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Environmental River Enhancement Programme

Annual Report 2015

Iascach Intíre Éireann
Inland Fisheries Ireland

EREP 2015 Annual Report

Inland Fisheries Ireland & the Office of Public Works

Environmental River Enhancement Programme

Acknowledgments

The assistance and support of OPW staff, of all grades, from each of the three Drainage Maintenance Regions is gratefully appreciated. The support provided by regional IFI officers, in respect of site inspections and follow up visits and assistance with electrofishing surveys is also acknowledged. Overland access was kindly provided by landowners in a range of channels and across a range of OPW drainage schemes.

Project Personnel

Members of the EREP team include:

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Environmental River Enhancement Programme Annual Report 2015

Table of Contents

Table of Figures

1. Introduction

In the light of restructuring within the Research Section of IFI a series of changes to the EREP study were made during 2015. Up to end 2014, the EREP study was handled by a dedicated 3-person team within IFI, supported by two senior IFI fisheries personnel. The IFI re-structuring led to a termination of any dedicated support from IFI and an agreed re-orientation of tasks and outputs for the EREP study.

In summary the changes to EREP during 2015 were as follows:

- Capital Works programme to continue as before with a target of documented plans for 25 km of channel
- Enhanced Maintenance programme to be discontinued, in regard to walkovers and preparation of plans for 75 km of channel
- Auditing programme to continue, the intention being that all driver crews should already be implementing the 10-step environmental guidance as standard practise
- Scientific studies to be curtailed and limited to a small suite of activity
- Much of the planning for Capital Works for 2015 had been undertaken during 2014. However, a low level of completion was recorded, as per Chapter 2 below.

The auditing process was fully supported by the civil foremen and the majority of the foreman team were visited by IFI personnel. There was a high level of compliance with several of the very basic environmental guidance strategies. The extent of implementation of Topic 10, undertaking new diggings, remained low even in situations where this strategy was feasible in terms of bed gradient and bed material. There were some notable exceptions, however, where very good work was being undertaken. There is considerable scope for this Topic to be ‘pushed’ by the civil foreman team in each OPW region.

A limited suite of scientific studies was completed, including extended-term monitoring of Capital Works on the R. Maine in Kerry and a catchment-wide fish and hydromorphology study on the R. Dee. This complemented a similar catchment-wide study of the R. Glyde completed in 2010. The long-term data set available for the Monaghan Blackwater was used to examine impact of some localised instream works on the fish community – as well as to assess the reversal of the impounding effect of the instream works. IFI’s R&D team undertook a catchment-wide survey of larval lamprey in the Boyne catchment in 2015 as part of its reporting procedures for the EU Habitats Directive. While the study was not associated with the EREP, the findings are very relevant to OPW and are made available by IFI.

Assessment of fish passability of barriers were undertaken at a number of sites, in planning for potential Capital Works projects under EREP.

2. EREP Capital Works Overview: 2015

Due to IFI restructuring a decision was taken and agreed between IFI and OPW that no new Capital Works plans would be drawn up for 2015. Instead the Capital Works element of EREP 2015 would see OPW only complete any unfinished and roll-over projects from 2014. The focus for 2015 would be to identify, walk and draw up Capital Work plans for the 2016 EREP programme.

Throughout 2015 a small number of river enhancement programmes were carried out through capital works which involved a site specific plan of instream development work. In total 9 individual catchments and 10 individual rivers were identified for enhancement works (Table 2.1). The distribution of these works is shown in Figure 2.1. A number of EREP projects were not achieved this year and where possible these channels will be included in the programme of works for 2016.

The Capital Works strand of EREP identified approximately 9.5km of channel for works in 2015 (Figures 2.3 to 2.6). Of this target almost 8km was achieved (Table 2.2) and any outstanding works will be accommodated under the 2016 capital works programme along with the full Capital target of 25km.

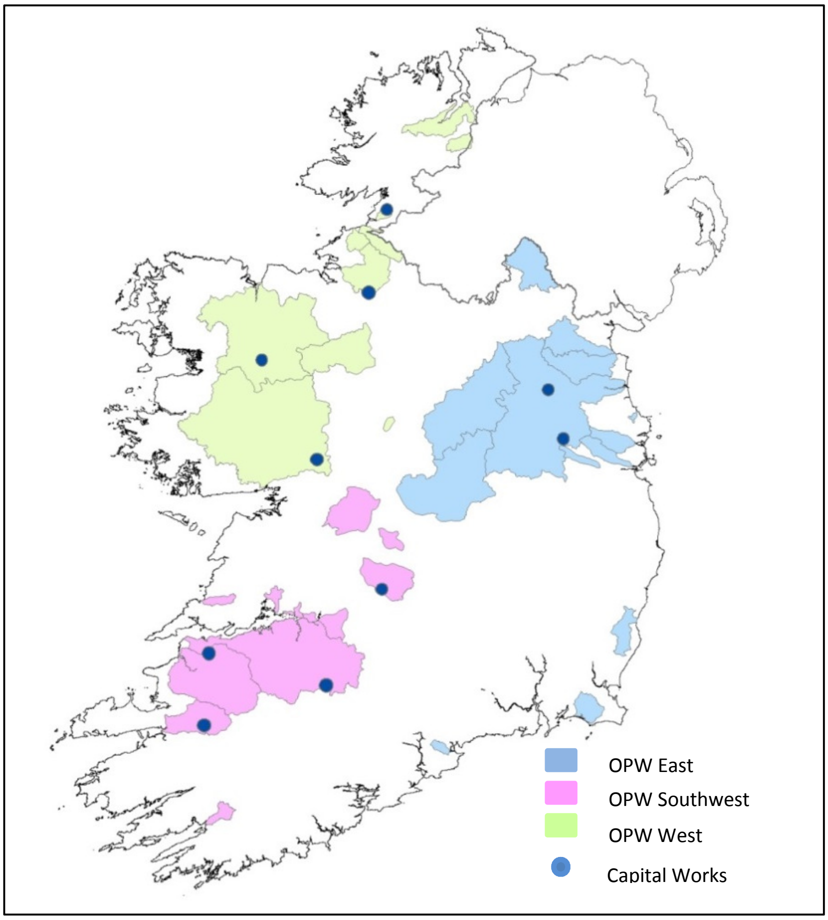

Figure 2.1. Location of EREP Capital Works programmes, 2015

Table 2.1. EREP Capital Works for 2015

Region	Catchment	River Name	OPW Channel Code	Year of Plan	Work Type	End of Year Status	Plan Length (m)
East	Boyne	Boyne MC	C1	2011	CW	Completed	250
	Boyne	Kells Blackwater	C1/8	2014	CW	Partial	1750
East Region Target 10km							**2000**
Southwest	Nenagh	Nenagh MC	C1	2015	CW	Completed	170
	Maigue	Loobagh	C1/34	2015	CW	Completed	650
	Maine	Maine MC	C1	2015	CW	Partial	1500
	Feale	Galey	C1/18	2012	CW	Completed	100
Southwest Region Target 7km							**2420**
West	Corrib	Derreen	C3/8/6	2015	CW	Completed	1070
	Bonet	Killanummery	C1/1/2	2014	EM / CW	Completed	1000
	Moy	Straide	C1/23	2014	CW	Completed	1350
	Abbey	Abbey MC	C1	2014	CW	Partial	1600
West Region Target 8km							**5020**

Table 2.2. Summary of EREP Targets and Achievements for Capital Works, 2015.

Region	**Target (km)**	**Set (km)**	**Achieved (km)**	**% achieved (of plans)**	**% achieved (of target)**
East	10	2	1.65	82.5	16.5
Southwest	8	2.42	1.92	79.3	24
West	7	5.02	4.4	87.6	62.9
Total	25	9.44	7.97		
Average				83.2	34.5

One issue that came to light during 2015 was that when OPW changed quarries there wasn't always a follow up with the quality and type of material being supplied by the new quarry. This, coupled with new drivers, led to incorrect gravel material being used for gravel spawning beds on the Kells Blackwater works. Incorrect gravel material was also supplied to the Boyne main channel works (Figure 2.2) but this was identified on-site and was not used.

Figure 2.2. Delivery of incorrect 'spawning gravels' (note the size range of the stone).

It was agreed that during 2016 a series of 'how to' video clips would be developed for a range of instream development techniques used in Capital Works plans. This programme of work will be done through an external contract working with both OPW and members of the EREP team in IFI. The video clips will capture the various stages of implementing each technique from start to finish. During the 2015 season a number of techniques were captured on film and this material is currently in video development stage. It is hoped these 'how to' video clips will be available through the OPW 'al fresco' system to all staff, once completed.

OPW has contracted Dr. Martin O' Grady to take video footage of works being undertaken within EREP – of specific structural items e.g. paired deflectors etc. This is in hand and some items have been completed. It was also agreed that footage should be obtained of specific items from the 10 environmental training points. The filming is scheduled to continue in 2016. It is planned to trial some video editing in-house in IFI.

Examples of EREP Capital Works 2015.

Figure 2.3. Addition of a gravel shoal in the Abbey River (C1).

Figure 2.4. Paired deflector on the Boyne main channel (C1).

Figure 2.5. Series of single deflectors around a bend, Boyne main channel (C1)

Figure 2.6. Paired deflector, pool and gravel shoal unit, Loobagh River (Maigue C1/34)

Figure 2.7. Straide River (Moy C1/23), paired deflector and pool.

3. Auditing Programme – Implementation of Enhanced Maintenance procedures

3.1 General

A total of 29 audits were undertaken in 2015, using the new form developed between IFI and OPW. Comparison of results of audits using the old and new forms indicated a broad concurrence in results. The new form is designed to compile more detail and to tease out and score for specific issues.

Table 3.1. List of audits undertaken in 2015 by IFI under the EREP study.

OPW Region	Catchment	Channel	No. Audits
West	Corrib Mask	CM4/25/2	3
	Corrib Clare	C3/11	
	Corrib Clare	C3/26/1/2	
	Boyle/Lung	C1	2
	Moy	C1/48/1 File ref	
	Kilcoo	C5	1
	Moy	C1/30/7/3	3
		C1/21/7/3	
		C1/39	
East	Inny	C61/5	4
		C37	
		C18/7	
		C27	
	Glyde-Dee	C13/1	3
	Monaghan B.W.	C1/1/11	
		C1/1/5/10/1	
	Owenavaragh	C2 Bracknagh	1
	Boyne N	C1/8/17/3	3
		C1/8/7/10	
		C1/43	
South-west	Maigue	C1/34/4	2
	Newport- B'mackeogh	C1/1/4	
	Deel	C24	3
	Maigue outfall	C1/17/5	
		C1/7/3/1	
	Feale	C1/14/8	2
		C1/14/1/1	
	Cappa-Kilcrow	E.D. Garryard	2
		C1/20	

The auditing was distributed among the three OPW regions and the majority of foremen were visited (Table 3.1). Auditing was undertaken by the IFI staff members working on the EREP project and, in all cases, they were accompanied by the supervising foreman. IFI views the audit process as a two-way exchange between the foreman and EREP staff, the EREP examining the opportunities for and implementation of the various relevant training points form the 10- step guidance notes of OPW. On-site discussion with the foreman covers issues, problems of implementation, positives and negatives. The audit visit also allows an opportunity to trial relevant measures that the drivers may not be implementing. The drivers may also identify issues on-site and problems with implementing certain strategies, as well as identifying how they have adopted certain measures to suit the specific site and its issues.

Given the extent of small channels (4' base width type) within the various OPW arterial drainage schemes it was not surprising that many audits were done in channels of 1 – 3 m width, or less (Figure 3.1). However, there was some representation of other channel sizes. It was clear, both from prior experience and from the current audits, that there are limited options for value-added works in small-width channels. The experience is, generally, that drivers implement 'habitat retention' measures relating to protection of the two bank slopes, minimise diggings, managing spoil and managing of the tree and shrub line along the channel in these smaller channels.

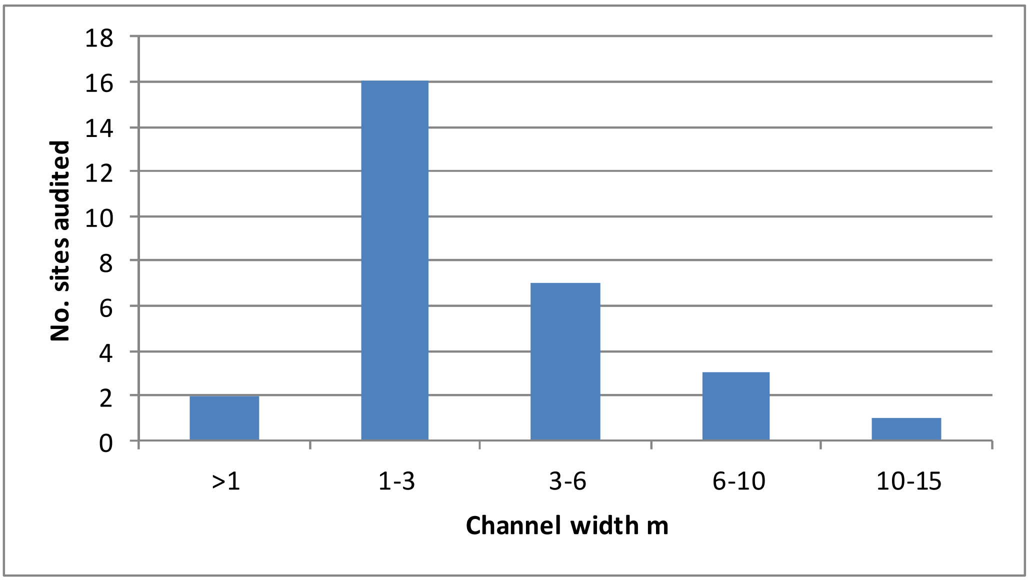

Figure 3.1. Distribution of sites audited in 2015 by channel width

At present, the auditing is organised through IFI arranging with an individual foreman to link up on a specific day, the type of sites/channels visited are entirely dependent on where the OPW machine crews of that foreman happen to be at the time of visit. If EREP is to achieve increased roll-out of more pro-active measures, such as the 'new excavations' compiled in Item 10 of the environmental guidance, it may be necessary to arrange audit visits in a different way – with foremen contacting IFI staff from the EREP team while one of their machine crews is operating in a channel with potential for new diggings.

