ERFB Rivers

Sampling Fish for the Water Framework Directive - Rivers 2008

The Central and Regional Fisheries Boards

PROJECT PERSONNEL

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1. INTRODUCTION

Fish stock surveys were undertaken in 83 rivers throughout Ireland during the summer of 2008 as part of the programme for sampling fish for the Water Framework Directive. These surveys were carried out at 11 river sites in the Eastern Regional Fisheries Board (ERFB) between July and early October 2008 by staff from the Central Fisheries Board (CFB) and the ERFB (Fig. 2.1). The sites were selected based on criteria set down by the Environmental Protection Agency. These surveys are required by both national and European law (Council of the European Communities, 2000). Annex V of the European Water Framework Directive (WFD) stipulates 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). Although fish survey work has been carried out in Ireland in the past, no project to date has been as extensive as the present study in providing data appropriate for WFD compliance. Continued surveying of these and additional river sites will provide a useful baseline in the future for monitoring water quality and compiling programmes of measures.

The ERFB is the third largest regional fishery board in the country and covers a land surface area of over 10,500km^2. Eleven counties, including Monaghan in the north and Wexford in the south, are either wholly or partially contained within this region. The ERFB's coastline stretches approximately 530km, reaching from Dundalk Bay in the north to Ballyteige Bay in the south. Some of the major river catchments within the region include the Liffey, the Boyne, the Nanny-Devlin and the Slaney. There are relatively few lakes within the ERFB when compared to some of the other Fishery Board Regions. Most of the lakes are restricted mainly to north Co. Wicklow and Co. Monaghan. The largest lake in the region is Pollaphuca Reservoir, which is located in Co. Wicklow. The population in the ERFB is higher than that of any other region and this is due to the presence of Dublin City and other major urban centres including Enniscorthy, Drogheda, Dundalk, Monaghan, Naas and Navan.

This report summarizes the main findings of the fish stock surveys in the 11 river waterbodies surveyed in the ERFB during 2008 and reports the current status of the fish stocks in each of these.

2. STUDY AREA

Eleven river sites, in six river catchments (Owenavorragh, Slaney, Liffey, Monaghan Blackwater, Coastal and Vartry) were surveyed. Sites ranged in surface area from 387.5m^2 (Douglas River) to 8680m^2 (River Liffey at Kilcullen). These sites were categorised into two catchment size classes - <100km^2 and <1000km^2) (Table 2.1 and Fig. 2.1) and were divided into two categories for reporting purposes, i.e. hand-set and boat sites.

Table 2.1. List of river sites surveyed for WFD surveillance monitoring in the ERFB, July to October 2008, details of catchment area (km^2), wetted width, surface area (m^2), mean depth (m) and max depth (m) are included

River	Catchment	Easting	Northing	Catchment Area (km^2)	Width (m)	Area (m^2)	Mean Depth (m)	Max Depth (m)
			Hand-set sites					
Banoge	Owenavorragh	315948	156340	<100	6.46	646.00	0.22	0.45
Clody	Slaney	289742	154970	<100	7.77	776.67	0.32	0.50
Dodder	Liffey	317704	231128	<1000	11.40	570.00	0.36	0.65
Douglas	Slaney	284445	163946	<100	3.88	387.50	0.22	0.55
Duncormick	Coastal	291366	110626	<100	4.72	471.67	0.34	0.63
Urrin	Slaney	287055	144031	<100	5.95	535.50	0.37	0.59
Rye Water	Liffey	294686	238556	<1000	6.38	638.33	0.26	0.54
			Boat sites					
Blackwater	Blackwater (Ulster)	271921	338773	<1000	11.20	2968.00	0.42	0.95
Liffey	Liffey	284110	209964	<1000	24.80	8680.00	0.77	1.40
Owenavorragh	Owenavorragh	315104	154291	<100	8.00	1280.00	0.50	1.00
Vartry	Vartry	328823	196717	<1000	7.40	1110.00	0.51	0.82

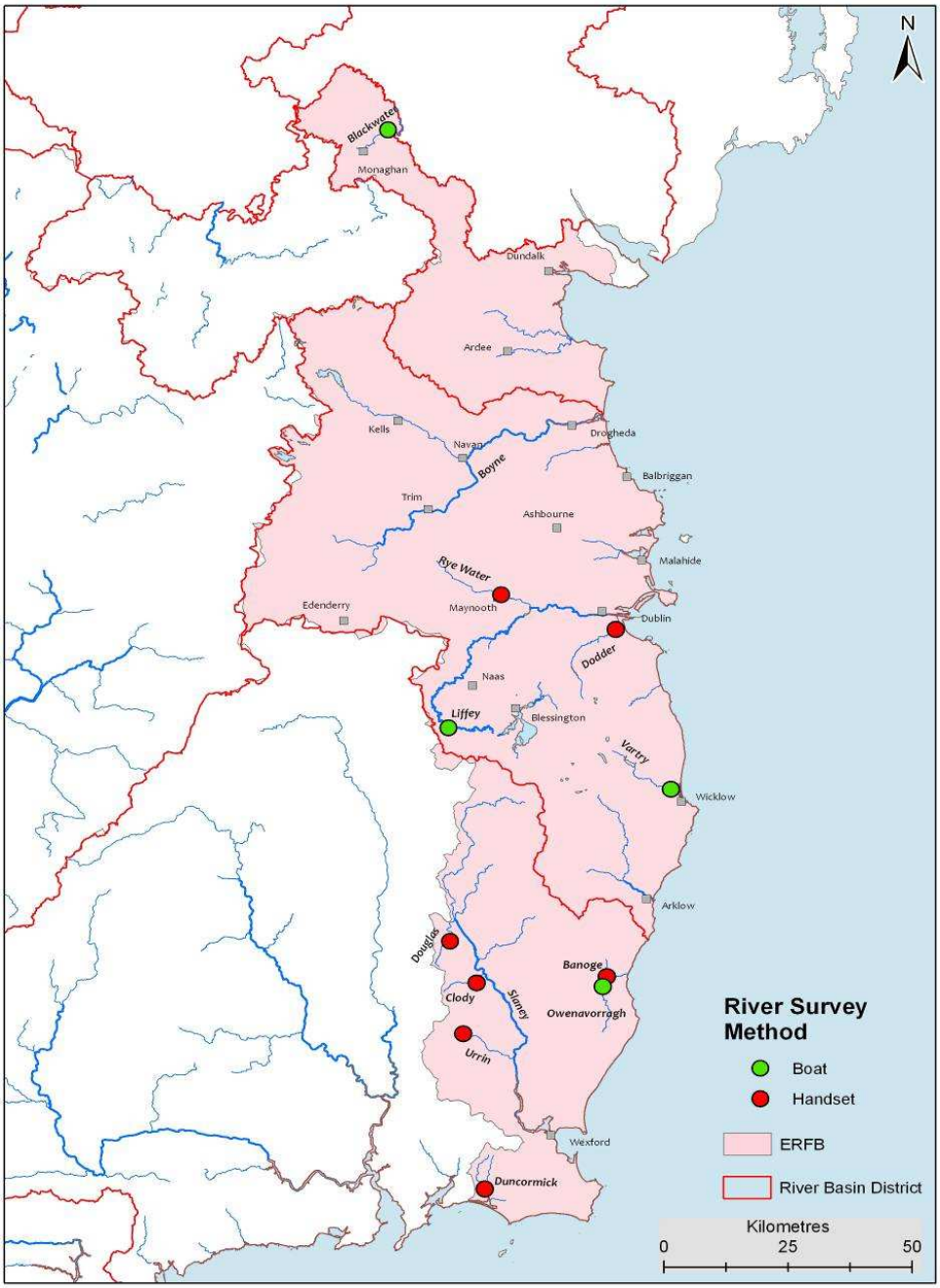

Fig. 2.1. Location map of river sites surveyed throughout the ERFB for WFD fish surveillance monitoring 2008

3. METHODS

Electric fishing is the method of choice for surveillance monitoring of fish in rivers in order to obtain a representative sample of the fish assemblage at each sampling site. The 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 carried in flat-bottomed boats. 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 and a multihabitat kick sample for macroinvertebrates were taken, and a macrophyte survey was conducted.

Fish captured in each fishing occasion were sorted and processed separately. During processing, the species of each fish was identified and its length and weight were measured; sub-samples were weighed when large numbers of fish were present. For species identification, river lamprey (*Lampetra fluviatilis*) and brook lamprey (*Lampetra planeri*) were treated as a single species. Scales were taken from salmonids greater than 8.0cm and from most coarse fish species. Opercular bones were used to age perch captured. All fish were held in a large bin of oxygenated water after processing until they were fully recovered and were then returned to the water. Samples of eels were retained for further analysis.

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

Plate 3.1: Electric fishing in a small wadeable stream using bank based units

4. RESULTS

4.1 Wadeable hand-set sites

4.1.1 The Banoge River

Plate 4.1. The Banoge River, upstream of the Owenavorragh confluence

The Banoge River flows southwards through Gorey, Co. Wexford and joins with the Owenavorragh River 3.5 kilometres west of Courtown (Plate 4.1 and Fig. 4.1). A 100m stretch of river was surveyed on the 30th of June 2008 upstream of the bridge, located upstream of the Owenavorragh River confluence (Fig. 4.1). Three fishings were carried out using two bank based electric fishing units. The substrate at the site was dominated by cobble and boulder and habitat consisted mainly of glide and riffle. Trees along the banks provided heavy shading to the channel (Plate 4.1), while the instream vegetation consisted of small amounts of moss including *Fontinalis antipyretica* and *Rhynchostegium riparioides*. The channel had a mean width of 6.46m and depth of 22cm, totalling a wetted area of 646 m² (Table 2.1).

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

Five species of fish were recorded in the Banoge River during the survey (Table 4.1). Eels were the most abundant species recorded, followed by stone loach, salmon, brown trout and 3-spined stickleback.

Table 4.1. Density of fish (no./m^2), Banoge River site (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total density
Anguilla anguilla	Eel	-	-	0.2260
Barbatula barbatula	Stone loach	-	-	0.1068
Salmo salar	Salmon	0.0093	0.0418	0.0511
Salmo trutta	Brown trout	0.0077	0.0325	0.0403
Gasterosteus aculeatus	3-spined stickleback	-	-	0.0016
All fish	**All fish**	**-**	**-**	**0.4257**

Eels ranged in length from 9.0cm to 29.5cm (Fig. 4.2). Stoneoach ranged in length from 5.2cm to 8.6cm (Fig. 4.3). Salmon varied in length from 4.8cm to 14.9cm and two age classes were present (Fig. 4.4).

Salmon fry (0+) accounted for 18% of the population and salmon parr (1+) were the dominant age class accounting for 82% of the population. The mean L1 for salmon in the Banoge was 6.7 cm (Appendix 2).

Brown trout ranged in length from 5.5cm to 19.8cm (Fig. 4.5). Two age classes (0+ and 1+) were present accounting for 19% and 81% respectively of the brown trout population at the site (Fig. 4.5). The mean length of brown trout at L1 and L2 was 8.4cm and 20cm respectively, indicating fast growth as classified by Kennedy and Fitzmaurice (1971) (Appendix 1).

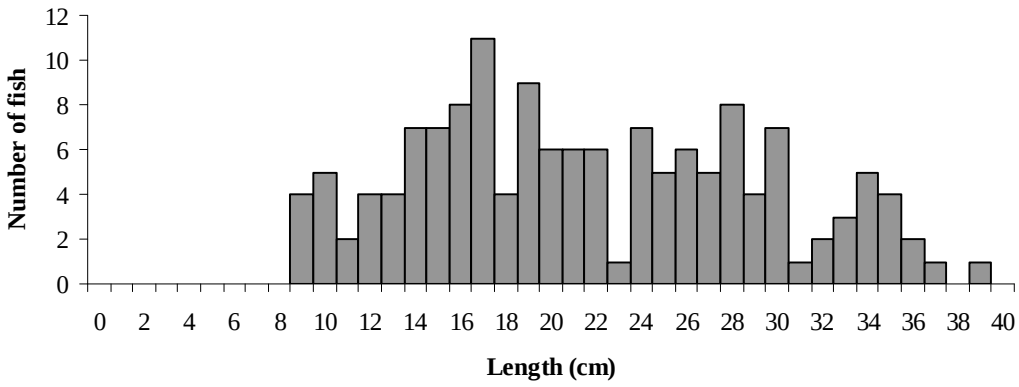

Fig. 4.2. Length frequency distribution of eels in the Banoge River, June 2008 (n = 145)

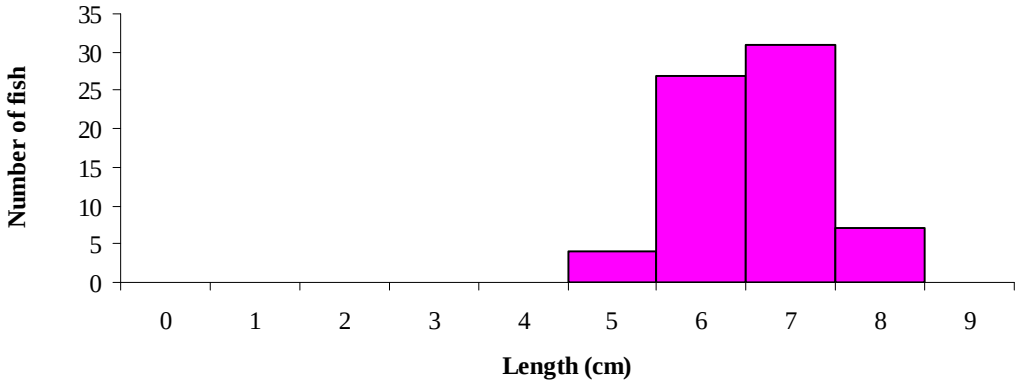

Fig. 4.3. Length frequency distribution of stone loach in the Banoge River, June 2008 (n = 69)

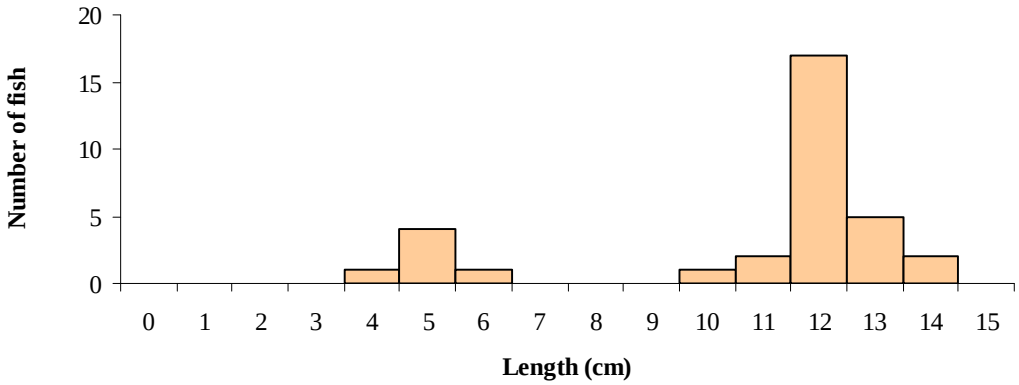

Fig. 4.4. Length frequency distribution of salmon in the Banoge River, June 2008 (n = 33)

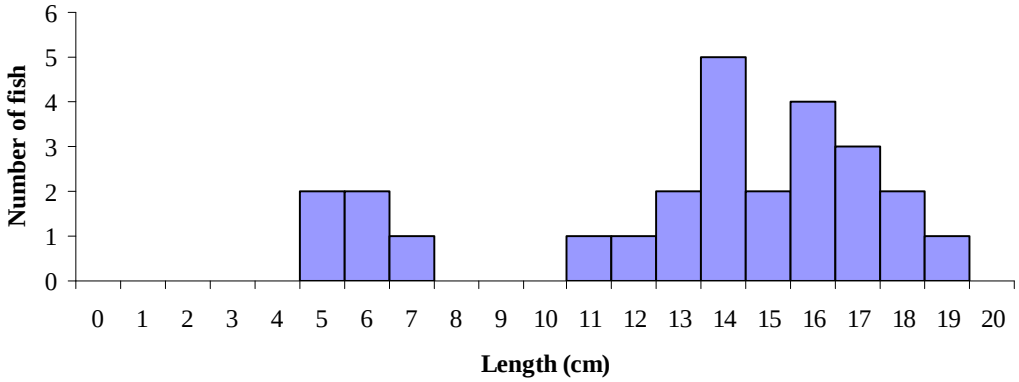

Fig. 4.5. Length frequency distribution of brown trout in the Banoge River, June 2008 (n = 26)

4.1.2 The Clody River

Plate 4.2. The Clody River, a short distance upstream of Bunclody, Co. Wexford

The Clody River is a small picturesque tributary of the River Slaney that runs along the border of counties Carlow and Wexford (Plate 4.1 and Fig. 4.6). The river joins the Slaney in Bunclody town at Slaney Bridge (Fig. 4.6). An electric fishing survey was carried out on the 2nd of July 2008 using three sets of bank based electric fishing equipment on a 100m stretch of river channel. The site itself was located on the downstream side of Ford Bridge, three kilometres upstream of Bunclody (Fig. 4.6). The dominant habitat types were riffle and glide over a gravel and cobble substrate. The site was heavily shaded by bankside vegetation, while numerous aquatic mosses including *Chiloscyphus polyanthus*, *Conocephalum conicum* and *Fontinalis squamosa* dominated the instream vegetation. The most abundant macrophyte was *Oenanthe crocata* (Hemlock Water Dropwort). The average width of the channel was 7.77m and average depth was 32cm. In total 776.67m^2 of channel was fished (Table 2.1).

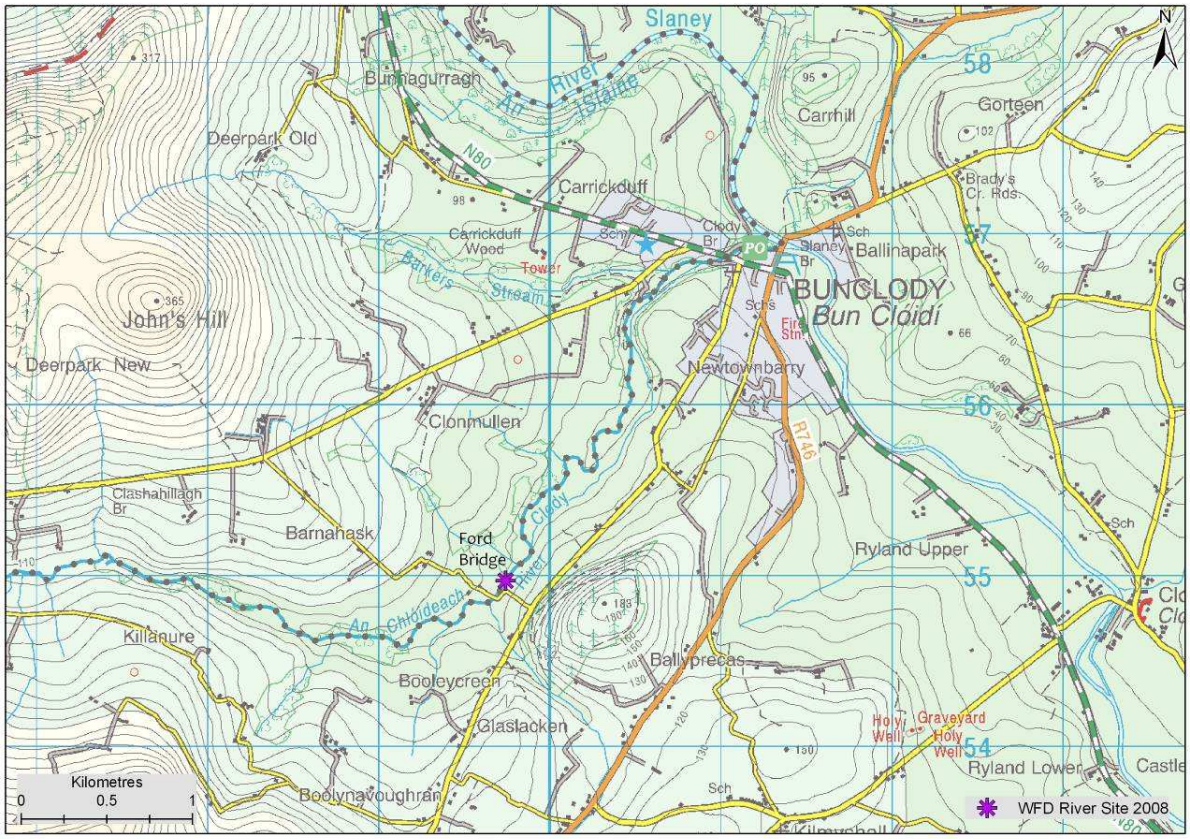

Fig. 4.6. Location of the Clody River surveillance monitoring site

Three fish species were recorded in the Clody River during the survey (Table 4.2). Brown trout were the most abundant species followed by salmon and eel.

