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Environmental River Enhancement Programme Annual Report

2013

IASCACH INTÍRE ÉIREANN
INLAND FISHERIES IRELAND

EREP 2013 Annual Report

Inland Fisheries Ireland & the Office of Public Works

Environmental River Enhancement Programme

Acknowledgments

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Table of Contents

1 Introduction 1

2 EREP Programme 2013 3

2.1 Introduction 3

2.2 EREP Overview 2013 4

3 Bio-diversity and EREP Monitoring 9

3.1 River Corridor Bio-diversity 9

3.1.1 River Monitoring Programme 10

3.2 Fish Population Index Survey (FPI) 2013 on R. Maigue catchment 17

3.2.1 River Restoration Potential In Maigue catchment 22

3.3 Shading Effects on water temperature 22

3.4 River Corridor Flora 28

3.4.1 Stonyford River Fencing Experiment 28

4 Brown Trout Genetics Studies 29

4.1 Introduction 29

4.1.1 Lough Sheelin Catchment 29

4.1.2 Results 29

4.2 Further Research 31

5 Other Scientific Studies 32

5.1 Lamprey Monitoring 32

5.1.1 Feale catchment study 34

5.1.2 Corrib Survey 37

5.1.3 Ballyteige-Bannow survey 38

5.1.4 Article 17 reporting, under Habitats Directive, to EU. 40

5.2 Crayfish Studies 41

6 EREP Audit Programme 42

6.1 Introduction 42

6.2 2013 Audit Results 42

7 River Hydromorphology Assessment Technique (RHAT) 46

8 References 47

9 Appendix 50

1 Introduction

Since the early 1990's the Office of Public Works (OPW) has been in engaged in scientific studies with Inland Fisheries Ireland, IFI (formerly the Central Fisheries Board). The aims of such studies were to identify the environmental impacts of drainage maintenance in OPW channels and to develop alternative strategies that would facilitate environmentally friendly maintenance programmes. In recent years a number of legislative and national polices, such as the EU Water Framework Directive (WFD), the EU Habitats Directive and the National Biodiversity Plan have increased the need for the OPW to consider the ecology of the environment in which they work in. As part fulfilment of these issues the OPW initiated the current five year research project with IFI - Environmental River Enhancement Programme (EREP).

The programme has two major strands – one dealing with river morphology enhancement and the second dealing with the robust implementation of OPW's own environmental protocols on channel maintenance. The effectiveness of these two strands will be assessed through monitoring the impacts of the necessary physical works on the river corridor biodiversity and hydromorphology.

The biodiversity element of the project includes monitoring fish, hydromorphology and riparian and instream vegetation using the river corridor in an exclusive manner as part of their ecology. Examination of physical habitat factors and how these may also be impacted both by channel enhancement works and by proactive maintenance is a significant component, complementing the biodiversity studies. Scientific studies investigating lamprey (*Lampetra sp.*) and white-clawed crayfish (*Austropotamobius pallipes*), initiated through previous OPW projects, continue to be monitored also.

River enhancement programmes are a capital works initiative whereby IFI design enhancement plans while OPW fund and undertake the works identified using their own resources including field staff and machinery. Work on enhanced maintenance is focused on increasing environmental awareness and improving the implementation (and further development) of the 10 steps of environmental enhancement amongst machine drivers. OPW have committed to achieving 100km of work programmes annually through both strands of the programme.

The Environmental River Enhancement Programme (EREP) is now in its first year of its second cycle (2013 – 2017). Throughout the current year the project made good progress addressing the aims and objectives initially set out, which included the following;

- To identify 100km of OPW channels for EREP annually.
- To select a number of these channels for capital enhancement works and a number for enhanced maintenance works.
- To undertake a biological monitoring programme across a range of these channels, addressing the impacts of works on the river corridor biodiversity and hydromorphology.
- To provide support and advice throughout the implementation period.
- To carry out external audits of machine crews engaged in routine maintenance.

As part of the 2013 programme approximately 110km of channel were identified for works through either enhanced maintenance or capital works programmes and 80km were completed. All channels were walked and a written enhancement report provided to OPW. Monitoring of the physical habitat and biological elements pre and post works at a number of these channels, across all OPW regions, is on-going with a number of experimental works also being undertaken. These scientific studies aim to assess the effectiveness of such works on the river corridor biodiversity and hydromorphology. While data is collected annually on fish communities, riparian and instream vegetation, aquatic macro-invertebrates, birds, crayfish and lamprey, it is often more appropriate to have several years data available before a full account of impacts is presented.

Throughout the programme IFI acted as an external auditor in relation to site assessment, implementation of the 10 Steps to environmentally friendly maintenance and the implementation of OPW's own standard operating procedures (SOP's) and environmental protocols (OPW, 2011). Approximately one third of all OPW's drivers were visited in 2013.

The EREP project continues to contribute annually to the WFD, Eel Management and Invasive Species databases within IFI. It also provides data and information to a number of non-fishery agencies, including BirdWatch Ireland (BWI), the National Biodiversity Data Centre and the National Botanic Gardens. Likewise, datasets relevant to OPW, e.g. catchment-wide larval lamprey distributions in drained catchments, are made available by the EREP team to OPW.

2 EREP Programme 2013

2.1 Introduction

The EREP programme continues to develop its two major strands – a capital enhancement works programme dealing with enhancement of OPW drained channels and an enhanced maintenance element dealing with the robust implementation of OPW's environmental protocols for channel maintenance. The capital works programmes involve importation of stone and gravels, diggings and placement of materials to create instream physical diversity and bankfull fencing on completion of the instream works. This approach to enhancement works is more specific than that for enhanced maintenance which primarily focuses on the implementation of OPW's own environmental protocols and where suitable and possible instream development work are carried out using available on-site materials. As such capital enhancement work programmes require a greater investment of time and resources for both OPW and the EREP team.

Drainage channels, due to their man-made nature, have less diversity with more extensive lengths of uniform depths, widths and gradients. Enhancement involves the increase of structural diversity of the river corridor to create a more natural physical form and this is achieved through a range of enhancement techniques such as construction of various instream stone structures, excavating pools and building riffles, fencing of river banks to allow vegetative regeneration etc. Reintroduction of more natural structural diversity within the river corridor increases the species richness in the river and has a positive effect on the whole food web surrounding the river corridor, which supports all the associated habitats and animals. Enhancement works also include remediation of fish barriers which have positive effects on the access for spawning fish and other aquatic species for large distances upstream.

All enhancement works were carried out using OPW staff and machinery, with IFI's staff working alongside OPW supervisory staff, with a geographic spread throughout the three arterial drainage maintenance regions. All materials required for the construction of enhancement structures were supplied by OPW.

The main focus of the EREP is to achieve enhancement and environmental methods of work to maximise the environmental quality of the Irish drained river corridor while balancing the channel's drainage outfall and flood conveyance capacity. It provides a tool for Ireland to comply with the WFD legislative obligations for hydromorphology.

2.2 EREP Overview 2013

Throughout the EREP period 2013 a wide range of river enhancement programmes were carried out through either capital works or enhanced maintenance, each involving a site specific plan of instream development work and/ or vegetation management. A summary of EREP targets and achievements is presented in table 2.1. In total 21 individual catchments and 40 individual rivers were identified for enhancement works (Tables 2.2 & 2.3). The distribution of these works is shown in figure 2.1. A small number of EREP projects were not achieved this year and where possible these channels will be included in the programme of works for 2014. As part of an OPW Drainage benchmarking exercise a section of the Knockcroghery River was identified for maintenance by an external contractor. This channel section was walked by IFI and OPW and an EREP work programme drawn up and provided to the successful contractor. The work was completed in 2013 but is not included as part of the 100km EREP target set for OPW as the work was not carried out by OPW.

Table 2.1. Summary of EREP Targets and Achievements for Capital Works and Enhanced Maintenance, 2013.

Capital Works	Target (km)	Set (km)	Achieved (km)	% achieved of plans	% achieved of target
East	10	19.8	11.5	58	115
West	8	10.03	7.43	74	93
Southwest	7	5.8	4.7	81	67
	25	35.63	23.63	66	95

Enhanced Maintenance	Target (km)	Set (km)	Achieved (km)	% achieved of plans	% achieved of target
East	30	35	11.5	33	38
West	24	20.2	12.7	63	53
Southwest	21	19.6	11.6	59	55
	75	74.8	35.8	48	48

EREP	**100**	**110.43**	**59.43**	**54**	**59**

Table 2.2 EREP Channels for 2013 – Capital Works

Region	Scheme	Channel Code	River Name	Work Type	Year of Plan	End of Year Status	Plan length (m)
East	Dodder FRS		Dodder	CW	2013	not completed	1000
East	Dee	C2(1)	Dee MC	CW	2012	completed	**1600**
East	Boyne	C1	Boyne MC	CW	2012	partial	2500
East	Boyne	C1/12	Skane	CW	2012	completed	**4900**
East	Boyne	C1/32	Stonyford	CW	2012	completed	**1800**
East	Boyne	C1/32	Stonyford	CW	2013	not completed	1600
East	Boyne	C1	Boyne MC	CW	2013	not completed	
East	Inny (Upper)	C62	Mount Nugent	CW	2012	completed	**1700**
East	Inny	C12	Rath	CW	2013	completed	2000
East	Brosna	C1(1)	Brosna MC	CW	2013	not completed	200
East	Brosna	C9(1)	Tullamore Silver	CW/EM	2013	not completed	2500
East Region Target 10km							**19800**

Region	Scheme	Channel Code	River Name	Work Type	Year of Plan	End of Year Status	Plan length
West	Moy	C1	Moy MC	CW	2012	completed	2500
West	Moy	C1/21/1/5	Balla	CW	2012	completed	**2000**
West	Mask (Robe)	CM4	Robe MC	CW	2012	completed	**1600**
West	Mask (Robe)	CM4	Robe MC	CW	2012	completed	**400**
West	Corrib Clare	C3 (Sect 39)	Clare	CW	2012	completed	**500**
West	Corrib (Headford)	CH 5	Ballycurran	CW	2013	completed	**240**
West	Corrib (Headford)	CH2/4	O'Briens	CW	2013	completed	**190**
West	Corrib Clare		Abbert	CW	2013	not completed	**2600**
West Region Target 8km							**10030**

Region	Scheme	Channel Code	River Name	Work Type	Year of Plan	End of Year Status	Plan length
SouthWest	Maine	C1	Maine MC	CW	2012	partial	**2000**
SouthWest	Feale	C1/18	Galey	CW	2012	not completed	100
SouthWest	Feale	C1/18/20	Galey	CW	2012	not completed	100
SouthWest	Feale	C1/14	Shanow	CW	2012	not completed	100
SouthWest	Maigue	C1/25	Camoge	CW	2013	completed	**1800**
SouthWest	Carrigahorig	C1	Carrigahorig MC (weir)	CW	2013	not completed	200
SouthWest	Carrigahorig	C2	Carrigahorig MC (sluice)		2013	completed	300
SouthWest	Nenagh	C1/9	Ollatrim	CW	2013	partial	**1200**
SouthWest Region Target 7km							**5800**

Table 2.3 EREP Channels for 2013 – Enhanced Maintenance

Region	Scheme	Channel Code	River Name	Work Type	Year of Plan	End of Year Status	Plan length (m)
East	Brosna	C9(1)	Tullamore Silver	CW/EM	2013	not completed	2500
East	Monaghan Blackwater	C1/3/2		EM	2013	completed	5000
East	Dee	C2(7)	White River	EM	2013	not completed	3500
East	Boyne	C1/37/10	Deel	EM	2013	not completed	5000
East	Boyne	C1/12/1	Skane	EM	2013	not completed	2500
East	Inny	C12	Rath	EM	2013	partial	5000
East	Inny	C33	Riffey	EM	2012	partial	1500
East	Brosna	C1/17	Gageborough	EM	Repeat previous plan	not completed	8000
East	Owenavorragh	C1	Owenavorragh	EM	2013	not completed	2000
East Region Target 30km							**35000**
West	Bonet	C1	Bonet	EM	2011	not completed	**2500**
West	Bonet	C1/12	Shanvas	EM	2013	completed	**1700**
West	Boyle	C6/7/5	Owenaforeesha	EM	2012	completed	**6000**
West	Mask (Robe)	CM4/47	Brickeens	EM	2013	completed	**2000**
West	Corrib (Clare)	C3/35/7	Flaskagh	EM	2011	not completed	5000
West	Corrib Clare	C3/9/8	Omaun	EM	2013	completed	**3000**
West Region Target 24km							**20200**
SouthWest	Deel	C24	Finglasha	EM	2013	not completed	3000
SouthWest	Deel	C17	Bunoke	EM	Repeat previous plan	not completed	3000
SouthWest	Deel	C18	Owenskaw River	EM	2012	partial	**4000**
SouthWest	Groody	C1	Groody	EM	2012	completed	**3000**
SouthWest	Maigue	C1/25/23	Mahore	EM	2013	completed	**3500**
SouthWest	Kilcrow	C1/23	Oxgrove stream	EM	2012	completed	**3100**
SouthWest Region Target 21km							**19600**

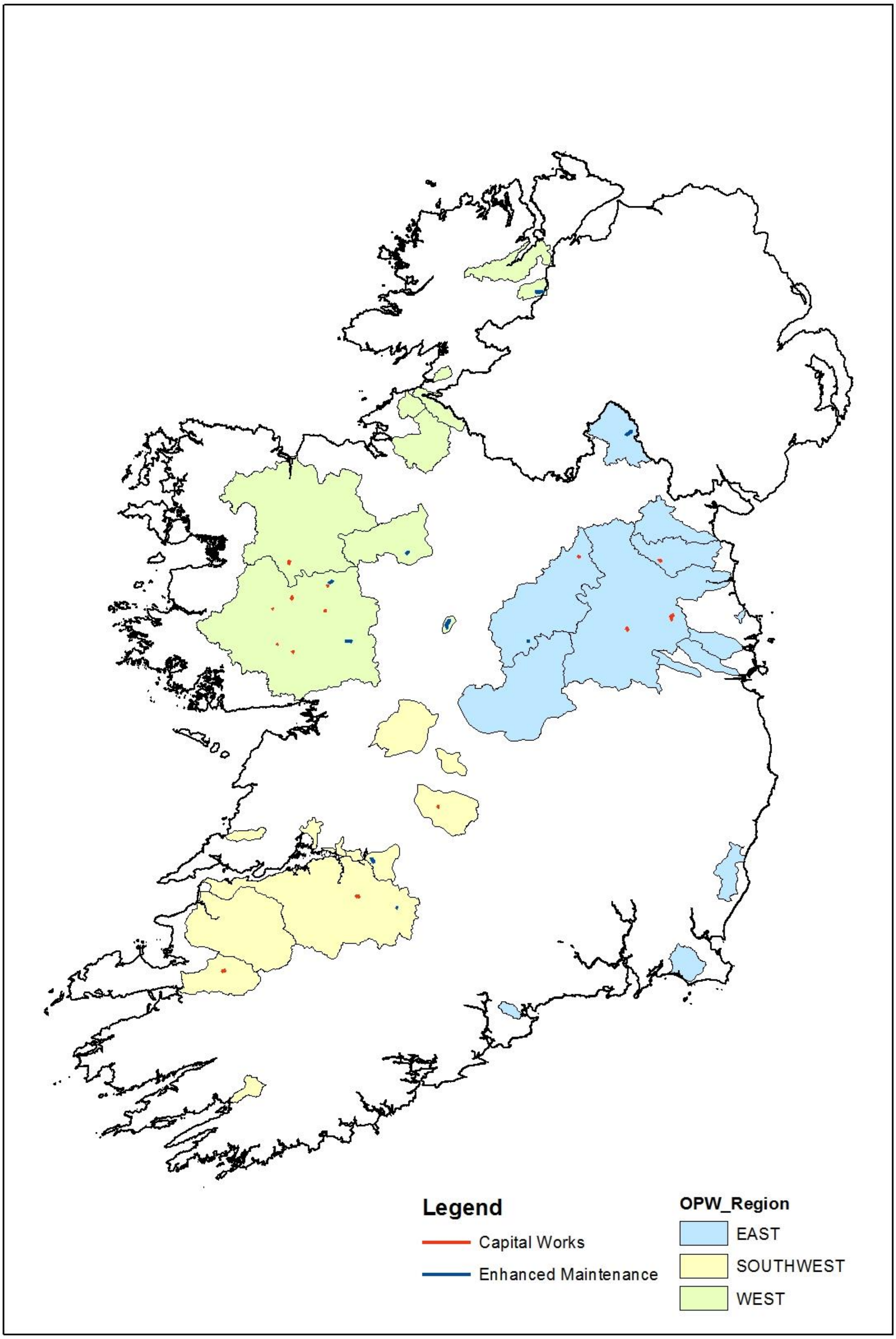


Figure 2.1. Location of EREP work sites for 2013.

3 Bio-diversity and EREP Monitoring

The EREP biological monitoring programme aims to assess the impacts of capital works and of routine environmental maintenance on the river corridor bio-diversity. Fish, flora, lamprey and crayfish, along with physical changes are being monitored across a number of sites.

3.1 River Corridor Bio-diversity

Our monitoring studies have shown that the temporal response exhibited by the various river corridor elements, that we sample, can differ (EREP Annual Reports 2008 to 2012). Our results also indicate that often the changes seen across the whole site can be interlinked. Enhancement of the physical regime can greatly improve the channel diversity, through restoration of the riffle / glide / pool sequence, addition of spawning gravels and bank protection. Such changes can improve the fish carrying capacity of these rivers. Fish dynamics will alter in response to the newly created habitat, with changes to population structure and abundance often noted. Indeed species composition may also be effected.

Sites chosen for capital works programmes will often exhibit limited salmonid potential for spawning opportunities, nursery waters, angling or a combination of these. As capital works programmes address these issues, there is the expectation that if the spawning potential has improved then we should see increases in 0+ fish numbers. Enhancement works in potential nursery waters should see the 1+ population improve while angling development, in salmon (*Salmo salar*) and trout rivers, should provide for greater numbers of adult fish.

As the physical aspect of the channel changes in response to an altered hydrology, there will be corresponding changes in the floral communities. For example the reintroduction of a proper thalweg may increase the gravelly nature of bed material in scoured areas encouraging the growth of species like *Ranunculus*. In contrast, in sections with increased sediment deposition one may see an increase in emergent plant species like *Phalaris* or *Sparganium*.

Often changes in the aquatic, marginal and riparian vegetation will influence changes in the macro-invertebrate communities. Increased vegetation cover and diversity will often correspond to increased invertebrate diversity and abundance. Both vegetation and the invertebrate fauna are important to the fish communities present in any channel.