3.2 Distribution of scoring – overall scores and distribution among the performance categories

An overview of the audit outcomes pointed to a very high level of performance, with the majority of visits scoring in the Very Good performance category i.e. greater than 85% score.

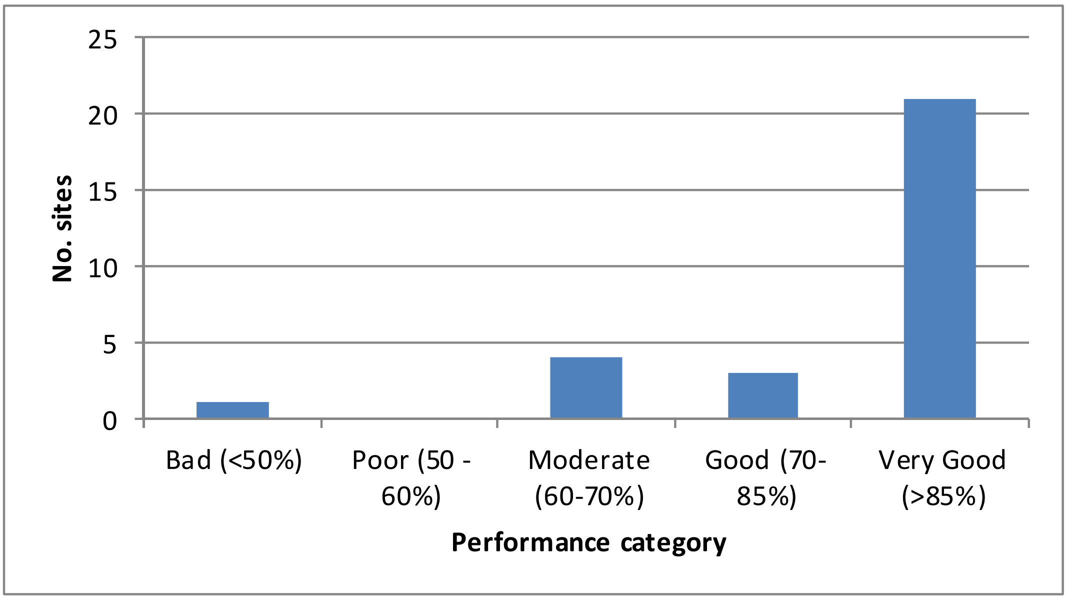

Figure 3.2. Distribution of audit scores among performance categories

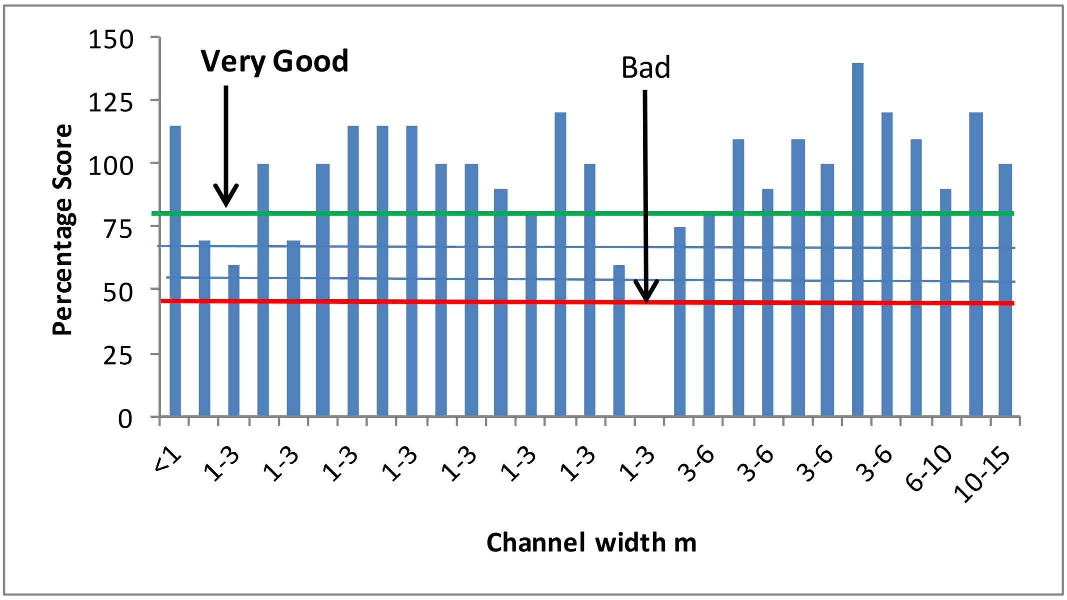

Figure 3.3. Distribution of audit scores among channel sizes

Scores in excess of 85% (Very Good category) were achieved in all sizes of channel examined. The revised audit form allowed for recording of deviation from compliance – with red, orange and yellow categories denoting reducing levels of deviation. Major deviation from compliance attracted 'red' category marking. This led to one score in the 'Bad' category (Figure 3.2). On the other hand, a 'bonus' scoring was also available in some categories within specific topic areas. This 'green' category of marks provided for scoring above the standard compliance level and is reflected in the scores exceeding 100% (Figure 3.3). 'Bonus' scoring was achieved by some drivers in areas such as water celery management (Item 4 – Managing vegetation), of skipping sections (Item 5) and substantial implementation of new diggings (Item 10).

3.3 Compliance with specific elements of the 10 point Environmental Guidance

Item 1 – bank slope protection: This topic was relevant in all cases. There was a high level of compliance - 25 of 29 - for non-working bank and 19 of 29 on working bank slope. Deviation from compliant was all in the lower level 'Yellow' category.

Item 2 - confining maintenance to channel centre / no over-digging: As with Item 1 there was a high degree of compliance (27 of 28) with Item 2. No records of significant or continuous over-digging of the channel bed was evident. It was difficult to ascertain the extent to which staff were implementing lamprey and crayfish SOPs, at the audit sites themselves. Some sites were clearly unsuitable as habitat for either larval lamprey or crayfish. Fresh sediments examined in audit did not show signs of either animal. This is an area that will benefit from continuous reference by the foremen to the drivers. In addition, evidence for either or both animal is collected on the driver time cards.

Item 3 – spoil management: Spoil management was recorded in 28 of the 29 audits and was fully compliant in 24 of the 28 cases. Deviation from compliance was in the low-level or 'Yellow' category. The deviation was assessed on the basis of the situation prevailing at each specific site. Spoil was generally placed on existing spoil heaps or on the bank full line. Placement of spoil was observed in limited cases both on the working bank slope and the non-working bank slope. In two situations the land owner had requested the driver crews to heap the spoil in mounds for the farmer to remove and dispose of.

The issue of allowing water to drain out of the bucket is seen as a benefit in possibly allowing fish and invertebrates to be washed out of spoil and back into the channel. In addition, it reduces the amount of water being drawn out onto land. Where spoil is being placed on the bank top, and more particularly, on the bank slope it is important that the drivers allow substantial tipping off of water. This can reduce or prevent sediment from flowing back down the bank slope and re-entering the channel. This feature was not commonly recorded in audits – 7 clear instances of compliance in 29. This was partly because many driver crews stop their machines, out of courtesy, when the audit team arrives and engages with the audit team. Some crews are a little uncomfortable to be working when the audit is in progress. Spoil was being spread thinly, as per guidance, in 15 of 29 cases.

Item 4 - vegetation management: Vegetation management was relevant in 21 of the 29 sites visited. Two stand-out cases were observed where the crew was retaining a wide margin of tall emergent vegetation on both sides of the channel, the width of this band being appropriate for the overall channel size.

There were 11 cases involving tall reeds and flaggers and 15 cases involving water cress/celery. In some audits, both plant groups were relevant. Five of the 11 cases involving tall reeds were removing excess vegetation cover (50% of cases). There was a higher degree of compliance in the case of water cress. Here, a combination of skimming off the celery and non-excavation of the channel bed was expected for compliance. The skimming process was being strongly implemented while two of 10 cases showed a degree of digging of the bed – the other 8 cases had skimmed cress without disturbing the channel bed.

Item 5 – skipping sections: Where there is a low gradient or a continuous potential for obstruction it may not be feasible to skip sections. This was evident in the audit outcomes, where this strategy could not be adopted in 16 cases and was relevant in 13 of the 29 visits.

Skipping arises for one or several reasons in any situation. A mature tree line was identified in 12 of the 13 cases of skipping. Along with this, reasons included presence of 'self-cleansing' gradient (5 cases), maintenance not being required (6 cases) and overhead power cables (2 cases). Skipping has been a common feature of maintenance practise for many years with several foremen, reflecting a practical approach to self-cleansing gradients and *in situ* tree and shrub cover.

Item 6 - managing trees: This item was relevant in 20 of the 29 audits –primarily in regard to avoidance of damage to trees during the closed season. The majority of crews were compliant - 17 of 20. One crew had problems of damage being created as a result of the jib configuration and dimensions.

2 crews were cutting trees in the closed season – attracting a 'RED' designation. In both cases the quality of work was good with correct use of gear, general management of low branches and individual trees and good retention of tree variety. However, from a purely audit perspective the procedure was highly inappropriate and attracted a high level of negative marking.

Item 7 - Managing berms: No sites displayed this item

Item 8 - placing rock / replacing rock stone the channel: Three instances of this were recorded– one for compliance in returning materials dug out in maintenance. The other two related to using available stone material – one was compliant and was availing of the opportunity to replace stone into the channel while the second situation had this same opportunity but was not implementing it. The compliant site was in a small (1 -3m wide) channel where such opportunities are generally limited. The channel had limited fisheries potential but the driver was robustly implementing diggings that were developing a more complex hydromorphology, the underlying aim of EREP.

Item 9 was not recorded in these audits

Item 10 – New excavations in the channel: This topic was considered relevant in 13 of 29 sites. Scoring was possible under three headings and in several cases more than one was being used:

Excavate bed to form riffle – pool areas

Overdig the bed on one side

Construct simple low-level structures with available stone

The most 'straightforward' measure involved overdig of channel bed to create pool areas and re-allocation of the spoil to create shallow embryo riffles. While this option was seen as relevant in 12 locations it was only being strongly implemented in 5 of these. The strategy was being done at a low level in three sites and largely omitted in two others.

Overdigging round the outer side of bends, creating a low-level berm and two-stage channel was being actively pursued in a one location.

Use of available stone material to form simple instream structures was undertaken in three sites.

4. Scientific Investigations and Monitoring

4.1 River Dee Fish Population Index (FPI) study

One fish population index (FPI) survey was carried out on the Dee River, part of the Glyde and Dee Catchment Drainage Scheme, in 2015.

The River Dee springs near Bailieboro in County Cavan and flows in an easterly direction for 60.75 km through County's Meath and Louth before entering the River Glyde and meeting the sea at the village of Annagassan. The Dee has three main tributaries, the Killary River that joins south of Drumconrath, Co. Meath. The Gara River which joins west of Ardee, Co. Louth and the White River which joins north of Dunleer, Co Louth. The Dee flows through Whitewood Lake near Nobber, Co. Meath.

In total, 34 bank and 12 boat based electrofishing sites were fished. In conjunction with electrofishing, invertebrate (Small Stream Risk Assessment Score, SSRS), macrophyte (RVEG) and hydromorphology (River Hydromorphology Assessment Technique, RHAT) surveys were carried out at each site.

In total, 2678 fish were captured measured and returned in the 2015 Dee FPI Survey. Brown trout were the most abundant species, followed by minnow, Three-spined stickleback, salmon, roach, Stone loach, Sea trout, European eel, Gudgeon, Perch, Lamprey sp., Flounder, Crayfish and Pike (Figure 4.1).

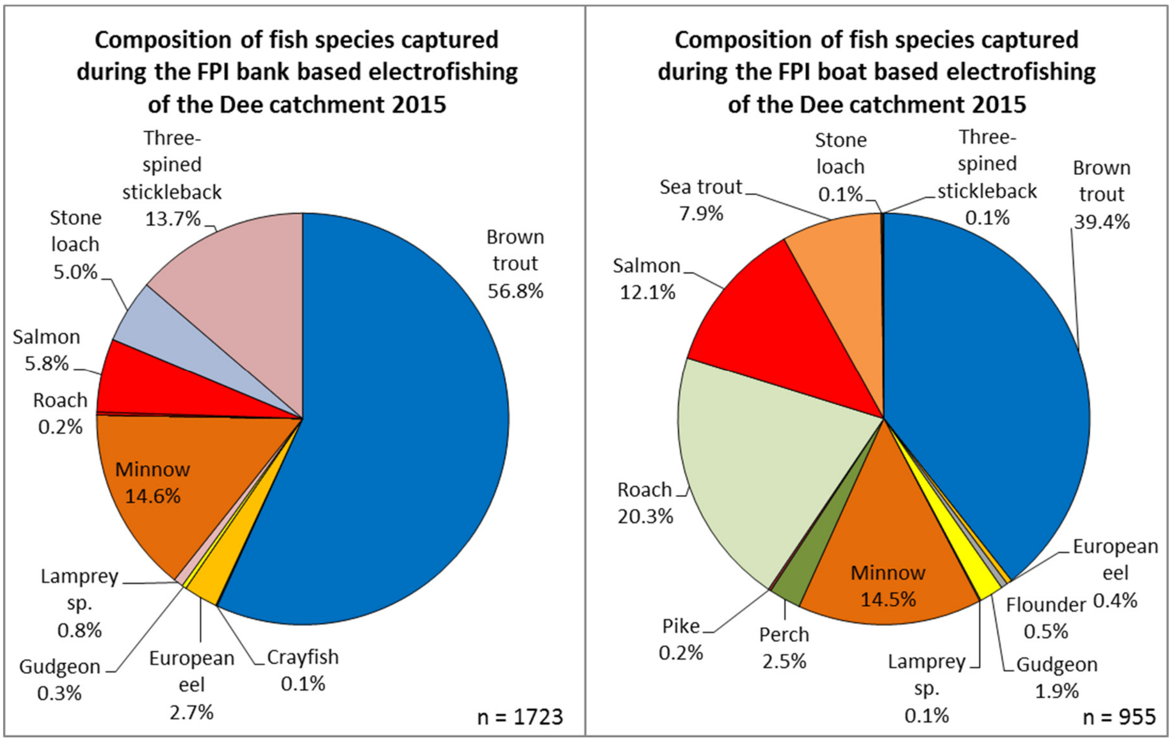

Figure 4.1. Composition of fish species captured in the Dee Catchment FPI survey using boat and bank electrofishing equipment.

