ECOLOGICAL STUDY OF THE DELVIN RIVER

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November 2008

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Acknowledgments

The authors gratefully acknowledge the assistance and advice of the following people. Hans Visser, Biodiversity Officer, Fingal County Council; Emmet Conboy, Meath County Council; Claire McIntyre Fingal County Council; Maeve O'Reilly, Environmental Protection Agency; Roisin Nash and Marcin Penk, Ecoserve; Martyn Kelly, Bowburn Consultancy; Bernadette Ní Chatháin, RPS; Rachel Kavanagh, Trinity College Dublin;

The assistance of the Heritage Council in the funding of this project is gratefully acknowledged

Flynn, Furney Environmental Consultants and Alan Sullivan,
November, 2008

1. Introduction

1.1 Scope of Report

The following report is a detailed ecological assessment of the Delvin River carried out by Flynn, Furney Environmental Consultants on behalf of Fingal County Council's Parks Division. The purpose of this study was to gather baseline ecological and hydromorphological data to assess the overall quality of this river and to contribute to the formulation of a strategy for actions for its maintenance and improvement.

The report details the findings of the following:

i. A walkover survey of the entire river corridor
ii. An assessment of river corridor habitats over 10 no. 0.5km stretches
iii. A review of water quality data
iv. A detailed ecological assessment undertaken at three sites in the river
v. An assessment of fisheries quality of the river corridor

The criteria and standards to be used for the survey, sampling and analysis undertaken are given in Section 2 (below). In addition to these above, the consultants undertook water quality sampling and analysis at the three sites chosen for detailed ecological survey. The findings of the above are to be used to draw up a schedule of actions which may be undertaken to improve the river in terms of habitat, water quality and fisheries value. These actions are to be included in the Fingal County Council Biodiversity Plan.

1.2 Objectives of Project

The main aims of this survey as given in the project brief were to:

- Establish ecological baseline conditions for future monitoring purposes
- Prepare a list of actions that will protect and improve the river habitat of the Delvin River.

The objectives of this survey were as follows:

- To carry out a detailed study of the hydromorphological conditions of the Delvin River
- To record and rank appropriately actions that could be undertaken to improve the overall habitat and fisheries quality of the river
- To establish three monitoring sites within the corridor under study
- To undertake a detailed ecological assessment at each of these sites, including (where possible) macro-invertebrates, vegetation, phytobenthos and hydromorphology.
- To carry out a review of existing water quality data on the river and report on this in terms of river status.
- To report on sightings of or evidence thereof, and habitat of protected characteristic river species.

This ecological study is planned to serve as a pilot scheme on ecological studies on rivers in the county of Fingal. Based upon this, other rivers within the county may be similarly assessed and included in the Fingal Biodiversity Plan.

The study also addresses the responsibility of the local authority and region in terms of current EU water policy and legislation. In particular in relation to a Directive 2000/60 EC , commonly known as the Water Framework Directive, which established a new framework for Community action in the field of water policy. This directive set a framework for comprehensive management of water resources in the European Community, within a common approach and with common objectives, principles and basic measures. It addresses inland surface waters, estuarine and coastal waters and groundwater. The fundamental objective of the Water Framework Directive aims at maintaining "high status" of waters where it exists,

preventing any deterioration in the existing status of waters and achieving at least "good status" in relation to all waters by 2015.

1.3 The Delvin River: Context and a Brief Summary Description

The Delvin River is found within the Eastern River Basin District (RBD. See www.rbd.ie) and OS catchment no. 162. Within this region it is in Hydrometric Area 08. Its Environmental Protection Agency (EPA) code is 08/D/01. The ERBD is the most highly populated of all of the districts (CDM, 2006) containing over 1.5 million inhabitants. It is also the most urbanised of the districts, urban land use covering 8% of the district. However, agriculture covers some 75% of the land area, and 55% of this is pasture and 20% arable. The district contains 10 of a possible 12 river types as developed by the EPA (Kelly-Quinn et al., 2004) Types 31 (calcareous with a low slope) and 32 (calcareous, medium slope) being the most common within the district (CDM, 2006). A total of 21% of rivers within this district are classified as 'at risk' or 'probably at risk'.

The Delvin belongs to the Nanny / Delvin catchment area (HA08) and within this, agriculture is thought to be the primary driving environmental factor (CDM, 2006), with up to 91% of the catchment area being in agricultural lands. The split between pasture and arable is close to even: 46:45% respectively. However, most of the lands drained by the Delvin are under pasture. Waste water treatment plants (20 in no.) are a main point source of pollution within the catchment and two of these are located on the Delvin. However, the dominant cause of poor water quality in the area is agricultural runoff. It should be noted that the Nanny/Delvin catchment area also contains the least well drained soils in the RBD, with 52% of soil either imperfect or poorly drained, and a further 44% only moderately drained (CDM, 2006). According to the above river characterisation (2006) all of the rivers within this catchment are either 'at risk' (99%) or 'probably at risk' (1%). The increased area under arable cops will heighten the risk of fertiliser runoff to these rivers.

Of the 12 no. known landfill sites within the catchment, only 5 no. are thought to be active at time of writing and none are found close to the Delvin river corridor (www.epa.ie). There are no known significant water abstraction uses of the Delvin. While there are a number of areas designated for conservation purposes within the district and hydrometric area (e.g. SACs such as Malahide Estuary, Rogerstown Estuary) there are no designated sites found within the Delvin corridor. There are a number of other water-related designations to protect areas that have been identified for abstraction of drinking waters, economically significant aquatic species, nutrient sensitive waters or recreational waters under both Irish and EU legislation. None of these areas are known to exist on the Delvin.

The Delvin River rises in Co. Meath at ING 056, 608 among low intensity agricultural lands. It flows over a shallow gradient in a roughly east to north-east direction, though flowing roughly northwards for around 2.5 km between the villages of Naul and Stamullin. For much of its course, the river forms the boundary between counties Fingal and Meath. The river is joined by over ten tributaries, none of these being major watercourses. For most of its course, the river flows through agricultural lands. The majority of these are under low-intensity grazing. Some tillage crops such as wheat or barley were noted in places. According to the EPA, (www.epa.ie/downloads/pubs/water/rivers/.pdf) some 60-65% of the catchment is pasture and 34-38% is miscellaneous agriculture. Limited water abstraction takes place in several areas for local use. There is one hydro-electric station (private) recorded on the river. The river flows through two urban centres. These are the villages of Naul and Stamullin. Wastewater treatment works are located in each of these villages and both discharge into the Delvin, downstream of the urban centre. There are two major breaks in the gentle gradient of the river. These are two waterfalls of over 5m at 132 611 ING and 134 611 respectively.

Channel modification is seen throughout much of the river corridor. In the upper reaches, modification for agricultural drainage is obvious. In the middle reaches of the river there are some areas of channel re-alignment, reinforcement and over-deepening. While some of these works are very modern, having been carried out in the last decade (e.g. at Naul), others are over a century old (e.g. downstream of Cockle's Bridge). The river flows through the

grounds of Gormanstown College, formerly a large demesne and flows into the sea at Knocknaggin ING 182 664, some 2km northwest of Balbriggan. The river is crossed by 9 no. local roads, the R108 at Naul, the M1 motorway west of Gormanstown and the R132 just above its point of discharge into the Irish Sea.

2. Materials and Methods

2.2 Methodologies Employed

A number of methodologies were employed for the various parts of the study under reporting. These are described below:

Walkover Study of River Corridor

The authors have followed the methodology given by the Joint Nature Conservancy Council (JNCC, 1993) for habitat assessment. The guidelines by the Environment Agency (2003) were also used. Habitat classification followed Fossitt (2000) and the floral nomenclature used follows Webb, Parnell and Doogue (1996) and Scannell and Synnott (1987). Mammal names and status information were taken from Hayden and Harrington (2000).

Habitat Assessment of key Stretches

Habitat assessment was carried out on 10 no. 0.5km stretches following the River Habitat Assessment Guidelines given by the Environment Agency (2003). Information on river habitat study given by the RSPB (1994) was also used. It should be noted that this methodology guides that left hand side (lhs) and right hand side (rhs) banks are dictated by the surveyor's position looking downstream. All banks referred to in this report are described as such.

Benthic Diatom and Macro-algae Sampling

The authors referred as directed by tender to Kelly Quinn et al. (2005). However, particular sampling techniques followed Kelly & Yallop (2005) and the Comite Europeen de Normalisation (CEN, 2003 & 2004).

Macrophyte Survey

Survey of aquatic macrophytes followed CEN (2002).

Macroinvertebrate Sampling

This procedure followed BS (EN, 1994) and Environment Agency (1999) for kick sampling of wadeable streams. Species names followed Fitter & Manuel (1986).

2.3 Fieldwork Descriptions and Dates

- Fieldwork on the Delvin River took place between the 15 October and 19 November 2008.
- Three days were taken to assess access to the river and examine tributaries and overall length of channel.
- The walkover study as per project brief took place between 20 October and 12 November. Approximately 7 no. days with at least 2 no. persons were taken to complete this.
- The RHS study of 10 river corridor lengths took place between 28 October and 14 November. A further 7 no. days were taken to complete this stage of works.
- Kick-sampling for macro-invertebrates took place on the 29 October.
- Sampling for benthic diatoms and macro-algae took place on 4 November.
- Water sampling took place on the 8 November.

2.4 Constraints

The main constraining factor of this project was the season in which the study was carried out. For administrative reasons, the project fieldwork was required to be carried out in October and November 2008 and the project substantially completed by end November of this year. This seasonal constraint meant that many of the plant species which might normally be found within the river corridor had completed flowering, had died back and were not obvious or were not visible. This considerably reduced the number of plant species recorded.

Electro-fishing as a method of qualitative fish survey was not permitted due to the seasonality of the work. Drift-diving could not be carried out due to river conditions at time of survey as well as health and safety considerations related to indicative water quality conditions.

Fieldwork took place following a period of high rainfall and on one occasion (29 October) during heavy snowfall. The resulting high water levels served to obscure many species which might otherwise have been observed, including mosses, stoneworts and algae. These groups were therefore required to be scoped out of the survey work as it was considered that unrepresentative numbers were being recorded.

The dates of sampling for macroinvertebrates and benthic diatoms were later than would ideally have been planned (i.e. May-August). However, it was felt that these groups could be sampled and recorded in representative numbers.

Bird activity during the months of sampling was lower than could be expected for months of higher temperature. However, it was considered that sightings or signs of activity of species such as dipper and kingfisher could still be expected during the months of survey.

The timing of survey was suitable for the survey of signs of otter activity such as paths, slides, prints and feeding or resting sites. However, the higher than average river levels may have served to obscure or wash away some otter spraints.

3. Results

3.1 Desk Study

3.1.2 Aerial Photography and Mapping

A series of aerial photographs was supplied to the authors by Fingal County Council. These were at a scale of 1:5000 and are shown in Appendix C. An additional digital map was also supplied which showed the overall river catchment with tributaries. These were reviewed prior to fieldwork. Mapping was later supplied in DWG format by the GIS Department of Fingal County Council. These were used to indicate report findings and are shown in Appendix B.

The aerial photography clearly shows that the upper reaches of the Delvin have been realigned. This is obvious from the highly straightened shape of the stream from Garristown Bridge to Glebe. The layout of the fields within this stretch indicates that the realignment was carried out for the purposes of agricultural drainage. The fields within this stretch tend to be generally narrow and elongate. The vast majority of these being under grazing or cut for silage. A small amount of tillage can be seen. Hedgerows appeared insubstantial and there was no woodland of any kind in this stretch. The tributaries of the Delvin in this area can be seen to have been modified for drainage.

The first significant bend in the river is at Tobeen where the river breaks from its eastward flow to bend to the northeast. There is further evidence of channel straightening between this bend and Naul, some 2.5km to the northeast. Field sizes were generally larger in this area and a greater degree of tillage was indicated. Some earthworks on the northern bank of the river were noted.

Woodland vegetation can be seen to the south of the stream approaching Naul. Here there were also earthworks obvious just west of the village and downstream of the village to the north of the river. The river bends after the bridge with woodland on both sides, indicating a greater gradient for almost 1km. A highly straightened tributary joins the Delvin at the end of this wooded area. The photography would indicate that the populated area does not have a great impact upon the catchment at this point.

The river bends northwards from the townland of Reynoldstown and flows in a roughly northward direction towards Stamullin. The river retains a more natural character in this stretch and closely follows the landscape contours. The hedgerows in this area appear more substantial and there is a small amount of woodland within the shallow river valley. This character is maintained as the river passes to the south east of the village of Stamullin, woodland, substantial trees and hedgerows being apparent as well as several short meanders. After Stamullin, the river bends eastward and passes under the M1 motorway. A series of 4 no. short meanders can be seen as well as small patches of woodland and scrub.

As it passes through the grounds of Gormanstown College with an apparently artificially sharp southward bend, the river is flanked by the most substantial woodland of its course. The photography would indicate that some channel realignment has taken place in this area. For the remainder of the river corridor, the channel appears to have a more natural course, having many tight meanders although some short stretches appear to have been straightened. The river banks appear to be substantially vegetated, there being trees, hedgerows or small areas of woodland along most of the channel until it passes under the R132 at Knockagin. From here the river flows in a straight channel which appears to be lacking in substantial vegetation, under the railway viaduct where it discharges into the Irish Sea.

3.1.3 Water Quality Statistics Review

The EPA currently maintains four monitoring locations on the River Delvin. These are as follows

Station No.	Station Location	National Grid Ref	
		X	Y
0080	Bridge West of Naul	312000	260678
0240	Bridge N. West of Forty Acres	314367	263758
0300	Bridge at Stamullin	315074	265757
0400	Gormanstown Bridge	317070	265794

With the exception of station No. 0300, biological monitoring takes place at all of these stations. This is carried out by the Environmental Protection Agency and the rationale of this is detailed in McGarrigle et al. (1992). Results of this monitoring is reported in 3.1.2(a) below. Physicochemical monitoring has taken place at a maximum of 7 no. locations on the river. This is currently carried out at the 4 no. sites listed in table above. Section 4.3(a) reviews the results of biological monitoring and Section 4.3(b) reviews the results of physicochemical monitoring. The results obtained are reviewed with reference to standards given by the EPA (2001) and other relevant legislation[1]

a. Environmental Protection Agency: Q-values.

The data acquired by biological monitoring of the Delvin at sites 0080, 0250 and 0400 was received from the EPA. This is given in PDF format in Appendix E. Values up to and including 2005 were received. Monitoring at site 0400 began in 1978 while 0080 was added in 1991 and 0250 in 1996.

b. Fingal County Council / Meath County Council and Environmental Protection Agency Physicochemical Parameters

As discussed above, physicochemical monitoring has taken place at up to seven monitoring stations. These are described below:

EPA_Site_Code	Location	XEasting	YNorthing
08D010080	Br W of Naul	312000	260677.6
08D010100	Br just E of Naul Park Ho	313164.7	261121.6
08D010200	Old Mill Bridge	314455.9	262646
08D010240	Br NW of Forty Acres	314367.4	263758.1
08D010300	Br in Stamullin (South End)	315074.1	265757.1
08D010400	Gormanstown Bridge	317069.8	265793.5
08D010500	Knocknagon Br	318026.3	266251.3

Full data sheets are given in Appendix E. The most recent monitoring results are contained in the file covering mid 2004 to June 2008.This file contains results for sites 0080, 0250, 0300, 0400 to June 2008 as these sites are part of the ongoing WFD operational monitoring carried out by Meath County Council. It should be noted that sites 0100, 0200 and 0500 have results to end 2006 only as these sites were dropped from the monitoring programme at that point. XY coordinates for the sites and details of parameters and detection limits relating to

[1] Water Quality Legislation Referred to: Directive 75/440/EEC and SI No. 294 0f 1989 (for surface abstraction), EC Directive 98/83/EC and SI No. 439 of 2000 (for drinking water), EC Directive 78/659/EEC (for Salmonid and Cyprinid spp.) and SI No. 293 of 1988 (for Irish Salmonid Standards).

the 2004-2008 data is included in this file. Other files contain earlier physicochemical monitoring data for the periods 1998-2000 and 2001-2003.These data would have been reported to EPA as part of national rivers monitoring programme at the time. The various data, beginning with the more recent, gained from the statutory bodies listed above is reviewed in Section 4.3. The following water quality statistics were reviewed:

i. Phosphate (P) concentrations 2004-2008.

ii. WFD Monitoring Sites 2007-2008

iii. Dangerous Substances (Fingal County Council) 2006-2008

iv. National Rivers monitoring Programme Data 2004-2008 (EPA / Meath County Council)

v. National Rivers monitoring Programme Data 2001-2003 (Meath County Council)

vi. Physicochemical Data Meath County Council 1998-2000

3.2 Walkover Study of Site

A walkover survey was carried out on the Delvin River to identify ecological constraints and opportunities. Results of the walkover study of the River corridor are given in Appendix A. This includes details and locations of notable features, modifications, erosion and other damage. These are also shown on in Appendix B on drawings Delvin/FFEC/001 to 011.

The findings are discussed in Section 4.1 (River Walkover Study). For the purposes of the study, the river has been divided into 8 reaches which are outlined in the table below. The rationale to divide the river into 8 reaches was based on information gathered during the walkover and RHS surveys which subsequently provided a logical mechanism to delineate reaches of the river that were easily identified and which have distinct management objectives.

Table 3.1 Details of Reaches

Reach	ING ref	ING ref	Townland/Area	Townland/Area
	Start	End	Start	End
1	06000 / 60987	10206 / 59535	Pluckhimin North	Glebe East
2	10206 / 59535	13229 / 61161	Glebe East	Naul north/Waterfall 1
3	13229 / 61161	13464 /61174	Naul north/Waterfall 1	Naul north/Waterfall 2
4	13464 / 61174	14019 / 61922	Naul north/Waterfall 2	Reynoldstown east/valley end
5	14019 / 61922	14877 / 65328	Reynoldstown east/valley end	Stamullin south
6	14877 / 65328	15731 / 66194	Stamullin south	Stamullin northeast/M1 overbridge
7	15731 / 66194	17084 / 65753	Stamullin northeast/M1 overbridge	Gormanston Bridge
8	17084 / 65753	18053 / 66275	Gormanston Bridge	Knocknagin Bridge weir/tidal zone

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3.3 River Habitat Study (RHS)

Results of the survey using the RHS methodology is recorded on the field sheets given in Appendix D. A summary of the results of the survey is given in 3.3.1 below. A discussion of these results in terms of overall river habitat quality is given in Section 4.2: River Habitat Survey: Site Descriptions and Assessment Summaries. An overview of the habitat study is given in the following sections. These are: a summary of the Delvin habitats under the main RHS methodology headings (3.3.1a) and an assessment of the habitats under the rating system of this methodology. The results of this are then summarised in Section 3.3.1c.

3.3.1 Delvin River RHS Overview

3.3.1a Delvin Habitats Summary

Survey data was collected and analysed by the consultants and a summary of the key findings from the data is given below. Additional information on aspects of the RHS methodology can be found in the Field Survey Guidance Manual (EA, 2003).

Bank Profiles

- Resectioned banks dominate the catchment with 70% of sites extensively resectioned on one or both banks. The river in Reach 1 is extensively resectioned on both banks.
- Only 30% of sites did not have any resectioning recorded. These sites (6, 7 and 8 in Reach 5) correlate with evidence indicating this is good to excellent riverine habitat.
- Embankments were recorded in 40% of sites though evidence of embankments in areas outside the RHS sites was also evident. Embankments have been used in areas (particularly the upper end of the catchment) to isolate the river from its flood plain.
- Bank reinforcement is fairly common throughout the catchment (present in 40% of sites) though the extent of reinforcement is not particularly extensive and is generally limited to sections of bank not more than circa 30m
- No sites had toe reinforcement present.
- Top of bank reinforcement was absent from survey sites.
- Poaching was only present in 10% of the sites surveyed though it was observed in other areas during the walkover. It cannot be described as extensive in any part of the catchment.
- There were no incidences of artificial two-stage channels within the catchment though the distinct stepped or shelf appearance becomes less evident over time and some sections of river may have been excavated as two stage channels.
- Vertical and undercut banks were present at 80% of the survey sites, throughout the catchment.
- Steep and gentle banks were recorded at 60% of sites in the middle and lower end of the catchment.
- There was only 1 site with composite banks in the catchment at site 10 (Knocknagin Bridge).

Bank Material

- The catchment has predominantly earth banks and these are present in 90% of the survey sites
- Bedrock banks were only present in two sites and dominated site 2 (Commons Lower) due to the extensive drainage works that were undertaken in the late 19th Century. It was also present at Naul where the river crossed a geological fault line between limestone and sandstone/shale/siltstone.
- Man-made bank materials recorded were brick-laid stone, concrete, and tipped debris, these materials were present in 40% of the sites.

Landuse (50m)

- The catchment is dominated by agricultural landuse.
- Improved grassland, rough pasture, and tilled land were the most commonly found landuse and are distributed throughout the catchment.
- Only one of the surveyed sites (Site 9 Gormanston) had neither improved grassland nor tilled land present. Though the site did have extensive parkland grass.
- Trees were fairly common throughout the catchment with the exception of the upper end of the catchment where arable land ran down to the banks of the river and no trees were present in over 1km of bank (both sides). Trees are a common riparian feature in the middle to lower end of the catchment.
- Broadleaf woodland occurs in 40% of the sites with coniferous plantation only in 20%. It should be noted that although coniferous woodland was present in two sites, the extent and impact of coniferous woodland on the catchment can be described as minimal.
- Suburban/urban and parkland/gardens were present in 30% of the sites with the obvious concentrations being in the lower section of the catchment from Stamullin to Knocknagin
- Moorland/heath and orchard were absent from all sites.
- Wetland, although only present at one site (site 6 old Mill Bridge) was present in other areas of the catchment, particularly between Cockles Bridge and Bodingtown Bridge.
- Scrub/shrub was present at 50% of sites.
- Open water and rock, scree & sand dunes were not present at any sites.

Flow Features

- Flow is perceptibly slow in the upper end of the catchment from Site 1 (Moorepark) through to site 3 (Cockles Bridge) a distance of approximately 5.5km. Riffles were absent from most of this river section.
- Flow is more diverse in the middle to lower end of the catchment, as gradient increases and the impact of resectioning and dredging decreases.
- One major waterfall (>5m) featured in the survey site at Naul and there is another major waterfall approximately 400m downstream of the surveyed waterfall.
- 100% of survey sites had smooth flow present.
- Riffles were present in 80% of survey sites.
- Natural riffle-pool-glide configuration is prevalent downstream of the second waterfall at Naul and with a couple of exceptions the river has relatively natural flow profile to the sea.

Bank Features

- 6 sites 60% contained transects wherein bank features were not visible due to high water or excessive vegetation.
- 70% of the survey sites had no bank features recorded.
- Stable Cliffs were the most common feature being present in 60% of the sites.
- Vegetated side bars were also a common bank feature, being present in 50% of sites. They were particularly prevalent in the middle reaches of the Delvin from site 6 to 10 only absent at Gormanston.
- Unvegetated side bars were only present in one site (site 6 0ld Mill Bridge) though it was difficult to adequately assess some sites due to high water levels during surveying.
- Eroding cliffs were present in 40% of sites. This does not necessarily indicate erosion problems.
- Vegetated point bars were found in 30% of the surveyed sites.

Channel Features

- Due to inclement weather the river levels were high and subsequently the data gathered is not comprehensive.
- In 50% of the sites at one or more transect, the channel features were not visible.
- No obvious channel features were recorded in one or more transects in 100% of the survey sites. No channel features were extensive.
- Exposed boulders were found at 2 sites in the upper reaches of the catchment and are predominantly associated with the historical drainage work undertaken.
- One site (3 Cockles Bridge) has exposed bedrock.
- Vegetated mid-channel bars were more common than unvegetated ones (3 sites had vegetated compared to 1 with unvegetated). Mid-channel bars were found throughout the middle/lower catchment.
- Mature islands were present on one surveyed site (site 5 Naul), mature islands were also noted in the walkover survey in the middle to lower end of the catchment
- There were no occurrence of discrete sand or silt deposits

Channel Substrate

- Difficulties were experienced assessing channel substrate due to high water levels and associated health and safety constraints. 100% of sites contained transects in which the channel substrate was not visible.
- Gravel/pebble was the most common substrate found in 70% of sites.
- Cobble was found in 40% of sites
- Gravel/pebble and cobble substrate dominate the middle and lower end of the catchment.
- Silt and sand substrate were extensive in site 2 (Commons Lower), this is due to resectioning, dredging and subsequent low flow velocity. It is apparent that silt and sand deposits dominate the upper reaches of the catchment.

Trees and Associated Features

- Trees were absent or isolated in 40% of sites so just under half of the surveyed sites have very poor tree coverage on one or both banks. As referred to earlier, the upper end of the catchment has the least amount of riparian trees.
- Trees were semi-continuous in 50% of sites and continuous in 40%. These were located mostly in the middle to lower end of the catchment.
- 20% of sites had regular, singular or clumps of trees. Clumps were more common on the upper end of the catchment.
- Associated features of trees were distributed throughout the catchment.
- Shading of the channel was present in 90% of the sites surveyed but was only deemed extensive in one site (site 3 Cockles Bridge) where the bedrock cut channel was completely shaded to the detriment of aquatic flora and fauna.
- Overhanging boughs were present in 100% of sites and additionally were extensive in 5 sites.
- Exposed bankside roots were present in 100% of the sites and extensive in 4 sites.
- Underwater tree roots were present in 90% of sites, providing excellent instream habitat.
- Fallen trees were present in 90% of sites.
- Large woody debris was recorded in 70% of sites.

3.3.1 b Delvin Habitat Assessment from RHS Data

The 10 no. stretches that were chosen for this study were examined under two assessment criteria that have been derived for the RHS system. These are described below with results.

Habitat Quality Assessment (HQA) is one of two key indices derived from River Habitat Surveys. It is a broad measure of the diversity and "naturalness of the physical (habitat) structure of the river channel and corridor. Its site value is determined by the presence and extent of features of known wildlife interest recorded by the standard survey procedure. A limitation of the system is the subjective nature of the scoring system, based, as it is, on a consensus of informed professional judgement.

As a rough guide, sections with a HQA of 40+% are good (average and above) for the river type considered during this survey. The scores were calculated by summing all component scores for each category (HQA = Flow types, Channel substrate, Channel features, Bank features, Bank vegetation structure, Channel vegetation, Land use within 50 m, Trees and associated features, and Special features, HMS = Modifications at spot-checks, Modifications present but not recorded in spot-checks, and Modified features within the whole site)

Habitat Modification Score (HMS) is a measure of the extent that the natural characteristics of the survey section have been modified by man. An HMS value of zero indicates no significant modification and represents natural (good) conditions.HMS values increase with increasing levels of modification. Like the HQA, the HMS can be described as an objective application of a set of subjective rules that provide a consistent form of comparison between sites. Arising from this, a Habitat Modification Index (HMI) may be assigned to sites that have been subject to RHS methodology.

Factors that contribute to high HMS values include resectioned, reinforced, poached, bermed and embanked banks and culverted, resectioned, reinforced, dammed, weired and forded channels.

RHS Methodology for Assessing HMI and HQA

This is illustrated in the tables below.

Table 3.3.1 Derivation of HMI

HMS	Descriptive category of channel	HMI Class
0	Pristine	1
0-2	Semi-natural	1
3-8	Predominantly unmodified	2
9-20	Obviously modified	3
21-44	Significantly modified	4
45+	Severely modified	5

Table 3.3.2 Derivation of HQA

HQA score category	HQA Class	Description
0 – 20%	5	Very Poor
20-40%	4	Poor
40-60%	3	Fair
60-80%	2	High
80-100%	1	Very High

3.3.1 c Habitat Assessment Results

Habitat Modification Index (HMI)

- The catchment is generally modified with two sites having a HMI class of obviously modified (9 Gormanston and 1 Moorepark) and two sites significantly modified (4 Bodingtown Bridge and 5 Naul). There were two severely modified sites, (2 Commons Lower and 3 Cockles Bridge).
- Four sites were found to be predominantly unmodified or semi-natural, (6 Old Mill Bridge, 7 Gibblocks Town, 8 Stamullin and 10 Knocknagin)
- The main reasons for the poor modification scores are the intensive landuse, bank resectioning and artificial features.

Habitat Quality Assessment (HQA)

- The upper reaches of the catchment (sites 1-3) is predominantly of poor habitat quality.
- 2 sites were found to be very high quality; sites 6 (Old Mill Bridge) and 7 (Gibblocks Town)
- There were two sites that were high quality, (8 Stamullin and 10 Knocknagin).
- Three sites were assessed as fair quality (4 Bodingtown Bridge, 5 Naul, and 9 Gormanston).

The results are summarised in the table below:

Table 3.3.3 Summary of Habitat Assessment of RHS Sites.

Site No. and Name	HQA	Habitat Quality Description	HMI	Modification Category
1 Moorepark	4	Poor	3	Obviously modified
2 Commons Lower	4	Poor/Very poor	5	Severely modified
3 Cockles Bridge	4	Poor/Very poor	5	Severely modified
4 Bodingtown Bridge	3	Fair	4	Significantly modified
5 Naul	3	Fair	4	Obviously modified
6 Old Mill Bridge	1	Very High	1	Seminatural
7 Gibblocks Town	1	Very High	1	Seminatural
8 Stamullin	2	High	2	Predominantly unmodified
9 Gormanstown	3	Fair	3	Obviously modified
10 Knocknagin	2	High	2	Predominantly unmodified

3.4 Ecological Assessments

3.4.1 Ecological Study Sites, Descriptions and Bank and Marginal Vegetation

Three sites were chosen as monitoring sites for the purposes of ecological sampling and recording for this project. These sites are as follows:

Site No.	Location / Name	Grid Reference			
		Start of site		End of Site	
		X	Y	X	Y
1	Moorepark	05487	60787	05959	60973
2	Bodingtown	12004	60675	12438	60980
3	Stamullin	14649	65156	14964	65405

Detailed hydromorphological descriptions of the RHS stretches in which these sites fall are given in Section 3.3 (above). The sites are described below in terms of overall structure, bank and marginal vegetation. These are further discussed in Section 4.2.

<u>Site 1 Moorepark</u>

This site is included in RHS Site 1. The site is located in the townland of Pluckhimin / Moorepark in Co. Meath. The site was chosen as it represents a channel length with suitable substrate for macroinvertebrate and algal survey that is representative of the character of the river within this reach. The channel has been modified by straightening, over-deepening and dredging but not for several decades. A suitable mixture of stream habitat types (e.g. riffle, pool, glide) exists at this site. The substrate here is small cobble and gravel.

The right bank is of uniform vegetation with low herb species predominantly of nettle, agricultural grasses, herb-robert, cow-parsley and some bramble. A single angelica plant was also recorded. The site is partially overhung from the left bank by 2 no. mature ash trees up to 18m in height and 5m crown spread. There is a sparse hawthorn understorey with a small amount of blackthorn and dog-rose that partially shade the site. A small amount of moss (un – identified) was noted at water level on the left bank.

<u>Site 2 Bodingtown</u>

This site is located immediately downstream of Bodingtown Bridge and is also an established EPA monitoring site. The river valley may be described as concave/bowl in nature. The channel has been obviously straightened and re-sectioned. There is a large embankment of tipped material on the left bank due to the quarry operation. This embankment is approximately 200m in length and does not form the bank of the river though extracted material has been used to form a lower embankment to form the left bank over the length of the quarry.

The base width of the channel's wetted area is relatively uniform at 2.7m and the flow is predominately fast and riffled, the natural riffle-pool-glide configuration has been impacted by previous management (dredging/resectioning) with riffle habitat dominating the section. Substrate was predominately cobble and gravel and a suitable mixture of stream habitat types (e.g. riffle, pool, glide) exists at this site.