However flora and fauna communities respond to change at differing rates. Some of the improvements mentioned may occur immediately, others over a number of years. For example it is not surprising to record increases in fish spawning and for older fish to move into deeper waters/pool areas almost immediately post works. The benefits to the floral and macro-invertebrate communities often take longer to materialise.

Most capital works programmes do not actually change the flora or fauna of the channel directly, i.e. no plants, invertebrates or fish are actually reintroduced. What the EREP programme does is to provide the channel with the necessary conditions/habitats it needs to achieve such changes itself. Changes to the channel come through enhancement of the morphological features of the river. If a channel has the appropriate hydromorphological conditions, then the rest should come naturally. If this does not happen, then most likely the river has water quality issues which are beyond the remit of this programme.

3.1.1 River Monitoring Programme

The Monaghan Blackwater is formed from the confluence of several small streams arising on the southern slopes of Slieve Beagh in the Eshbrack Bog complex. It then flows in a south-easterly direction through Monaghan Town, joining the Clontibret River before it eventually enters the Ulster Blackwater south of Caledon.

This study examined the trout and pike stocks, using the mark-recapture electrofishing method, in the 4km of channel from Raconnel Br. to Monaghan Co-op Bridge on the Monaghan-Emyvale road (figure 3.1). For the purposes of this report, this section has been broken into 2 stretches each of 2 km length, Raconnel Br. to Milltown Br. and from Milltown Br. to the Monaghan Co-op Bridge. This survey was initiated before the arterial drainage scheme was commenced in 1981. The sequence of events in this survey is pre arterial drainage (1981), post drainage but pre river enhancement (1993) and post river enhancement in 1997, 2002 and 2013.

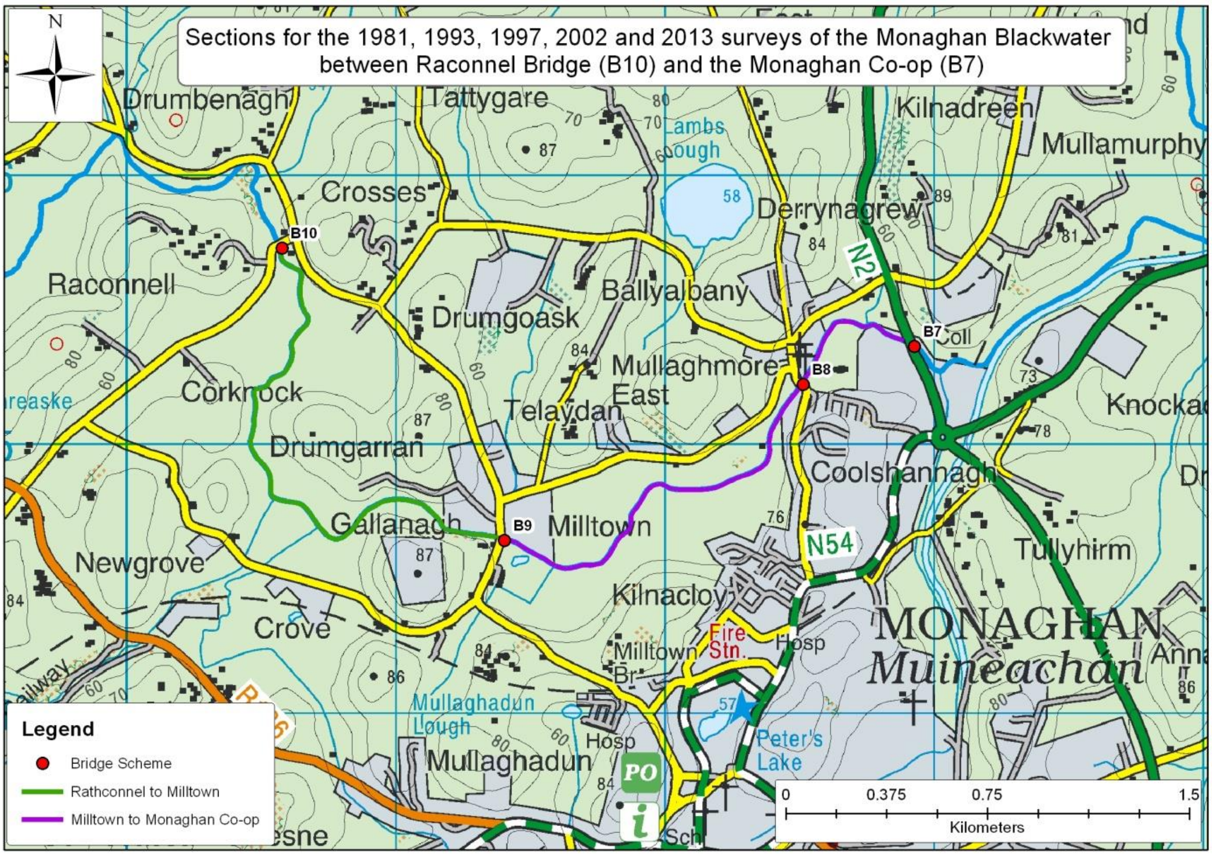


Figure 3.1. Location of the two sites surveyed on the Monaghan Blackwater River, starting at Raconnel Bridge (B10) and finishing at the Monaghan Co-op Bridge (B7).

The ecological condition in the Monaghan Blackwater has remained stable since 2007, based on the EPA's 'Q' rating unsing invertebrate community composition. The sites downstream of Bellanode continue to be of generally unsatisfactory ecological condition (Table 3.1). The complete absence of sensitive macroinvertebrates below Monaghan town (Faulkland Bridge upper,) when biological sampling was carried out in 2010, is indicative of considerable ecological disruption, with continued pollution by suspected sewage and industrial discharges (EPA, 2013). The 2011 EPA physico-chemical monitoring data reveals elevated BOD, nitrate and o-phosphate levels on occasion at the Milltown station but in particular at the Faulkland Bridge upper station which is consistent with intermittent pollution.

Table 3.1. EPA Q-values 1971 to 2010 on 3 sites on the Monaghan Blackwater, Bellanode is ~2km upstream of Raconnel Bridge and Faulkland Bridge upper is ~2.5km downstream of the Monaghan Co-op Bridge.

Stations/Q-Values	1971	1973	1977	1981	1983	1985	1989	1993	1996	1998	2001	2004	2007	2010
Bellanode	4	4	3-4	4	4	3-4	3-4	4	4	4	4	4	3-4	3-4
Milltown	4	4	3-4	4	3-4	3-4	3	3	3-4	3	3	3-4	3-4	3-4
Faulkland Bridge Upper	3	3	2	3	2-3	3	2-3	3	2-3	3	3	3	3	3

Post arterial drainage the Monaghan Blackwater was left with a uniform trapezoidal cross section and a flat bed, leaving little of the original pool habitat. In low flow conditions the trout population was limited by the lack of sufficient deep water refuge habitats. Therefore, in 1993 extensive sections of the fisheries rehabilitation programme concentrated on installing water-retention structures in the form of the horseshoe weirs, designed to pond water and create localised pool areas. In other sections a more sinuous, narrowed low-flow regime was created with the use of alternating deflectors. In slow flowing or impounded sections the addition of random boulders either individually or in clusters was used to increase habitat diversity. Further to work done in the early 1990's, additional works were carried between 2009 and 2011 in the Milltown Bridge area creating large weir structures.

To estimate the fish population abundances, a mark-recapture fishing was conducted over two days spaced a week apart. In the first week fish were electrofished, measured, marked (a small section was removed from their tail fin) and released. Marked fish captured a week later were then noted with the rest of the captured individuals. This was done for trout, pike and roach. The ratio of marked/unmarked fish captured in the 2^{nd} week of electrofishing was used along with physical stream measurements to calculate fish abundance estimates.

Plate 1. Trout captured and marked on the Monaghan Blackwater River, September 2013.

Trout numbers recorded between Raconnel and Milltown Bridge have not recovered to a pre arterial drainage level (figure 3.2). Post river enhancement (1993) this stretch has shown an improvement in trout numbers in 1997 and 2013. The Milltown Bridge to Monaghan Co-op stretch has recovered post arterial drainage and in 2013, supports a higher density of trout then pre drainage (1981). Post river enhancement (1993) this stretch has shown a steady improvement in trout numbers.

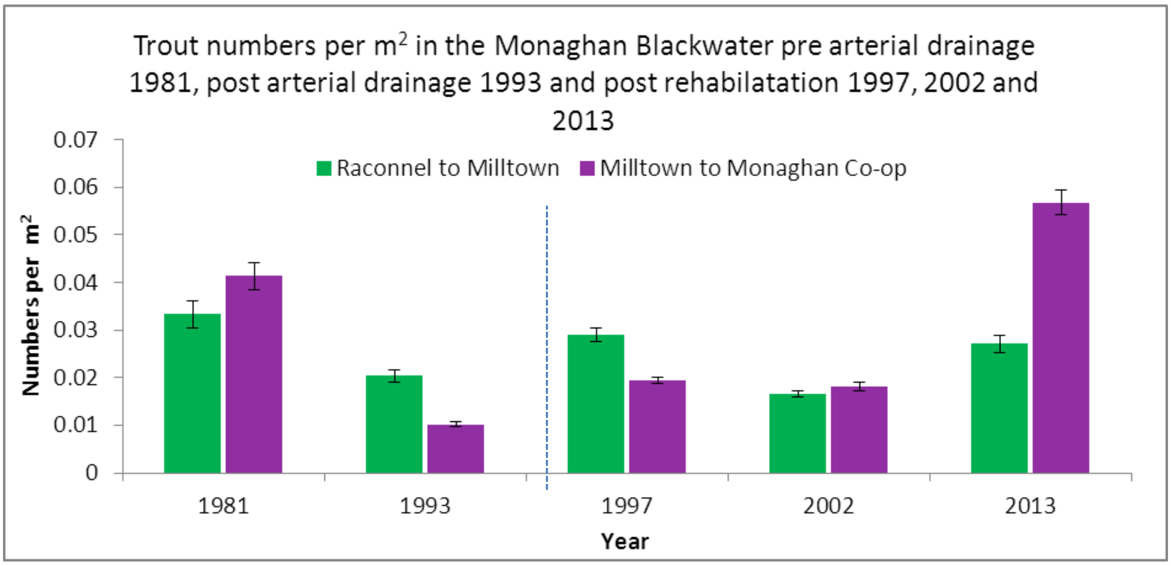


Figure 3.2. Trout numbers for two sections of the Monaghan Blackwater from Raconnel Bridge to Milltown Bridge and from Milltown Bridge to Monaghan Co-op. Pre arterial drainage 1981, post arterial drainage 1993 and post rehabilitation 1997, 2002 and 2013.

The percentage length frequency distribution for the trout captured in the 5 sampling years is given in figure 3.3. The black line represents the size above which trout become desirable for anglers (≥28cm). The percentage of trout above 28cm in the Raconnel to Monaghan co-op stretch was consistently 30-40% of the population from 1981 to 2002. The percentage of trout ≥28cm in the Raconnel to Monaghan Co-op stretch fell to 9.4% in the 2013 survey. There is a significant cohort of fish in the 18-26cm size classes for 2013. This reduction in larger trout (≥28cm) in the 2013 survey could be explained by natural processes, such as the unusually dry summer of 2013 which may have resulted in larger trout migrating out of this section to the deeper waters downstream.

The length frequency distribution of pike captured between Raconnel to Monaghan co-op is given in figure 3.4. The size distributions of pike from 1981 to 2002 indicate the majority of the population were in the 30 to 50cm size range with few larger older fish present. The opposite appears to be the case with the pike from the 2013 survey. Here the majority of the fish were in the 50 to 85cm size range with few smaller fish present.

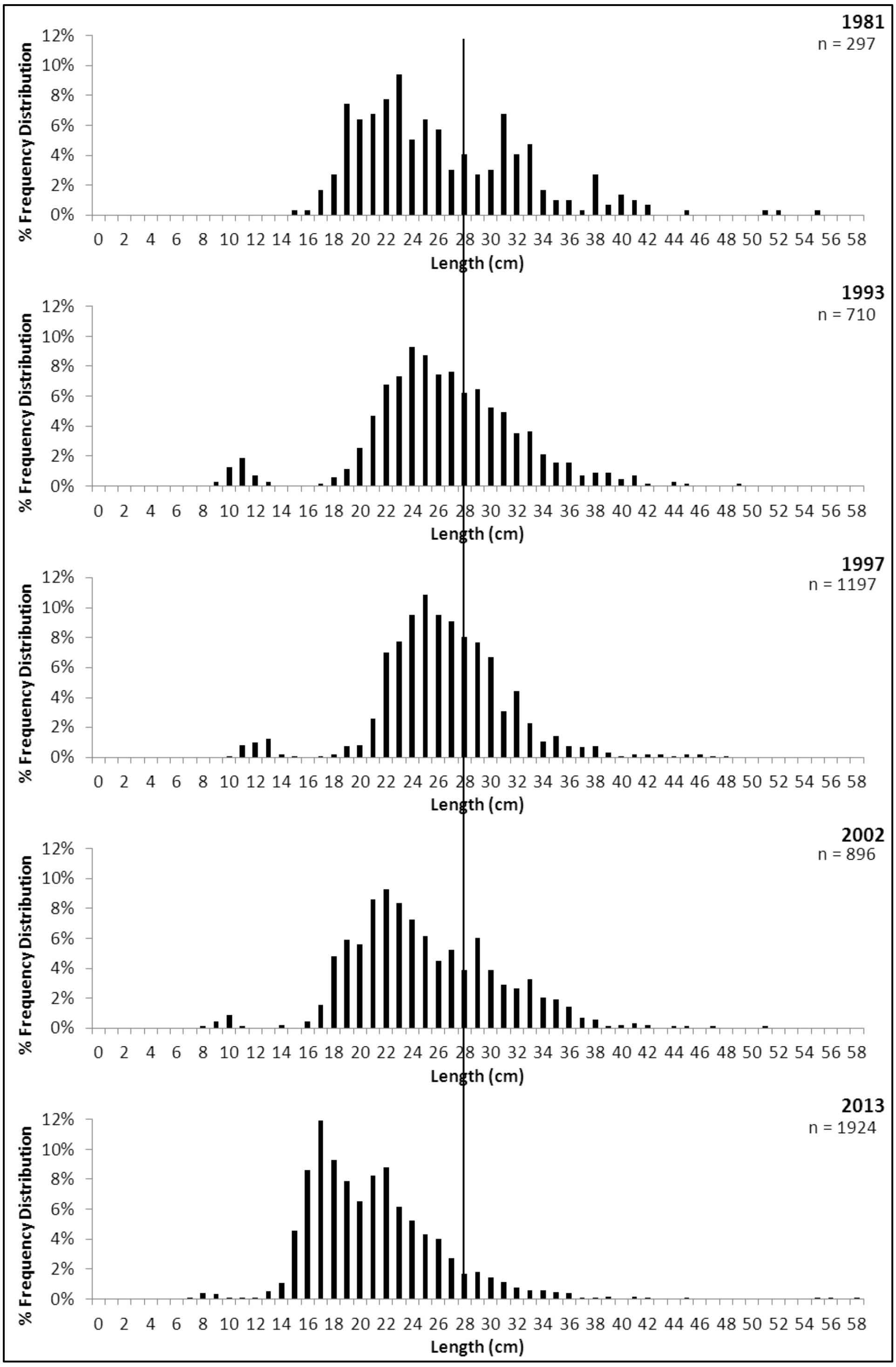


Figure 3.3. Length frequency distribution of brown trout captured in the Monaghan Blackwater between Raconnel Bridge and Monaghan Co-op in 1981,1993,1997,2002 and 2013. (Black line = Trout ≥28cm).

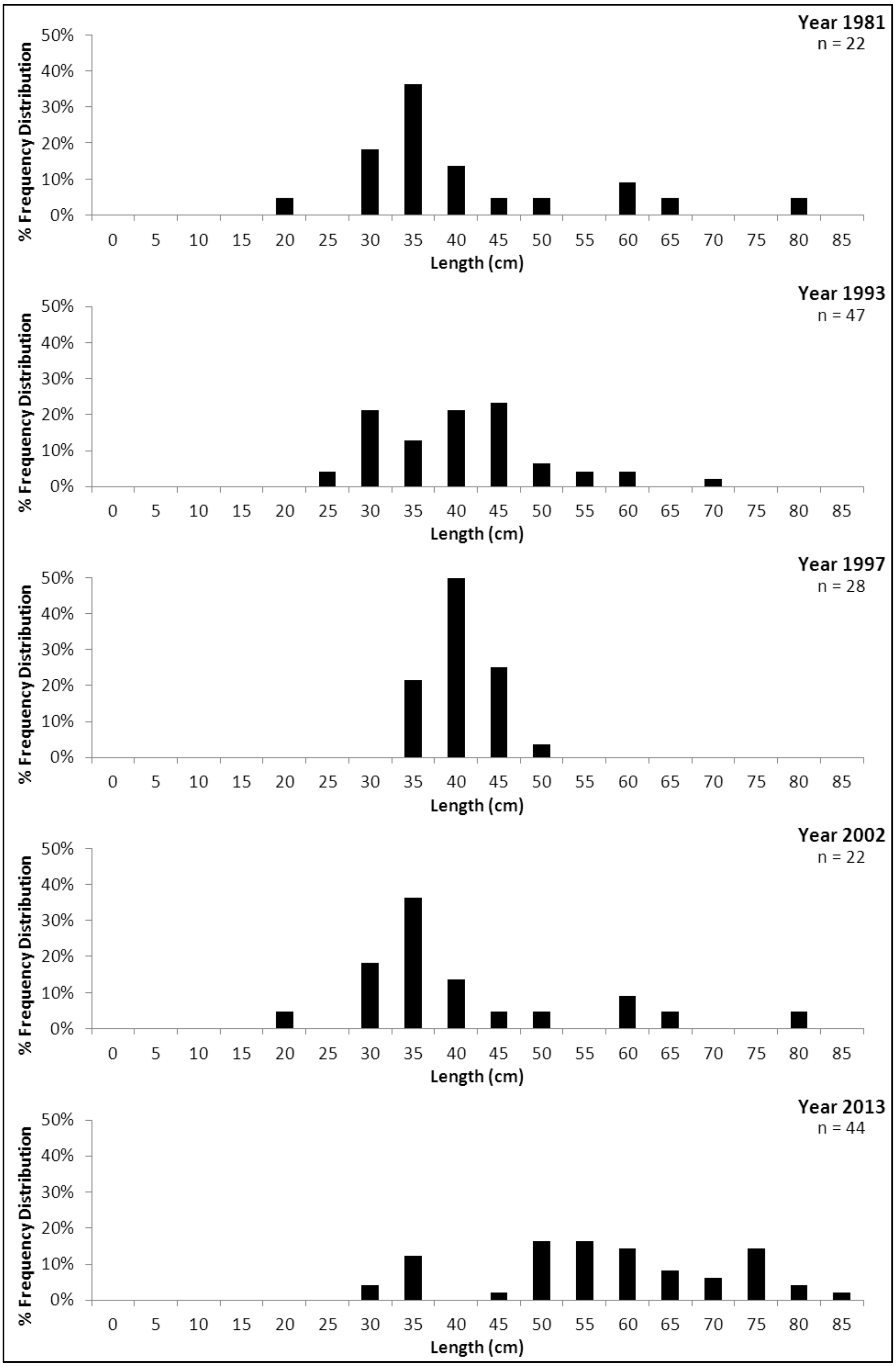


Figure 3.4. Percentage Length frequency distribution of brown trout captured in the Monaghan Blackwater between Raconnel Bridge and Monaghan Co-op in 1981,1993,1997,2002 and 2013.

