ENVIRONMENTAL RIVER ENHANCMENT PROGRAMME

Annual Report 2008

Environmental River Enhancement Programme (EREP)

Interim Report

2008

A report commissioned by the Office of Public Works (Drainage Division / Environment Section) and prepared by the Central Fisheries Board.

Central Fisheries Board
An Príomh Bhord Iascaigh

OPW
The Office of Public Works
Oifig na nOibreacha Poiblí

1. Introduction 1

2. Sampling Methodologies 3
2.1. Site Selection and Monitoring Frequency 3
2.2. Fish Sampling Methodologies 5
2.3. Physical Survey Methodologies 5
2.4. Botanical Survey Methodologies 6
2.4.1. Methodology design 7
2.5. Macroinvertebrate Survey Methodologies 7

3. Enhanced Maintenance Programme 2008 9
3.1. Selection of channels 9
3.2. Walkover Surveys 9
3.3. Current Status 10

4. River Enhancement Programme 2008 12
4.1. Selection of Sites 12
4.2. Walkover Surveys to Design Enhancement Plans 13
4.3. Progress Report 15

5. Biodiversity Assessment 17
5.1. Introduction 17
5.2. River Corridor Flora 17
5.2.1. Vegetation 17
5.2.2. Wooded sites and tree species 18
5.2.3. Habitat types and management influences on riparian plant communities 20
5.3. Macroinvertebrates 22
5.3.1. Wooded sites versus Open sites 23
5.3.2. Conclusions 25
5.4. Fish Investigations 25
5.4.1. Site comparisons 25
5.4.2. Biodiversity – fish community structures 27
5.5. Hydromorphology and Physical Assessment 29
5.5.1. Width and Depth 30
5.5.2. Flow 31
5.5.3. Canopy Cover 33
5.5.4. Longitudinal and Cross Sectional Profiles 35

6. Other Scientific Studies 37
6.1. Lamprey Studies 37
6.2. Crayfish Studies 39

7. Training Programme 44

8. Auditing Programme 45

Acknowledgments and Project Personnel 49

References 50

1. Introduction

Since the early 1990's the OPW have been in engaged in scientific studies with the Central Fisheries Board. The aims of such studies have been 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, 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 a new research programme this year, 2008, - Environmental River Enhancement Programme (EREP).

This new programme has two major strands – one dealing with enhancement or restoration of the pre-drainage hydraulic regime and the second dealing with the robust implementation of OPW's recently-developed protocol 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 will include monitoring fish, aquatic invertebrates, riparian and instream vegetation as well as mammals and birds 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 will be a significant component, complementing the biodiversity studies.

Scientific studies investigating lamprey and crayfish, initiated through previous OPW projects, will also be incorporated into the EREP project initially.

It is the intention of OPW to implement river enhancement, on a national scale, in those channels where the pre-drainage hydraulic regime can be achieved and maintained naturally thereafter. This will involve a capital works programme, funded and undertaken by OPW and using OPW's existing field staff experience base. 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. It is envisaged that a total of 100km of channel will be targeted annually through both strands of the programme.

A driver training programme was initiated during the EDM project (Environmental Drainage Maintenance (2002-2006)), in which the protocols developed for environmentally friendly maintenance were described and discussed with OPW foremen, machine drivers and other key members of staff, involved in maintenance programmes. The new EREP project will deliver the next phase of driver training, which will be an updated version of the original training programme, aimed at focusing on those areas of enhanced maintenance which are proving difficult for machine drivers to implement. The new training regime will incorporate new Standard Operating Procedures (SOPs) being developed by OPW's Environment Unit. These have particular relevance to biodiversity issues insofar as they relate to handling populations of Annex II (Habitats Directive) species such as lamprey, crayfish and otter. They are also highly significant in regard to invasive aquatic species. The updated programme will be developed by a small group of Central and Regional Fisheries personnel along with a member of the Environmental Section of OPW. Phase two of training will be initiated in late 2009 and rolled out to OPW staff early in 2010.

A follow up to the driver training programme has, in previous projects, involved site visits to a number of drivers actively implementing drainage maintenance. The aims of these visits are to assess whether environmentally friendly maintenance is being achieved, whether the potential has been identified and acted upon and how successful it is. This process will be continued during the EREP study.

2. Sampling Methodologies

A detailed description of all sampling methods is provided in a separate document (CFB Sampling Methodologies for EREP, 2009). This section presents a summary of these sampling methodologies.

2.1. Site Selection and Monitoring Frequency

Where possible, paired sites are selected and may include more than one pair of sites within the same channel, depending on the type of works being carried out within that channel. One of these sites should act as a control in which no manipulation occurs and the second as an experimental section which would receive treatment / enhancement (e.g. tree clearing, pool digging etc.) in a pre-determined manner. Within each site (Control or Experimental) a series of replicate sub-sections are delineated. The length of replicates will be a product of the channel width and the sequence of hydraulic features present within, e.g. riffles / glides / pools. Each of these replicates should be representative of the river as a whole and if a physical feature of the channel is to be measured (e.g. berms, shading), it must be uniformly present throughout the five replicates within the site. The establishment of five replicates within each site allows for future statistical analysis. If sites are being compared (e.g. wooded, open) optimally, a similar base width and volume discharge should be present at each site. Baseline monitoring is carried out prior to any treatment / enhancement works. Future post-monitoring should occur at pre-determined intervals at approximately the same time of year and with similar water levels. Paired experimental and control sites should be monitored within the same week and under similar water conditions.

An overview of channels locations, included in the 2008 EREP project, is presented in Figure 1.

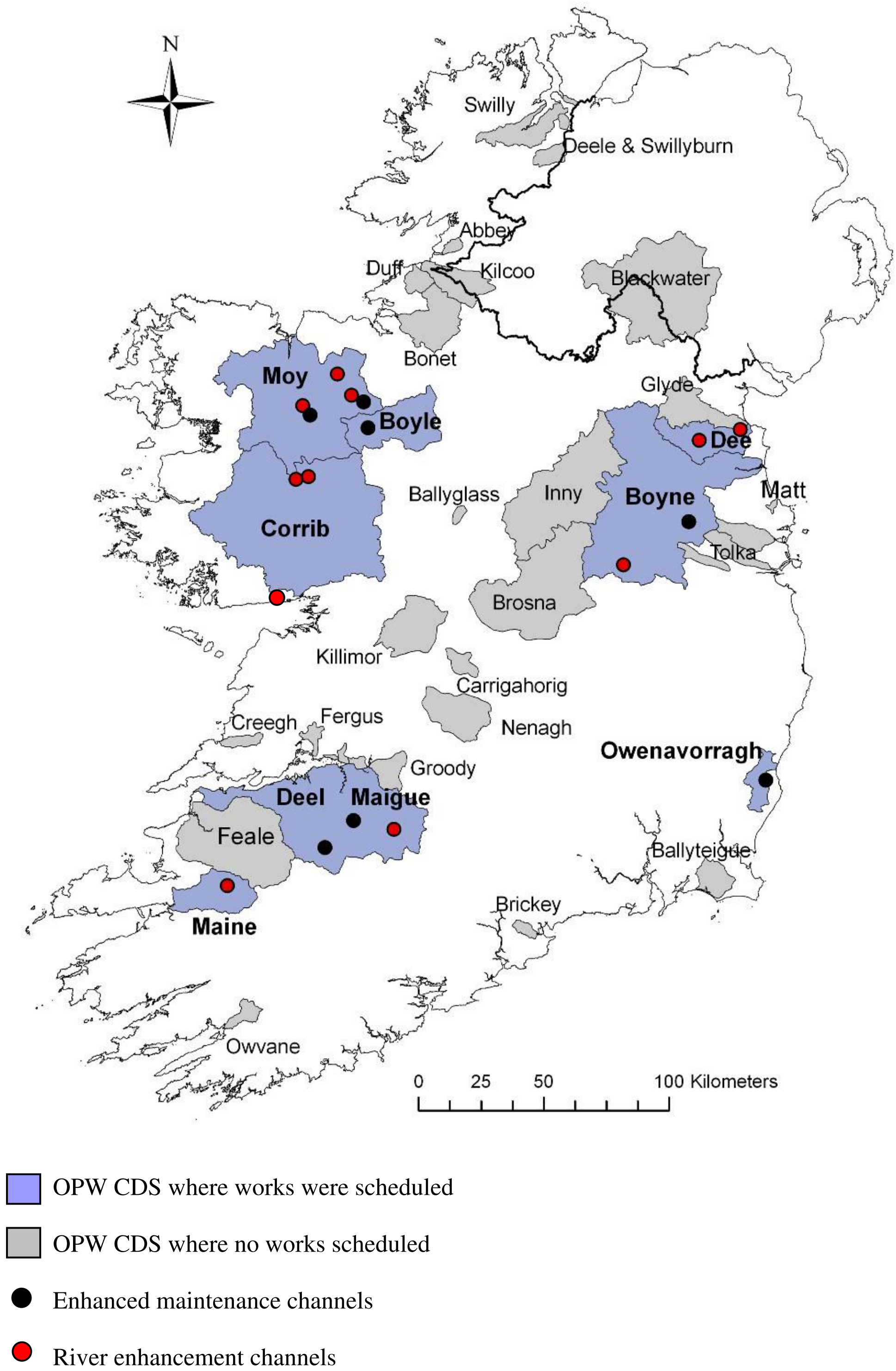


Figure 1. Location of channels identified for enhancement works under EREP in 2008.

2.2. Fish Sampling Methodologies

The principal emphasis, within the EREP fish stock survey, is on brown trout and salmon. Data collected will provide information concerning population estimates (nos/m^2), length frequency distributions, age structure and growth patterns. An assessment of the occurrence, population size and structure of all other fish species is also required. As population estimates are not calculated for non salmonid species an abundance rating is presented. This system scores fish abundance 1 – 5 scale (1= 1-10 fish , 2= 11-50 fish, 3= 51-100 fish, 4= 101-200 fish, 5= >200 fish).

Choice of electrofishing equipment, used to assess fish stocks in rivers, varies depending on the wetted width of the channel and its depth. In general, shallow wadeable waters are sampled using bank-based electrofishing equipment. Deeper channels require the use of small flat bottomed boats and the suitable electrofishing equipment. A third option is available, back-pack electrofishers, which would be used mainly to 'spot fish'.

Quantitative electrofishing methods are always employed, with the exception of 'spot fishing'. With quantitative methods there are two options in use, depletion fishing or mark and recapture fishing. The method chosen will depend on the length of channel to be surveyed. It is important to use the same technique on all subsequent electrofishing occasions.

2.3. Physical Survey Methodologies

This type of sampling involves taking a series of measurements which represent channel dimensions, throughout the selected sites, including all replicates. Variables to be measured include bank-full width, wetted width, channel length, depth, velocity and canopy cover). These measurements will be taken annually, initially, at those sites where alteration or changes in these dimensions are likely to occur as a result of enhancement or of maintenance works. Transects are uniformly spaced, at 5 - 10m intervals, depending on channel size and length of replicate site. Each of these measurements should be taken at right angle transects from left hand bank to (LHB) to right hand bank (RHB).

Longitudinal and cross sectional surveys of a channel under investigation are undertaken using a theodolite or levelling telescope and 5m telescopic survey staff and surveying was conducted using standard engineering practices. Cross sections are taken at representative locations along the river bank and measured from LHB bank top to RHB bank top. Long sections are measured at 5m intervals up through the river channel, from the bottom of the site. A permanent benchmark is also located at each site to allow for accurate re-measuring during subsequent visits. Permanent wooden stakes are installed on the bank in each cross section to ensure that cross sections will be measured in the same place before and after maintenance.

Velocity is measured using a Marsh McBirney Flow-mate™ portable flowmeter (electromagnetic). This type of meter was chosen as it can be used in situations where rotary meters cannot be operated, such as within clumps of vegetation. The meter is mounted on a top-setting wading rod, which allows the current meter to be easily set to the standard engineering recording depth (60% of depth). 14 width/depth/velocity measurements are taken in the cross sectional transect of any specified channel. The number of readings taken permits a calculation of 'Q' or volume discharge.

Depth is measured, at transects of 5m intervals, to the nearest centimetre using a survey staff. 5 readings are taken (evenly spaced) across the transect in the wetted width and 2 more, 1 at each margin within 0.05m of the wetted edge.

Canopy cover, also known as, crown closure, crown cover, or canopy closure, is defined as the percent of canopy overlying the forest floor / river bed. Canopy cover/closure is measured to the nearest percent using a concave Spherical Densiometer. The canopy cover readings are taken 30cm off the waters surface. Shading from tall marginal plants, as well as from woody canopy, may also be taken into account.

2.4. Botanical Survey Methodologies

Collectively, the three vegetation 'types' that contribute to a properly functioning river corridor are the aquatic (in-channel), the marginal and the riparian plants. Given this, any survey methodology must sample all vegetation types to get a representative record of the flora of the river corridor. Sampling of the control and experimental area is conducted before and after treatment allowing changes recorded to be compared within and between sites.

2.4.1. Methodology design

Three strands were involved in the sampling programme for aquatic and riparian plants:

Strand 1: Vegetation Structure and Functional Habitats

The purpose of this was to provide information on the range of functional habitats that vegetation may be providing for aquatic invertebrates, fish and other animals. It involved an overview assessment of the extent and complexity of bankslope cover, of the instream plant forms and extent of cover, of tree cover and of significant habitat features - shading of channel, exposed bankside roots and underwater tree roots and fallen trees. In addition, land use within 5 m of the top of the bank full line was also assessed.