Stable cliffs comprise the dominant bank profile feature and vegetation was predominantly uniform on the bank faces and bank top with briar, willow and grasses dominant throughout. The right hand bank land use is tilled land and the left bank is a relict of extraction works.

Site 3 Stamullin

This site is located just upstream of Stamullin village and a substantial bridge over which a local road crosses to the south of Stamullin. The site was chosen as it represents part of a largely unmodified stretch of river with suitable substrate and a range of stream habitats.

The left bank of the river is dominated by a near-continuous treeline of alders, most being mature. There is also some white and crack willow. The understorey includes mature bramble. Although the treeline is less continuous on the right bank, there is evidence of both alder and willow regeneration on the right bank. The tall herb vegetation on the right bank is dominated by great willow-herb but there is also some meadowsweet and tall umbellifer that were probably angelica (substantially died back).

The right bank has been embanked (probably in the last decade) and there is tree regeneration on this. There is also a diverse range of plant species on the slopes of this mound including *Phragmites*, great willow-herb, nettle, elder, crack willow, gorse and umbellifers such as chervil and cow-parsley. Hard rush and tall sedge are found on the right bank close to the sampling site downstream.

3.4.2 Freshwater macro-invertebrates

Kick-sampling for freshwater macroinvertebrates took place at each of the above sites. A three-minute kick-sample was taken over riffle, pool and glide areas of each site. Each kick-sample was replicated 3 times. Rock and leaf washing was also carried out on each site. Samples were partially sorted (e.g. vegetation discarded) on site before invertebrate samples were transferred to sealed containers. Samples were preserved with 70% industrial methylated spirits before transporting to laboratory.

Samples were identified to species or to the lowest taxonomic level possible. The results of this are given in Appendix F. Macroinvertebrate taxa recorded during N7 survey in September 2007. Numbers shown are numbers of individuals per sample. Q indices calculated as follows: 1 or 2 individuals = Present, <1% = Scarce/Few, <5% = Small numbers, 5-10% = Fair numbers, 10-20% = Common, 25-50% = Numerous, 50-75% = Dominant, >75% = Excessive. The EPA faunal indicator groups of sensitivity to pollution are A (sensitive), B (less sensitive), C (tolerant), D (very tolerant) and E (most tolerant).

A total of 4,971 no. individual invertebrates were counted, representing a maximum of 26 species or taxa per sample. An average of 17 species or taxa were represented in the samples from Site 1. Greater diversity was found in the Site 2 sample at Bodingtown where over 21 groups or species were represented on average. However, the Site 3 samples showed over 24 species or taxa on average. A full description of the macroinvertebrate results is given in Section 4.2.

3.4.3 Macrophytes

Due to seasonal constraints and higher than average river levels, a representative survey of macrophytes could not be carried out.

3.4.4 Benthic Diatoms

The substrate at the three reference sites were sampled for benthic diatoms on 4 November 2008 as per standard methodologies such as Kelly et al. (2005). Analysis was carried out by Bowburn Consultancy (UK), using standard methods. Results are expressed as TDI (Trophic Diatom Index) and EQR (Ecological Quality Ratio)[2], following the DARLEQ methodology

[2] The TDI has a scale 0-100, with 0 indicating very low inorganic nutrients and 100 indicating very high nutrients. EQR is calculated as observed TDI / expected TDI, and runs from 1 (observed = expected) to 0.

(Diatoms for Assessing River and Lake Ecological Quality: Kelly et al., 2008). The results are summarised in Table 3.2 below. The full list of diatoms analysed is given in Appendix F, Part 2. The results are discussed in Section 4.3.3.

Table 3.2: Trophic Diatom Index (TDI) and Ecological Quality Ratio (EQR) for the three River Delvin sites.

Sample	River	Site No.	Date	TDI	EQR	Status
108466	Delvin River	1 Moorepark	05-Nov-08	70	0.45	Poor
108467	Delvin River	2 Bodingtown Bridge	05-Nov-08	85	0.22	Bad
108465	Delvin River	3 Stamullin	05-Nov-08	90	0.15	Bad

3.4.5 Macro-algae

Scrapings and samples of visible vegetation were taken at the three reference sites according to the methodology by Kelly et al. (2005). The samples were analysed for algal species by Bowburn Consultancy (UK) using standard methodology. The results are summarised in the table below and discussed in Section 4.3.4.

Table 3.3: Results of macro-algae analysis for the three River Delvin sites.

River	Site No.	Date	Results
Delvin River	1 Moorepark	05-Nov-08	Mineral particles plus some young moss shoots. No filamentous algae found.
Delvin River	2 Bodingtown Bridge	05-Nov-08	Organic debris, moss fragments, fungal hyphae plus chains of *Melosira varians* (centric diatom). No filamentous algae found.
Delvin River	3 Stamullin	05-Nov-08	SM1 A fragment of moss (*Amblystegium riparium*?) with filaments of *Cladophora glomerata* entangled around it. Parts of the *Cladophora* - especially recently dead cells - were smothered with *Cocconeis pediculus*, an epiphytic diatom (interestingly, *C. pediculus* was not recorded in the diatom analysis).

3.5 Water Quality (Physicochemical) Sampling November 2008

A substantial review of physicochemical water quality data held by the Environmental Protection Agency, Fingal County Council and Meath County Council is given in Section 3.1.2. However, in order to present findings in terms of recent and site specific data (in particular with reference to diatom sampling), the authors carried out water sampling at each of the three reference ecological sites. The results of this are given in Appendix F and discussed in Section 4.3. The following parameters were laboratory tested:

Parameter	**Unit**
pH	pH Units
Nitrite	Mg/l as NO2
Nitrate	Mg/l as NO3
Orthophosphate	Mg/l as PO4
Ammoniacal Nitrogen	Mg/l as N
Bicarbonate Alkalinity	Mg/l as CaCO3
Carbonate Alkalinity	Mg/l as CaCO3
Hydroxide Alkalinity	Mg/l as CaCO3
Total Alkalinity	Mg/l as CaCO3

In addition, the following parameters were field-tested using portable Hanna meters:

Parameter	**Unit**
pH	pH units
Temperature	oC
Electrical conductivity	uS
Total dissolved solids	ppm

The results are discussed in Section 4.4(c).

3.6 **Fisheries: Quality Assessment**

Due to seasonal legal restrictions electrofishing surveying was not possible. It was planned that a drift dive survey could be undertaken but flooding in the river and inclement weather made this impossible. There were also health and safety issues relating to the drift dive that could not be resolved.

To attempt to ascertain some qualitative data, the river was walked from source to sea by two surveyors both wearing polaroid glasses. The survey also involved periodically entering the river and checking under stones and LWD for the presence of White-clawed Crayfish (*Austropotamobius pallipes*).

The only fish witnessed and positively identified was the three-spined stickleback (*Gasterosteus aculeatus).* When discussing the river with local land owners, it is apparent that brown trout were present in the upper reaches of the river (above Naul) in modest numbers over thirty years ago, but most farmers reported that they had not witnessed trout in this section of the river in recent years.

Below Naul landowners and farmers reported reasonable numbers of trout and the owners of the hydroelectric unit at Naul have seen brown trout over 0.5kg trying to jump the waterfall. Gormanston and District Anglers report reasonable numbers of small brown trout and sea trout in the lower end of the catchment with brown trout up to 0.75 kg and sea trout up to 1.25kg caught on rod and line.

4. Discussion

4.1 River Walkover Survey

The results of the walkover study are given below within the context of the 8 no. reach sections that were devised for the purposes of this survey. The reaches are as follows:

Table 4.1 Reach Details

Reach	ING ref	ING ref	Townland/Area	Townland/Area
	Start	End	Start	End
1	06000 / 60987	10206 / 59535	Pluckhimin North	Glebe East
2	10206 / 59535	13229 / 61161	Glebe East	Naul north/Waterfall 1
3	13229 / 61161	13464 /61174	Naul north/Waterfall 1	Naul north/Waterfall 2
4	13464 / 61174	14019 / 61922	Naul north/Waterfall 2	Reynoldstown east/valley end
5	14019 / 61922	14877 / 65328	Reynoldstown east/valley end	Stamullin south
6	14877 / 65328	15731 / 66194	Stamullin south	Stamullin northeast/M1 overbridge
7	15731 / 66194	17084 / 65753	Stamullin northeast/M1 overbridge	Gormanston Bridge
8	17084 / 65753	18053 / 66275	Gormanston Bridge	Knocknagin Bridge weir/tidal zone

Reach 1: From the source in the townland of Pluckhimin North to Glebe East

The predominant feature of Reach 1 is the extensive modification of the river channel for drainage and flood alleviation. A proportion of these modifications were undertaken in the late 19th Century under the auspices of the Garristown Drainage Board. These traditional drainage practices resulting in the widening, deepening and straightening of the upper Delvin catchment and the creation of channels of uniform gradient were highly destructive to the rivers ecosystem. Such drainage has resulted in severe habitat loss and the problem has been perpetuated by continuing maintenance schemes which have kept the river flora and fauna in an impoverished state.

There is strong evidence of eutrophication from high nutrient loading as a result of agricultural practices but it should also be mentioned that domestic discharges from local residences (some with very perceptible sewage odours) were also discharging directly into tributaries and the main river channel.

A final notable feature of Reach 1 is the heavily vegetated bedrock channel that has been cut from Cockles Bridge for approximately 700m downstream into the townland of Glebe East. The river is heavily modified in this section and in conjunction with excessive shading and bedrock substrate; there is little of note in respect of river-based biodiversity. The trees will provide shelter, food and nesting areas for birds and though light is an essential prerequisite for life in rivers it is not deemed a priority to reduce the canopy cover due to the bedrock substrate.

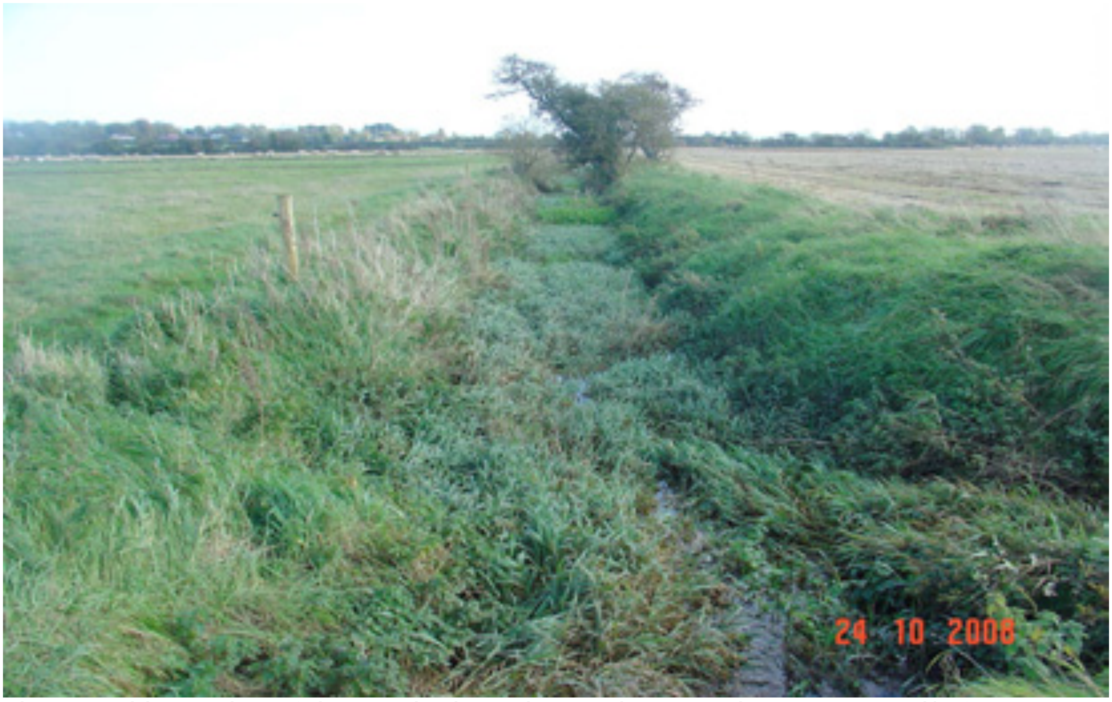

Fig 4.1 : This section of the Delvin river channel is approximately 500m d/s from RHS site 1. This is the beginning of the highly modified (Reach 1) that runs from near the source to the end of Reach 1 at Glebe East. The channel is choked with Reed Canary Grass *(Phalaris arundinacea)* and at least three kilometres of channel have at best the occasional tree or none.

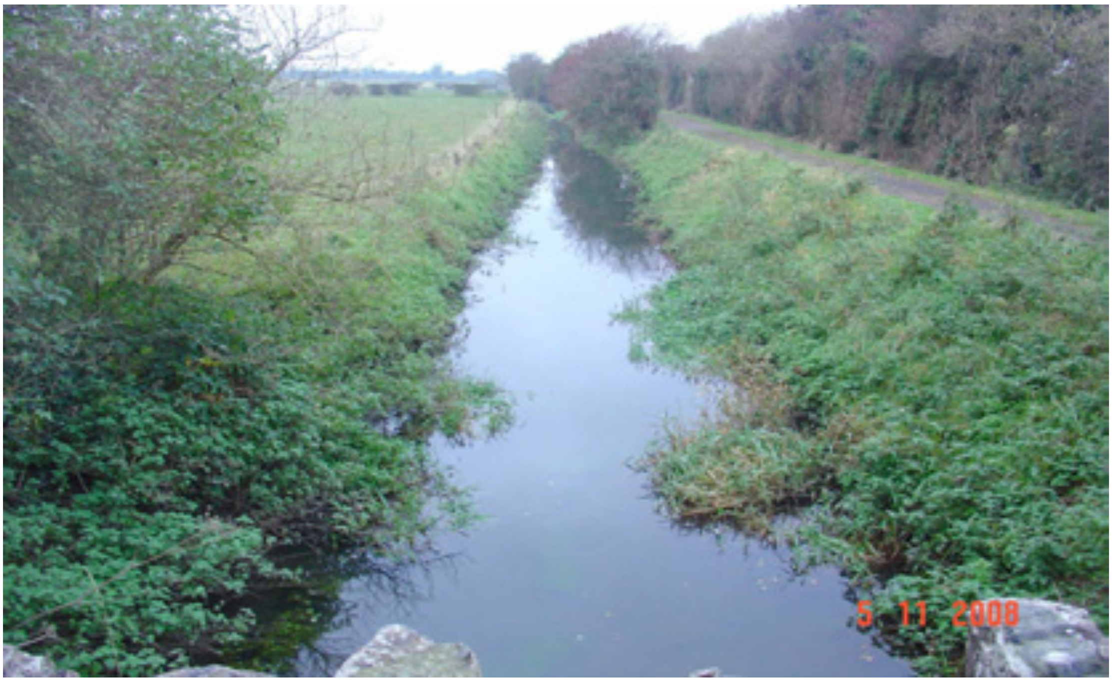

Fig 4.2: A typical stretch of resectioned, dredged and straightened river in Reach 1 at Commons Lower. River flow was generally not perceptible in this section. Instream macrophyte growth was abundant/excessive, and in some areas diverse, though all species were associated with slow/still water, drainage ditches or canals.

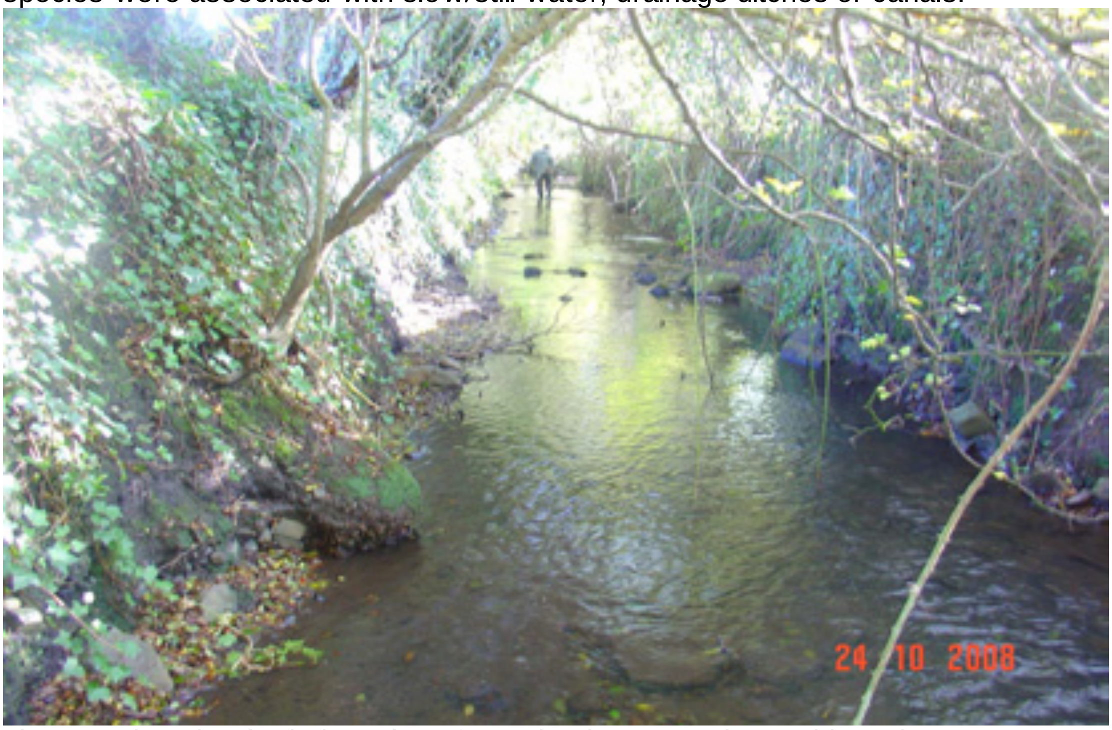

Fig 4.3: A heavily shaded section of Reach 1 below Cockles Bridge. There were no instream macrophytes in this section and the bed of the river consisted primarily of cut and channelled bedrock. At a local habitat scale, substratum and current velocity are probably the most important factors determining the type of macroinvertebrate taxa present. The stream substratum has obvious importance because the vast majority of stream micro-invertebrates spend most of their lives attached to substrata. The particle size of inorganic matter has a large influence on macroinvertebrate community structure and this bedrock environment presents a very poor environment for both macro and micro invertebrates.

Reach 2: From Glebe East to Naul North (Waterfall 1)

Reach 2 begins at the end of the shaded bedrock channel at the townland of Glebe East. It is immediately apparent that the riverbanks and bed change from limestone bedrock to earth and gravels and there is strong evidence to suggest that the natural physical processes of the river are beginning to regenerate the river channel to a semi-naturalised state. However, recent resectioning/dredging operations within the Reach have had a deleterious impact on the river channel structure, and both instream and riparian flora and fauna.

The key features/points of Reach 2 are:

- the self regeneration of a proportion of the previously resectioned and dredged river channel,
- a connected active floodplain with seasonal wetlands in the regenerating section
- areas of farmland not intensively farmed within the regenerating section
- protection and associated incentives should be provided for landowners to maintain the current status quo within the regenerating section
- environmentally insensitive resectioning and dredging in the mid-section of Reach 2 has had a highly negative impact on biodiversity
- establish investigation into necessity of extreme maintenance and possible education of landowners into environmentally sensitive river maintenance programmes

It is evident that in recent years, no major river maintenance work has been undertaken on the majority of Reach 2 and as a result the river's natural morphological processes are resulting in a semi-recovery from its degraded state. In its attempts to attain a regained equilibrium the canalised river may erode and deposit sediment from its bed and banks thus creating a meandering or braided course. There is sufficient space in the resectioned channel for these processes to occur without negatively impacting the landowner's property. The process can be assisted by removing redundant bank revetment and by reducing the frequency or cessation of maintenance operations. All that may be needed is to monitor whether lateral migration is causing problems in respect of prejudicing drainage or flood defence requirements.

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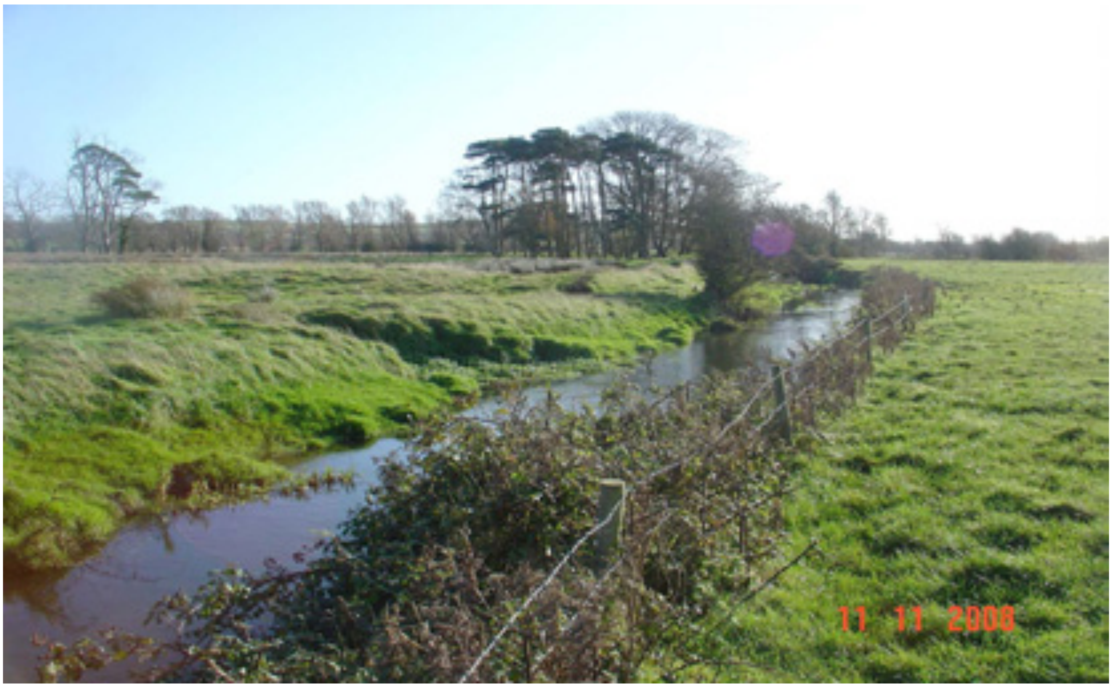

Fig 4.4:The beginning of Reach 2; it was immediately apparent that the river corridor was undergoing positive changes. This change is directly attributable to no major river maintenance in respect of dredging or resectioning being undertaken. However, it is difficult to assess how long this regeneration process has been in operation, and

every effort should be made to monitor progress and discuss maintenance issues with local landowners.

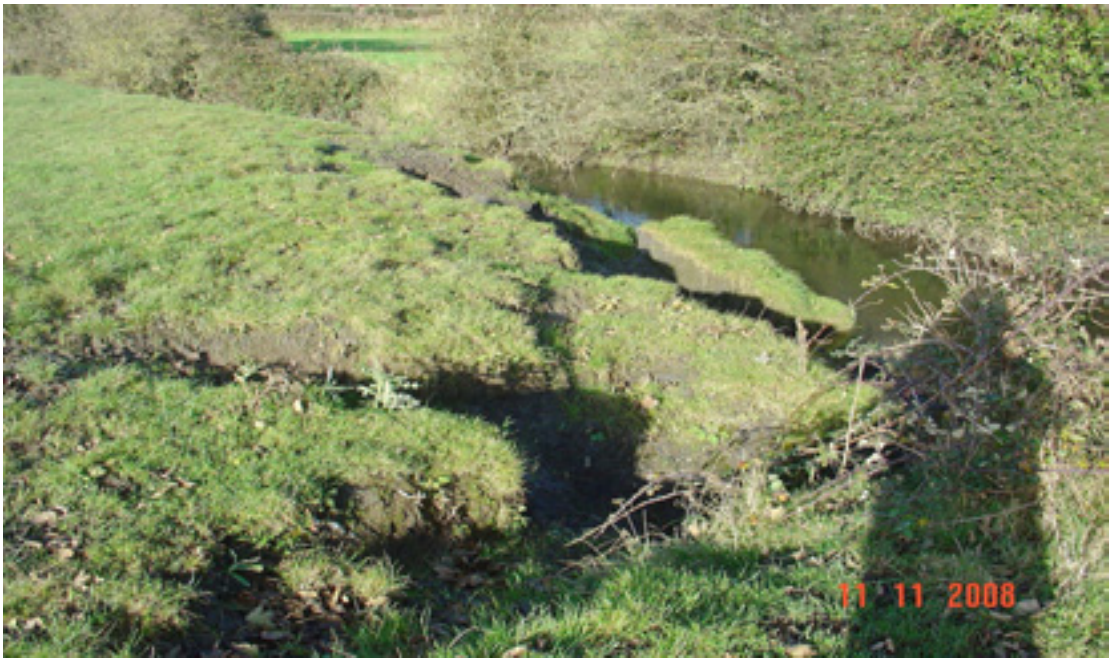

Fig 4.5: Poaching from cattle is severe in this section at the top of Reach 2 but this is an exception. Generally the river bank was fenced on the RHB and land use on the LHB was predominantly lightly grazed impoverished grassland and wetland.


Fig 4.6: Vegetated side bars and deposition. The river channel is reverting back to a base width in which flow is perceptible and instream morphological features are beginning to reform. There were riffled areas in this section and pools developing on bends. A degree of sinuosity was reappearing in the resectioned areas and associated biodiversity was evident.

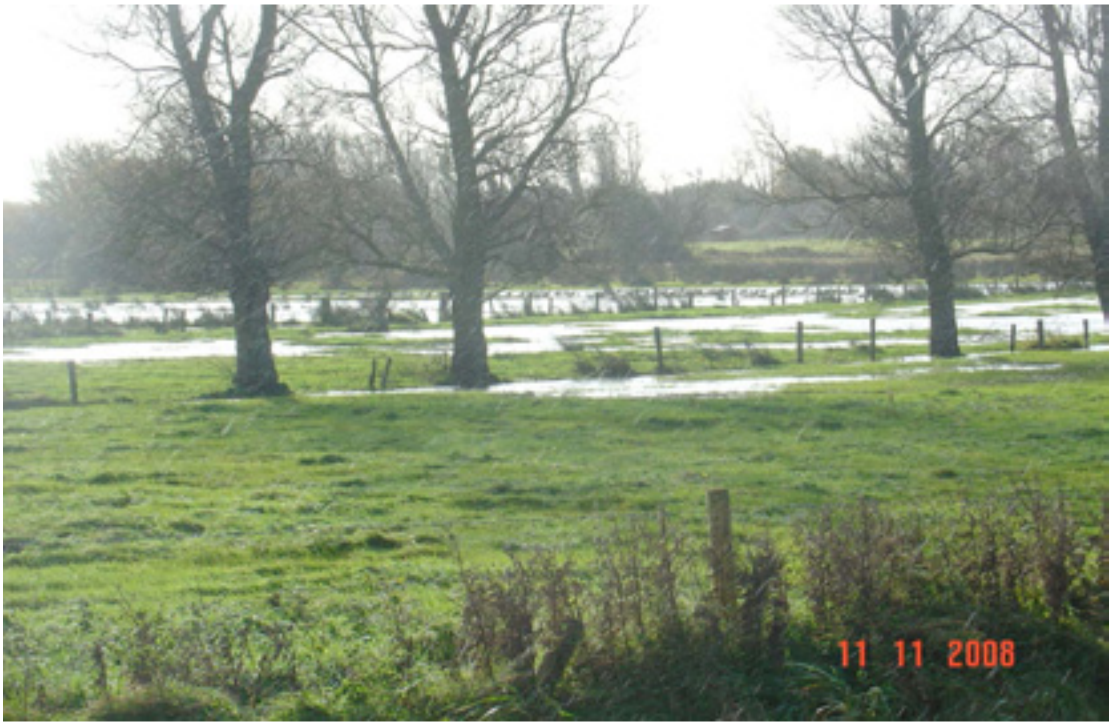

Fig 4.7: The floodplain is active. During the walkover, large flocks of Curlew, Widgeon and Teal were present. Snipe were also seen. The water in the fields in view appeared to be at the same level as the river level and attempts had been made to try and drain this ground. It would require a major drainage operation to alleviate flooding in these fields and would have catastrophic consequences for upper reaches of the Delvin River.

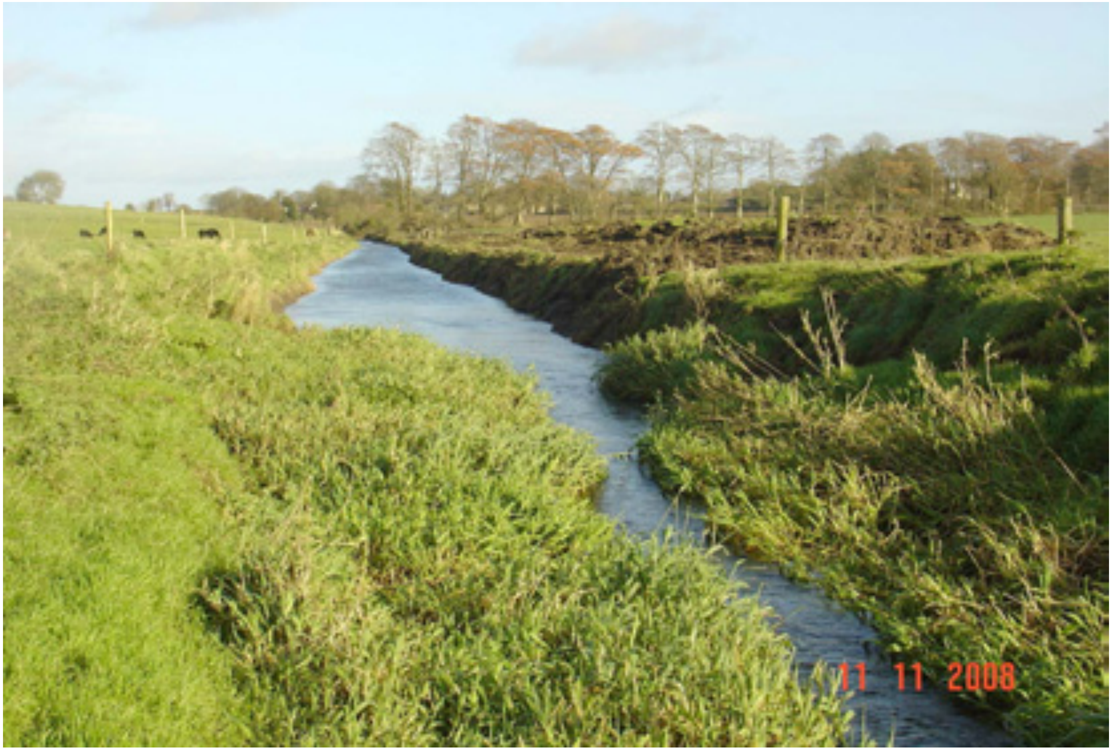

Fig 4.8: This is the middle section of Reach 2 upstream from Bodingtown Bridge. This picture highlights the difference between the regenerating section and a section of the river that was dredged while this survey was being undertaken.