The greatest change in the trout and pike population was observed in location 5 between 2002 and 2013. This is probably due to the construction of a large stone horseshoe weir structure built upstream of the bridge in Milltown Between 2009 and 2011 (put in by the local angling club and the OPW). This weir structure is approximately ~1 meter high and ponds water back approximately 600 meters upstream. This ponding coupled with extensive large woody habitat in the channel has created excellent adult pike habitat. In location 5, the pike numbers increased from 0.0017 to 0.0073 no/m^2 between 2002 and 2003. The trout numbers have dropped from 0.016 to 0.0001 no/m^2 between 2002 and 2003. The percentage contribution of the pike and trout populations have responded to the construction of the weir in location 5 (figure 3.5). Comparing 1993, 1997, 2002 and 2013 a higher proportion of the pike population is now located in location 5, inversely far fewer trout were found in location 5 in 2013, compared to previous years. The relationship between pike and trout observed in location 5 is probably predator / prey and the trout are most likely actively avoiding large concentrations of predatory pike.

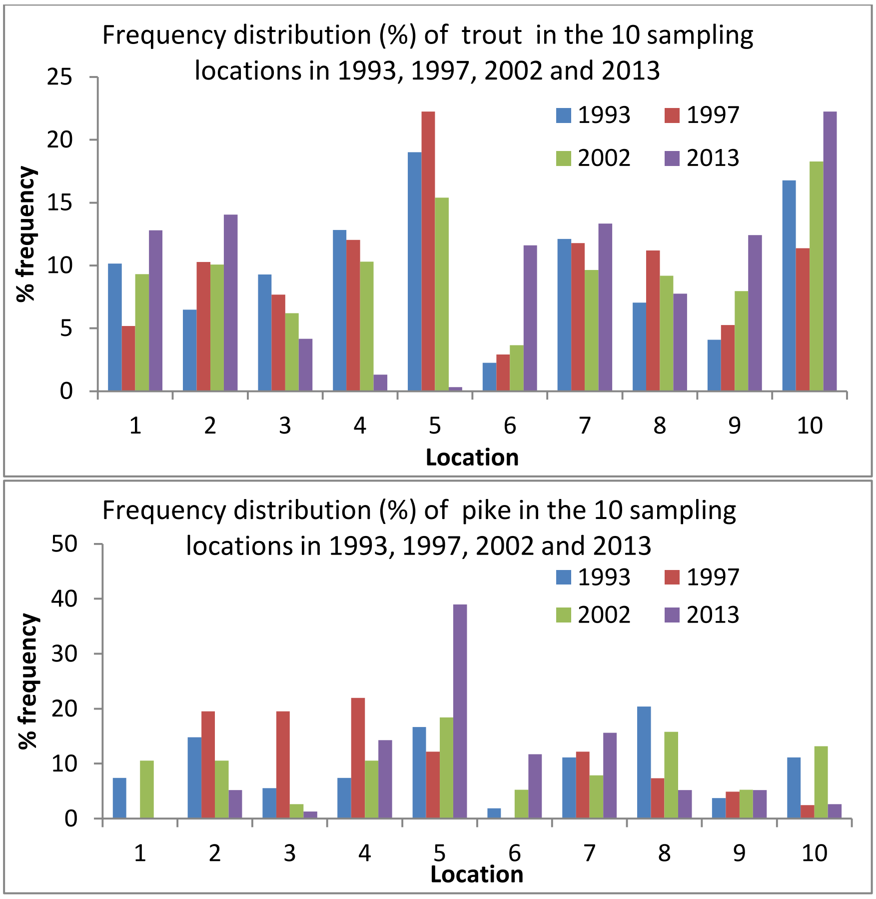


Figure 3.5. The contribution of trout at each site as a % of the total trout populations taken during electrofishing between site 1 and site 10 in 1993, 1997, 2002 and 2013.

3.2 Fish Population Index Survey (FPI) 2013 on R. Maigue catchment

In 2013 fish population index (FPI) surveys were carried out on the Maigue CDS, part of the Shannon River Basin District.

The River Maigue rises in the Milford area of North County Cork and flows north through Croom and Adare in County Limerick into the Shannon Estuary at Carrigclogher Point. This is a rich limestone river and together with its tributaries the Camogue, Morning Star and Loobagh, drains the lush pastures of Limericks Golden Vale.

"The Maigue was regarded as one of Ireland's premier trout rivers up until the start of an arterial drainage scheme in the 1970s, which subsequently channelised the river, destroying its natural character" (O'Reilly, 2002). The Maigue catchment has high nutrient export rates as it drains intensively cultivated agricultural land, contributing significantly to the nutrient budget of the Shannon Estuary, especially where phosphorous inputs are concerned (Marine Institute, 1999). The river also holds a population of dace, an invasive species in Ireland, which were first recorded in the Maigue in 1990 (Caffrey *et al*., 2007). However no dace were recorded during this survey. This catchment drains approximately 1102 square kilometres, with 760 km's of OPW drained channel and estuarine embankment.

Based on the findings of Kelly *et al*. (2006) habitat enhancement for salmon should only be undertaken if a moderate water quality status (Q3-4) or greater is achieved, while trout can tolerate slightly poorer water quality (status Q3). Consequently, any habitat enhancement work undertaken in zones where water quality indicator values are at or below poor status (Q3) will not be effective, in terms of increasing salmonid production. Therefore even though there is significant scope for capital works in significant sections of the Maigue catchment, due to poor water quality they fail the minimum requirement for the capital works programme.

Water quality in the Maigue catchment as measured by EPA Q-values has decreased since the 1970's (Table 3.2). There are currently no high status sites in the Maigue catchment and there has been a significant increase in moderate and poor sites since the 1970's. Since the 2000's there has been an increase in good status sites.However the number of poor sites has remained constant. In terms of water quality, 56% of EPA Q-value sites in the Maigue catchment are failing to reach good status. The location and breakdown of EPA Q-value sites in the Maigue catchment is given in figure 3.6. This indicates that there are water quality issues in the Upper Maigue catchment (C1 and C1/36), the upper Camogue catchment (C1/25 and C1/25/23) and in the Clonshire system (C1/17).

Table 3.2. Breakdown of EPA Q-Values from the Maigue catchment over the last four decades.

Q-Value	Quality Status	1970's	1980's	1990's	2000's	20012
Q5	High Status					
Q4-5	High Status	33%		3%		
Q4	Good Status	58%	16%	19%	33%	44%
Q3-4	Moderate Status		61%	31%	33%	17%
Q3	Poor Status	8%	13%	44%	31%	36%
Q2-3	Poor Status		3%	3%	3%	3%
Q2	Bad Status		6%			
Q1-2	Bad Status					
Q1	Bad Status					
	Total Number of Sites	12	31	36	36	36

The Maigue FPI survey consisted of 56 sites, 11 boat based and 45 bank based, where electric fishing was undertake n to examine fish community composition and status. In decreasing order of abundance, fish species present were minnow, trout, salmon, 3 spined stickleback, stone loach, crayfish, eel, lamprey *sp.*, flounder and perch. Their distribution and abundance in each sub catchment is given in in Appendix I. For simplicity the Maigue catchment is displayed here in 6 subsections:

- The Estuary tributaries Barnakyle R. (C1/10), Ballyloughnaan stream (C1/15), Clonshire and its tributaries (C1/17/4-7),
- the Camogue River (C1/25) and its tributaries (C1/25/23 & C1/25/23/1),
- the Glosha River (C1/30) and Howardstown Stream,
- Morningstar system (c1/31)
- the Loobagh (C1/34) its tributaries (C1/34/4 & C1/34/10) and un-drained sections
- the Maigue Main Channel (C1) its Headwaters (C1) and its tributaries (C1/20 & C1/32).

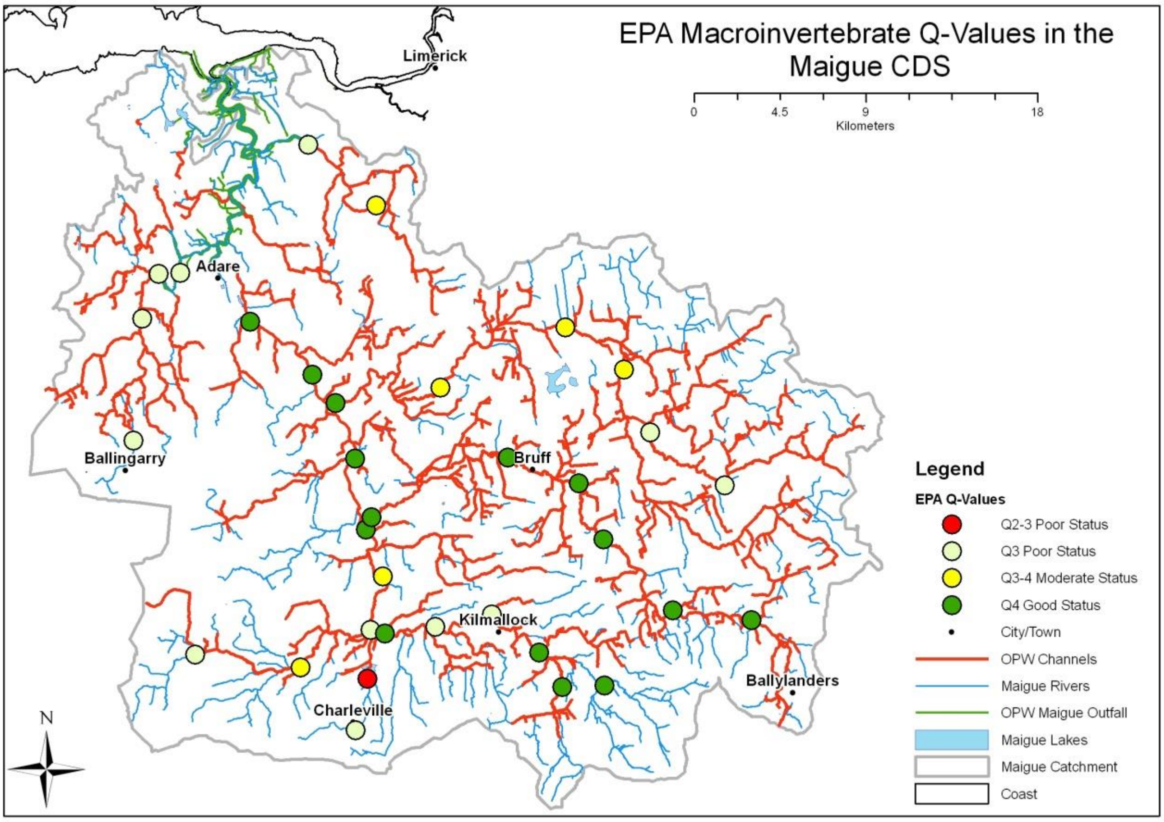


Figure 3.6. EPA Macro-invertebrate Q-Values in the Maigue catchment recorded in 2012.

Salmon and trout were found in every major river in the Maigue catchment (figure 3.7). The absence of salmon in some sites reflects an unfavourable habitat type (low gradient/discharge, e.g. (C1/34/4 & C1/34/10)), their absence in other locations i.e., Maigue headwaters (C1), the upper Clonshire River and its tributaries (C1/17/4-7) and the Camogue's tributaries (C1/25/23 & C1/25/23/1) is a reflection of poor water quality making the water body unfavourable for salmon survival.

Crayfish and lamprey *Sp.* were found in almost all catchment in the Maigue FPI survey (3.8a and 3.8b). The exceptions were the Barnakyle R. (C1/10), Ballyloughnaan stream (C1/15) and the Glosha River (C1/30) and Howardstown Stream. The Barnakyle R. (C1/10) and Ballyloughnaan Stream (C1/15) discharge directly into the Maigue estuary, both river/brook and sea lamprey have been recorded during water framework directive Maigue estuary surveys. Therefore, both species have the ability to colonise both the Barnakyle R. (C1/10) and Ballyloughnaan Stream (C1/15) catchments and it would be prudent to assume both species are present in these catchments. The high level of larval lamprey absence at survey sites mirrors findings of a catchment-wide IFI lamoprey survey of 2012 (http://www.fisheriesireland.ie/fisheries-research-1/390-habitats-directive-report-2012-1)

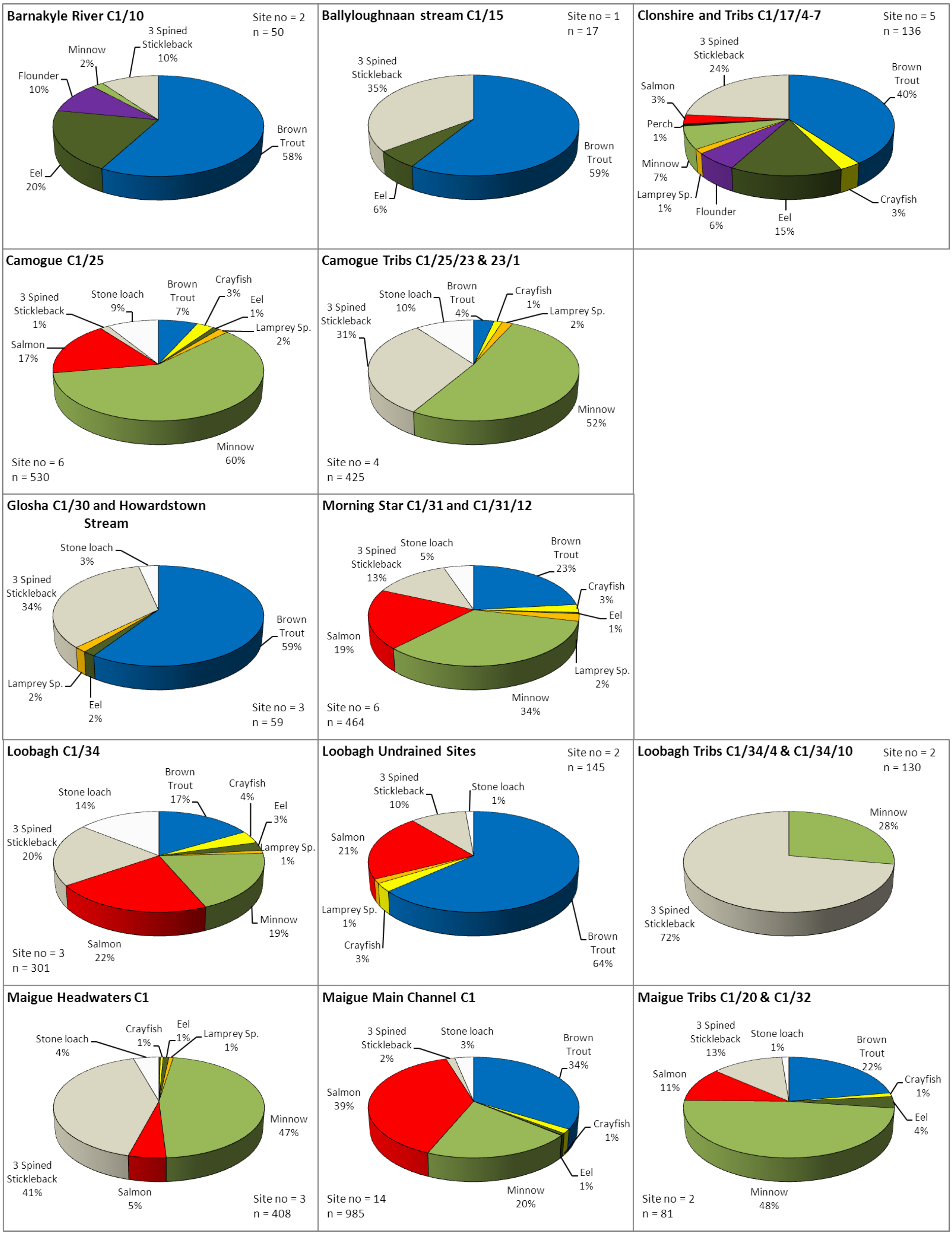
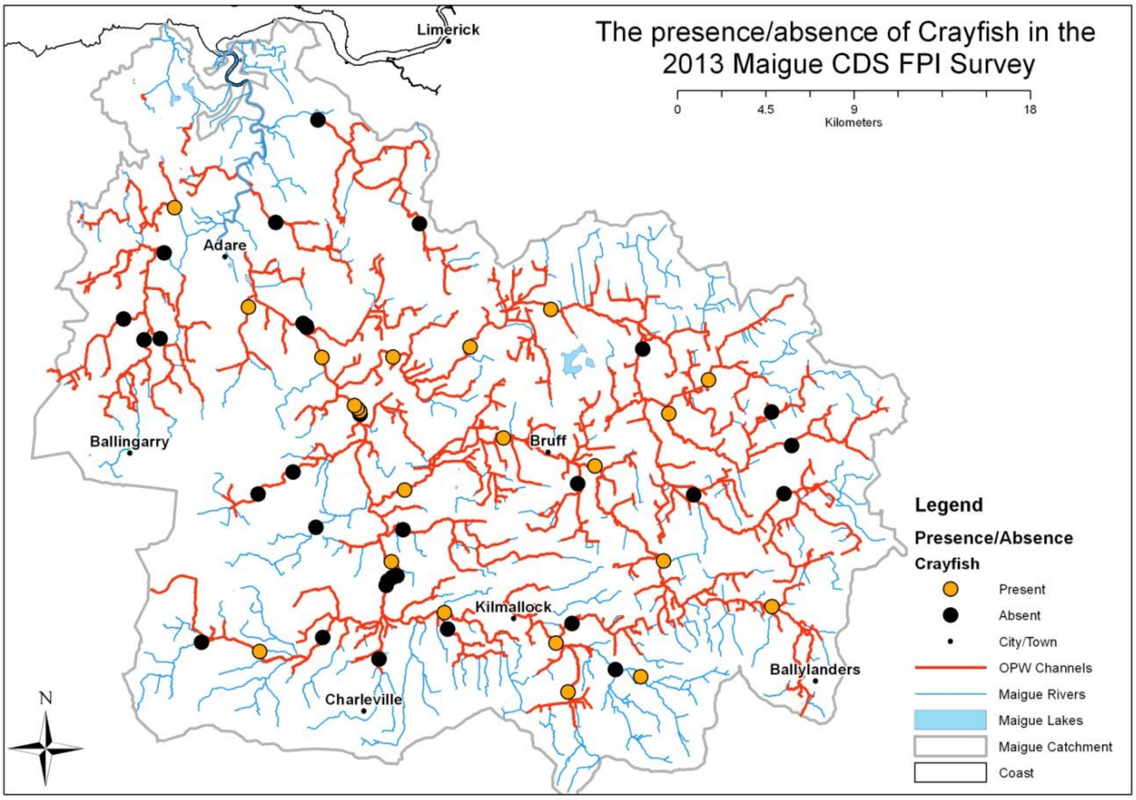