Table 4.2. Density of fish (no./m^2) in the Clody River site (fish density has been calculated as minimum estimates based on three fishings)

Species name	Common name	0+	1+ & older	Total density
Salmo trutta	Brown trout	0.2215	0.0850	0.3063
Salmo salar	Salmon	0.0605	0.0682	0.1287
Anguilla anguilla	Eel	-	-	0.0039
All fish	**All fish**	**-**	**-**	**0.4389**

Brown trout ranged in length from 2.8cm to 21.3cm (Fig. 4.7). The dominant age class for brown trout was 0+ (fry), followed by 1+ (16%) and 2+ (9%). The mean length of brown trout at L1 and L2 was 6.5cm and 11.95cm respectively. Hence trout growth in the Clody was categorised as very slow, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

Salmon ranged in length from 5.0cm to 12.2cm and three age classes were present (0+, 1+ and 2+). Salmon fry (0+) accounted for 43% of the population and salmon parr for 58% of the population (1+ (54%) being the dominant age class). The mean L1 for salmon in the Clody was 5.43cm (Appendix 2).

A small number of eels were captured during the survey and these ranged in length from 22cm to 34cm.

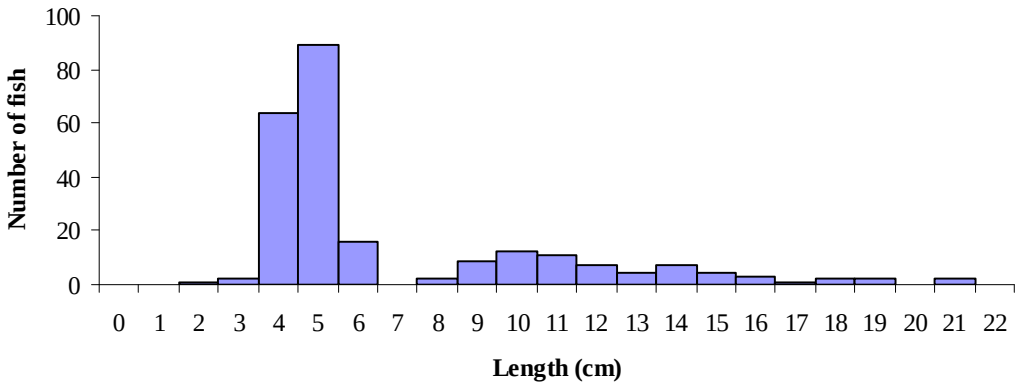

Fig. 4.7. Length frequency distribution of brown trout in the Clody River, July 2008 (n = 238)

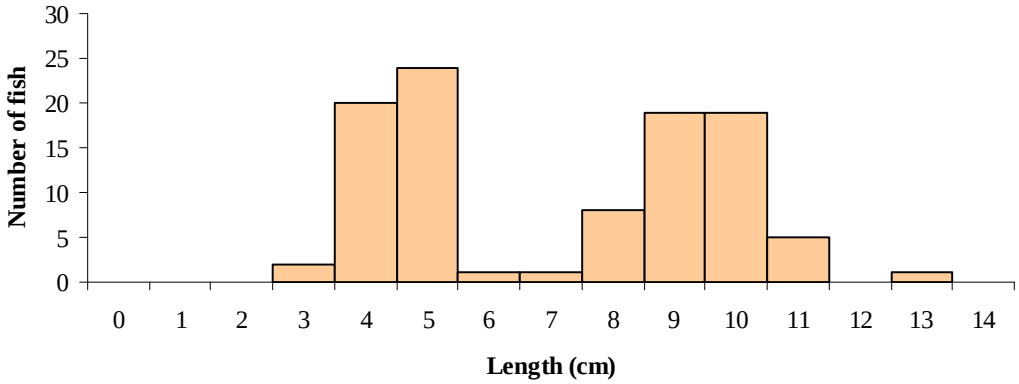

Fig. 4.8. Length frequency distribution for salmon in the Clody River, July 2008 (n = 100)

4.1.3 The River Dodder

Plate 4.3. The River Dodder site at Beaver Row, Dublin

The River Dodder rises in the Wicklow Mountains and travels northwards towards Dublin city, before joining the Liffey Estuary near Ringsend (Fig. 4.9). The river drains many of Dublin's southside suburbs, yet still, surprisingly, contains low levels of pollution and good stocks of brown trout (O'Reilly, 2002). Despite being flanked on both sides by Dublin's busy urban sprawl, it remains popular among anglers fly fishing for brown and sea trout (O'Reilly, 2002). A series of weirs upstream of the site appear to obstruct salmon access to the higher reaches of the river.

An electric fishing survey was carried out on the upstream side of the footbridge at Beaver Row, Donnybrook on the 25th of September 2008 to assess the status of the fish stocks (Fig. 4.9). Three electric fishing backpack units were used over a distance of 50m using the three fishing depletion method. Riffle was the dominant habitat type present and cobble was the principal substrate. Shading was quite light on this section of river and the channel was strewn with various pieces of litter. The high banks contained significant patches of *Impatiens glandulifera* (Himalayan Balsam), an invasive weed to Ireland. The mean

width of the channel was 11.4m and mean depth was 36cm. The total wetted area fished was 570m² (Table 2.1).

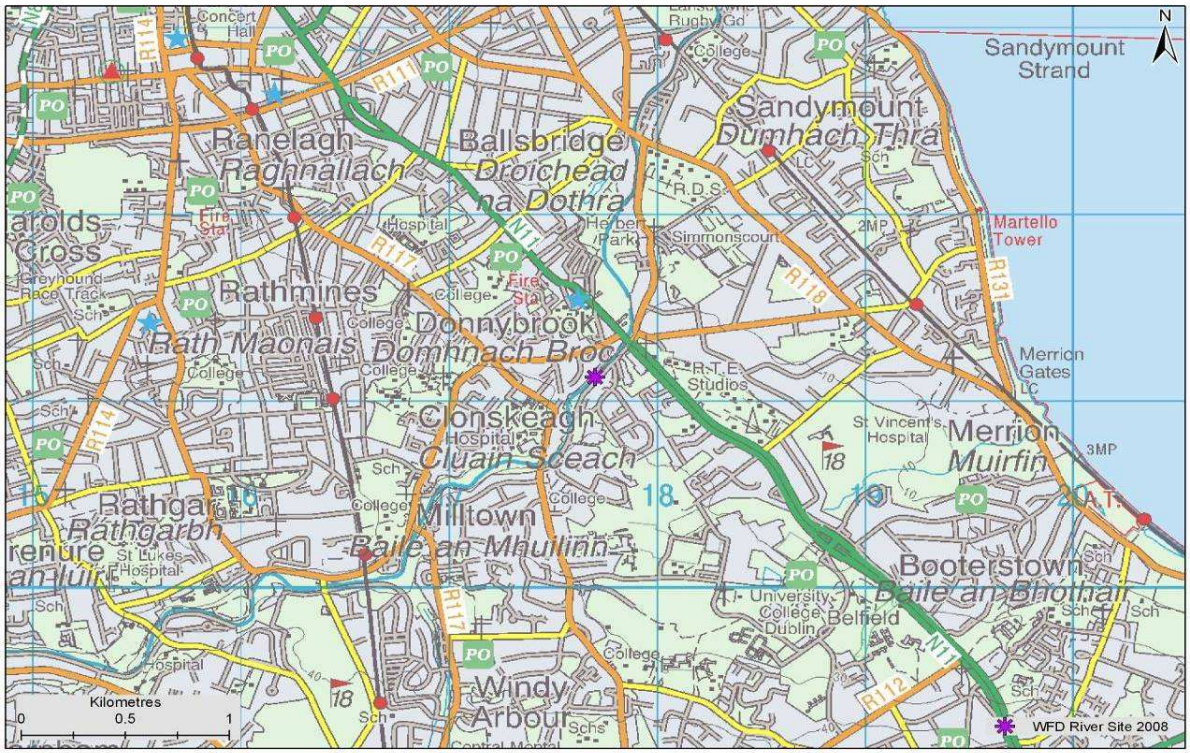

Fig. 4.9. Location of the River Dodder surveillance monitoring site

Five species of fish were recorded in the Dodder during the survey (Table 4.3). Sea trout are included as a separate "variety" of trout. Salmon were the most abundant fish species, followed by brown trout, eels, minnow, stone loach and sea trout.

Table 4.3. Density of fish (no./m^2), River Dodder site (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total
Salmo salar	Salmon	0.0877	0.0667	0.1544
Salmo trutta	Brown trout	0.0579	0.0368	0.0947
Anguilla anguilla	Eel	-	-	0.0509
Phoxinus phoxinus	Minnow	-	-	0.0193
Barbatula barbatula	Stone loach	-	-	0.0105
Salmo trutta	Sea trout	-	-	0.0018
All fish	**All fish**	-	-	**0.3316**

Salmon ranged in length from 6.3cm to 16.2cm (Fig. 4.10). The dominant age class for salmon was 0+ (fry) accounting for 57% of the population, followed by 1+ (38%) and 2+ (5%). The mean L1 and L2 lengths for salmon in the Dodder were 6.02 cm and 9.29 cm respectively (Appendix 2).

Brown trout ranged in length from 6.2cm to 26.1cm (Fig. 4.11) and three age classes were present in the population (0+ to 2+). The dominant brown trout age class was 0+ (fry) and this accounted for 61% of the population, followed by 1+ (20%) and 2+ (19%). The mean length of brown trout at L1 and L2 was 8.02cm and 15.6cm respectively. Hence trout growth in the Dodder was categorised as slow, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

The largest salmonid captured at the site was a two-year old sea trout measuring 32.4cm in length and 390g in weight. Eels ranged in length from 7cm to 59.5cm (Fig. 4.12).

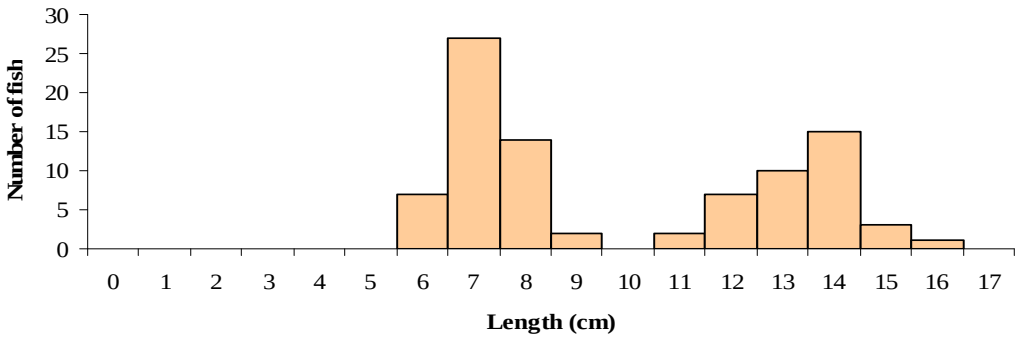

Fig. 4.10. Length frequency distribution for salmon in the Dodder River, September 2008 (n = 88)

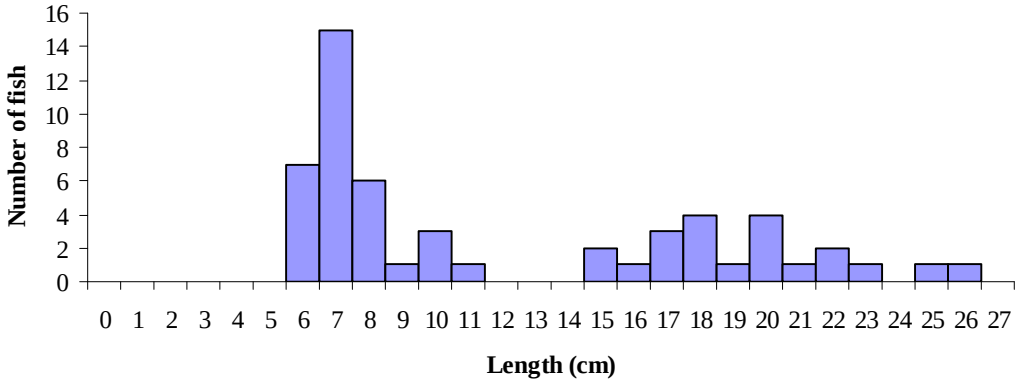

Fig. 4.11. Length frequency distribution for brown trout in the Dodder, September 2008 (n = 54)

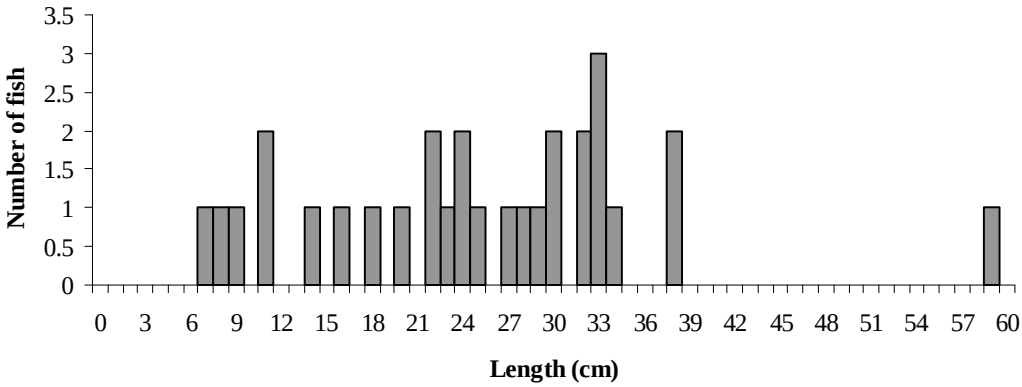

Fig. 4.12. Length frequency distribution of eels recorded in the Dodder, September 2008 (n = 29)

4.1.4 The Douglas River

Plate 4.4. The Douglas River, at Sragh Bridge near Ballon, Co. Carlow

The Douglas River is a small tributary of the River Slaney and joins with it northeast of Ballon in Co. Carlow. The river was surveyed on the upstream side of Sragh Bridge near Ballon on the 1st of July 2008 (Fig. 4.13). Two bank based electric fishing units were used over a distance of 50m using the three fishing depletion method. The dominant habitat type was glide over a substrate of gravel. Shading was heavy due to bankside vegetation. *Ranunculus* sp. dominated the instream flora but many other types of macrophyte were also recorded. Mosses including *Rhynchostegium riparioides* and *Conocephalum conicum*, floating species such as *Lemna minor* and *Callitriche* sp. and emergents such as *Rorippa nasturtium-aquaticum* and *Apium nodiflorum* were also present. *Impatiens glandulifera* (Himalayan Balsam), an invasive bankside weed, was also found along the banks. The mean channel width of the site was measured at 3.88m and the mean depth was 22cm. The total wetted area was 387.5m² (Table 2.1).

Fig. 4.13. Location of the Douglas River surveillance monitoring site

Six fish species were recorded at the site during the survey (Table 4.4). Minnow were the most abundant, followed by lamprey, brown trout, 3-spined stickleback, stone loach and eel.

Table 4.4. Density of fish species (no./m^2) recorded on the Douglas River (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total
Phoxinus phoxinus	Minnow	-	-	0.3814
Lampetra spp.	Lamprey	-	-	0.1186
Salmo trutta	Brown trout	0.0465	0.0258	0.0722
Gasterosteus aculeatus	3-spined stickleback	-	-	0.0696
Barbatula barbatula	Stone loach	-	-	0.0593
Anguilla anguilla	Eel	-	-	0.0206
All fish	**All fish**			**0.7217**

Juvenile lamprey captured at the site ranged in length from 4cm to 15.7cm (Fig. 4.14).

Four age groups (0+ to 3+) of brown trout were recorded in the Douglas ranging in length from 5.9cm to 22.4cm (Fig. 4.15). The dominant age class was 0+ (fry) and this accounted for 64% of the population, followed by 1+ (11%), 2+ (21%) and 3+ (4%). The mean length of brown trout at L1, L2 and L3 was 8.12cm, 13.3cm and 19.76cm respectively. Hence trout growth in the Douglas was categorised as slow, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

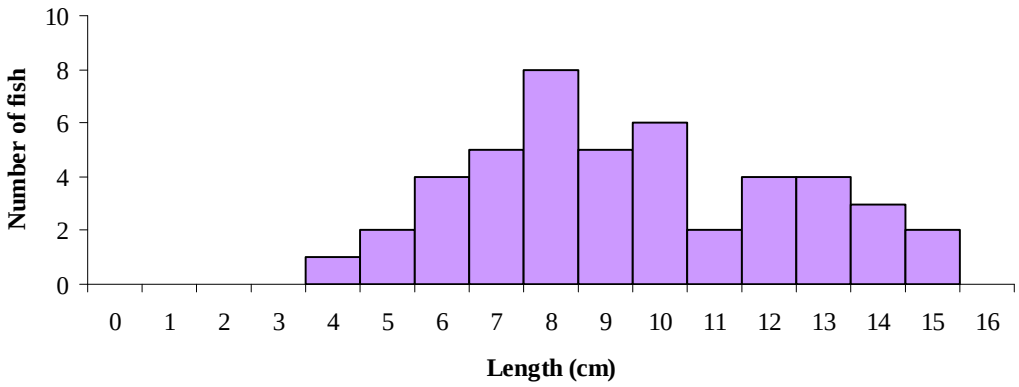

Fig. 4.14. Length frequency distribution for juvenile lamprey in the Douglas River, July 2008 (n = 46)

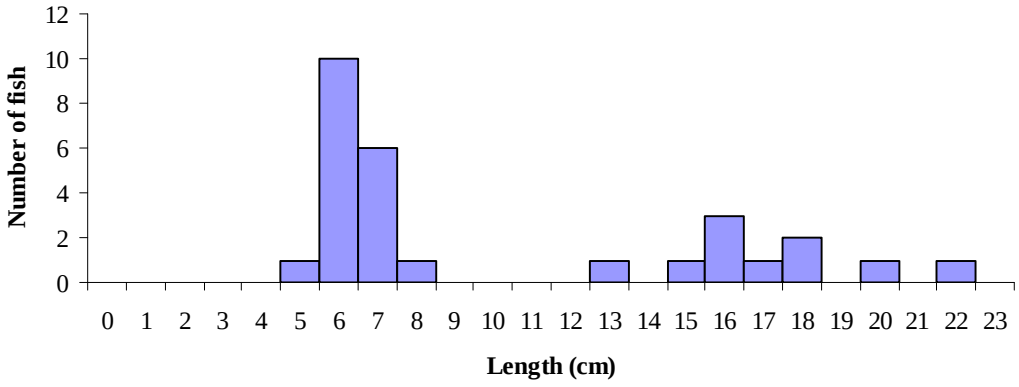

Fig. 4.15. Length frequency distribution for brown trout in the Douglas River, July 2008 (n = 28)

4.1.5 The Duncormick River

Plate 4.5. The Duncormick River near Duncormick Railway Station)

The Duncormick river is a small stream located north of Duncormick, Co. Wexford (Fig. 4.16). It flows for approximately seven kilometres southwest before reaching the sea at Ballyteige Bay (Fig. 4.16). The river was surveyed for fish downstream of a railway bridge near Duncormick Railway Station on the 4th of July 2008 (Fig. 4.16). Two bank based electric fishing units were used over a distance of 100m using the three fishing depletion method. This site had a medium level of shading caused by bankside vegetation and contained a good mix of habitat, dominated mainly by glides. The substrate was mostly gravel and sand, with instream vegetation composed of species such as *Sparganium erectum*, *Oenanthe crocata* (Hemlock Water Dropwort), *Ranunculus* sp., *Fontinalis antipyretica* and *Rhynchostegium riparioides*. The mean width of the site was measured at 4.72m and mean depth was 34cm with a maximum depth of 60cm being recorded in some places. The total wetted area surveyed was 471.67m² (Table 2.1).