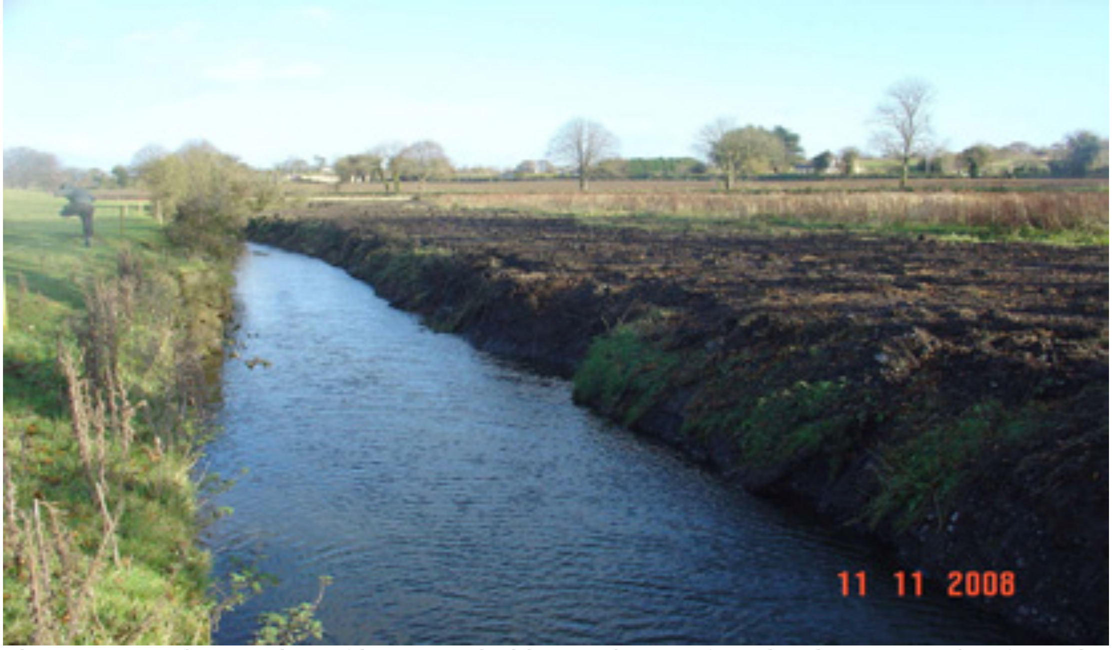

Fig 4.9: Total destruction of instream habitat and loss of all riparian vegetation from the RHB, this will result in increased sediment loading, bank erosion and long term highly negative impacts on the biodiversity of the river corridor. This style of dredging is very outdated and highly unnecessary; it would be advisable to educate landowners in environmentally sensitive methods of drainage/dredging.

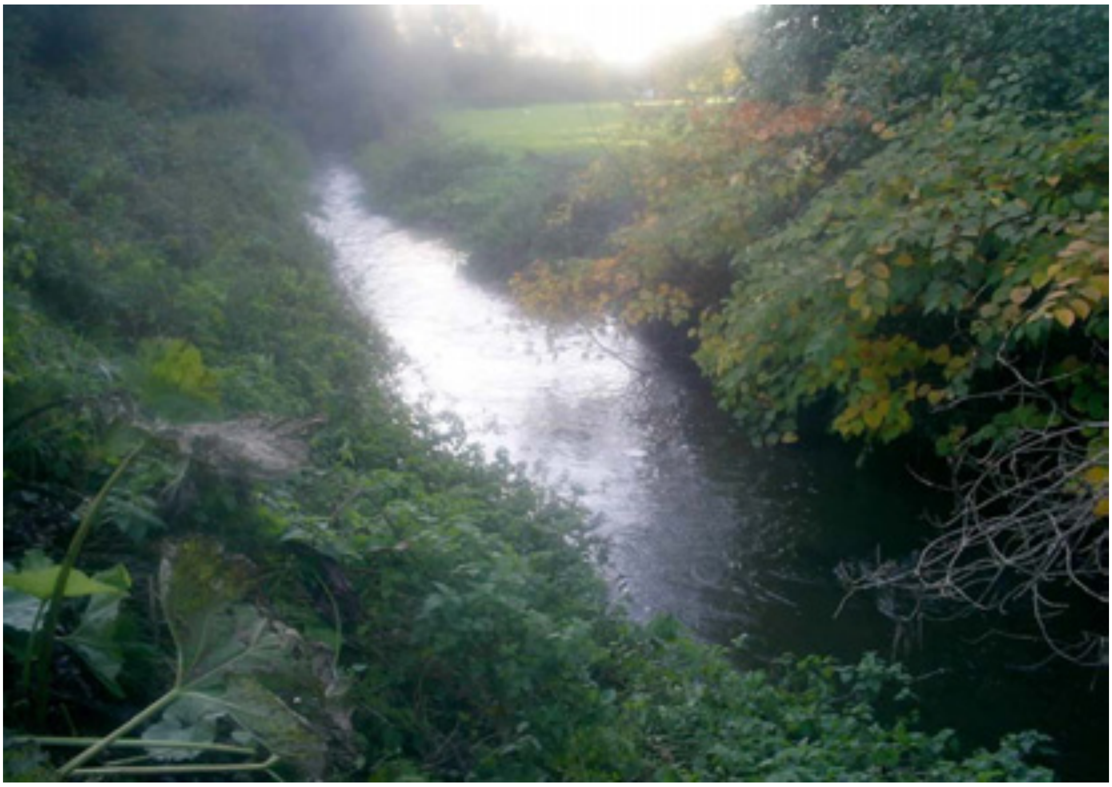

Fig 4.10: The end of Reach 2 at Naul, despite obvious resectioning of the river bank, there is a diversity of instream and riparian habitat as the river approaches Naul. There are, however, overall negative factors relating to water quality in this reach and serious concerns that the instream biota has been severely impacted with possible elimination of fish and invertebrate species on a localised level.

Reach 3: From Naul North (waterfall 1) to Naul North (waterfall 2)

There are two waterfalls in excess of five meters on the Delvin catchment and both are at the downstream side of Naul. One is natural (at the sewage treatment works and one is man-made approximately 500m downstream of the first.

The natural falls at the Naul treatment works are as a result of a fault line between dark-grey argillaceous, cherty limestone and shale above the falls and slate, shale, minor sandstone and siltstone below.

The impact of the natural and man made falls can be interpreted in a number of ways:

- There will be no migration of any fish species over the water fall at the hydro-electric station; this is further compounded by the natural falls less than 500m upstream.
- The impact of the two waterfalls is the isolation of fish and aquatic communities upstream of the obstructions. There will be genetically discrete populations of indigenous fish and aquatic species such as crayfish, should those species exist above the falls.
- A negative impact of the falls relates to fish kills, habitat abuse or chronic water quality problems upstream of the falls that may have resulted in some species no longer present above the falls. Subsequently there would be no natural upstream migration to repopulate the river in the upper reaches of the Delvin catchment.

Fig 4.11: The natural falls at Naul, no upstream migration of instream aquatic fauna but possibly an opportunity for a small scale hydro-electric unit.

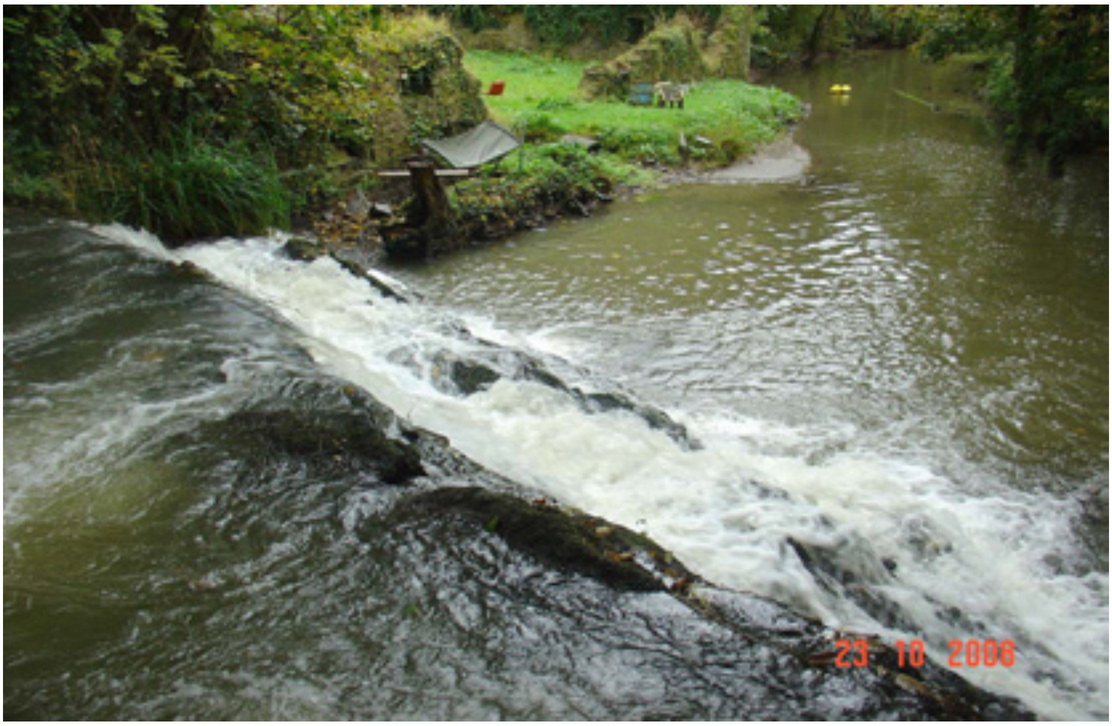

Fig 4.12: The yellow buoys in the picture denote a small-scale water abstraction facility The falls are occasionally used by locals as a recreational area. It should be noted that access to this area on the LHB is private and the RHB is a council owned sewage facility with illegal access routes that are currently dangerous. There may be possibilities in opening access to the falls and in turn help connect the local community with the river and the issues surrounding its health and biodiversity.

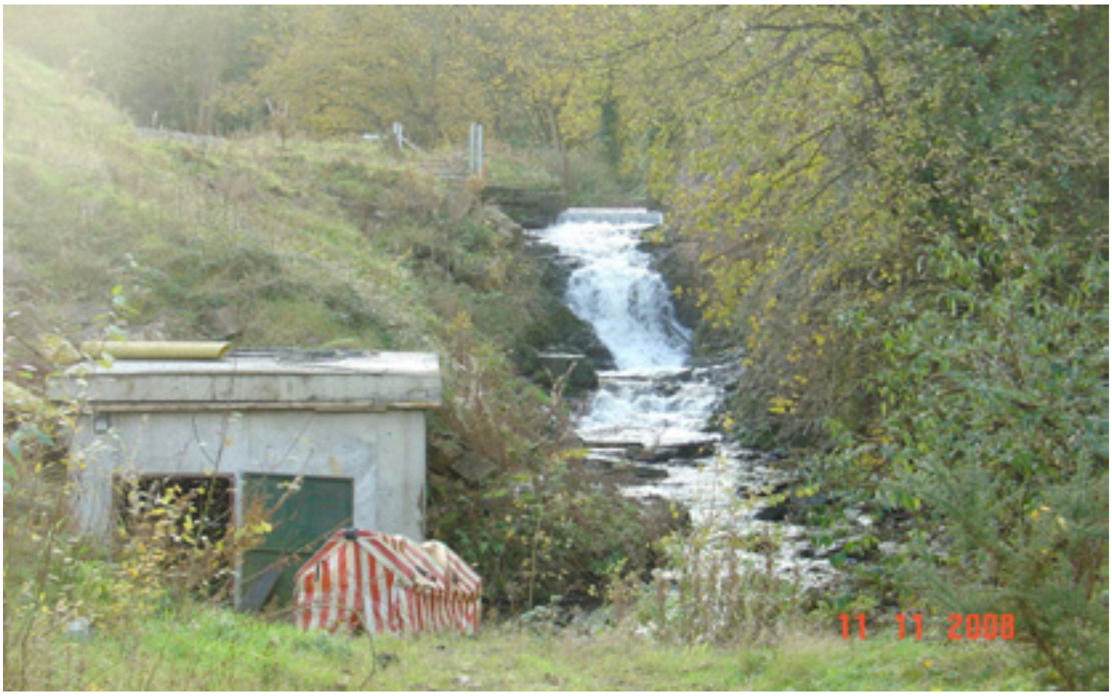

Fig 4.13: The hydroelectric unit below Naul. The river was artificially re-routed and impounded to form a pond upstream and provide sufficient head loss to run a turbine. Although not seriously impacting the river relative to migration (due to the falls immediately upstream) this work will have required planning permission and ministerial consent under the 1959 Fisheries Act. Any such work is potentially devastating to all upstream migration.

Reach 4: From Naul North (waterfall 2) to Reynoldstown East/Valley End

The primary issue in Reach 4 is Conley's quarry and associated waste tipping site at Clashford, Naul. There are a number of major erosion and subsidence points on the embankments running parallel to the River Delvin on the LHB, that are currently discharging silt and sediment into the river during periods of heavy rainfall or when the river is in spate. There is an immediate risk of a large scale deposition of tipped material into the river that could have a highly detrimental impact on all instream flora and fauna in the immediate vicinity of the quarry and have far reaching consequences for salmonid spawning grounds for many kilometres downstream.

Brown trout and seatrout require un-compacted gravels in which to lay their eggs. If fine sediment accretes on the redd after the eggs have been laid, the permeability to water of the gravel is reduced, which has a deleterious affect on the survival of young trout by reducing the level of dissolved oxygen available to the embryos.

It is recommended that an investigation into gravel compaction and siltation is undertaken at the site and downstream of the impacted area with the possibility of a rehabilitation programme for gravels that have become infiltrated. However, unless all the factors causing siltation are established and controlled any benefits will be temporary. The problem of accretion of silt on instream fauna and flora can only be addressed by reducing the source of silt.

In addition to fish and invertebrates there are likely to also be impacts upon other organisms such as macrophytes and diatoms from both suspended and deposited solids. In line with the remit of this review, the entire aquatic ecosystem has been taken into consideration when assessing the impact of solids released, on attempts to reach good ecological status.

The river channel throughout Reach 4 is evidently resectioned and embankments dominate much of the riparian zone on the LHB, in spite of the obvious and potential problems experienced in this reach, the river channel does have a diversity of instream habitats and the valley in which the river flows is steep sided and terraced with mixed indigenous broadleaved woodland, a diversity of associated habitats and is aesthetically very appealing.

In the context of this report, the instream and riparian habitat immediately downstream of Reach 4 has the highest degree of biodiversity and would be at risk should a major landslide occur at the quarry, it is imperative that these problems are addressed quickly.

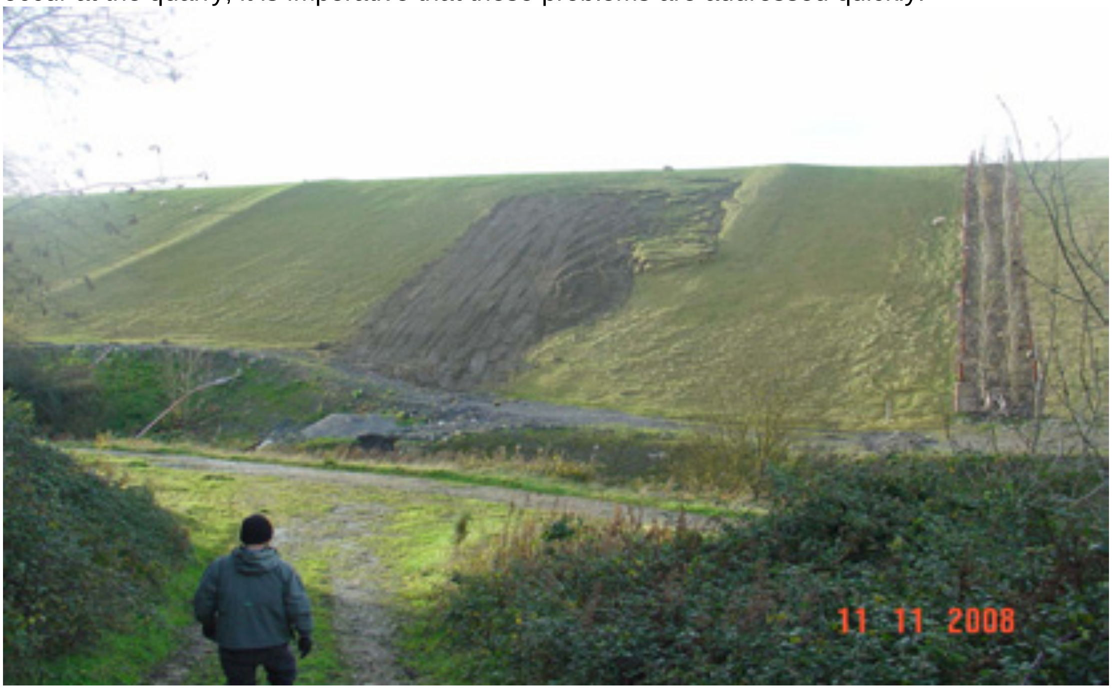

Fig 4.14: This picture puts the scale of the landslide into perspective. This instability could potentially have a devastating impact on the Delvin River environment.

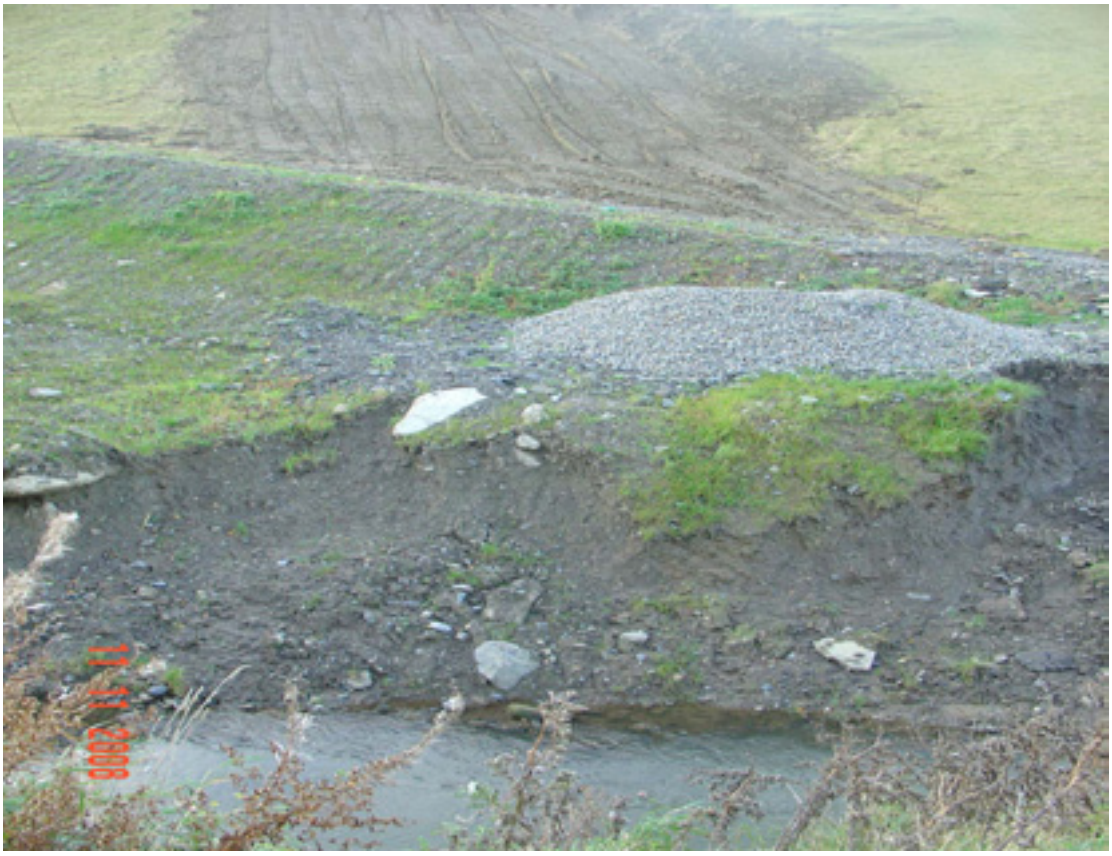

Fig 4.15: In this picture, there are a number of major issues impacting the river and the surrounding riparian habitat. The main bank at the top of the picture is unstable and has recently had a major landslide which has been patched up. Below this, tipped stone, quarry infill and the bank have eroded and deposited materials into the river.

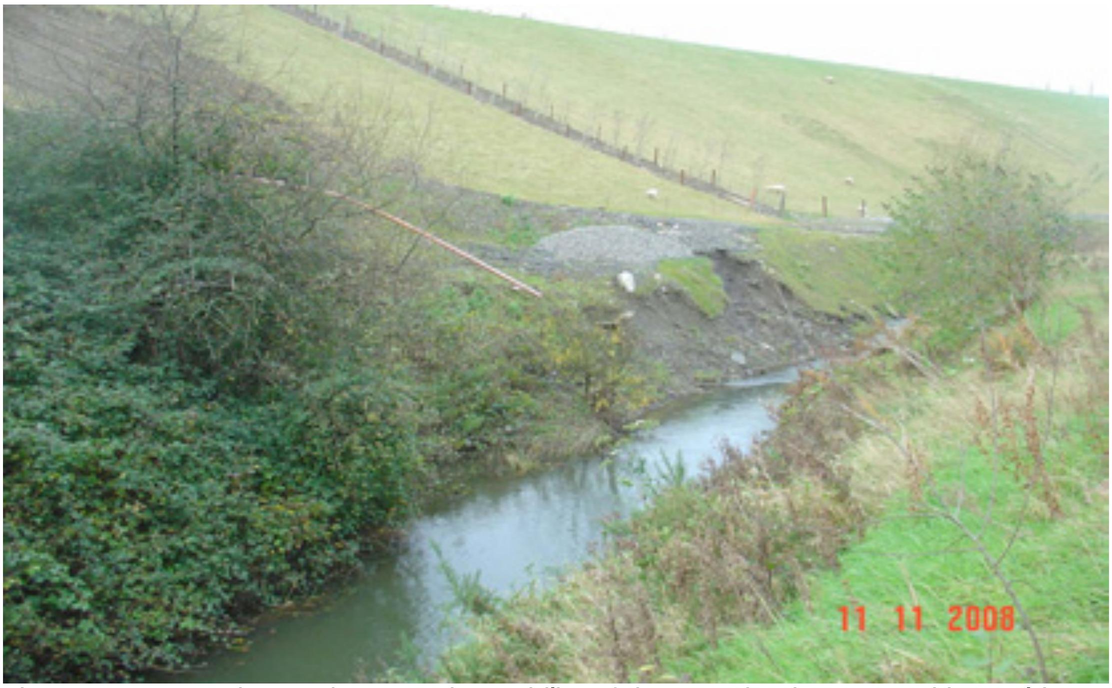

Fig 4.16: Reservations exist as to the stability of these embankments and it would seem irrational to graze sheep on these embankments as they can exacerbate

erosion problems. It would be preferable to establish scrub and indigenous woodland on these embankments to provide stability and develop habitat diversity.

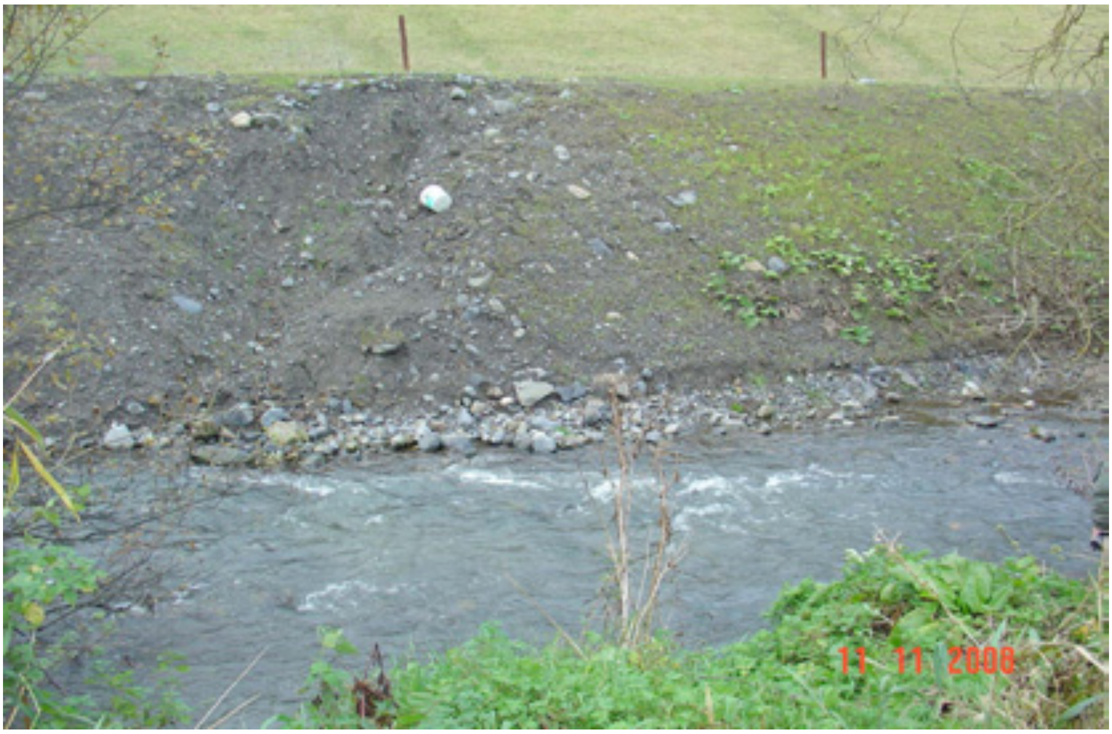

Fig 4.17: There was little or no evidence to suggest that any preventative measures have been taken to reduce silt loading into the river by the operators of the quarry. It is evident from the flood-line in this photo that moderate to large amounts of silt have and will continue to be discharged into the river.

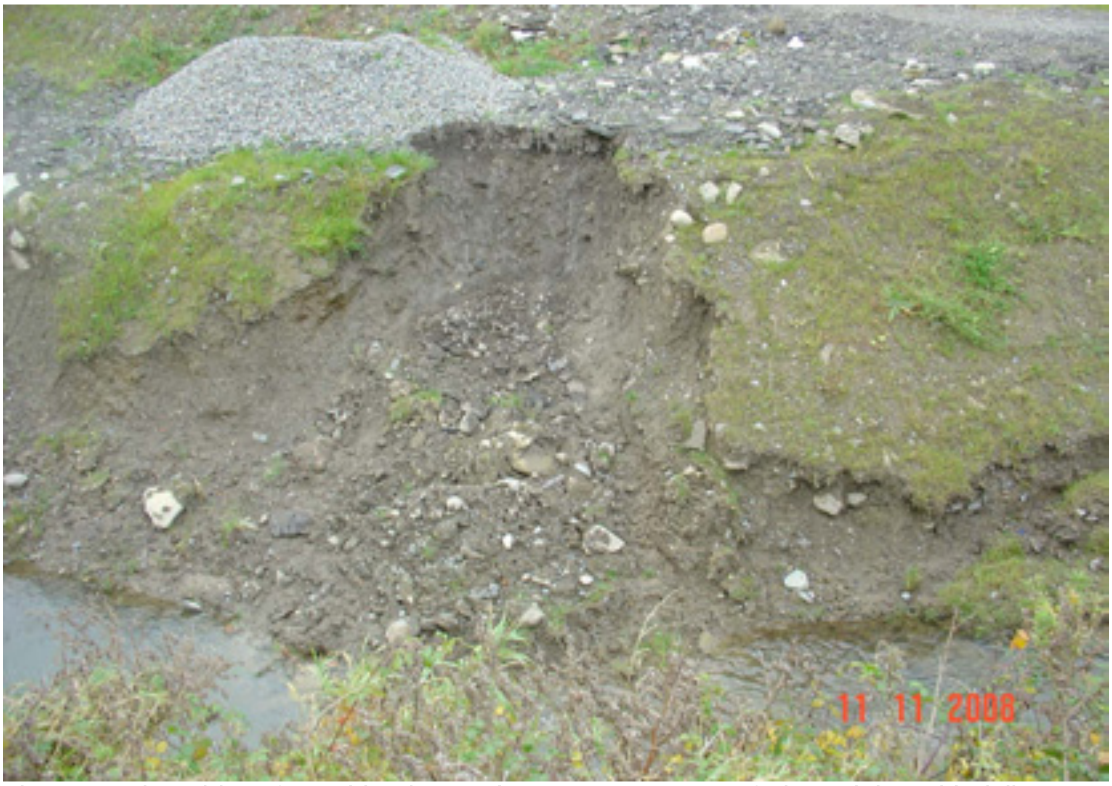

Fig 4.18: It is evident from this picture that large amounts of silt and tipped building material has already been washed into the river. Again, there is no visible evidence of any remedial work to tackle erosion or prevent silt entering the river. This bank is

particularly unstable and mitigation will require re-profiling, bank stabilisation and revetment.

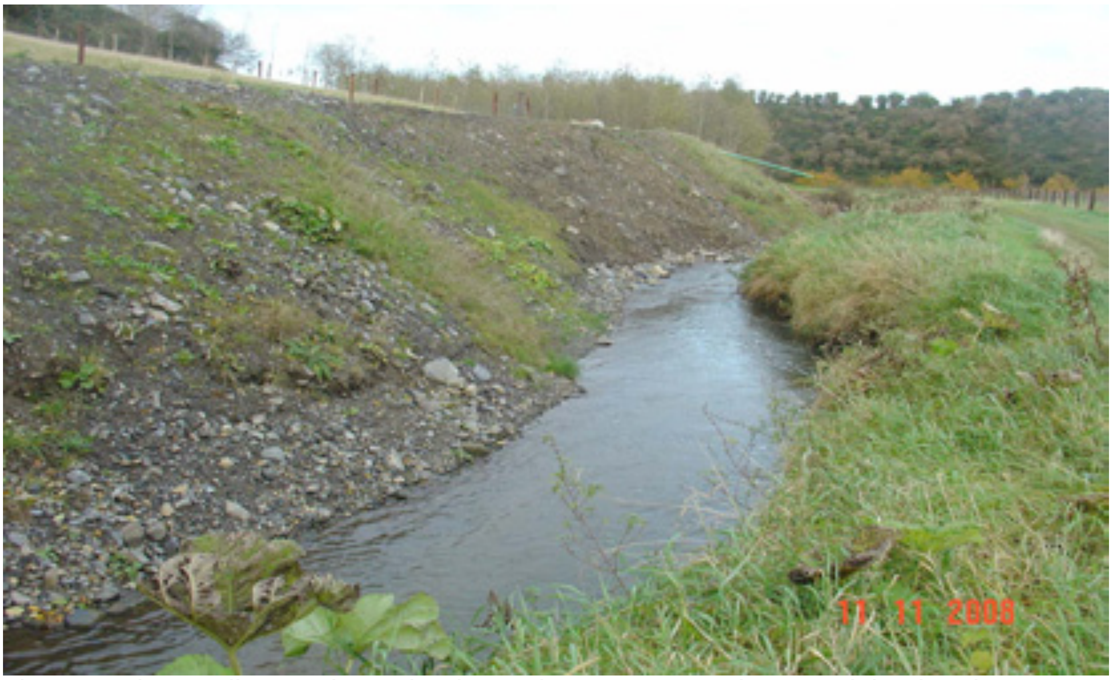

Fig 4.19: The gradient of the embankment is too steep and no provision has been made for a two-stage channel or buffer zone between the tipped material and the stream. No topsoil has been put on the embankment to promote re-vegetation and subsoil is constantly eroding and entering the river. The structural integrity of this entire structure is vulnerable and it is envisaged that large sections of this embankment will break off and enter the river.

Reach 5: From Reynoldstown East/Valley End to Stamullin South

Reach 5 could well be described as the best habitat of the Delvin River. The river flows through primarily improved grassland and rough pasture, and expresses a wide diversity of both riparian and instream habitat.

