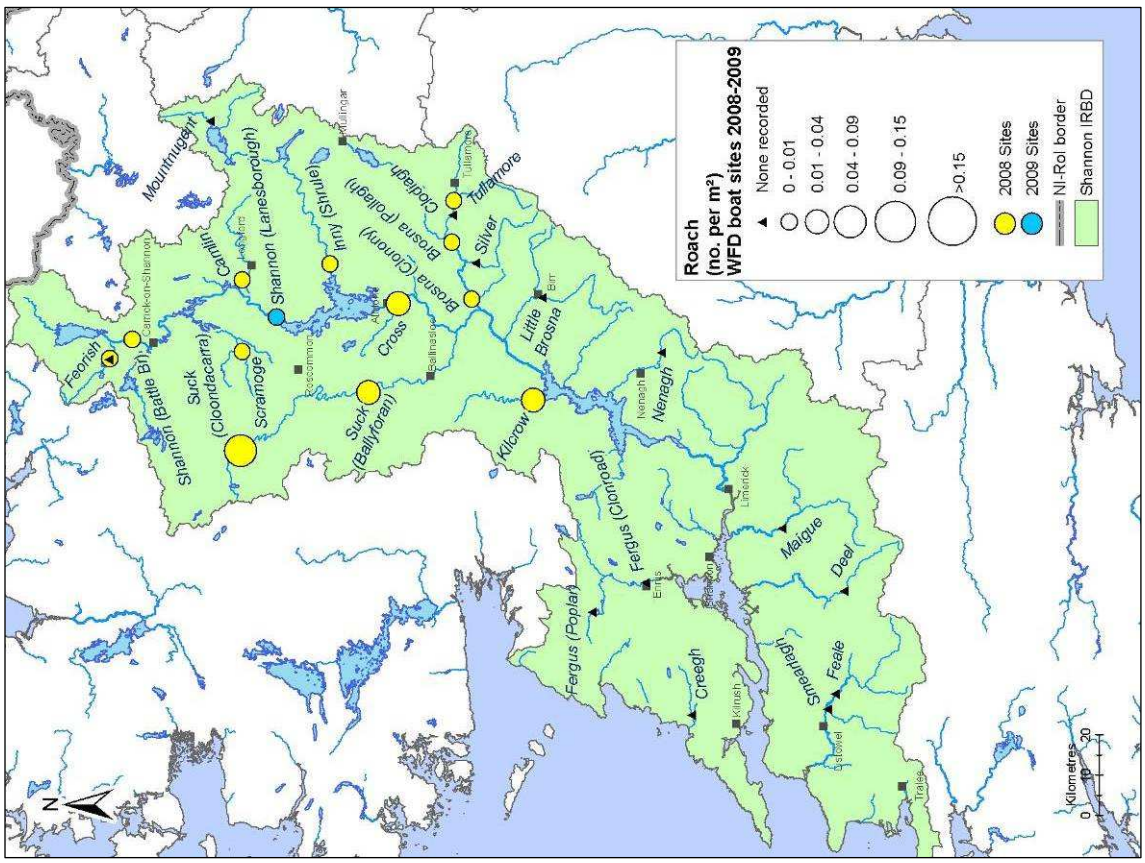

Fig. 4.73. Distribution map of roach in ShIRBD boat sites surveyed for WFD monitoring 2008–2009

4.3.3 Age and growth of brown trout and salmon

Age and growth were determined for brown trout and salmon, which were the dominant species at most sites. Brown trout ages ranged from 0+ to 5+, with 0+ being the dominant age class at most sites. The largest brown trout (3+, length 37.4cm and weight 0.57kg) recorded was captured in the Nenagh River. Three age classes of salmon were recorded, 0+, 1+ and 2+, with those in the 0+ age group the most abundant.