Strand II: Survey of ground cover

A detailed botanical survey was undertaken at each site. This had two elements:

I. Qualitative: A walkover survey of the entire site to compile a species inventory of riparian and instream species.

II. Quantitative: A series of 1x1m quadrats were taken from botanically representative areas within a site. Within these quadrats a quantitative assessment of individual species was compiled, in terms of aerial cover

Strand III: Tree Survey

A species list and record of composition and abundance of tree cover in the site was compiled together with a general record of the age/size structure.

2.5. Macroinvertebrate Survey Methodologies

The macroinvertebrate community of a river responds quickly to change and so it is a good reflection of conditions in the short-term. Invertebrate assemblages reflect changes in habitat as well as changes in water quality as most species have preferences for either fast or slow flowing water, sheltered or exposed areas, silt or cobbles. The objective of this study is to adequately assess changes in the aquatic macroinvertebrate community following execution of capital enhancement works. Incorporated within this objective is the requirement to describe the biodiversity of the macroinvertebrate community.

As with all other aspects of the EREP project there is a need to provide a species inventory list for OPW channels. The development of the aquatic macroinvertebrates species inventory will be an ongoing task that will be built upon over the life of the EREP study. This programme will also involve monitoring the impacts of enhancement works, pre- and post development within a selected number of channels, on the macroinvertebrates. Again this monitoring will involve sampling both experimental and control sites. Individual samples will be taken from a range of niche locations within replicates. All samples will be identified to the lowest taxonomic level suitable for water quality assessment, in accordance with EPA guidelines. Following identification, taxa will be allocated to their functional feeding group. This will compliment the biodiversity taxonomic listing and show changes in community composition that may be a reflection of the OPW's instream works e.g. removal of stone material and vegetation may reduce the number of shredders and grazers present in a site.

3. Enhanced Maintenance Programme 2008

Every year the OPW draw up a maintenance schedule to be carried out on drained channels within that year. It is the policy of the OPW that all channel maintenance be achieved in an environmentally friendly manner, using the 10 point environmental approach. This project aims to develop and expand these methods and provide assistance to achieve greater implementation of enhanced maintenance where it is possible to do so. A target of 50km of channel is to be selected annually for walkover survey compilation and execution of enhanced maintenance options elaborated in the survey report.

3.1. Selection of channels

Channels included under this project are selected annually from those included in the annual OPW maintenance programme. They are chosen on account of their physical and ecological characteristics such as gradient, flow regime and riparian vegetation and the extent to which these might permit application of one or more of the 10-point environmentally sensitive guidance elements. They may also offer the opportunity to experiment with enhancement techniques and further develop existing maintenance procedures. OPW have three regional districts (East, Southwest and the West) and, where possible, a number of channels will be included from each of these regions.

3.2. Walkover Surveys

The purpose of walkover surveys is to get an impression of the ecological and physical characteristics of given channels. This allows fishery staff and the OPW to ascertain if a channel is suitable for enhanced maintenance works. It also allows for the identification of opportunities to implement specific environmental engineering techniques such as the creation of pool, riffle glide sequences, loosening of gravel beds and selective vegetation removal in clearly defined locations.

In 2008, walkover surveys were undertaken in seven channels. Reports were compiled in each case by the EREP team and circulated to the resident OPW engineer and foreman as well as to the local senior Regional Fisheries Board officer. The walkovers specified works – both habitat retention elements and experimental opportunities – based on a full implementation of the 10-point environmental guidance notes. Works were specified over a total of 33 km in 2008 (Table 1).

3.3. Current Status

Heavy rainfall throughout the summer and early autumn resulted in access problems and the diversion of OPW machinery and man power to flooded areas. This prevented work taking place on the Deel, the Gloshagh and the Owenavorragh Rivers. Enhanced maintenance works have been completed on a number of the designated channels with a total of 15.6km achieved in 2008 (Table 1). Particular problems arose in regard to both the Boycetown and the Gloshagh. In each case, two elements dominated the enhanced maintenance proposals – excavation of pools and management of extensive tree lines. The extent of the latter compromised execution of the former. Tree management is confined to an autumn-winter environmental window while instream works on salmonid channels are confined to a summer – early autumn window. A strategy of double-handling is required, with two passes, one in each appropriate season, to achieve both element of the enhanced maintenance. This double-handling has been used by OPW's Southwest Region in the past and is being applied to the present situation in both the Boycetown (Boyne) and the Gloshagh (Maigue) channels.

Table 1**:** Channels subject to walkover survey and proposed enhanced maintenance works in 2008.

Catchment	**River**	**Location**	**Channel Code**	**Peg No.**	**Length of channel designated (m)**	**Length of channel achieved (m)**
Boyne	**Boycetown**	U/s of confluence to Boycetown Bridge	C1/15	0 - 67	6125	2725 (incomplete)
Owenavorragh	**Owenavorragh**	U/s Ballycanew Bridge	C1	118 - 156	3750	to be undertaken in 2009
Boyle (Lung tributary)	**Kilaclare Stream**	Outfall to Lung u/s to peg 44	C1/16	0 - 44	4023	**COMPLETED**
Moy	**Killeen Stream**	Bridge at Meelick to N5	C1/31	32-78	4206	**COMPLETED**
Moy	**Owengarve**	Srah Upper to Calveagh Upper	C1/48	190 - 241	4663	**COMPLETED**
Maigue	**Gloshagh**		C1/30	0 - 81	7400	to be undertaken in 2009
Deel	**Deel**	Accrour Bridge to Ballymongaun Bridge (B17 - B18)	C1	464 - 498	3109	to be undertaken in 2009
				Total	**33,276**	**15,617**

The support of Regional Fisheries Board was significant in undertaking the walkovers and in developing agreed strategies. In addition, RFB colleagues provided on-site support to OPW during the course of implementing enhanced maintenance options. This was particularly the case in the C1/16 tributary of the Boyle system. Such linkages will, inevitably, lead to greater local liaison between RFB and OPW staff, with potential for an acceleration of implementation of cost-effective and environmentally-sound enhanced maintenance options

River channels that were scheduled for maintenance in 2008 and not initiated or subject to incomplete works will be targeted in 2009 as well as other channels identified for the coming year.

Table 2: Summary of Proposed Enhanced Maintenance Works

River	**Proposed Enhanced Maintenance Works**
Boycetown (C1/15)	Extensive scrub and tree clearance in tunnelled zones. Some instream vegetation removal and excavate riffle/pool sequences
Owenavorragh (C1)	Excavate pool/riffle sequences, prune and remove fallen trees, remove flaggers and maintain berms in EDM manner
Kilaclare (Lung trib.) (C1/16)	Excavate riffle/pool sequence, removal of instream flagger vegetation, berm management and some tree pruning
Killeen (C1/31)	Excavate riffle/pool sequence, removal of instream flagger vegetation, berm management and some tree pruning
Owengarve (C1/48)	Creating riffle/pool sequences, selective thinning/pruning/removal of the riparian cover, over digging of the channel bed to create a thalweg, selective management of flaggers to retain sinuous flow path in relevant areas
Gloshagh (C1/30)	Extensive scrub and tree clearance in tunnelled zones. Some instream vegetation removal and excavate riffle/pool sequences
Deel (C1)	Extensive berm management, limited tree pruning, some instream vegetation removal

4. River Enhancement Programme 2008

4.1. Selection of Sites

Sites were selected for the river enhancement strand of EREP using three main criteria - gradient, development potential and water quality. Previous studies undertaken by the CFB have shown that the capacity of any salmonid riverine channel, to support juvenile salmon and juvenile and adult trout, can be significantly reduced by poor water quality (Kelly *et al*., 2008). In Ireland water quality is monitored by the Environmental Protection Agency (EPA) who categorise river water quality on the basis of macro-invertebrate community composition/diversity in association with aquatic plants (macrophytes and algae) and water chemistry. The resulting EPA quality rating system (Q-Values) allows for in-situ assessment of the water quality of rivers and streams. The Q-value system rating system is from Q1 - bad status to Q5 - high status (Table 3).

Table 3**.** The EPA scheme of Biotic Indices or Quality (Q) Values and its relationship to water quality is set out bellow (EPA 2008)

Q' Value	Community Diversity	Water Quality	Condition *
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Much Reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very Low	Bad	Unsatisfactory

* 'Condition' refers to the likelihood of interference with beneficial or potential beneficial uses.

Based on the findings of the Kelly *et al.* (2008) study habitat enhancement for salmon should only be undertaken if a Q3-4 or greater is achieved, with trout slightly more tolerant at Q3. Consequently, any work undertaken in zones where water quality indicator values are below a Q3 will not be effective, in terms of increasing salmonid production. Therefore it is important that potential enhancement zones have relatively good water quality and those rivers failing this water quality criteria may be rejected for possible enhancement works.

Channel gradient is probably the most important factor that will ultimately determine the suitability of a channel reach for river enhancement. Gradient refers to the degree to which the river bed is inclined over a specified length of channel (e.g. a mountain stream with a gradient of 10% falls one meter for every ten meters of horizontal length). The identification of high gradient river sections is critical, as it is the combination of gradient, volume discharge and bed type, which dictates rehabilitation techniques. If the gradient is below 0.2% existing enhancement structures are likely to fail due to silting and impoundment of water flow. At the opposite end of the scale very high gradients (≥ 4%) could result in an enhancement structures simply being washed away.

The developmental potential of the channel is also of concern; will the structures put in place make a meaningful difference to fish numbers in the river? This can be ascertained by consultation with the relevant Regional Fishery Board, and then through walkover surveys of the channels identified. Exploratory electrofishing can also be undertaken to examine the extent of any imbalances in the fish stocks. Other possible sources of information are also scrutinised, such as the CFB's catalogue of aerial river photographs and historic fisheries data. These sources are then used to identify imbalances in the river corridor which can then be addressed with the construction or development of specific enhancement structures. Developmental potential can simply be broken down to which fish population in a number of rivers or catchments is in greatest need of fisheries enhancement.

In a limited number of circumstances more specific operations at discrete locations will be undertaken. For example, the repair/modification of fish passes or bridge 'floors' in drained rivers which are impeding the passage of fish.

4.2. Walkover Surveys to Design Enhancement Plans

Walkover surveys have been an essential part of the EDM programme since its inception and this valuable procedure has been carried through to the new EREP programme. It allows for several kilometres of channel to be surveyed and is an ideal opportunity to identify problems apparent from each agency's point of view and to discuss how compromise strategies might be undertaken in designing the enhancement plan. These documents are of particular value to foremen in implementing the agreed enhancement plan, and ensure the precise placement of enhancement structures. The channels selected for EREP enhancement in 2008 are listed in Table 4, along with a brief description of works to be undertaken. In total 13 draft enhancement plans were generated for the EREP project in 2008. The level of detail in these plans is illustrated by example below (Plate 1).

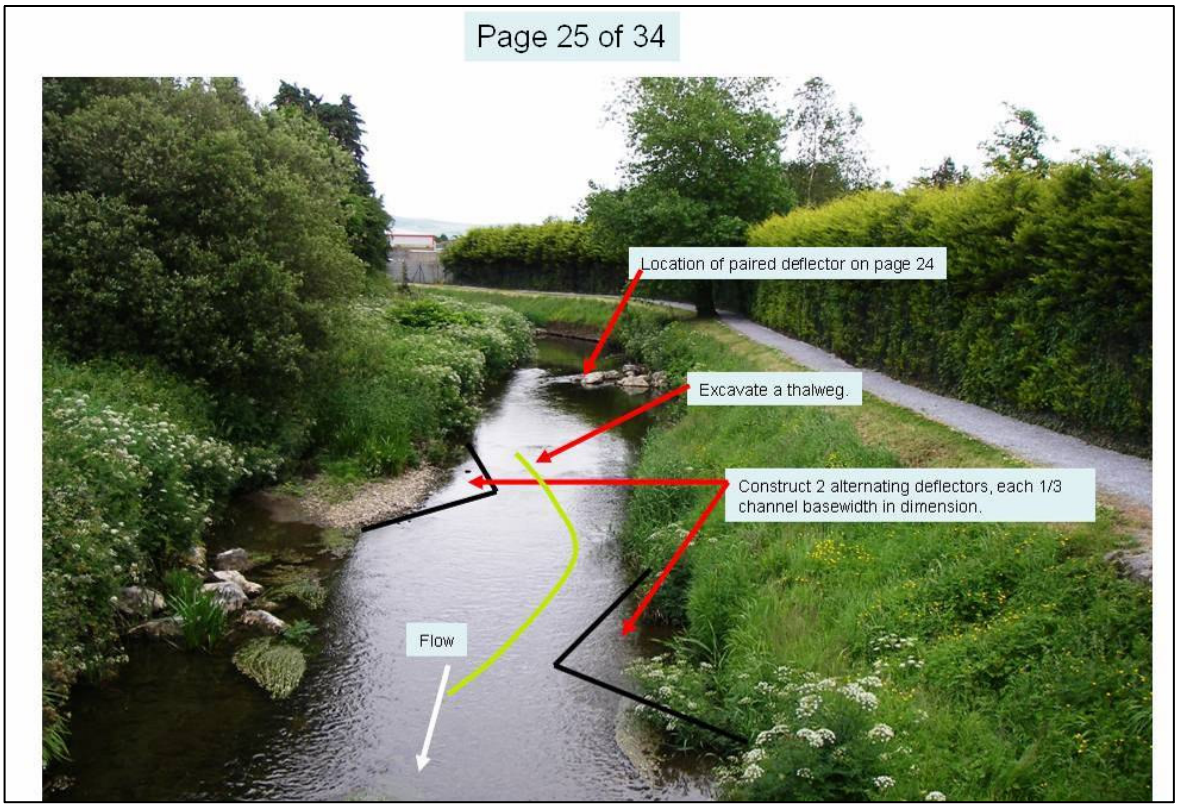


Plate 1. A typical page from an EREP enhancement plan report (R. Maine, C1).