Notable features throughout Reach 5 are:

- A predominantly unmodified river channel
- A diverse range of riparian vegetation and associated habitats
- Stable bank structure
- A diversity of large woody debris (LWD), exposed underwater tree roots, undercut banks etc.
- An intact riffle-pool-glide configuration with an array of instream habitats suitable for a range of indigenous aquatic flora and fauna
- Large sections of the river bank are fenced from livestock and there was only a small section of arable land directly adjacent to the river

Throughout the course of the study, Reach 5 has consistently impressed due to the physical instream structures, and the hydrological and riparian vegetative features exhibited from Reynoldstown to Stamullin South. The stable unmodified bank structure ensures a consistent wetted area in terms of base width and the associated natural morphological features ensure a stable instream environment from low summer flows to seasonal floods. The river has a connected and active floodplain that relieves pressure on both the riverbed substrate and the banks during flood events.

However, the chief aspect of concern was the apparent lack of associated wildlife that would have been expected. There were no fish species seen at any time throughout the course of the walkover study or during the three RHS surveys that were conducted in this Reach despite using Polaroid glasses throughout. Conditions were admittedly far from ideal but experience from previous surveys in a similar riverine environment would indicate that both species diversity and population sizes are not at potential levels. On the evidence presented in Reach 5, water quality would appear to be one of the major limiting factors of the Delvin River catchment.

Reach 5 has undoubtedly the highest ecological value of all the Reaches surveyed and it is vital that the river, the riparian zone and the floodplain are afforded adequate protection. There should be no resectioning, dredging or modification of these areas to facilitate drainage or land reclamation and incentives to farmers and riparian land owners to maintain or even enhance the biodiversity of the river corridor should be investigated and implemented into the biodiversity action plan.

Fig 4.20: Defined pools, natural stream processes of sediment deposition, side and point bars all contribute to a diversity of physical habitats in Reach 5

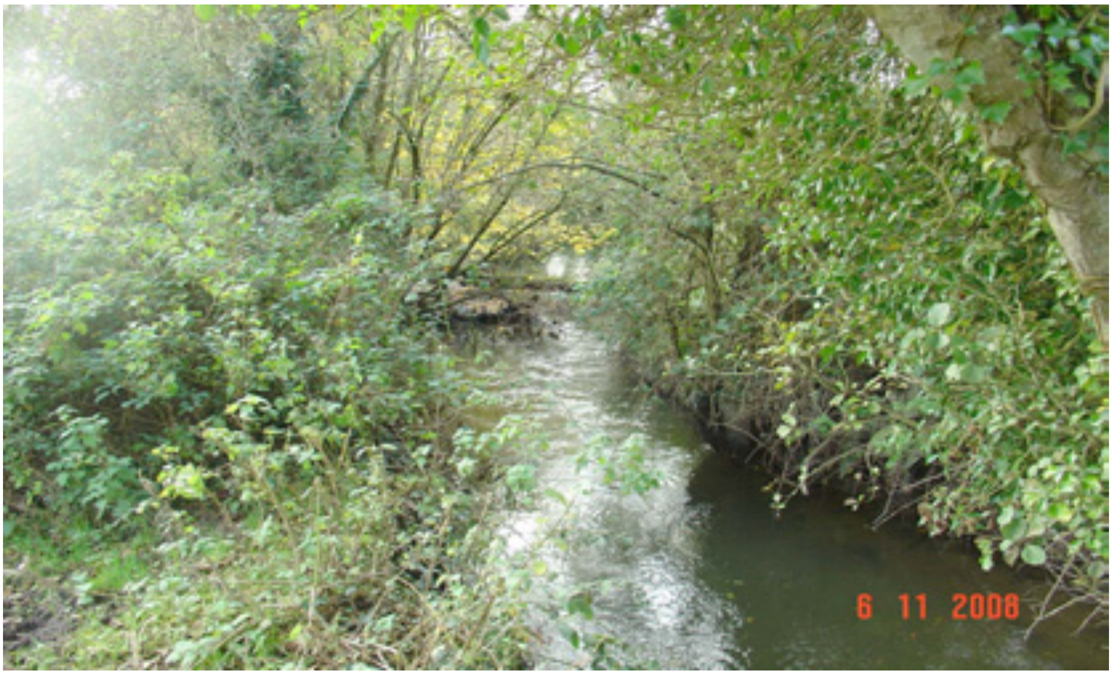

Fig 4.21: Complex riparian vegetation is present throughout most of the area.

Fig 4.22: Riffles with a diversity of cobbles and gravels are present throughout the Reach and provide an excellent environment for invertebrates, macrophytes and spawning medium for salmonids and other indigenous fish species.

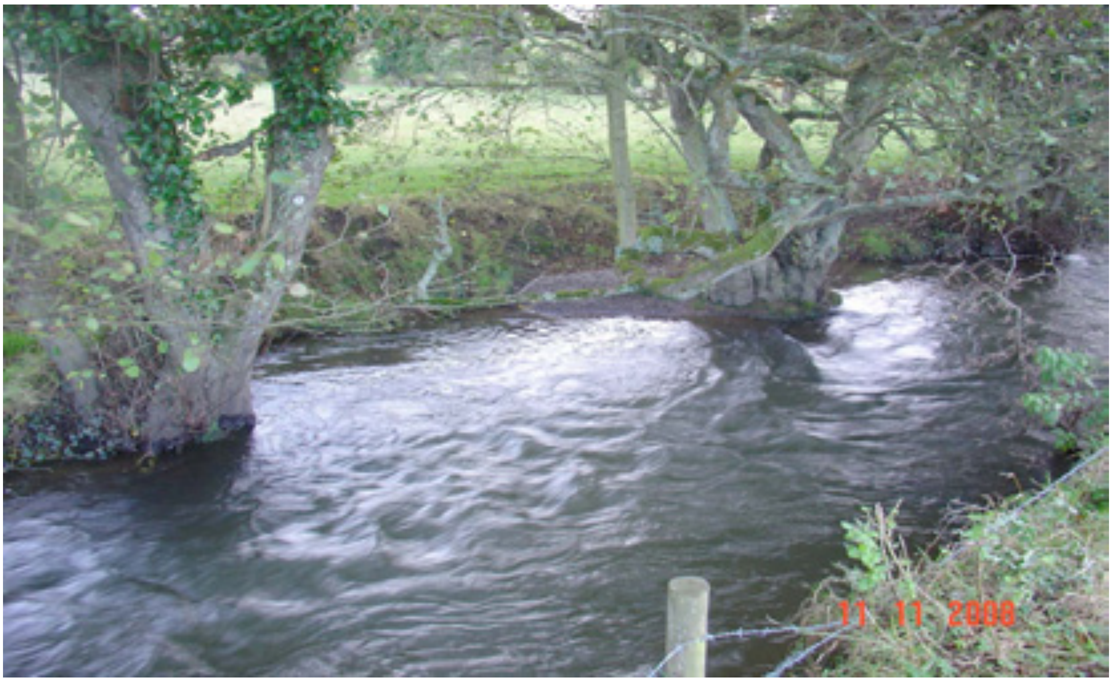

Fig 4.23: Stable banks in combination with an unmodified channel and established vegetation provide the essential elements of good riverine habitat but the physical qualities of the river cannot compensate for poor water quality and there are serious concerns in relation to water quality data and associated biological indicator species.

Reach 6: From Stamullin South to Stamullin Northeast/M1 Overbridge

At Reach 6, the river runs through Stamullin, the most densely populated area of the catchment. The river has been resectioned and straightened in a proportion of the Reach but in general it has maintained semi-natural instream morphology with gravel riffles, glides and defined pools.

The floodplain has been developed in a section of the Reach (see Fig 4.24 and Fig 4.26) though most of the Reach has a vegetated buffer zone between urban development and the river corridor. There is a recreational/nature area at the rear of a housing development that has merits as a conservation area and further community/financial investment into this area could be encouraged.

Issues have been raised through personal communications with Gormanston and District Anglers Association of pollution from sources in the Stamullin area, one of which resulted in a fish kill within the last five years. There was also a perceptible level of urban trash dumped in the river such as shopping trolleys, metal and associated rubbish.

Due to the proximity of the river to an urbanised area it is probable that a proportion of the land in the riparian/floodplain zone may be reviewed for rezoning in the future. It would be advisable that no development is permitted within this area as the environmental conditions present in Reach 6 are currently sustainable and may even be improved.

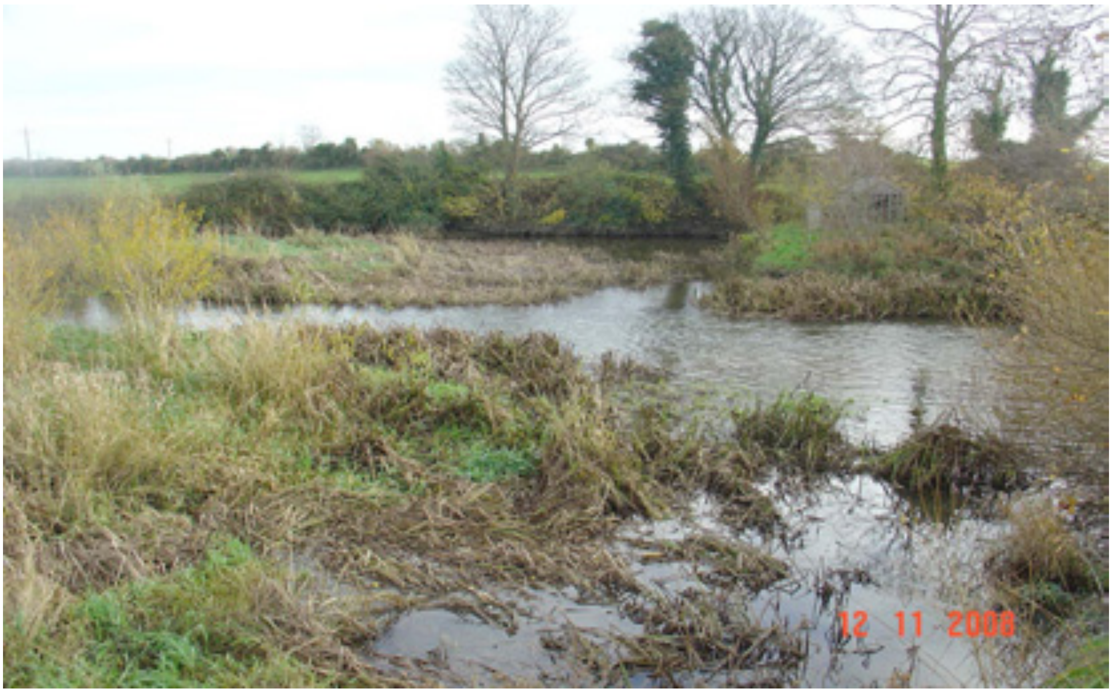

Fig 4.24: Despite the river being realigned/straightened and the partial loss of two oxbow meanders, this section of the Delvin at the rear of a housing estate in Stamullin has a diversity of wetland habitats due to a weir maintaining water height throughout the flooded site. Coots, moorhens and mallard duck were present during the walkover survey.

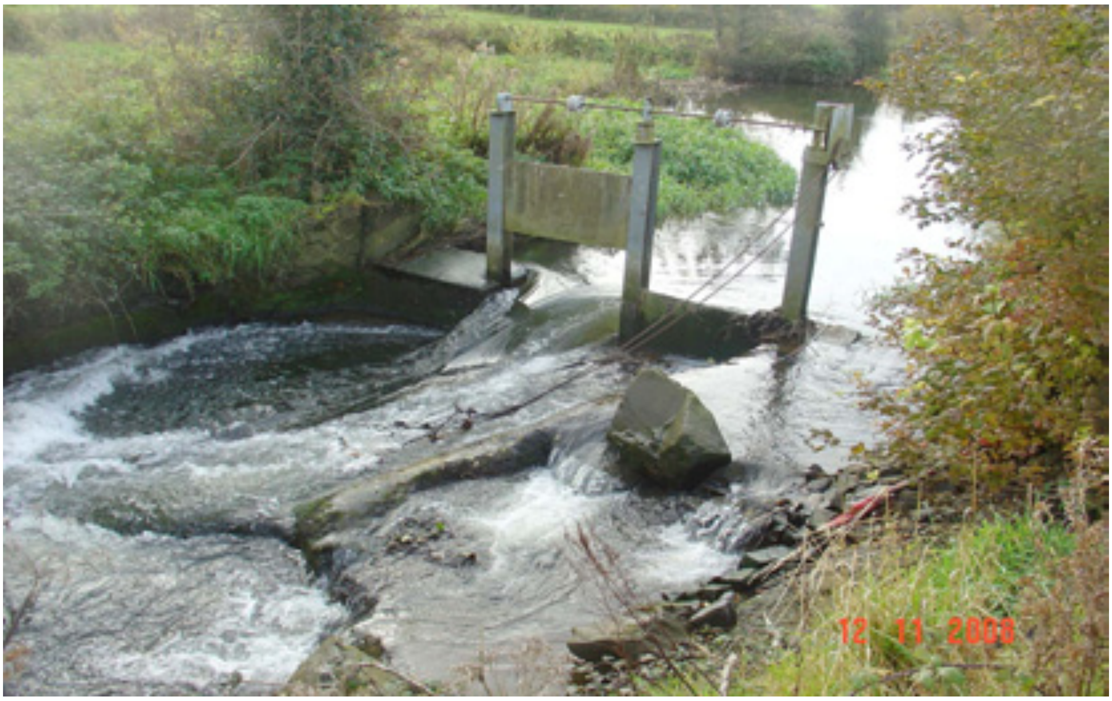

Fig 4.25: This hybridised weir/sluice system is maintaining water depth in the wetland area described in fig . The only modification that may be undertaken would be to enhance fish passage facilities.

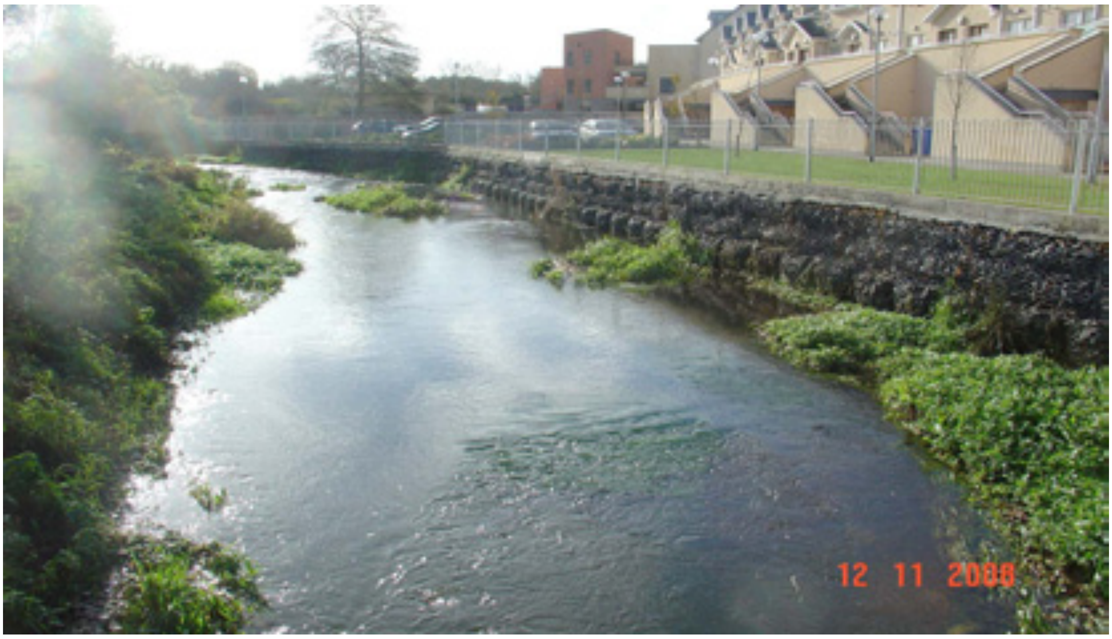

Fig 4.26: This section of the Delvin to the south of the main street in Stamullin has been widened and the LHB reinforced with gabions. Although altered, the river channel has good deposits of cobble and gravel and constitutes good invertebrate habitat and spawning environment for salmonids. There may however be a seasonal problem of low water levels and channel braiding in low summer flows due to the channel widening.

Fig 4.27: The only area of the Delvin River that Water-crowfoot (*Ranunculus penicillatus)* was confirmed present during the walkover survey was in the resectioned area south of Stamullin High Street. Due to poor weather and high water river conditions during the walkover and RHS surveys, it is not possible to comment accurately on the distribution of Water-crowfoot within the Delvin catchment.

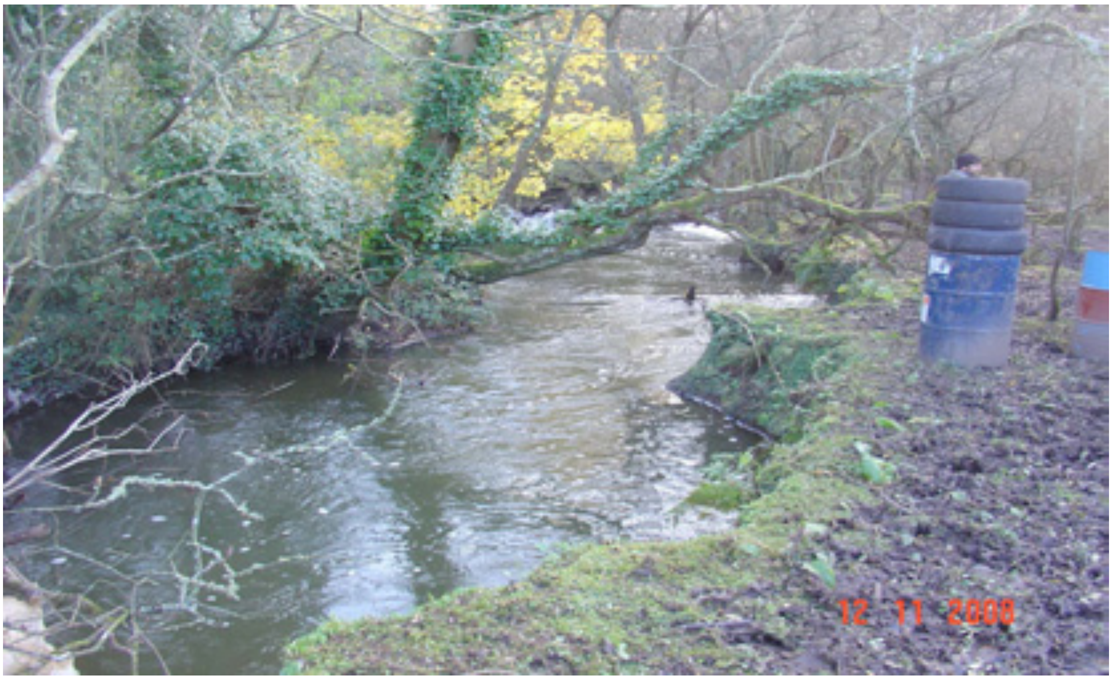

Fig 4.28: This area just upstream of Stamullin is used in a recreational capacity for paintball games. The riverine habitat is relatively diverse in this section though does suffer from moderate/excessive shading. The combination of the shading and the active pursuits that are undertaken have impacted the riparian zone by poaching of the bank top and the loss of riparian understory vegetation on the LHB. It would be advisable to suggest that a three metre buffer zone is established to protect the banks and reduce erosion.

Reach 7: From Stamullin Northeast/M1bridge to Gormanston Bridge

There are two main land uses within Reach 7 and both have associated impacts on the Delvin River. In the upstream section of the Reach, the land is primarily improved grassland and large areas of bank erosion are evident. The erosion is primarily caused by inadequate fencing and stock-related damage that has weakened banks. There were large chunks of bank freshly deposited into the bed of the river and this problem will continue to impact this area and undoubtedly have associated negative impacts further downstream unless mitigated.

The lower section of Reach 7 is primarily recreation ground/parkland in the Gormanston demesne. The main problem identified in this section of the Reach is the cutting of grass to the end of the river bank which has impoverished the natural riparian vegetation, reduced biodiversity in the river corridor and had negative impacts on the structural integrity of the river banks.

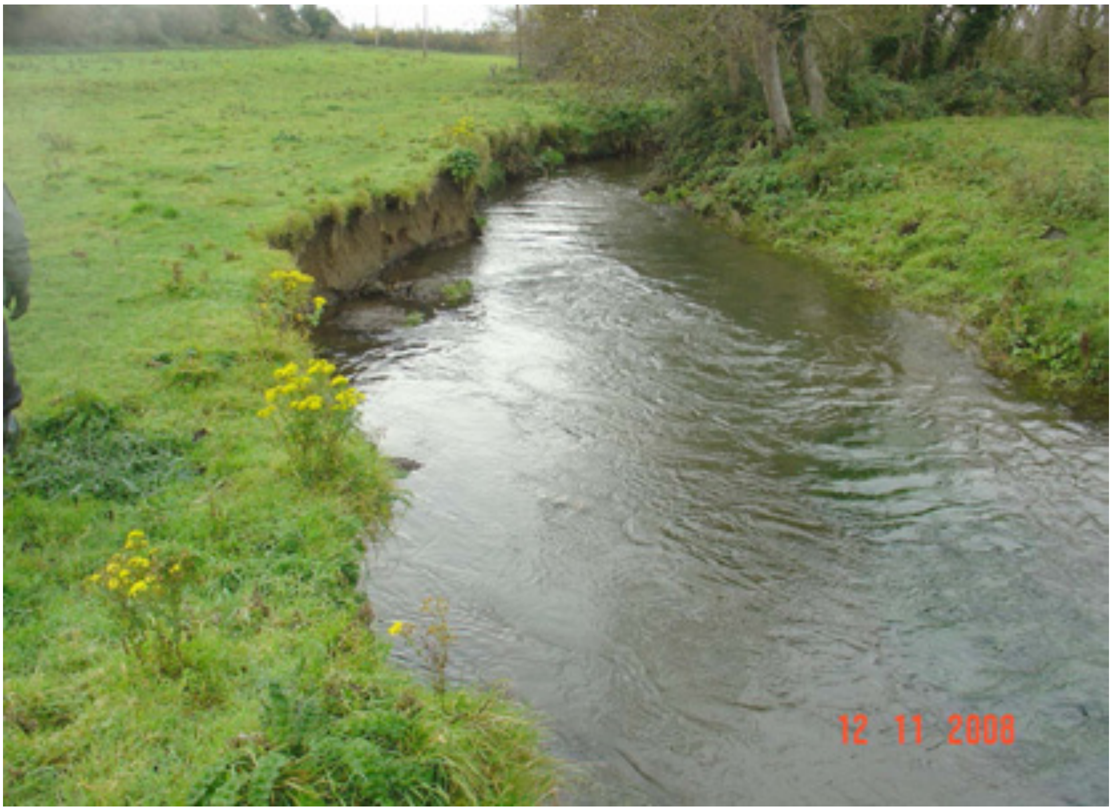

Fig 4.29: The bank erosion at the top end of Reach 7 is primarily caused by the pressure of cattle grazing too close to the bank of the river. The bank throughout this section consists of a sandy loam and will be prone to erosion. Adequate fencing at least two metres from the bank top and bank stabilisation is required.

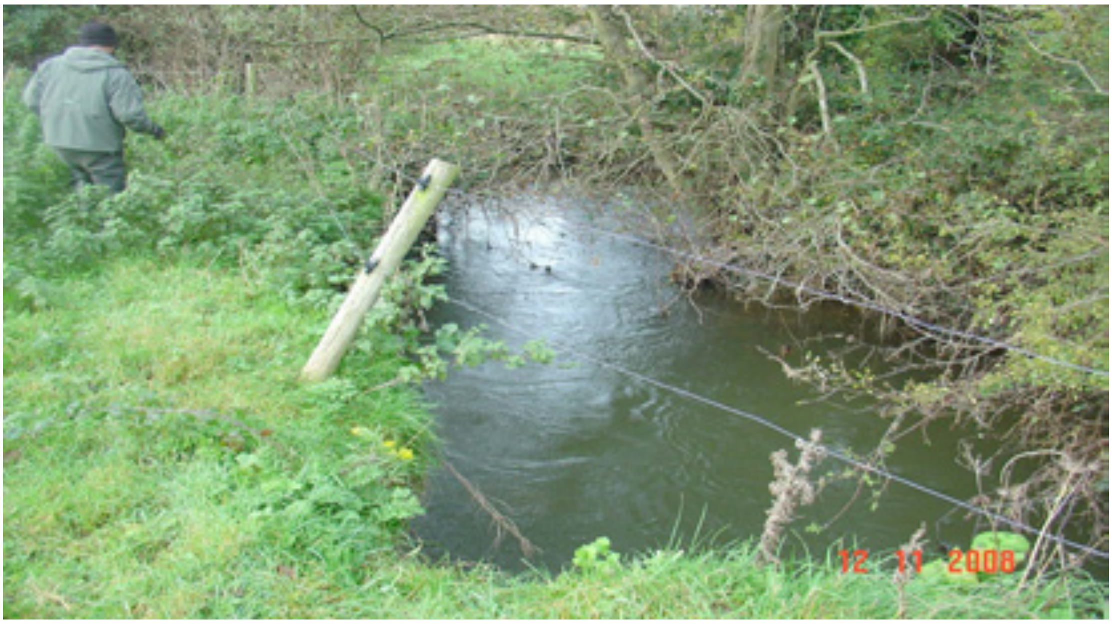

Fig 4.30: Fencing was erected too close to the river bank and did not adequately limit the areas grazed by livestock to permit the long term establishment of riparian and bankside vegetation. The bank collapse, the destruction of the fence and the subsequent loss of land and money for the fencing are the result of ‘cutting corners’.

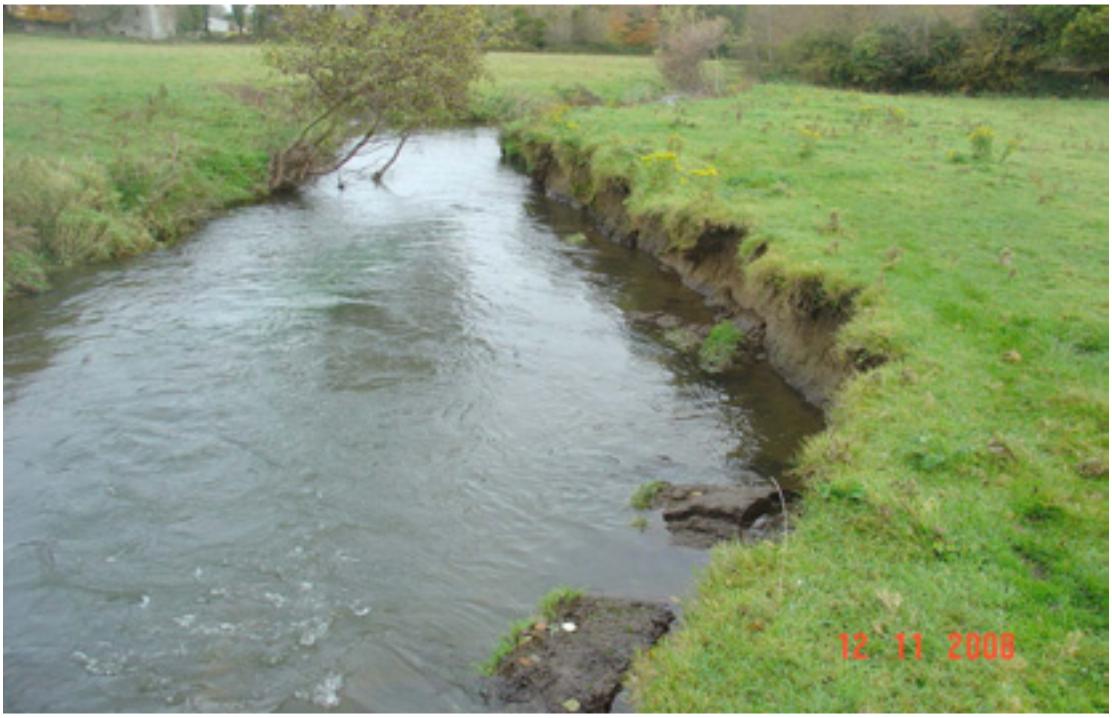

Fig 4.31: Large chunks of freshly eroded bank were evident throughout the upper section of Reach 7. There will be knock-on effects downstream as silt is released into suspension but more importantly the changes in the stream morphology and subsequent changes in flow dynamics may induce further erosion problems downstream. Currently, the stability of sections of the bank further downstream in Gormanston Demesne could be described as fragile due to present bankside maintenance practices and every effort should be made to stabilise and establish vegetation in this section.

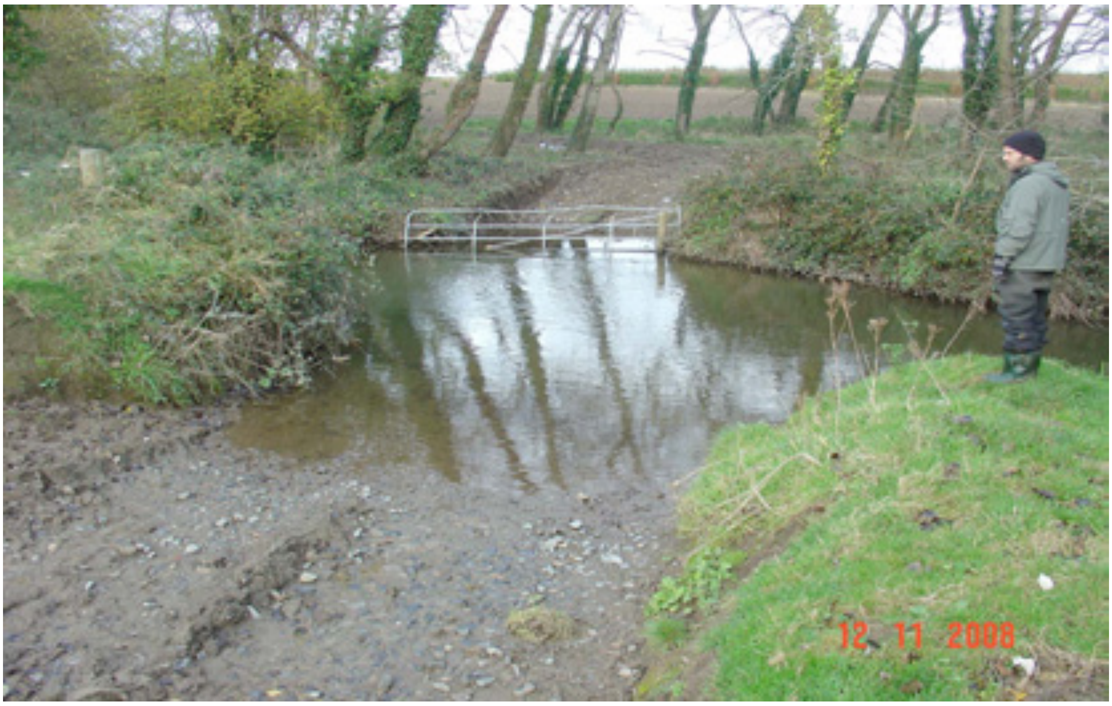

Fig 4.32: The ford is poorly constructed and releasing silt and suspended solids during use and high flows in the river. Livestock have unmanaged access to the river and erosion problems will be further exacerbated unless this area is properly fenced and managed.