Length-at-age analyses and growth curves are presented for brown trout (Fig. 4.75 and Appendix 1) and salmon (Fig. 4.76 and Appendix 2). The brown trout at each river site were assigned growth categories described by Kennedy and Fitzmaurice (1971), who examined the relationship between alkalinity and growth of brown trout in Irish streams and rivers. Growth was classified as slow in the Ballyfinboy, Bilboa, Creegh, Glendine and Nenagh Rivers, fast in the Dead River and very fast in the River Fergus (Appendix 1).

The Glendine River had the highest mean L1 for salmon parr 1+ or older, whereas the Newport River had the lowest mean L1. The Creegh River had the highest mean salmon L2 amongst the rivers where 2+ fish were recorded.

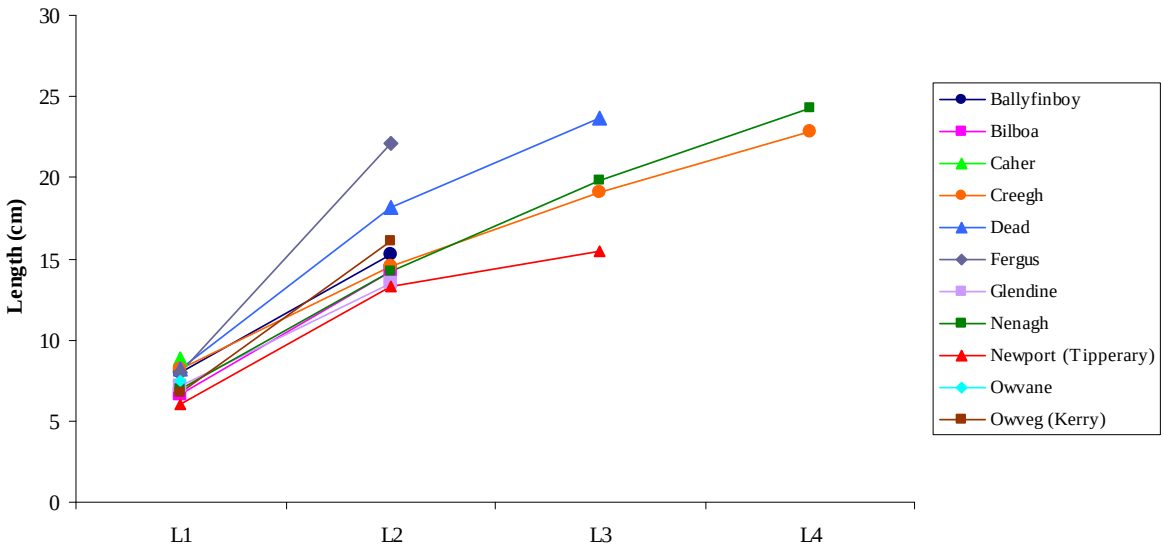

Fig. 4.75. Back calculated lengths at age for brown trout in each river, WFD surveillance monitoring 2009