Figure 3.7. FPI survey species breakdown for the Maigue catchment



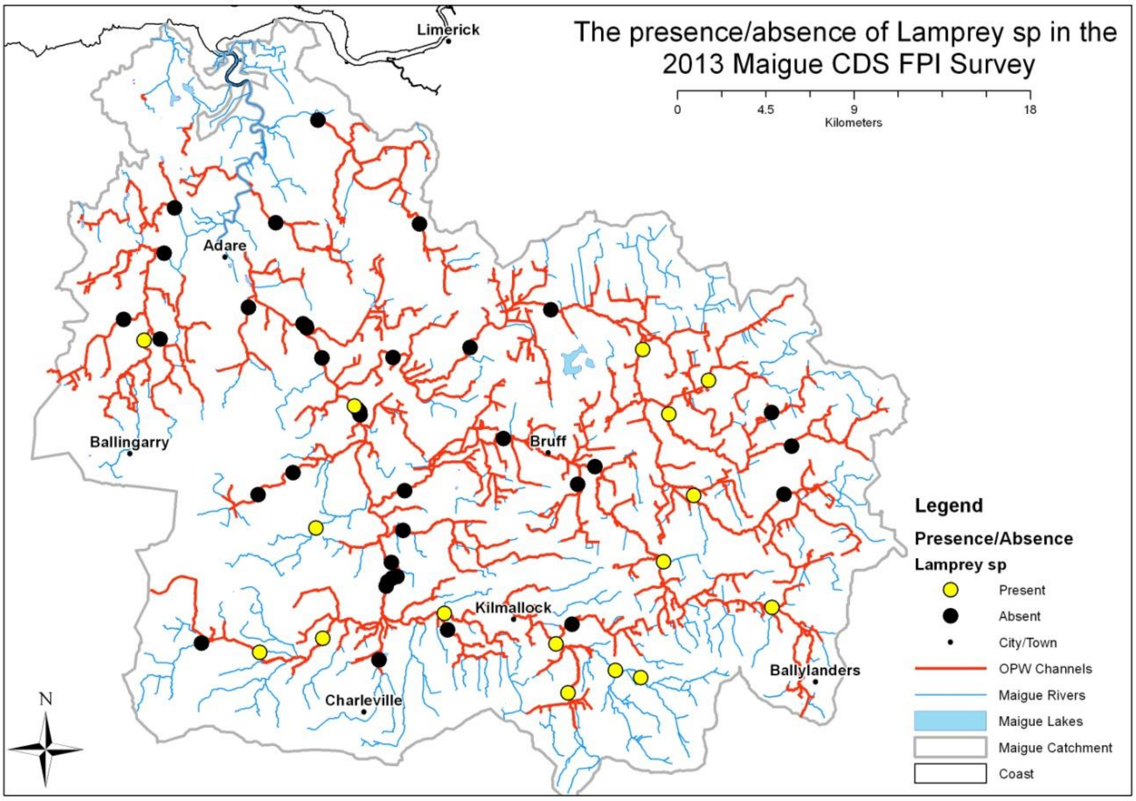


Figure 3.8a and b. The presence/absence of crayfish and lamprey in the 2013 Maigue FPI Survey

3.2.1 River Restoration Potential In Maigue catchment

There is extensive potential for river restoration either through capital work or enhanced maintenance in the Maigue catchment. The Clonshire River (C1/17), the C1/17/4 and the C1/17/4/1 in the Clonshire system all have the gradient and water quality for extensive works tailored to trout and in the case of C1/17/4 salmon also. Enhanced maintenance, involving excavating pools and riffle areas has been undertaken here with OPW since 2003.

Currently the Maigue is below its salmon conservation limits and is closed for salmon angling in 2014. The Loobagh (C1/34) upstream of Killmallock and the Morning star upstream of Ballynahinch Bridge both have potential for increased salmon production. The main Maigue channel (C1) from Buree (chg. 22200) downstream to below Croom (chg. 4200) had the highest densities of salmon fry and parr recorded, as part of the FPI survey, and has significant scope for river enhancement.

3.3 Shading Effects on water temperature

Water temperature is a key factor regulating salmonid growth and metabolic maintenance and is one of the diverse factors affecting the ecology of freshwater organisms. The thermal regime of a river is affected not only by a range of natural factors (climate, geology, hydrology and topology) but also by human impacts (riparian land use and abstraction). Fish respond to all aspects of the temperature regime, including the maxima and minima, seasonal and daily fluctuations, rates of change and the duration of extreme thermal events. Temperature can affect the metabolism and growth of invertebrates and their community structure. Potentially, changes in the streams thermal regime may alter the food resource available to fish. Other important factors such as water quality and discharge have the potential to significantly interact with water temperature.

All salmonids have high metabolic rates and oxygen demands, being the most temperature-sensitive of Irish native fish species, typically thriving in temperatures below 20°C with an upper thermal limit of 24–30°C (Elliott *et al.*, 1995). High water temperature can be lethal to salmonids, particularly during periods of low flow with concurrent reduced oxygen levels and increased pollutant concentrations. The threat of climate warming to native cold-water fish species has been recognized as a key priority for research and action by UK Government (DEFRA, 2005).

Shade cast by riparian vegetation can substantially modify the thermal regime of a watercourse and, therefore, influence the potential survival of sensitive fish such as salmonids during extreme conditions (Broadmeadow, 2011). During periods of extreme temperatures and low flows, the influence of riparian shade becomes increasingly important in protecting salmonid populations from thermal stress.

This study was devised, to determine the effect of shading by riparian trees on thermal regimes in an arterially drained lowland river channel. Arterial drainage has the potential to intensify the effect of thermal heating by widening the channel base width and creating a uniform bed gradient over extended lengths, exposing significantly more river bed area to thermal heating. During drainage, bank slopes were re-profiled and de-brushed creating uniformly-sloped (trapezoidal) bare banks thereby reducing possible shade. In places, poor agricultural practices have inhibited the regrowth of a significant riparian corridor leaving the river exposed in its disconnected flood plain.

This study was conducted on the Broadmeadow catchment, which has two sub-catchments, the Broadmeadow proper and the Ward River a slightly smaller sub catchment. Together they drain a catchment area of approximately 169 Km^2. Temperature data loggers were deployed at 18 sites, 11 on the Broadmeadow and 7 on the Ward (figure 3.9). At each site water temperature was recorded at 15-min intervals using Onset Hobo Water Temp Pro v2 data loggers, ensured that all relevant diurnal fluctuations were detected. The loggers were deployed from June to November 2013.

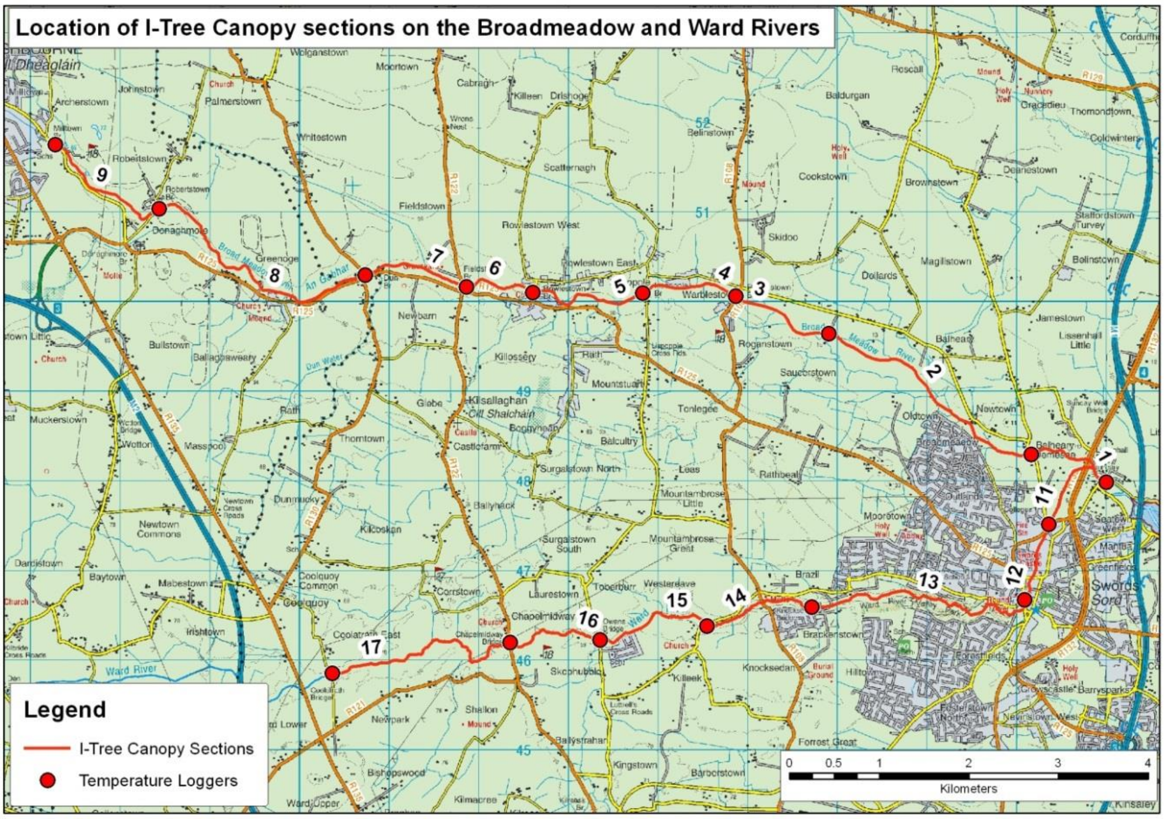


Figure 3.9. Location of I-Tree Canopy sections in the Broadmeadow Catchment on the Broadmeadow and Ward Rivers.

Riparian canopy cover was calculated using I-Tree Canopy, this web-tool is used to produce a statistically valid estimate of land cover types (e.g., tree cover) using aerial images available in Google Maps (images dated: 12/7/2013). The tool randomly lays points (number being determined) onto Google Earth imagery and then classifies what cover class each point falls upon. Shape files of the riparian corridor were created using ArcMap 10 these were then loaded into I-Tree Canopy to estimate land cover types. Percentage land cover types have been calculated between probe locations. Average distance between probes on the Broadmeadow were 1706m (SD:±841m) and on the Ward were 1698m (SD:±770m).

This analysis focussed on July 2013, which had above average air temperatures 16.7°C, compared to an historical average of 14.5°C (AccuWeather.com) and low water levels. This analysis gives an insight into the effect of poor large scale riparian management and the possible effects of more extreme weather events. Temperatures for the lower loggers in sections 2 and 12 are given in figure 3.10.

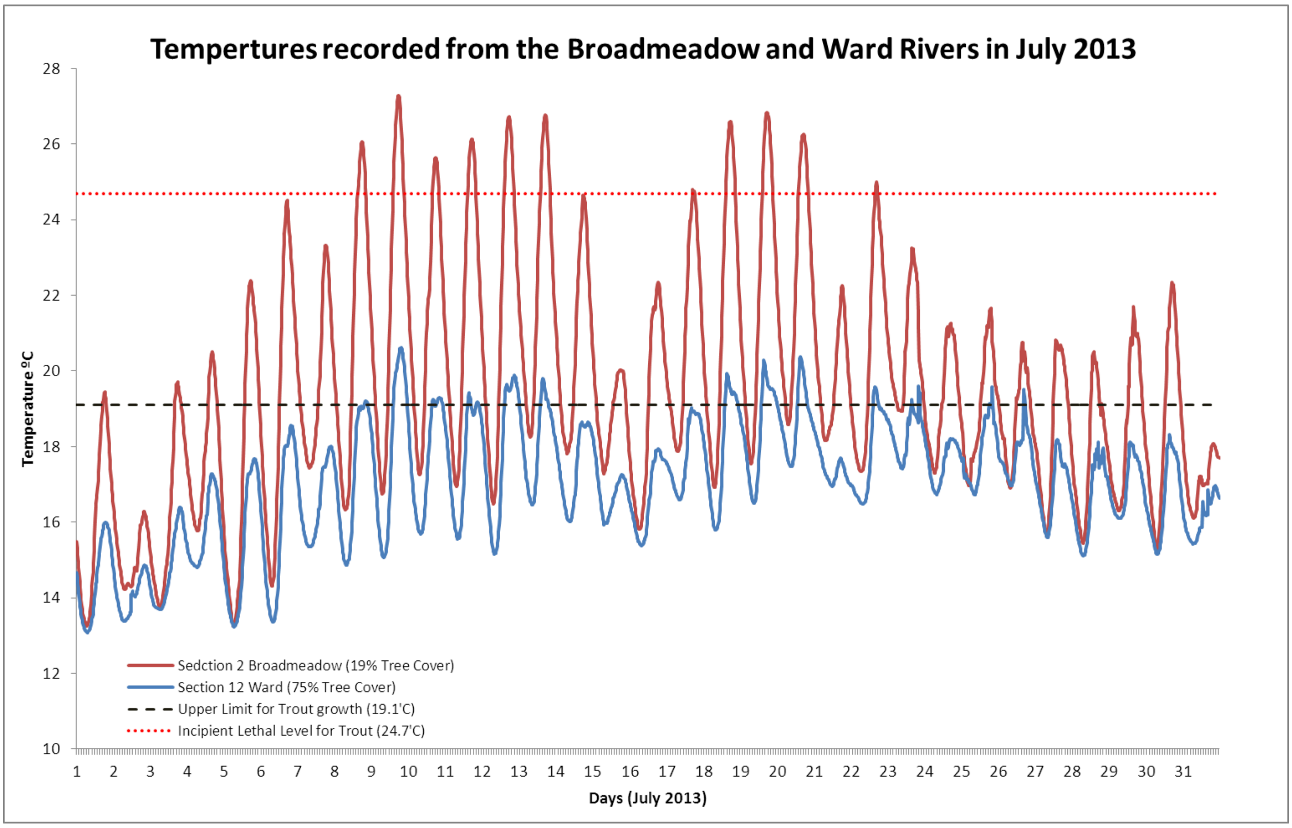


Figure 3.10. Showing water temperature recorded in 15 minute intervals from section 2 and 12 in the Broadmeadow Catchment July 2013.

A comparison of the canopy cover and water temperature between the Broadmeadow and Ward Rivers (Table 3.3) indicates the two rivers are significantly different both in terms of mean water temperature, number of days in July the water temperature exceed upper limit of growth for trout and in canopy cover (Mann Whitney U, $P<0.05$).

Table 3.3. Showing the Broadmeadow and Ward Rivers July mean, max and min temperatures and number of occurrences when water temperature exceeded the upper limit of growth for trout (19.1°C), the number of occurrences the water temperature exceed the incipit lethal level (24.7°) for trout (Elliott *et al*., 1995), and the percentage tree cover calculated using I-Tree Canopy.

Broadmeadow River				No of Occurences Where Temp Exceeded:		
Section	Mean	Max	Min	Upper limit of Growth	Lethal Level	Percentage Tree Cover
1	19.2	24.0	13.5	24	0	15.1
2	19.5	27.3	13.3	29	12	19.8
3	19.8	27.1	13.8	27	12	18.0
4	19.9	27.1	13.7	27	10	10.6
5	19.4	26.4	14.0	25	10	32.4
6	18.8	24.3	13.5	25	0	31.7
7	18.7	24.1	13.4	25	0	34.6
8	19.2	27.5	13.6	26	12	21.0
9	18.7	25.6	13.1	26	3	16.8
Ward River				No of Occurences Where Temp Exceeded:		
Section	Mean	Max	Min	Upper limit of Growth	Lethal Level	Percentage Tree Cover
11	19.2	24.0	13.5	24	0	33.1
12	17.0	20.6	13.1	13	0	75.6
13	17.4	22.8	12.9	18	0	49.4
14	17.5	22.3	13.5	13	0	66.6
15	18.5	25.9	13.8	23	3	45.8
16	19.4	27.3	13.7	24	10	27.1
17	17.0	23.0	12.4	16	0	60.3

A comparison of mean water temperature and canopy cover is given in figure 3.11. There is a significant correlation between mean water temperature and percentage canopy cover (Pearson correlation, $r = -0.906$, $t = -8.043$, $DF = 14$, $P = <0.05$).