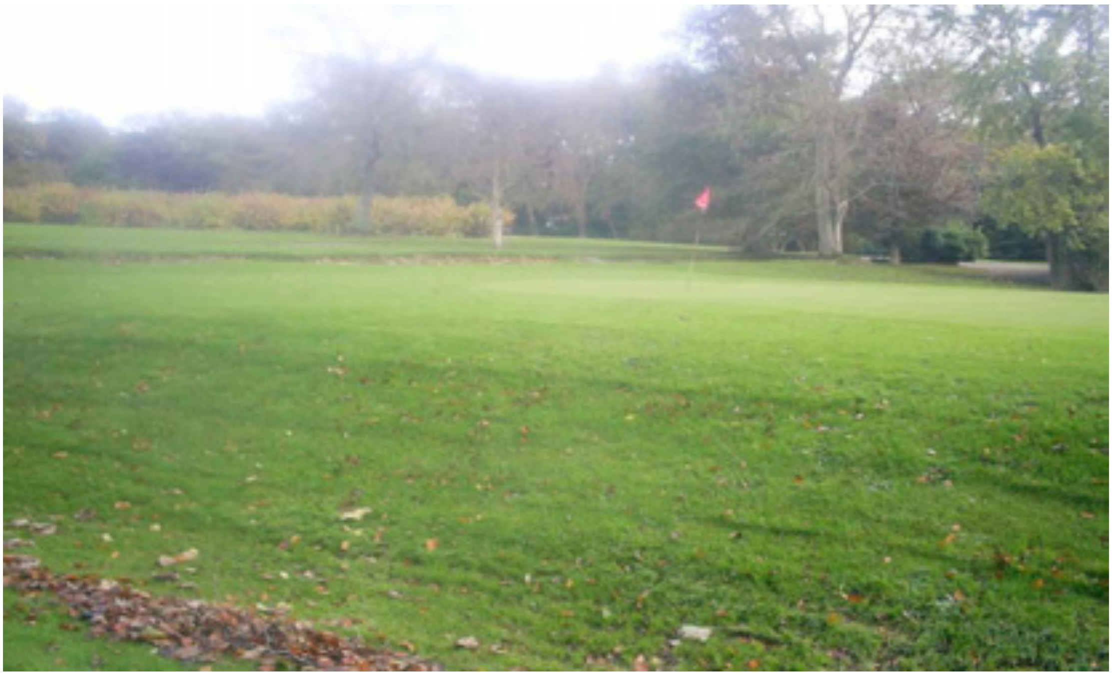

Fig 4.33: Recreation, parkland and gardens are the predominant features of the Gormanston Demesne. The practice of mowing to the top of the river bank should be prohibited and a minimum of a three metre buffer zone from the edge of the river bank should be left uncut where possible. There could be an interesting study for students at Gormanston to study re-colonisation and assist in planting willow and alder to promote riverbank stability.

Fig 4.44: A proportion of conifers within the plantation at Gormanston College are too close to the river bank and are shading the bank top preventing the establishment of vegetation. It would improve the biodiversity of the river section if conifers within 10m of the bank-top were removed and would also assist in stabilising the banks through the establishment of riparian grasses, herbs, shrubs and trees.

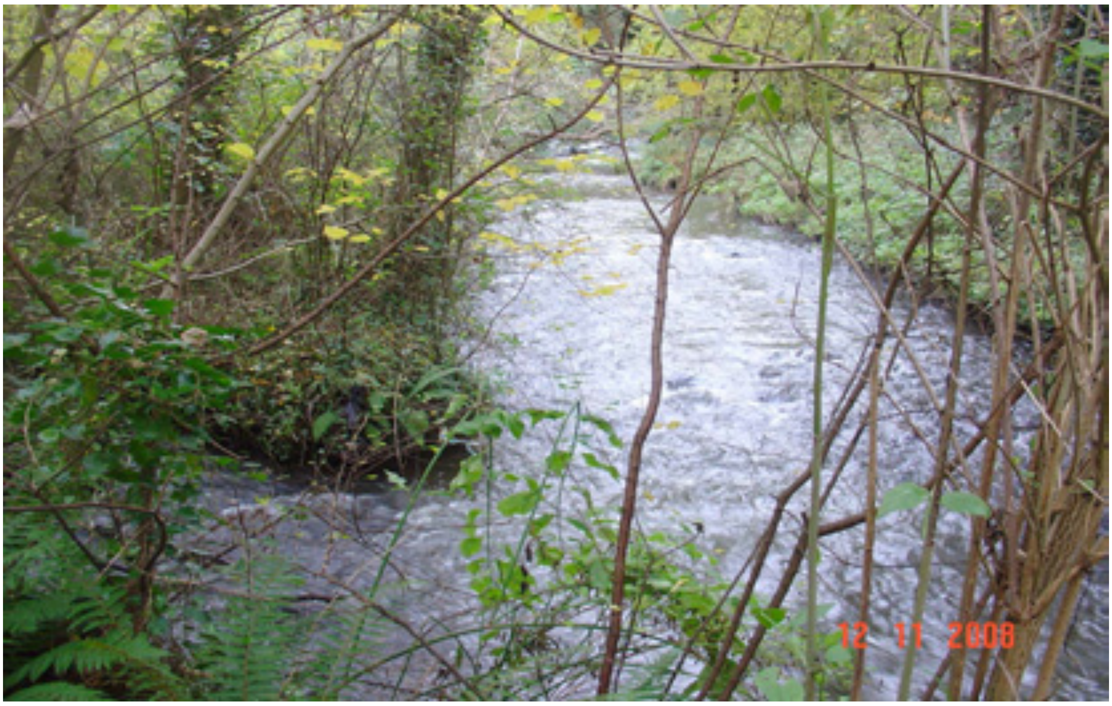

Fig 4.45: Despite a number of problems associated with landuse in Reach 7; there is a reasonable proportion of very good salmonid spawning and nursery habitat and a diversity of riparian vegetation and instream features.

Reach 8: From Gormanston Bridge to Knocknagin Bridge Weir/Tidal Zone

The final Reach in the Delvin River has a good diversity of instream and riparian habitats. There are no major concerns identified within this reach in respect of morphological and hydrological factors. The river channel has been reinforced and possibly resectioned in some areas but not sufficiently as to negatively impact on the ecology of the river. There were no signs of serious bank erosion due in part to an established buffer zone between the river and major landuse. This Reach would have the majority of angling pressure and there is evidence of bank and instream clearance by anglers for fishing. The Gormanston and District anglers have also periodically stocked the river with brown trout.

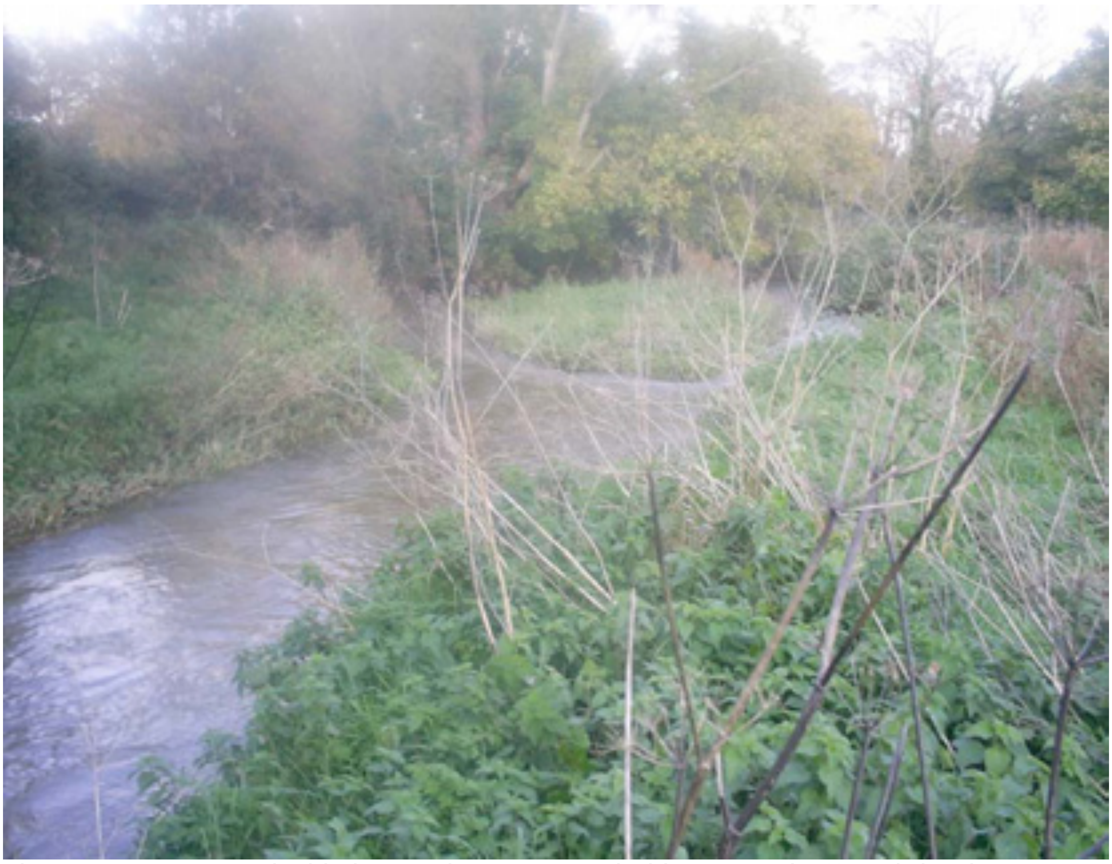

Fig 4.46: A vegetated mid channel bar, surrounded by a well-buffered riparian zone. In general there is sufficient protection afforded the river from landuse practices and every effort should be made to protect this and encourage the local landowners to maintain the buffer. Salmonid spawning and nursery areas are present throughout the Reach and it is feasible that a reasonable proportion of seatrout that spawn in the Delvin River would do so in this section.

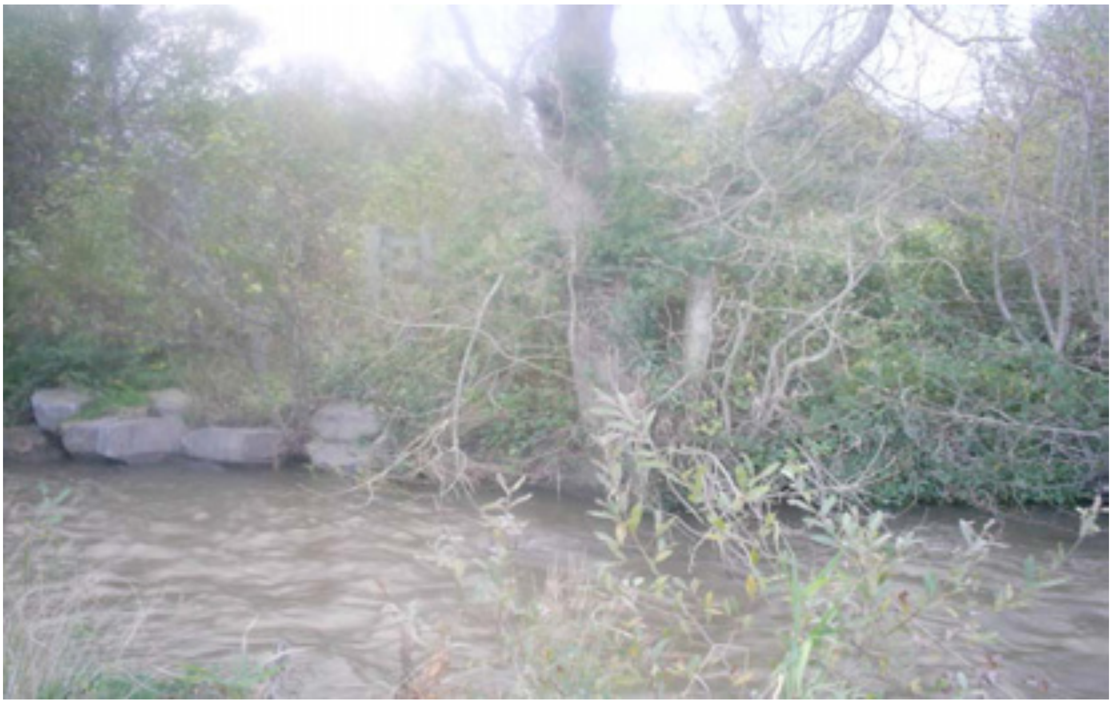

Fig 4.47: The river channel has been periodically modified in Reach 8 though not to the overall detriment of the river as it still maintains a natural riffle-pool-glide configuration with good holding pools and riffles.

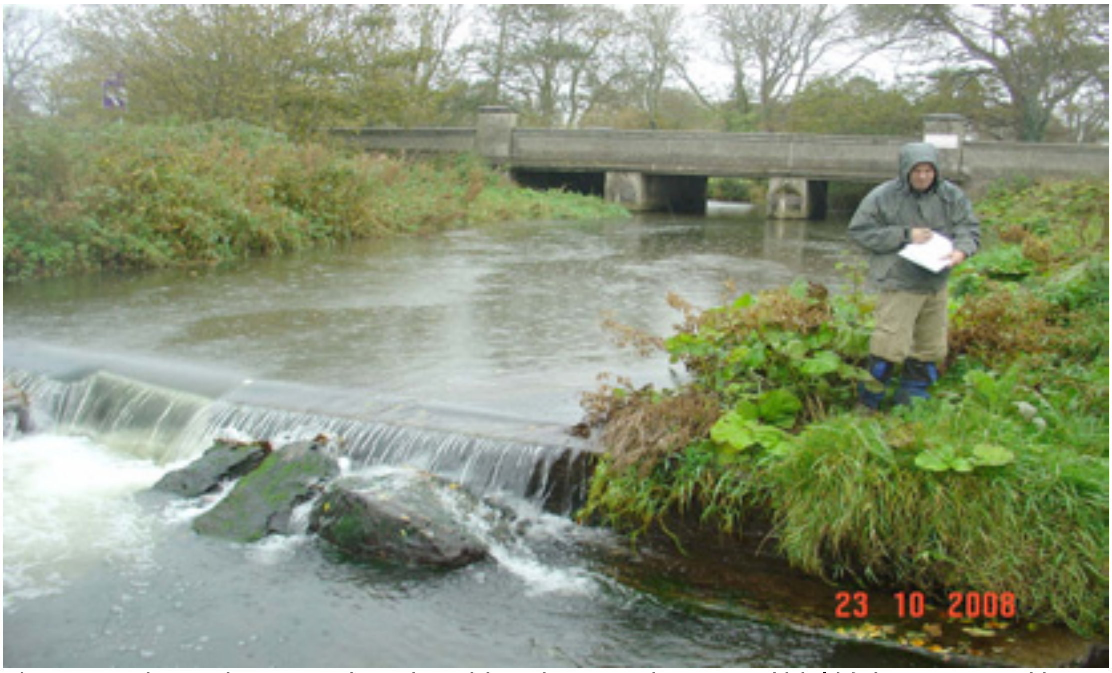

Fig: 4.48: The weir at Knocknagin Bridge denotes the HWM (tidal high water mark) on the OS maps. It is likely that aquatic species that are euryhaline (adaptable to salt and freshwater) such as Dab (*Limanda limanda)* may travel upstream beyond the HWM, though predominantly aquatic fauna will be freshwater species from this point upstream.

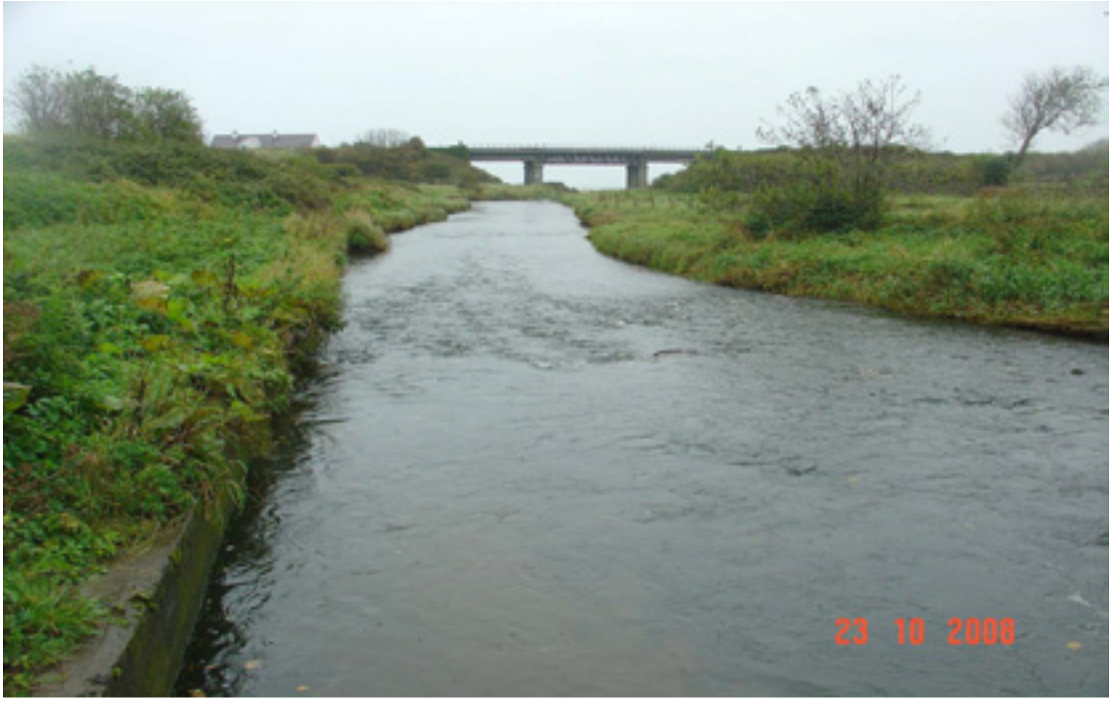

Fig 4.49: The final run of the Delvin River below the weir is tidal. This is the primary area for sea trout fishing in the river and large brown trout have also been caught in this area.

4.1.2 Protected Characteristic River Species

During the walkover study, there were 2 no. sightings of dippers. These were at ING 14649 65156 and 14451 62786. There was one sighting of a kingfisher. This was just downstream of Cockles Bridge at around ING 09338 59603. There were no sightings of grey wagtail, another familiar riverside bird species. It is thought that the dearth of insect prey species is the driving factor in the lack of sightings throughout the river corridor. This insufficiency would due to a combination of lack of suitable habitat (substrate) and poor water quality. The upper stretches of the river have been most heavily modified and also contain the poorest bank quality. This is a crucial factor in nest location and success for these bird species. In the lower stretches of the river, where more substantial and less modified banks are found, water quality and thus prey abundance would probably be the main limiting factor.

No signs of any otter activity were recorded during this survey. Otter utilisation of the upper reach of the river above Naul is highly unlikely given both the physical impediments described in the previous section and also the poorer available bank habitat. Otter holts are rarely found away from river banks (Hayden & Harrington, 2000). The apparently total lack of available prey species in the lower sections of the river would indicate that otters do not occupy or utilise this stretch on a regular basis. Although a recent (Collins, 2004) study found otter use of this watercourse, no evidence from the present study suggests that this is still the case. This last study found no evidence of otter activity in the upper reaches of the Delvin but a great deal of activity in the lower reaches, spraints being found at 26 of the 29 sites surveyed. The most recent findings point therefore to a collapse over the last four years in an ecosystem that could once support a top carnivore. This finding alone has grave implications for the fisheries status and potential of the river and should be verified by a brief survey of mammal activity in spring / summer months and a fisheries study when the season allows.

4.2 River Habitat Survey (RHS): Site Descriptions and Assessment

Site 1 Moorepark

Description:

This survey site is in the upper reaches of the Delvin catchment near its source and runs through predominantly improved grassland. Despite being embanked and resectioned in parts, the river still has riffles and a cobble/gravel substrate.

The channel width is less than two metres (1.75) and with a relatively small base flow, it would be very susceptible to pollution or the impacts of mechanical manipulation.

The left hand bank is predominantly broadleaved woodland and does provide some habitat diversity to the site.

This site can be described as poor with a HQA class of 4, and a HMI of 3,

There were no invasive/alien species found on this site

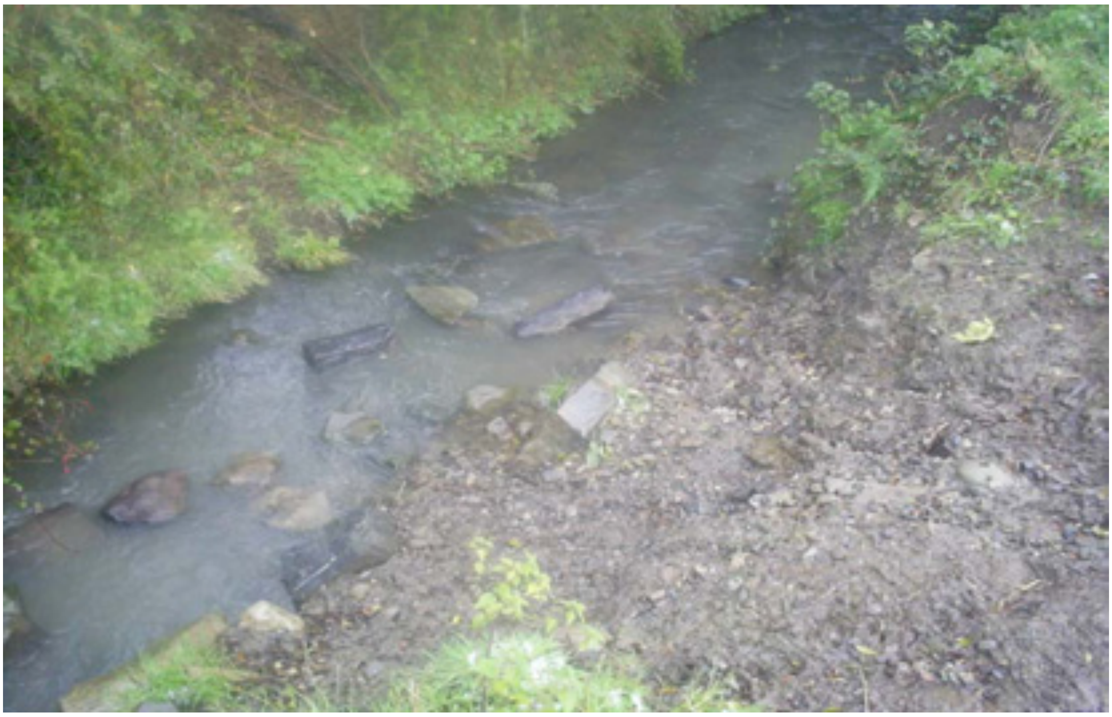

Fig 4.50: The channel is embanked to an average height of 1.75m and has been straightened, there is evidence of poaching in this section.

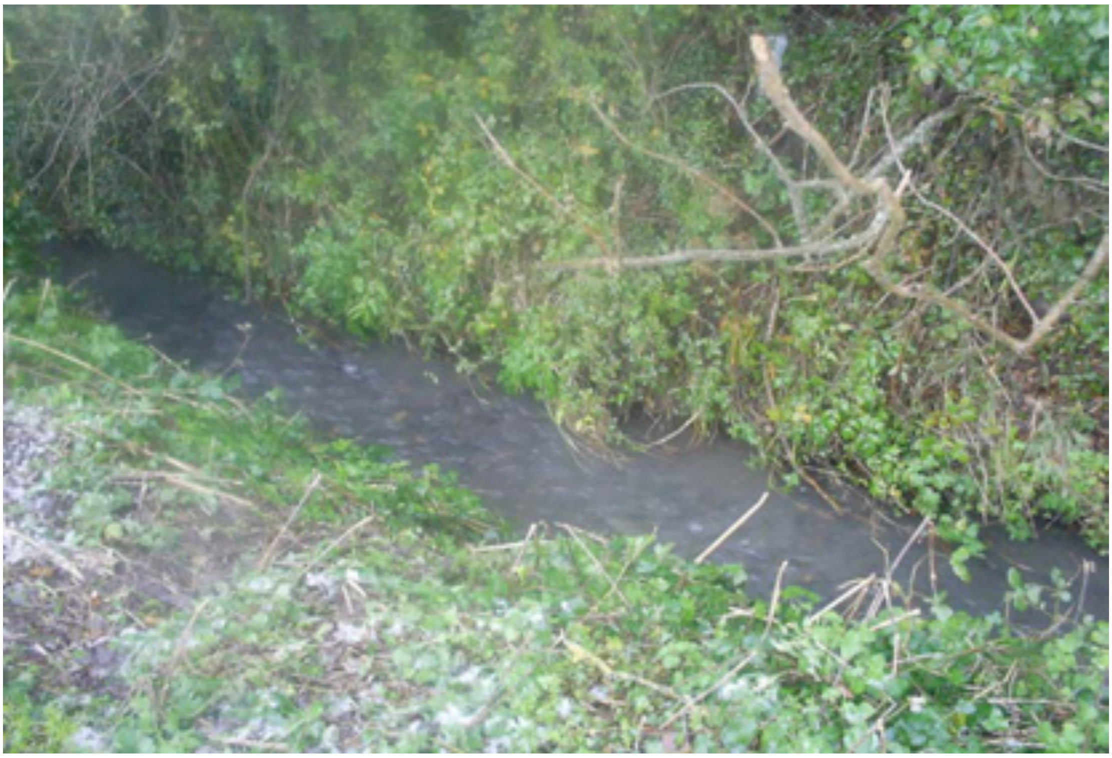

Fig 4.51: Riffles and glides were the dominant flow features. The gravel was relatively clean though that may be due in part to the extensive rainfall in the summer, this was evident in other parts of the catchment.

Fig 4.52: The bank face and top were quite heavily vegetated primarily with briars particularly on the left bank and there would be a risk that this area could suffer from over shading unless maintained.

Site 2 Commons Lower

Description

The river valley has been described as having no obvious valley sides. The channel has been significantly straightened and resectioned and such action may be rated as severe.

The base width of the channel wetted area is relatively uniform at 4.5m as is depth (0.7m) and the flow is predominately slow and in places not perceptible.

The natural riffle-pool-glide configuration has been completely destroyed by previous management (dredging/resectioning) and ongoing maintenance.

Substrate was predominately silt and sand with silt present in six transects and sand present in three.

The river channel had high densities of instream macrophytes and it is highly likely that the channel will be choked in summer; when combined with high water temperatures, low flow and reduced DO levels it is unlikely that salmonids would survive in this section of the river.

This site can be described as poor/very poor with a HQA class of 4, and a HMI of 5,

There were no invasive/alien species found on this site.

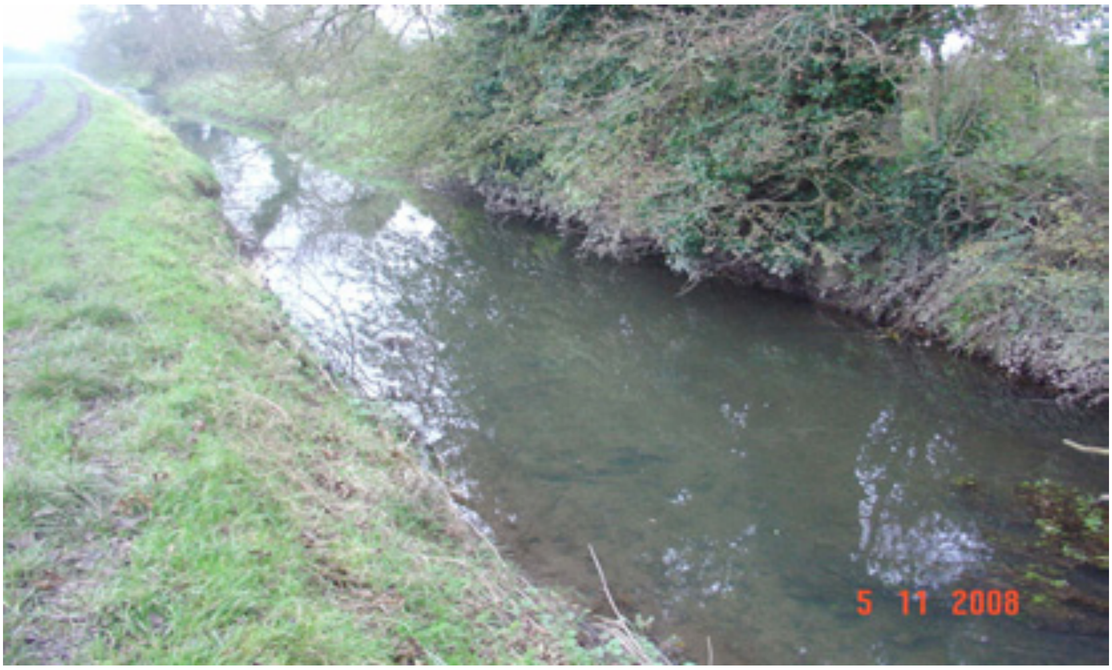

Fig 4.53: The river has been resectioned and dredged and this canalised section is completely straight from top to bottom. This survey site is indicative of circa 8km of the Delvin River at the upper end of the catchment.

Fig 4.54: Instream macrophyte growth is excessive and many species recorded are associated with slow/still flowing water

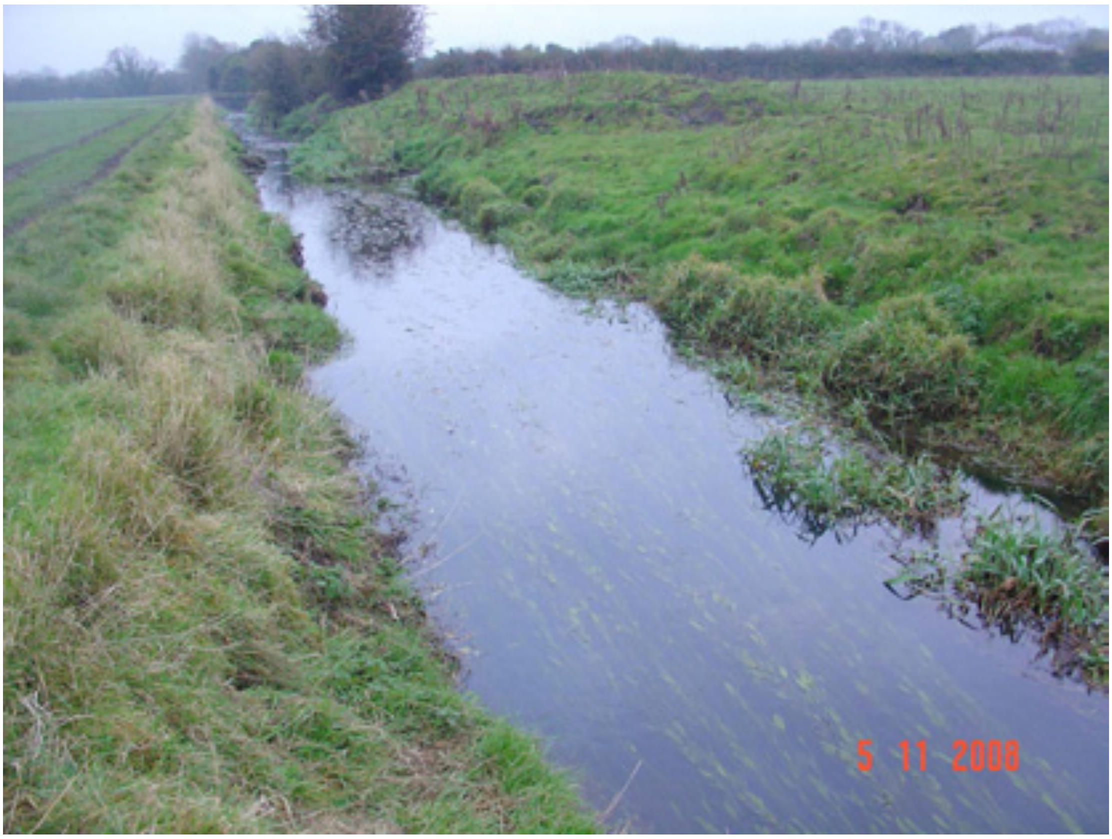

Fig 4.55: The channel substrate in this section is predominantly silt and sand. Silt deposits were up to half a metre deep in some areas.