Fig. 4.16. Location of the Duncormick River surveillance monitoring site

Six fish species were recorded in the Duncormick Stream during the survey (Table 4.5). Brown trout were the most abundant species, followed by 3-spined stickleback, eel, salmon, stone loach and flounder.

Table 4.5. Density of fish species (no./m^2) recorded on the Duncormick River (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total
Salmo trutta	Brown trout	0.127	0.076	0.206
Gasterosteus aculeatus	3-spined stickleback	-	-	0.102
Anguilla anguilla	Eel	-	-	0.059
Salmo salar	Salmon	0.018	0.006	0.019
Barbatula barbatula	Stone loach	-	-	0.011
Platichthys flesus	Flounder	-	-	0.002
All fish	**All fish**	**-**	**-**	**0.398**

Three age classes (0+ to 2+) of brown trout were recorded in the Duncormick River ranging in length from 5cm to 26.2cm (Fig. 4.17). Fry (0+) were the dominant age class in the brown trout population

accounting for approximately 66% of the fish, followed by 1+ (26%) and 2+ (8%). The mean length of brown trout at L1 and L2 was 8.18cm and 14cm respectively. Hence trout growth in the Duncormick was categorised as slow, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1). Eels ranged in length from 8.1cm to 28.5cm (Fig. 4.18). Salmon fry (0+ - 67%) and parr (1+ - 33%) were recorded in low numbers and ranged in length from 5.5cm to 12.9cm. The mean L1 for salmon in the Duncormick was 6.04cm (Appendix 2).

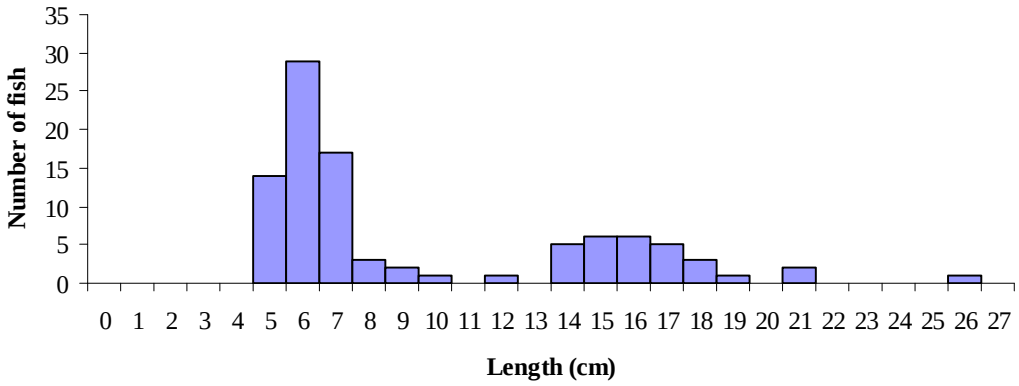

Fig. 4.17. Length frequency distribution of brown trout in the Duncormick River, July 2008 (n = 97)

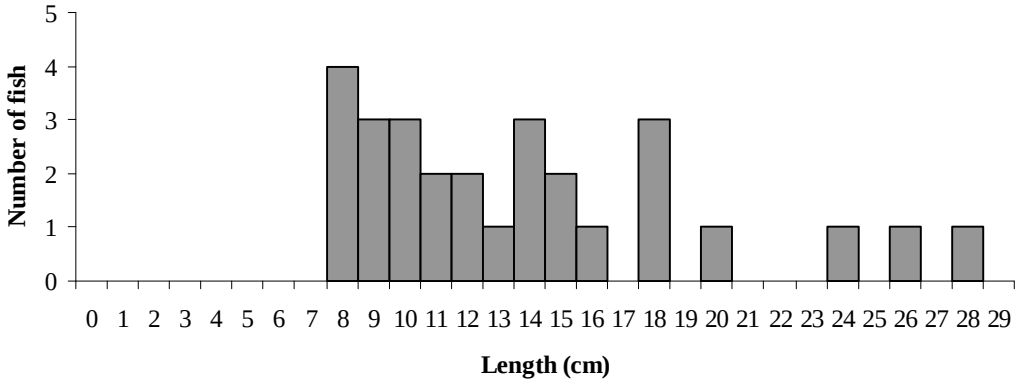

Fig. 4.18. Length frequency distribution of eels in the Duncormick River, July 2008 (n = 28)

4.1.6 The Urrin River

Plate 4.6. The Urrin River, at Buck's Bridge looking downstream

The Urrin is a tributary of the River Slaney. It flows south eastwards from its source in the Blackstairs Mountains and joins the Slaney in Enniscorthy, Co. Wexford. It is quite a picturesque stream and is known locally for good sea trout angling (O'Reilly, 2002). The river was surveyed downstream of Bucks Bridge on the 3rd of October 2008 with two bank based electric fishing units over a distance of 90m using the three fishing depletion method (Fig. 4.19).

The habitat was well mixed at this site but glides were more common than any other habitat type. Substrate types on the other hand were very evenly mixed across a gradient from boulder to silt. Shading on this site was at a medium level with patches covered and exposed in different places. The instream flora was dominated mostly by mosses such as *Fontinalis squamosa*, *Chiloscyphus polyanthus*, *Hygrohypnum* sp. and *Pellia epiphylla*. The only other macrophyte recorded was *Oenanthe crocata* (Hemlock Water Dropwort). The mean width of the river channel was measured at 5.95m and the mean depth was 37cm. The wetted area was 535.5m² (Table 2.1).

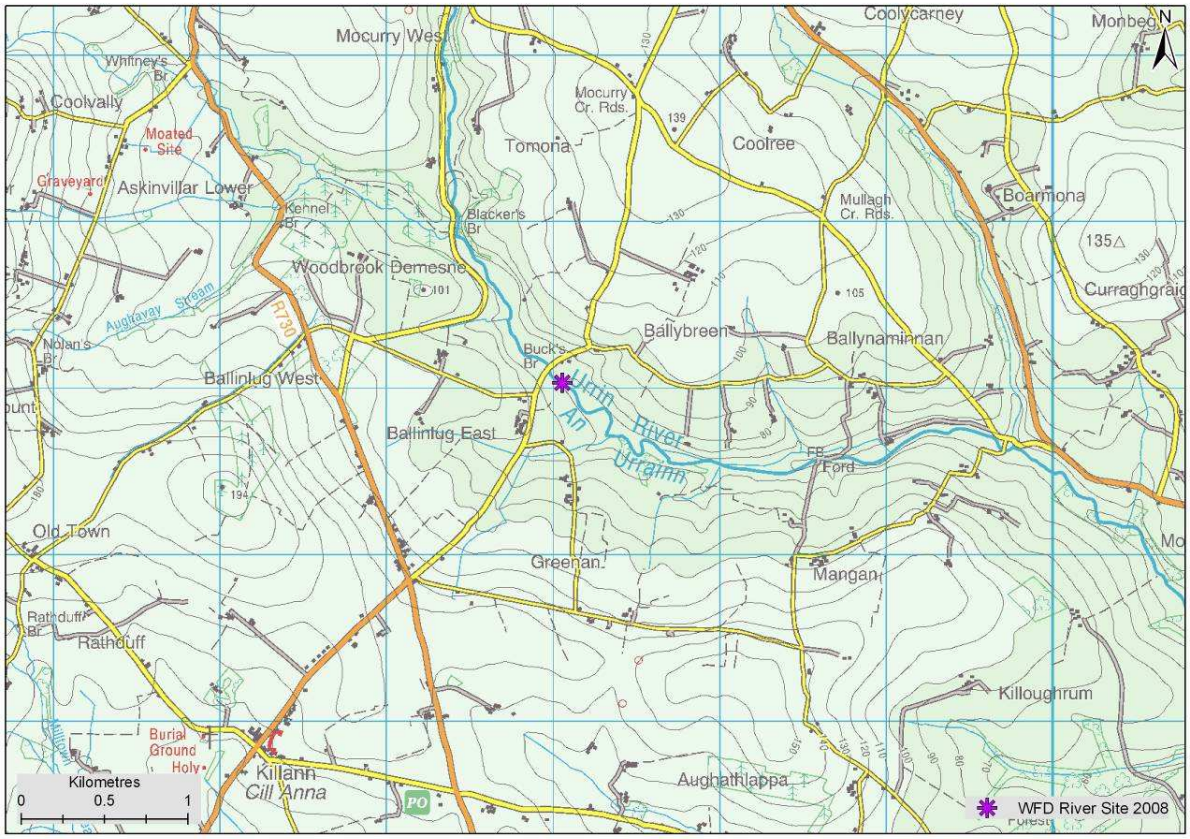

Fig. 4.19. Location of the Urrin River surveillance monitoring site

Three fish species (sea trout are included as a separate "variety" of trout) were recorded at the site during the survey (Table 4.6). Brown trout were the most abundant species followed by salmon, eel and sea trout.

Table 4.6. Density of fish species (no./m^2) recorded on the Urrin River (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total
Salmo trutta	Brown trout	0.082	0.129	0.2130
Salmo salar	Salmon	0.022	0.030	0.052
Anguilla anguilla	Eel	-	-	0.009
Salmo trutta	Sea trout	-	-	0.0020
All fish	**All fish**	-	-	**0.276**

Brown trout ranged in length from 5.7cm to 25.7cm (Fig. 4.20). A total of 92 brown trout scales were examined for age analyses. The dominant age class was 0+ (fry) and this accounted for 48% of the

population, followed by 1+ (26%), 2+ and 3+ (4%). The mean length of brown trout at L1, L2 and L3 was 6.92cm, 12.3cm and 16.8cm respectively. Hence trout growth in the Urrin was categorised as very slow, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

Salmon ranged in length from 5.0cm to 12.2cm and three age classes were present (0+, 1+ and 2+). Salmon fry (0+) accounted for 43% of the population and salmon parr for 58% of the population (1+ (54%) being the dominant age class). The mean L1 and L2 for salmon in the Urrin were 6.14cm and 9.18cm respectively (Appendix 2).

One sea trout was recorded during the survey and this measured 25.2cm in length and weighed 142.5cm. Five eels were recorded during the survey and these ranged in length from 21.4cm to 33.4cm.

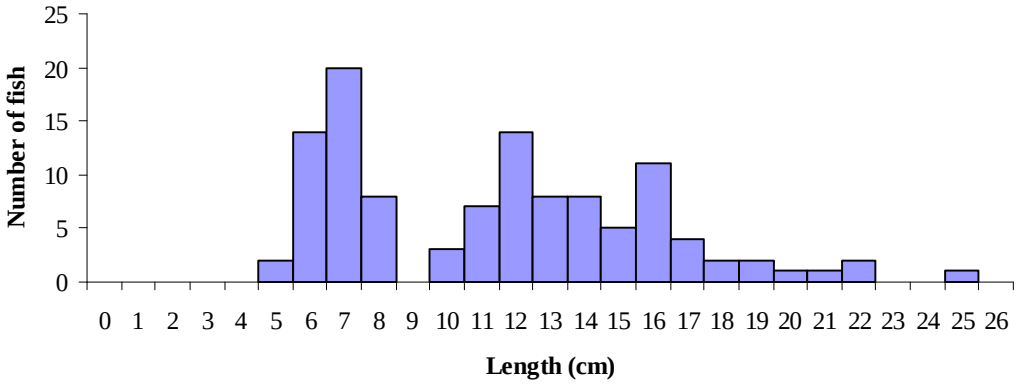

Fig. 4.20: Length frequency distribution of brown trout in the Urrin River, October 2008 (n = 114)

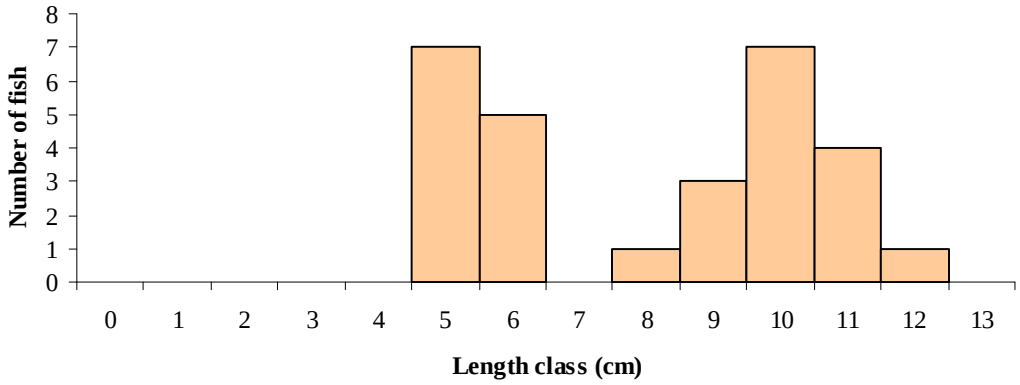

Fig. 4.21: Length frequency distribution for salmon in the Urrin River, October 2008 (n = 29)

4.1.7 Rye Water

Plate 4.7. The Rye Water u/s of Kildare Bridge

The Rye Water rises near Kilcock and follows an east south-east course for 24.8 kilometres before it joins the River Liffey in Leixlip, Co. Kildare. It is one of the most important salmon spawning tributaries in the Liffey catchment downstream of Leixlip dam. Although the river contains salmon, it is of much more interest to the fly fishing angler for its plentiful stock of trout (O'Reilly, 2002). The Duke of Leinster initiated a drainage scheme on the Rye Water on the 1850s which involved deepening of the river and installing field drains. The river was also drained by the Office of Public Works between 1952 and 1954 to alleviate flooding in Leixlip village. To rectify this work a fisheries enhancement programme was initiated on the river in 1994 on a 2.4 kilometre stretch of the river downstream of Carton Estate by the OPW in conjunction with the CFB, ERFB and the Zoology Department, University College Dublin (Kelly and Bracken, 1998). This work was extended downstream during 2004 and 2005.

This river was surveyed just upstream of Kildare Bridge on the 27th of June 2008 (Fig. 4.22) with three bank based electric fishing units over a distance of 100m using the three fishing depletion method. The principal habitat at the site was glide and pool. The substrate was composed mostly of cobble and channel shading was light. There were only a few instream macrophyte species and these included two common mosses, *Fontinalis antipyretica* and *Rhynchostegium riparioides* and a bankside grass *Phalaris arundinacea* (Reed Canary Grass). The total wetted area was calculated at 638.33m² (Table 2.1).

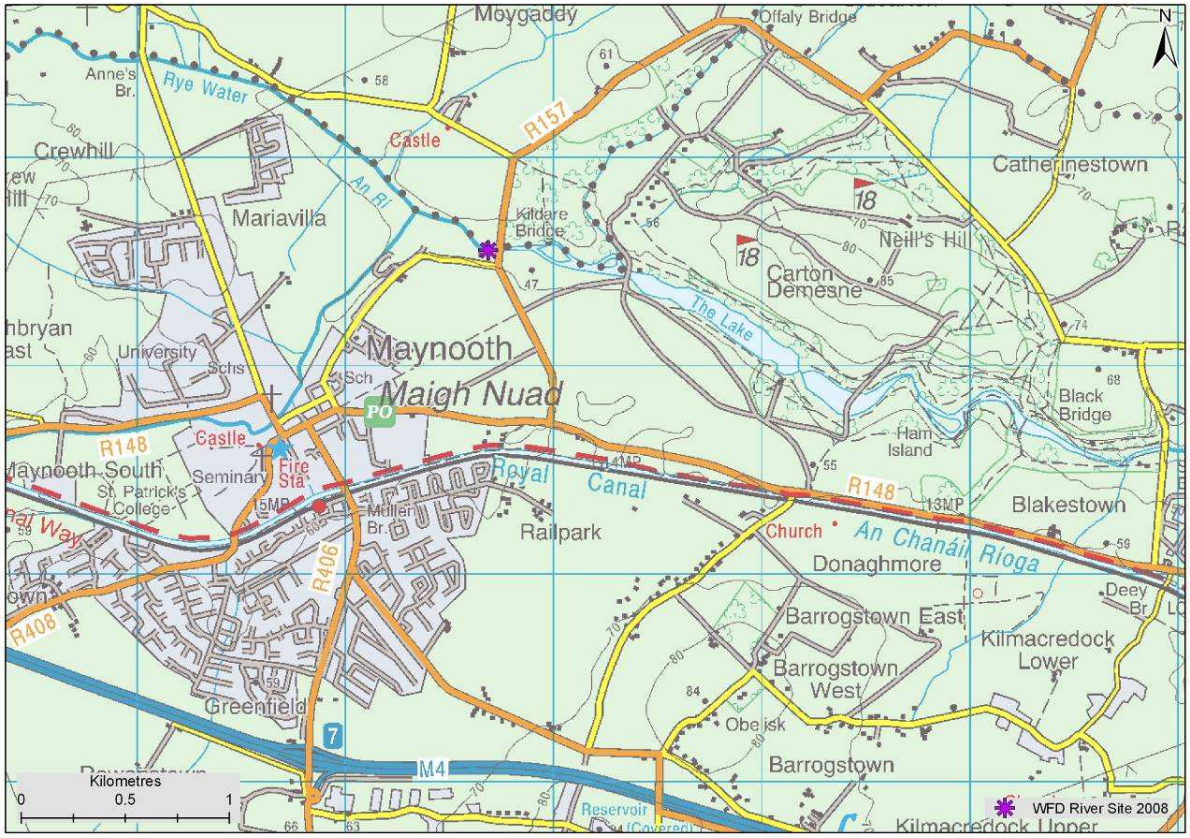

Fig. 4.22. Location of the Rye Water surveillance monitoring site

A total of seven fish species were recorded in the Rye Water during the survey (Table 4.7). Minnow were the most abundant species followed by stone loach, brown trout, lamprey, eel, 3-spined stickleback and pike.