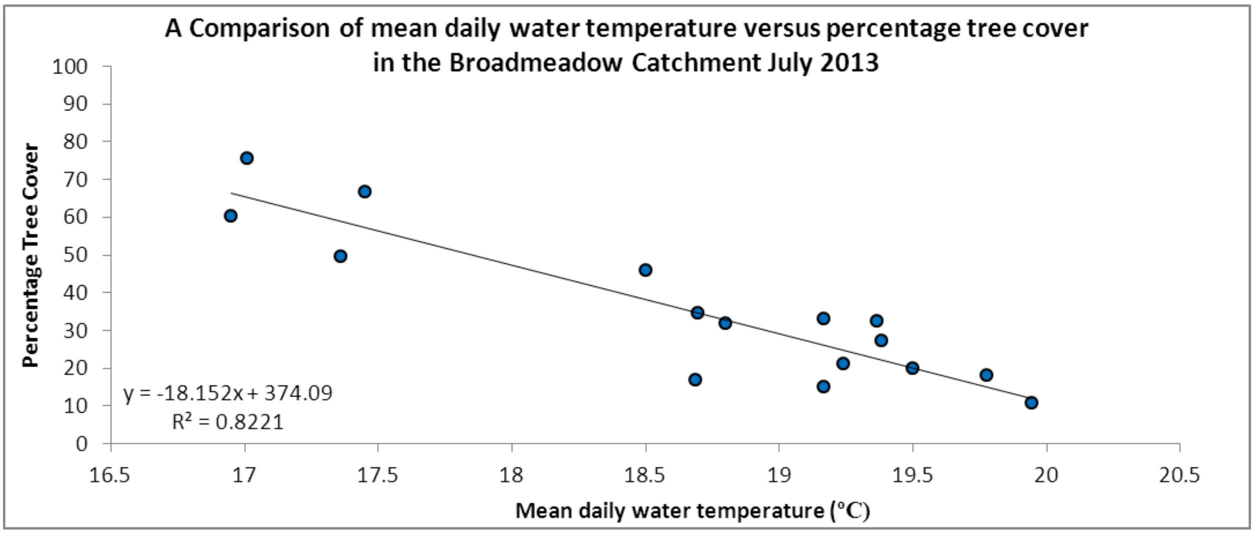


Figure 3.11. Mean daily water temperature for July 2013 versus percentage canopy cover for 16 sites in the Broadmeadow catchment.

The correlation of water temperature and canopy cover is significant in the Broadmeadow catchment, the scarcity (<20%) of canopy cover resulted in significant thermal heating during the extreme thermal event of July 2013. In July 2013 the temperature regime observed in 8 of the 16 sites on the Broadmeadow catchment would be fatal to trout. For ≥10 days in July 2013 water temperatures in the Broadmeadow River exceed the lethal level for trout in 5 of the 9 survey locations. In the Ward River lethal water temperatures were only reached in 2 of the 6 sites.

Reduced levels of riparian canopy cover (<20%) along significant stretches of the Broadmeadow river facilitates significant thermal heating, while significant levels of riparian canopy cover (>45%) on the Ward River facilitates the rivers thermal buffering. Utilising the liner regression from figure 3.11 ($y = -18.152x + 374.09$), it is possible to calculate a theoretical percentage canopy cover which will prevent the mean daily water temperature exceeding the upper limit of growth for trout (19.1ºC). For the Broadmeadow catchment to buffer the mean water temperature to stay below 19.1ºC, ≥29% canopy cover should be maintained on extended river sections.

This study demonstrates the importance of mature riparian corridor in arterially drained lowland rivers. At present there is insufficient canopy cover on the Broadmeadow River to effectively moderate stream temperatures below the incipient lethal limit for trout. Our findings indicate that planting and fencing riparian woodland to achieve ca. ≥29% canopy cover along 1000m reaches, could be effective in preventing current summer maximum water temperatures from exceeding lethal limits for trout. Higher levels of riparian woodland cover are likely to be needed to address future climate warming; as predicted air temperature rise of 4–5ºC (Hulme *et al*., 2002) would likely lead to thermal thresholds for fish being exceeded more frequently and for longer.

3.4 River Corridor Flora

EREP undertook a detailed study of the plant communities occurring within and beside OPW channels from 2008-2012. The main objectives were to record the plant species inhabiting these channels and to assess the impact of OPW maintenance and capital works on these plant communities. As of 2013, EREP has begun a new 5 year programme. A number of monitoring sites have been rolled over from the first 5 year cycle, for the purpose of assessing long term changes associated with capital works and enhanced maintenance (table 2.2 and 2.3). Looking forward, one studies focusing on the effect of fencing on the riverine plant community were started in 2013. The fencing study will be ongoing for 5 years. The objectives and methodology are briefly outlined below.

3.4.1 Stonyford River Fencing Experiment

Evaluate the effectiveness of fencing as a management tool in the rehabilitation of riparian and aquatic vegetation and its consequent impact on the hydromorphology and fish community in a reach of degraded river.

The objective is to quantify the effect of this commonly adopted stream rehabilitation methodology on a small channel. The rehabilitation strategy is to exclude livestock by fencing off the riparian zone, provide cattle drinks and allow the riparian and instream channel to revegetate. The key research issues under investigation are:

- The response of riparian and aquatic vegetation to fencing (2-3 years), and to habitat change in the longer term (3-5 years)
- The response of channel morphology to riparian and aquatic vegetation rehabilitation
- Effect of riparian rehabilitation on flow regime and instream temperature
- The response of the fish community to riparian and aquatic vegetation rehabilitation (2-3 years) and to habitat change in the longer term (3-5 years)

4 Brown Trout Genetics Studies

4.1 Introduction

One of the main challenges in conservation biology is to preserve genetic variability and adaptive variation within and among populations. However, habitat degradation and anthropogenic activity can affect the structure of natural populations causing changes in the spatial dynamics and the evolutionary dynamics shaping wild populations and can pose a serious threat to the natural evolution of biodiversity. The aim of current genetic studies, within the EREP project, is to unravel the genetic structuring of brown trout populations in some of the large freshwater catchments in Ireland, whose habitats have experienced major human-mediated changes over at least two centuries.

This genetics study along with previous studies (EREP 2011 & 2012) carried out through EREP will provide invaluable information in relation to;

- Impact OPW drainage has had on a particular catchment
- Identify productive and less productive trout fisheries which in turn will help in the development of appropriate habitat enhancement plans
- Monitoring the success of certain enhancement projects

4.1.1 Lough Sheelin Catchment

A genetic study of the brown trout populations in the Lough Sheelin catchment was undertaken as part of EREP (Bradley *et al., in press*). The aims of this study were to:

1. To establish the "status quo" in relation to the genetic diversity of trout stocks in L. Sheelin.
2. To establish the extent to which trout from individual sub catchments contribute to the mixed adult stock of the lake.
3. To determine the extent, if any, to which a major arterial drainage programme may have altered the genetic makeup of stocks.
4. To establish "inter-family relationships" between discrete genetic groups of trout within L. Sheelin.

4.1.2 Results

Results suggest the existence of considerable genetic sub-structuring among populations inhabiting the main catchment rivers of Lough Sheelin.

- An interesting "gradient" of genetic structuring has been observed among samples from Mountnugent, Upper Inny and Glore suggesting a clear pattern of isolation by distance and restricted gene flow. Genetic differences among major catchments are likely to be maintained by strong home behaviour.

- Despite considerable stocking history, there is no evidence suggesting major impact in terms of contribution of farm-derived fish to wild stocks. That is, there is no evidence suggesting that past stocking history has had any major effect into the current wild stocks (figure 4.1).

- Taking into consideration potential ecological impact (e.g. competition for food resources and habitat) between farm and wild fish, the value of this practice should be reconsidered.

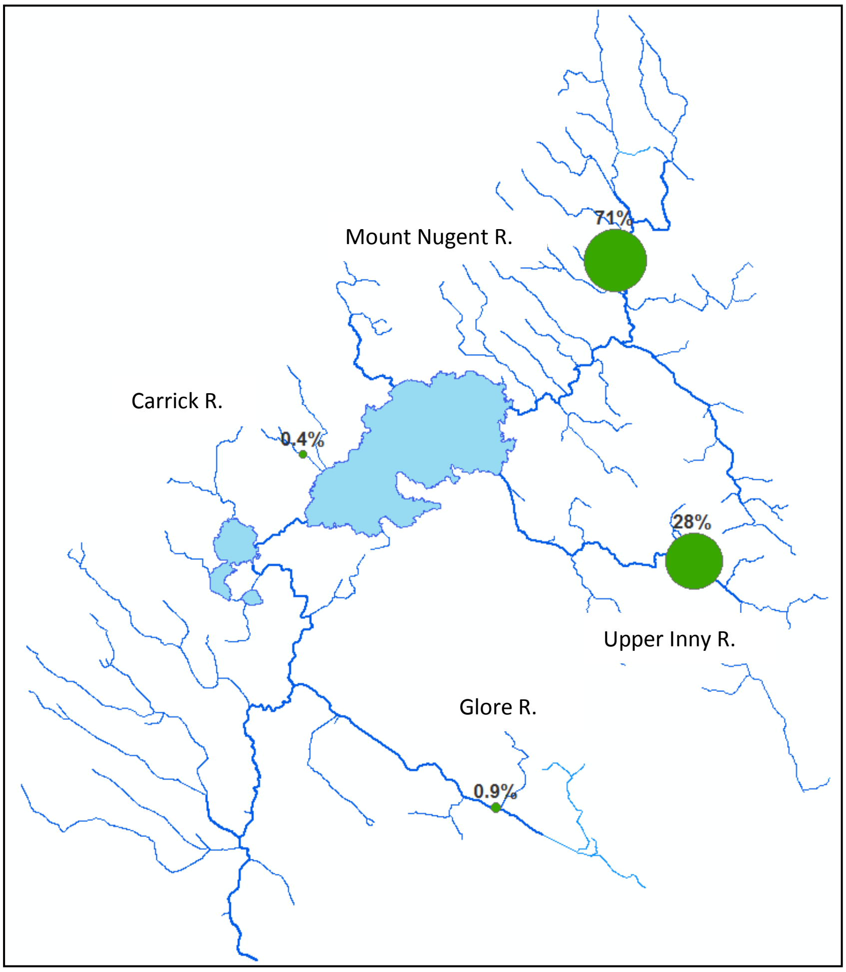


Figure 4.1. Contribution of the individual sub catchments to the adult brown trout stock in Lough Sheelin.

4.2 Further Research

The data now available on brown trout genetics is quite substantial with six individual projects completed, in which OPW contributed, and a further 3 planned for 2014. These projects covered catchments both large and small and have provided fisheries with a great insight to the genetic status of Irish brown trout.

This genetic information is a valuable fisheries tool in that it can aid in the selecting of channels for enhancement projects and can also be used as a monitoring tool to help assess the success of individual projects.

While there are still many OPW catchments which lack genetic information in terms of brown trout the current EREP project will not attempt to assess them all. It is planned that EREP will continue to assist and contribute to the 3 catchments planned for 2014, which are - the Moy, the middle Shannon (Inny and L. Ree) and the Dublin Bay Rivers.

5 Other Scientific Studies

5.1 Lamprey Monitoring

The Minister for Communications, Energy and Natural Resources (DCENR) is responsible, under the Irish enabling legislation for Habitats Directive, for the monitoring and status assessment of the fish species listed In Annex II of that directive. The species listed include the Atlantic salmon, the pollan, shad species and the three species of lamprey found in Ireland. Since 2009, IFI has been undertaking specific catchment-wide studies on lamprey populations to assess distribution and status. Some of these catchments have been wholly or partly arterially drained by OPW under the 1945 Arterial Drainage Act. The geo-referenced data collected in these surveys has been made available to OPW, where relevant, and the relevant catchments are summarised in Table 5.1 (Rooney *et al*., 2013). Specific lamprey studies were not undertaken by IFI in 2013 as part of the EREP study. However, IFI did collect larval lamprey data sets in the Feale, Corrib and Bannow-Ballyteigue catchments (figure 5.1) and this information is summarised below (Rooney *et al*., 2013).

Table 5.1. List of catchments in which larval lamprey surveys have been undertaken by IFI since 2009.

Catchment/Channel	OPW Region	Date of lamprey survey by IFI (CFB)
Bonet/Garavogue	West	2009
Swilly		2009
Finn		2010
Deele		2010
Corrib		2013
Boyle		2012
Feale	Southwest	2013
Mulkear		2012
Maigue		2012
Inny	East	2009
Glyde-Dee		2011
Ballyteigue - Bannow		2013

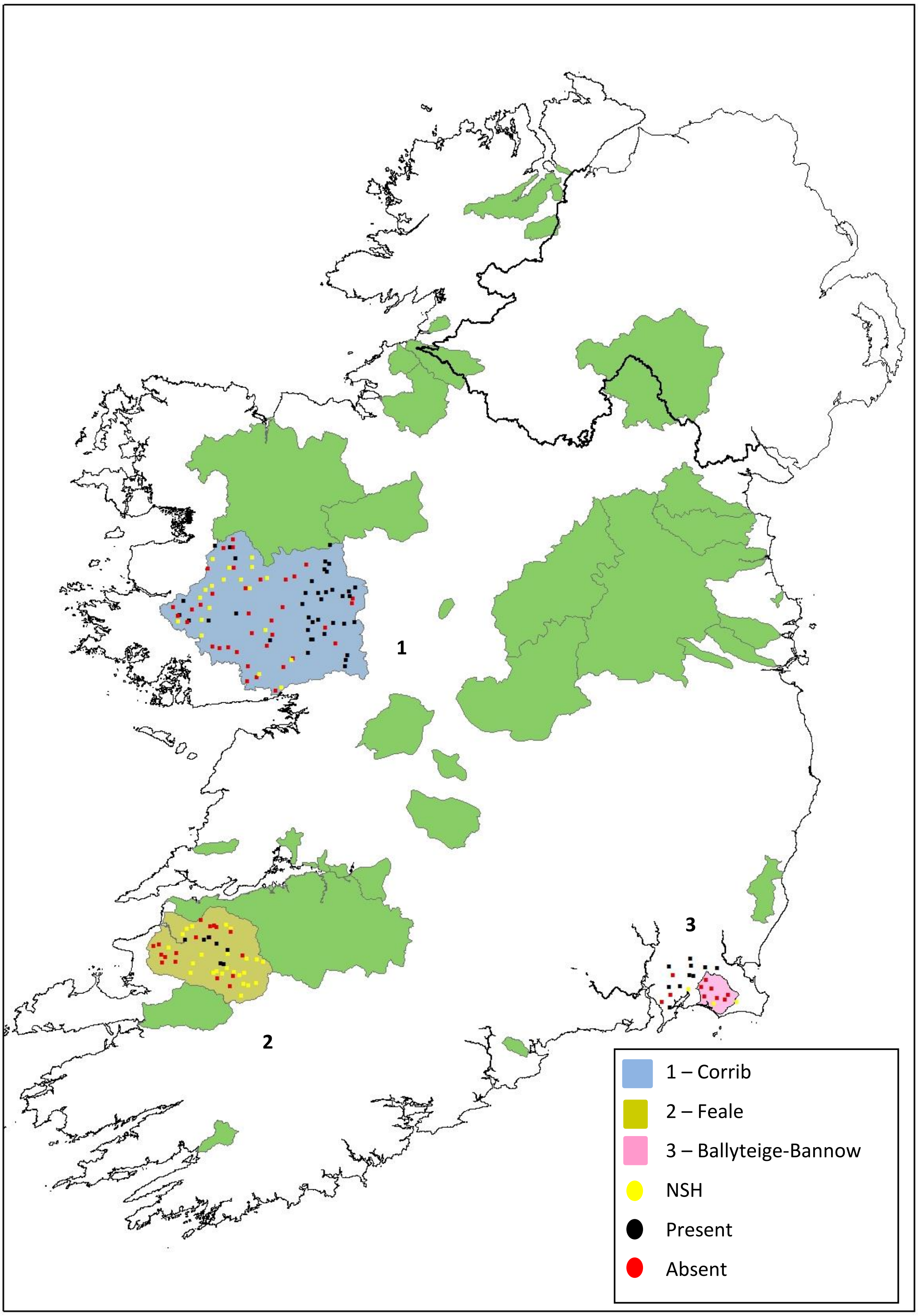


Figure 5.1. Location of lamprey sampling sites within the 3 catchments surveyed as part of the Habitats Directive survey in 2013.

5.1.1 Feale catchment study

The Feale catchment was surveyed previously in 2006 (O' Connor 2006) as a commissioned study for National Parks and Wildlife Service. That survey focussed on larval lamprey status within the areas designated as part of the Lower Shannon Special Area of Conservation (SAC). The IFI survey of 2013 sampled for lamprey ammocoetes throughout the Feale catchment, including channels drained by OPW but lying outside the SAC.

A major feature of the 2013 survey was the large extent of locations lacking suitable habitat i.e. no suitable habitat (NSH). Both the Shannow and Galey catchments were arterially drained by OPW. No ammocoetes were found in either system. Both contained NSH locations and those suitable habitats sampled contained no larval lamprey. The main stem of the Feale contained lamprey ammocoetes at a number of locations sampled. The overall length frequency for the catchment indicated a wide range of size classes, including recent recruitment of young-of-year fish in 2013.

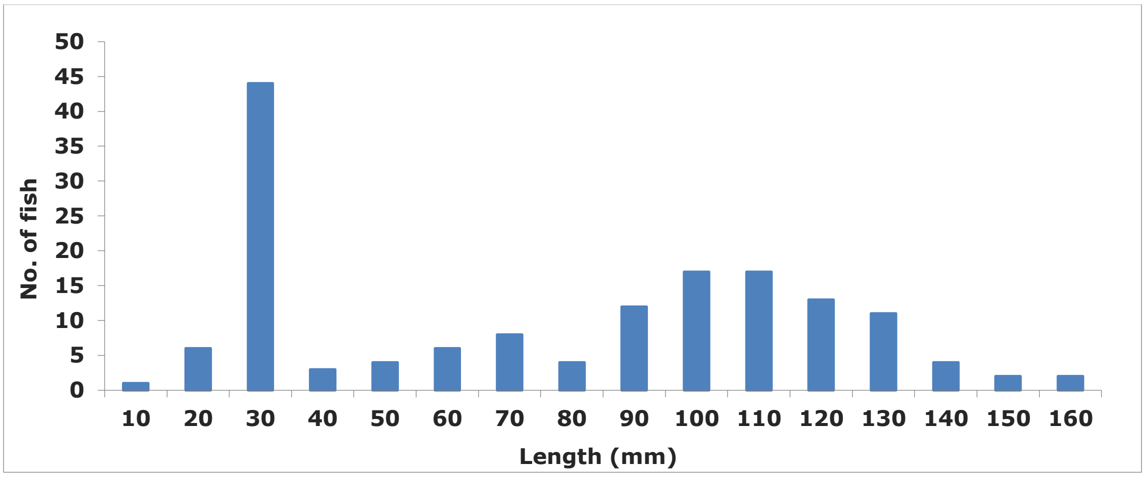


Figure 5.2. Length frequency distribution of all juvenile lamprey (n=154) captured at survey locations throughout the River Feale catchment.

A number of weirs are present in the Feale system. Some of these have been installed by OPW as part of the overall arterial drainage scheme design. Many are not passable by lamprey species. The large weir at Scartleigh, just upstream of the tidal limit functions as part of a potable water abstraction. This structure is impassable to adult sea lamprey, for which this SAC is designated, in low and moderate flow conditions, as a minimum. Many of the weirs represent a fixed transition from bed design levels in tributaries into the main stem channels (see Plate 5.1 below). These are generally impassable to lamprey, and indeed to brown trout. It is likely that these structures cannot be removed, due to their engineering function, but they would require modification e.g. rock ramping or downstream ponding, to permit fish passage.