In a 2013 report the EPA noted, compared to the national picture, water quality in County Louth remains quite poor. Only 37.5% of the EPA (Q-Value) water monitoring sites in the Dee catchment are meeting WFD requirements or "Good Status" (Figure 4.2) compared with 65% nationally. This Q-value result corresponds to the SSRS results with indicated 60% of the channels are probably at risk of pollution. In the 2013 report, the EPA identified diffuse agricultural and mixed rural influences as the primary source of pollution in the Dee catchment.

There are no bad Q-value sites in this catchment; however, the SSRS indicates that 44% of the sites sampled are "at risk" of water pollution. The "moderate" sites recorded in this catchment are scoring Q3-4 which is still within the biological limits for salmonid enhancement. However, if this "moderate" water quality decreases from Q3-4 to Q3 water quality will threaten the salmon population.

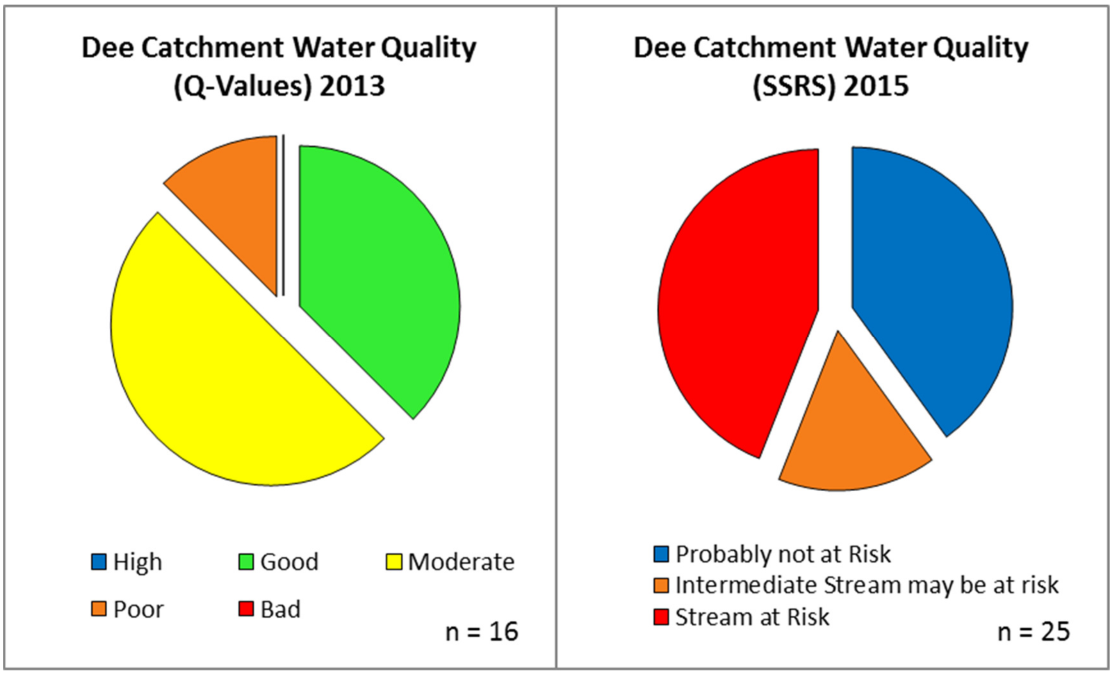

Figure 4.2. Results from EPA Q-Value and SSRS macro-invertebrate monitoring sites in the Dee Catchment

The trout stock in the lower reaches of the Dee River represents a valuable angling resource. Approximately 5% (58 Trout) of the trout captured were ≥28cm. Downstream of Drumcar Bridge there is a healthy game fishery with good numbers of seatrout and salmon. The 2 salmon life stages can be seen in figure 4.3. Fish under 20 centimetres are salmon fry and parr, the freshwater component of the salmon life cycle. The salmon >20cm are adults which have returned from feeding at sea to spawn. These adult salmon were captured upstream of Ardee and around Drumcar Bridge. Good Numbers of salmon were found on the main Dee channel between Nobber and Ardee (Figure 4.4). The capital works section downstream of Hem Bridge supporting a good number of salmon fry and parr.

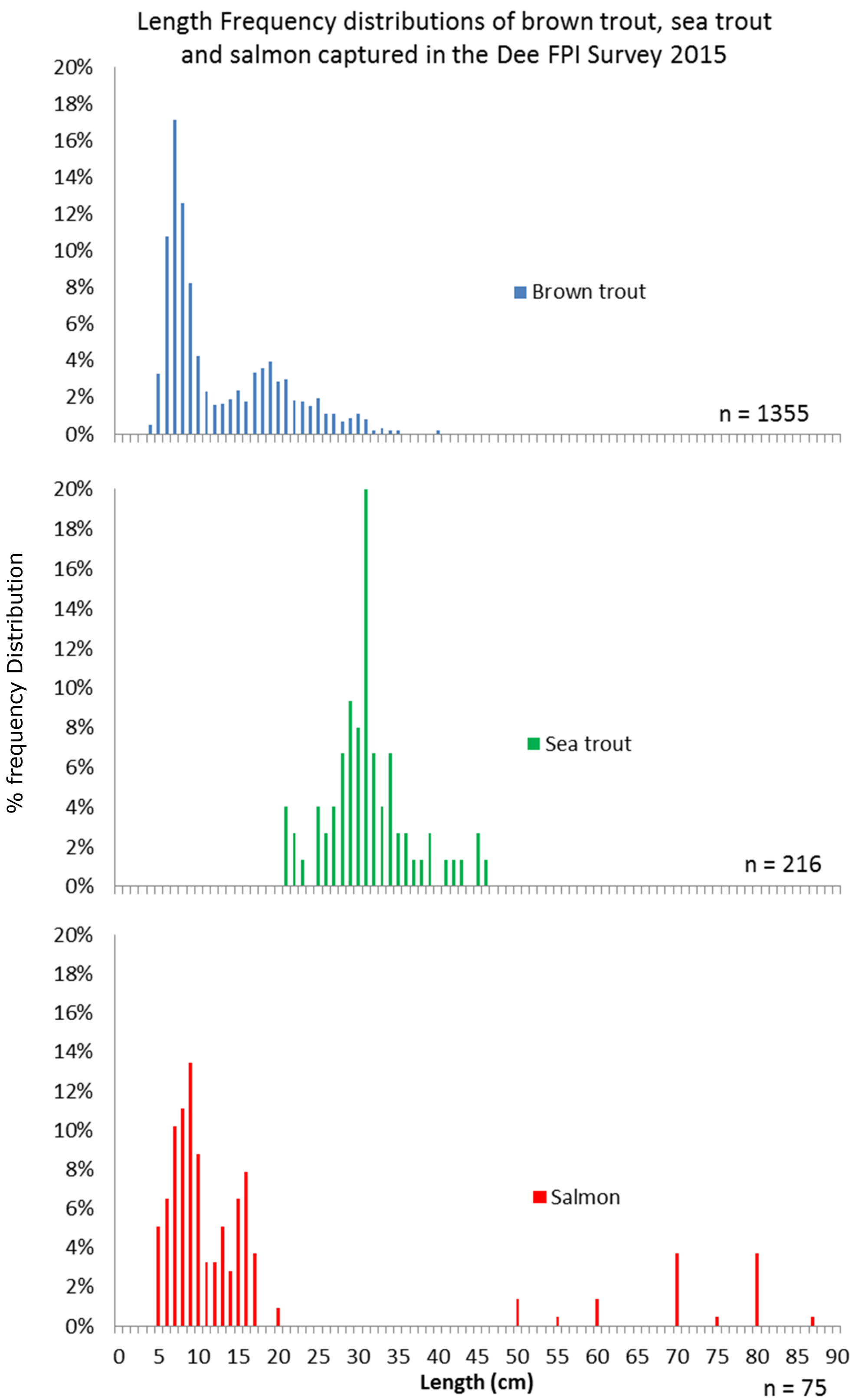

Figure 4.3. Length frequency distribution of trout, sea trout and salmon from the Dee FPI Survey.

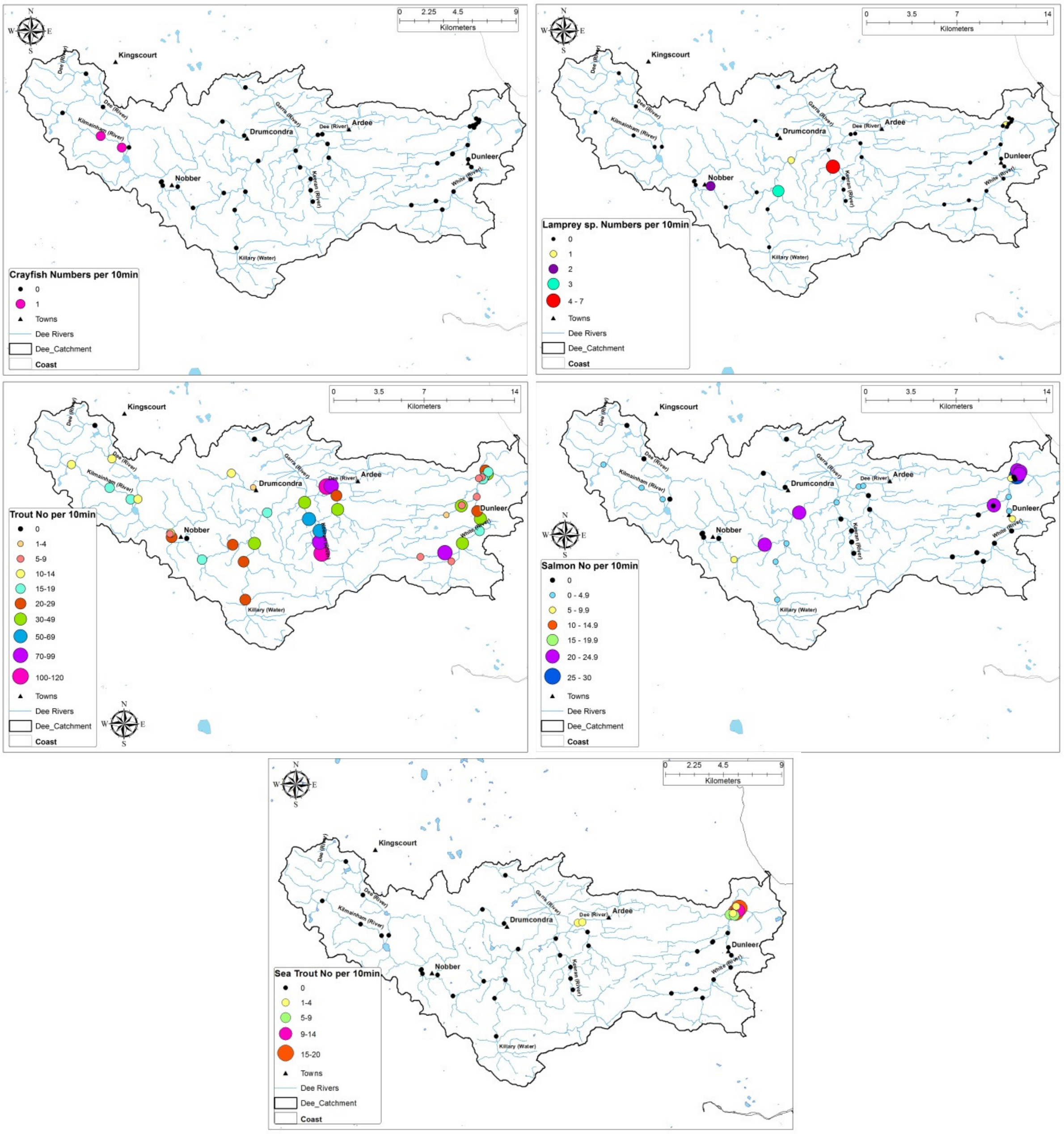

Figure 4.4. Distribution of crayfish, lamprey, trout, salmon and seatrout captured in the Dee FPI survey 2015

4.2 R. Dee – Assessment of physical habitat using RHAT (River Hydromorphology Assessment Technique)

River Hydromorphology was assessed using the River Hydromorphology Assessment Technique (RHAT), an inter-calibrated, WFD and CEN standard compliant tool. RHAT classifies river hydromorphology based on a departure from naturalness assigning a morphological classification directly related to EQR, based on semi-qualitative and quantitative criteria. Thirty-two sites were surveyed for hydromorphology using the RHAT (Figure 4.5 and 4.6). Only one site passed the WFD minimum requirement of good status. There is significant potential for increasing this RHAT score in a number the Dee tributaries and the main stem itself. Mitigating barriers on the Dee and white Rivers would be a simple way to increase this RHAT score.

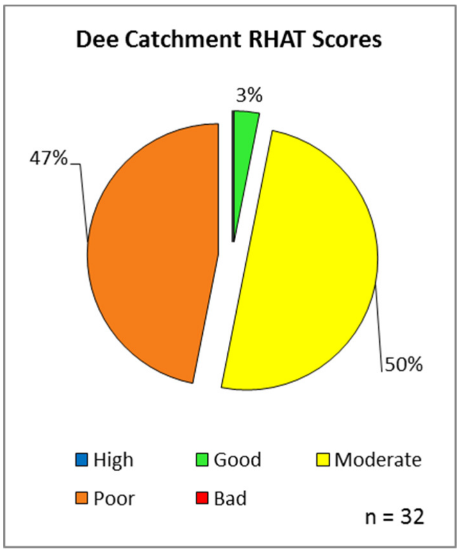

Figure 4.5. River Hydromorphology Assessment Technique (RHAT) results from the Dee catchment taken during the Dee FPI Survey.