Table 4.7. Density of fish species (no./m^2) recorded on the Rye Water at Kildare Bridge (fish density has been calculated as minimum estimates based on 3 fishings)

Species name	Common name	0+	1+ & older	Total
Phoxinus phoxinus	Minnow	-	-	0.9750
Barbatula barbatula	Stone loach	-	-	0.271
Salmo trutta	Brown trout	0.036	0.053	0.089
Lampetra spp.	Lamprey	-	-	0.077
Anguilla anguilla	Eel	-	-	0.028
Gasterosteus aculeatus	3-spined stickleback	-	-	0.003
Esox lucius	Pike	-	-	0.002
All fish	**All fish**			**1.445**

Minnow ranged in length from 2.8cm to 7.7cm (Fig. 4.23). Stone loach ranged in length from 4.2cm to 10.4cm (Fig. 4.24). Juvenile lamprey ranged in length from 8.7cm to 16cm (Fig. 4.25).

Brown trout ranged in length from 4.9cm to 31.5cm (Fig. 4.26). Four age classes were present in the population, i.e. 0+, 1+, 2+ and 3+ and these accounted for 41%, 29%, 29% and 2% of the trout population respectively. The mean length of brown trout at L1, L2 and L3 was 8.72cm, 19.77cm and 24.98cm respectively. Hence trout growth in the Rye Water was categorised as fast, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

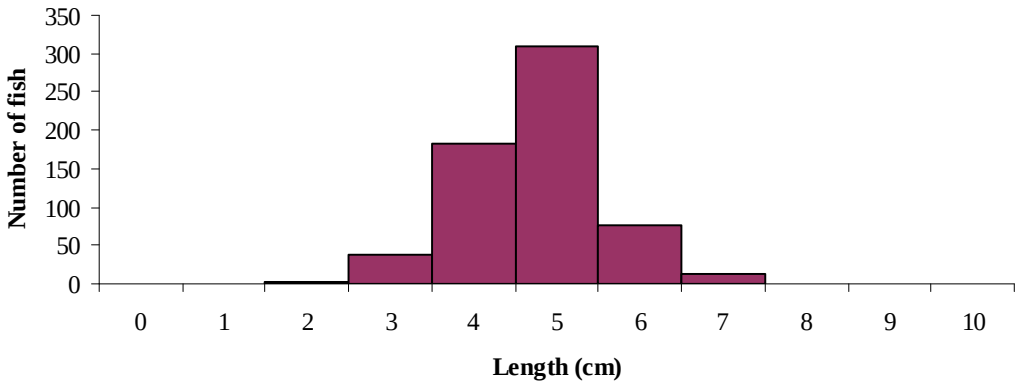

Fig. 4.23. Length frequency distribution of minnow in the Rye Water, June 2008 (n = 622)

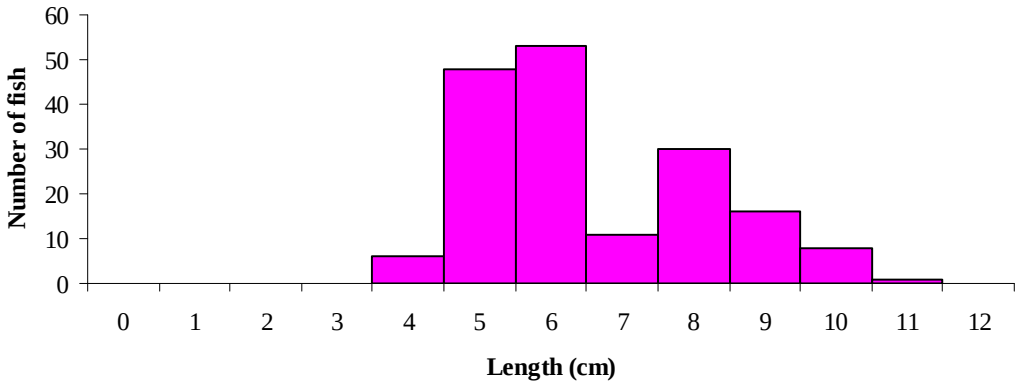

Fig. 4.24. Length frequency distribution of stone loach in the Rye Water, June 2008 (n = 173)

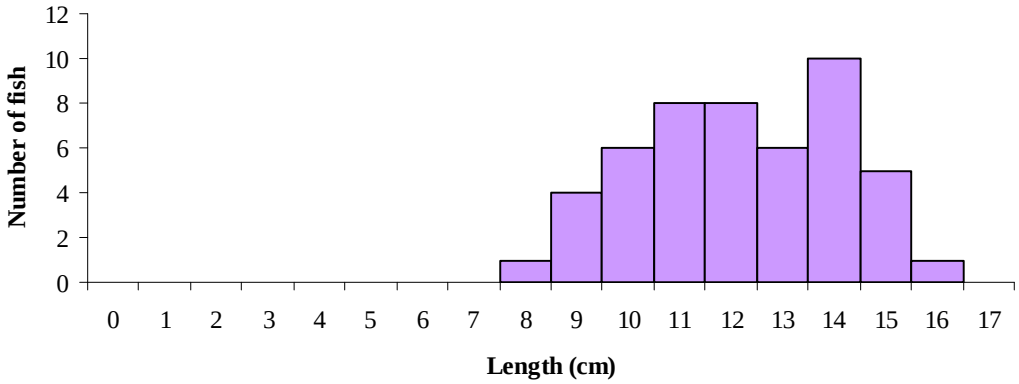

Fig. 4.25. Length frequency distribution of lamprey in the Rye Water, June 2008 (n = 49)

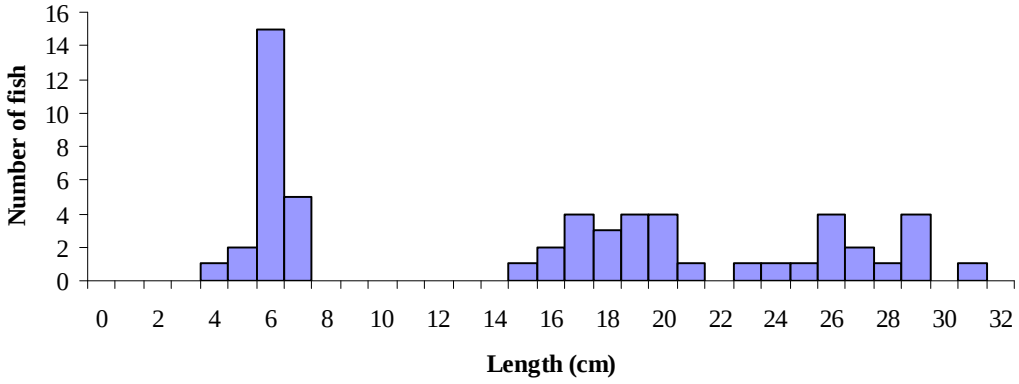

Fig. 4.26. Length frequency distribution of brown trout in the Rye Water, June 2008 (n = 57)

4.2 Boat sites

4.2.1 The Monaghan Blackwater

Plate 4.8. The Monaghan Blackwater at Newmill's Bridge

The River Blackwater rises in Co. Monaghan and flows north eastwards along the border of Co. Armagh and Co. Tyrone before entering Lough Neagh. It was once considered one of the most productive trout rivers in the area and was a reliable source of large fish, but pollution has since reduced the quantity and quality of the fish present (O'Reilly, 2002). The river was drained in the past by the Office of Public Works (OPW) as part of the Monaghan Blackwater drainage scheme.

The site was surveyed above and below Newmill's Bridge (Fig. 4.27) on the 27th of August 2008 with two sets of boat based electric fishing equipment, over a distance of 265m, using the three fishing depletion method.

Glide was the dominant habitat type and cobble was the primary substrate type. Shading levels at this site were moderate. The mean channel width was 11.2m and the mean depth was 0.42m. The total wetted area fished was 2,968m² (Table 2.1).

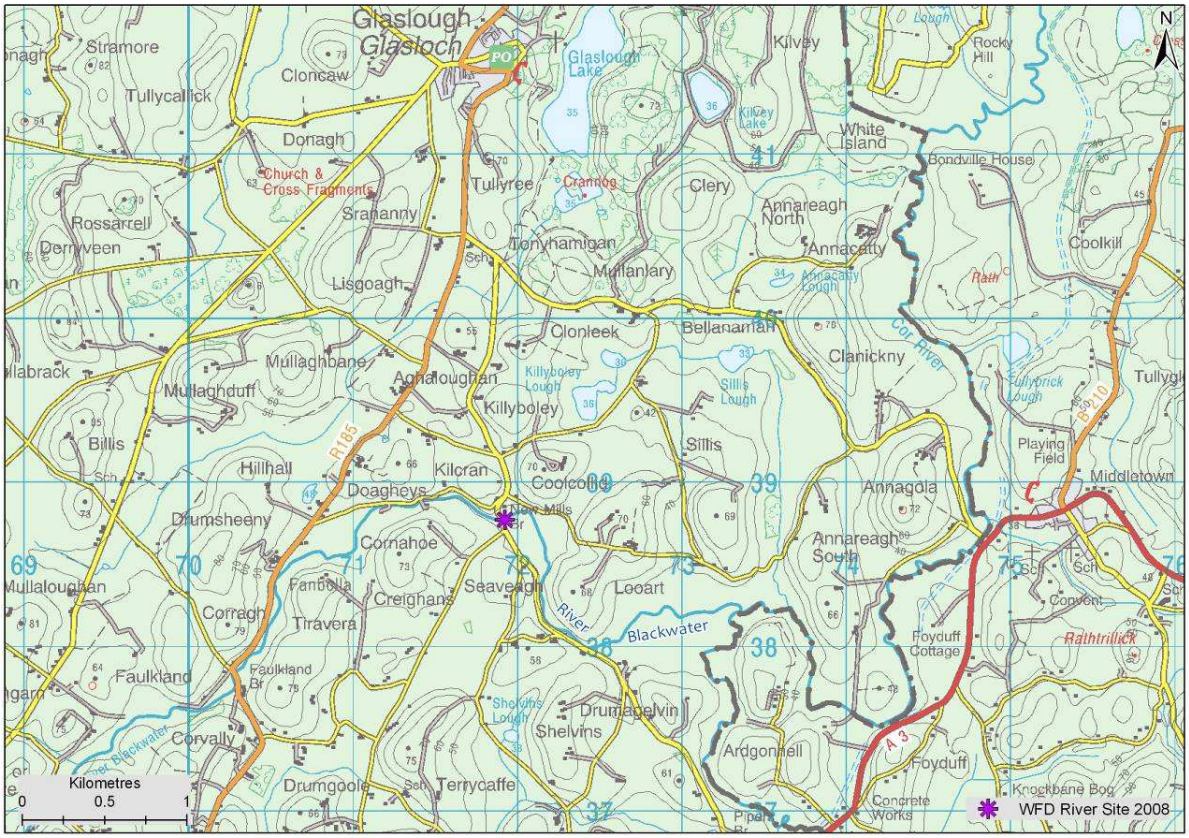

Fig. 4.27. Location of the River Blackwater surveillance monitoring site

Seven species of fish were recorded in the Blackwater during the survey (Table 4.8). Brown trout were the most common species, followed by gudgeon, stone loach, minnow, eel, 3-spined stickleback and lamprey.

Table 4.8. Density of fish (no./m^2) in the Blackwater River site (fish density has been calculated as minimum estimates based on three fishings)

Species name	Common name	0+	1+ & older	Total
Salmo trutta	Brown trout	0.0007	0.0138	0.0142
Gobio gobio	Gudgeon	-	-	0.0128
Barbatula barbatula	Stone loach	-	-	0.0104
Phoxinus phoxinus	Minnow	-	-	0.0044
Anguilla anguilla	Eel	-	-	0.0020
Gasterosteus aculeatus	3-spined stickleback	-	-	0.0007
Lampetra spp.	Lamprey	-	-	0.0003
All fish	**All fish**	**-**	**-**	**0.0448**

Brown trout ranged in length from 13.0cm to 34.5cm. Four age classes were present in the population, i.e. 1+, 2+ 3+ and 4+ accounting for approximately 38% 43% 14% and 5% of the population respectively. Mean lengths of brown trout at L1, L2, L3 and L4 were 7.21cm, 14.05cm, 24.18cm and 29.67cm respectively. The growth of trout in the Blackwater was categorised as fast, based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

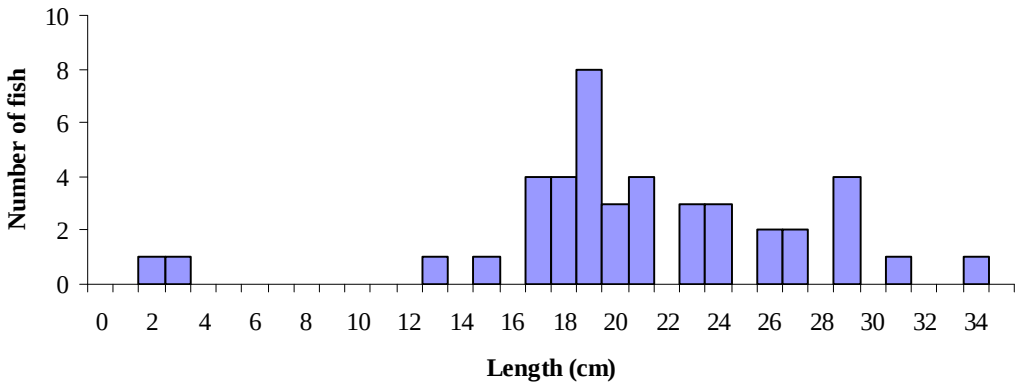

Fig. 4.28. Length frequency distribution for brown trout in the Blackwater River, August 2008 (n = 42)

4.2.2 The River Liffey (Kilcullen)

Plate 4.9. The River Liffey, Kilcullen, Co. Kildare

The River Liffey is one of Ireland's best known rivers. It rises in the Wicklow Mountains, flows westwards into Pollaphuca Reservoir before looping northwards through Kildare and east through Dublin City. The river transforms dramatically throughout its course, changing from an acidic and rocky upland stream in the Wicklow Mountains, to a rich productive, gliding channel in the lower-lying parts of Kildare (O'Reilly, 2002).

There are a number of anthropogenic pressures affecting the Liffey throughout its course, including water abstraction and channel modification due to the hydro-electric power stations located at Pollaphuca, Golden Falls and Leixlip (O'Reilly, 2002). Impassable barriers pose a problem on this river, where they create a barrier for fish migration. In recent years the run of adult salmon in the Ballymore Eustace area has been poor, yet juvenile stocks show some promise. Despite these pressures, however, fishing remains good in certain parts of the river, with salmon, trout and sea trout fishing being popular (O'Reilly, 2002).

The survey site located downstream of Kilcullen Bridge was sampled on the 19th of August 2008 over a distance of 350m using two sets of boat based electric fishing equipment (Fig. 4.29). Glide and riffle were the dominant habitat types present, while the substrate was composed mostly of gravel. Shading levels were medium and mainly restricted to the margins. The mean width was 24.8m and depth was 0.77m. The total wetted area sampled was 8,680m² (Table 2.1).

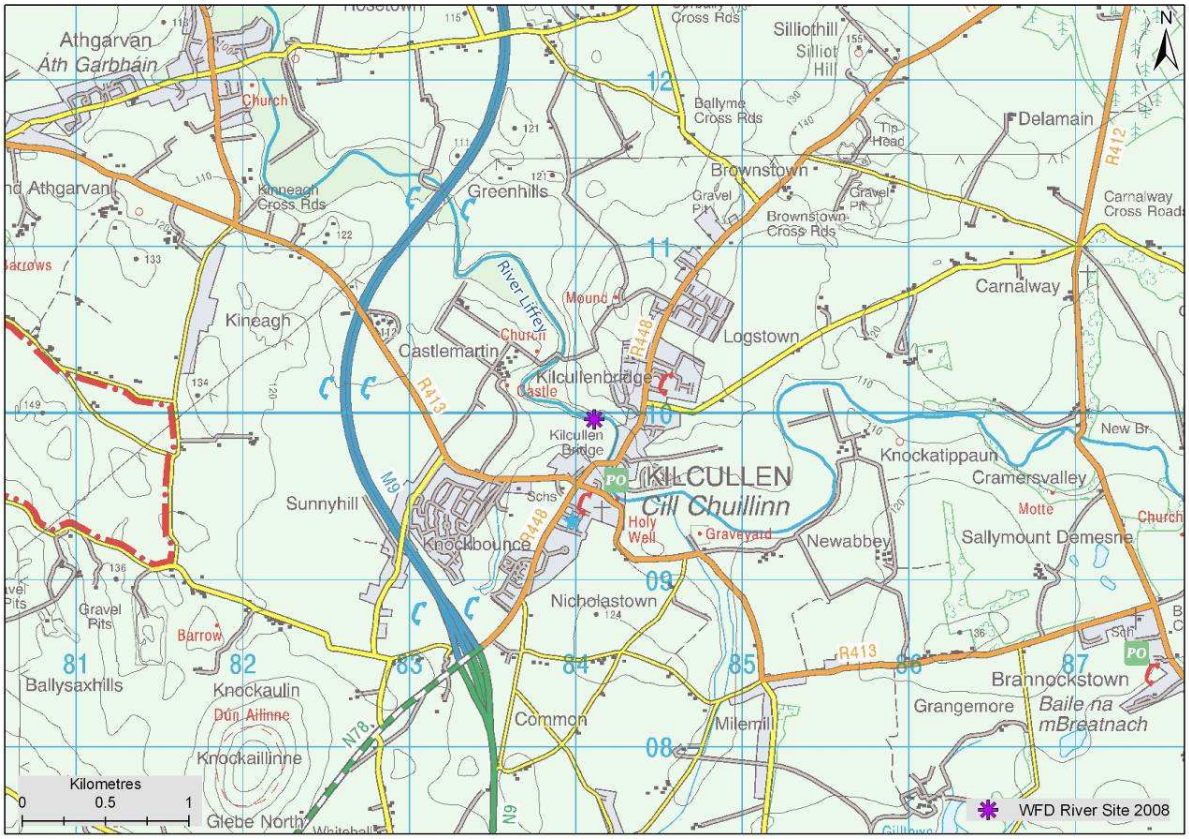

Fig. 4.29. Location of the River Liffey surveillance monitoring site

Four fish species were recorded in the Liffey downstream of Kilcullen bridge (Table 4.9). Brown trout were the most common species captured, followed by salmon, eel and stone loach (Table 4.9).

Table 4.9. Density of fish (no./m^2) in the River Liffey site at Kilcullen (fish density has been calculated as minimum estimates based on one fishing)

Species name	Common name	0+	1+ & older	Total
Salmo trutta	Brown trout	0.0056	0.0132	0.0189
Salmo salar	Salmon	0.0022	0.0099	0.0121
Anguilla anguilla	Eel	-	-	0.0004
Barbatula barbatula	Stone loach	-	-	0.0001
All fish	**All fish**	**-**	**-**	**0.0315**

Brown trout ranged in length from 5.9cm to 50.3cm (Fig. 4.30). Five age classes were present in the population, i.e. 0+, 1+, 2+, 3+ and 4+ and these accounted for 30%, 31%, 30%, 5% and 4% of the population respectively. Mean lengths of brown trout at L1, L2, L3 and L4 were 9.03cm, 19.97cm, 27.02cm and 30.96cm respectively. Hence trout growth in the Liffey at Kilcullen was categorised as fast based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1).

Three age classes were present in the salmon population recorded at the site, i.e. 0+, 1+ and 2+, accounting for 18%, 70% and 11% of the population respectively. Salmon ranged in length from 7.0cm to 18.9cm and the mean L1 and L2 lengths for salmon in the Liffey were 5.53 cm and 12.45cm respectively (Appendix 2).