In the lower sections of many sub-catchments, however, juvenile lamprey remained absent despite the presence of suitable habitat (figure 5.3). This was especially marked in the Brick and Galey sub-catchments (Plate 5.2). Both have undergone extensive arterial drainage, particularly in the case of the latter. The resultant altered flow regimes may be significant in precluding recolonisation and establishment of lamprey populations. Lamprey were absent from the Galey during the 2005 survey, whilst the Brick was not investigated.

Plate 5.1. The confluence of the Rivers Moyvane and Galey, indicating the extent of excavation and deepening in the latter

No sea lamprey larvae were encountered from any of the sites surveyed along the main channel, in contrast to previous surveying (O' Connor 2006). A number of sites along the Feale main channel as well as on the Owbeg were specifically surveyed with sea lamprey in mind, following on directly from positive observations made during the previous survey in 2005. Returning adult sea lamprey on their upstream spawning migration contend with a number of barriers in the lower section of the Feale which have the potential to restrict access to much of the upper catchment.

Plate 5.2. The heavily modified Douglas River, north of Listowel

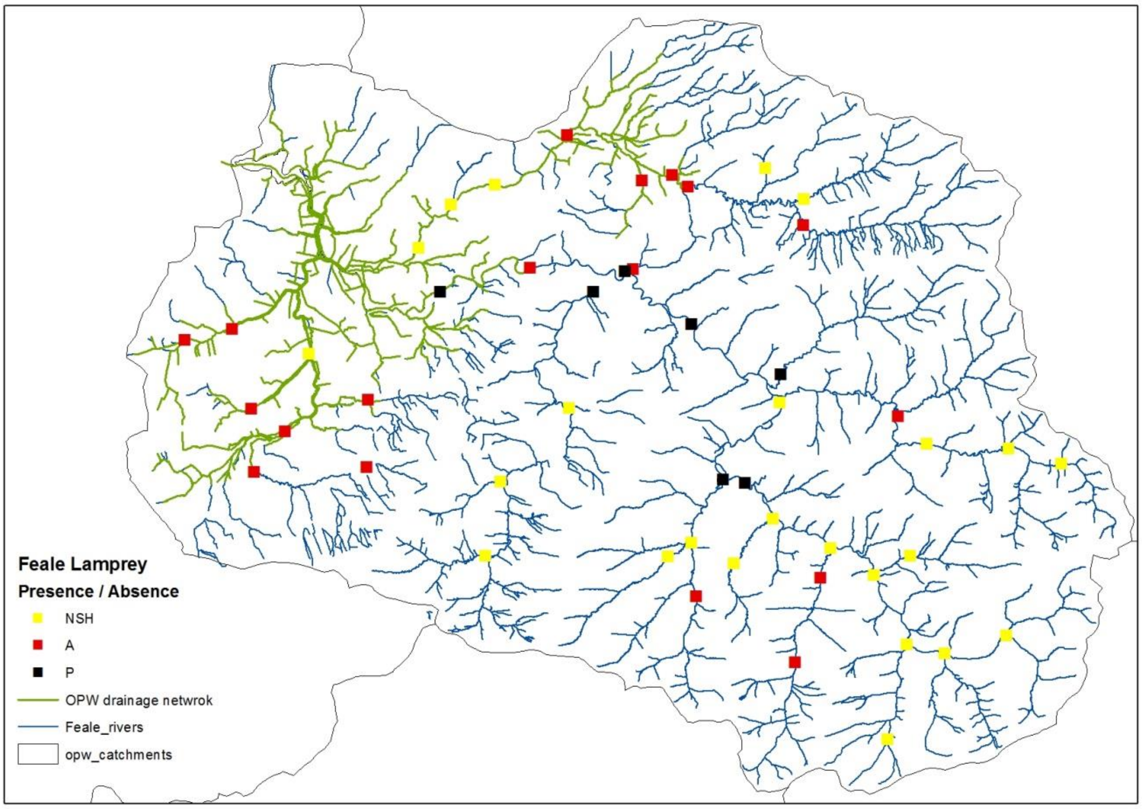


Figure 5.3. Presence / absence of lamprey within the Feale catchment, 2013.

5.1.2 Corrib Survey

The Corrib survey encompassed the entire catchment, including the full extent of the Corrib drainage scheme (figure 5.4 and 5.5). There was a clear distinction between outcomes from the west and east sides of the catchment with a paucity of suitable habitat on the west and a high level of larval lamprey occurrence on the east side. These outcomes are not surprising in view of the topography, with high elevation and steep channel with large particle sizes of cobble and gravels common on the west side. This terrain is not conducive to formation of fine-grained sediment and its deposition to form potential larval lamprey habitat. Ammocoetes were recorded at a small number of sites where fine sediment had accumulated, such as lower riverine reaches where back-up of water from one of the lakes permitted deposition.

On the east side of the catchment no ammocoetes were found in the Cregg, Black or Cross systems. The largest catchment within the Corrib system is formed by the Clare River and its tributaries and this system has been arterially drained. Almost all of the sites examined in this system contained lamprey ammocoetes.

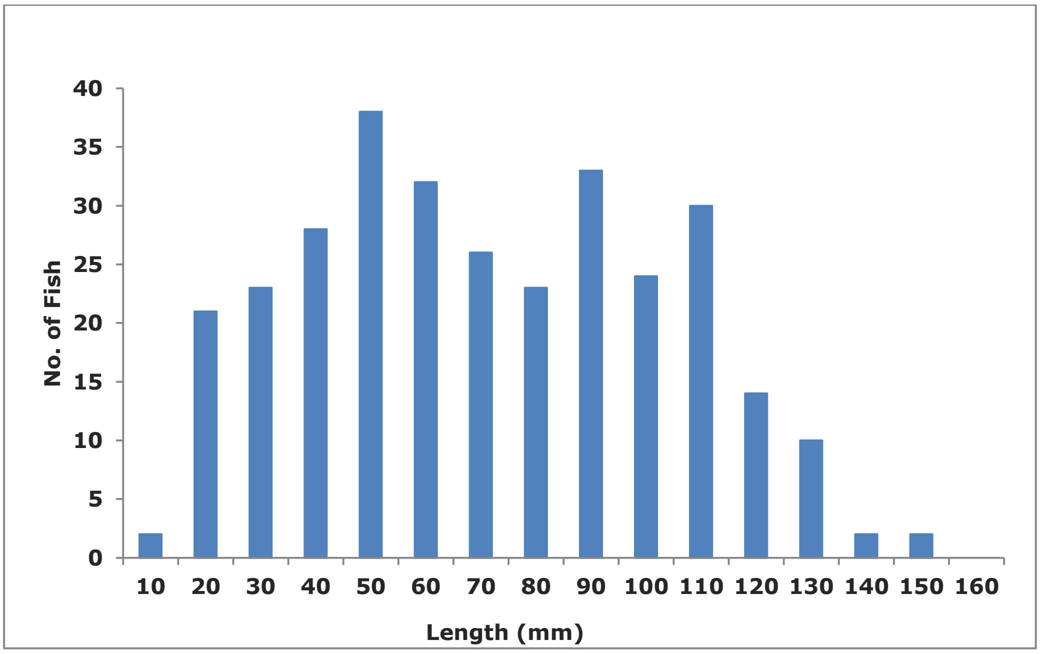


Figure 5.4 Length frequency distribution of all juvenile lamprey (n=308) captured at survey locations throughout the Corrib catchment

A wide span of size classes was recorded from the catchment as a whole, indicating a continuous recruitment and presence of a range of age groups. Modal peaks were recorded at size classes of 50 mm, 90 mm and 110 mm.

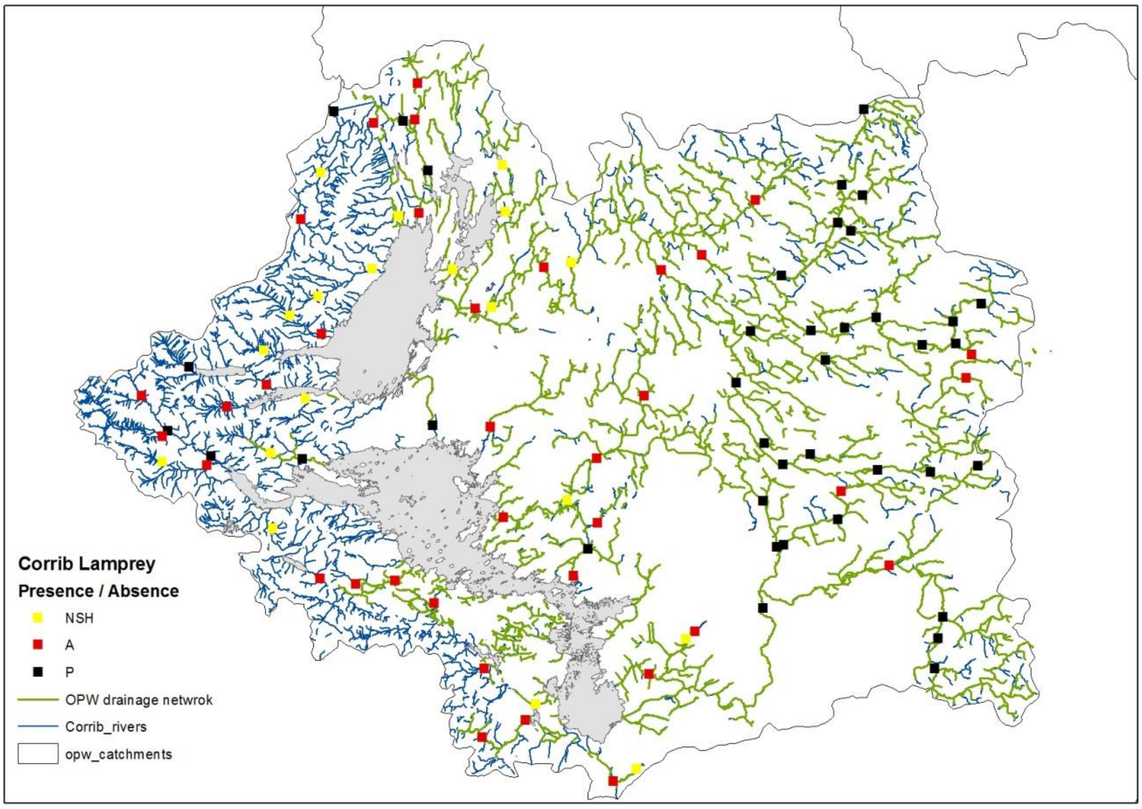


Figure 5.5. Presence / absence of lamprey within the Corrib catchment, 2013.

5.1.3 Ballyteige-Bannow survey

The Ballyteige-Bannow hydrometric area is located in the south east of Ireland along the Wexford coast. No prior information was available on the status of larval lamprey within the catchment (Kurz and Costello 1999). The Corock River and its tributary the Mulmontry, drain the centre of the hydrometric area. This river discharges at Wellington Bridge which lies at the north of Bannow Bay. The Owenduff and Tintern Abbey Stream also discharge to Bannow Bay. The Bridgetown River flows through the east of the catchment to Ballyteige Bay.

In total twenty three sites were sampled for juvenile lamprey, and 8 of these were within the Ballyteige sub basin with only 3 being within actual drained channels. Of these three presented with

No Suitable Habitat (NSH). Lamprey were present at 10 of the sites which presented with suitable habitat (figure 5.7). Of the eight sites within Ballyteige 7 recorded no lamprey and 1 did not have suitable habitat – no lamprey were recorded within the Ballyteige sub-basin during this survey.

In total 162 juvenile lamprey were captured over the course of the survey (figure 5.6). The length of fish varied between 30 and 126 millimetres. The length of fish recorded indicated a distribution of fish across all size classes indicating a good population structure. The smaller sizes represent young of the year and indicate recent recruitment. The larger fish demonstrate the possibility of future spawning events to continue the population numbers.

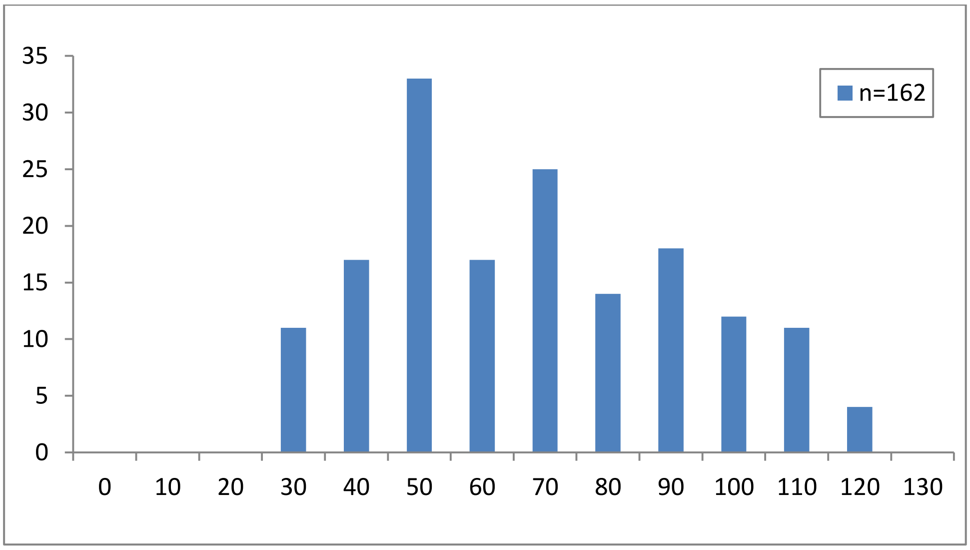


Figure 5.6. Length frequency of juvenile lamprey captured across the Ballyteige Bannow hydrometric area.

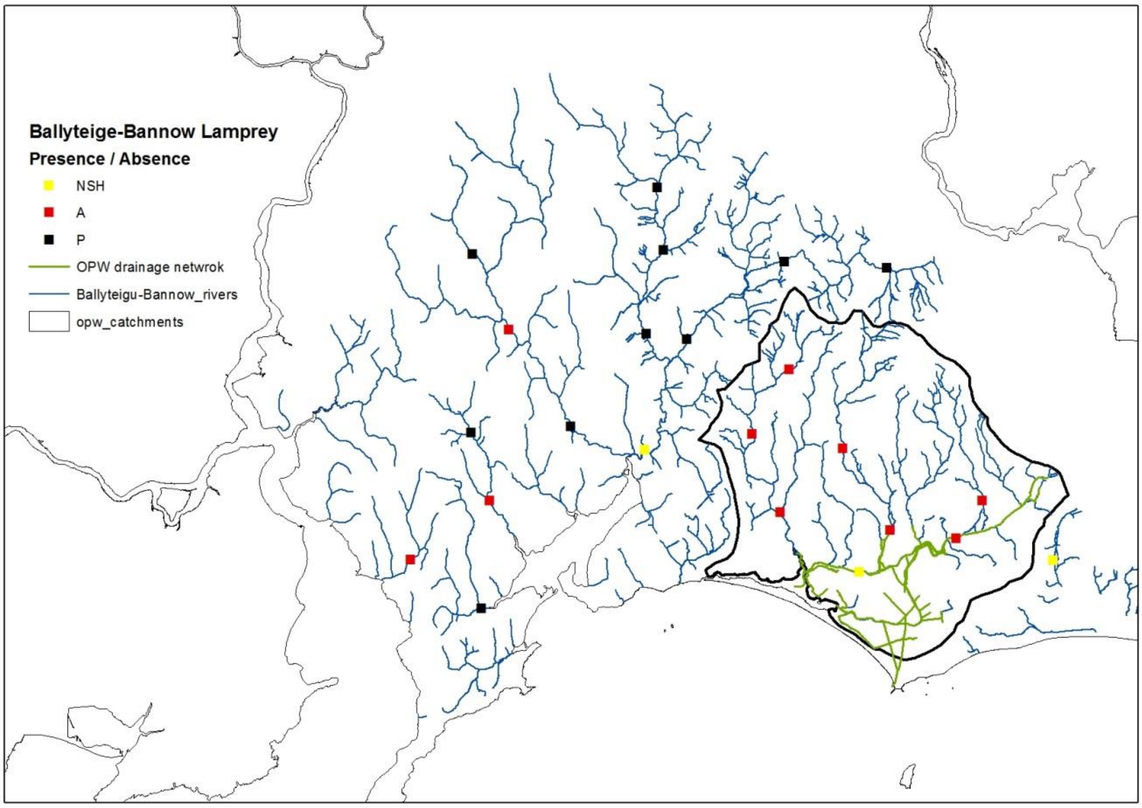


Figure 5.8. Presence / absence of lamprey within the Ballyteige-Bannow catchment, 2013.

5.1.4 Article 17 reporting, under Habitats Directive, to EU.

The assessment of each lamprey species was summarized under the headings of 'Range' – 'Population' – 'Habitat' – 'Future Prospects' and 'Overall Assessment of Conservation Status'. The traffic-light colour coding of green-orange-red was used to emphasise the outcome of the assessment (Table 5.2).

In view of issues in regard to speciation of river-and brook lamprey at the larval or ammocoete stage, the two species were merged in regard to status assessment for Ireland. The situation for river/brook lamprey was considered Favourable in respect of all attributes. However, a much less satisfactory situation presented itself for the sea lamprey. The range was considered 'Inadequate'. It is known from the literature that sea lamprey can migrate long distances into freshwater to spawn. This is considered an evolutionary advantage in maximizing access to downstream areas of fine sediment needed by the ammocoetes over the several years of life prior to developing into adult fish.

Table 5.2 Summary Conservation Status for lamprey species in Ireland 2007-12 based on IFI data.

Attribute	River/Brook lamprey	Sea lamprey
Range	Favourable	Inadequate
Population	Favourable	Bad
Habitat	Favourable	Favorable
Future Prospects	Favourable	Bad
Overall assessment of Conservation Status	Favourable	Bad

5.2 Crayfish Studies

As part of the 2013 EREP project crayfish monitoring was carried out on the Brosna (Brosna scheme), Glore (Inny scheme) and Robe (Corrib – Mask scheme) river. These channels have been monitored over several years thus allowing us to develop long term datasets in relation to crayfish populations pre maintenance and for several years post maintenance. Details and results for these channels have been provided in previous EREP annual reports (EREP, 2008-2012).

Zero crayfish were found in the Brosna or Glore survey sites in 2013. The findings from the Robe form part of a longer-term comprehensive study that is examining the impact of instream works designed to facilitate brown trout populations.