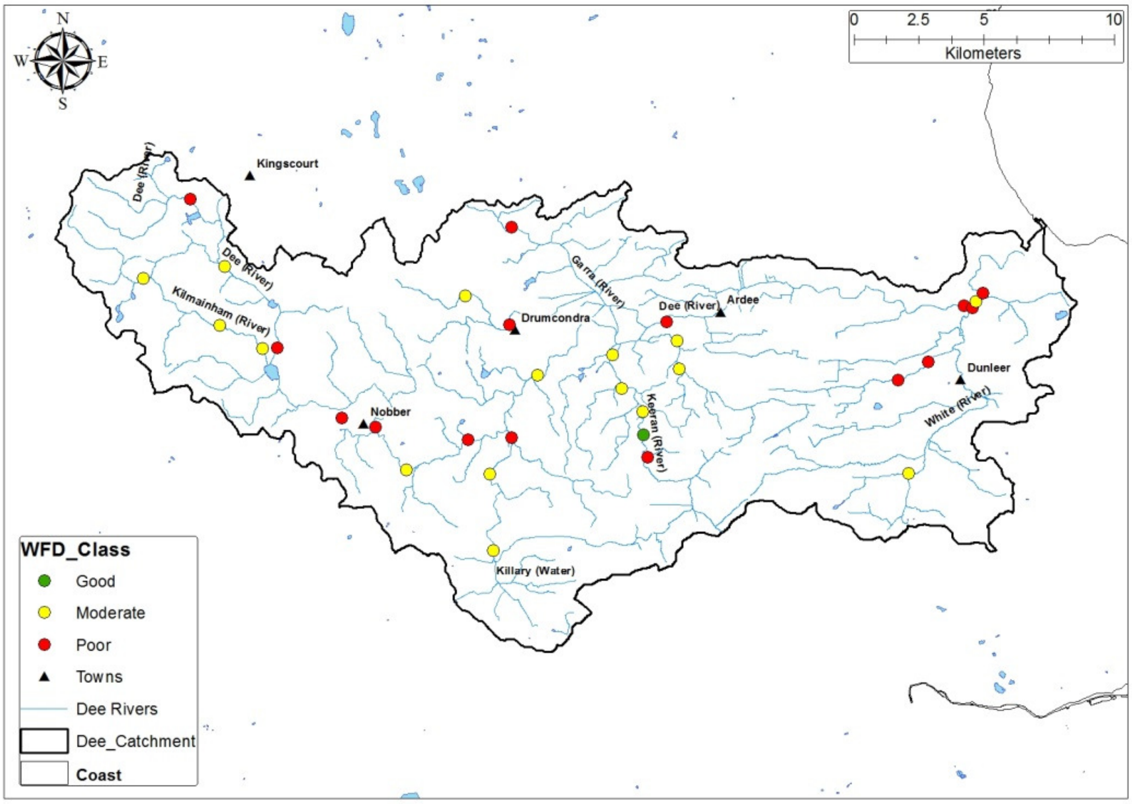

Figure 4.6. Locations of River Hydromorphology Assessment Technique (RHAT) results from the Dee catchment taken during the Dee FPI Survey.

4.3 River Maine Capital Works Programme 2008 - 2015

The River Maine discharges into Castlemaine Harbor at the head of Dingle Bay, it has two major tributaries the Little Maine and Brown Flesk Rivers. In 2008 a capital works program was draw up for the River Maine through Castleisland, however the works did not start until 2009. Capital works attempts to increase the hydrological variation within the channel, using in-stream structures to recreate more natural flow condition. Alternating deflectors scour a thaweg, paired deflectors keep dug pools open and maintain spawning shoals and random boulders provide areas of scour, slack water and deposition.

The experimental section is downstream from the bridge at Tullig (Figure 4.7 and 4.8), was chosen, as it is representative of the River Maine. The Maine in this area is composed of shallow riffle-glide sections with high bed load mobility. The control site, downstream of Fairfield Bridge is very similar to the experimental sites comprising of shallow riffle-glide sections, although at a smaller base width.

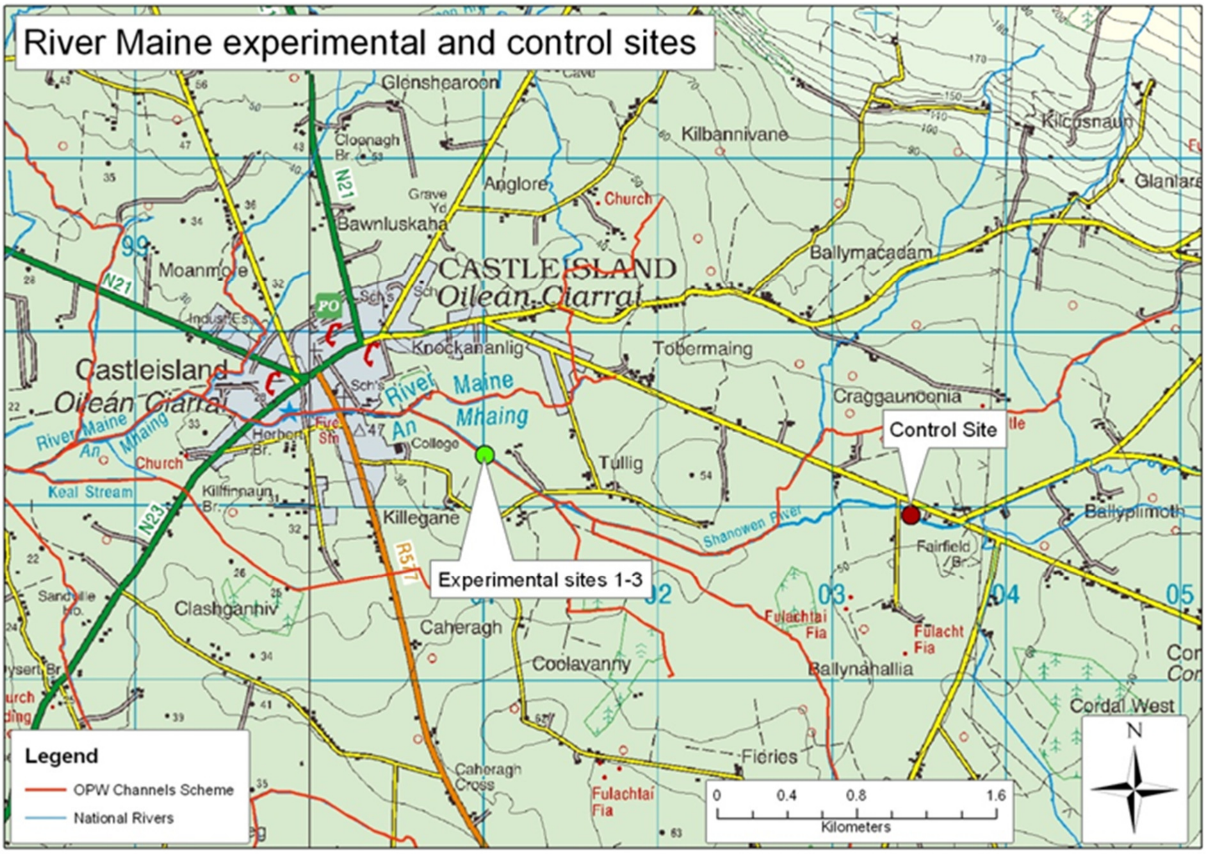

Figure 4.7. The location of the River Maine experimental and control sites.

Figure 4.8. Aerial view of the River Maine experimental post works October 2009 (note alternating deflectors and random boulders).

In the experimental site, three 30m sections were depletion electro-fished (back to back) in 2008, 2010 and 2011. However, in 2015, logistical constraints resulted in only 2 of the three sites in the experimental site being fished. The control site downstream of Fairfield Bridge was also fished in these years. In addition to fish surveys, long sections and depth profiles of the sites where also recorded. For simplicity, the two experimental sites fished in 2015 will be combined and discussed against the same sites in the previous survey years.

4.4 Maine Capital Works Results

In decreasing order of abundance, fish species present were salmon (*Salmo salar*), brown trout (*Salmon trutta*), three spined stickleback (*Gasterosteus aculeatus*), stone loach (*Barbatula barbatula*), Lamprey Sp. (*Lampetra sp*.), eel (*Anguilla anguilla*) and minnow (*Phoxinus phoxinus*). Salmon and trout and were the most numerous species and were found in each site in each sampling year. No Crayfish were captured.

Salmon and trout numbers were investigated across the three sampling years, pre and post capital works (Figure 4.9). Salmon fry and parr and 0+ trout, 1+ trout and >1 trout No/m^2 were calculated using Seber and Le Cren (1967). Adult trout numbers (>1 trout) were very low over the sampling years, therefore adult trout were combined with 1+ trout in the analysis.

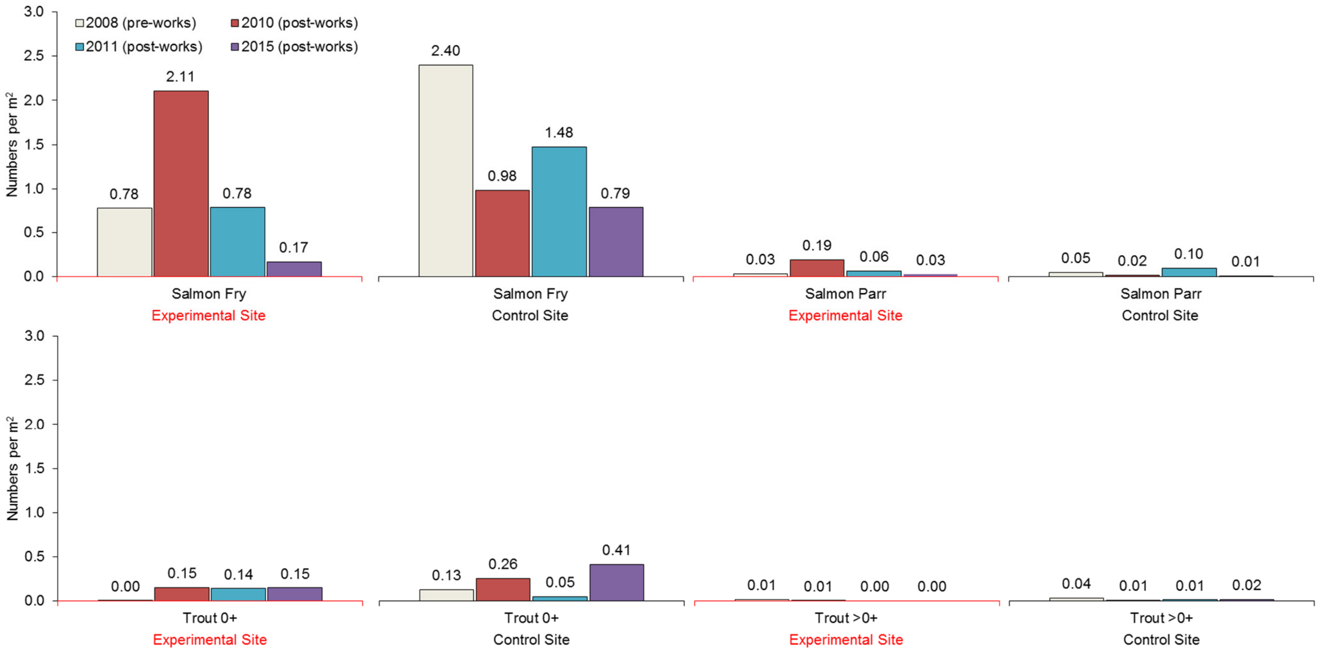

Figure 4.9. Salmon and trout life stages (No/m²) in the experimental and control site in 2009, 2010, 2011 and 2015

Post capital works increases in trout and salmon numbers were observed in the experimental site. The increases seen in 2010 and 2011 are probably related to salmonids using the new spawning habitat made available through capital works. The decreases in the 2015 salmon fry numbers possibly represents a poor returning run of adult salmon into the system or salmon choosing not to spawn in this location in 2014. The spawning habitat is available to salmonids in the experimental sites as the trout fry numbers increased post "works" and have remained stable. Salmon fry numbers in the control site show considerable fluctuation / variation and this may now be evident in the experimental site.

The bed material in the experimental site is predominantly composed of large cobble, which is mobile in high flow conditions. This material has filled in some of the pools and thalweg dug in the experimental site in 2009. This can be seen in the long sections (figure 4.10) where pools constructed in 2009 are shallower in 2010, and 2011. However, as the pools were constructed bellow paired deflectors the extra velocity created by these structures will scour the pools, keeping them clear and it is expected that these pools will retain the 2015 depth profiles into the future (Figure 4.10). A statistical comparison of the long sections between years is given in Table 4.1. A comparison of long sections utilising Wilcoxon matched pair's shows that long section bed heights were changing significantly ($P < 0.01$) between years. There was no significant change in bed level between 2011 and 2015 suggesting the site may have reach a form of equilibrium.