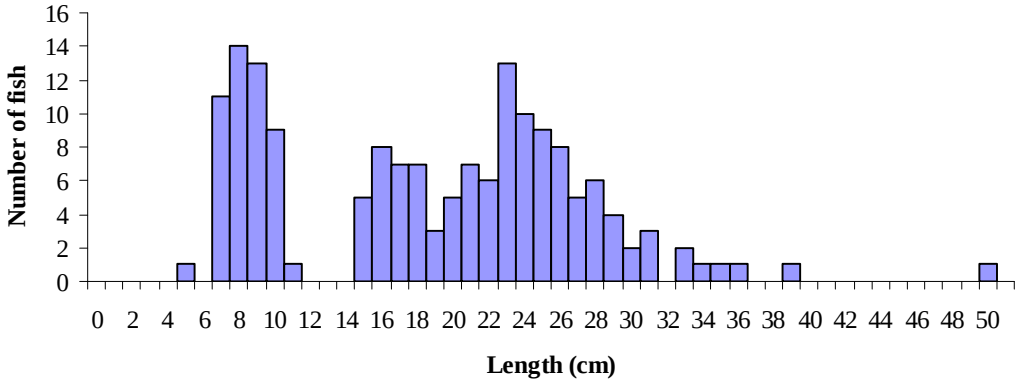

Fig. 4.30. Length frequency distribution for brown trout in the River Liffey (Kilcullen), August 2008 (n = 164)

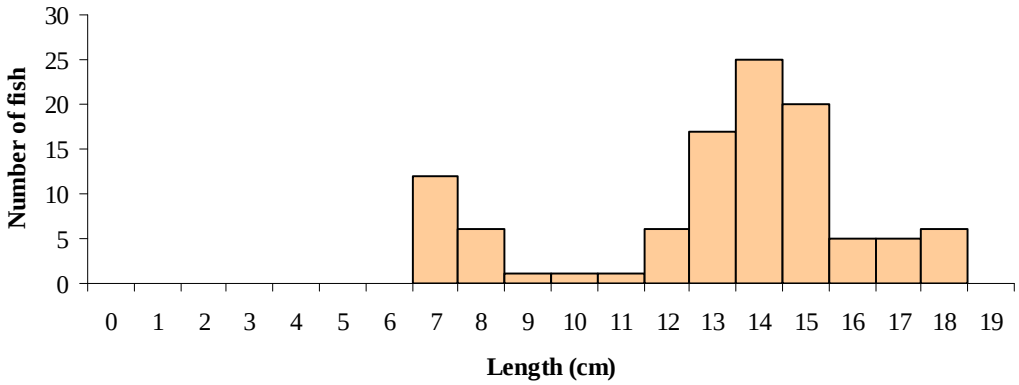

Fig. 4.31. Length frequency distribution for salmon in the River Liffey (Kilcullen), August 2008 (n = 105)

4.2.3 The Owenavorragh River

Plate 4.10. The Owenavorragh River north of Ballinamona, Co. Wexford

The Owenavorragh rises a few kilometres north of Kilmuckridge in Co. Wexford. It flows northwards for about 15 kilometres through the village of Ballycanew to join with the Banoge River. It then continues east for another five kilometres, where it reaches the sea at Courtown. There is a significant amount of agricultural activity within the catchment and as a result suffers from excessive nutrient input (O'Reilly, 2002). The river was drained by the OPW in the past.

The Owenavorragh site was surveyed for fish on the 26th of September 2008 over a stretch of channel measuring 160m in length with one set of boat based electric fishing using the three fishing depletion method. The site is located downstream of a bridge located north of Ballinamona (Fig. 4.32) The channel was lightly shaded and had a good even mix of habitats (riffle, glide and pool). The substrate was composed primarily of sand and gravel. The mean channel width was 8m and depth was 0.5m. The total wetted area amounted to 1,280m² (Table 2.1).

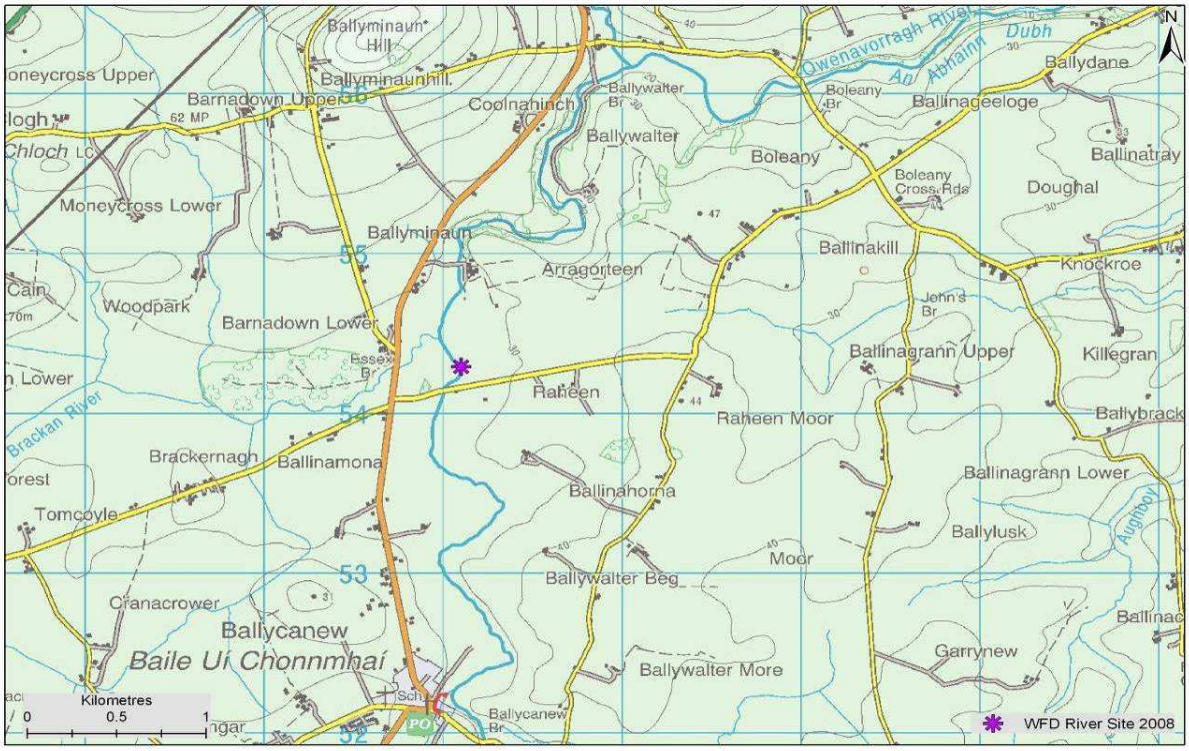

Fig. 4.32. Location of the Owenavorragh River surveillance monitoring site

The Owenavorragh site contained seven species of fish (Table 4.10) as well as sea trout which are included as a separate "variety" of trout. Minnow were the most abundant species, followed by salmon, brown trout, stone loach, lamprey, eel and 3-spined stickleback. .

Table 4.10. Density of fish (no./m^2) in the Owenavorragh River site (fish density has been calculated as minimum estimates based on three fishings)

Species name	Common name	0+	1+ & older	Total
Phoxinus phoxinus	Minnow	-	-	0.1875
Salmo salar	Salmon	0.0672	0.0164	0.0844
Salmo trutta	Brown trout	0.0383	0.0383	0.0766
Barbatula barbatula	Stoneloach	-	-	0.0625
Lampetra spp.	Lamprey	-	-	0.0609
Anguilla anguilla	Eel	-	-	0.0227
Gasterosteus aculeatus	3-spined stickleback	-	-	0.0188
Salmo trutta	Sea trout	-	-	0.0039
All fish	**All fish**	**-**	**-**	**0.5172**

Salmon ranged in length from 5.5cm to 16.6cm and two age classes were present, i.e. 0+ and 1+ (Fig. 4.33). These represented 79% and 21% of the population respectively. The mean length at L1 was 4.79cm (Appendix 2).

Brown trout ranged in length from 6.5cm to 33.5cm (Fig. 4.34). Three age classes were presenting the population, 0+ to 2+ and these represented 50%, 43% and 7% of the population respectively. The mean L1 length for brown trout was 9.63cm giving them a fast growth rate based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1). A small number of sea trout were recorded at the site and these ranged in length from 21.2cm to 31cm.

Lamprey abundance was high in comparison to other sites surveyed in the ERFB. These varied in length from 6cm to 13.5cm (Fig. 4.35). Eels were also present and ranged in size from 7.7cm to 48.7cm (Fig. 4.36).

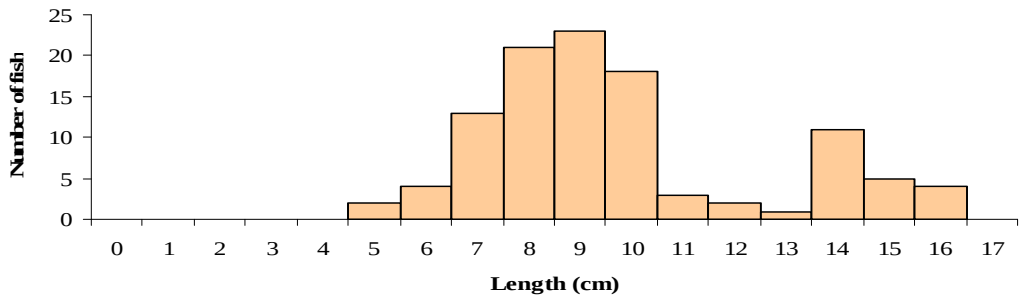

Fig. 4.33. Length frequency distribution for salmon in the Owenavorragh River, September 2008 (n = 108)

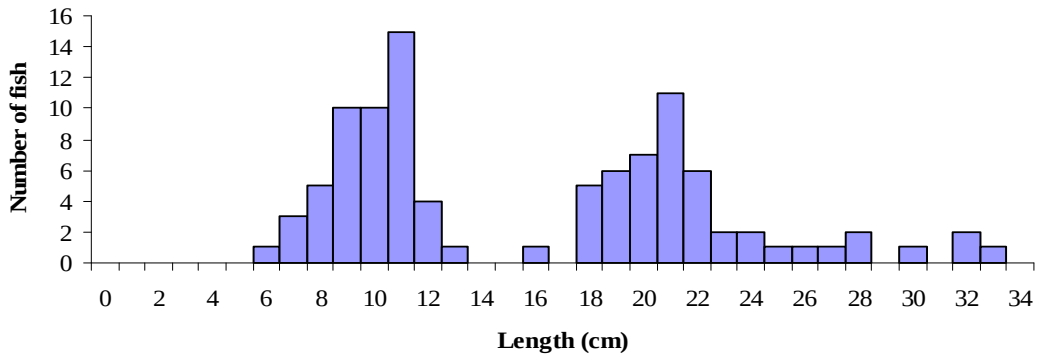

Fig. 4.34. Length frequency distribution for brown trout in the Owenavorragh River, September 2008 (n = 98)

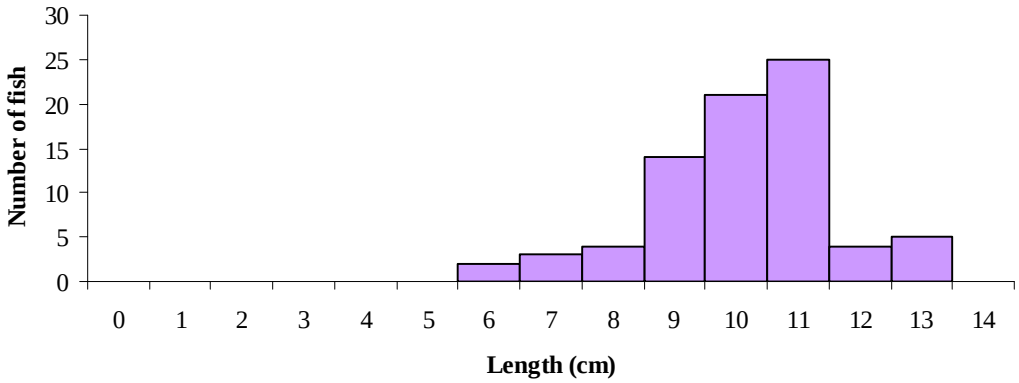

Fig. 4.35. Length frequency distribution for lamprey in the Owenavorragh River, September 2008 (n = 78)

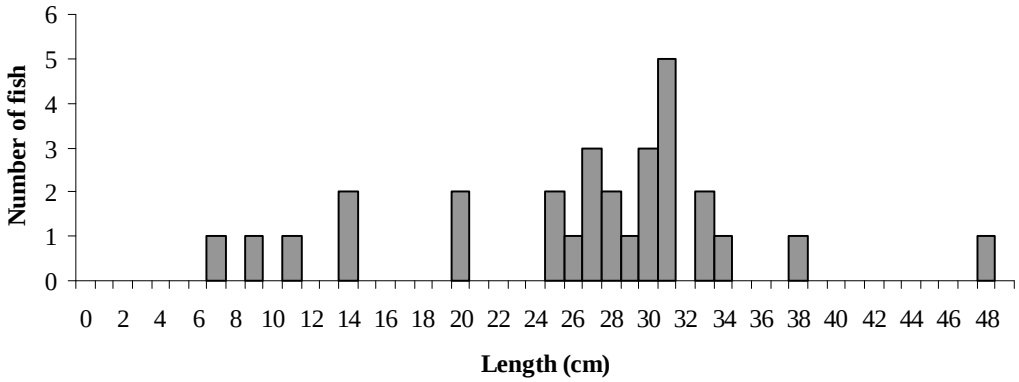

Fig. 4.36. Length frequency distribution for eels in the Owenavorragh River, September 2008 (n = 29)

4.2.4 The Vartry River

Plate 4.11. The Vartry River at Newrath Bridge

The Vartry rises in the Wicklow Mountains and travels south through two reservoirs near Roundwood, Co. Wicklow. The river flows through Ashford in Co. Wicklow before entering the Irish Sea.

The Vartry site was surveyed for fish on the 28th of August 2008 over a stretch of channel measuring 150m in length with two sets of boat based electric fishing using the three fishing depletion method. The site is located downstream of a bridge located north of Ballinamona (Fig. 4.32). The primary habitat types were riffle and glide with a substrate of cobble (Fig. 4.37). The levels of shading were medium and were restricted mainly to the banks. The mean width of the river was 7.40m and depth was 0.51m. The total wetted area was 1,110m² (Table 2.1).

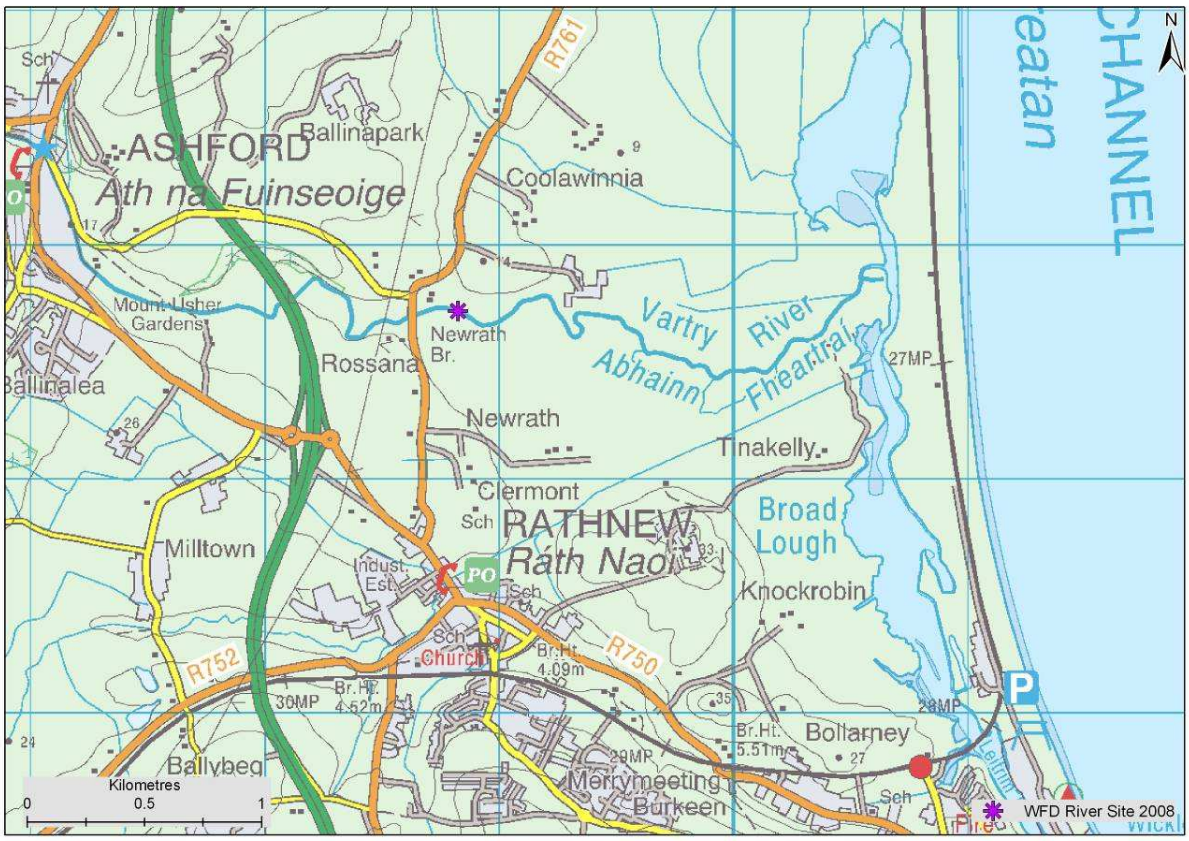

Fig. 4.37. Location of the Vartry River surveillance monitoring site

The Vartry had a good diversity of native fish species (Table 4.11). Salmon was the most abundant species captured, followed by brown trout, lamprey and eel. Sea trout were also recorded at the site.

Table 4.11. Density of fish (no./m^2) in the Vartry River site (fish density has been calculated as minimum estimates based on three fishings)

Species name	Common name	0+	1+ & older	Total
Salmo salar	Salmon	0.0045	0.0234	0.0279
Salmo trutta	Brown trout	0.0009	0.0081	0.0090
Salmo trutta	Sea trout	-	-	0.0036
Lampetra spp.	Lamprey	-	-	0.0027
Anguilla anguilla	Eel	-	-	0.0018
All fish	**All fish**	**-**	**-**	**0.0451**

Salmon were the most common species in the Vartry River and ranged in length from 7.6cm to 16cm. Two age classes were present, 0+ (fry) and 1+ (parr). These represented 16% and 84% of the population respectively. The mean L1 for salmon in the Vartry was 5.33 cm (Appendix 2).

Brown trout ranged in length from 10.9cm to 37cm. Three age classes were present in the population; 0+ (10%), 1+ (50%) and 2+ (40%). The mean L1 and L2 for brown trout were 6.38cm and 15.98cm respectively, therefore the growth rate for brown trout in the Vartry was determined to be slow based on a classification of growth in rivers by Kennedy and Fitzmaurice (1971) (Appendix 1). A small number of two year old sea trout were also recorded and these measured between 26.9cm and 33cm in length.