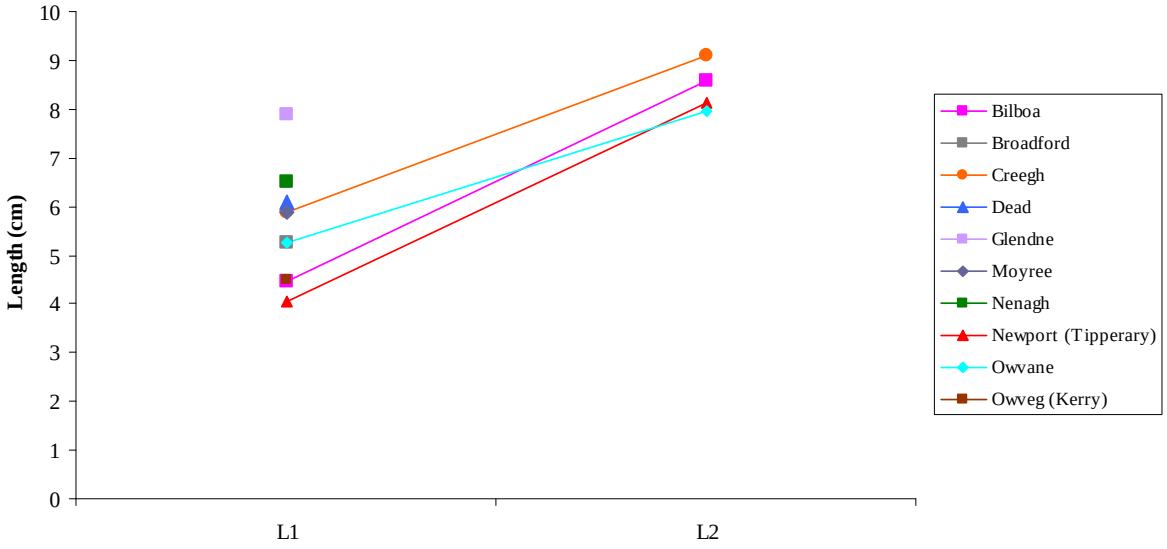

Fig. 4.76. Back calculated lengths for salmon in each river, WFD surveillance monitoring 2009

5. DISCUSSION

Most of the rivers in the ShIRBD were surveyed using hand-set electric-fishing gear, reflecting the fact that these river sites were, on average, smaller in size than river sites sampled in other regions. In contrast to the 2008 surveillance monitoring programme, sampling in 2009 was concentrated around the lower reaches of the Shannon catchment, in streams feeding into the Shannon estuary and on small local streams entering directly into the Atlantic Ocean (e.g. Creegh, Glendine, Caher and Tyshe). A total of 12 fish species were recorded in the ShIRBD, which is comparable to the number of species captured in other River Basin Districts. The main summary report provides results for the whole country (Kelly *et al*., 2010). European eels were the most widely distributed species within the ShIRBD and occurred in all but two sites.

The Moyree River was the most diverse site in terms of fish species richness, with six species present. The highest species diversity recorded in any site throughout the country during 2009 was eleven and this only occurred in one site within the South Eastern River Basin District (SERBD) where there was a high number of non-native fish present (Kelly *et al*., 2010). The Feorish River had the lowest diversity in the region, with only one species present. Such a low species diversity is commonly found around Ireland in small wadeable streams that contain only native fish species (Kelly *et al*., 2009). However; this was unusual in that only one species, the non-native pike, was recorded within this river. The lack of any other fish in this site warrants further investigation to determine the cause of this situation.

Brown trout were present in 13 of the 16 ShIRBD sites surveyed, with the highest density being recorded on the Glendine River. There were no sea trout captured in any of the ShIRBD river sites surveyed during 2009. Most of the sites surveyed in this region in 2009 were in the lower portion of the Shannon catchment, which contains some very good salmon rivers. Salmon were captured at 11 sites, with the highest density recorded in the Bilboa River. European eel were also well distributed, occuring in 14 sites, with the highest densities in sites close to the coast such as the Tyshe River. Three-spined sticklebacks were scattered throughout the southern end of the region but were absent from sites in the Upper Shannon. The remaining species encountered occurred in only a few sites each. Flounder were notably only present in sites close to the sea. Perch and pike were only present in the Moyree River and River Fergus, while roach were only recorded in the River Shannon at Lanesborough. Non-native fish were much more prevalent during the 2008 WFD surveillance monitoring programme when a greater number of deeper rivers in the northern portion of the ShIRBD were sampled (Kelly *et al*., 2009)

Ireland's indigenous fauna has come under increasing threat from non-native introductions. Invasions by non-native species represent one of the greatest threats to natural biodiversity, second only to habitat destruction (Scalera and Zaghi, 2004). Non-native and invasive species can transform

ecosystems, threatening both indigenous and high conservation status species (Stokes *et al*., 2006), with impacts including displacement through competition for space and food. Direct impacts through predation are also evident (Barton and Heard, 2005). A comparison of the results presented here to those in the 2008 WFD surveillance monitoring report (Kelly *et al*., 2009) shows that the Upper Shannon system is affected to a much greater extent by non-native species than the lower reaches.