Table 4. Channels selected and works proposed for the EREP enhancement programme in 2008.

CDS	River	Brief Description of Works
Glyde & Dee	Dee (C2/1)	Extensive Christmas tree work, random boulders, pool development. Fence LHB, toss gravels in small sections. Low grade vortex weir and rip rap
Glyde & Dee	Dee (C2/1)	Extensive random boulders, gravel tossing and debris removal. Improve thalweg and excavate a number of pools. Paired deflectors/point bars
Boyne	Mongagh (C1/64/1)	Vortex stone weirs, thalweg excavation and tree pruning are the prominent features. Pools and gravel shoals also constructed
Moy	Spaddagh (C1/35)	Creating/repairing fish pass at outflow of river
Moy	Clydagh (C1/21/1)	Repairing old fish pass
Moy	Owenaher (C1/54)	Thalweg excavation, random boulder placement and fencing are the prominent features gravel shoals also to be constructed
Moy	Owengarve (C1/48)	Tree Pruning, channel/thalweg excavation and rock weir construction needed in this zone
Moy	Owengarve (C1/48)	Fencing, rip rapping, alternating deflectors and vortex weirs in this section
Corrib	Nanny (C3/18)	Alternating deflectors and excavate thalweg.
Corrib/Mask	Robe (CM4)	Rubble mat, pool and thalweg excavation are predominant features. Cattle drinker and random boulders also in plans
Corrib/Mask	Robe Trib. (CM4/32)	Deflectors, thalweg excavation and prunning
Corrib/Mask	Robe (CM4)	Experimental and extensive control section. Expermental section containing alternating/paired deflectors and pool excavation
Maigue	Morningstar (C1/31)	Gravel shoals, vortex weirs and rubble mats are predominant features. Some rip rap and thalweg excavation
Maine	Maine (C1&C1/36)	Paired/alternating deflectors, random boulders and thalweg excavation prominent features. Pool excavation and vortex weirs also suggested

These rivers were selected because they meet all the above mentioned criteria and it was felt that any enhancement work carried out at the above locations would significantly improve fish stocks in those rivers. Enhancement work on the Clydagh (C1/21/1) and the Spaddagh (C1/35) was limited to easement of fish passage.

Following the implementation of enhancement plans each project will be reviewed and an implemented plan, as opposed to the initial draft plan, will be documented.

4.3. Current Status

Heavy rain and the resulting flooding caused serious delays and rescheduling in the EREP river enhancement programme of 2008. Of the 13 EREP scheduled works only 4 sites were selected to be surveyed pre-works. Pre-works surveys are important to allow for pre and post works analysis at a later date. The pre-surveys undertaken on EREP river enhancement sections are given in Table 5.

Table 5. Showing EREP channels which were surveyed pre-works and the information collected.

Catchment (CDS)	River	Channel code	Fish Survey	Plant Survey	Hydromorphology Survey	Macroinvertebrate Survey
Corrib	**Robe**	CM4	No	Yes	Yes	Yes
Glyde and Dee	**Dee**	C2/1	No	Yes	Yes	Yes
Maigue	**Morningstar**	C1/31	Yes	Yes	Yes	Yes
Maine	**Maine**	C1 & C1/36	Yes	No	No	Yes

A complete breakdown of the 2008 EREP river enhancement programme is given in Table 6, with the total proposed and completed enhancement channel lengths provided. Approximately 14km of channel were identified for enhancement under the 2008 EPEP programme, of this only 3.8km were completed. This was mainly due to bad weather and the associated flooding.

River channels that were scheduled for enhancement in 2008 and not initiated or subject to incomplete works will be targeted in 2009 as well as other channels identified for the coming year.

Table 6. Channels selected for the EREP river enhancement programme with length of works proposed and works completed for 2008.

CDS	River	Location	Channel Code	Peg No.	Completed	Length of Channel Designated (m)	Length of Channel Achieved (m)
Glyde & Dee	**Dee**	Hem Br	C2/1	317 - 322	No	634	
Glyde & Dee	**Dee**	Drumcar Br	C2/1	49 - 68	No	1769	
Boyne	**Mongagh**	Castlejordan Br d/s to confluence with Yellow R	C1/64/1	0 - 14	**Near completion**	1177	951
Moy	**Clydagh**	East of Park by Camp site	C1/21/1	85 - 87	No	157	
Moy	**Owenaher**	at Bellanagraugh	C1/54	26 - 32	**Partially completed**	502	331
Moy	**Owengarve**	u/s of Curry	C1/48	94 - 104	No	1029	
Moy	**Owengarve**	u/s of confluence with Owengarve R	C1/48	173 - 178	**Yes**	416	416
Moy	**Spaddagh**	Outfall of Spaddagh River	C1/35	0 - 2	No	98	
Corrib/Mask	**Robe**	d/s of Hollybrook Br	CM4	289 - 299	**Yes**	1396	1396
Corrib/Mask	**Robe**	u/s of Hollybrook Br	CM4	299 - 391	No	1111	
Corrib/Mask	**Robe Trib**	First trib. u/s of Crossboyne Br on RHB	CM4/32		**Yes**	682	682
Corrib/Mask	**Nanny**	Tuam	C3/18		**Yes**	160	160
Maigue	**Morningstar**	d/s of Elton	C1/31		No	1228	
Maine	**Maine**	u/s and d/s of Castleisland	C1 & C1/36		No	3790	
					Total (m)	14,147	**3,935**

5. Biodiversity Assessment

5.1. Introduction

Assessing biodiversity involves both the number of plant/animal species present and the quality, diversity and complexity of physical habitat and the interaction between these elements within the river corridor.

5.2. River Corridor Flora

5.2.1. Vegetation

In excess of 190 plant species were recorded overall. Of these, the overwhelming majority of species (165 +) were riparian with aquatic (in channel) and marginal species constituting the rest. Species numbers recorded per site ranged from 29 to 74, with the majority of sites lying in the range of 30-50.

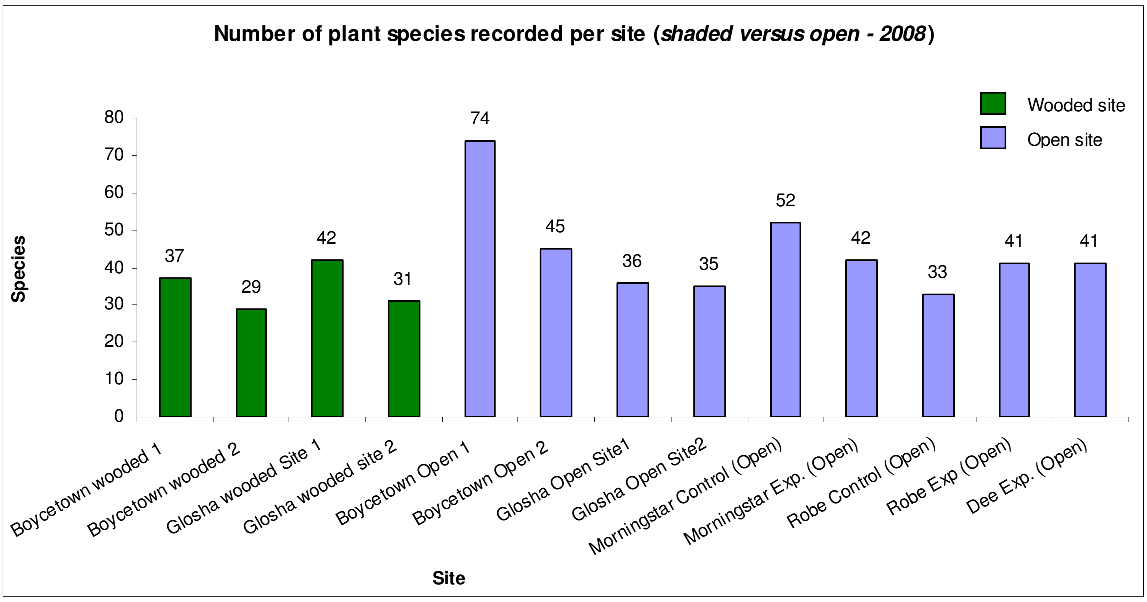


Figure 2. Total number of plant species recorded at each surveyed site.

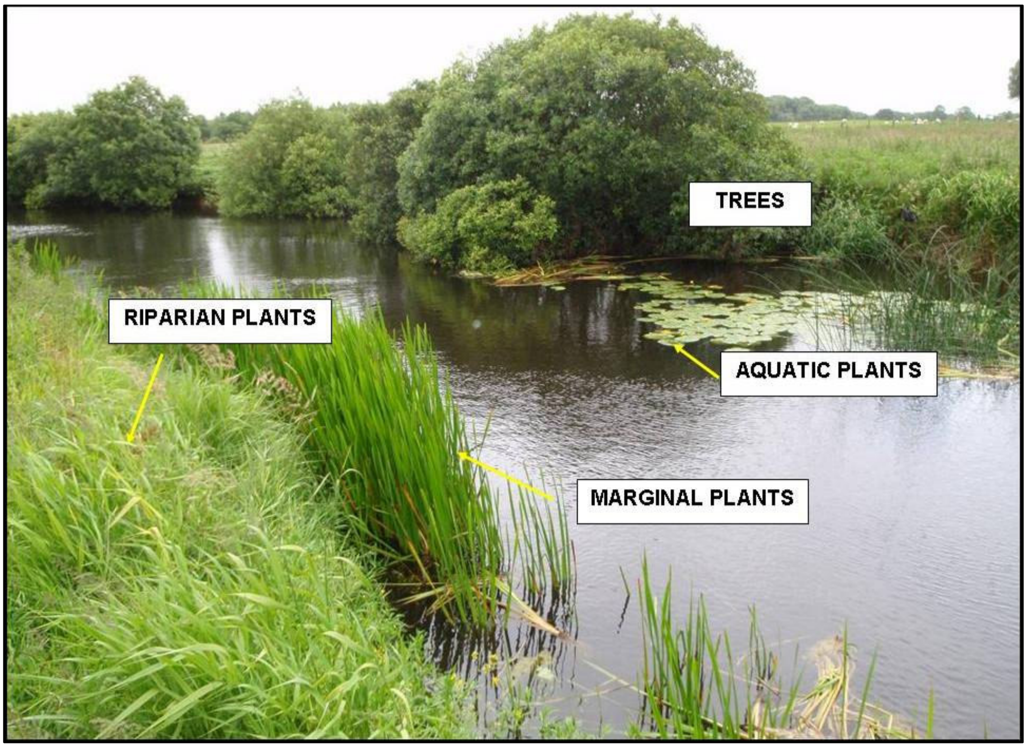


Plate 2: The different vegetation types that contribute to a healthy river corridor.

5.2.2. Wooded sites and tree species

- Four pairs of wooded - open sites were surveyed during the Summer/Autumn of 2008, two on both the Boycetown and Gloshagh rivers. No apparent differences were noted in species numbers between the open and wooded sites (Figure 2). Nevertheless, a clear distinction was evident in terms of the plant assemblages and physical habitat structure provided by plants. The tree cover provided niche opportunities in the understorey for shade seeking plants e.g. Herb Robert *(Geranium robertianum),* Ivy *(Hedera helix)*, Lords and ladies *(Arum maculatum*), ferns (e.g. *Dryopteris filix-mas, Phyllitis scopendrium* and *Polystitchum setiferum*) and Liverworts (Marchantiophyta spp.) (Plates 2 and 3).

- 17 tree species were recorded along river corridors examined in 2008 (Figure 3). Hawthorn (Crataegus monogyna), Ash *(Fraxinus excelsior)* and Alder *(Alnus glutinosa)* predominated with lesser numbers of species that are typical of river banks such as Willow *(Salix sp),* Blackthorn *(Prunus spinosa)* and Wych elm *(Ulmus glabra)*. The species mix and degree of dominance differed substantially between the Gloshagh and the Boycetown channels (Figure 3).