Site 3 Cockles Bridge

Description

The river valley has been described as having no obvious valley sides. The channel has been significantly straightened and resectioned and such action may be rated as severe.

The base width of the channel wetted area is relatively uniform at 2.6 m as is depth (0.5 m) and the flow is perceptibly laminar and glide like.

There are a number of key factors of interest in this section:
- the bed of the river consists entirely of cut limestone bedrock
- the channel has been cut in a straight line with no sinuosity and the gradient/water levels are uniform throughout with the loss of riffle-pool-glide configuration
- the surveyed section of 500m is excessively shaded by trees, this is extended for up to a further 300m downstream
- there is limited instream macrophyte growth and is limited to occasional emergent plants.

This site would rank as the poorest in the ten sites surveyed, suffering from a high degree of modification, excessive shading and a bed rock substrate.

This site can be described as poor/very poor with a HQA class of 4, and a HMI of 5,

There were no invasive/alien species found on this site

Fig 4.56: This site was heavily shaded and the river flowed over limestone bedrock for the duration of the survey area.

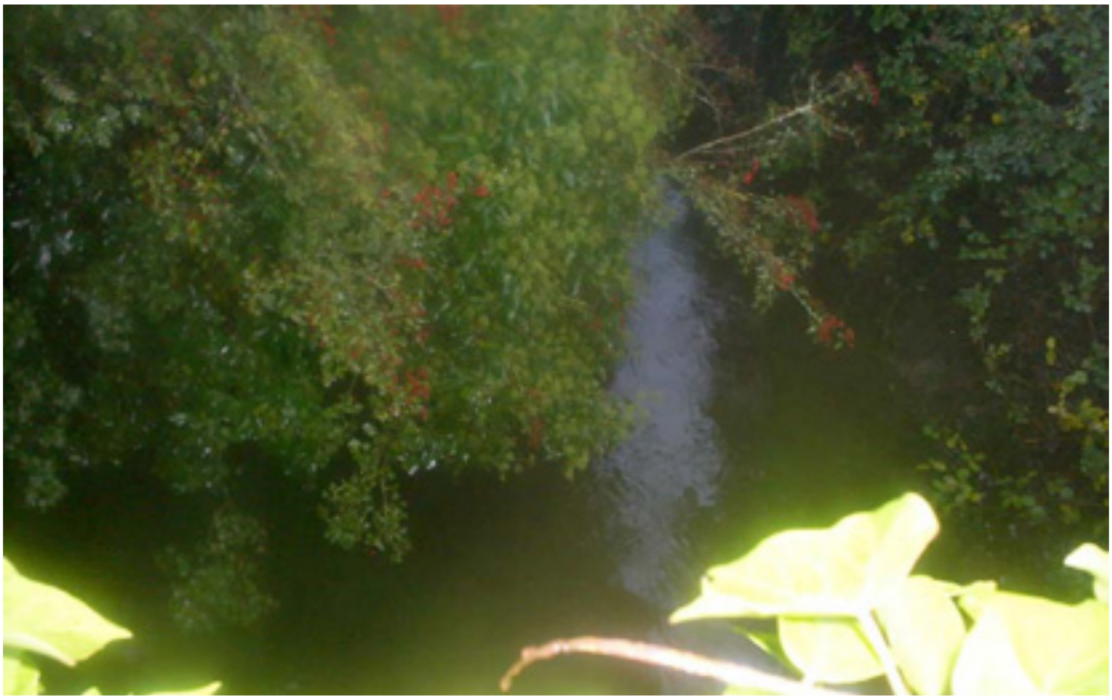

Fig 4.57: The poor picture quality is due to low light levels in the channel. This site was the poorest in respect of habitat quality, excessive modification and is contributing little to the biodiversity of the Delvin catchment.

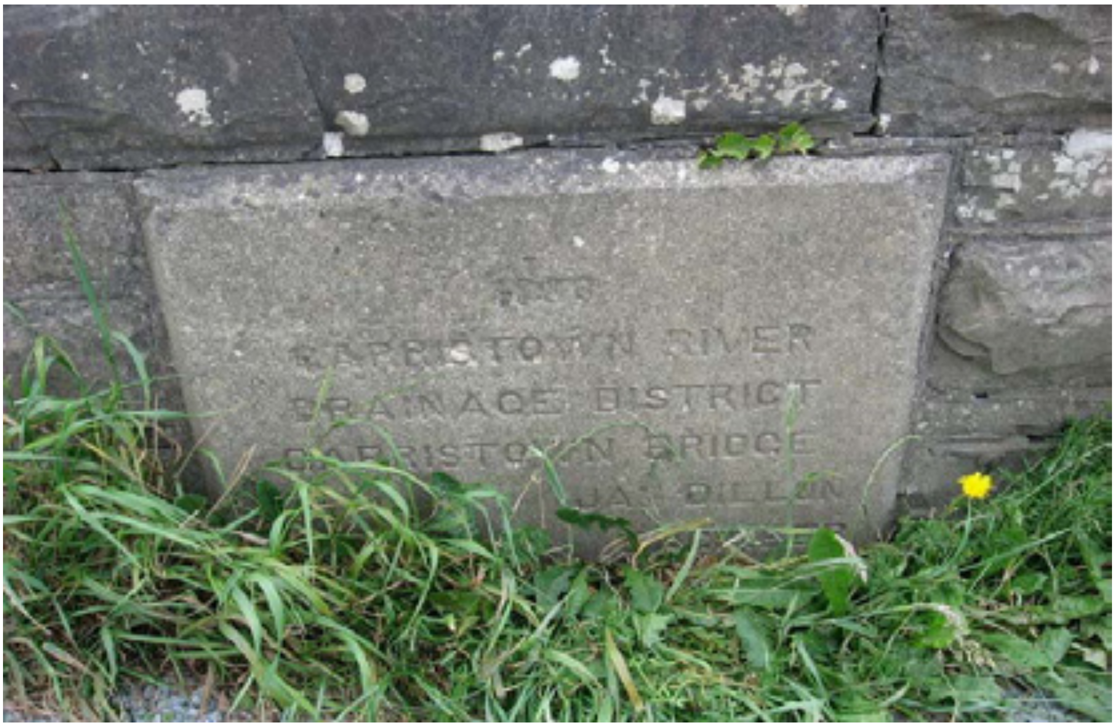

Fig 4.58: This stone at Cockles Bridge commemorates the work of the Garristown drainage district and dates to 1889. This gives an indication of the period of time in which the river has been modified. There is a parliamentary reference from Westminster outlining drainage proposals on the Delvin River in 1880.

Site 4 Bodingtown Bridge

The river valley has been described as concave/bowl in nature. The channel has been obviously straightened and resectioned. There is a large embankment of tipped material on the left bank due to the quarry operation. This embankment is approximately 200m in length and does not form the bank of the river though extracted material has been used to form a lower embankment to form the left bank over the length of the quarry.

The base width of the channel wetted area is relatively uniform at 2.7m and the flow is predominately fast and riffled, the natural riffle-pool-glide configuration has been impacted by previous management (dredging/resectioning) with riffle habitat dominating the section.

Substrate was predominately cobble and gravel. Liverworts/mosses/lichens present on three transects with emergent reeds/sedges/rushes/grasses etc present on nine transects.

Trees were isolated/scattered and consisted predominantly of willow and hawthorn and ash, no alders present.

Stable cliffs are the dominant bank profile feature and vegetation was predominantly uniform on bank face and bank top with briar, willow and grasses dominant throughout.

The right hand bank landuse was tilled land for the entire site and the left bank was tilled on the last four transects.

This site can be described as fair with a HQA class of 3, and a HMI of 4,

Giant Hogweed was present on this site

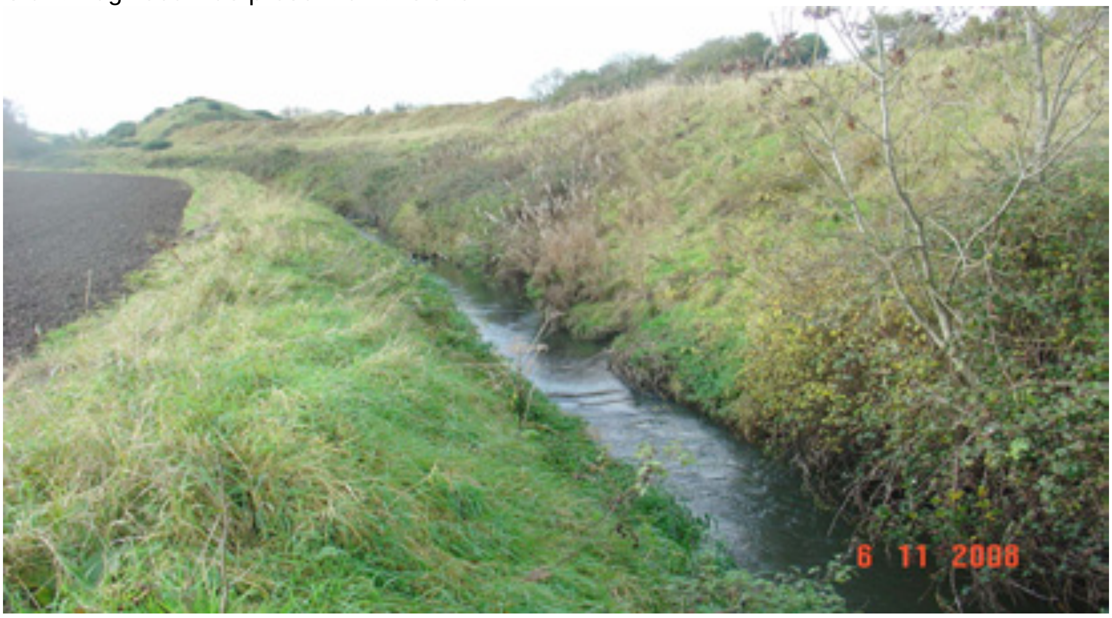

Fig 4.59: The river is obviously resectioned and embankments separate the river from the flood plain. The base width of the channel is 2.3m and in conjunction with a reasonable gradient, the water maintains depth and velocity.

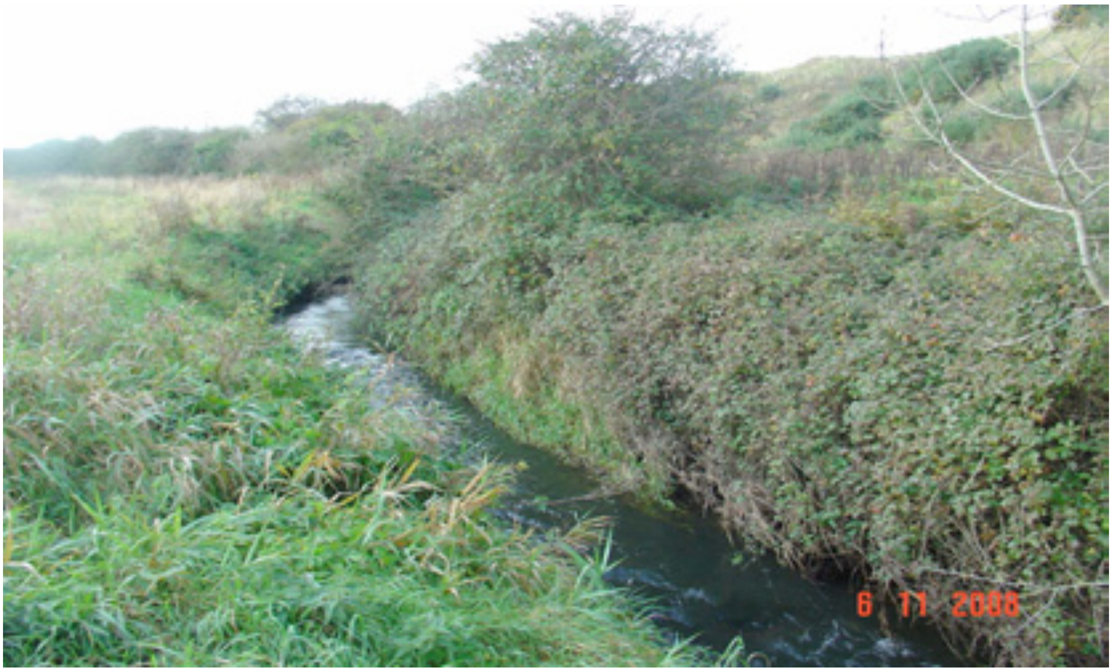

Fig 4.60: Despite its resectioned and embanked nature, this section of river has the capacity to provide food and shelter to a range of aquatic organisms and concerns should be raised in relation to the neighbouring quarry's application to expand operations.

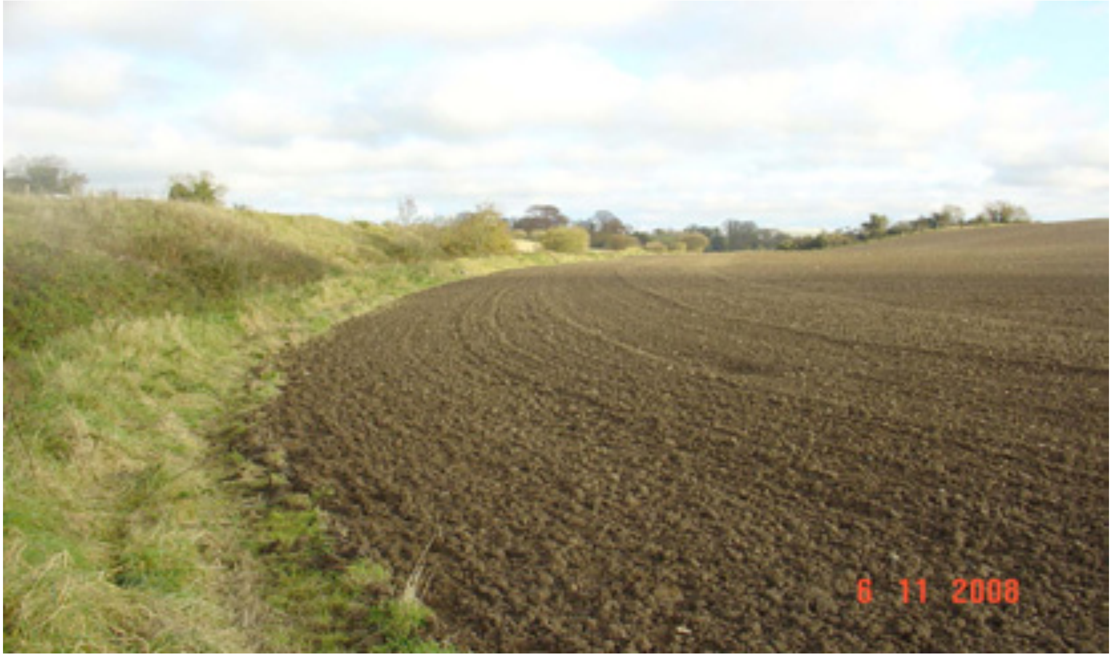

Fig 4.61: Land use is predominantly arable. The river is to the left of the picture. The river has an embankment on this field to prevent flooding

Site 5 Naul

Description

The river is flowing through an asymmetrical valley and exhibits obvious signs of modification. The river corridor has been resectioned, embanked and reinforced in discrete sections with areas of relatively unmodified channel.

The base width of the channel wetted ranged from narrow (2.5m) to 3.4 m in the mid section to 5m in the lower section and the flow is predominately fast and riffled, the natural riffle-pool-glide configuration has been impacted by previous management (dredging/resectioning) with riffle habitat dominating the section.

A major waterfall is a feature of the site; this is a naturally occurring feature and constitutes a total migration barrier. There are sluice gates at the top of the waterfall that would indicate a previous industrial use for the water.

There is a sewage treatment plant adjacent to the river on the right hand bank this discharges into the river downstream of the waterfall.

Substrate was predominately cobble and gravel. There were no channel vegetation types visible due to water height and turbidity and no emergent vegetation was present. Trees were in occasional clumps and consisted predominantly of willow, sycamore and hawthorn and ash. No alders were present

This site can be described as fair with a HQA class of 3, and a HMI of 4

Japanese knot weed was present on the left hand bank above the bridge in Naul. Cherry laurel and privet were also present.

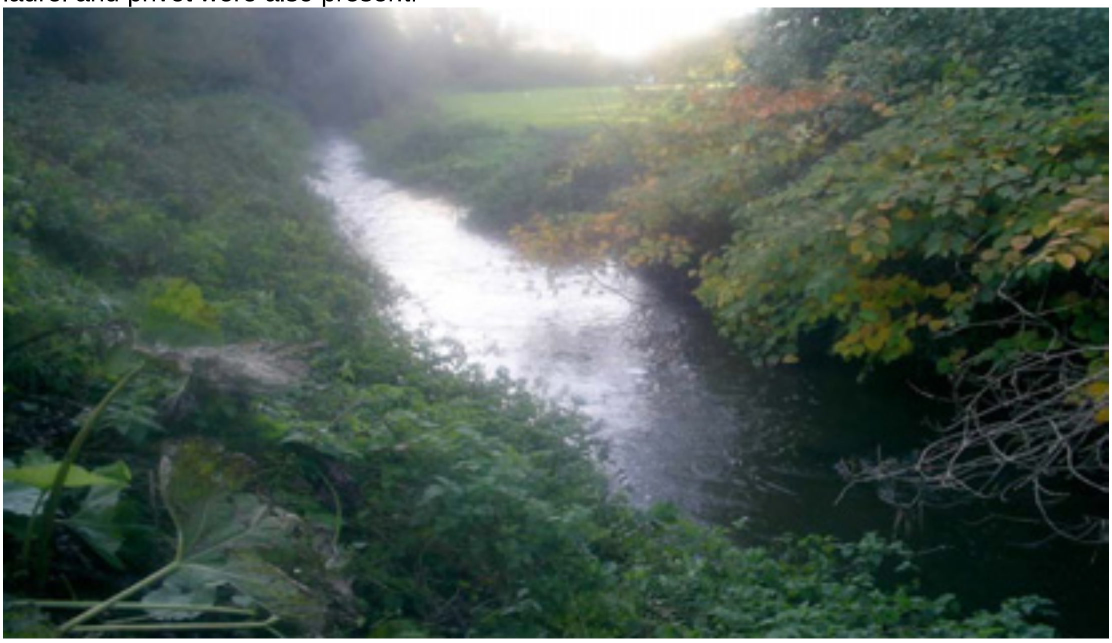

Fig 4.62: The top section of the site, the river bank on the right side has been embanked using tipped material from a recent development. The embankment is over 5m high and steep sided.

Fig 4.63: The waterfall at Naul is >5m in height and presents a total block to all upstream migration of fish and aquatic invertebrates. There is also however, a man-made water fall 400m d/s which is similarly prohibitive to all upstream migration.

Fig 4.64: Mid section of the site, riparian vegetation is well established and banks are stable.

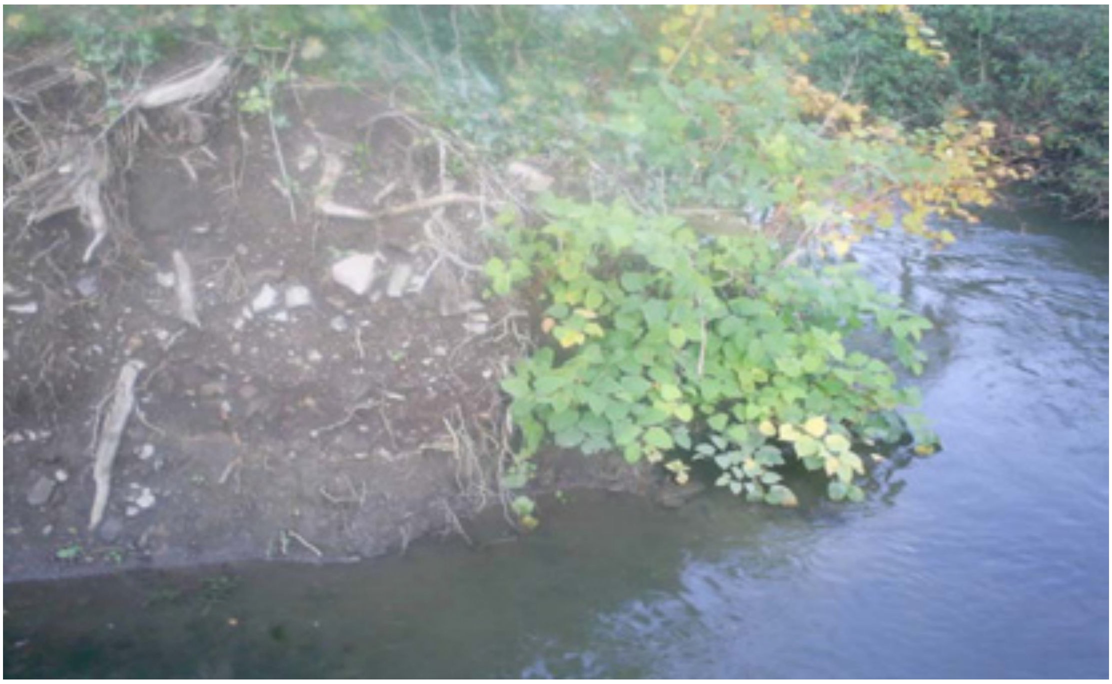

Fig 4.65: Japanese Knot Weed; this area had been recently excavated as part of a land drainage and floodplain reclamation scheme.

Site 6 Old Mill Bridge

Description

The river is flowing through an asymmetrical valley with natural terracing on the right hand side of the valley. This is an area of natural beauty with a diverse range of habitats within the river valley.

The river is unmodified with the exception of a very small area resectioned at the top of the site. The river exhibits excellent riffle-pool-glide configuration with a diverse range of instream and riparian habitats. Unvegetated mid-channel bars, vegetated mid channel bars, vegetated side bars, fallen trees and large woody debris are some of many outstanding features of this site.

Channel substrate is predominantly gravel/pebble substrate with stable cliff earth banks throughout the site.

There is evidence of a limited amount of poaching by horses on the right bank and cattle on the left bank. This should not be considered excessive as poaching was predominantly limited to discrete areas of the floodplain.

This section of the river was the most impressive with a diverse range of channel morphology, sinuosity, habitat types (see fig) and was given a HQA class of 1 and a HMI class of 1.

There were no alien/invasive species present on the site.

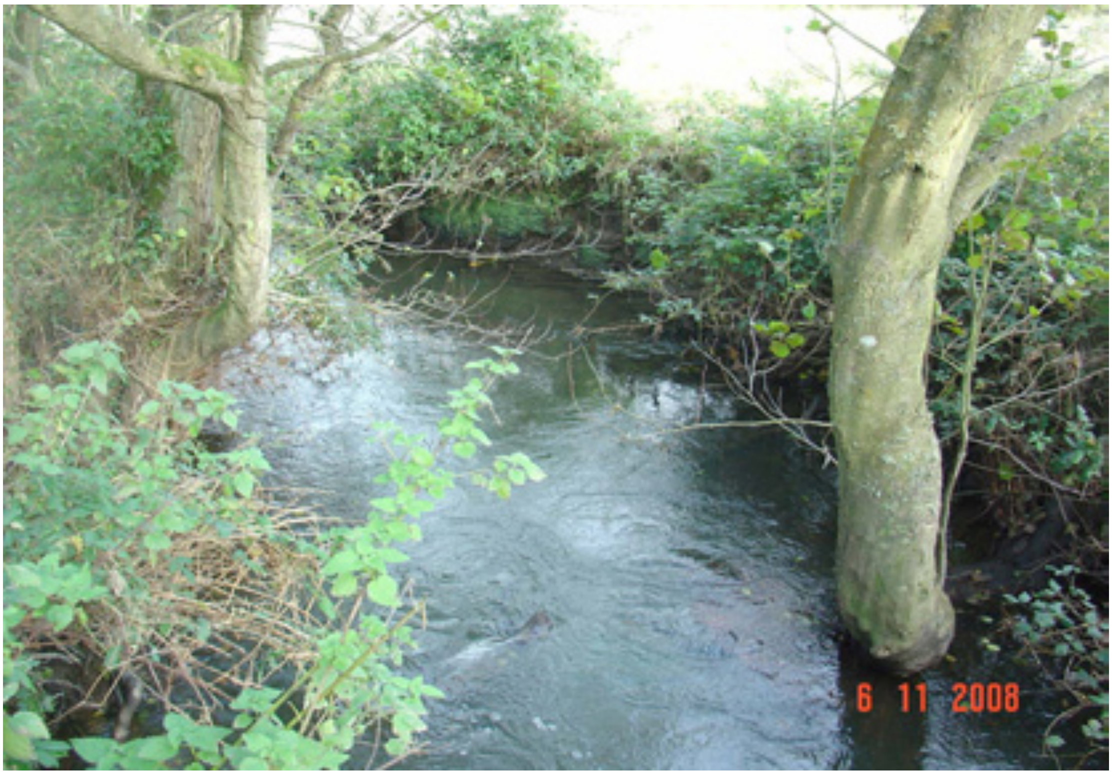

Fig 4.66: A very high quality riverine environment, exhibiting stable banks, and diversity of riparian and instream habitat.

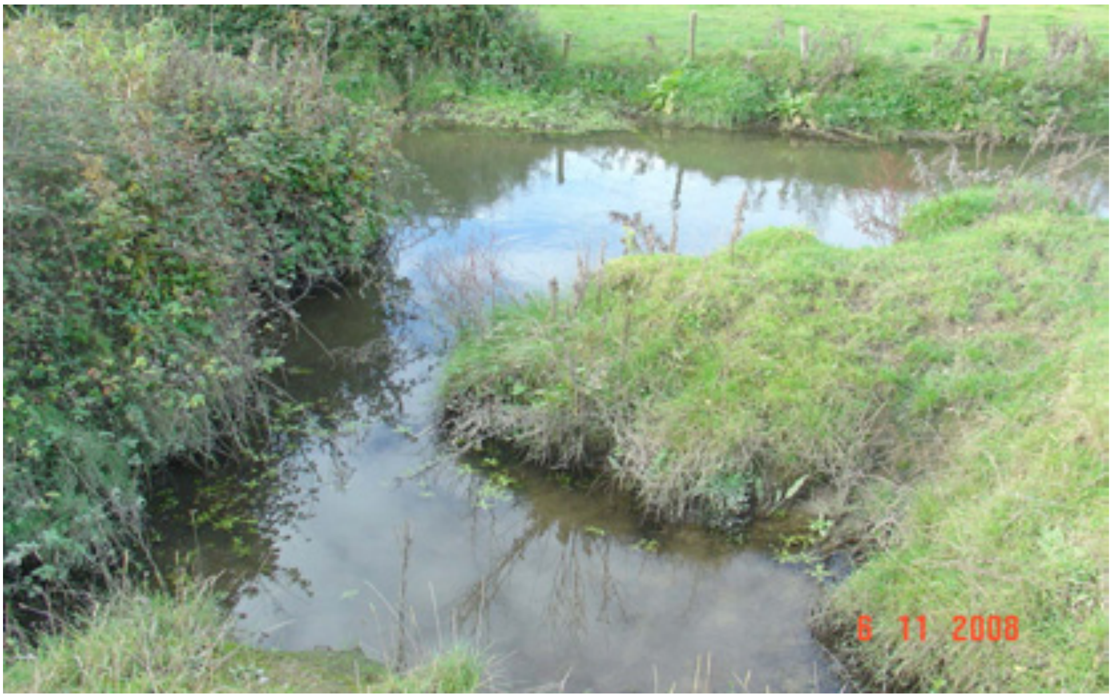

Fig 4.67: Protected backwaters and inlets enhance diversification. There were a number of such features on this site.

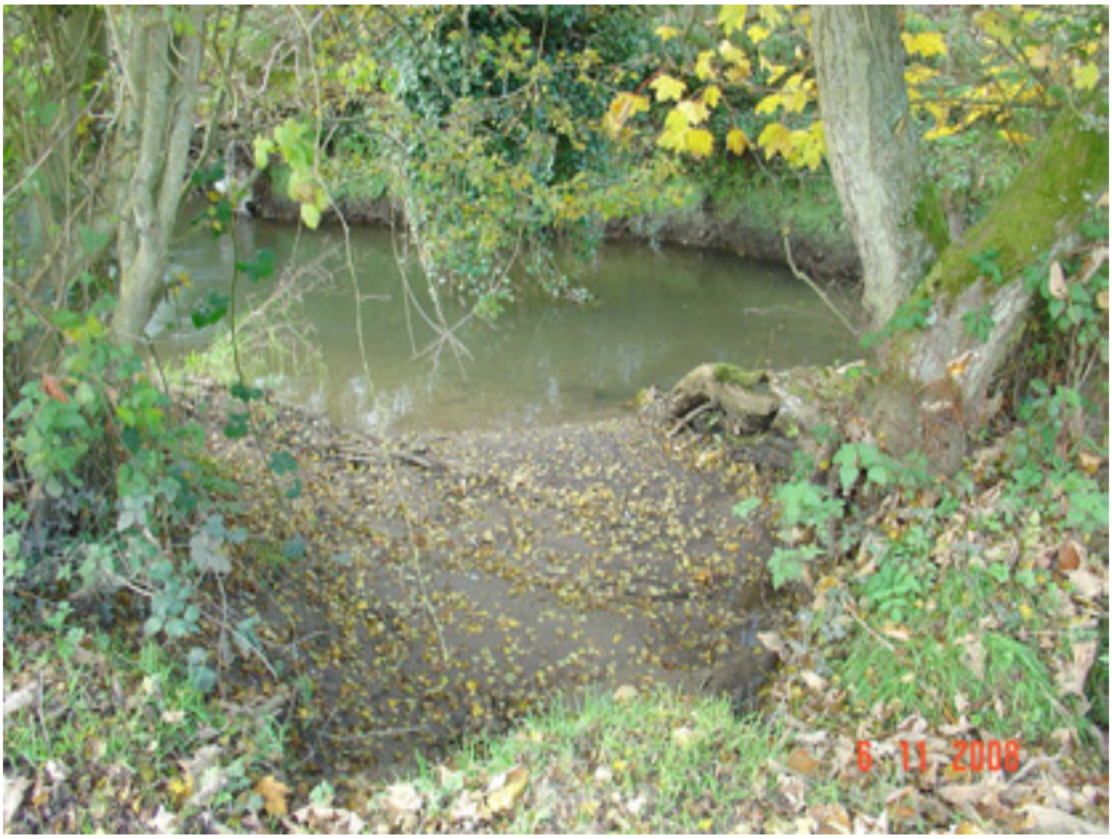

Fig 4.68: Well-established pools and deposition zones were evident throughout the site.