Non-native fish species were recorded in nine of the 16 river sites surveyed in the ShIRBD during 2009. Eno *et al*. (1997) differentiate between both non-native and alien species, with the former being those that have established themselves and the latter being those that have not established themselves and cannot do so without some sort of human intervention. Rivers containing only native fish species include the Owvane (Limerick), Glendine, Newport, Caher, Owveg and Tyshe Rivers. Kelly *et al*. (2008) categorised non-native species in Ireland into two categories (Group 2, which are those that influence the ecology, and Group 3, which are those that generally have no influence on the ecology). Five Group 2 species - stone loach, pike, perch, minnow and roach, and one Group 3 species - gudgeon, were recorded within the ShIRBD.

Following the methods of Kennedy and Fitzmaurice (1971), brown trout growth was classified as slow in the Ballyfinboy, Bilboa, Creegh, Glendine, Nenagh and Newport Rivers, fast in the Dead and Owveg Rivers and very fast in the River Fergus. Salmon L1 ranged from 4.0cm in the Newport River to 7.9cm in the Glendine River. There are some very good salmon nursery sites within the lower parts of the ShIRBD, with relatively high densities in the Bilboa, Dead and Owveg Rivers.

An essential step in the WFD process is the classification of the ecological status of lakes, rivers and transitional waters, which in turn will assist in identifying objectives that must be set in the individual River Basin District Management Plans. No fish classification method currently exists in Ireland for classifying river water quality based on fish populations. Currently, ecological status classifications are based on expert opinion using information collected during a project to investigate the relationship between fish stocks, ecological quality ratings (Q-values), environmental factors and degree of eutrophication (Kelly *et al*., 2007c). An ecological classification tool, however, is being developed for the Republic of Ireland and Northern Ireland, along with a separate version for Scotland to comply with the requirements of the WFD. Agencies throughout each of the three regions have contributed data to be used in the model, which is being developed under the management of the Scotland & Northern Ireland Forum for Environmental Research (SNIFFER). It was recommended during the earlier stages of this project that an approach similar to that developed by the Environment Agency in England and Wales (FCS2) be used. This scheme works by comparing various fish community metric values within a site (observed) to those predicted (expected) for that site under reference (un-impacted) conditions using a geo-statistical model based on bayesian probabilities. The proposed method will provide an Ecological Quality Ratio (EQR) between 1 and 0 for all sites. Five class boundaries will be defined along this range, to correspond with the five ecological status classes of

High, Good, Moderate, Poor and Bad. Confidence levels will then be assigned to each class and represented as probabilities. Work on the rivers classification tool is still ongoing and is due for completion in mid-2010.

6. REFERENCES

Barton, E. and Heard, J. (2005) *Alien, Non-native and Invasive Marine Species. Marine Life Topic Note. The Marine Biological Association of the United Kingdom.* Available at: http://www.marlin.ac.uk/PDF/MLTN_alien_non_natives.pdf

CEN (2003) *Water Quality—Sampling of Fish with Electricity*. European Standard. Ref. No. EN 14011:2000.

Council of the European Communities (2000) Establishing a framework for Community action in the field of water policy. Directive of the European Parliament and of the Council establishing a framework for community action in the field of water policy (2000/60/EC). *Official Journal of the European Communities*, **43**, 1-73.

Eno, N.C., Clark, R.A. and Sanderson, W.G. (1997) *Non-native marine species in British waters: a review and directory*. Peterborough: Joint Nature Conservation Committee.