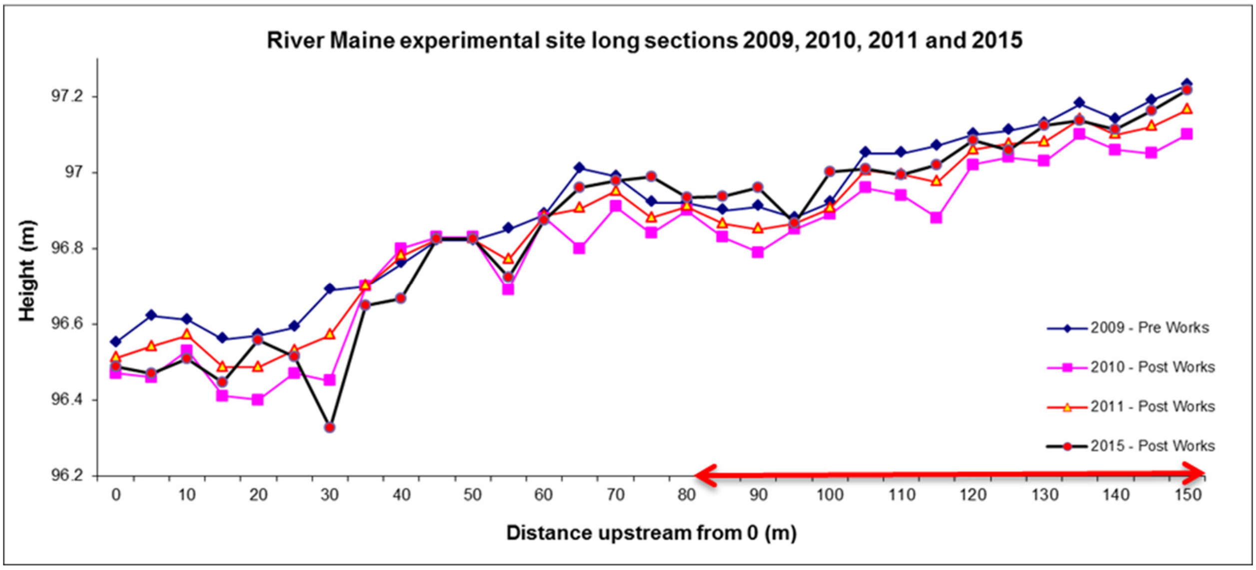

Figure 4.10. River Maine experimental site long sections pre (2009) and post works in 2010, 2011, 2015 (arrow indicates location of depth contour plot in Figure 4.11).

Table 4.1. Wilcoxon matched pair's comparison of long section bed heights between the sampling years in the Main experimental site.

Year	2009	2010	2011	2015
2009				
2010	P <0.01			
2011	P <0.01	P <0.01		
2015	P <0.01	P <0.01	P >0.05	

The capital works has increased the average depth and decreased the average width of the river from 7.9m to 7.1m (Table 4.2). Narrowing and deepening of the channel through Capital works has addressed some of the hydromorphological problems of this site. Post capital works the uniform cross-section left post drainage has been altered and is no longer as overly wide and shallow (Figure 4.11). The natural riffle / glide / pool sequence for this channel type has been reinstated. Bed material diversity has improved with scour produced by alternating deflectors and random boulders sorting bed material.

Table 4.2. Mean depth and width in the Maine experimental site pre works (2008) and post works (2009, 2011 and 2015).

	2008	2009	2011	2015
Mean Depth (m)	0.13	0.18	0.18	0.14
Mean Width (m)	7.87	6.77	7.30	7.14

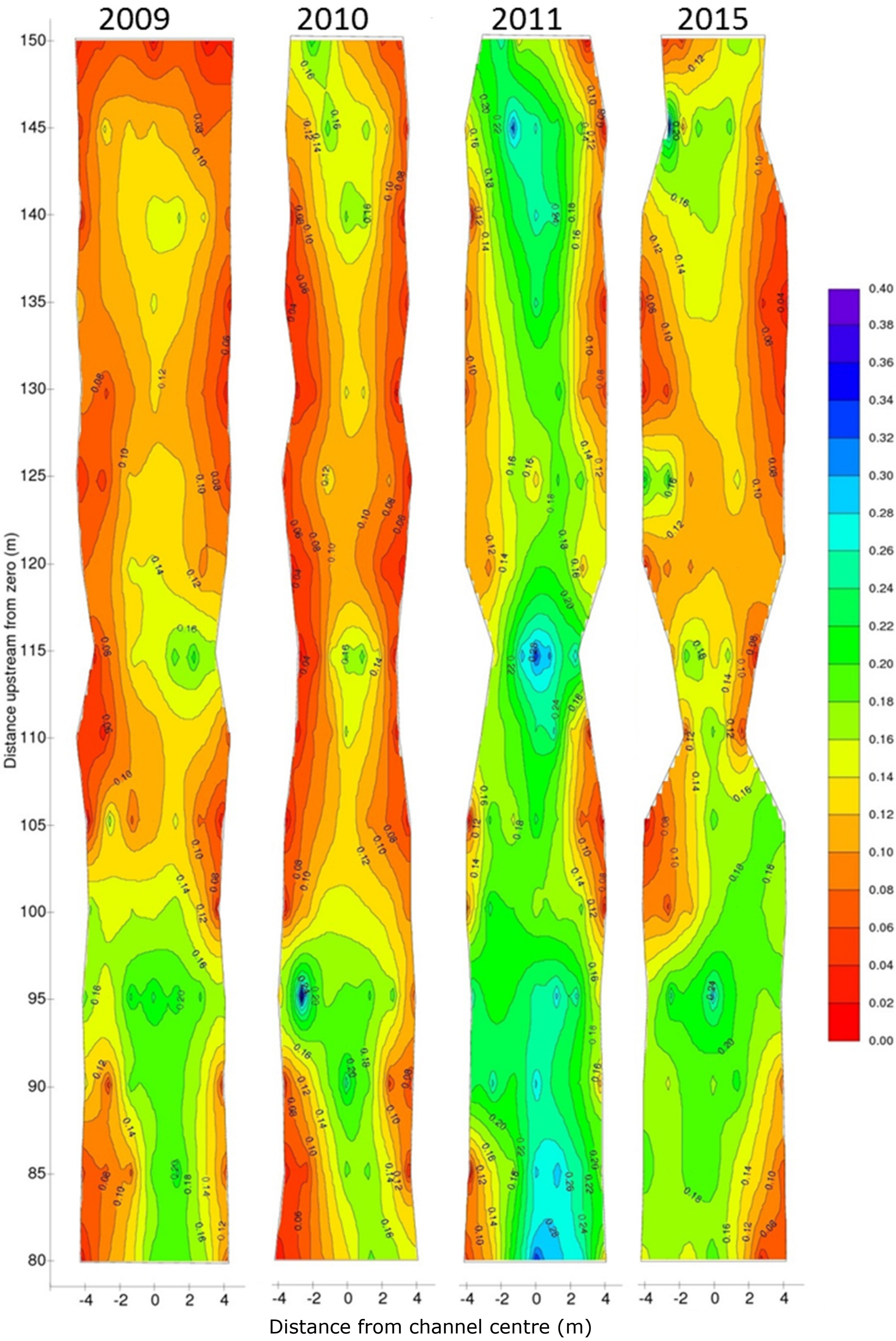

Figure 4.11. Depth contours of a section of the River Maine experimental site: pre works (2009) and post works (2010, 2011 and 2015).

4.5 Monaghan Blackwater Weir Removal

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 survey examined the fish stocks, using the mark-recapture method, in the 2km of channel from ~800m us of Miltown Br. to 1.2 km ds of Miltown Br. Surveyed data was available before the arterial drainage scheme was commenced in 1981. River Enhancement was commenced in 1992 and the trout stocks have been surveyed again in 1993, 1997, 2002, 2013 and 2015. The sequence of events in this survey covers pre river restoration (1993) and post river restoration in 1997, 2002 and 2013. In 2014 the weir upstream of Milltown Bridge was replaced with a paired deflector and instream works was implemented downstream of Milltown Bridge. This report discusses hydromorphology and fish community compositioal changes in the site upstream of Milltown Bridge.

Water Quality in the Monaghan Blackwater as measured by the aquatic invertebrate community has remained stable since 2007 (Table 4.3). However continued EPA physico-chemical monitoring data reveals elevated BOD, nitrate and othro-phosphate levels on occasion at the Milltown which is consistent with intermittent pollution.

Table 4.3. EPA Q-values 1971 to 2013 on two sites on the Monaghan Blackwater at Bellanode (~4km upstream of Milltown Bridge) and at Milltown Bridge.

Station	1973	1977	1981	1983	1985	1989	1993	1996	1998	2001	2004	2007	2010	2013
Bellinode	3-4	3-4	4	3-4	3-4	3-4	4	4	4	4	4	3-4	3-4	4
Milltown	4	3-4	4	3-4	3-4	3	3	3-4	3	3	3-4	3-4	3-4	4

The survey undertaken in 2013 observed a significant change in the trout and pike population upstream of Milltown Bridge from the 1997, 2002, 2013 surveys. It was hypothesised this was due to the construction of a large stone horseshoe weir structure built upstream of the bridge between 2009 and 2011. This weir structure was ~0.45 meter high and ponded water ~800 meters upstream. This ponding coupled with extensive large woody habitat in the channel created excellent adult pike habitat. Upstream of Milltown Bridge, the pike numbers increased from 1.7 to 7.3 No/100m^2 between 2002 and 2013, a 4 fold increase. The trout numbers dropped from 16.0 to 1.0 No/100m^2 between 2002 and 2013, a 16 fold decrease. Comparing 1993, 1997, 2002 and 2013 a higher proportion of the pike population was located upstream of Milltown Bridge, inversely far fewer trout were found upstream of Milltown Bridge in 2013, compared to previous years. The relationship between pike and trout observed upstream of Milltown Bridge was probably predator and unfavourable habitat avoidance. In 2013, the trout were actively avoiding large concentrations of predatory pike in a location that had unfavourable habitat.

In 2014, it was decided to undertake capital works to improve trout fishing in the Milltown Bridge area. As part of these works, the horseshoe weir upstream of Milltown Bridge was replaced with paired deflector (Figure 4.12). This was done to return the river to a more natural state, by removing the ponding effect of the weir.

Figure 4.12. Capital works on the Monaghan Blackwater upstream of Miltown Bridge pre (Top -2014) and post (Bottom - 2015) works.

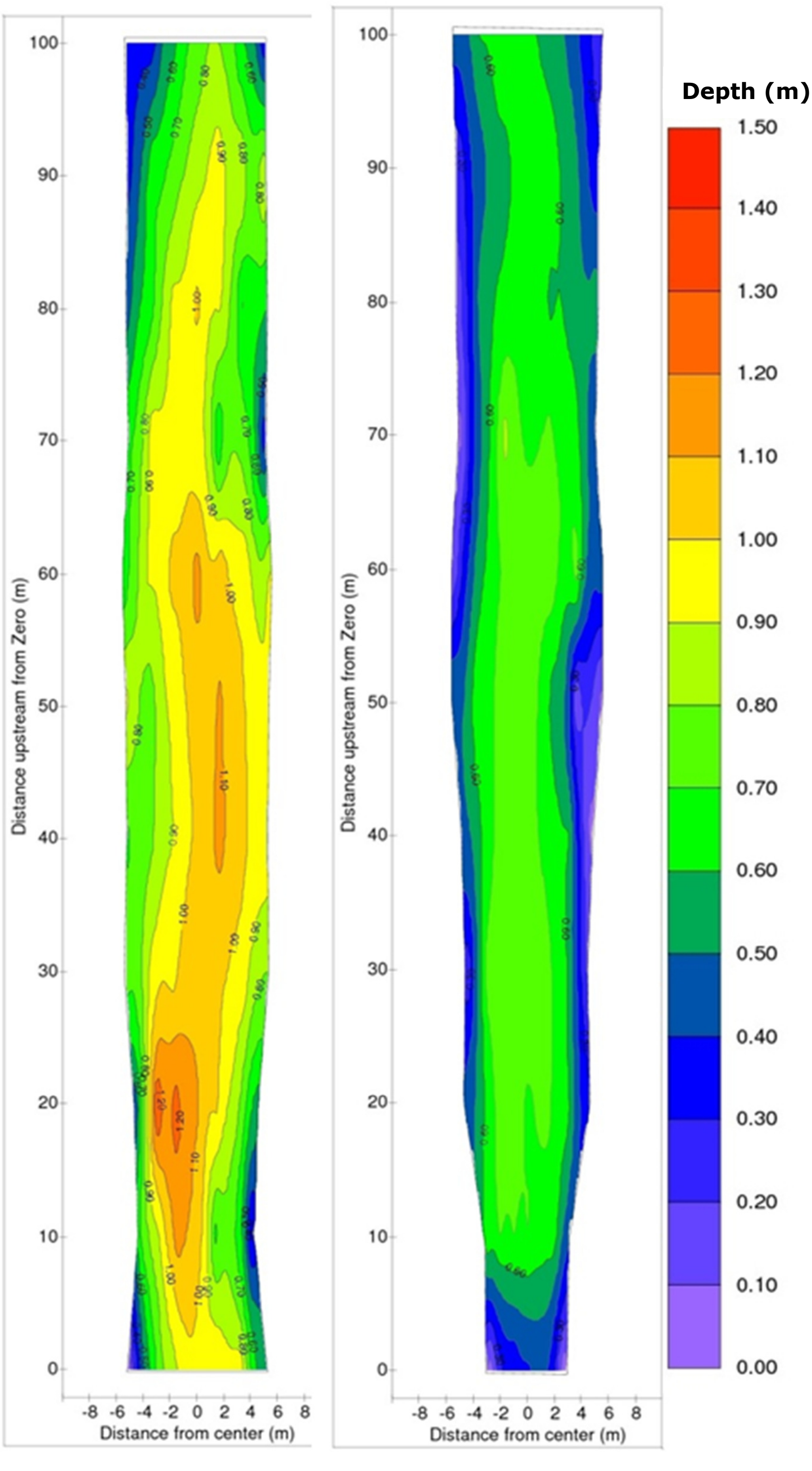

Figure 4.13. **Depth (m) contour plots of the 100m upstream of Milltown Bridge pre (left – 2013) and post (right – 2015) removal of horseshoe weir and construction of alternating deflectors.**