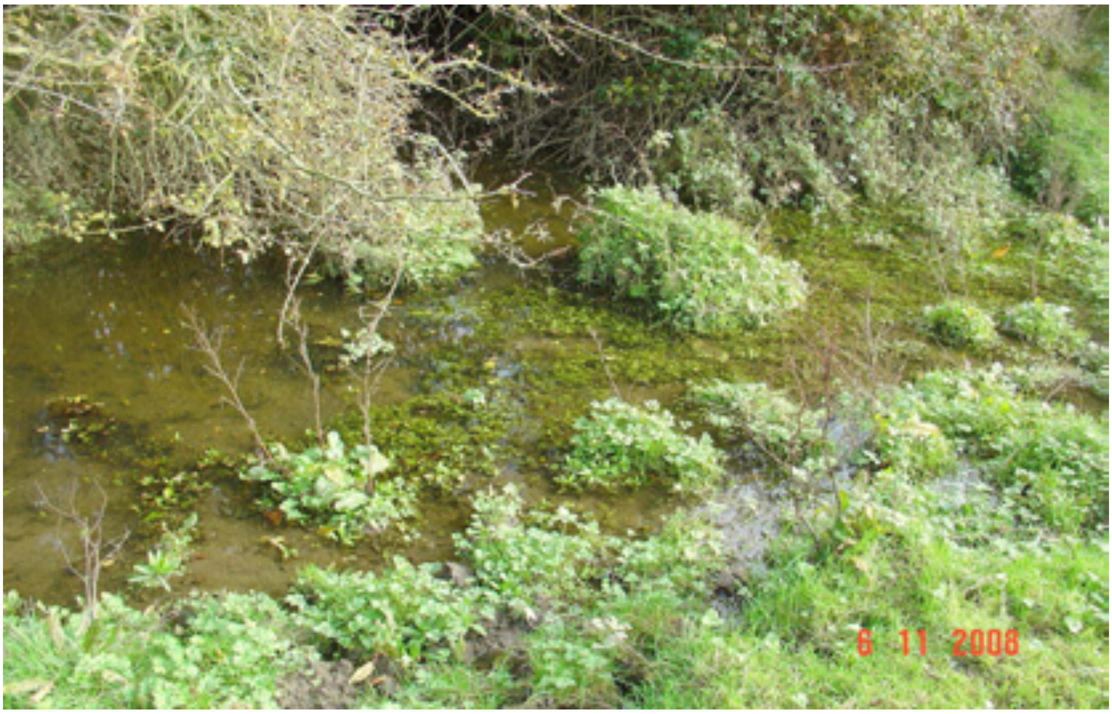

Fig 4.69: The floodplain and margins of the river has spring fed flushes and areas of wetland.

Site 7 Gibblocks Town

Description

The river is flowing through a shallow 'v' valley with improved grassland on both sides of the river. The floodplain is connected to the river and there was evidence of localised flooding on both sides of the valley.

The river is unmodified and undamaged with the exception of a poorly designed cattle watering point (see Fig 4.73)

The river exhibits excellent riffle-pool-glide configuration with a diverse range of instream and riparian habitats. Vegetated mid channel bars, vegetated side bars, and vegetated point bars were present and exposed bankside roots and underwater tree roots were extensive.

Channel substrate is predominantly gravel/pebble substrate with stable cliff earth banks throughout the site with the exception of the cattle watering point where erosion on the left bank was present..

There is evidence of a limited amount of poaching by cattle on both banks though again this should not be considered problematic as it was predominantly limited to discrete areas and not severe.

This section of the river was very impressive with a diverse range of instream vegetation, channel morphology, sinuosity, habitat types (see photos) and was given a HQA class of 1 and a HMI class of 1.

There were no alien/invasive species present on the site.

Alders were extensive and willow relatively abundant

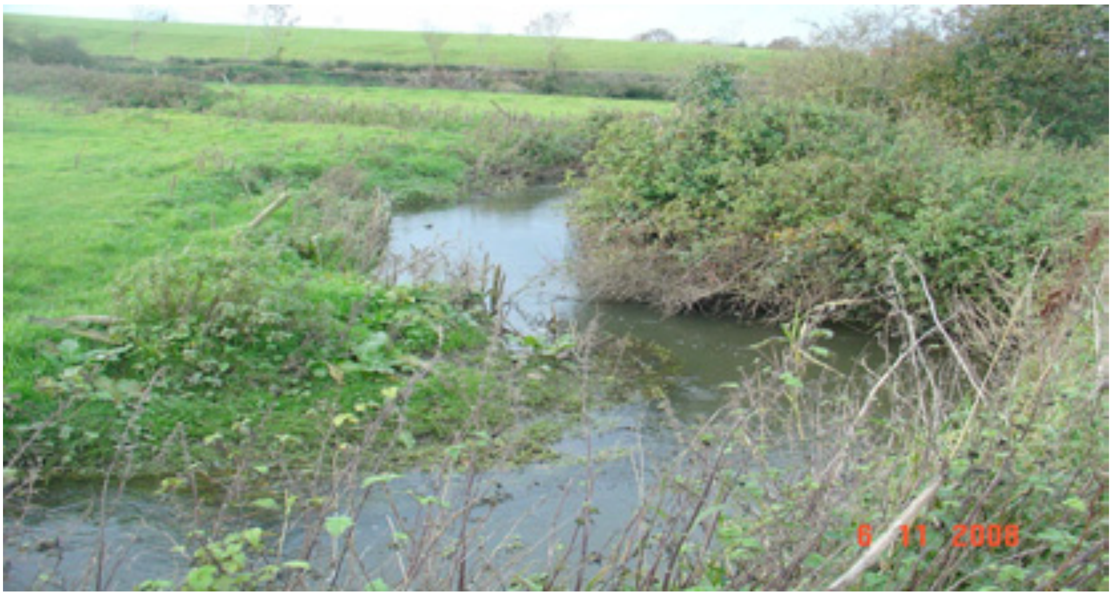

Fig 4.70: This site had a diverse range of riverine morphological habitats among them vegetated point and side bars

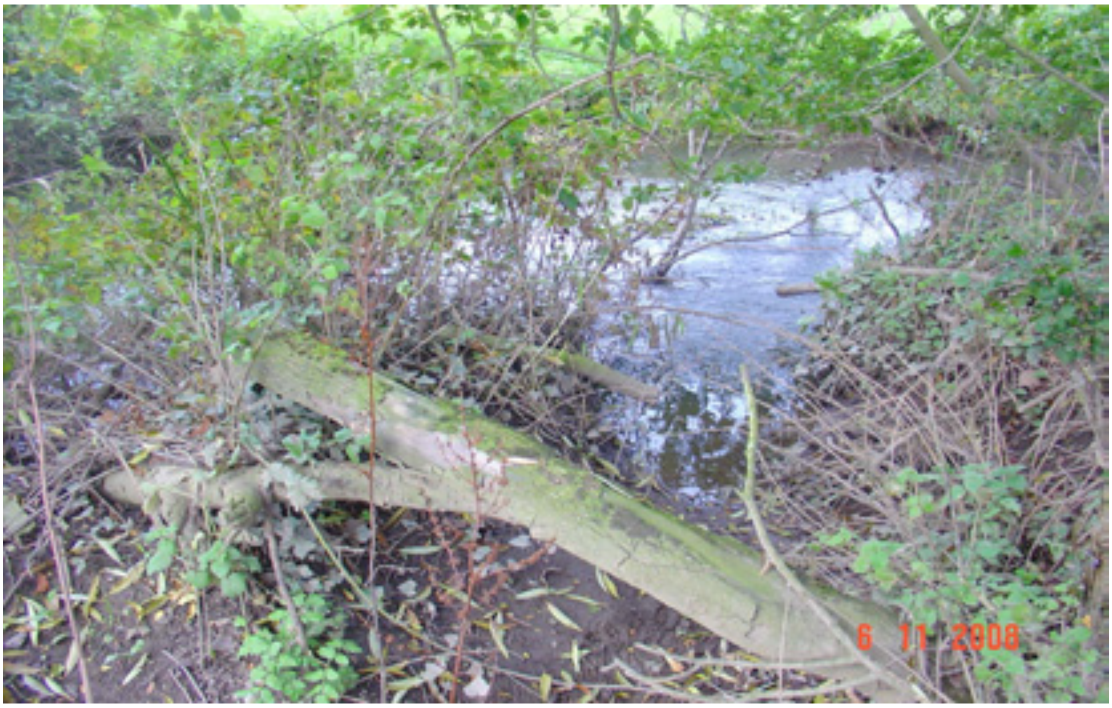

Fig 4.71: Fallen trees and large woody debris were a feature of the site and despite a number of trees in the river channel, bank stability was relatively good.

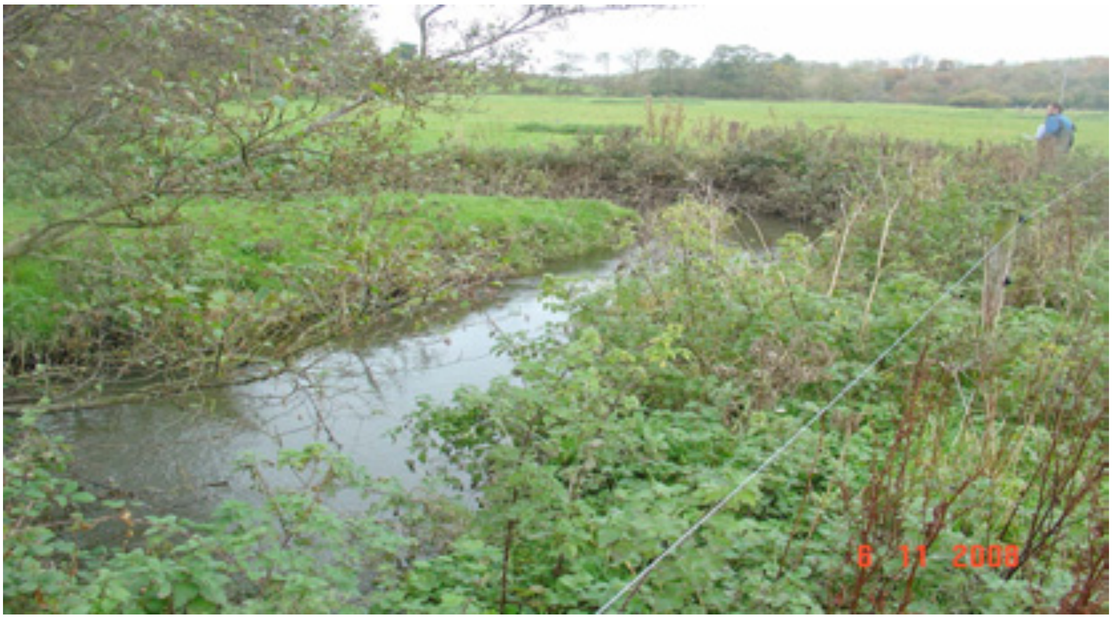

Fig 4.72: Excellent channel sinuosity was a feature of this site with good riffle-pool-glide configuration.

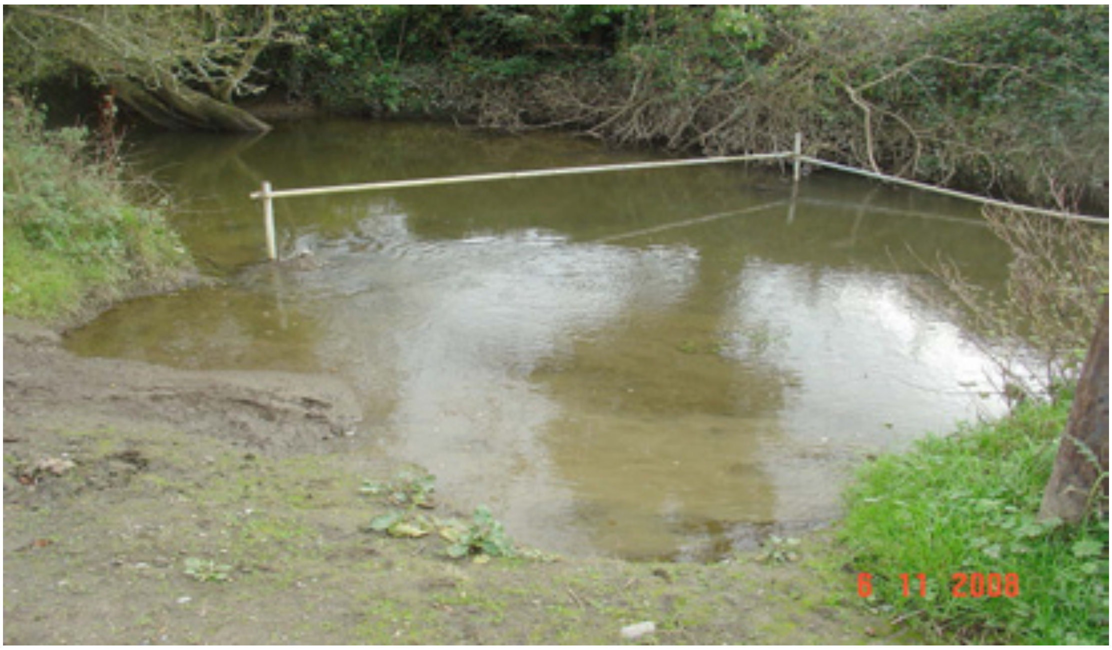

Fig 4.73: A poorly designed cattle drink was responsible for localised siltation and may prove problematic to a spawning area immediately downstream.

Site 8 Stamullin

Description:

Lower end of the catchment, this section of river is in a shallow 'v' valley and is relatively unmodified. It has well defined riffle-pool-glide configuration at a frequency relative to its base width and has well established riparian vegetation.

On the left bank of the river, there is an extensive flood plain of wet woodland and marsh that extends up to 1km upstream from the end of the site. This is an area of high ecological value and a valuable asset to the biodiversity of the river and its floodplain.

On the right bank there is arable land adjacent to the river for 70% of the site and rough pasture on the remaining 30%. The right bank has been embanked on 20% of the site, though this has not had any serious adverse action on the general morphology of the river.

This site can be described as semi-natural with a broad range of riparian and instream features such as vertical/undercut banks, underwater tree roots, fallen trees, large woody debris and vegetated side and mid channel bars.

The channel width was approximately 9m with a banktop height on both right and left banks of 0.85m allowing the river to connect on to the flood plain during flood events. The site can be described as high quality with a HQA of 2 and HMI of 2.

There were no invasive species present on the site.

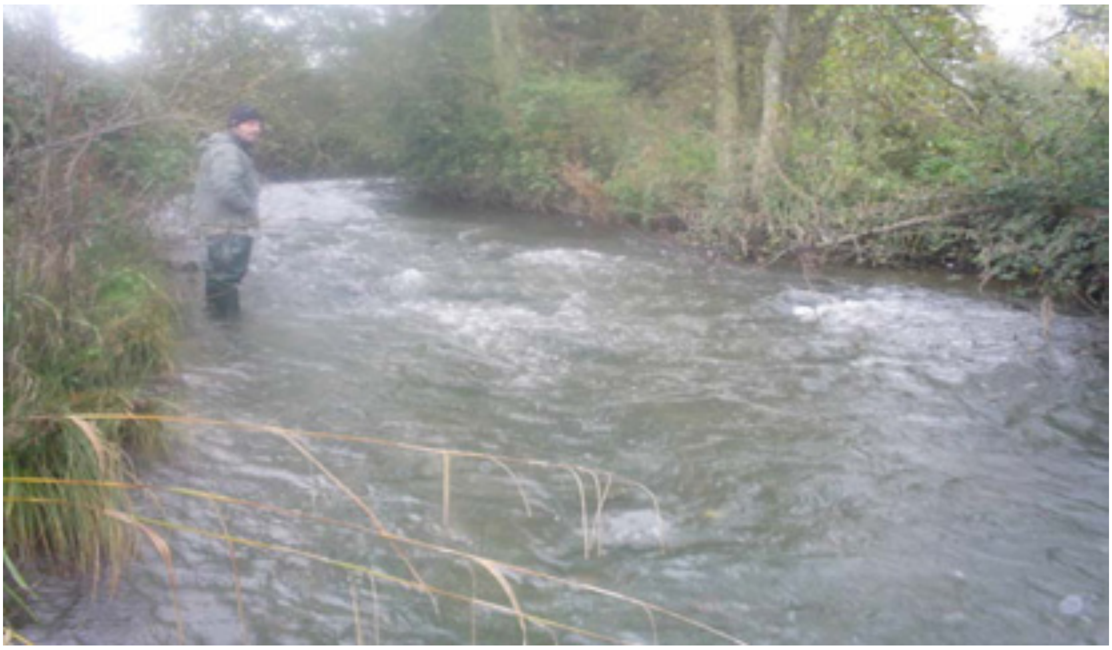

Fig 4.74: Good quality riffle-pool-glide configuration, clean gravels and a diverse instream and riparian habitat.

Fig 4.75: There is an extensive flood plain on the left bank at the Stamullin site with wet woodland and associated features. It also plays a vital role in buffering the river from anthropogenic actions.

Fig 4.76: *Anthoceros laevis*, a liverwort found on much of the surface area of the clay banks at this site.

Site 9 Gormanston College

Description

The river flows through no perceptible valley sides. Landuse on the right hand bank is predominantly recreation area with golf and sporting grass pitches. The college campus is on the left bank and is a mixture of broadleaved mixed plantation, and semi-urbanised environments on the river corridor. Parkland/ gardens have been listed as extensive.

The river channel has been modified with reinforced concrete sections and evidence of resectioning at the top end of the site. Despite the channel modifications, the river channel exhibits a natural configuration with riffles, pools and glides throughout the site.

The instream habitat is reasonably diverse with exposed bankside roots, underwater tree roots, fallen trees and large woody debris. Due to the height of the river during surveying it was difficult to completely assess all instream features. The river had an average wetted width of 6.17m.

Riparian vegetation is poor on right hand bank due to maintenance practices on the recreation grounds, and is having an impact on the stability of the riverbank.

This site can be described as fair with a HQA class of 3, and a HMI of 3

Cherry Laurel and sycamore are present on the site.

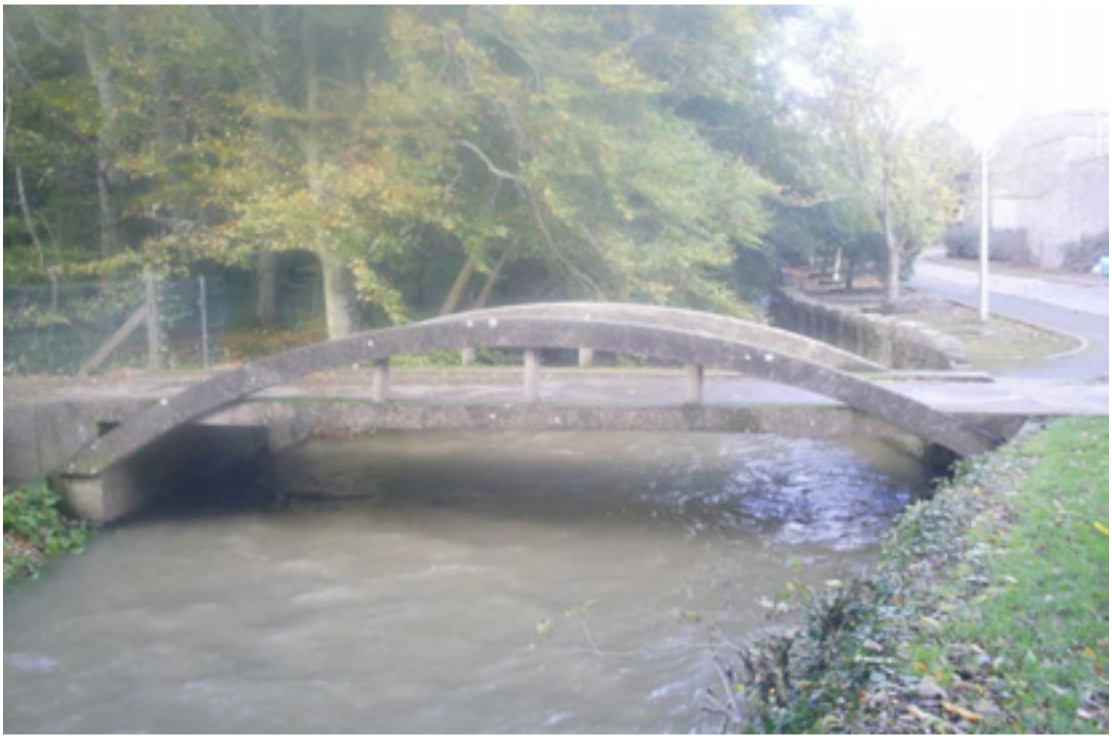

Fig 4.77: Sections of the survey site were modified though would not be considered extensive. This photo shows a reinforced and possibly resectioned area of the river.

Fig 4.78: Despite some channel modifications, there are sections of channel with good riffle-pool-glide configuration and areas of good quality cobble/gravel.

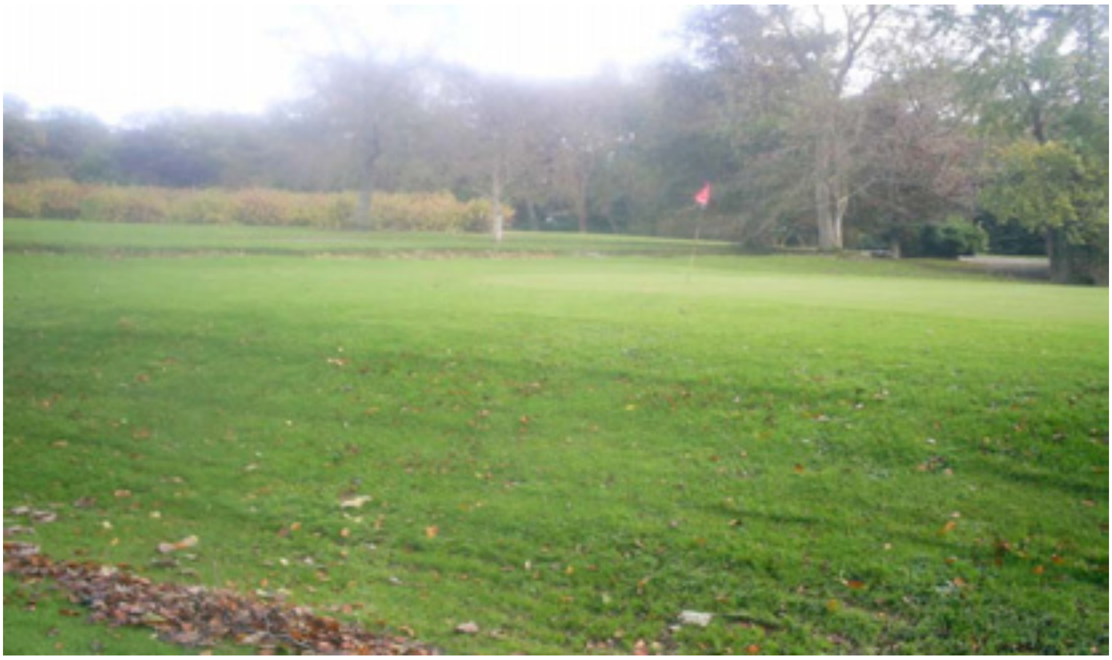

Fig 4.79: Landuse is the one major factor of concern in the Gormanston Demesne. The grass on the recreational grounds is mown to the bank of the river reducing biodiversity, increasing bank instability and causing erosion

Fig 4.80: The right hand bank of the river for the entire length of the recreation area has evidence of erosion. There is poor riparian and bankside vegetation and issues relating to erosion are only going to increase unless immediate action is taken.

Site 10 Knocknagin

Description

This site is the lowest downstream on the Delvin catchment being approximately 400m from the tidal High Water Mark.

The survey sheets will reveal that 50% of transects showed evidence of reinforcement or resectioning in this site, however most of this work has been sensitively undertaken and does not impact greatly on the overall quality of the riverine habitat.

The river channel has a diversity of noted features including vegetated mid-channel bars, unvegetated side bars, vegetated and unvegetated point bars, large woody debris, fallen trees, exposed roots etc.

The site has established pools and riffles and excellent salmonid spawning areas. It has been given a HQA class of 2 and a HMI of 2.

Giant Hogweed was present in the survey area

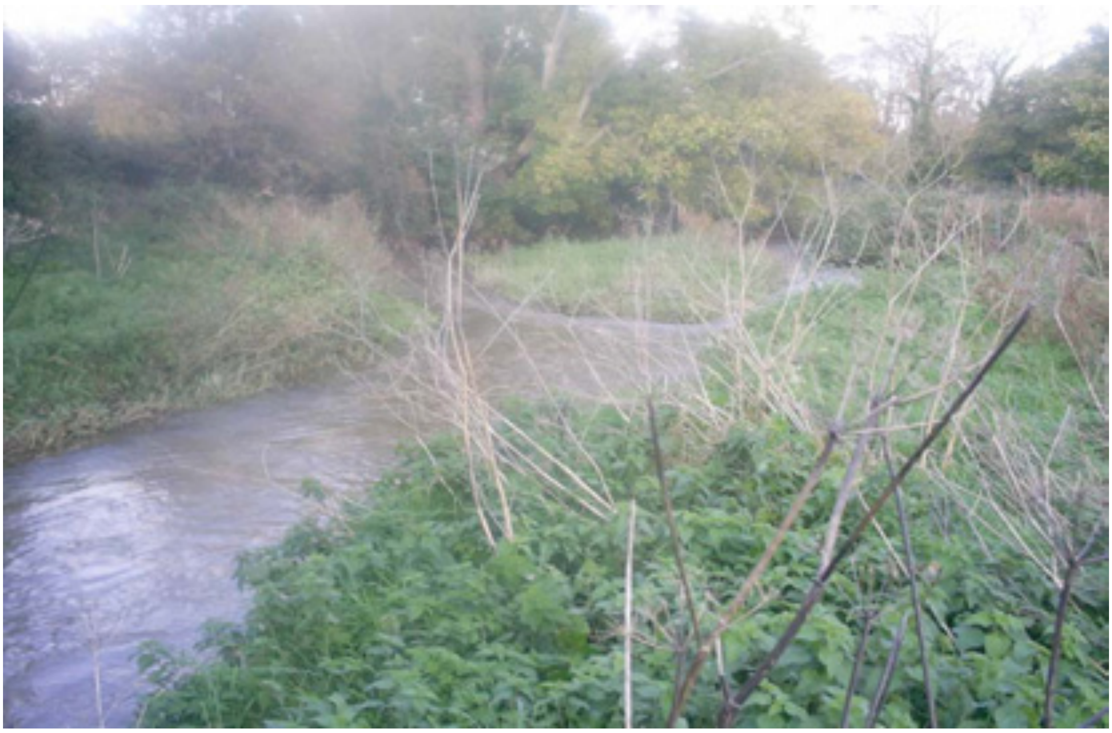

Fig 4.81: Vegetated mid channel bar. There was excellent spawning gravel for salmonids in this section of the site.

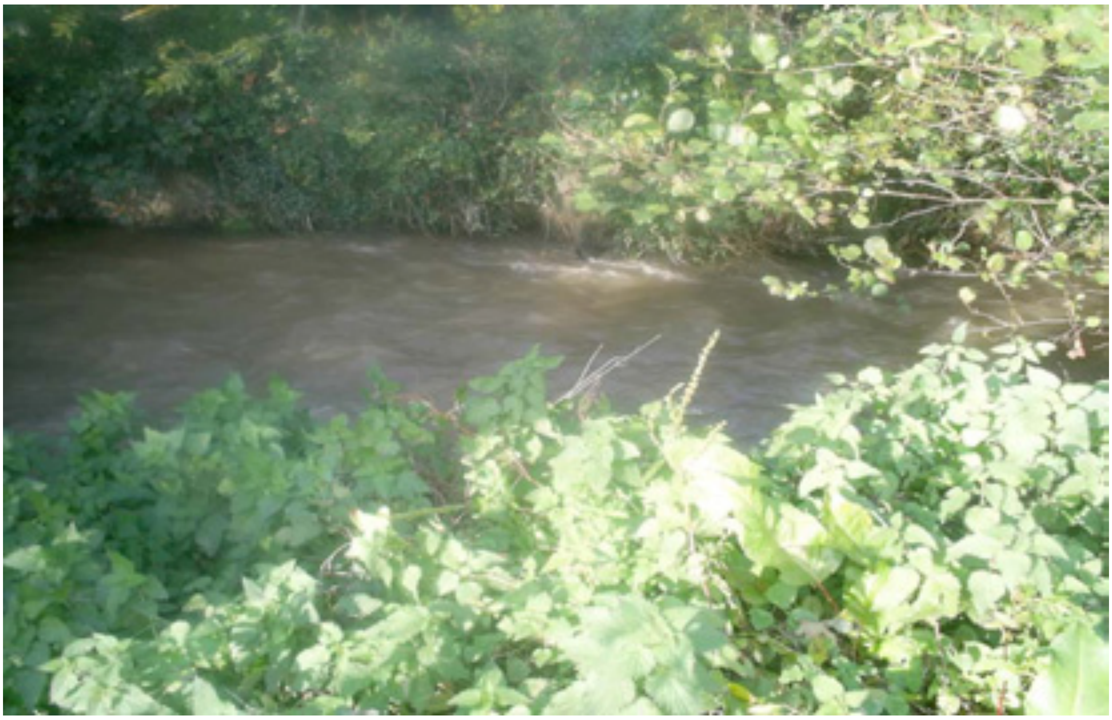
Fig 4.82: Bankside vegetation is well established and banks are stable

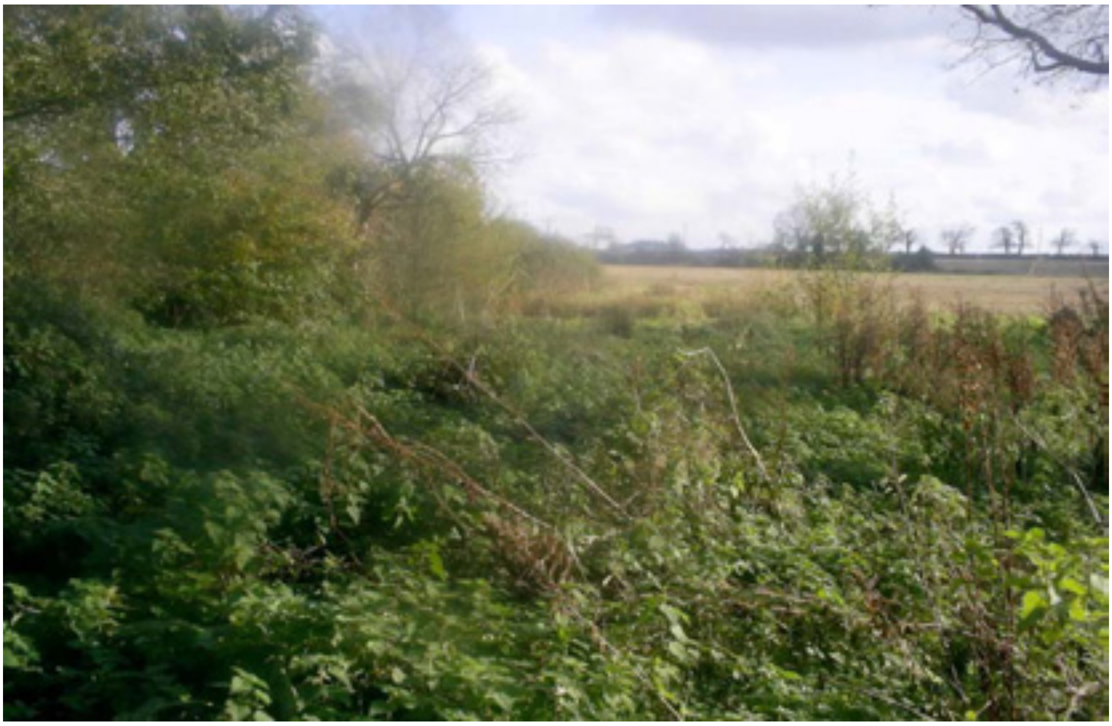
Fig 4.83: Landuse was predominantly tilled land on the right hand bank with a reasonable buffer zone of tall herb and rank vegetation and scrub and shrubs. The left bank was dominated by broadleaved mixed plantation and parkland.