Kelly, F., Harrison, A., Connor, L., Allen, M., Rosell, R. and Champ, T. (2008) *North South Shared Aquatic Resource (NS Share) Lakes Project: FISH IN LAKES*: *Task 6.9: Classification tool for Fish in Lakes. Final Report*. Available at: www.nsshare.com

Kelly, F., Connor, L., Wightman, G., Matson, R., Morrissey, E., O'Callaghan, R., Feeney, R., Hanna, G. and Rocks, K. (2009) *Sampling Fish for the Water Framework Directive - Summary Report 2008*. CFB unpublished report.

Kelly, F.L., Harrison, A.J., Connor, L., Matson, R., Wightman, G., Morrissey, E., O'Callaghan, R., Feeney, R., Hanna, G., Wogerbauer, C. and Rocks, K. (2010) *Sampling fish for the Water Framework Directive – Summary report 2009*. CFB unpublished report.

Kennedy, M. and Fitzmaurice, P. (1971) Growth and Food of Brown Trout *Salmo Trutta* (L.) in Irish Waters. *Proceedings of the Royal Irish Academy*, **71 (B) (18),** 269-352.

O'Reilly, P. (2009) *Rivers of Ireland, a Flyfisher's Guide (7th Edition). Merlin Unwin Books, Shropshire, UK.*

NPWS (2001) *Moyree River. Site Synopsis, Site code: 000057*. Available at: http://www.npws.ie/en/media/Media,3854,en.pdf

NPWS (2002) *Black-Head-Poulsallagh Complex. Site Synopsis, Site code: 000020*. Available at: http://www.npws.ie/en/media/Media,3848,en.pdf

NPWS (2003a) *Lough Derg, North East Shore. Site Synopsis, Site code: 002241*. Available at: http://www.npws.ie/en/media/Media,4194,en.pdf

NPWS (2003b) *Slieve Bernagh Bog. Site Synopsis, Site code: 002312*. Available at: http://www.npws.ie/en/media/Media,4230,en.pdf

NPWS (2004) *Lough Derg (Shannon) SPA. Site Synopsis, Site code: 004058.* Available at: http://www.npws.ie/en/media/Media,4472,en.pdf

NPWS (2005) *Lower River Shannon. Site Synopsis, Site code: 002165.* Available at: http://www.npws.ie/en/media/Media,4177,en.pdf

Scalera, R. and Zaghi, D. (2004) *Alien species and nature conservation in the EU. The role of the LIFE program. LIFE focus European Communities Luxembourg*, 56 pp. Available at: http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/alienspecies_en.pdf

SHIRBD (2009) *Shannon River Basin Management Plan (2009-2015).* Shannon International River Basin District.

Stokes, K., O'Neill, K. and McDonald, R.A. (2006) *Invasive species in Ireland.* Report to Environment and Heritage Service and National Parks and Wildlife Service. Quercus, Queens University Belfast, Environment and Heritage Service Belfast and National Parks and Wildlife Service Dublin, 151 pp. Available at: http://www.npws.ie/en/media/Media,3701 ,en.pdf

APPENDIX 1

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

River		L1	L2	L3	L4	Growth category
Ballyfinboy	Mean	8.0	15.3			Slow
	S.D.	1.7	4.4			
	S.E.	0.8	3.1			
	n	5	2			
	Range min.	6.3	12.2			
	Range max.	10.6	18.4			
Bilboa	Mean	6.6	14.2			Slow
	S.D.	1.2	2.5			
	S.E.	0.2	0.9			
	n	30	8			
	Range min.	4.9	10.7			
	Range max.	9.1	17.1			
Caher	Mean	8.8				n/a
	S.D.	1.2				
	S.E.	0.2				
	n	24				
	Range min.	6.8				
	Range max.	11.5				
Creegh	Mean	8.2	14.5	19.1	22.8	Slow
	S.D.	1.1	1.9	1.7	n/a	
	S.E.	0.2	0.4	0.5	n/a	
	n	39	25	12	1	
	Range min.	6.3	10.4	16.2	22.8	
	Range max.	10.4	17.5	22.8	22.8	
Dead	Mean	8.2	18.2	23.7		Fast
	S.D.	1.4	2.4	2.7		
	S.E.	0.3	0.5	1.2		
	n	31	23	5		
	Range min.	4.5	11.6	20.8		
	Range max.	10.7	22.8	27.6		
Fergus	Mean	8.0	22.1			Very fast
	S.D.	0.7	3.1			
	S.E.	0.1	1.8			
	n	31	3			
	Range min.	7.1	20.1			
	Range max.	10.1	25.6			
Glendine	Mean	7.2	13.5			Slow
	S.D.	0.8	0.9			
	S.E.	0.3	0.5			
	n	6	4			
	Range min.	6.2	12.5			
	Range max.	8.5	14.3			