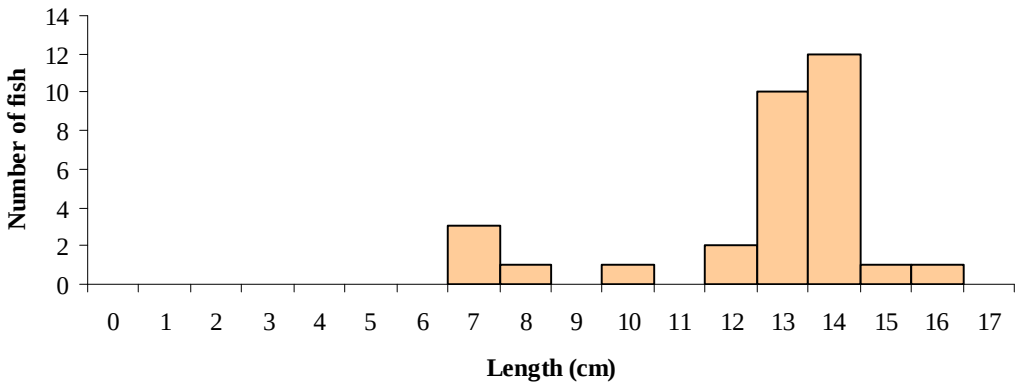

Fig. 4.38. Length frequency distribution for salmon in the Vartry River, August 2008 (n = 31)

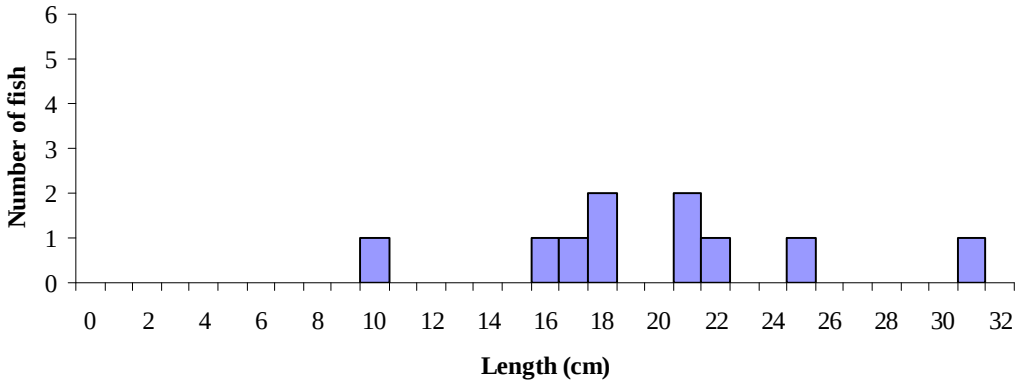

Fig. 4.39. Length frequency distribution for brown trout in the Vartry River, August 2008 (n = 10)

4.3 Community structure

4.3.1 Species richness and composition

A total of eleven fish species (sea trout were included as a separate variety of trout) were recorded within the eleven ERFB sites surveyed. Brown trout and eels were the most common fish species recorded, occurring at all sites surveyed within the region, followed by salmon (73%), stone loach (73%), 3-spined stickleback (55%), minnow (45%), lamprey (45%) and sea trout (36%) (Fig. 4.40). Gudgeon, pike and flounder were only recorded at one site each.

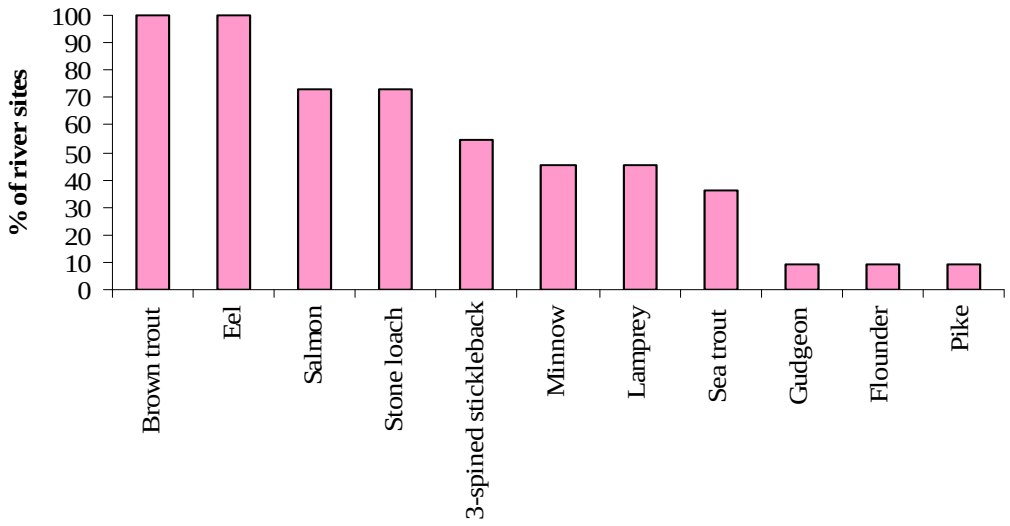

Fig. 4.40. Percentage of sites where each fish species was recorded in the ERFB for WFD SM monitoring 2008

Fish species richness ranged from three species at two river sites (Urrin and Clody) to a maximum of eight species at one site (Owenavorragh) (Table 4.12). Native species (e.g. salmonids, eel, etc.) were present at all sites surveyed (Table 4.12). Non native species (group 2 – e.g. pike and minnow) were recorded at eight of the sites surveyed in the ERFB. Non native group 3 fish species (e.g. gudgeon) were absent from all sites surveyed (Table 4.12). Kelly *et al* (2008) give an explanation of the different fish groups.

Table 4.12. Species richness at each river sites surveyed in the ERFB, July to October 2008

Site	Species richness	No. native species (Group 1)	No. non-native species (Group 2)	No. non-native species (Group 3)
		Boat sites		
Owenavorragh	8	6	2	0
Blackwater	7	4	2	0
Vartry	5	5	0	0
Liffey (Kilcullen)	4	3	1	0
		Hand-set sites		
Rye Water	7	4	3	0
Duncormick	6	5	1	0
Dodder	6	4	2	0
Douglas (Ballon)	6	4	2	0
Banoge	5	4	1	0
Urrin	4	4	0	0
Clody	3	3	0	0

4.3.2 Species abundance and distribution

Abundance and distribution maps of fish species recorded at the eleven sites within the ERFB are shown below in Figures 4.41 to 4.50. Brown trout were present at all the sites surveyed. The highest densities of brown trout fry recorded were on the Clody (0.22 fish/m^2) followed by the Duncormick (0.13 fish/m^2) and Urrin (0.08 fish/m^2) sites (Fig. 4.41). The Urrin (0.13 fish/m^2) followed by the Clody (0.08 fish/m^2) and Duncormick (0.076 fish/m^2) also recorded the highest densities of 1+ and older brown trout (Fig. 4.42). Sea trout were recorded in sites close to the sea and were most abundant in the Owenavorragh (0.0039 fish/m^2) and Vartry (0.0036 fish/m^2) (Fig. 4.43).

Salmon fry (0+) and parr (1+ and older) were captured at eight sites surveyed. Highest densities of salmon were recorded on the Dodder (fry - 0.088 fish/m^2 and parr - 0.067 fish/m^2) (Fig. 4.44 and 4.45). No adult salmon were recorded during the survey.

Eels were also well distributed but displayed a greater abundance in sites closer to the coast, such as the Banoge, Dodder and Duncormick (Fig. 4.46). Stone loach (Fig. 4.47), 3-spined stickleback (Fig. 4.48) and minnow (Fig. 4.49) were recorded in a number of sites each. Minnow and stone loach were particularly prevalent in the Rye Water (Fig. 4.47 and 4.49). Lamprey, gudgeon, flounder and pike displayed a sparse distribution and low abundance throughout the sites surveyed.

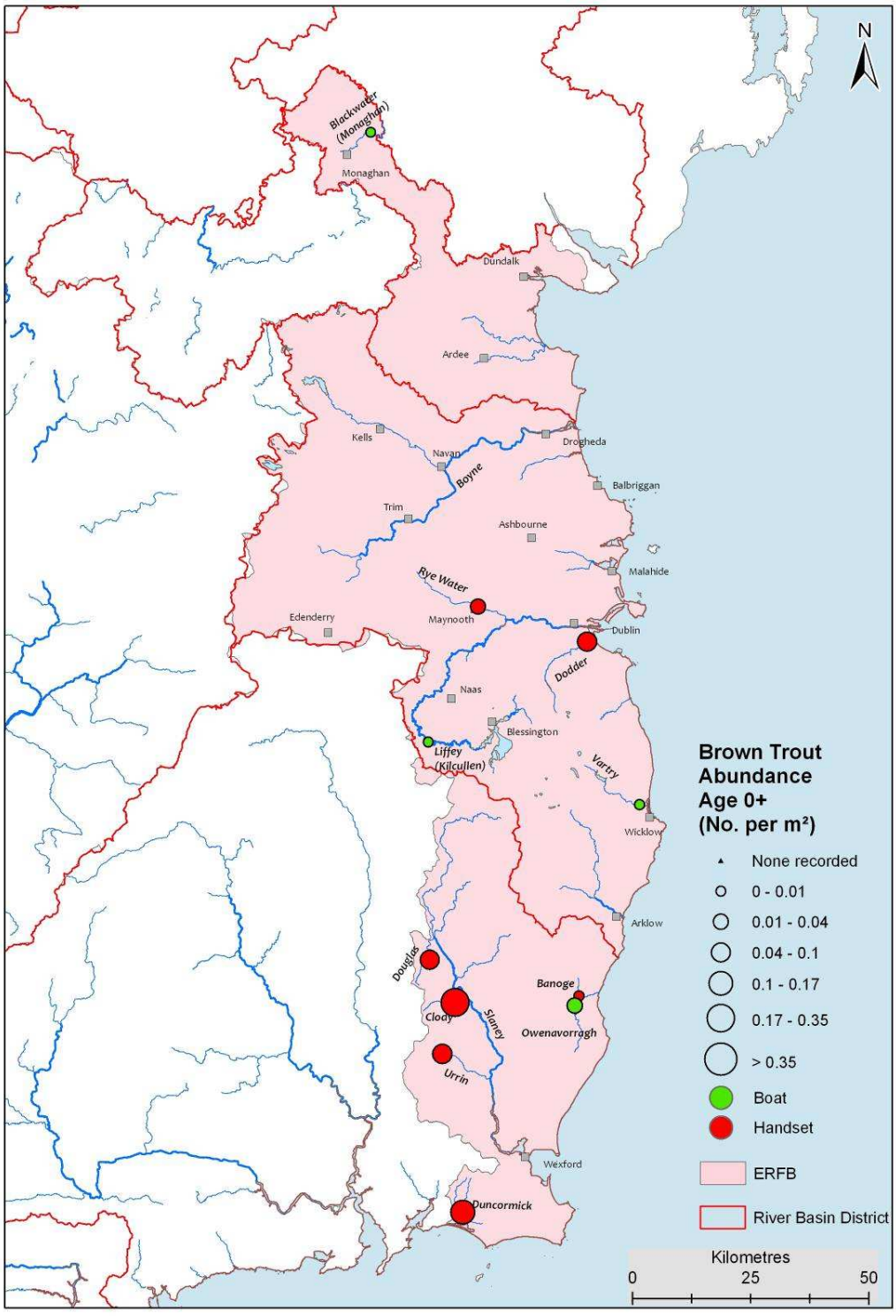

Fig. 4.41. Distribution map for 0+ brown trout in the ERFB, WFD surveillance monitoring 2008

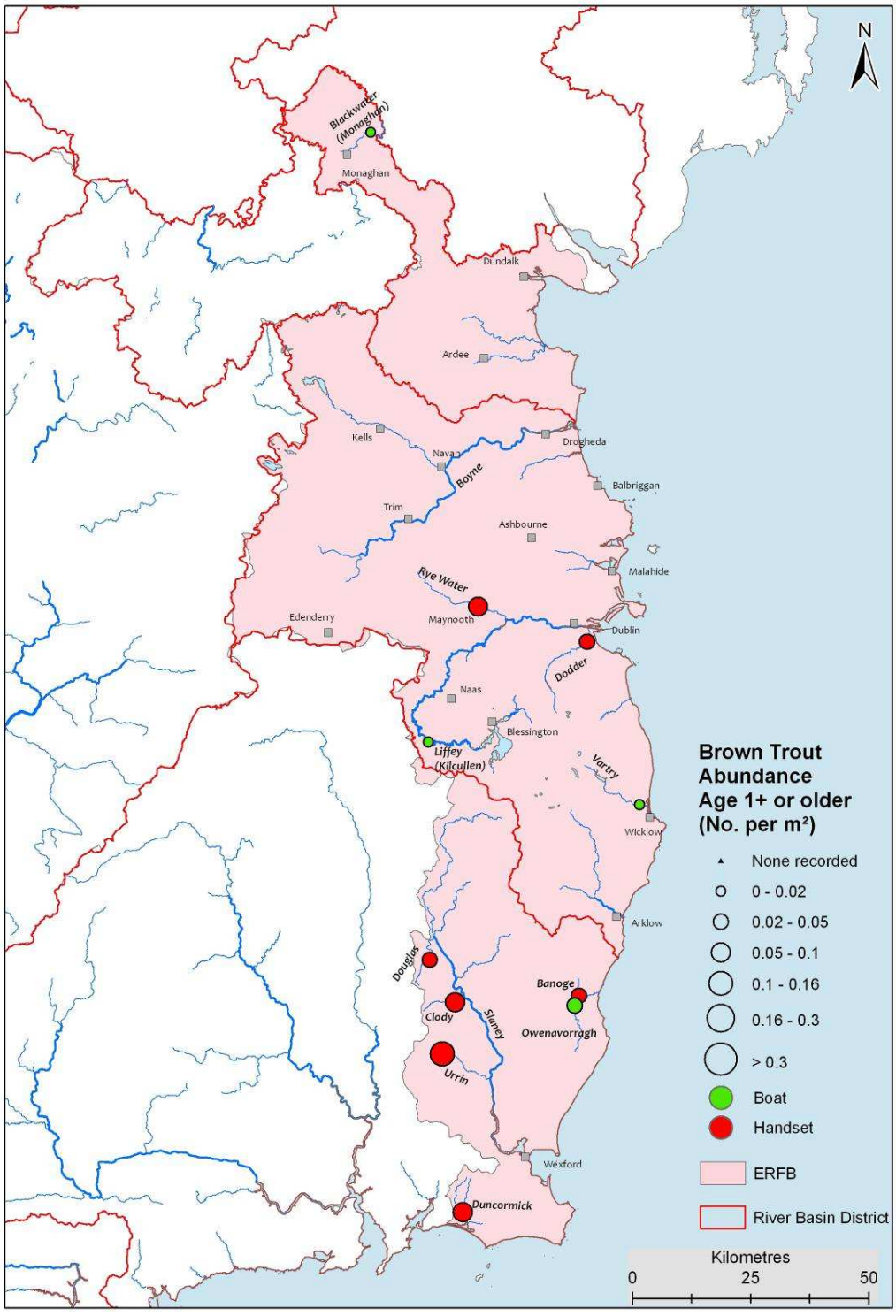

Fig. 4.42. Distribution map for 1+ brown trout in the ERFB, WFD surveillance monitoring 2008

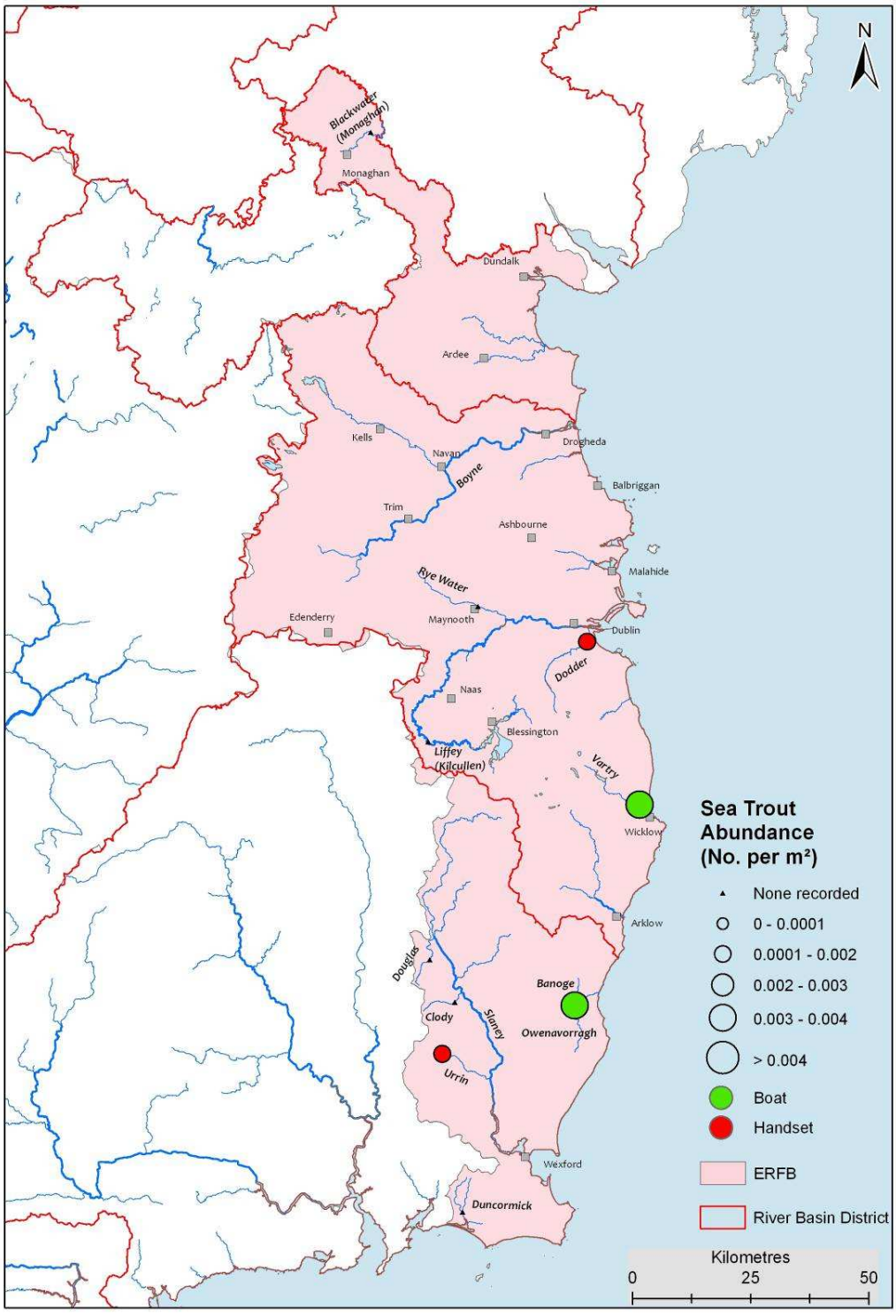

Fig. 4.50. Distribution map for sea trout in the ERFB, WFD surveillance monitoring 2008