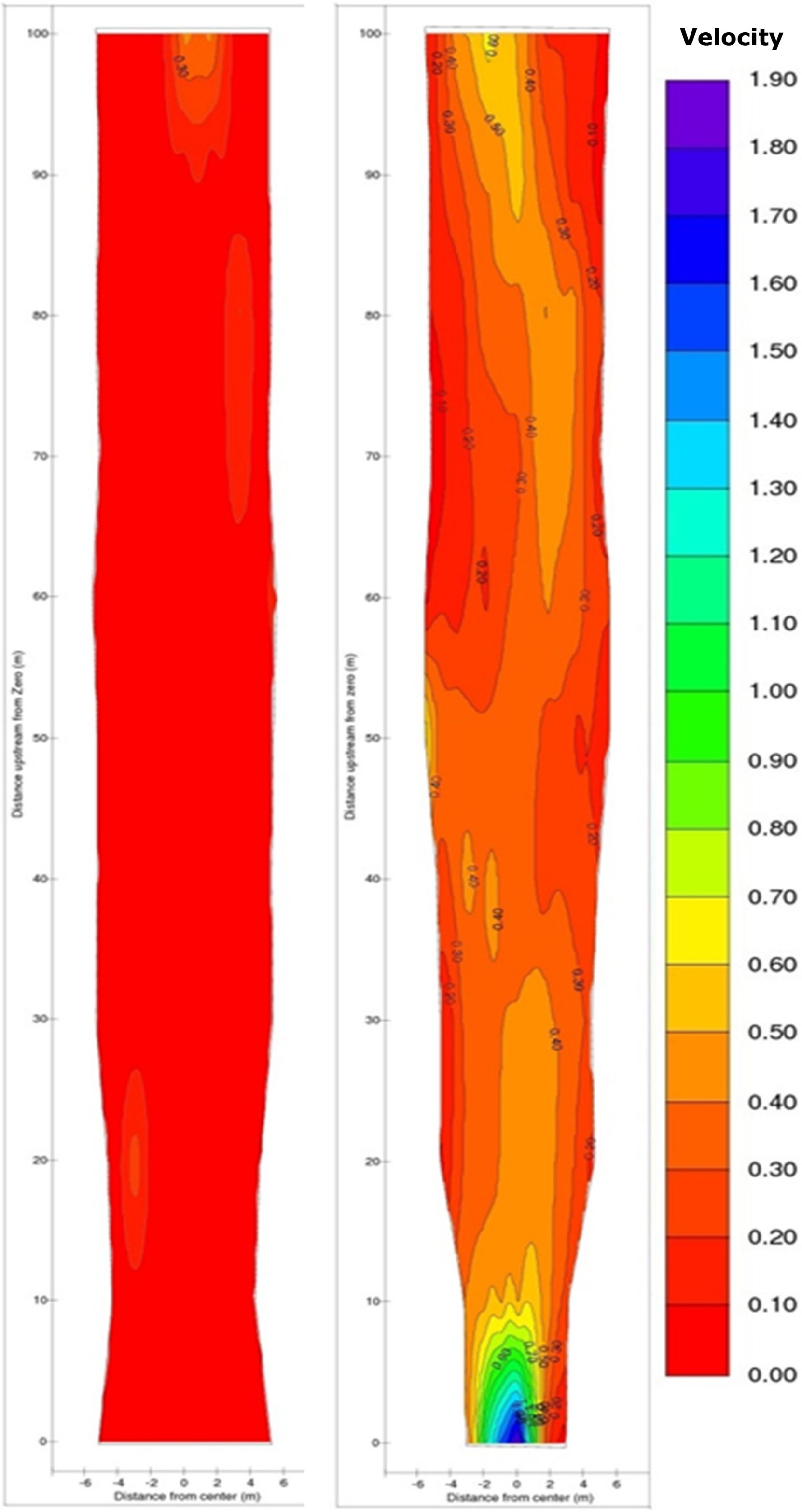

Figure 4.14. Velocity (m/sec) contour plots of the 100m upstream of Milltown Bridge pre (left – 2013) and post (right – 2015) removal of horseshoe weir and construction of alternating deflectors.

Depth/ velocity measurements were taken pre and post works and are shown in figures 4.13 and 4.14. There was a significant decrease in water depth and increase in water velocity post horseshoe weir removal. The velocity increase due to the paired deflector is apparent in the post works velocity contour plot in figure 4.14. The increase in velocity through the site had the effect of "washing out" a significant amount of large woody habitat that was present upstream of the bridge. The increase in velocity, decrease in depth and simplification of structural habitat upstream of the bridge has had a significant impact on the composition of fish species present in the site (Figure 4.15).

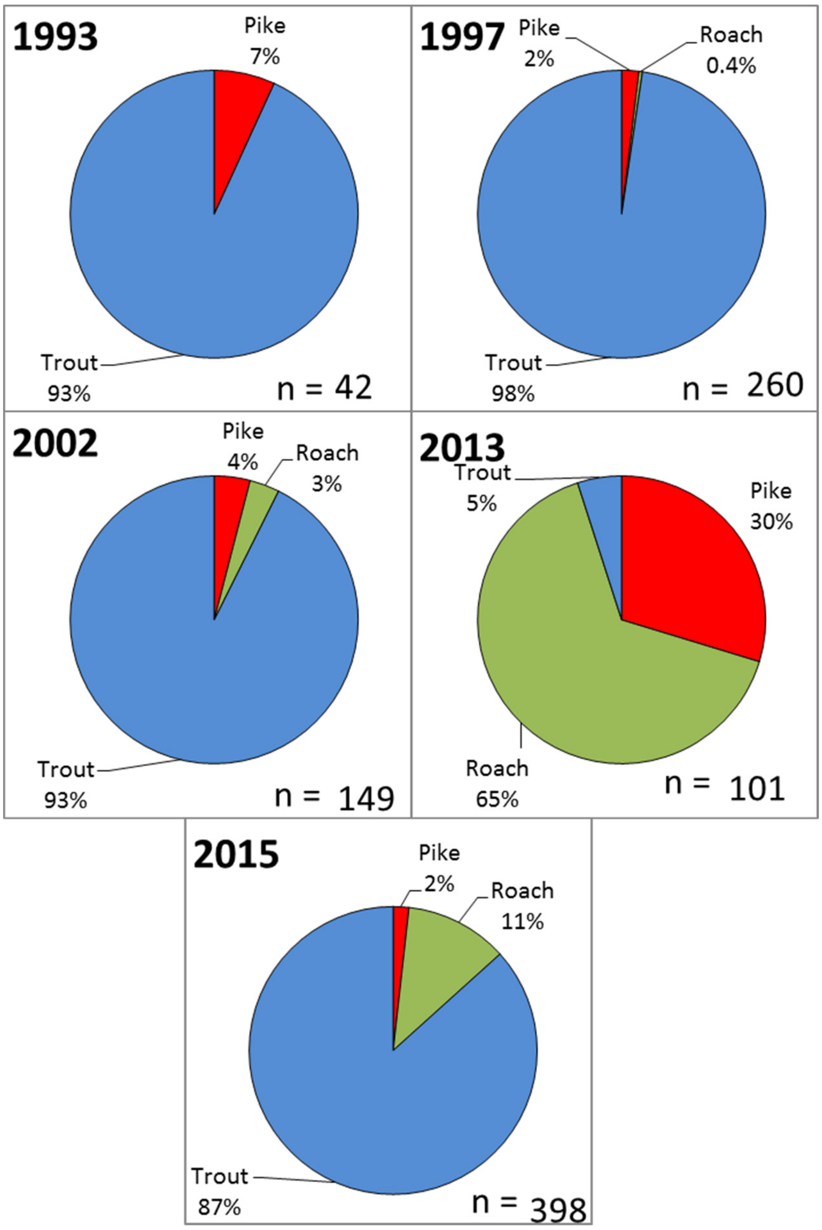

Figure 4.15. Fish community numbers and composition upstream of Milltown Bridge 1993, 1997, 2002, 2013 and 2015.

It is hypothesised that roach were introduced into the Monaghan Blackwater catchment between 1993 and 1997 as roach were not present in the original pre drainage survey of 1981. Like the pike, roach in this section of the Monaghan Blackwater are probably recruiting from the lakes upstream of this section. Fry or young of the year being washed out of lakes (Hollywood/Quig Lough) into the Monaghan Blackwater.

The horseshoe weir created a backwatering effect generating excellent river pike habitat. Reduced flow velocities allowed large woody habitat to build in this slow flowing section further improving the pike habitat. The weir alteration has effectively removed this large pike (60cm) habitat and reinstated a more natural form for this river section (Figure 4.14). Upstream of Milltown Bridge, the pike numbers decreased from 7.3 to 3.5 No/100m^2 between 2013 and 2015. The large pike (>60cm) that were utilising this section have probably redistributed themselves downstream, to slower flowing section in the Monaghan Blackwater at the confluence of the Corr River and Border Blackwater (Figure 4.16).

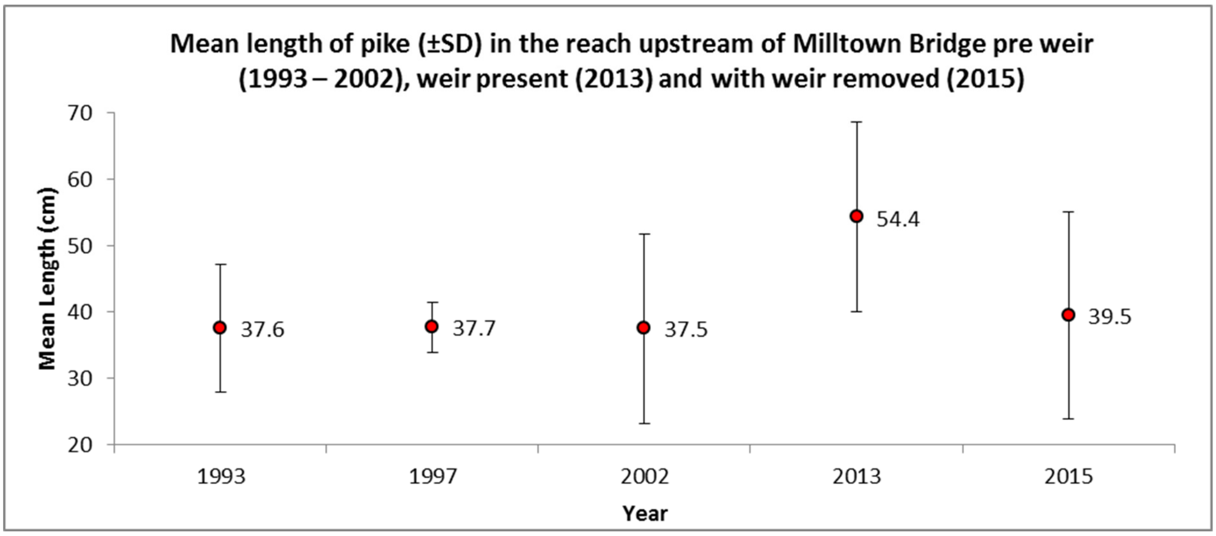

Figure 4.16. Mean length of pike (±SD) in the reach upstream of Milltown Bridge pre weir (1993 – 2002), weir present (2013) and with weir removed (2015).

The trout numbers increased from 1.0 to 48.5 No/100m^2 between 2013 and 2015. The removal of the weir upstream of Milltown Bridge has significantly reduced the pike population and increased the trout population utilising this site. Creating more available trout habitat, these works should increase the trout population in this area in the medium to long term. This section is also a large trout habitat with fish >40cm recorded each sampling year, apart from 2013. Four trout >40cm were recorded in the 2015 survey. Capital works downstream of Milltown Bridge will allow anglers to access this resource and intercept trout overspill from the site upstream (Figure 4.17).

Figure 4.17. Alternating deflectors constructed downstream of Milltown Bridge as part of the Capital works programme 2014.

4.6 Larval lamprey survey of the Boyne catchment

The Boyne – Kells Blackwater catchment was arterially drained by OPW and continues to undergo channel maintenance. In the context of the EU Habitats Directive, this catchment was designated as a Special Area of Conservation (SAC) for a suite of habitats (in Annex I of the Directive) and of species (Annex II of Directive). The species list includes the Atlantic salmon and species of lamprey. Channel maintenance has the potential to impact adversely on larval lamprey, in particular, as the larvae live in fine sediment that may be removed to improve channel conveyance (King *et al.* 2015).

The IFI's Habitats Directive fish survey team undertakes an annual programme, contributing to a six-year reporting cycle to the EU on behalf of our Minister. In the current six year cycle (2013 – 18) the IFI team has scheduled catchment-wide surveys on all of the SACs designated for lamprey. This will permit comparison with previous catchment-wide surveys undertaken in the period 2003 – 07. The results of this programme are relevant to OPW insofar as a number of the SACs correspond to Arterial Drainage Schemes e.g. Moy, Corrib, Boyne. The data generated by IFI is made available to OPW for inclusion in GIS maps that can advise OPW on lamprey sensitivities in channels and catchments. The information below was collected by IFI's Hbaitats Directive team in 2015 on the Boyne catchment and is made available to OPW.

In 2015 a total of 109 sites were selected as part of a catchment-wide larval lamprey survey on the Boyne catchment. All 109 sites were visited (Fig. 4.18). Surveying was not possible at 7 sites due to lack of access and/or no obvious suitable ammocoete habitat. Semi-quantitative electrofish surveying was undertaken at all remaining 102 locations. *Lampretra* spp. Ammocoetes or larvae (total n=583) were encountered at 73 (72%) of the 102 sites (Table 4.4). A broad range of size classes (12-153mm) were represented, considered representative of different age groups (Fig. 4.19). Densities of river/brook ammocoetes at positive sites ranged from 1-42 individuals per m^2 (Fig. 4.20). Sea lamprey ammocoetes were not encountered, despite surveying downstream of historical spawning locations.