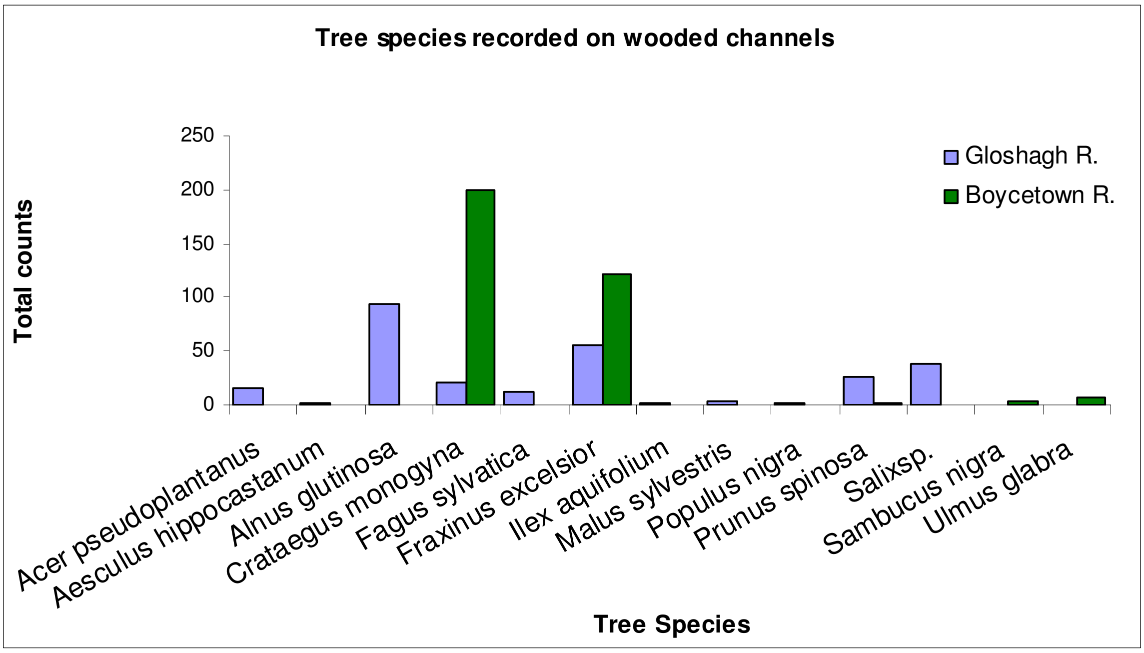


Figure 3. Total counts of tree species recorded on the Boycetown and the Gloshagh rivers.

Previous management practises involved substantial tree removal from river-banks, with the result that most river corridors have very low tree densities. Consequently, from a biodiversity perspective, it is important that any future management of existing wooded sites is sympathetic to their ecological function.

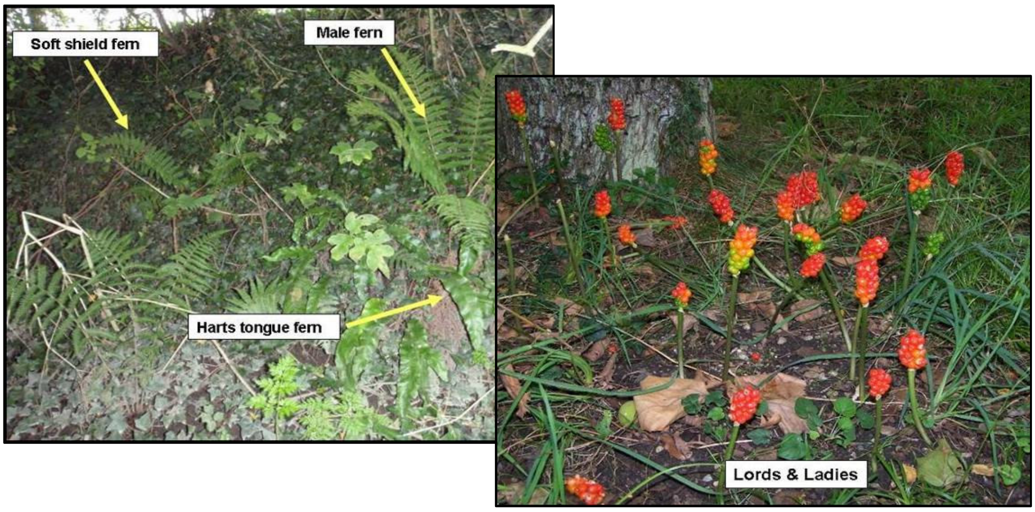


Plate 3. Understorey vegetation on the Boycetown characterised by ferns. Top: Harts Tongue, *Phyllitis scopendrium* and Male Fern (*Dryopteris filix-mas*) and other shade tolerant species. Bottom: Ivy *(Hedera ilex)* and Lords and Ladies (*Arum maculatatm*).

5.2.3. Habitat types and management influences on riparian plant communities

The riparian plant assemblages situated on the river bank away from the wetted area are relatively diverse. However, it is often difficult to categorise them as belonging to a habitat type, since they have species representative of a variety of types (Fossitt, 2000). Any number of factors could be influencing the species composition occurring on these open sites. For example, determining factors may include fencing or absence of, how long sites have been fenced, the intensity of grazing/poaching by livestock and whether or not fertilisers are applied. The river banks themselves have also been physically subjected to management by OPW in the past.

Among the habitat types represented along riparian zones examined in 2008 were:

Dry calcareous and neutral grassland: these are important habitats for orchids and a number of species were sampled (Plate 4).

Dry meadows: 'dry meadows are now rare in Ireland' (Fossitt, 2000). Most have been improved for agriculture and are now mainly limited to grassy roadside verges, the margins of tilled fields, railway embankments, churchyards and cemeteries. This vegetation type is best represented on the Boycetown open site 2 (Plate 5).

Wet grassland and Freshwater marsh: the Morningstar experimental site contained a species mainly indicative of wet grassland (e.g. sedges and rushes), but in other places was closer to freshwater marsh. This site was poorly-drained farmland that had not been improved recently.

Plate 4. Pyramidal orchid (*Anacamptis pyramidalis,* Left) on the Stonyford River and O'Kelley's spotted orchid (*Dactylorhiza fushii* var. okelli, Right) on the River Robe.

Plate 5. Dry meadow grassland dominated by tall grasses and umbellifers.

Plate 6. Unfenced site on the Robe subject to grazing/poaching.

Fencing was also identified as a major factor impacting on status of riparian plant communities (Plate 6). Some fenced sites where instream berms had developed tended to be dominated by marginal plants and other species typical of damp sites. For example on the Owenavorragh and some locations on the Gloshagh open sites and Morningstar, Reed Canary Grass (*Phalaris arundinacea)*, Water Mint (*Mentha aquatica*), Greater Willow Herb *(Epilobium hirsutum)*, Common Nettle (*Urtica dioica*), and Thistle species (*Cirsium* sp.) dominated.

5.3. Macroinvertebrates

Aquatic invertebrates occupy many different feeding niches, from deposit, filter and shredder feeders (Plates 7 – 9) to herbivores and predators, which feed on other invertebrates or even small vertebrates like tadpoles, frogs and small fish.

During the sampling process, three habitat types were targeted i.e. pool, riffle, glide, as outlined in the methodology section. This allows for a comparison between habitats to see if it has any effect on species composition. This is important because pools and riffles are often rare or absent on large stretches of many channels on account of past drainage works. However, under the EREP, these physical features will be reinstated where possible. It will, therefore, be possible to compare sites pre and post maintenance in terms of macroinvertebrates communities. This may have implications for how the EREP is carried out.

The presence of wooded areas along river corridors not only affects the composition, species diversity and ecological function of plant communities, but also, potentially that of fish and macroinvertebrates. This is a consequence of changes in energy input into the river channel. Unlike open channels, where sunlight represents the major energy source, leaf litter and woody debris from trees may play a more important role in wooded channels. In turn this can influence availability of feeding niches and the composition of the invertebrate community that exploits them. For this reason, the macroinvertebrate community is discussed below with reference to how they feed e.g. shredder, grazer, predator etc.


Plate 7. A crustacean, the freshwater louse *(Assellus aquaticus)* shreds coarse leaf litter and the caddis fly (Agapetus sp.) is a 'scraper/grazer' that feeds on algae.


Plate 8. The uncased caddis larva (Hydrodpsyche sp.) and the adult beetle (*Nebrioporus depressus*) are deposit/gatherers who feed on fine organic matter in the substrate.


Plate 9. White clawed crayfish (*Austropotamobius pallipes)* are omnivores and water mites (Hydrachinidiae sp.) are predators.

5.3.1. Wooded sites versus Open sites

A comparison of open and wooded sites in the Boycetown found that grazers were far more prevalent in the open site, where they can feed on algae, on account of light penetration, whereas the presence of shredders was substantially higher in the wooded areas where leaf litter was more abundant (Figure 4).

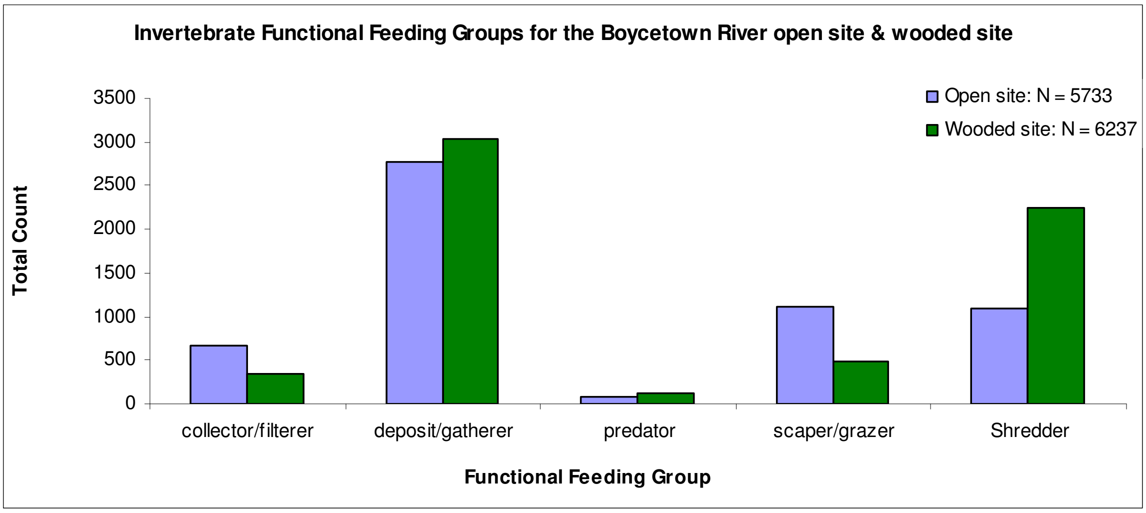


Figure 4. Macroinvertebrate functional feeding groups and total counts of individuals within each, for the Boycetown sites.

Comparison of the wooded sites on the Boycetown and Gloshagh channels identified that the Boycetown river was the more productive channel, supporting a higher density of macroinvertebrates (Figure 5). The sample sites on the two channels were very similar in terms of functional feeding groups (Figure 5).

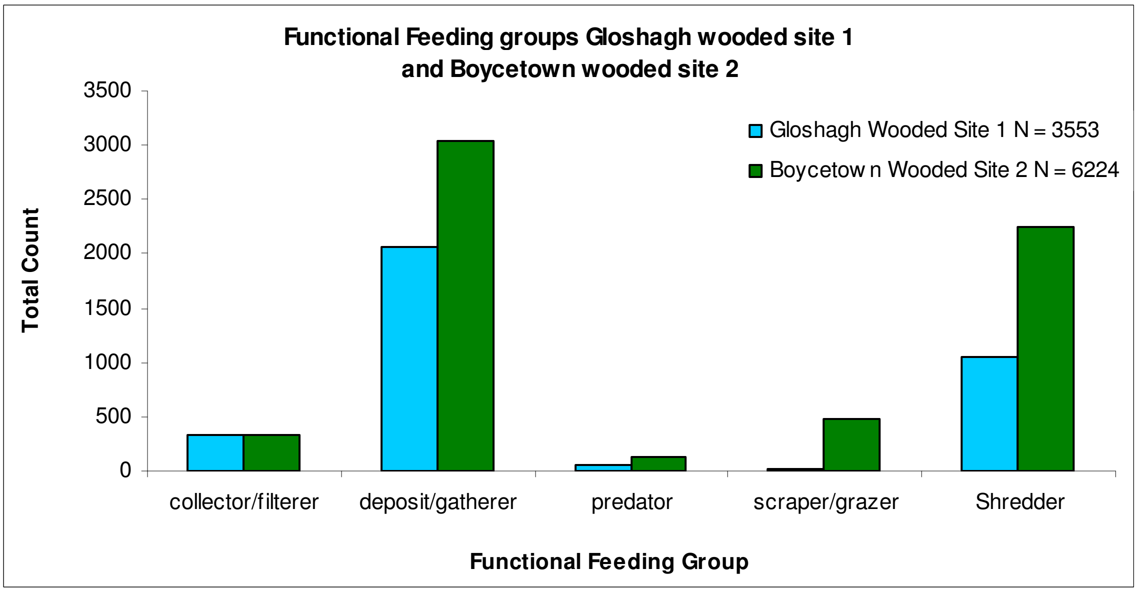


Figure 5. Comparison of functional feeding groups between wooded sites on the Boycetown and the Gloshagh channels.

5.3.2. Conclusions

The Boycetown results indicate that open and wooded sites are important for certain functional feeding groups i.e. open sites for scraper/grazers and wooded sites for shredders. Habitat diversity may also have a similar effect on the composition of macroinvertebrate communities in the Gloshagh. Collector/filterers were largely limited to riffles, whereas pools represent an important habitat for shredders. This supports the idea that environmental heterogeneity is important for biodiversity, and, therefore should be considered during maintenance works.