APPENDIX 1 continued

River		L1	L2	L3	L4	Growth category
Nenagh	Mean	7.0	14.2	19.8	24.3	Slow
	S.D.	1.2	2.1	4.8	5.7	
	S.E.	0.2	0.4	1.5	4.0	
	n	53	27	11	2	
	Range min.	4.8	9.5	14.9	20.3	
	Range max.	10.0	17.3	32.3	28.3	
Newport	Mean	6.0	13.2	15.5		Slow
	S.D.	1.5	2.4	3.0		
	S.E.	0.4	0.6	1.5		
	n	15	14	4		
	Range min.	4.2	9.3	12.5		
	Range max.	8.9	17.5	18.6		
Owvane	Mean	7.4				n/a
	S.D.	1.3				
	S.E.	0.3				
	n	20				
	Range min.	4.6				
	Range max.	10.0				
Owveg	Mean	6.7	16.1			Fast
	S.D.	1.4	n/a			
	S.E.	0.4	n/a			
	n	14	1			
	Range min.	4.8	16.1			
	Range max.	9.8	16.1			

APPENDIX 2

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

River		L1	L2
Bilboa	Mean	4.5	8.6
	S.D.	1.0	1.0
	S.E.	0.1	0.3
	n	45	12
	Range min.	2.7	7.2
	Range max.	6.6	10.3
Broadford	Mean	5.3	
	S.D.	0.4	
	S.E.	0.1	
	n	13	
	Range min.	4.5	
	Range max.	6.1	
Creegh	Mean	5.9	9.1
	S.D.	0.9	0.8
	S.E.	0.2	0.5
	n	29	2
	Range min.	4.4	8.6
	Range max.	8.2	9.6
Dead	Mean	6.1	
	S.D.	1.1	
	S.E.	0.3	
	n	16	
	Range min.	4.5	
	Range max.	8.0	
Glendine	Mean	7.9	
	S.D.	n/a	
	S.E.	n/a	
	n	1	
	Range min.	7.9	
	Range max.	7.9	
Moyree	Mean	5.9	
	S.D.	0.6	
	S.E.	0.2	
	n	8	
	Range min.	4.9	
	Range max.	6.7	
Nenagh	Mean	6.5	
	S.D.	1.0	
	S.E.	0.4	
	n	7	
	Range min.	4.7	
	Range max.	7.8	

APPENDIX 2 continued

River		L1	L2
Newport	Mean	4.0	8.1
	S.D.	0.8	1.1
	S.E.	0.2	0.3
	n	27	10
	Range min.	2.5	6.9
	Range max.	5.6	9.5
Owvane	Mean	5.2	7.9
	S.D.	1.1	1.7
	S.E.	0.2	0.8
	n	23	4
	Range min.	3.3	6.3
	Range max.	7.1	10.3
Owveg	Mean	4.5	
	S.D.	1.3	
	S.E.	0.2	
	n	33	
	Range min.	2.4	
	Range max.	7.9	

The Central Fisheries Board
Swords Business Campus,
Swords,
Co. Dublin,
Ireland.

Web: www.wfdfish.ie
www.cfb.ie
Email: info@cfb.ie
Tel: +353 1 8842600
Fax: +353 1 8360060

The Central and Regional Fisheries Boards