6 EREP Audit Programme

6.1 Introduction

Environmentally sensitive maintenance is seen by OPW as the way forward for all routine maintenance operations. This standard approach to maintenance applies to all channels at all times of the year. One of the objectives of EREP requires that a number of machine crew audits be carried out annually. Such audits will inform OPW to the level of compliance with these environmental measures. Audits will be undertaken internally by the Environmental Unit of OPW and externally by the EREP team of IFI. External auditing covers a minimum of one third of all OPW drainage machine crews, annually. As drainage maintenance occurs throughout the whole year IFI auditing will also be spread out across the year. The majority of audits will, however, take place during the summer/autumn season or 'fishery open window', as this is the optimal time for implementing fishery instream works.

Machine crew auditing provides an opportunity for assessing the level of compliance with implementing OPW's environmental maintenance procedures. It also allows for further discussion and demonstration of certain maintenance options. It also provides OPW with up-to-date information on the level of compliance being achieved by their machine drivers and whether their staff are implementing as standard the environmental measures and protocols developed for routine drainage maintenance. Audit results are returned to OPW on a quarterly basis.

6.2 2013 Audit Results

In 2013, IFI carried out 31 external audits (table 6.1), representing approximately 48% of all OPW maintenance crews. Audit outcomes are presented in figure 6.1. OPW has developed a rating system, based on the score obtained at each audit visit. This rating generates a series of broad categories for rapid assessment of outcomes (table 6.2).

Table 6.1. Number of audits carried out in each OPW Region, 2013.

		East	West	South West
Compliance Rating		**2013**	**2013**	**2013**
0-49	unacceptable		3	
50-59	poor	2	1	
60-70	acceptable		1	
71-84	good	2	3	2
85-100	very good	11	1	5
Total audits		**15**	**9**	**7**

Table 6.2. Summary of 2013 compliance ratings.

OPW % Rating	Category	2013 over-all %	No. of Audits
0 - 49	unacceptable	10	3
50 - 59	poor	10	3
60 - 70	acceptable	3	1
71 - 84	good	22	7
85 - 100	very good	55	17

The 2013 IFI audits results show 6 audits were below the acceptable rating of 60% (within the category of unacceptable and poor). This represents 20% of all audits carried out (table 6.2).

The overall mean compliance (audit score) for each OPW Region is provided in table 6.3.

Table 6.3. Summary of 2013 over-all % compliance ratings.

OPW Region	Mean % compliance
East	86.4
West	60.3
Southwest	88.7
Bench marking contractor	63

When the 10 protocols (10 Steps) are broken down and reviewed it becomes clear that certain protocols are still not being implemented to a standard that is acceptable (figure 6.1). The average compliance value for all the instream protocols are below acceptable. Further training and guidance for OPW machine drivers is required in these areas. Indeed regular training in environmental river enhancement and the 10 Steps would be recommended for all drivers / foremen on a 3 or 5 year cycle to help ensure machine driver compliance in relation to OPW's environmental SOP's and protocols.

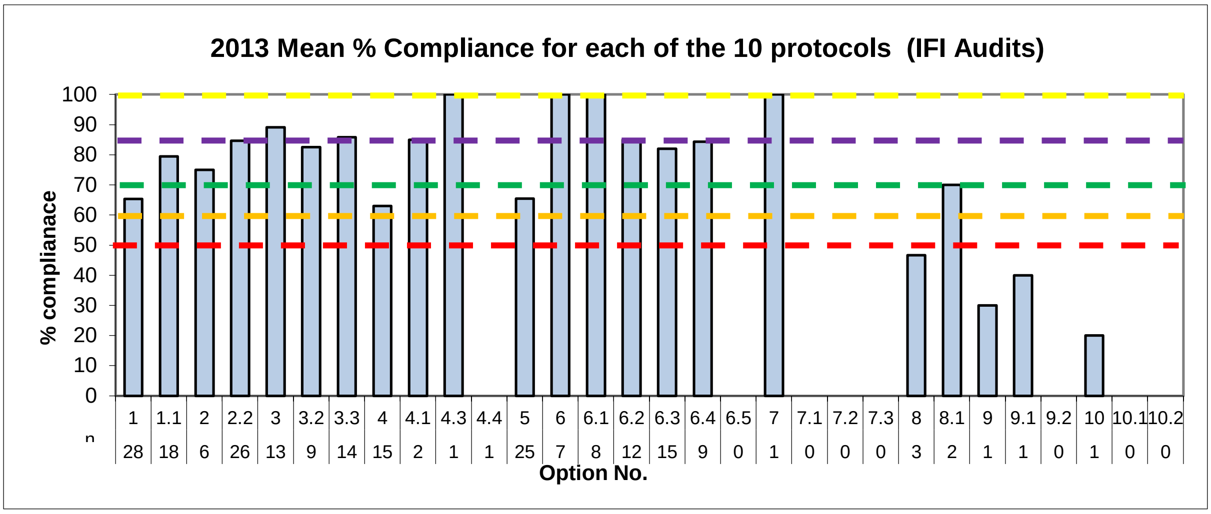


Figure 6.1. Mean compliance of each of the 10 Protocols.

In 2013 OPW carried out a small number of bench marking exercises in relation to drainage maintenance. This is where OPW contract out drainage maintenance operations on a number of channels / schemes to private contractors which then allows them to bench mark their drainage maintenance operations with the private sector. One such bench marking exercise was carried out on the Knockcroghery Scheme, Co. Roscommon. As part of this exercise two IFI EREP audits were completed. The results of these audits were 70% and 56% respectively.

IFI report back to OPW on all EREP audits. This is usually done within a two week period after the initial EREP audit whereby copies of the completed audit forms and photographs are submitted to the relevant OPW engineer. IFI also submits the EREP audit results on a quarterly basis for OPW senior management meetings. A summary of the 2013 report is provided in table 6.4.

Table 6.4. Summary of OPW Regional compliance for each protocol, 2013.

PROTOCOL NUMBER	ENVIRONMENTAL MAINTENANCE PROTOCOLS	COMPLIANCE %		
		EAST	WEST	SOUTH WEST
1	Protect Bank Slopes	80	46	87
2	Restrict maintenance to channel	83	67	93
3	Spoil Management	88	78	95
4	Selective Vegetation Removal	80	60	86
5	Leave Sections Intact	83	45	77
6	Management of Trees	98	41	90
7	Manage Berms to Form 2 Stage Channels	100		
8	Replace Stones and Boulders	20	57	90
9	Working in Gravel Bed Channels	40	30	
10	Re-profile Channel Bed		20	
	Total Audits	15	**9**	**7**

In 2014 it is planned to review the current EREP Audit form that both IFI and OPW use. Both agencies feel that current form does not adequately assess both the work carried out by OPW machine drivers or the environmental issues being addressed.

7 River Hydromorphology Assessment Technique (RHAT)

The Water Framework Directive (WFD) requires information on hydromorphological conditions, along with biological quality and physico-chemical conditions, in order to determine the ecological status of any given waterbody. A classification of 'High Ecological Status' cannot be assigned to a water body unless the hydromorphological conditions are high also. If the hydromorphological condition of a waterbody has not been determined and the system has been impacted by drainage then that catchment is deemed to be "probably at risk". Therefore it has become an additional objective of EREP to provide information on hydromorphology status in relation to OPW channels.

The River Hydromorphology Assessment Technique (RHAT) monitoring system has been approved as the appropriate method to determine hydromorphological status of a channel and is being used by the EPA and the NIEA (Northern Ireland Environment Agency) to assess hydromorphological (hydromorph) condition at those sites identified for WFD monitoring.

RHAT surveys score a site based on eight individual channel attributes (NIEA, 2009). These scores then provide a hydromorph score which in turn determines the WFD class of that site (table 7.1).

Table 7.1. Conversion of RHAT scores to WFD Class.

Hydromorph Score	WFD Class	RHAT Score
> 0.8	high	4
> 0.6 - 0.8	good	3
> 0.4 - 0.6	moderate	2
> 0.2 - 0.4	poor	1
< 0.2	bad	0

In 2013 approximately 15 RHAT surveys were carried out. Where possible EREP aims to undertake RHAT surveys pre works, both capital and enhanced maintenance. Post surveys in some cases are still outstanding due in part to works not being fully implemented yet.

Of these attributes scored there is very little enhancement potential for floodplain connectivity or with riparian land cover. Bank structure & stability and channel form & flow type are two areas where improvements could be achieved through EREP.

8 References

Bradley, C.R., Prodohl, P., Delanty, K. & O'Grady, M. (*in press).* Lough Sheelin – Population Structure, Genetic Stock Identification & Potential Impact of Farm Stocking.

Broadmeadow, S. B., Jones, J. G., Langford, T. E. L., Shaw, P. J., & Nisbet, T. R. (2011). The influence of riparian shade on lowland stream water temperatures in southern England and their viability for brown trout. River Research and Applications, 27(2), 226-237.

Caffrey, J.M., Hayden B. and Walsh T. (2007) Dace (*Leuciscus leuciscus* L.): an Invasive Fish Species in Ireland. Irish Freshwater Fisheries, Ecology and Management, No. 5. Central Fisheries Board, Dublin, Ireland.

Department of Environment, Food & Rural Affairs (DEFRA). 2005. Final Report, Executive Summary. Baseline Scanning Project prepared by Talwar, R and Schultz, W. of Fast Futures for DEFRA's Horizon Scanning and Futures Programme and the Strategy and Sustainable Development Directorate. Appendix E. Table I. High priority trends. http://horizonscanning.defra.gov.uk/ViewDocument_Image.aspx?Doc_ID-195 (accessed 4 January 2010).

Elliott JM, Hurley MA, Fryer RJ. 1995. A new, improved growth model for brown trout, *Salmo trutta*. Functional Ecology 9: 290–298.

Hulme M, Jenkins GJ, Lu X, Turnpenny JR, Mitchell TD, Jones RG, Lowe J, Murphy JM, Hassell D, Boorman P, McDonald R, Hill S. 2002. Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research, School of environmental Sciences, University of East Anglia, Norwich, UK. 120pp

I.F.I. (2009). Environmental River Enhancement Programme Annual Report, 2008. Inland Fisheries Ireland, Dublin, Ireland.

I.F.I. (2010). Environmental River Enhancement Programme Annual Report, 2009. Inland Fisheries Ireland, Dublin, Ireland.

I.F.I. (2011). Environmental River Enhancement Programme Annual Report, 2010. Inland Fisheries Ireland, Dublin, Ireland.

I.F.I. (2012). Environmental River Enhancement Programme Annual Report, 2011. Inland Fisheries Ireland, Dublin, Ireland.

Kelly, F., Champ, T., McDonnell, N., Kelly-Quinn, M., Harrison, S., Arbuthnott, A., Giller, P., Joy, M., McCarthy, P., Cullen, P., Harrod, C., Jordan, P., Griffiths D., & Rosell, R., (2006) *Fish stock assessment for the water Framework Directive: investigation of the relationship between fish stocks ecological quality ratings (Q-values) environmental factors and degree of eutrophication*. Environmental RTDI Program 2000 – 2006. Environmental Protection Agency (2000-MS-4-M1).

Kurz, I. and Costello, M. J. 1999 An outline of the biology, distibution and conservation of lampreys in Ireland. *Irish Wildlife Manuals*, No. 5, 27pp, Dublin, Duchas – The Heritage Service.

Marine Institute (1999) Ireland's Marine and Coastal Areas and Adjacent Seas: An Environmental Assessment. Dublin, Ireland. 388 pp.

N.I.E.A. (2009). River Hydromorphology Assessment Technique (RHAT) - Training Guide. Northern Ireland Environment Agency, Lisburn, Northern Ireland.

O'Connor W. (2006) A baseline survey of juvenile lamprey populations in the River Feale catchment. Irish Wildlife Manuals No. 22. National Parks and Wildlife Service. Dept. of Environment, heritage and local Government, Dublin.

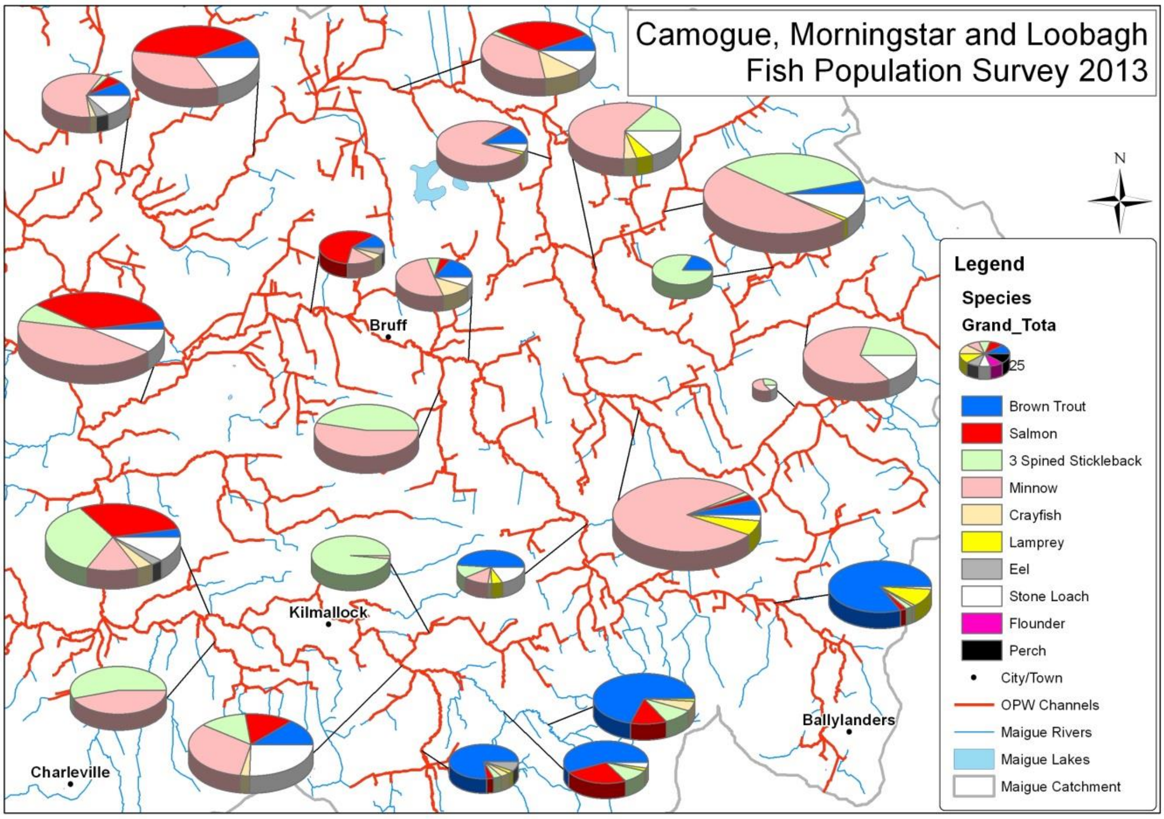
O.P.W. (2011). Environmental Management Protocols and Standard Operating Procedures, Arterial Drainage Maintenance Service, Office of Public Works.

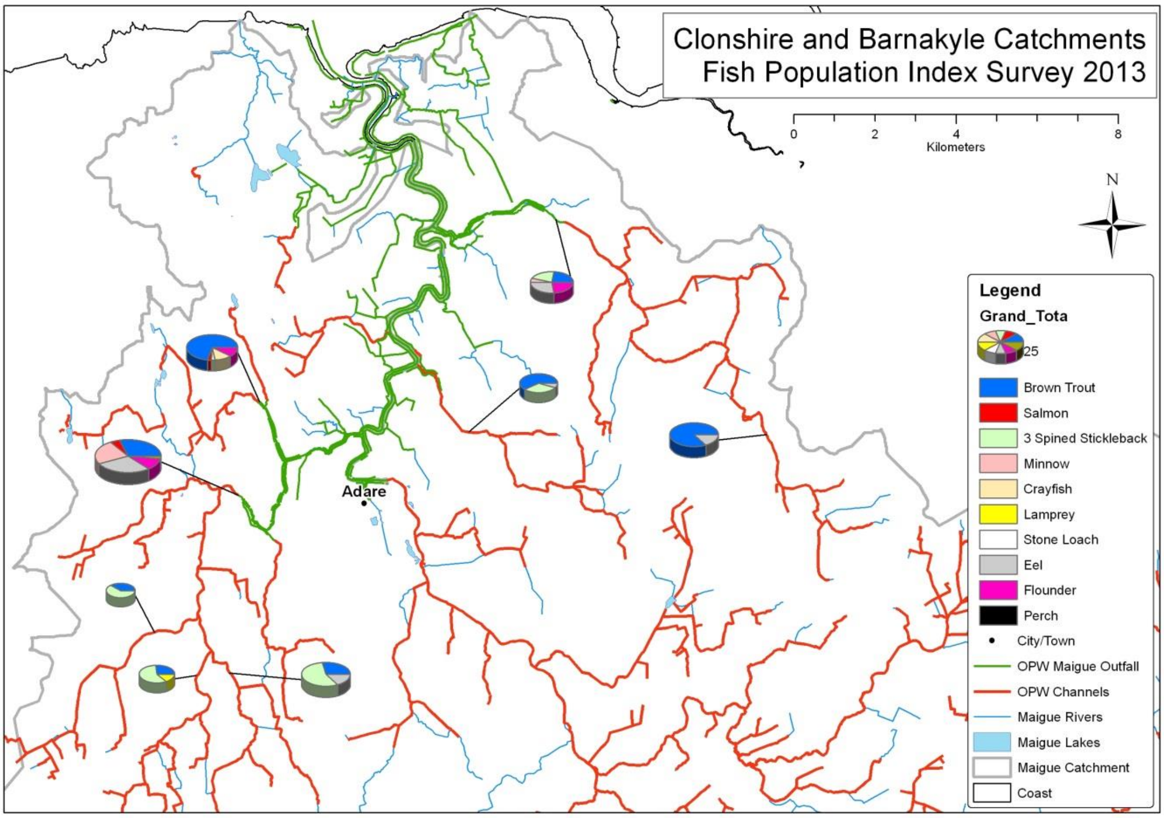
O'Reilly, P. (2002) Rivers of Ireland, a flyfisher's guide (5^{th} Edition). Merlin Unwin Books, Shropshire, UK.