5.4. Fish Investigations

Population density and structure of salmon and trout on the R. Boycetown: Trout and salmon densities and their 95% confidence intervals are calculated for 3 life stages in trout (0+, 1+ and >1+) and 2 for salmon (0+ and 1+), an example is given in Figure 6.

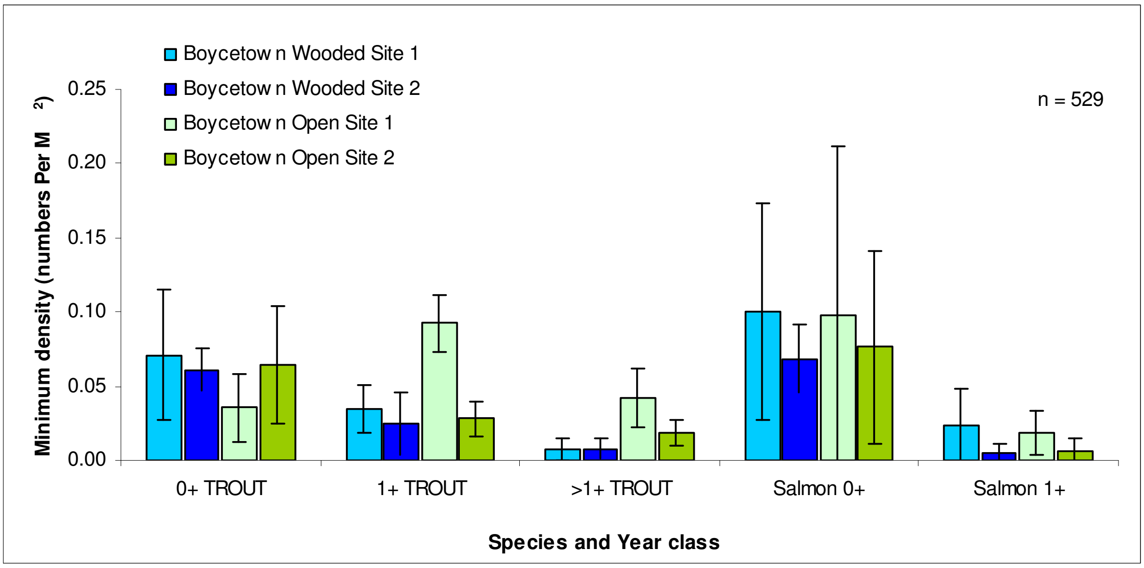


Figure 6. Minimum density estimates for trout and salmon (No./m^2), with relevant standard deviations, for 4 river sites surveyed pre-works on the Boycetown River, Boyne Catchment 2008.

5.4.1. Site comparisons

Density estimates showed mixed results though in general no difference in the minimum densities of specific age groups of trout and salmon were noted. However, an examination of the population structure (or length frequency distribution) of the trout population indicated substantial differences, with more small trout (5 – 8 cm) recorded within the shaded sites and a greater number of 1+ and of older trout in the open site (Figure 7).

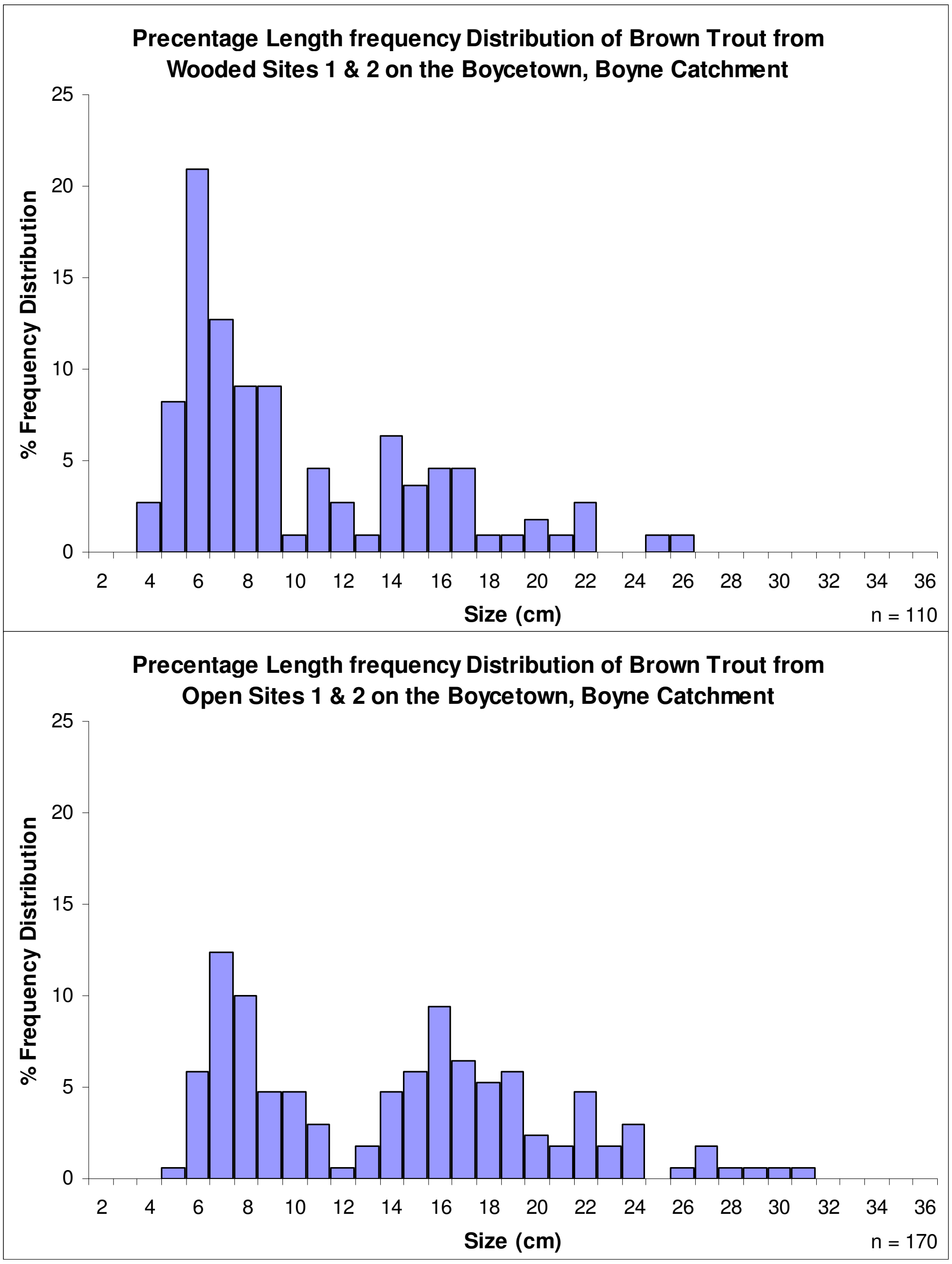


Figure 7. Showing the percentage length frequency distribution of brown trout from the wooded and open sites on the Boycetown River, Boyne Catchment 2008

Table 7. Trout age class percentages recorded from the Boycetown wooded and open sites.

Trout Age Class	wooded %	open %
O+	62.7	34.1
1+	29.1	41.8
>1+	8.2	24.1

Statistical analysis of the length frequency distribution for the two trout populations, the wooded and open sites, indicated they were significantly different (Kolmogorov-Smirnoff, $p<0.05$). This difference in the trout population structure is most probably generated by the greater water depths and instream habitat complexity found at open sites. In turn, this complexity is considered to be related to the presence of riparian and marginal plant cover.

5.4.2. Biodiversity – fish community structures

A total of nine freshwater fish were recorded across the 57 sites sampled in the 2008 EREP project (Figure 8). However, not all species were present at each site surveyed. The most abundant species was salmon, comprising almost 50% of the total fish numbers. Gudgeon was the least recorded species with only one individual captured (Dee River).

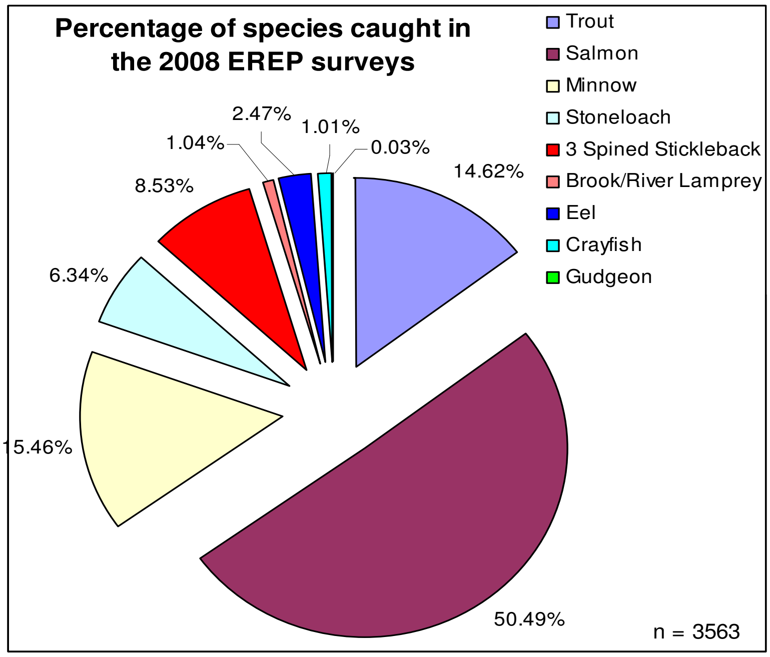


Figure 8. Composition of fish species caught in the 2008 EREP sampling season

Figure 8 presents the structure of fish populations present in all the 2008 EREP sampling sites. However, the composition of these fish communities differed greatly between sites (Figure 9). Such differences may be a reflection of a range of factors including geographic location, stream gradient, water hardness, water quality, habitat complexity, land use, invasive species introduction, underlying rock type, drainage, in-stream/marginal vegetation and canopy closure. Examining four different sites surveyed in 2008 (Figure 9) indicated how different these fish communities can be, even in adjacent channels within the same catchment, e.g. the Morningstar and Gloshagh, both Maigue tributaries.

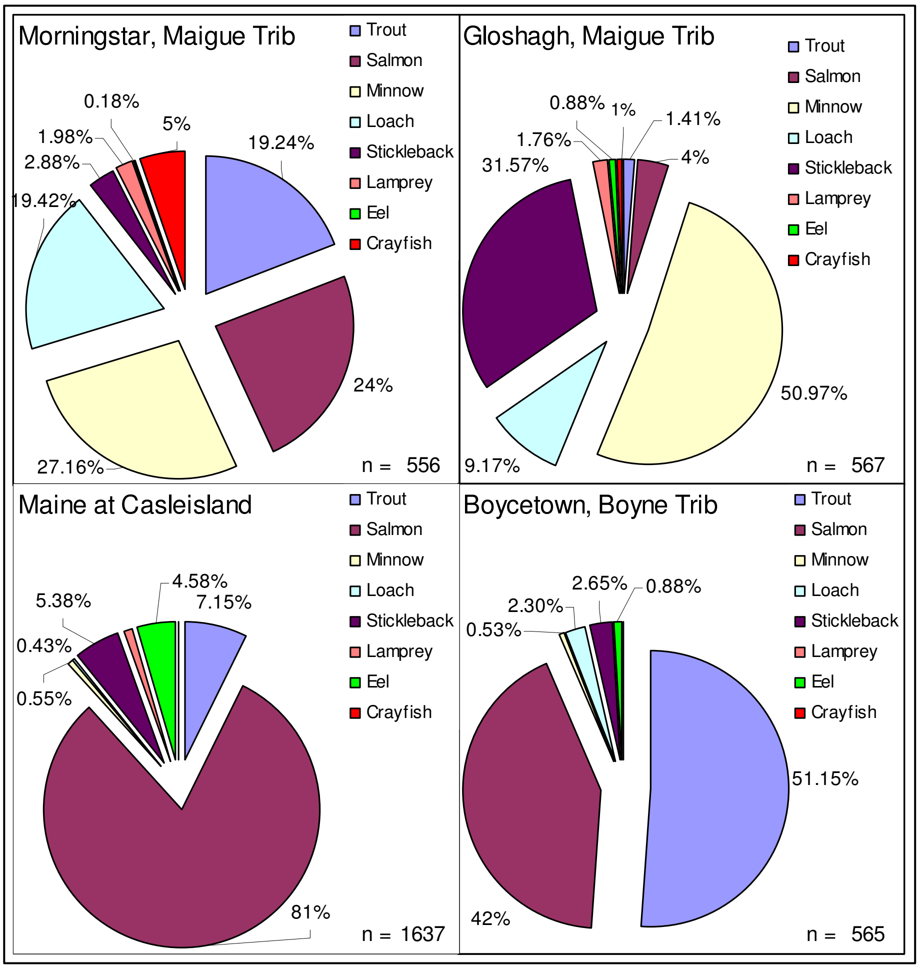


Figure 9. Fish community structure for 4 rivers surveyed in the EREP programme 2008

Taking an overview of these complex systems it would be possible to separate the four rivers, in Figure 9, into four communities, salmon dominated, salmonid dominated (trout and salmon), mixed species and a minnow/stickleback community.