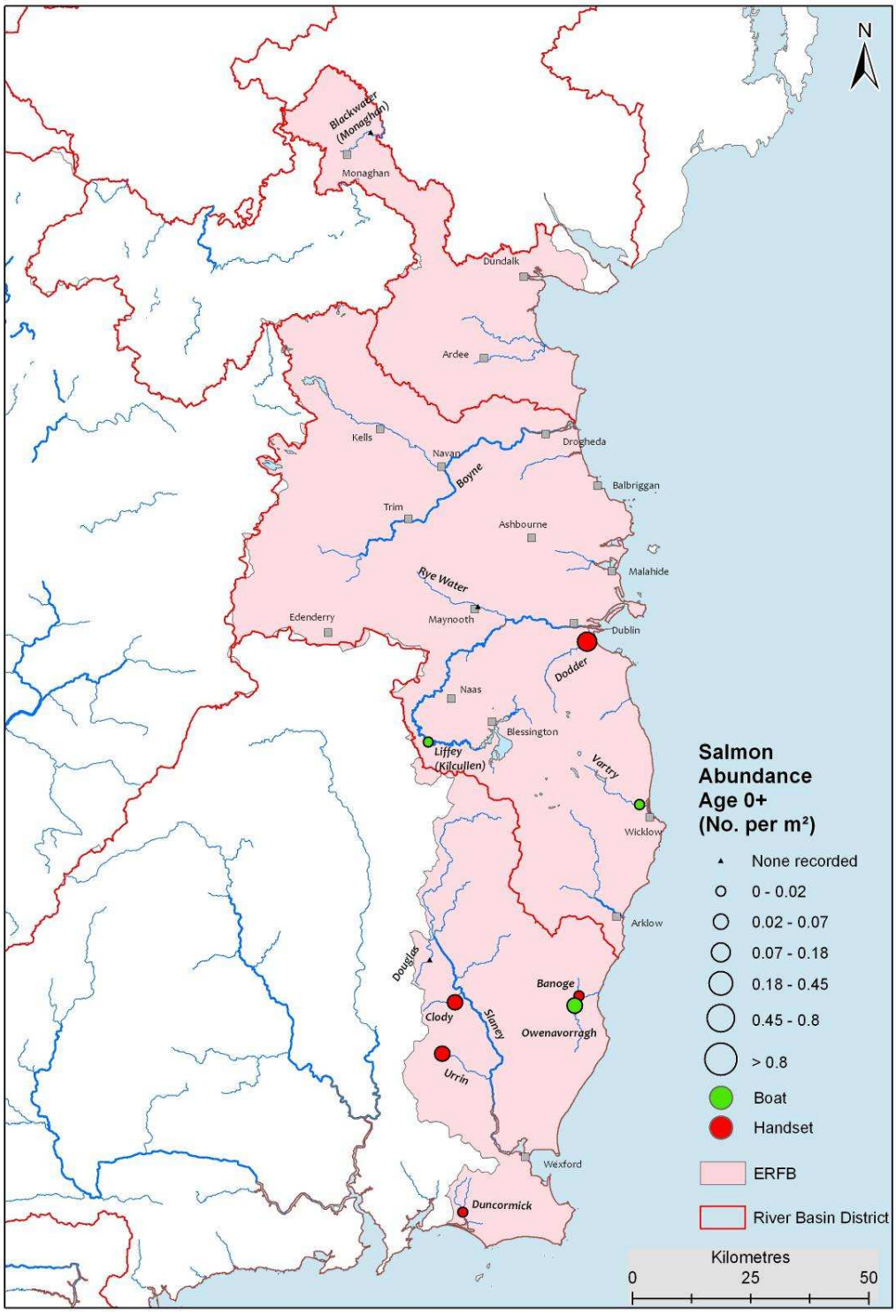

Fig. 4.44. Distribution map for 0+ salmon in the ERFB, WFD surveillance monitoring 2008

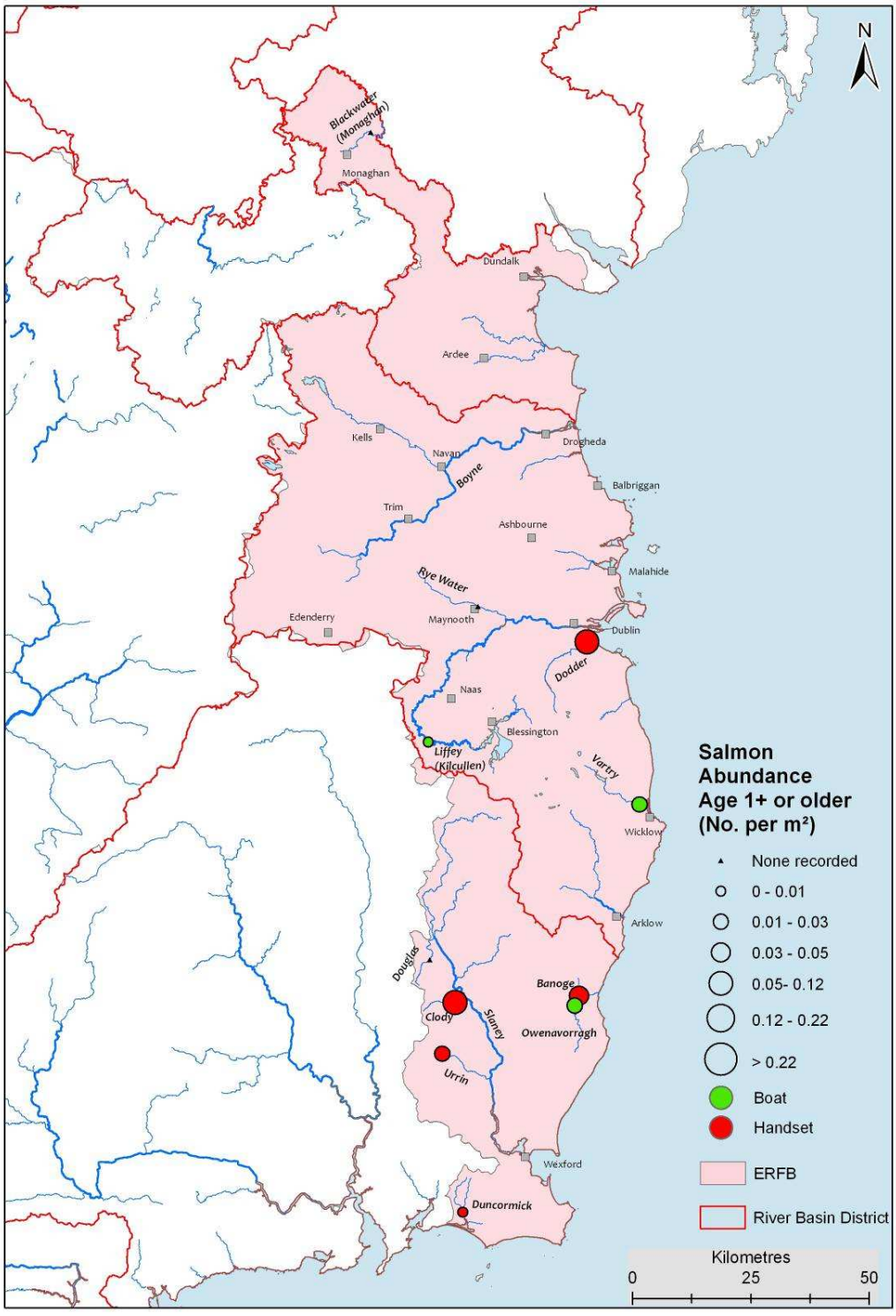

Fig. 4.45. Distribution map for 1+ salmon in the ERFB, WFD surveillance monitoring 2008

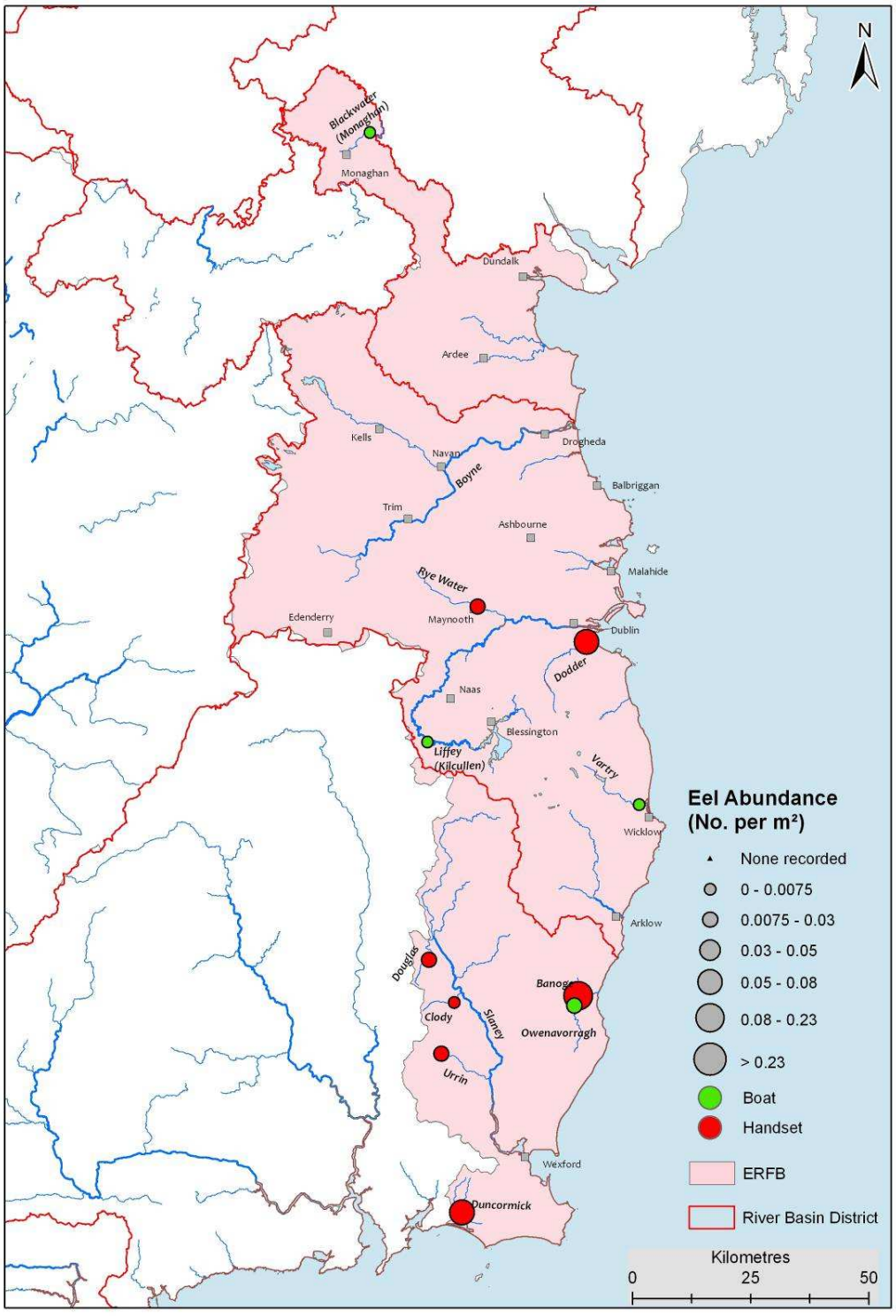

Fig. 4.43. Distribution map for eels in the ERFB, WFD surveillance monitoring 2008

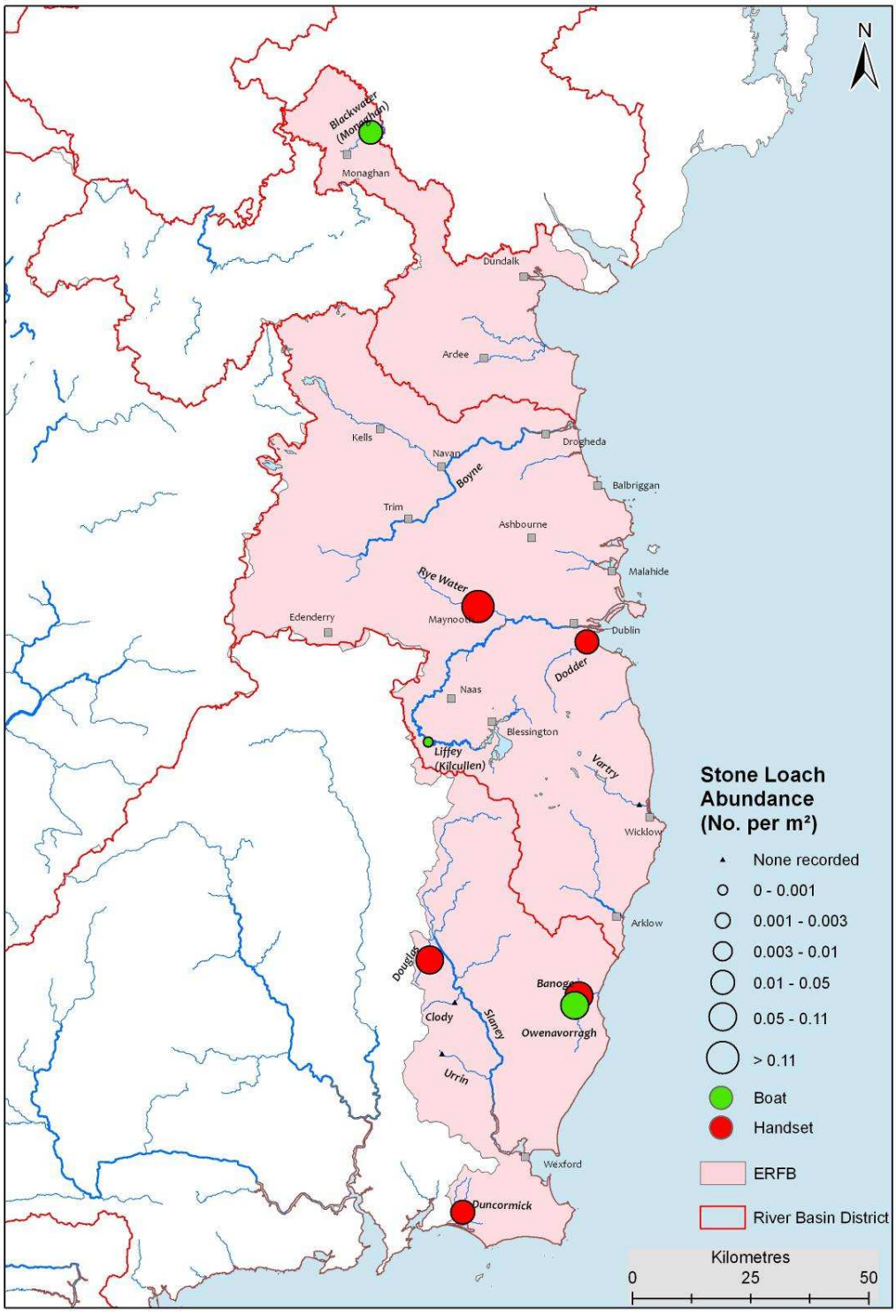

Fig. 4.46. Distribution map for stoneloach in the ERFB, WFD surveillance monitoring 2008

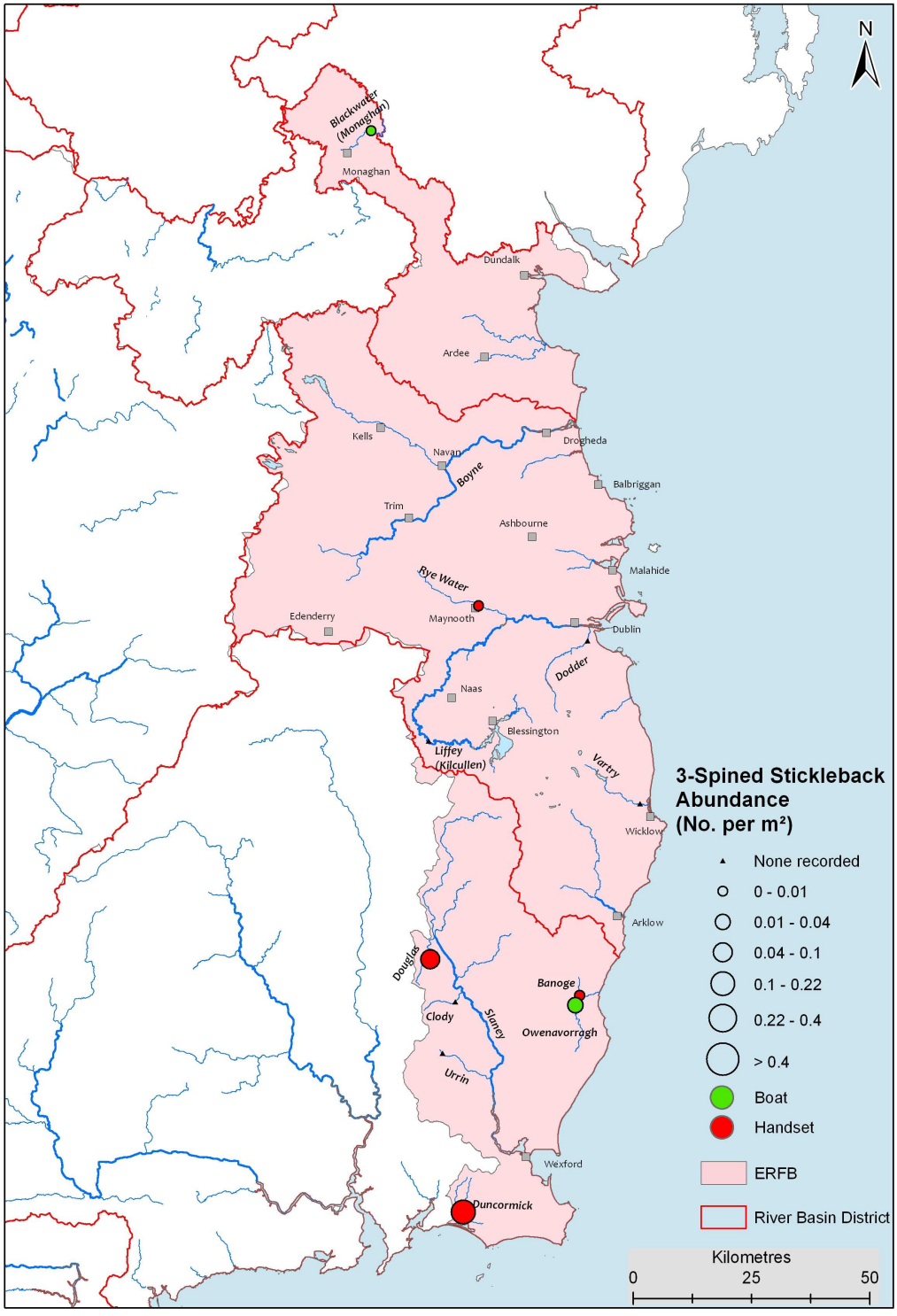

Fig. 4.47. Distribution map for 3-spined stickleback in the ERFB, WFD surveillance monitoring 2008