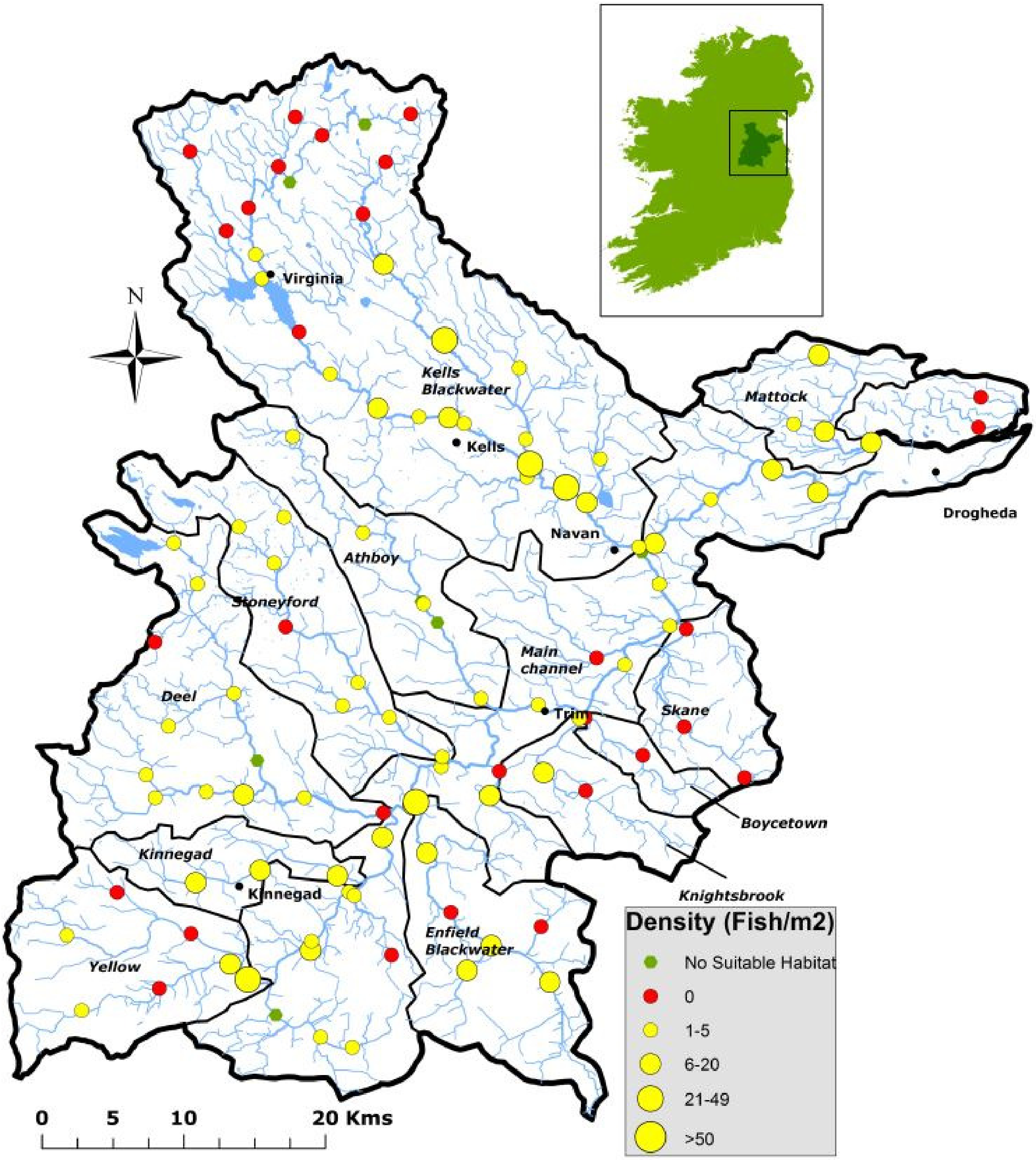

Figure 4.18. Map outlining sampling locations across the Boyne catchment for larval lamprey, August-October 2015.

An Excel spreadsheet with geo-references to the sampling sites will be made available to OPW's Environment Unit. This will allow pre-planning for OPW staff, linking information layers on channel maintenance work and on distribution of sensitive species, such as larval lamprey or ammocoetes.

Table 4.4. Comparison of distribution, density, population structure of *Lampetra* spp. ammocoetes across the Boyne catchment, August - October 2015.

	No. Sites	No Suitable Habitat	No. positive Sites	Max. Density (Fish/m^2)	Min. Density (Fish/m^2)	Mean Density (Fish/m^2)	Max. Length (mm)	Min. Length (mm)
Athboy / Tremblestown (km^2)	6	2	4	4	3	3.25 (n=15)	132	37
Boycetown (km^2)	2	0	0	-	-	-	-	-
Deel (km^2)	12	1	9	7	2	3.7 (n=35)	135	45
Enfield Blackwater (km^2)	7	0	5	26	9	13.6 (n=68)	132	16
Kells Blackwater (km^2)	29	2	17	42	1	10.1 (n=182)	215	22
Kinnegad (km^2)	3	0	3	18	11	14 (n=50)	121	12
Knightsbrook (km^2)	3	0	2	14	1	7.5 (n=15)	127	38
Main Channel Boyne (km^2)	23	2	18	15	1	7.1 (n=128)	153	17
Mattock (km^2)	4	0	4	15	4	9.3 (n=37)	148	51
North Drogheda (km^2)	2	0	0	-	-	-	-	-
Skane (km^2)	3	0	0	-	-	-	-	-
Stoneyford (km^2)	8	0	7	5	1	2.7 (n=17)	137	40
Yellow (km^2)	7	0	4	21	2	9 (n=36)	143	45

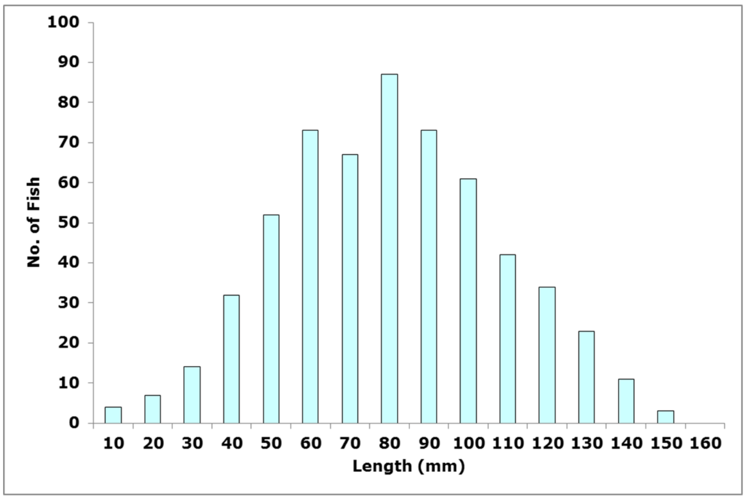

Figure 4.19. Length frequency distribution of *Lampetra* spp. ammocoetes captured at locations across the Boyne catchment in 2015 (n=583).

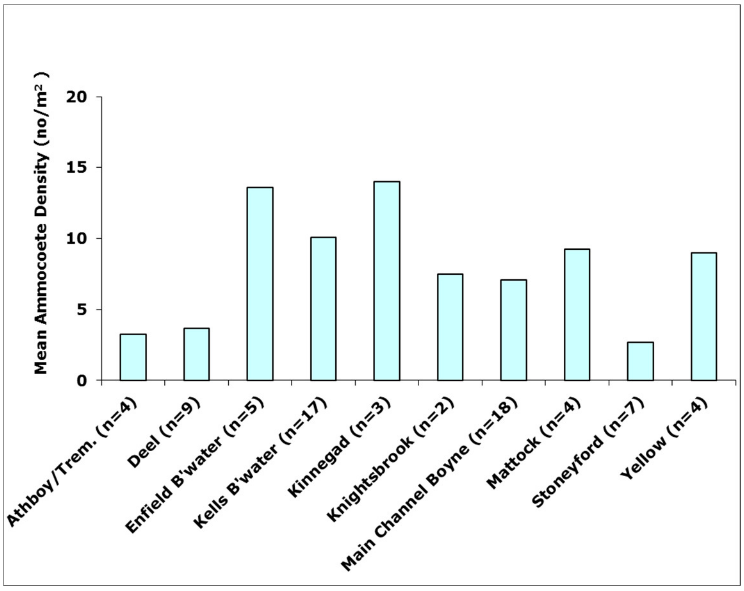

Figure 4.20. Comparative densities of *Lampetra* spp. ammocoetes recorded on tributary and main stem channels of the Boyne catchment during 2015.

Geographic distribution was similar in 2015 when compared to that observed in 2005 (O'Connor, 2006). *Lampetra* spp. larvae remain widely distributed across the Boyne catchment. Semi-quantitative electric fishing surveying was undertaken at 102 sites, with a wide geographic spread and broad representation of the range of habitat types available to larval lampreys. Ammocoetes were recorded at 73 sites (72%). Overall status can be considered favourable (Harvey and Cowx, 2003). Ammocoete densities in excess of $2m^{-2}$ were observed at 59 (81%) of positive sites, with

18 (25%) of these exceeding 10 individuals m^{-2}. A distinctive number of year classes (>2) were frequently observed in samples. However, no *P. marinus* ammocoetes were encountered.

Ammocoetes continue to be un-recorded from the Boycetown and Skane Rivers, as well as the upper reaches of the Kells Blackwater system. Distribution records showed a more widespread distribution in the Yellow, Riverstown, Kinnegad, Athboy, Knightsbrook and Mattock Rivers.

5. Hydromorphology – Barriers to fish passage in OPW channels

5.1 Introduction

Salmonids, lamprey, eels and shad engage in substantial migrations, linking spawning and recruitment grounds. Individual species recruitment migrations can be from hundreds to thousands of kilometres while growing to maturity, before returning to their spawning grounds. In freshwater systems these species migrate significant distances, an adaptation that maximised species dispersal within a watershed.

Barriers to fish passage are identified as either being natural or artificial. Natural barriers are generally of a geological origin (waterfalls). Artificial barriers are of man-made origin and take many forms. The majority were constructed to produce hydropower, supply water or to achieve a constant water level for leisure activities. These structures can have a pronounced effect on the flow regimes both down- and upstream of the barrier, affecting the aquatic species, their ecology and physical habitat. These structures can impede natural migration patterns of diadromous and catadromous fish species. As mitigation, fish passage structures are frequently inserted into weirs and dams. However, these facilities have tended to be designed to facilitate salmon with little concern for other fish species.

The Water Framework Directive (WFD) identifies the importance of hydromprphology as an essential part of ecological quality. The term hydromorphology takes in both the quantity of water (hydrology) and the form or condition of the waterbody (morphology). In addition, the term, as used in WFD, also takes in the concept of 'connecctivity' or 'continuity'. In the light of WFD, the issue of river continuity – and barriers to connectivity - has assumed an importance wider that a fisheries interest and a process of recording structures/barriers and of surveying them is now underway in Ireland. IFI is playing a lead role in this process. Two barrier assessment methodologies are employed by IFI, the standard IFI field assessment sheet (now digitized) and WFD III or SNIFFER barrier assessment protocol. IFI will utilize these tools in a two-phase assessment. Initially the digitized IFI field assessment sheet will be used to developing a national GIS-based information layer on 'features' or structures or barriers in Irish rivers. The WFD III method will be a second-phase assessment of specific structures impacting on target fish species in a catchment and that are earmarked for modification. In these cases, the WFD III assessment will be done before and after any modification.

5.2 Barrier Assessments in OPW Catchments

5.2.1 IFI barriers field assessment

IFI have been utilising the standard IFI barriers field assessment sheet in OPW catchments since 2011. This process has been streamlined with the digitization of the field assessment using portable computer tablets. The ultimate aim is to generate a geo-referenced layer for barriers or structures (natural and man-made) on Irish rivers. A series of different studies by IFI personnel has been completed, including an overview of structures in the Shannon catchment (upstream of Limerick) and several county-wide surveys undertaken through Local Authorities. To date 189 barriers have been assessed in OPW catchments (Figure 5.1). The barrier field assessment scores the risk of the barrier being an impediment to passage for several fish species. Therefore "Impassable" is a complete barrier, "High" is a significant barrier, "Moderate" is a partial barrier and "Low" is not a barrier. This scoring is then applied to the barrier for each fish species, acknowledging the different physical abilities of different species to pass barriers. Tables 5.1 and 5.2 are the Risk scores for adult salmon and lamprey in passing assessed barriers in named OPW catchments. The swimming ability of lamprey is highlighted here with 63% of barriers being high risk to lamprey passage. Compared to adult salmon, High-risk barriers comprise ~44% of the barriers surveyed with the barrier field assessment.