The high salmon numbers recorded on the Maine River is typical of the type of habitat present there; high gradient riffle/glide, with good water quality (EPA Q4 rating).

The Boycetown River in the Boyne catchment has a lower gradient and is more meandering in nature. This section of the Boycetown River is rated as Q3-4 (slightly polluted), resulting in less favourable conditions for pollution intolerant salmon. Post drainage there has been little recovery in the natural pool/riffle/glide sequence. However, in open sections the instream, marginal and riparian vegetation has recovered allowing for greater depth and physical diversity. This is reflected in the composition of the instream community, with salmonids dominating the community structure. The increased trout component in the salmonid stock here, compared to the Maine sites, is most likely a reflection of the poorer water quality and the deeper nature of the channel

The Morningstar River, a tributary of the Maigue, had the greatest numerical diversity of species. No one species was dominating the community structure. This may be due to the partial natural regeneration of the riffle/glide/pool sequences found in the sampled sites. This regeneration allows for multiple complex niches to reform, in turn leading to higher biodiversity potential. Deep water (>0.5m) was predominant in pool/riffle segments with bed material composed of large cobble. This added to the physical complexity of the site and coupled with a high Q value (Q4), provides the opportunities for greater species abundance.

The Gloshagh River is also a tributary of the Maigue. Its gradient regime is similar to that of the Boycetown. However the species compositions, of the Gloshagh, showed a marked difference (Figure 9), with very low salmonid numbers present. Salmon and trout were virtually absent from the sampling sites and no salmon fry were recorded. The relative abundance of stickleback and minnow would seem to indicate poor water quality.

5.5. Hydromorphology and Physical Assessment

EREP river sites have been investigated in terms of: 1) width and depth, (2) flow, (3) shading and (4) longitudinal and cross sectional profiles. Independently each measurement offers insight into the hydromorphological condition of the river post drainage. In combination they allow for habitat deficiencies in particular stretches of river to be identified.

5.5.1. Width and Depth

These depths when displayed using a contour plot (Figure 10) give an indication of how depth and channel width varies through the river sections.

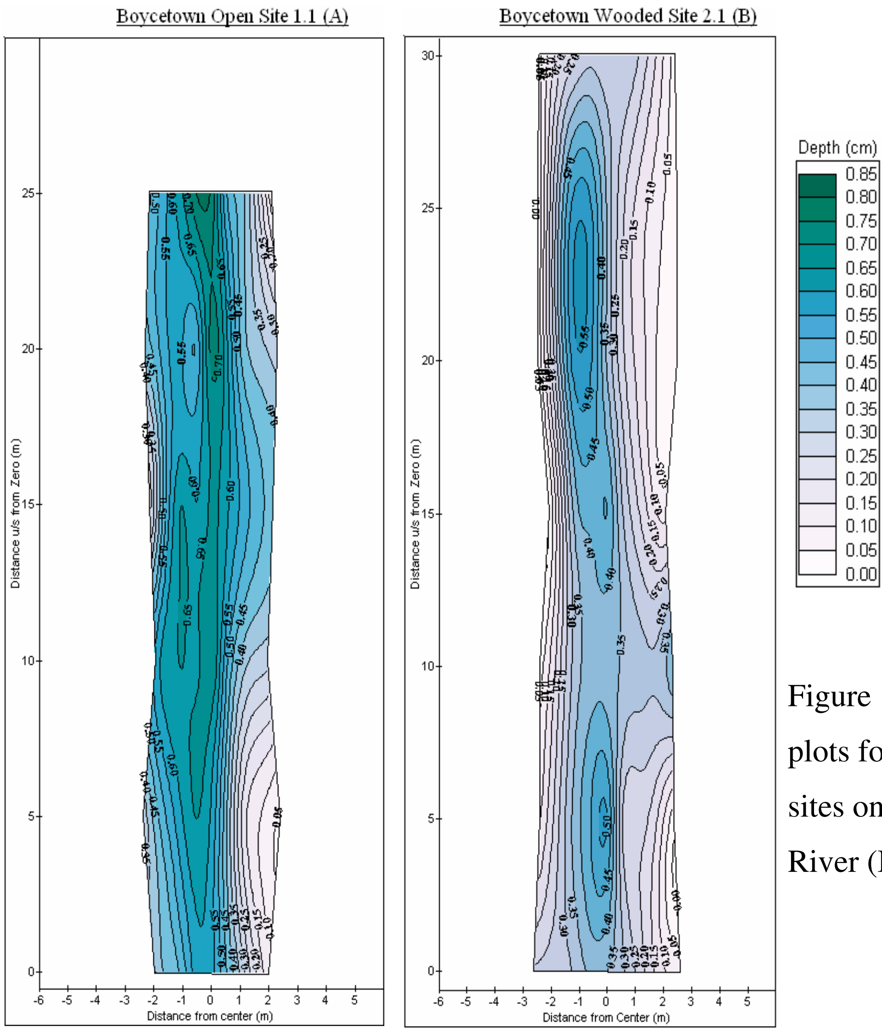


Figure 10. Depth contour plots for open and wooded sites on the Boycetown River (Boyne Trib. C1/15).

The depth and width variations across two sites from the Boycetown River (Figure 10) show substantial differences in depth/width profiles between the open and, wooded sites, the wooded site being wider and shallower than the open site. Differences in depth and width between the open and wooded sites on the Boycetown can be partly explained by the bankslope and aquatic vegetation that grows in the open sites. The bankslope vegetation binds the physical fabric of the bank and reduces or prevents erosion. This offsets a widening of the wetted width that can occur in shaded sections of channels. In addition, the vegetation has the effect of narrowing and deepening the channel by containing the flow to a central section of the channel.

In future years comparing depths and widths of wooded and open sites, post works (after tree thinning, pool digging etc.), will give a good indication of how heavy tree cover affects the hydromorphology and productivity of an OPW drained channel. Repeated over many years these measurements will reflect long term morphological changes and their ecological consequences.

5.5.2. Flow

Velocity (V) measurements are presented as contour plots (Figure 11). These plots show channel cross sectional velocities at a number of representative locations at each site. A study on a pre-enhancement stretch from the Morningstar River (Figure 11) demonstrated the application of this graphical method. The plots show how width, depth and velocity can change over very short lengths of channel. In the future these contour plots will be used to graphically show the effect of works – both capital enhancement and enhanced maintenance on channel form, dimensions and velocity.

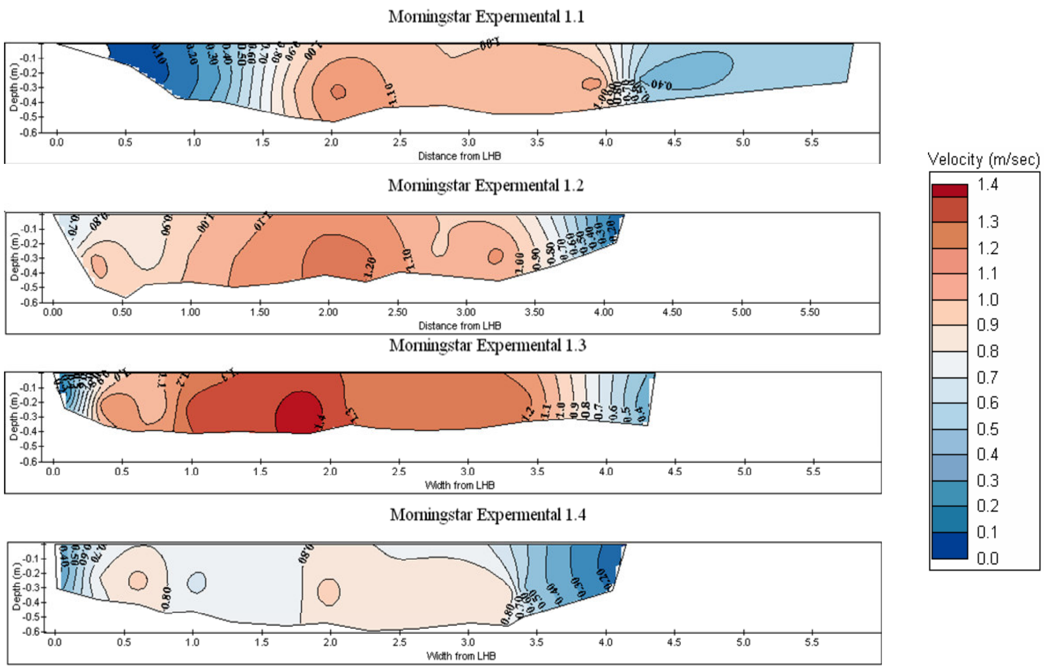


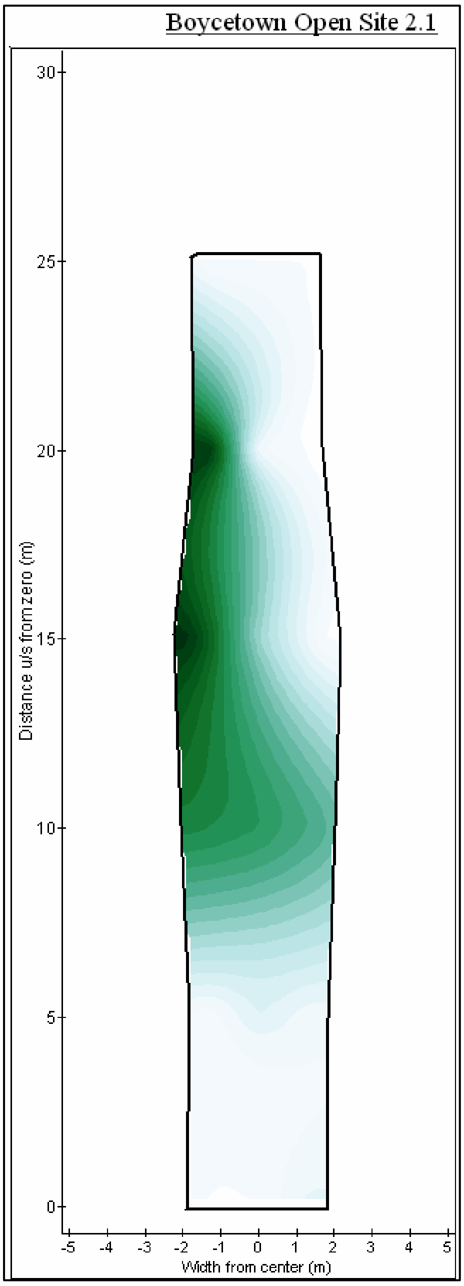
Figure 11. Shows contour plots of depth velocity profiles taken from the Morningstar River, (Zero is from the waters edge on the left hand bank (LHB). 1.1 is at the site, 1.2 is at 20m, 1.3 is at 40m and 1.4 is at 60m upstream.

A typical riffle/glide sequence from a drained OPW channel is shown in Plate 10. Morningstar experiment 1.3 is taken through a riffle while Morningstar experiment 1.4 is taken through a deep glide. In an undrained, channel Morningstar Experiment 1.4 should be a pool in the riffle/glide/pool sequence. However in this case it is a deep glide with corresponding high velocities. The Morningstar experimental site is shown in Plate 10, giving the location of each of the velocity cross sections in Figure 11. The image gives a good indication of the riffle/glide sequence found in drained channels and the corresponding lack of pools. In the EREP enhancement plan for this site, three vortex stone weirs with associated pools and gravel shoals, will be constructed.

Plate 10. The Morningstar experimental section (Maigue Catchment) monitored pre-works in the EREP programme.

5.5.3. Canopy Cover

The image and contour plot in Figure 12 shows an open site on the R. Boycetown that has an average of 21% canopy cover, which can be defined as sparse cover using Table 8.



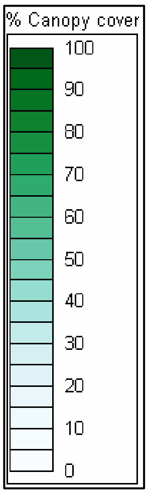


Figure 12 (left) and Plate 11 (right). Shows the percentage canopy cover contour plot of Open site 2.1 on the Boycetown and a photo of that site looking upstream from zero.

Table 8. 6-point forestry definition for canopy cover, which can be used to classify OPW channels pre and post enhancement/maintenance in terms of tree cover.

Canopy cover can be defined by 6 different classes.	
1. Very sparse 1-9%	4. Medium 50-69%
2. sparse 10-29%	5. Dense 70-84%
3. Low 30-49%	6. Very Dense 85-100%

(taken from Brack, 1999)

In some wooded sites canopy closure is almost complete, giving very high percentage canopy cover values (Plate 12).

Plate 12. A wooded site on the Boycetown River. This site has on average 81% canopy cover giving it a rating of dense canopy as from Table 8.

The dense shading seen at the wooded site in Plate 12 prohibits the growth of most aquatic/marginal plants and enables the growth of shade tolerant plants such as ferns and ivy. The absence of bankslope vegetation, in turn leads to the erosion seen at the waters edge in wooded sites.

5.5.4. Longitudinal and Cross Sectional Profiles

Longitudinal and cross sectional profile surveys were conducted at selected sites before maintenance or enhancement works.