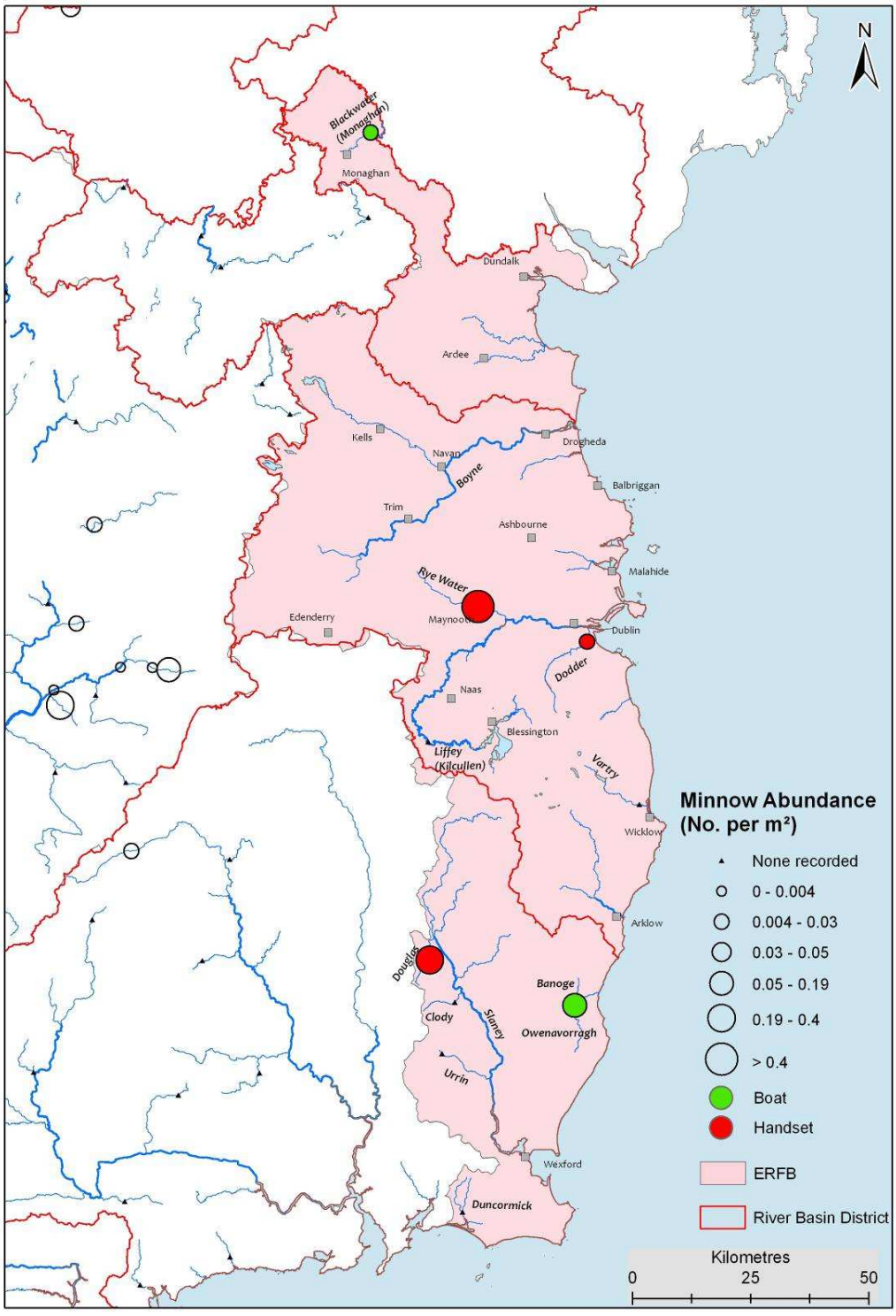

Fig. 4.48. Distribution map for minnow in the ERFB, WFD surveillance monitoring 2008

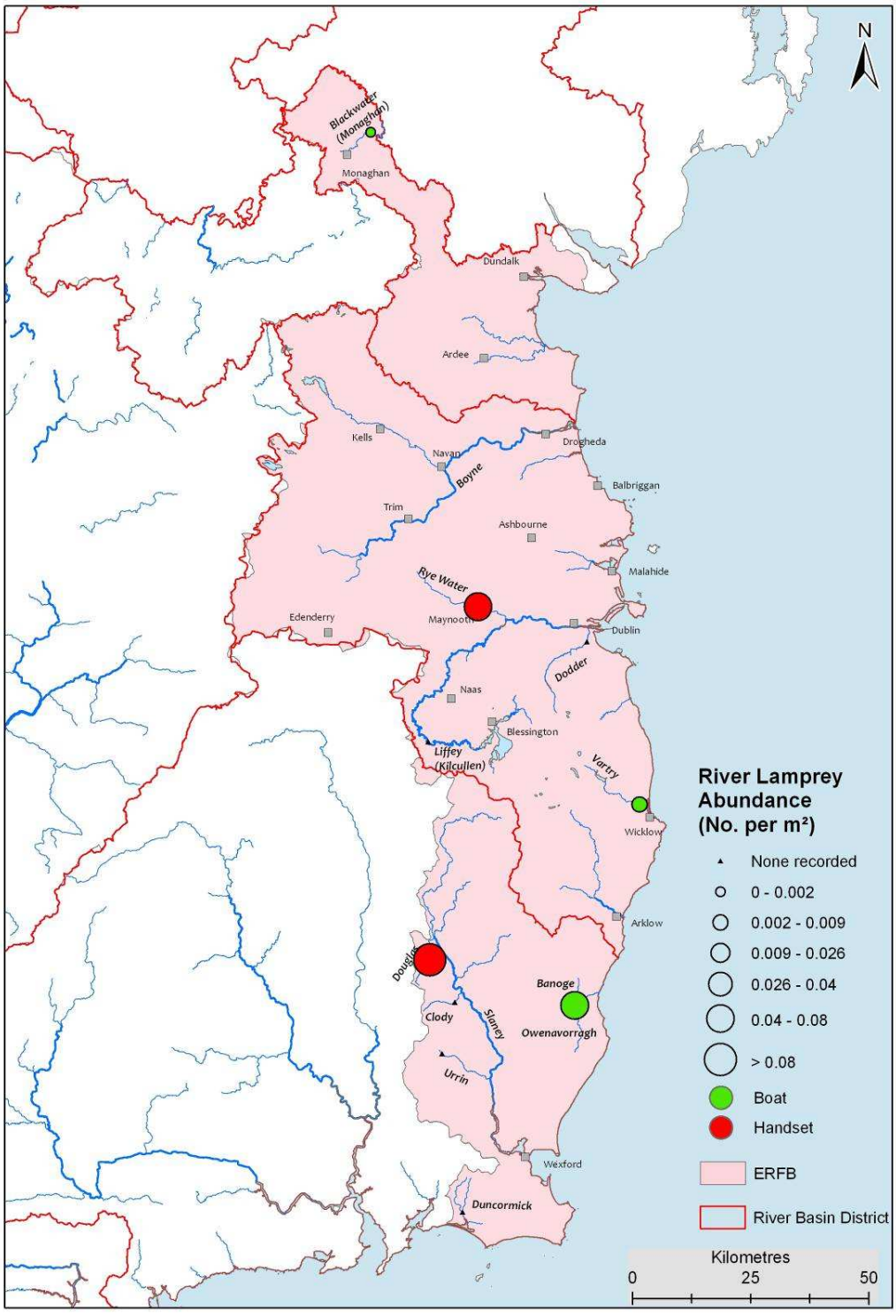

Fig. 4.49. Distribution map for lamprey in the ERFB, WFD surveillance monitoring 2008

4.3.3 Growth of brown trout and salmon

Age and growth of fish were determined for the dominant fish species on each river site, comprising a range of age groups (from 0+ to 4+ depending on species). Brown trout ages ranged from 0+ to 4+ with 0+ and 1+ being the dominant age classes at most sites. The largest brown trout (length 50.3cm and weight 1.79kg) recorded during the survey was captured on the River Liffey site at Kilcullen.

Length at age analyses and growth curves are presented for brown trout and salmon recorded at the eleven river sites surveyed in the ERFB during 2008 (Fig. 4.51 and Appendix 1 and 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 trout in Irish streams and rivers. Growth was classified as very slow in the Clody and Urrin, slow in the Dodder, Douglas, Duncormick and Vartry, and fast in the Blackwater, Liffey, Owenavorragh and Rye Water (Fig. 4.51).

One year old salmon in the Banoge river displayed the fastest growth rate at L1, whereas salmon in the Liffey exhibit the fastest growth at L2.

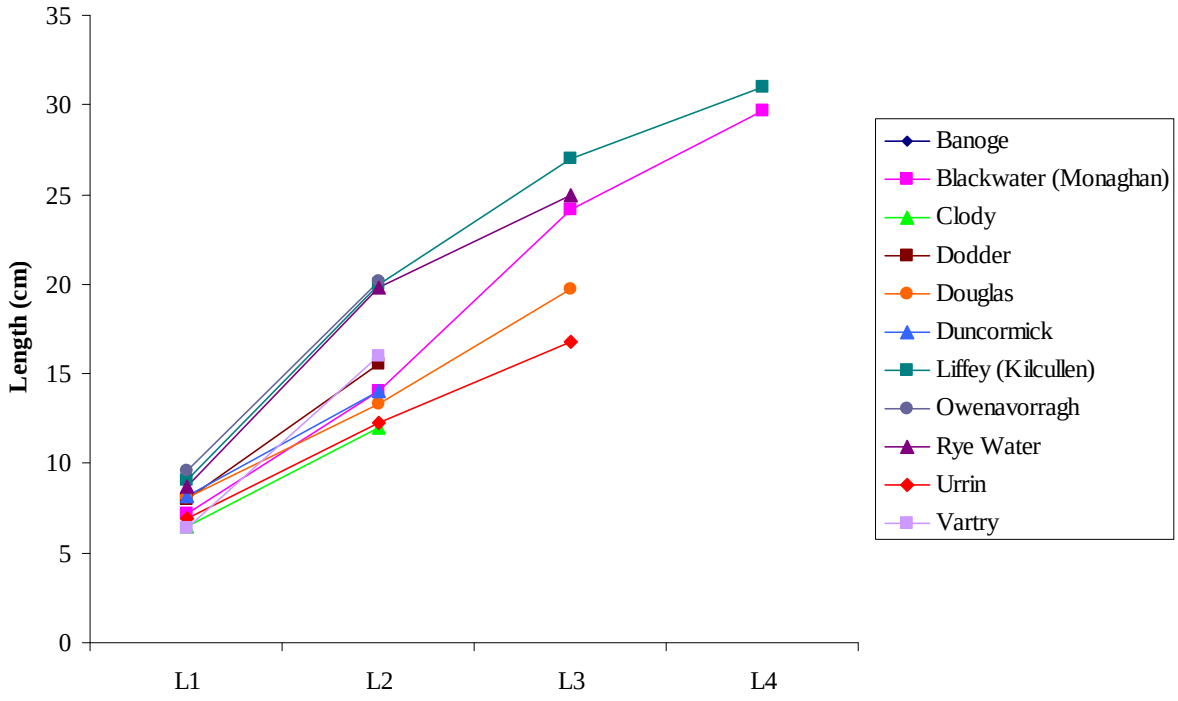

Fig. 4.51. Back calculated lengths for brown trout in each river, WFD surveillance monitoring 2008

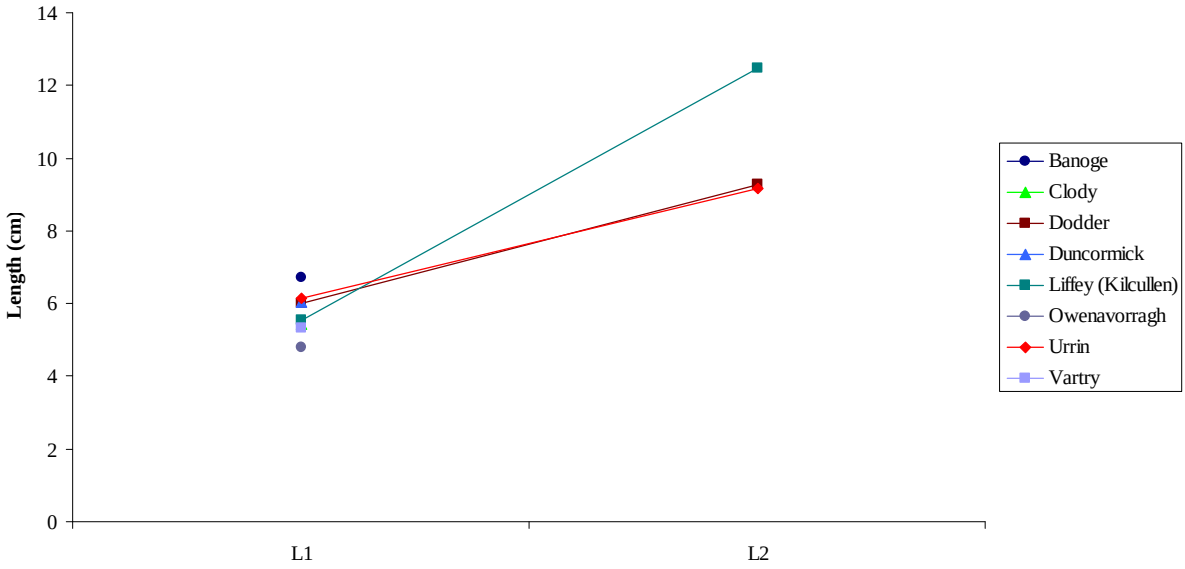

Fig. 4.52. Back calculated lengths for salmon in each river, WFD surveillance monitoring 2008

5. DISCUSSION

There were ten species of fish recorded during the 2008 sampling program in the ERFB. This was comparable with the numbers captured in other Regional Fishery Boards, except the ShRFB, where the fish species diversity totalled 14 species. The main summary report shows the results for the whole country (Kelly *et al*., 2009). Brown trout and eels were the most widely distributed species in the ERFB and occurred in all eleven sites. The distribution of these two species was relatively uniform throughout the whole country; however, eels were generally more abundant in sites close to the coast. The ERFB, with its high coastline to area ratio, had sites (Duncormick, Dodder and Banoge) with some of the highest eel densities for anywhere in Ireland. Salmon stocks were not as good in the ERFB as they were in other regions bordering the west coast, but they did fare better than those in areas with large barriers downstream and high coarse fish numbers, such as the upper half of the ShRFB and Cavan/Monaghan area of the NRFB.

Brown trout growth was classified as very slow in the Clody and Urrin, slow in the Dodder, Douglas, Duncormick and Vartry, and fast in the Blackwater, Liffey, Owenavorragh and Rye Water (Fig. 4.51). Kennedy and Fitzmaurice (1971) also assigned growth categories to brown trout in a selection of Irish rivers. These authors assigned a rating of slow growth to trout from the Dodder and fast growth to trout from the Liffey at Kilcullen and the Rye Water which agrees with the data from the current study.

The Owenavorragh, Rye Water and Monaghan Blackwater were the most diverse sites in terms of fish species richness, with seven species present. The highest species diversity recorded in any site throughout the country was ten and this only occurred in one site within the ShRFB where there was a high number of non-native, coarse fish present. The Clody and Urrin had the lowest diversity in the region, with only three species present. Such low diversity is commonly found around Ireland in small wadeable streams that contain only native fish species (Kelly *et al*., 2007).

Older brown trout displaying faster growth rates were recorded in the larger rivers such as the Liffey, Monaghan Blackwater and Owenavorragh, while some of the smaller channels such as the Urrin and Clody recorded the youngest fish and the slowest growth rates. This was mirrored throughout the whole country, where it was the larger high alkalinity rivers that showed faster growth rates and older fish (Kelly *et al*., 2009).

Non-native fish species were recorded in eight of the eleven rivers surveyed in the ERFB. 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 were the Clody,

Urrin and Vartry. 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). Three group 2 (pike, minnow and stone loach) and one group 3 species (gudgeon) were recorded in the ERFB region. Minnow and stone loach appear to be quite common throughout the country, while pike and gudgeon are more confined to certain areas, including the ShRFB and NRFB (Kelly *et al*., 2009). Single specimens of pike and gudgeon were recorded in the Rye Water and the Monaghan Blackwater. These results suggest that the rivers surveyed for the WFD to date in the ERFB are still relatively free of non-native species but these species may become more of a concern in the future due to the effects of climate change. The low diversity of non native coarse fish and notable absence of species such as roach and perch may be attributed, to some extent, to the paucity of lakes within the region and lack of connectivity to systems within other regions where these fish are present, such as the ShRFB and NRFB.

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. There is currently no WFD compliant classification tool for fish in Irish rivers. However; a new project (WFD68) has been initiated (summer 2009) through the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) to develop a rivers fish classification tool for ROI, NI and Scotland and is due for completion in May 2010. Ecological status classes will therefore be calculated once this tool has been developed.

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Appendix 1

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

River		L1	L2	L3	L4	Growth category
Banoge	Mean	8.44				n/a
	SD	1.34				
	n	21				
	Range min.	5.3				
	Range max.	11.04				
Blackwater (Monaghan)	Mean	7.21	14.05	24.18	29.67	Fast
	SD	2.19	3.42	2.48	3.79	
	n	38	24	8	2	
	Range min.	3.78	9.26	20.65	26.99	
	Range max.	12.41	21.11	28.57	32.34	
Clody	Mean	6.5	11.95			Very slow
	SD	1.44	1.11			
	n	51	14			
	Range min.	4.03	10.3			
	Range max.	9.69	13.95			
Dodder	Mean	8.02	15.58			Slow
	SD	1.55	3.53			
	n	19	10			
	Range min.	6.07	11			
	Range max.	10.7	21.68			
Douglas	Mean	8.12	13.3	19.76		Slow
	SD	0.68	1.67	n/a		
	n	10	7	1		
	Range min.	7.24	10.87	19.76		
	Range max.	9.57	15.66	19.76		
Duncormick	Mean	8.18	14			Slow
	SD	2.02	2.56			
	n	30	7			
	Range min.	5.14	11.45			
	Range max.	11.63	18.75			
Liffey (Kilcullen Br)	Mean	9.03	19.97	27.02	30.96	Fast
	SD	1.94	2.67	2.79	3.05	
	n	82	44	13	5	
	Range min.	5.12	14.36	22.59	26.87	
	Range max.	14.4	25.54	32.92	34.5	
Owenavorragh	Mean	9.63	20.16			Fast
	SD	2.16	2.74			
	n	38	5			
	Range min.	5.2	16.48			
	Range max.	15.39	23.31			

Appendix 1 continued

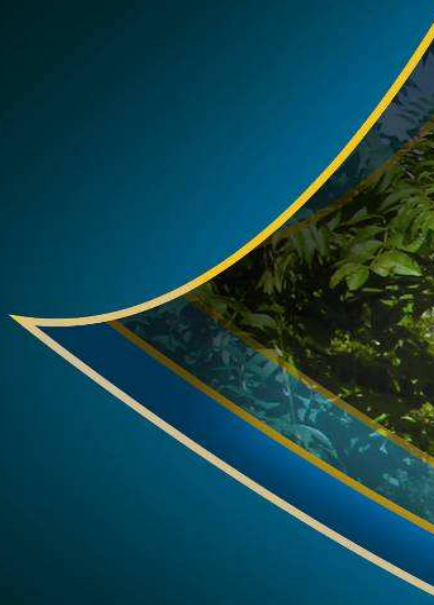
Summary of the growth of brown trout in the rivers (L1=back calculated length at the end of the first winter etc.)

River		L1	L2	L3	L4	Growth category
Rye Water	Mean	8.72	19.77	24.98		Fast
	SD	2.14	3.66	n/a		
	n	33	17	1		
	Range min.	5.77	12.31	24.98		
	Range max.	13.95	24.27	24.98		
Urrin	Mean	6.92	12.30	16.82		Very slow
	SD	1.25	1.11	1.02		
	n	48	24	4		
	Range min.	4.15	10.13	15.92		
	Range max.	9.53	14.63	18.24		
Vartry	Mean	6.38	15.98			Slow
	SD	0.8	3.76			
	n	9	4			
	Range min.	4.94	10.77			
	Range max.	7.28	19.63			

Appendix 2

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

River		L1	L2
Banoge	Mean	6.7	
	SD	1.3	
	n	26	
	Range min.	4.32	
	Range max.	10.05	
Clody	Mean	5.43	
	SD	0.82	
	n	47	
	Range min.	3.83	
	Range max.	7.44	
Dodder	Mean	6.02	9.29
	SD	0.89	0.55
	n	21	4
	Range min.	4.63	8.78
	Range max.	7.67	9.98
Duncormick	Mean	6.04	
	SD	0.51	
	n	3	
	Range min.	5.45	
	Range max.	6.39	
Liffey (Kilcullen Br)	Mean	5.53	12.45
	SD	1.09	1.62
	n	37	10
	Range min.	3.44	10.26
	Range max.	8.32	14.67
Owenavorragh	Mean	4.79	
	SD	0.98	
	n	15	
	Range min.	3.38	
	Range max.	7.01	
Urrin	Mean	6.14	9.18
	SD	0.73	n/a
	n	16	1
	Range min.	5.1	9.18
	Range max.	7.13	9.18
Vartry	Mean	5.33	
	SD	0.84	
	n	13	
	Range min.	3.47	
	Range max.	6.25	



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