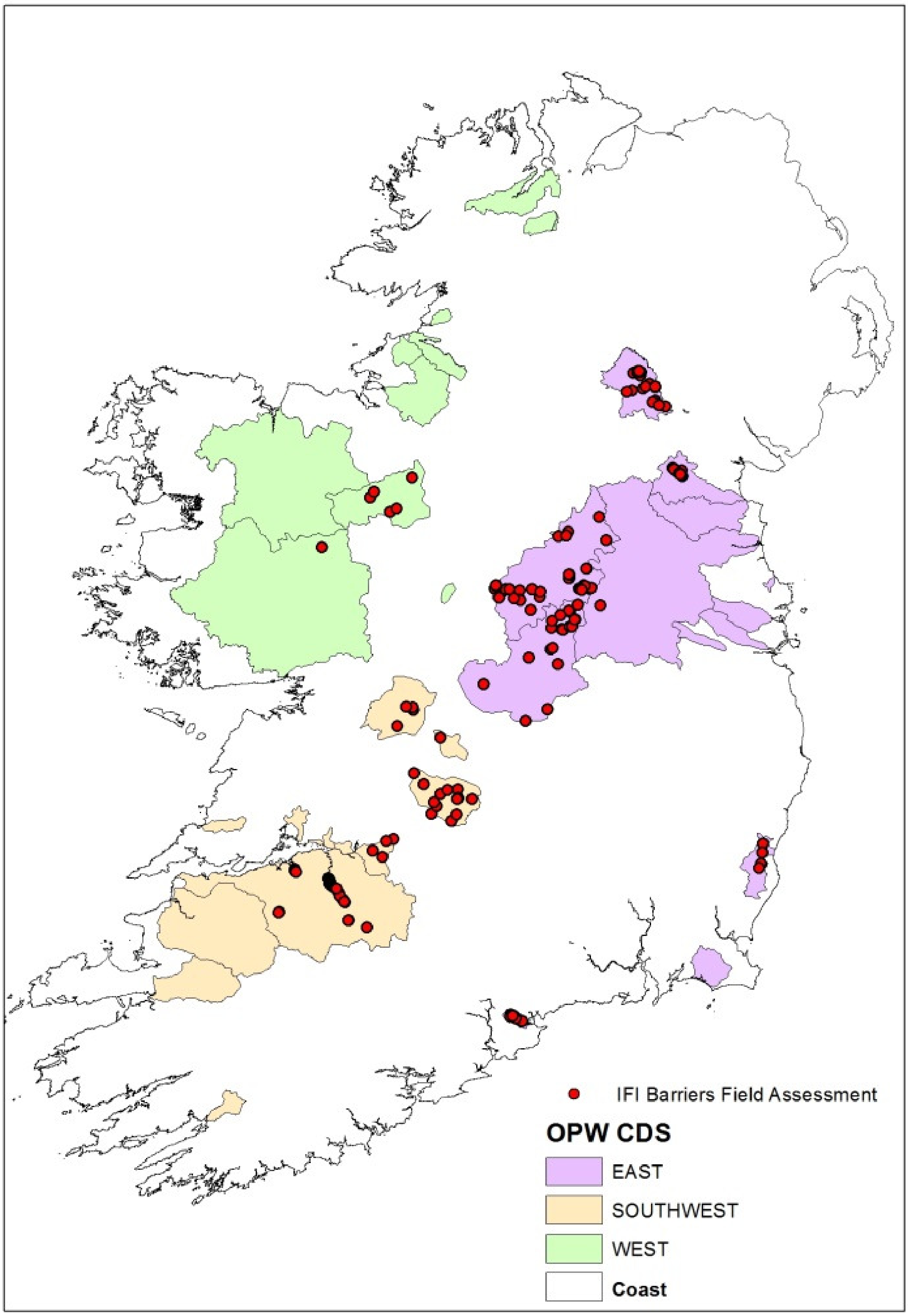

Figure 5.1. Location of barrier field assessment sites in OPW Catchments

Table 5.1. Passage risk results for adult salmon in OPW Catchments (2012-2015), calculated using IFI's onsite barrier field assessment.

CDS/ Barrier Impact	Impassable	High	Moderate	Low	Total
Boyle		3	1	1	5
Boyne		1			1
Brickey	1	11			12
Brosna		7	7	8	22
Carrigahorig			1		1
Corrib Mask			1		1
Deel		1	2	3	6
Glyde & Dee	1	16	1	3	21
Inny		20	17	13	50
Killimor		3		1	4
Maigue		2	5	13	20
Monaghan Blackwater	6	12	4	2	24
Mulkear Ballymackeogh		1	2	1	4
Nenagh		5	4	5	14
Owenavorragh		2	2		4

Table 5.2. Passage risk results for lamprey in OPW Catchments (2012-2015), calculated using IFI's onsite barrier field assessment.

CDS/ Barrier Impact	Impassable	High	Moderate	Low	Total
Boyle		4		1	5
Boyne		1			1
Brickey	1	11			12
Brosna		8	10	4	22
Carrigahorig		1			1
Corrib Mask		1			1
Deel		5	1		6
Glyde & Dee	1	16	2	2	21
Inny		26	16	8	50
Killimor		3	1		4
Maigue		19		1	20
Monaghan Blackwater	6	14	2	2	24
Mulkear Ballymackeogh		2	2		4
Nenagh		7	2	5	14
Owenavorragh		2	2		4

5.2.2 WFD III or SNIFFER Barriers Assessment

WFD III was designed to provide a methodology to allow agencies and fishery managers to identify the obstacles that have the greatest impact upon fish migration, both upstream and downstream. This allows obstacles to be prioritised for removal or to have passage facilities installed, thus maximising the ratio of ecological benefit to capital expenditure. The criteria for determining passability scores are based on published data describing the swimming and leaping abilities of different fish species. WFD III describes passability as the extent that fish passage is possible across the obstacle. Scoring is in categories from 1.0 = no obstacle, partial low impact obstacle = 0.6, partial high impact obstacle = 0.3 and complete obstacle = 0.0. However, data particularly for non-salmonid species is not extensive, and so extensive validation of the method has not been possible. Thus the scores produced, particularly for non-salmonid species should be taken as indicative, rather than as a definitive statement of the passability of an obstacle.

Seventeen WFD III assessments have been undertaken in OPW catchments to date (Figure 5.2, Table 5.2). These represent structures that IFI has recognised as being problematic to fish passage. Ahavoher Bridge on the Galey River (Feale CDS) was identified as an issue to fish passage due to a damaged fish pass. This problem was addressed in 2015 as a Capital Works measure and a follow up surveys will be initiated in 2016 (Figure 5.3).

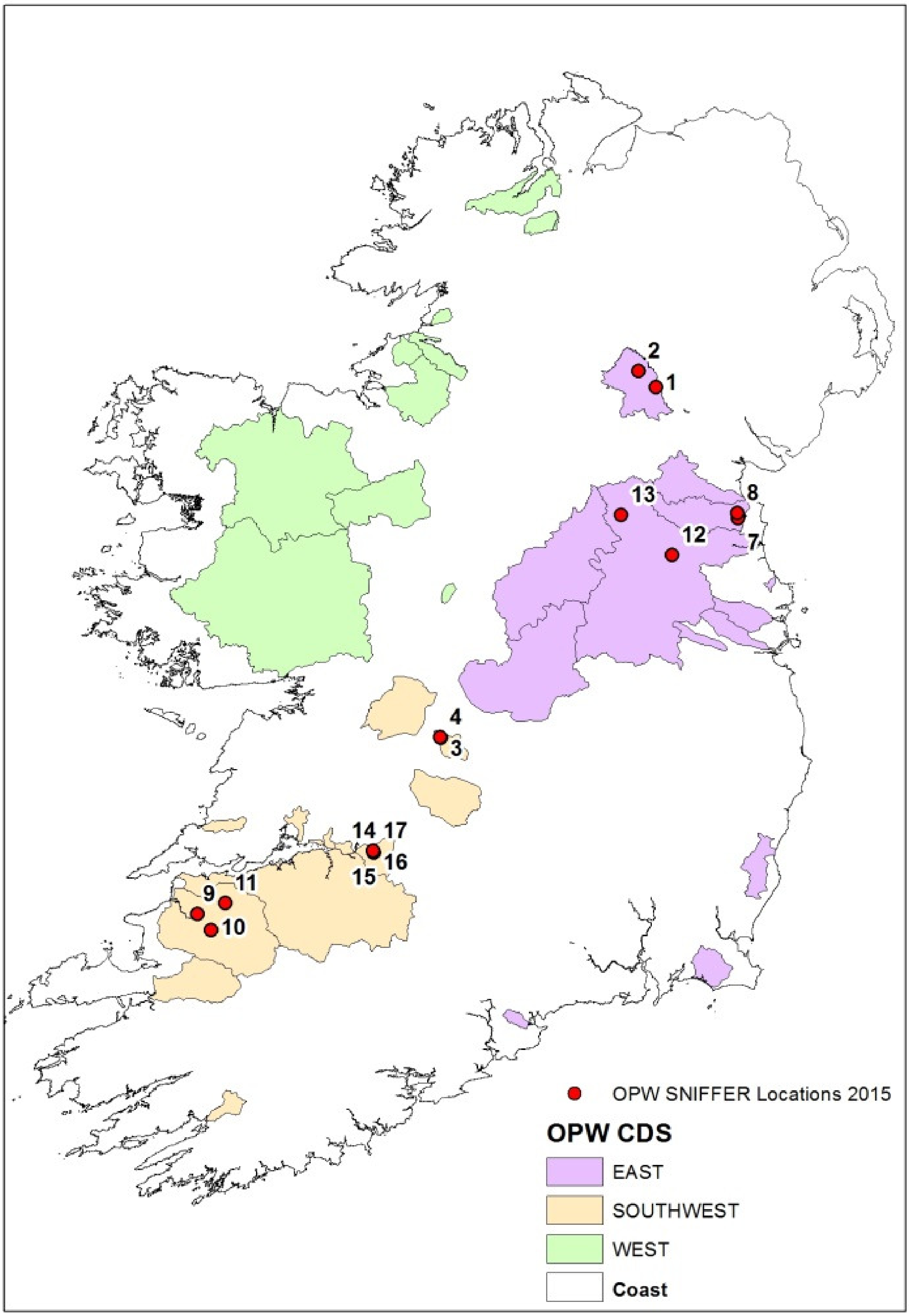

Figure 5.2. Location of SNIFFER barrier assessment sites in OPW Catchments (Sites 5-8 are on the White River, Glyde & Dee CDS) See Table 5.3 for salmon passage data.

Table 5.3. SNIFFER passage results for adult salmon in OPW Catchments. (Map Number corresponds to figure 5.2).

Catchment/ Location Name	Map Number	Complete Barrier	High Impact Partial Barrier	Low Impact Partial Barrier	No Barrier
Boyne (Kells BW)					
Martry Mill	12		1		
Virginia Weir	13	1			
Glyde & Dee (White R)					
Athclare Br	7			1	
Skibbolmore Weir	5	1			
Weir ds Athclare Br	6		1		
White River Railway Br	8	1			
Feale					
Ahavoher Br	11			1	
Bunglasha Br	10		1		
Scartlee Weir	9			1	
Monaghan Blackwater					
Annareagh South (Border) Ford	1		1		
Emyvale Weir	2	1			
Mulkear					
Annacotty Weir	14/ 17		2		
M7 Weir	15/ 16				2
Carrigahorig					
Carraigahorrig 2 (overflow)	3	1			
Carraigahorrig Weir	4	1			

Figure 5.3. 2015 remediation works at Ahavoher Bridge on the Galey River (Feale CDS), Pre (top) and Post (Bottom) works.

Structures, which are in the process of mitigation or highlighted for a WFD III assessment are Martry Mill on the Kells Blackwater (Figure 5.4), the weir upstream of Ballycathall Brige on the Kilcrow River (Killimore CDS) and structures on the main stems of the Boyne, Feale and Deel Catchments.

Figure 5.4. Martry Mill on the Kells Blackwater (Boyne CDS) a structure highlighted for mitigation (rock ramp). This is a high impact barrier to adult salmon and a complete barrier to lamprey.

6. Planning for 2016 and beyond

OPW and IFI met in autumn 2015 to review the revised workings within the EREP study and to identify strategies going forward.

Implementing works to improve hydromorphological condition: Of particular concern was the low level of implementation of the agreed 25 km of Capital Works by OPW. The aim of both the Capital Works and the Enhanced Maintenance programmes is to achieve an improvement in channel hydromorphology, consistent with the aims of the Water Framework Directive. While a programme of 25 km of detailed plans was compiled, its implementation was commonly a difficulty for a variety of reasons. One difficulty was that, in order to compile 25 km of channel plans it was necessary to assess a large number of channels and to select relatively short segments from many channels in order to arrive at a total of 25 km. This segmented approach introduced delays as deployment of materials and machinery by OPW was required at a larger number of short discrete channel sections as opposed to working continuously over extended channel lengths.

One strategy discussed at the autumn review meeting (2015) was the idea of using a combination of both Capital Works and Enhanced Maintenance strategies in order to provide longer 'works sites' where the hydromorphology would be altered and diversified in a manner appropriate to the character of the channel in question. The Capital Works strategies were all geared to altering the existing hydromorphology to create one that was more appropriate to the channel and landscape. In the case of Enhanced Maintenance, only some of the strategies are aimed at directly altering the hydromorphology e.g. Topic 10 which involved undertaking new diggings to alter the channel long- or cross-section. It was evident from audit visits in 2015, however, that strategic use of Topic 4, Managing Vegetation, could also be used effectively to 'manage' channel hydromorphology in a way that provided both conveyance benefit and habitat benefit, particularly in channel types described as 'lowland meandering rivers'.

The meeting agreed that this combined approach to improving hydromorphological condition could be trialled. Many of the plans for Capital Works for 2016 had already been developed and submitted by the November meeting and it is likely that the combined approach will be more in evidence from 2017 onwards.

Impacts of channel maintenance on Annex II species – particularly lamprey and crayfish: IFI had compiled valuable data from studies under EDM and EREP in relation to maintenance impacts on lamprey and crayfish. The impacts of maintenance on larval lamprey and recovery of the larval populations formed the basis of a scientific paper published by IFI in 2015 in a peer-review engineering journal (King *et al,* 2015). OPW have always welcomed the public dissemination of scientific findings from EREP and its EDM predecessor and were involved in authorship of the larval lamprey paper.

At the November meeting OPW requested that IF would again look at its stored crayfish information with a view to bringing forward a similar peer-review journal article. IFI identified the difficulties in bringing forward manuscripts for publication but agreed to again look at the feasibility of doing so in the case of maintenance impacts on white-clawed crayfish populations.

Other scientific studies: IFI identified that valuable, previously-non-existent data collections had and continue to be compiled in EREP. These include:

- Catchment-wide fish studies on OPW systems where such data did not previously exist
- Hydromorphology surveys (RHAT) undertaken in these catchment-wide studies
- Repeat or long-term monitoring of works programmes. The extended duration of EDM and EREP has meant that long-term impact studies are possible. A frequent shortcoming of monitoring studies is that they do not run for a sufficiently long period after completion. The available time span (1990 – 2015) has allowed for long term monitoring of arterial drainage works (e.g. Monaghan Blackwater); long-term impact of river enhancement works (e.g. TAM works on the Moy and Corrib catchments from mid-1990s); studies on environmental maintenance impacts on fish, instream and riparian features (e.g. EDM studies from 1997 – 2007 reviewed in 2012 *et seq*.)
- Impact studies of maintenance and instream works on larval lamprey and on crayfish (2005 – 2015)

The value of the long-term time frame is incalculable and the shortfall of such information is commonly identified in the international scientific literature. The capacity of the EREP study to contribute here is substantial and is a valuable ingredient in the successful 'mix' of this programme.

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