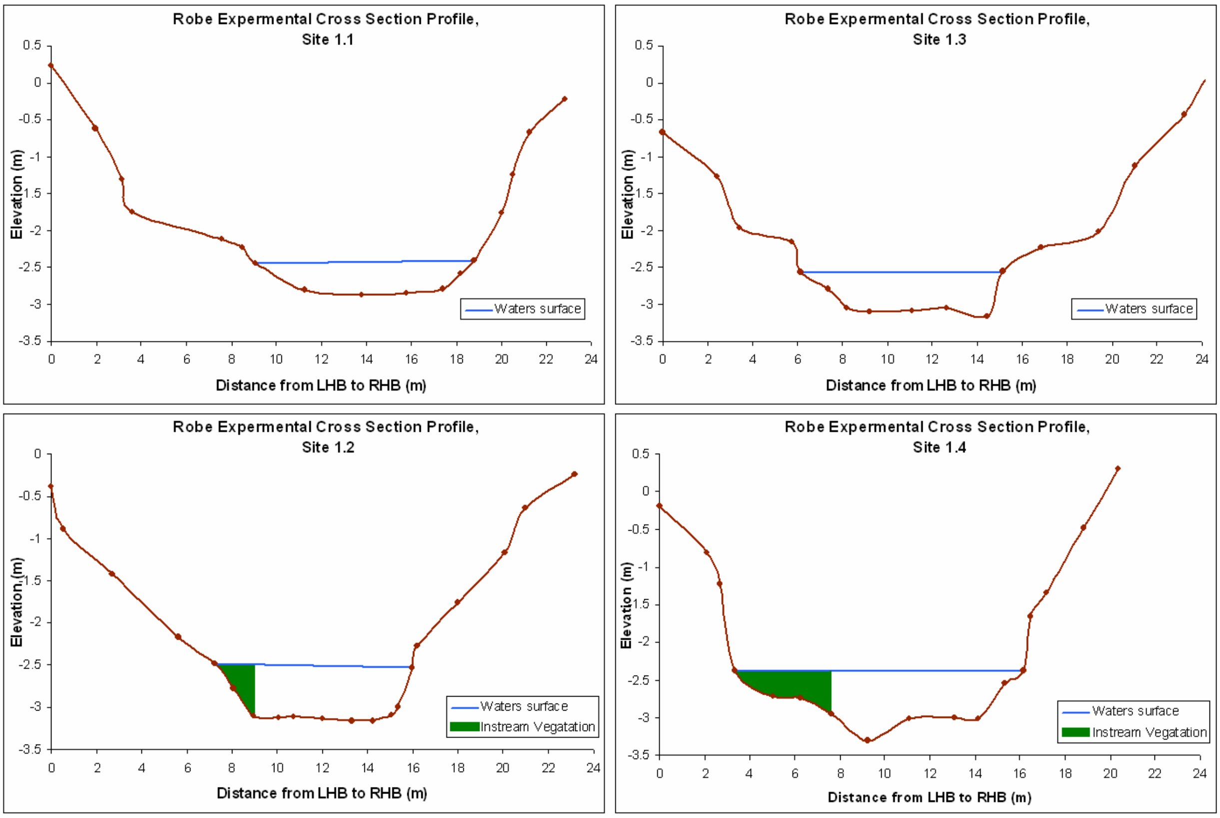


Figure 13 Cross-sectional profiles of four cross sections before enhancement works taken on the Robe River (CM 4)

The surveyed cross sections as given in Figure 13 are extremely useful to quantify the difference in bank, bed and water height pre- and post- enhancement and maintenance. It is also gives the ability to accurately map and possibly quantify the aquatic vegetation in the river channel. In the future channel cross sectional profiles will be used in berm management projects, allowing for berms to be measured pre and post works and as they redevelop over subsequent years. For these projects, integrating channel cross sections with plant surveys and velocity profiles will show the physical and biological process which combine to reform maintained berms. This integration will enable an assessment of both hydromorphological change and biological change.

Longitudinal profiles of channel thalweg, with water surface levels, were measured at selected EREP physical survey location. Pre- and post channel thalweg profiles will be used to examine and assess the degree of change brought about by channel works and measure the effect and long-term viability of bed over-digging, in enhanced maintenance, and of instream structures in the capital programme as a time series (Figure 14).

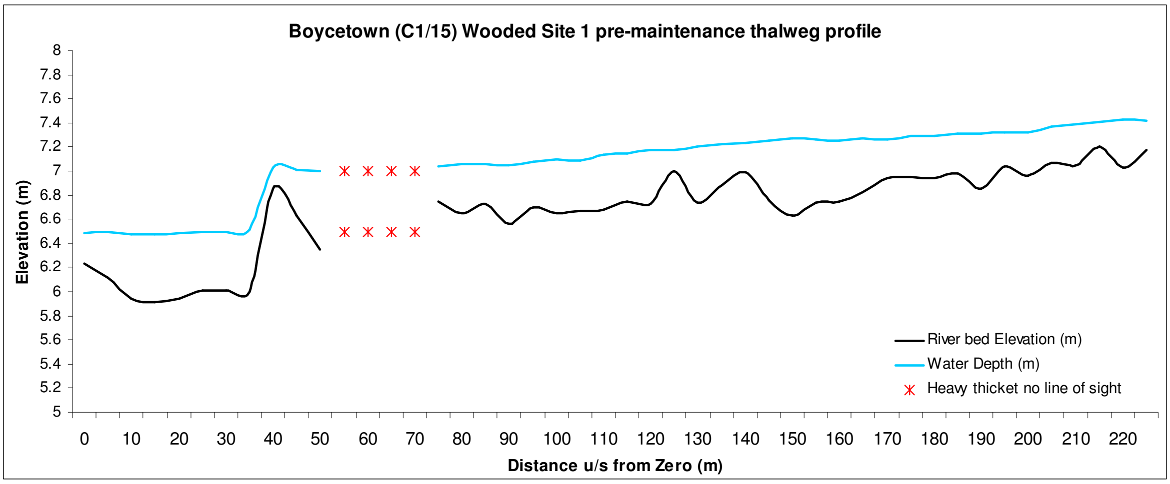


Figure 14. Boycetown wooded site 1 longitudinal profile before maintenance work (C1/15 Boyne).

6. Other Scientific Studies

This topic area within the EREP brief was included as a form of catch-all to accommodate additional scientific or technical issues that might arise but might not be directly related to the main biodiversity and hydromorphology thrust of the programme. In the 2005-07 period, CFB undertook a set of focussed studies, looking at channel maintenance impacts on two Annex II Habitats Directive groups – the lamprey and the white-clawed crayfish. Deliverables included the production of Ecological Impact Assessment (EcIA) documents, one dealing with each taxonomic group.

The studies on the two groups followed a similar format in surveying channels prior to- and following maintenance in order to assess impact and commence an examination of recovery patterns and rates. One detailed pre-post study was undertaken for lamprey in 2007 while a series of eight comparable studies were undertaken for crayfish in the 2006-07 period. All studies displayed impacts, of varying degree, and it was agreed by OPW that follow-up assessment should be, ideally, continued in order to develop some sense of how populations of the target taxa recover following maintenance. This was deemed particularly so given the potential for impact and the importance of conservation of the Annex II taxa.

The EREP provided an opportunity to continue the post-impact studies on both taxa in 2009.

6.1. Lamprey Studies

A series of 17 replicates were surveyed prior to maintenance in 2007 on the upper reaches of the R. Stonyford, in the Boyne catchment. Comparison of the pre-and post data sets in 2007 indicated a substantial loss of individual animals, with zero density recorded at some replicates. Those juvenile lamprey remaining spanned the same size range as that present prior to maintenance.

The survey in 2008 re-fished the set of 17 replicates (Plate 13). Density values remained low (Figure 15), relative to the 2007 pre-maintenance condition. However, a larger overall number was recorded and the population structure indicated a definite trend of recolonisation by younger age groups or size-classes. There was a predominance of small ammocoetes, with two modal peaks in the 35mm-40mm and 55mm-65mm range (Figure 16). This pattern of colonisation was also observed in newly-excavated sites on the R. Nore in Kilkenny (King, Hanna and Wightman, 2008).

It would be extremely valuable to continue monitoring of these replicates in 2009. This might indicate a common pattern of recolonisation and recovery following major instream disturbance.

Plate 13. Electro-fishing 1m^2 enclosure on C1/32, Stonyford, May 2008.

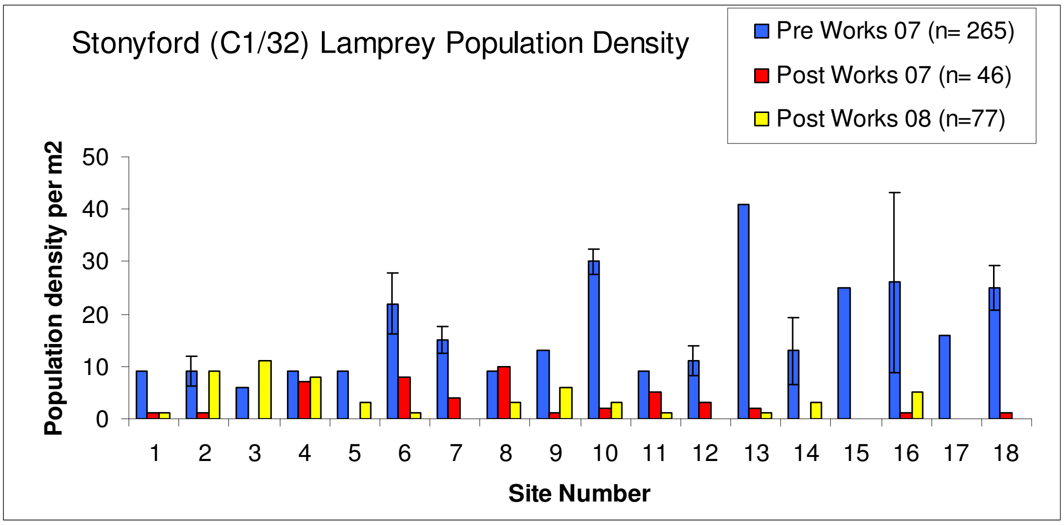


Figure 15. Lamprey population density per m^2, C1/32 (Stonyford).

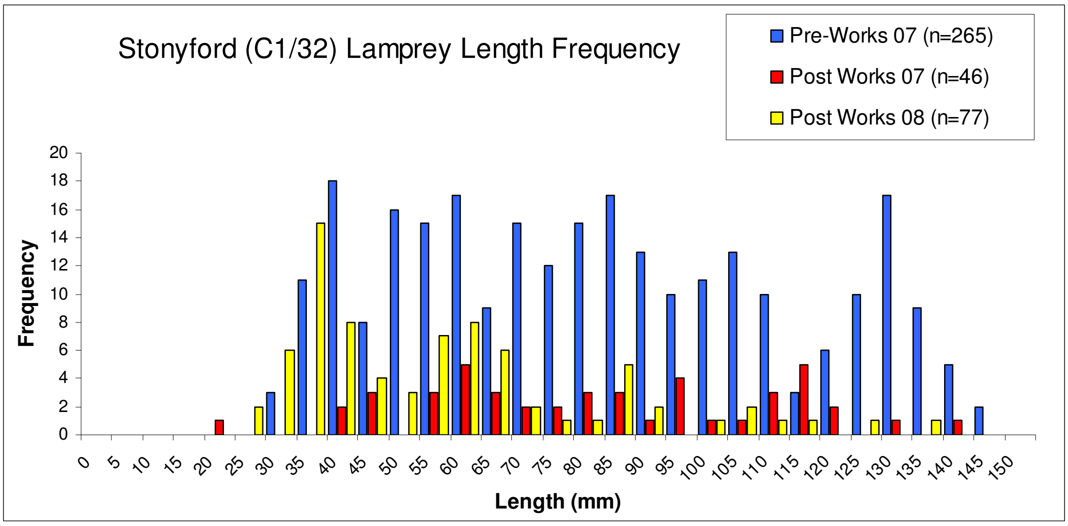


Figure 16. Lamprey length frequency distribution for C1/32, Stonyford, 2007 & 2008.

6.2. Crayfish Studies

Six studies have been on-going since 2006 with two additional studies in 2007 and one new investigation in 2008.

The summer 2007 survey on the R. Glore initially indicated no impact of maintenance on the resident crayfish population, in the immediate post-works stage. However, by that autumn a substantial decline in numbers was evident. A repeat of the summer survey in 2008 indicated a further substantial decline in crayfish numbers.

It is considered that the decline is related to loss of habitat rather than actual mortalities of crayfish. The maintenance work was carried out in line with the environmental guidelines adopted by OPW, with retention of the full marginal and bankslope vegetation on the non-working bank, retention of tree cover and appropriate spoil management (Plate 14). Loss of instream habitat and of cover on the working bank is considered to be likely causes of the crayfish decline. These issues are addressed to some degree in a series of mitigations developed in a recently-published Ecological Impact Assessment (EcIA) study (King, Lordan and Wightman, 2009).

Plate 14. C50-1 (R. Glore) Survey site during maintenance June 2007.