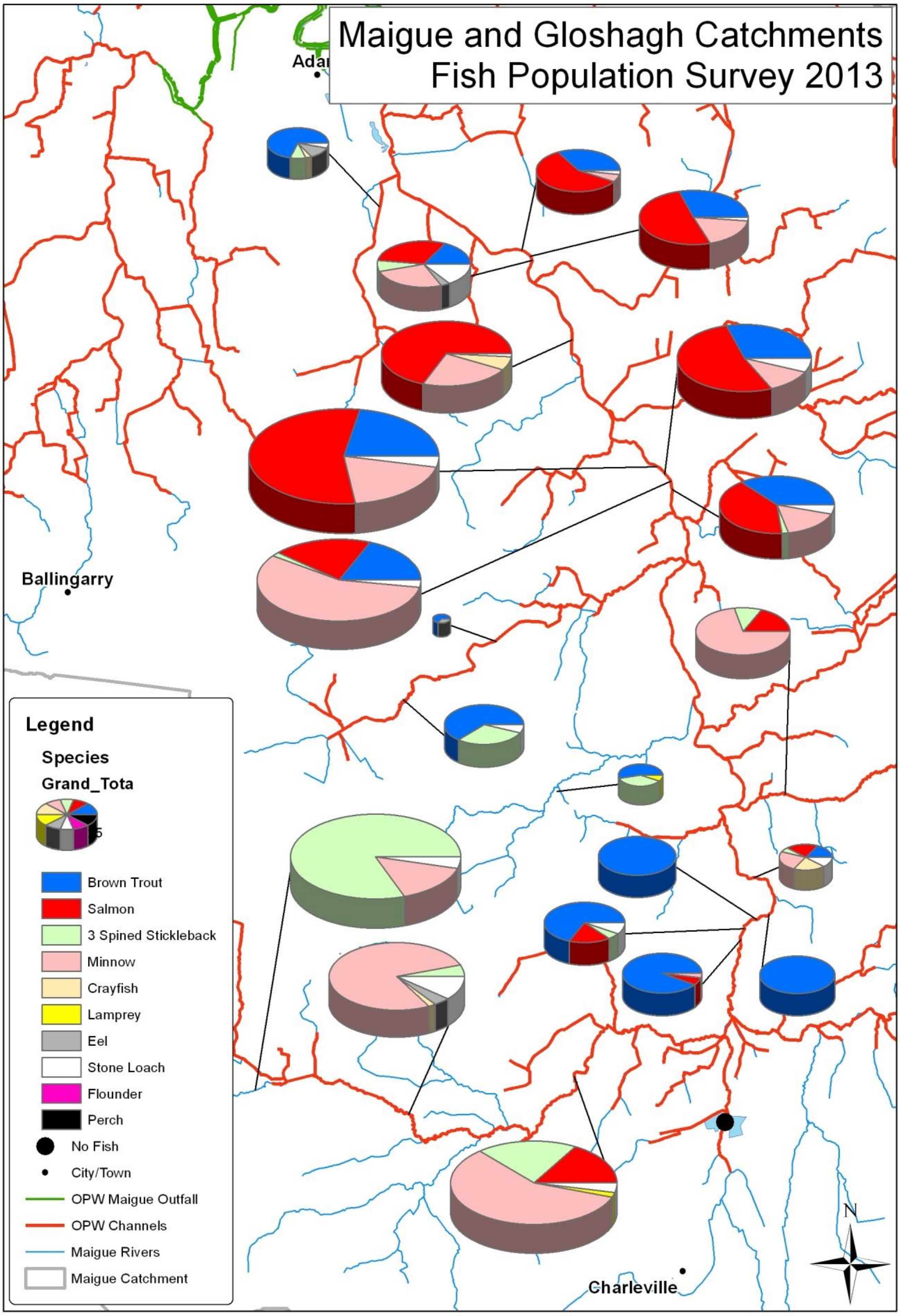
Rooney, S.M., O'Gorman, N.M., Cierpial, D. and King, J.J. (2014) National Programme: Habitats Directive and Red Data Book Species Executive Report 2013. Inland Fisheries Ireland, Swords Business Campus, Swords, Co. Dublin, Ireland.

9 Appendix

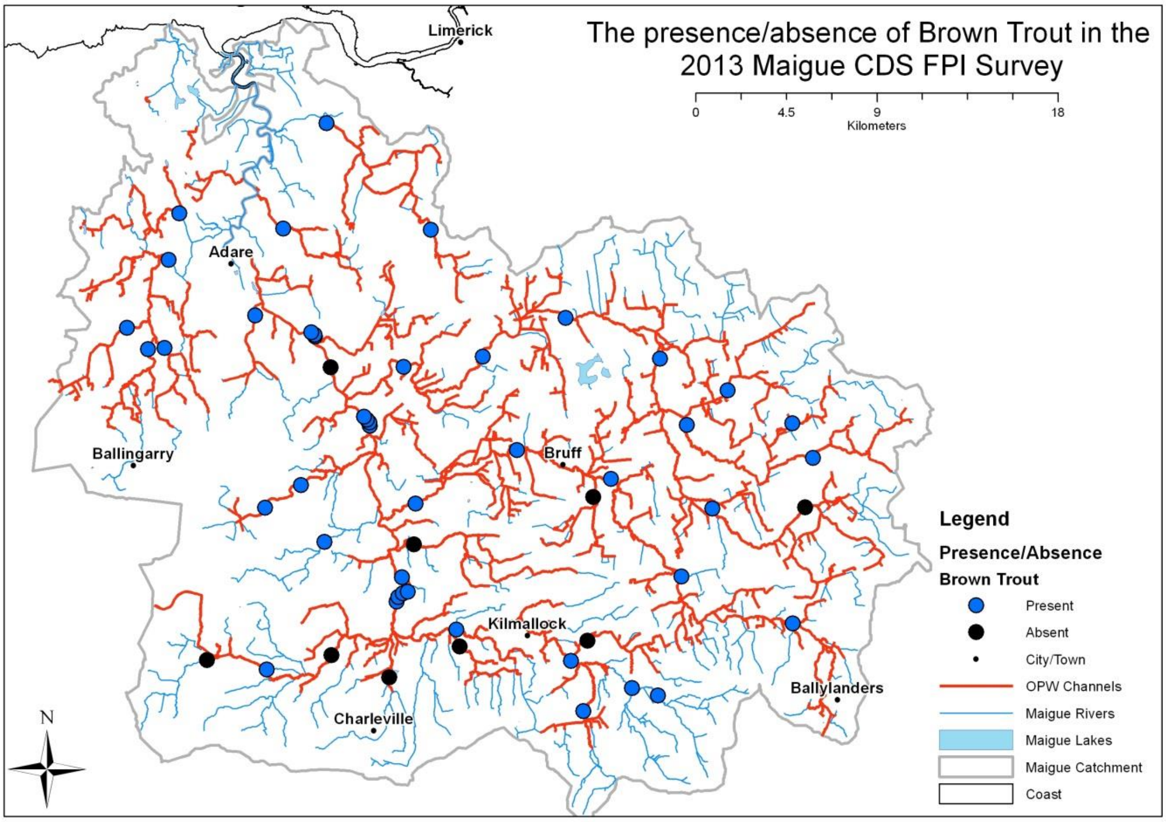
Appendix 1A – C: Results of the 10 minute electrofishing survey in Maigue catchment- distribution and abundance of all species recorded.


Camogue, Morningstar and Loobagh
Fish Population Survey 2013
Legend
Species
Grand_Tota
25
Brown Trout
Salmon
3 Spined Stickleback
Minnow
Crayfish
Lamprey
Eel
Stone Loach
Flounder
Perch
City/Town
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Bruff
Kilmallock
Charleville
Ballylanders
N

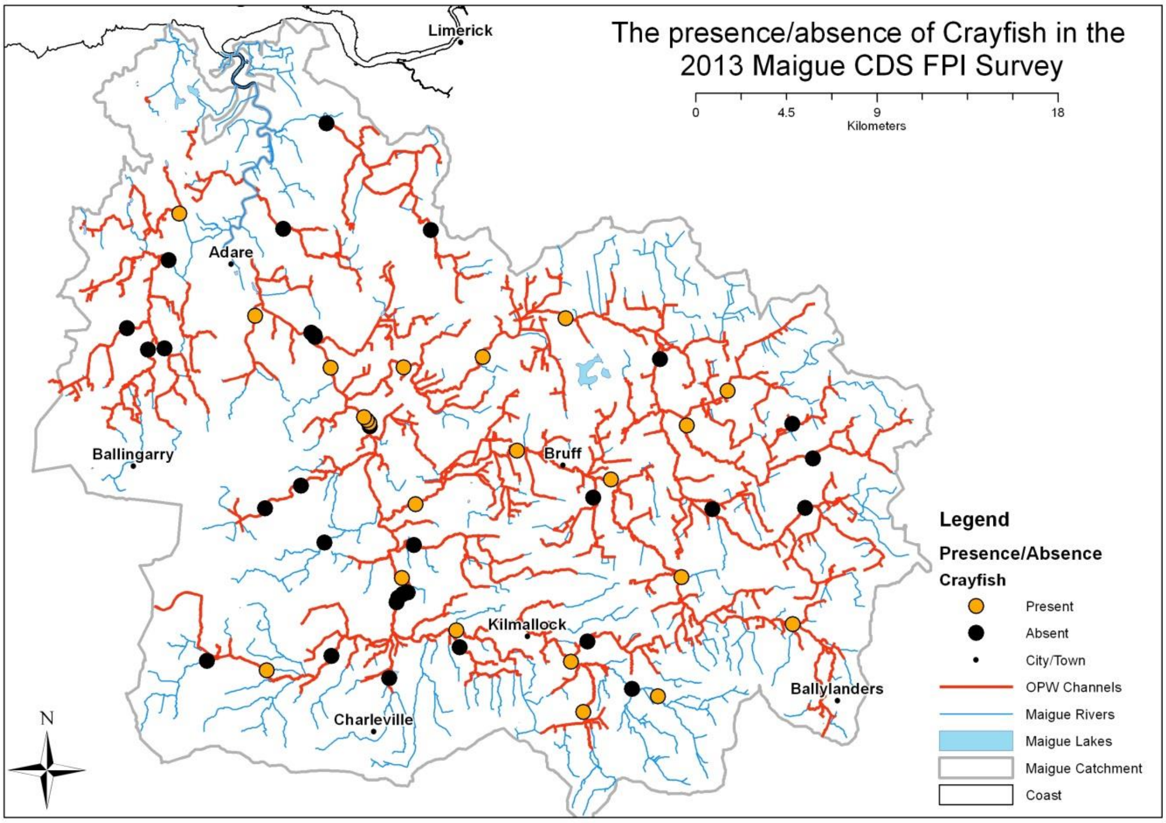

Clonshire and Barnakyle Catchments
Fish Population Index Survey 2013
0
2
4
8
Kilometers
N
Legend
Grand_Tota
25
Brown Trout
Salmon
3 Spined Stickleback
Minnow
Crayfish
Lamprey
Stone Loach
Eel
Flounder
Perch
City/Town
OPW Maigue Outfall
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Coast
Adare


Maigue and Gloshagh Catchments
Fish Population Survey 2013
Ballingarry
Charleville
Legend
Species
Grand_Tota
Brown Trout
Salmon
3 Spined Stickleback
Minnow
Crayfish
Lamprey
Eel
Stone Loach
Flounder
Perch
No Fish
City/Town
OPW Maigue Outfall
OPW Channels
Maigue Rivers
Maigue Catchment
N

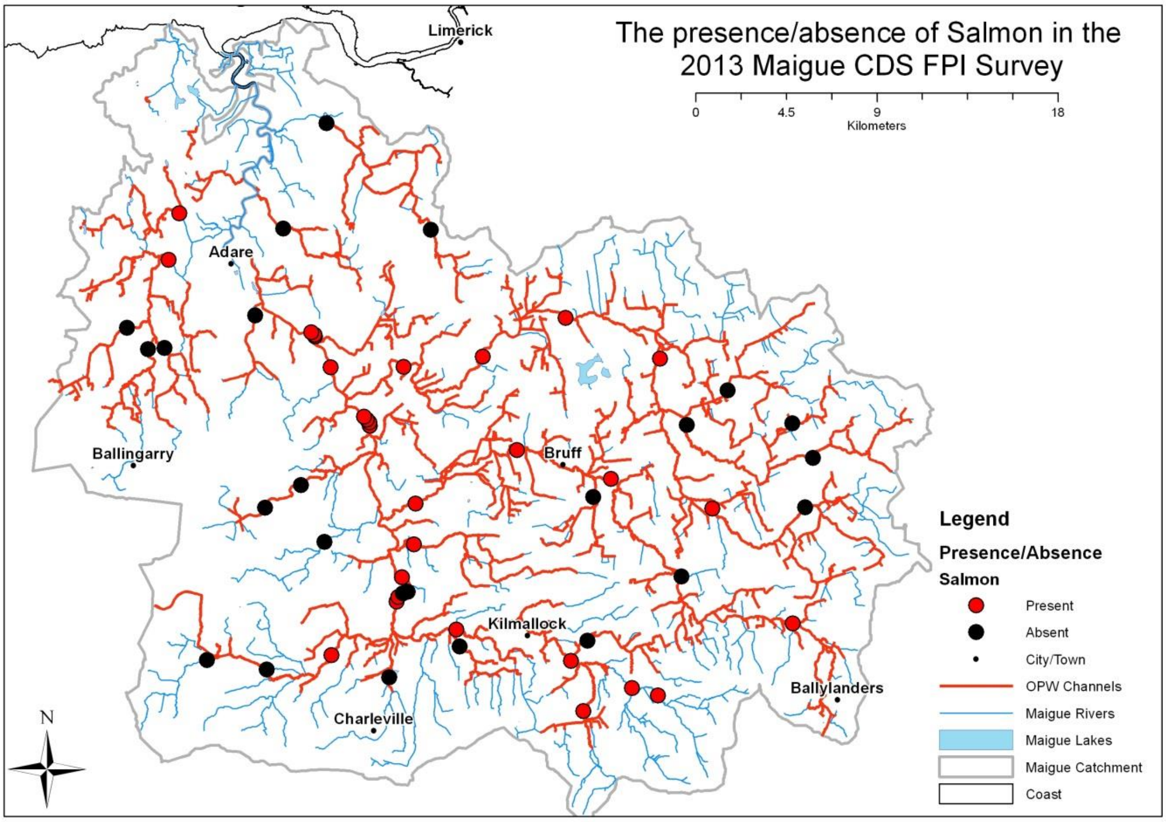
Appendix 2D – G Presence / Absence of main species recorded in Maigue electric fishing survey

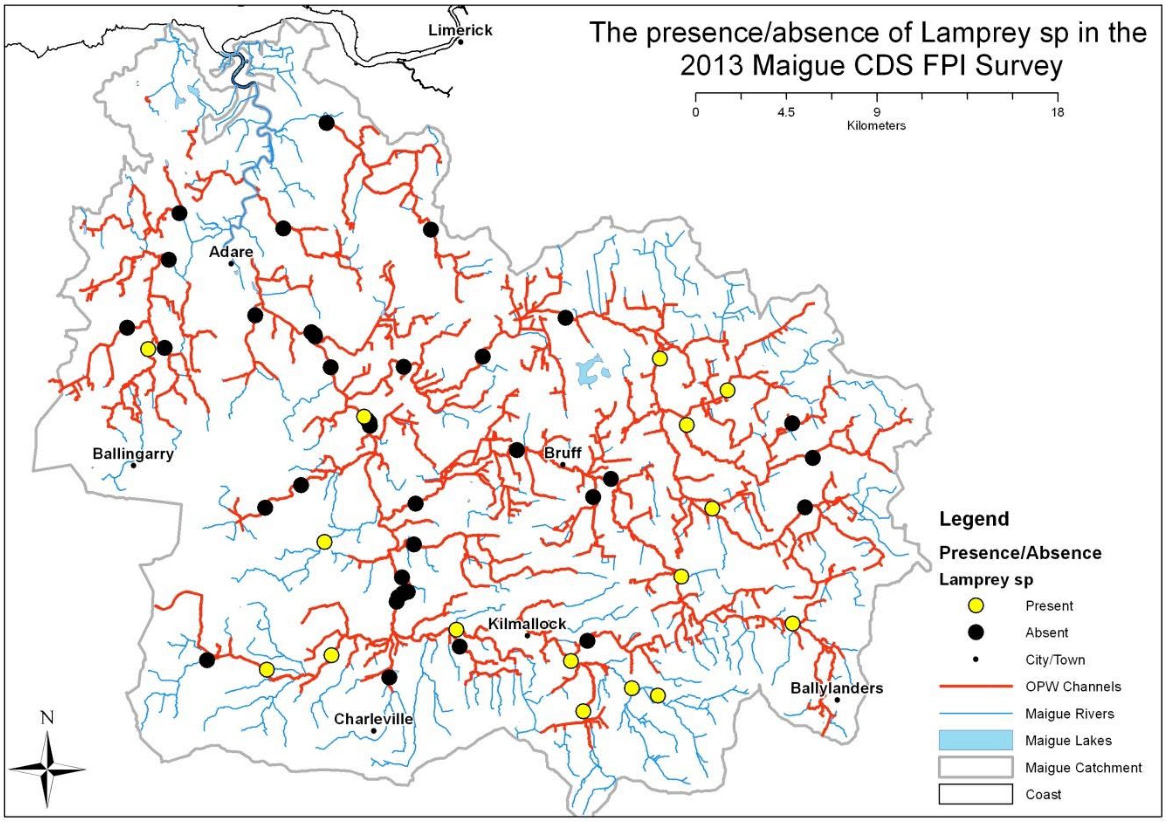


The presence/absence of Brown Trout in the 2013 Maigue CDS FPI Survey
0
4.5
9
18
Kilometers
Limerick
Adare
Ballingarry
Bruff
Kilmallock
Ballylanders
Charleville
N
Legend
Presence/Absence
Brown Trout
Present
Absent
City/Town
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Coast



The presence/absence of Crayfish in the 2013 Maigue CDS FPI Survey
0
4.5
9
18
Kilometers
Limerick
Adare
Ballingarry
Bruff
Kilmallock
Ballylanders
Charleville
N
Legend
Presence/Absence
Crayfish
Present
Absent
City/Town
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Coast


The presence/absence of Salmon in the 2013 Maigue CDS FPI Survey
0
4.5
9
18
Kilometers
Limerick
Adare
Ballingarry
Bruff
Kilmallock
Charleville
Ballylanders
N
Legend
Presence/Absence
Salmon
Present
Absent
City/Town
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Coast


The presence/absence of Lamprey sp in the 2013 Maigue CDS FPI Survey
0
4.5
9
18
Kilometers
Limerick
Adare
Ballingarry
Bruff
Kilmallock
Charleville
Ballylanders
N
Legend
Presence/Absence
Lamprey sp
Present
Absent
City/Town
OPW Channels
Maigue Rivers
Maigue Lakes
Maigue Catchment
Coast