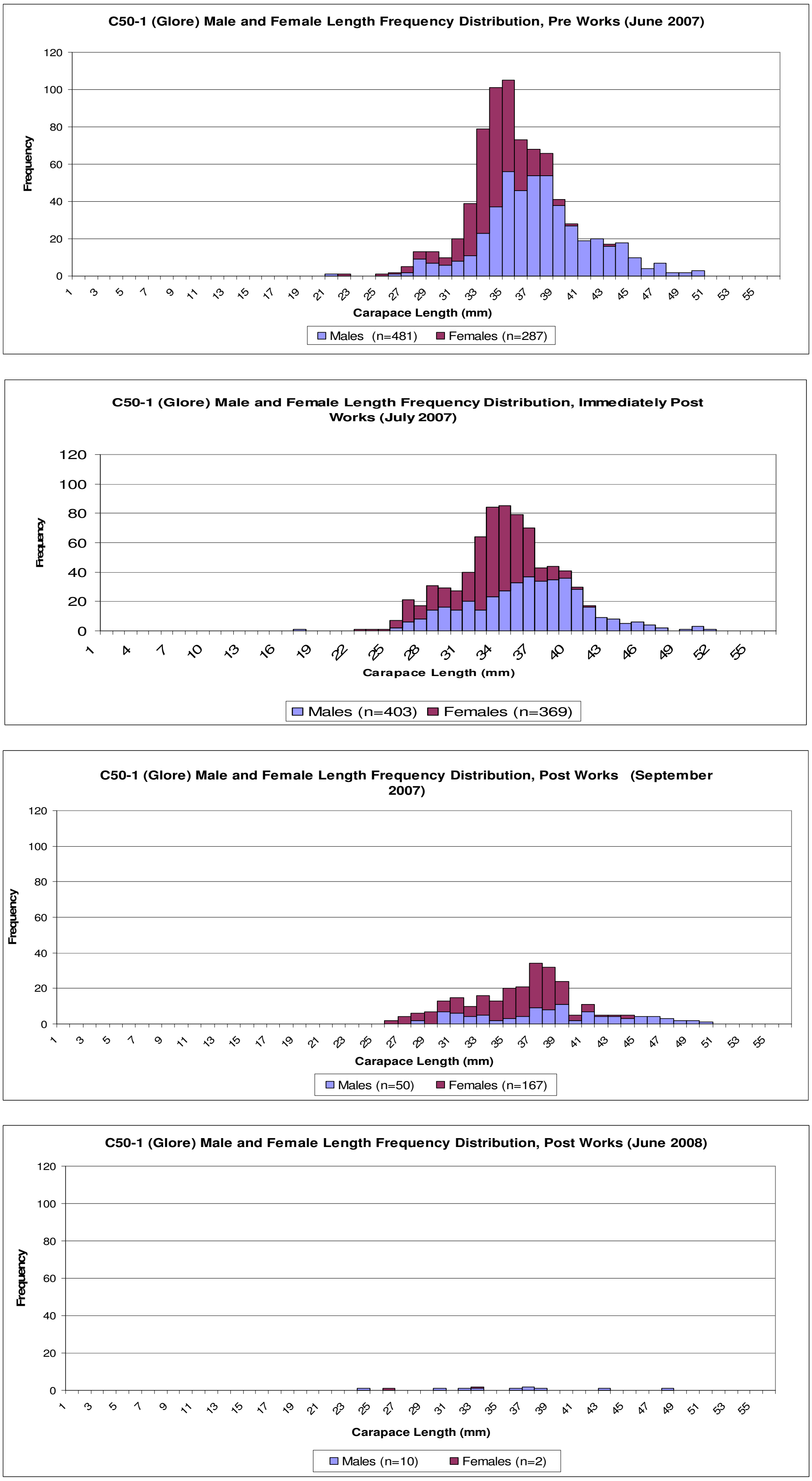


Figure 17. C50-1 (R. Glore) Crayfish carapace length frequency distribution.

The studies in 2006-07 were primarily concerned with adult crayfish, in excess of 20 mm carapace length, capable of being captured by fyke nets and traps. A study in 2008 examined crayfish emerging in spoil samples from a vegetated segment of a tributary channel of L. Ennel, in the Brosna system. The sampling indicated a substantial degree of loss of both larger (> 20 mm) and smaller crayfish. Comparison of vegetation only, growing in the water surface, and of bed sediment indicated that the majority of crayfish were using the vegetation. This was particularly so in the case of areas of water celery-type vegetation (*Apium* and *Rorippa*) and highlighted the importance of this type of cover for crayfish (Plate 15).

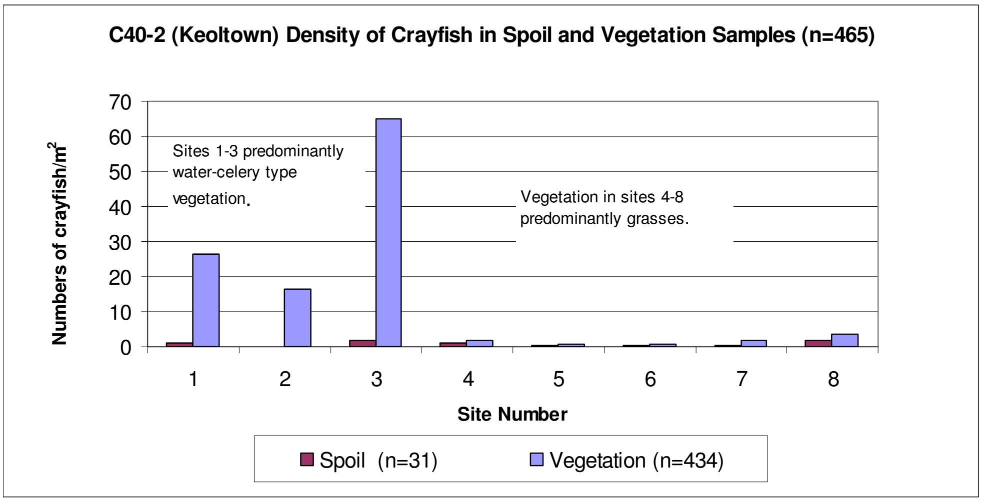


Figure 18. C40-2 (L. Ennel Tributary) Density of Crayfish per m^2.

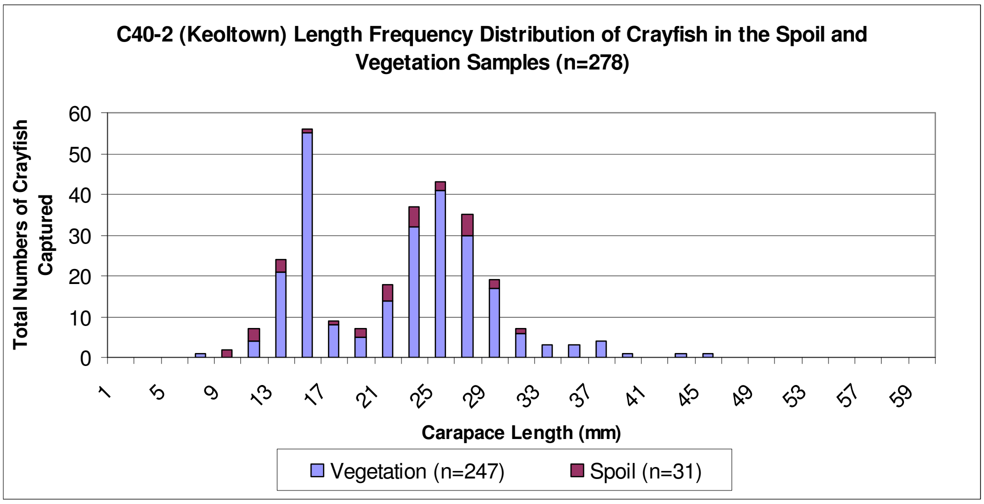


Figure 19. C40-2 (L. Ennel Tributary) Crayfish carapace length frequency distribution.

Plate 15. C40-2 (L. Ennel Tributary) Survey site during maintenance October 2008.

7. Training Programme

An initial training programme was developed in the 5-year EDM study (2002 – 2006). The training was rolled out to OPW staff in the winter-spring period of 2002-03. A review of the EDM machine driver training programme will be carried out and will be redeveloped to include new OPW initiatives and SOP's that will impact on routine maintenance.

It is envisaged that the roll out of this updated training programme will commence during late 2009 and continue into 2010. This programme will incorporate a number of training media including PowerPoint presentations, video footage and, where appropriate, on site demonstrations.

A small working group, consisting of members of the EREP team and colleagues from the Regional Fisheries Boards was established to advance the training programme and ensure a consistency of approach. In discussions with OPW's Environment Unit during 2008, it was agreed that one member of that unit would also join the working group.

Colleagues within the Research Division of the National Parks and Wildlife Service (NPWS) have met with members of the EREP team and will contribute to ensuring that the new training programme is as comprehensive as possible, in terms of covering issues of particular concern to NPWS. As the training modules are developed it is envisaged that discussions with other relevant groups will take place and additional components may emerge for inclusion based on these discussions.

8. Auditing Programme

Another element of the EREP project involves an assessment of compliance of machine drivers to implement the 10 steps to environmentally-friendly maintenance. Going forward, the new auditing programme will require to examine implementation of the 10-point environmental training of the EDM study in addition to new procedures that may emerge in EREP and new SOPs being developed by OPW.

As was the case during the EDM project, site visits will be made to a number of machine drivers, while works are in progress, by a member of the CFB team along with the relevant OPW foreman. A section of channel recently maintained will be reviewed and the following points assessed; enhancement potential of the channel, has this been identified by the maintenance crew, have any of the 10 steps of environmental enhancement been implemented by the crew and to what extent. The assessment will be recorded on a standard auditing form and a copy of this will be sent to the relevant OPW engineer.

These assessments often highlight topics that drivers find difficult to understand and therefore implement and thus may be areas that should be addressed through the training programme. The audit visits also provide an opportunity to provide mentoring, as required, in specific topics that may be pertinent. It is envisaged that bed over-digging, with consequent pool creation, will be a major topic for implementation under the Enhanced Maintenance element of the new EREP. Audit visits will provide an ideal platform for undertaking trials with drivers on this topic, where they have not previously implemented it.

In conjunction with the auditing programme carried out by the EREP team, the OPW Environment Section will carry out a degree of internal auditing annually. These assessments are independent of those undertaken by the CFB-EREP team. However both assessments are recorded on an agreed form. The auditing programme of the EREP project aims to visit at least 1/3 of all OPW machines, while in operating mode, in any year of the programme.

During 2008, audit visits were made to a number of machine crews, in the company of two different OPW foremen. These preparatory visits identified a range of issues

- Compliance with specific elements of the 10-point training guidance
- Significant non-compliance with some core elements
- Sophisticated implementation of some advanced elements such as sequential riffle-pool creation

It is clear that a higher level of standardisation and compliance is needed. Under the EREP, it is envisaged that a robust approach will be taken to implementation of agreed training elements and SOPs during routine maintenance and the auditing process will address this, in addition to its role in on-site training provision.

Maintenance issues identified in 2008 that need to be addressed:

Plate 16. Machine bucket cutting into the non working bank.

Plate 17. Both the bank slope and bank full cleared of vegetation

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Plate 18. Excessive removal of all bank side vegetation from working side.

Plate 19. Excavated material deposited on the bank slope and damage also caused to the non working bank.

Achieving environmental friendly maintenance – compliance observed in 2008:

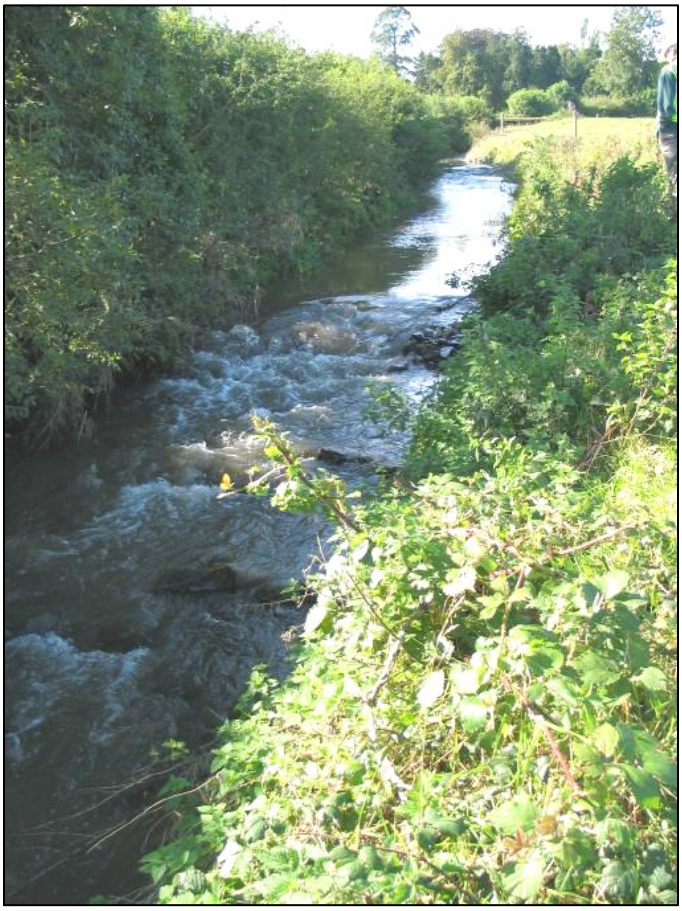

Plate 20. Instream potential identified and works successfully implemented, involving reprofiling of long section.

Plate 21. Trees and tree branches removed with chainsaw, effect is less damaging to the trees and visually more environmental friendly.

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Project Personnel

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