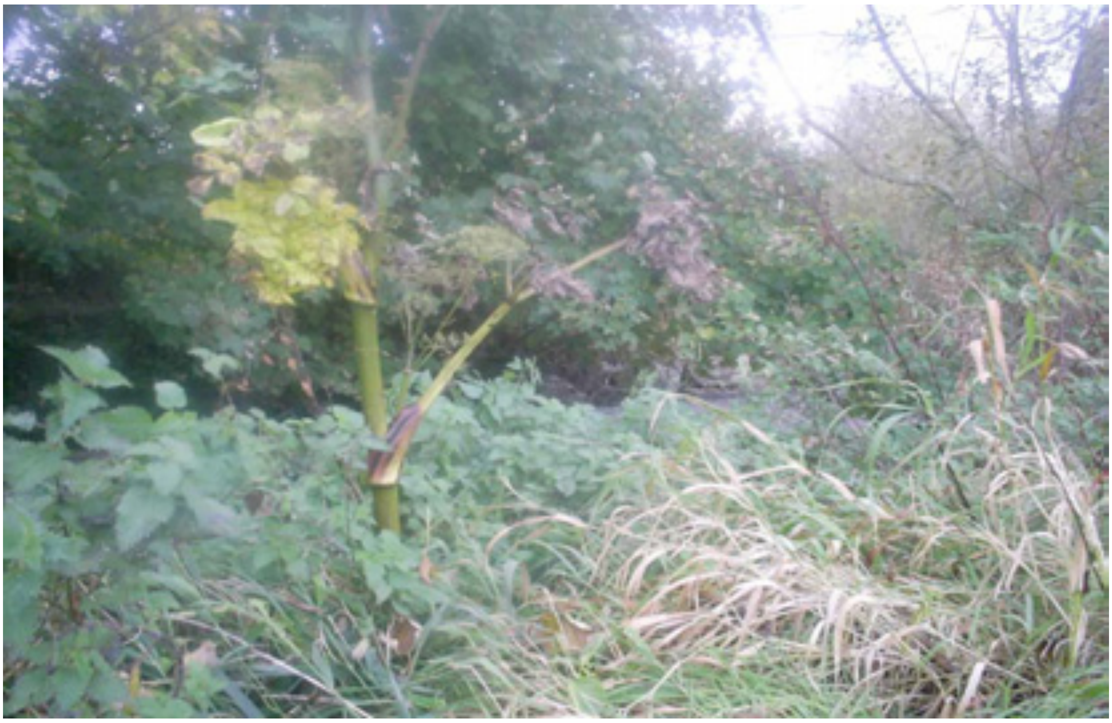

Fig 4.84: Giant Hogweed

4.3 Ecological Assessment

4.3.1 Habitat Quality at Ecological Reference Sites

The three reference sites as described in Section 3.4 were chosen as reference sites for the assessment of a range of ecological factors. As the brief directed that the survey was to select one existing EPA monitoring point (this is Site 2, Bodingtown Bridge), it was decided to chose reference sites upstream and downstream of this. These sites were selected on the basis of the degree of modification and semi-natural or natural states as represented in their structure and vegetation communities. This was derived through assessment under the RHS (EA, 2003) Habitat Modification Index (HMI) and Habitat Quality Assessment (HQA).

Site 1. Moorepark

This site is found within farmland in the upper reach of this river. Although there is ample evidence of modification such as channel re-alignment and deepening, the cobble/gravel substrate of the river was found to be suitable for sampling for a range of groups. The rate of flow and depth allowed for a range of habitat types to be found in-stream, the predominant being riffle and glide. Embankment was seen on both sides of the river though this was more obvious on the right bank which was not as heavily vegetated. This right bank contained a number of herb and grass species as previously described. The bank would be subject to some grazing pressure as the adjacent field is pasture. A small amount of poaching was noted but this was not significant enough to cause damage to the stream. The left bank has more 'natural' vegetation type in that it has undergone less grazing pressure, some of this bank being joined by adjacent hedgerows which prevent this. There are mature ash trees on this bank as well as understorey shrubs which shade up to 50-60% of the site. In terms of the assessment criteria given above, this site can be described as poor with a HQA class of 4 (poor quality), and a HMI of 3 (obviously modified).

Site 2. Bodingtown

This site has undergone much modification, some of this being relatively recent (within last two decades). The channel has been straightened and resectioned and the natural habitat configuration of a stream at this age (riffle-pool-glide) has been lost in places. Nevertheless, a riffle-glide environment exists over a predominantly cobbled substrate which is suitable for sampling for arrange of groups. The earthworks (sand, gravel extraction) which have taken place on the left bank of this site do not appear to impact significantly on the river water quality although the natural vegetation of the set-back of this bank has been substantially lost. However, there has been much regeneration within the stream and on the banks and margins, several groups of plants including common reed, *Juncus* species and herbs are found. Some small amounts of algae were noted at the site and some stoneworts recorded downstream of the reference site. This site has the potential to further naturalise. In terms of the assessment criteria given above, this site can be described as poor with a HQA class of 3 (fair quality), and a HMI of 4 (significantly modified).

Site 3 Stamullin

This site has undergone the least modification of the three reference sites and has retained the most in terms of natural character. This is due in part to the near continuous nature of the treeline of mature alder on the left bank which is interspersed with willow and shows regeneration of the undergrowth. The right bank has a range of herb species despite some relatively recent embanking being noted. This bank also shows regeneration of willow and elder. A wide zone of non-cultivated vegetation is found on the right bank which serves in part as a buffer zone and is of value to the site. The left margins extend into scrub and then wet grassland in which much willow-herb was noted as well as beds of iris and *Juncus* spp. This area has also buffered the channel and associated vegetation. The site is located on one of a number of naturally shaped meanders which have allowed for a range of habitats to persist within the channel and its margins.

The channel itself appears to be largely unmodified and contains a good mixture of riffle, pool and glide features. The banks have abundant liverwort (*Anthoceros*) and moss (*Brachythecium*) growth. The substrate is c. 60% cobble, the remainder being gravel with little silting though some bars were noted. Water levels at time of survey did not allow for identification of algae or macrophytes. In terms of the assessment criteria given above, this site can be described as poor with a HQA class of 2 (high quality), and a HMI of 1-2 (predominantly unmodified - seminatural).

4.3.2 Macroinvertebrate Sampling

The three reference sites were kick-sampled and benthic macroinvertebrates collected as described in Section 3.2 Full results are given in Appendix F. The results of the analysis of the macroinvertebrates sampled is given below.

<u>Site 1. Moorepark</u>

The kick sample from Site 1 contained 1610 individuals representing 19 taxa. The most abundant (being categorised as 'dominant') were *Gammarus duebeni* which belongs to Group C represented by organisms tolerant to organic pollution. Another Group C species the mayfly *Baetis rhodani* was also represented in abundance (328 individuals, c. 20%). Simuliidae larvae, also a Group C family was found to be common (c. 11% of total individuals). The aquatic stages of Simuliidae may be found in a wide range of flowing waters. Mild organic pollution or enrichment is tolerated by some species but generally all members are absent from grossly polluted waters. Another fly larva from Group C, *Dicranota* was found in small numbers. Group B species were represented by *Agapetus* and *Potamophylax* spp. but only in small numbers. Group A, E and D species were absent. Macroinvertebrate communities were characteristic of waters with a moderately polluted status. As a result a Q3 value was assigned, indicating Class C water.

<u>Site 2. Bodingtown Bridge</u>

The kick sample from Site 2 contained 2013 individuals representing 23 taxa. Group D was dominant, being represented in greatest abundance by *Asselus aquaticus*, there being 1059 individuals, over 52.6% of the total. The caseless caddis fly *Hydropsyche siltalai* was found to be common (17%). However, *Oligochatae*, a Group E subclass were found in fair numbers (6% of sample). *Elmis* and *Limnius* beetles, both belonging to Group C were present in small numbers, representing 4.8% and 2.6% respectively. Undetermined Chironomid larve made up 2% of the sample. A number of other Group C organisms were found in small numbers. These included the trichopteran *Tinoedes waeneri*, *Tipula* larvae and Simuliidae. The beetle *Brychius elevatus* was present, as were undetermined larvae of the Empididae family, both being Group C species. Given the abundance of Group D and E taxa recorded, relative to the representation of Group C, as well as the absence of representative organisms from Group A and B, this stream at this point may be assigned a value of Q2, indicating class D water and heavy pollution.

<u>Site 3. Stamullin</u>

The kick sample from Site 3 contained 1348 individuals representing 26 taxa. A Group C invertebrate, the nymph of the mayfly *Baetis rhodani* was found in greatest abundance (460 individuals, 34% of total organisms). Another Group C insect, the *Hydropsyche siltalai* (a caseless caddis) was found to make up 15% of total individuals (208 no.). However, a Group D species *Asselus aquaticus* made up some 8.5% of the sample and oligochaeta (worms) a Group E family made up 8% of the sample. A Group C species, the beetle *Elmis aenea* was recorded at 110 individuals (also 8% of sample). The shrimp *Gammarus duebeni* is a Group C species that was found in fair numbers. Several Group B taxa were recorded in small numbers. These included the cased caddis flies *Lepidostoma hirtum* and *Sericostoma personatum*. Mollusca (Group C) were found in small numbers as were leeches (Group E).

Group A species were absent. Given the relative abundance of Group C species over those of other groups a Q3 value was assigned, indicating Class C water. Water quality is further discussed in Section 4.4 d (below)

Macroinvertebrate Results and Functional Feeding Group Analysis

The ecological role of freshwater invertebrates within the the freshwater ecosystem depends on its feeding behaviour. The main types of feeding behaviour depending on foodstuff and feeding mechanism have been categorised in groups known as the *functional feeding groups*. These are:

- Scrapers—scrape their food off surfaces (many mayflies)
- Shredders—shred organic matter like leaves (many caddis flies)
- Filterers / Collectors—collect fine organic particles (many fly larvae)
- Predators—eat other invertebrates (such as many beetles)

Scrapers (also known as grazers) scrape and graze on the biofilm of stream surfaces, consuming diatoms and cyanobacteria. Scrapers include mayfly, caddis fly and midges. Shredders shred and chew coarse particulate organic material such as leaves, bark and other plant matter. Shredders include stoneflies, caddis flies, crane flies and midges. Filterers / collectors (also known as Filtering collectors or collector-gatherers either collect or use a filter mechanism to collect food primarily fine particulate organic material (e.g. decaying detritus) and/or small organisms. Filterers / collectors can be mayflies, stoneflies, midges, caddis flies, crane flies and midges. Predators attack and devour/engulf other macroinvertebrates. Examples include many types of flies, beetles and some stoneflies.

An examination of the species or other taxa found in a watercourse in terms of the functional feeding groups represented can help in gaining further information on the status of the ecosystem. For example, a dearth of filter-feeders or predators and an overabundance of detritivores might suggest an over-abundance of organic matter. The feeding mechanisms of the larvae of creatures such as blackfly depend on filtration. These will fail in the event of pollution of the stream with fine substrate or sedimentation. On the other hand, an absence of shredders such as freshwater shrimps can give information on the lack of organic material available. The three sites are briefly described below in terms of these groups.

<u>Site 1 Moorepark</u>

More than 50% of the individuals of this sample were the freshwater shrimp Gammarus duebeni a shredder. A gathering collector, the mayfly Baetis rhodani made up around 20% of the sample. A filtering collector, the larva of the blackfly (Simulidae) made up 11% of the sample. The only predators were the larva of a fly *Dicranota,* and this only found in small numbers and scarce numbers of *Tipula* larvae. Also found in small numbers was the freshwater houglouse Asellus aquaticus. Molluscan and trichopteran scrapers were scarce, as were indetermined species of oligochate worms and chironomid larvae, both gathering collectors. Two shredders, the Limnephilid caddis fly, *Potamophylax cingulatus* and another caddis belonging to the Polycentropidae were scarce. The overall lack of diversity of groups at the site suggest a relatively poor ecosystem. The particular lack of predators is telling here as well as the dominance of a single shredding species. However, there is good representation of filtering collectors in overall numbers if not diversity, suggesting that fine particulate organic matter pollution is not an issue at this stage of the watercourse.

<u>Site 2 Bodingtown Bridge</u>

Another shredder species, the freshwater hoglouse *Asellus aquaticus* was dominant in this sample and represented over 50% of all organisms. However, the caddis fly *Hydropsyche siltalai* a filtering collector was found to be common, representing 17% of the sample. Another larva of the Hydropsychidae (*Tinoedes waeneri*), also a filtering collector was found but in small numbers only. The only other filtering collector was represented by small numbers of Simuliidae larvae. A gathering collector (an indetermined Oligochate) made up 6% of the sample. Another beetle, *Brychius elevatus*, a shredder was scarce. Scrapers were

represented in small numbers by *Elmis* and *Limnius* beetles and some scarce mollusks. The sole predator of the sample was the larva of the *Tipula* genus and only 4 no. individuals of this were found.

The predominance of *Asellus aquaticus* a shredder (that is tolerant of poor oxygen concentrations) indicates an excess of organic material at this site. However, this might at least in part be a function of the shading of this site. Enrichment and thus preponderance of some phtyobenthos could also be a factor. The high abundance of a filtering collector indicates that siltation is not a crucial limiting factor. However, the dearth of predatory species and the more motile gathering collector species is suggestive of poor ecosystem functioning.

<u>Site 3 Stamullin</u>

By far the most abundant species was the gathering collector mayfly *Baetis rhodani* (representing 34% of all organisms). The caddis fly larva of *Hydropsyche siltalai*, a filtering collector was common, representing 15% of the total sample. Another filtering collector however, the larva of the blackfly (Simulidae) was only found in small numbers. A shredder species *Asellus aquaticus* was found in fair numbers (c. 8%) as were the larvae of the beetle *Elmis aenea*, a scraper. Oligochate worms, gathering collectors, made up another 8%. The freshwater shrimp *Gammarus duebeni* was found in fair numbers. This is a shredder species. Another shredder, the caddis fly *Lepidostoma hirtum*, was only found in small numbers, as were 3 no. taxa of scrapers: a cased caddis fly, a mayfly larva of the Heptageniidae and 4 no. mollusc species.

A reasonably good representation of the feeding groups can be seen in the Stamullin sample, reflecting the range of habitat here, with the obvious exception being the absence of predatory species. This may be a result of some of the exceptional weather conditions but it is unlikely. Gathering collectors dominate the sample which is a positive indication of ecosystem functioning as is the relative abundance of filtering collectors. An over-abundance of substrate organic material is not indicated, nor is siltation an apparent problem here. All of the above would indicate that the lack of predators such as the Plecoptera is a function of poor water quality, given their relative sensitivity, rather than unsuitable habitat conditions.

The macroinvertebrate sampling showed poor correlation with the reference species given by Kelly-Quinn et al. (2004). Of the species or taxa listed in the above work as occurring in 100% and 67% of the rivers of this type only approximately one third (12/36 and 10/35 respectively). Correlation was poorest between the species or taxa occurring in 33% of the river types in the 2004 survey and this present work (9/74).

Of the three reference sites on the Delvin, Site 3 (Stamullin) showed the closest correlation, with 12 of the 36 species or taxa being found in the groups occurring 100% of the time in RIVTYPE. 7 of the 35 species / taxa found in the 67% category and 8 of the 74 of the species or groups listed as occurring in 33% of the RIVTYPE samples were found at this site. Site 1 (Moorepark) showed the poorest correlation overall.

4.3.3 Benthic Diatoms

49 taxa were identified at the three sites. These are listed in Appendix F. An unusual *Nitzschia* species was encountered that did not match any description in the literature. For this study it has been recorded as "*Nitzschia* sp" but some more work on this is needed before a specific name can be applied with confidence.

All sites had diatom assemblages characteristic of nutrient-rich conditions. Site 1 contained 26% *Achnanthidium minutissimum*-type, a species that is characteristic of reference conditions; however, the remainder of the assemblage suggested nutrient enrichment and, indeed, some forms of *A. minutissimum* are tolerant of nutrient enrichment. The remaining two samples were dominated by *Amphora pediculus* and *Navicula gregaria*, both of which are

characteristic of enriched conditions. Results would indicate enrichment of the river at all sites and a poor or bad status of water quality.

The following assessment of the results was given by Kelly, M. G. (Pers. Comms, 2008): The likely classification based on these samples is bad or poor but this needs to be set into context. First, an assessment based on a single sample has wide confidence limits; second, experience in the UK has shown that classifications based on the TDI alone are stringent, compared to classifications based on macrophytes. This reflects the origin of the TDI as an index of inorganic nutrient enrichment.

The benthic diatom sampling showed poor correlation with the reference species as given by Kelly-Quinn et al. (2004). Of the 51 species or other taxa listed in the above work for rivers of Type 32, only 17 were found in the Delvin samples. Of the three reference sites, the closest correlation was seen at Site 1 (Moorepark), here, 3 of the 6 reference species listed as occurring in 100% of the RIVTYPE project rivers were found and a large percentage (26%) of the species found in this sample was made up of one of these species: *Achnanthidium minutissimum*. Of the species found occurring in 67 and 33% of the RIVTYPE samples, all sites showed poor correlation to reference conditions having less than half and one tenth of these species respectively. Site 2 (Bodingtown Bridge) had the poorest correlation overall.

4.3.4 Macro-algae

Only one of the sample sites (Site 2 Stamullin) contained any macro-algae. This was the filamentous algae *Cladophera glomerata*, a widespread species. It is not known why the samples showed such small amounts of algae, being lacking from Sites 1 and 2. The physicochemical conditions recorded at time of survey indicate suitable enrichment for a proliferation of algae of this (*Cladophora*) genus. The substrate at these sites was noted by the authors as being very bare and devoid of vegetation. This may well be due to a scouring effect from the extreme rainfall conditions received in this catchment over the previous weeks or possibly months. Another explanation is the unsuitability of the substrata despite the apparent suitability of the stream substrate for this sampling method. Communication with Kelly, M. G. (Pers. Comms, 2008) confirmed that recent spates may well have caused scouring of the river. This, coupled with an unsuitable substrate (i.e. very small) may well explain lack of algae. Given the dearth of species found, no useful comparisons may be made with RIVTYPE Type 32 river reference species of macro-algae.

4.4 Water Quality Review and Discussion

4.4 a. Environmental Protection Agency: Q-values.

Sampling site 0080 (Bridge W of Naul, referred to as Bodingtown Bridge in our reporting) most recently achieved a Q Value of 3. With the exception of sampling events in 1991 and 1996 when the river received values of 3-4, this part of the river has achieved Q3 status (moderately polluted) on every event. Monitoring at 0250 began in 1996 and a score of Q3 was calculated. However, this site has been scored at Q4 (slightly polluted) at every sampling event since then. The site at Gormanstown Bridge has been monitored since 1978 and has mostly achieved Q3 or Q3-4 scores. However, between 1998 and 2005 the site has twice achieved Q4 status (slightly polluted). It was noted in the EPA (Clabby et al, 1998) *Biological Survey of River Quality* that there was evidence of pesticide pollution in this river: '*the disappearance of sensitive insect species indicated a deterioration in the Naul area (0080) where large number of empty fungicide containers was observed on the river bank: the river is obviously used for mixing these and possibly other agricultural biocides'.*

In summary, the upper reaches (above Naul) appear to continue to be moderately polluted. Although records are limited for site 0250, the remainder of the river shows a sustained improvement.

The comparison of the macroinvertebrate samples in terms of functional feeding groups would indicate that there is some significant enrichment of the sites under study. A predominance of shredder species at Sites 1 and 2 indicate an abundance of organic material but scarce predators. There is an overall lack of diversity within the groups also. The absence of predatory species in the sample from Site 3 is indicative of a poorly functioning ecosystem despite the presence of suitable habitat areas. The abundance of one species of filtering collector species would indicate that silt loading is not a significant problem at this site. However, there was a poor diversity found within the groups in this sample. Notably absent were the less pollution tolerant gathering collector taxa and as stated, any predators whatsoever. Water quality is therefore believed to be the chief limiting factor.

4.4 b. Fingal County Council / Meath County Council and Environmental Protection Agency Physicochemical Parameters

Physicochemical monitoring has taken place at up to seven monitoring stations. These sites are detailed below:

EPA Site Code	Location	XEasting	YNorthing
08D010080	Br W of Naul	312000	260677.6
08D010100	Br just E of Naul Park Ho	313164.7	261121.6
08D010200	Old Mill Bridge	314455.9	262646
08D010240	Br NW of Forty Acres	314367.4	263758.1
08D010300	Br in Stamullin (South End)	315074.1	265757.1
08D010400	Gormanstown Bridge	317069.8	265793.5
08D010500	Knocknagon Br	318026.3	266251.3

<u>Phosphate (P) concentrations 2004-2008.</u>

All of the three monitoring sites used for P monitoring (0080, 0240 and 0400) have been seen to exceed target P values (0.03, 0.05 and 0.05 mg/l, respectively) over this period. The median values for all of these years (2008 not yet complete) have exceeded these targets. While the trend for median P values over this period would appear to show an improvement in quality over this period and average concentrations appear to fall at both 0240 and 0400, the target values have been exceeded at these sites several times, exceeding the target by a factor of 2 on 3 no. occasions at 0400 in 2008 thus far. Median P concentrations are consistently higher than target at the most upper sampling station (0080) and has not achieved the Q4 status set as target value.

WFD Monitoring Sites 2007-2008

Three of the sites listed above (0080, 0240 and 0400) have been included in the WFD programme for this river catchment. A review of the data for 2007 and available to date for 2008 is given below, beginning with the more recent year.

Biochemical oxygen demand (BOD) was seen to be within standard limits for all river points in 2008. Chloride, colour and electrical conductivity were also within parameter limits. DO concentrations were of salmonid water standards (100% being over 7 mg/l). Fluoride and nitrate levels were of surface water abstraction quality. Nitrite levels were at or close to salmonid quality for 5 of the 6 samples this year, the highest levels (0.042 mg/l) being recorded at Bodingtown Bridge. pH, temperature, sulphate and total organic nitrogen (N) results were within standard limits. Phosphorous (P) levels in 2008 were below admissible limits for salmonid class waters for 4 no. of the 6 no. total samples, and only narrowly exceeding the limit at Bodingtown Bridge.

In 2007 dissolved oxygen concentrations fell below salmonid standards at both 0080 (Bodingtown Bridge) and 0370 (Bridgefoot House) one result being very low (5.4 mg/l) in June 2007 (but it should be noted that this had improved to 8.3 mg/l for the same month in 2008). The BOD standard for salmonid waters was exceeded twice in this year. Nitrite concentrations were found to be above salmonid class water standards on all sampling events (albeit twice only narrowly), and in breach of cyprinid guidelines on half of the eight events. The maximum admissible concentration of phosphorous (as P) for salmonid waters was exceeded on all occasions and that for cyprinid species was exceeded on 3 no. events. Temperature, pH and sulphate were all within acceptable limits.

Dangerous Substances (Fingal County Council) 2006-2008

No results exceeding the set limits for these substances (e.g. arsenic, cyanide, toluene) were recorded during this time period. Zinc and copper concentrations were within EC and Irish standard limits for salmonid waters.

National Rivers Monitoring Programme Data 2004-2008 (EPA / Meath County Council)

Data from the above dates was obtained from Meath County Council. These are shown in Appendix E. This included physicochemical data on the following parameters:

Parameter	**Unit**
Dissolved Oxygen, % saturation	% saturation
Dissolved Oxygen, mg/L	mg/L
Temperature	deg C
pH	pH units
Conductivity	uS/cm at 25 degC
Biochemical Oxygen Demand	mg/L
Suspended_Solids	mg/L
Total Ammonia (NH3 + NH4)	mg N/L
Molybdate Reactive Phosphorus, unfiltered	mg P/L
Total Oxidised Nitrogen (NO3 + NO2)	mg N/L
Nitrite (NO2)	mg N/L
Chloride	mg Cl/L
True Colour (filtered sample)	Pt / Co units
Total Hardness as CaCO3	mg/L CaCO3
Alkalinity	mg/L CaCO3

Conductivity, hardness and alkalinity showed no unusual variations across the sites. Temperatures were all below the admissible limits. pH values were all acceptable. NH4 concentrations were all below the maximum admissible concentrations for fish. However, (MR) phosphate concentrations exceeded the admissible standards for salmonid fish in almost 94% of the samples. Limits for cyprinid species were exceeded in over 25% of the samples. Only 9 no. of the samples were under the EC guide concentrations of nitrite (NO2) for salmonids while less than 88% were within the Irish salmonid limit (95% < 0.05 mg/l).

Dissolved oxygen (DO) concentrations were all above the guide limit of 7 mg/l for salmonids and more than 50% were over 9 mg/l. Do was seen to be notably lower at Bodingtown Bridge with concentrations below 8 mg/l being recorded three times over this period. However, BOD concentrations only exceeded 3 mg/l on 5 no. occasions. pH results were generally lower at this station than other stretches. No evidence of serious pollution was recorded at this station. DO concentrations were slightly higher on average at Station 0100 over this period although 5 no. samples exceeded 2 mg/l BOD. All other parameters were within expected ranges. Results for station 0200 (Old Mill Bridge) showed only slight pollution. BOD at this site exceeded 3 mg/l on 3 no. occasions, indicating slight organic pollution. Results for station 0250 (Bridge NW of Forty Acres) indicate only slight pollution. A low of dissolved oxygen concentration of 7.88 mg/l was recorded in July 2006 but was not repeated. Station 0300 results (Bridge at Naul) showed no evidence of significant pollution. BOD was seen to be slightly higher than would be expected from a clean watercourse at station 0400 (Bridgefoot / Gormanstown), indicating organic pollution, albeit at low levels. Dissolved oxygen levels at station 0500 (Knocknagon) were almost uniformly high, none being lower than 9 mg/l. BOD was also seen to be low while pH values at this site were seen to be commensurate with a relatively clean river.

National Rivers Monitoring Programme Data 2001-2003 (Meath County Council)

Data from Stations 0100, 0150, 0200, 0300, 0310 (0.5 km downstream of Stamullin), 0400 and 0500 were collated from 2001 – 2003. These are shown in Appendix E. The following parameters were tested over this period:

Parameter	**Unit**
Dissolved Oxygen, % saturation	% saturation
Dissolved Oxygen, mg/L	mg/L
Temperature	deg C
pH	pH units
Conductivity	uS/cm at 25 °C
Biochemical Oxygen Demand	mg/L
Chloride	mg Cl/L
Nitrates	Mg/l N03
Orthophosphate	Mg/l P and Mg/l PO4*
Total Ammonium	Mg/l/NH4

* due to a change in analysis protocol end 2002

No evidence of any serious pollution or pollution events was noted. pH, electrical conductivity temperature were all within expected limits. DO did not fall below 7 mg/l. BOD was less than 3 mg/l at all events. Chloride concentrations did not exceed 42.1 mg/l. Ammonium (as NH4) concentrations were all within the 1 mg/l permissible level but exceeded the guide level on 75 no. sampling events (greater than 0.04 mg/l) Nitrites exceeded the guide levels for salmonid species on all but 3 no. sampling events and for cyprinid species on all but 27 events. The water does not therefore meet the Irish salmonid waters standard (1988). Two trends within the data were seen. These was an increase in BOD concentrations across all stations between sampling dates 08.04.03 and 27.06.03. There was also a notable fall in DO concentrations on all sites between 27.06.03 and 24.09.03. This would indicate that a degree of organic pollution had occurred at this time.

Physicochemical Data Meath County Council 1998-2000

The following data was obtained from Meath County Council for the above period. The parameters measured and reviewed are listed below with the units of measurement.

Parameter	**Unit**
Dissolved Oxygen, % saturation	% saturation
Dissolved Oxygen, mg/L	mg/L
Temperature	°C
pH	pH units

Conductivity	uS/cm at 25 °C
Biochemical Oxygen Demand	mg/L
Chloride	mg Cl/L
Nitrates	Mg/l N03
Phosphate	Mg/l PO4*
Ammonium	Mg/l/NH4
Suspended solids	Mg/l
Colour	Hazen
Nitrite	Mg/l NO2
Weather	Description

The results may be summarised as follows. Dissolved oxygen concentrations were generally high across all stations over the period under monitoring. BOD was recorded at exceeding 3 mg/l at only one time during this period (7.4.98). pH levels were generally above 7.5 and fell to 7-7.2 on only 3 no. occasions (1998-99). Gross discolouration of water occurred at 3 no. sampling events. One of these (10.2.99) saw a concurrently high Phosphate concentration being recorded. Only two other high phosphate results were recorded but neither indicated serious pollution. Nitrite (NO2) exceeded the EC (1978) guide limits for salmonid waters on all but one sampling at 0310 on October 2000. Nitrate (NO3) concentrations were generally within accepted limits for surface waters. Ammonium (NH4) concentrations were in excess of the guide limit for salmonid fish almost half (26/62) of the samples. However, all samples were within limits (0.2 mg/l) for cyprinid species. No serious pollution events were indicated by the data reviewed.

4.4 c Physicochemical Water quality Assessment (November 2008)

The results of the water quality sampling carried out by the authors on the 9.11.08 are given in Appendix E. No significant differences were seen in the field measurements taken. Dissolved oxygen readings taken in the field were discarded, as they were erroneous. The pH readings recorded in the field would also appear to indicate a machine malfunction on comparison with the laboratory results received.

Significant differences in laboratory results were observed in alkalinity concentrations between those recorded at site 3 and those sites 2 and 1. Total alkalinity and bicarbonate alkalinity was found to be higher in sites 1 and 2. Carbonate alkalinity was significantly higher at site 3. Nutrient levels in terms of nitrite were found to be in excess of salmonid standards. PO4 (orthophosphate) levels were just within limits for these species at all sampling stations. pH concentration was found to be higher at site 3. The above results are reflective of the changes in geology within this site (between Sites 2 and 3) as well as water quality. The above data although limited, also reflects pH and alkalinity variations found in the NRMP data (2004 – 2008).

4.4 d Overall Discussion of Water quality Data

The results gained from the macroinvertebrate analysis for this present work would appear to indicate a decline in water quality. Site 2 (Bodingtown Bridge, EPA Code 0080) has deteriorated to Q2 from the Q3 / Q3-4 status it has held since sampling began on this site. However, the physicochemical parameters of water quality (reviewed above) up until 2008 have not indicated a serious pollution event. Nor indeed have they indicated an overall decline in water quality over the period under survey. The physicochemical results do not reflect the Class D status (heavily polluted) indicated by the macroinvertebrate analysis. Macroinvertebrate analysis of sites 1 (Moorepark) and 3 (Stamullin) gave Q3 values, indicative of Class C water.

It is highly likely that the poor invertebrate fauna found at Site 2 may be as a result of the dredging and re-alignment works observed upstream at ING 11333 59650. Substrate siltation arising from such works can have serious negative impacts upon several groups. Species such as mayflies (Ephemeroptera), caddisflies (Trichoptera) and stoneflies (Plectoptera) are adapted to live in crevices beneath and between stones, particularly in riffle areas. The presence of silt on stones is capable of reducing invertebrate abundances for prolonged

periods. The major impacts of siltation are to increase species mortality and to alter community structure by:

- blocking interstitial spaces, causing oxygen-depletion and hence species mortality;
- coating stones and thereby reducing the number of attachment points for larvae and reducing their feeding success;
- allowing benthic species, such as chironomids, to survive in preference to attachment species, such as Ephemeroptera;
- reducing interstitial volume available to invertebrates.

Suspended sediment and turbidity increases will:

- reduce primary productivity, thus reducing the amount of energy available to macro-invertebrates and organisms higher up the food chain;
- tend to induce invertebrate drift, thus reducing instream benthos populations in the dredged reach and possibly also downstream;
- clog the food filtering and trapping apparatus of stream insects, for example black-flies (Simuliidae).

It should also be noted that sampling took place in October, the latest possible month for this biological sampling method (McGarrigle et al., 2002). It is recommended, therefore, that macroinvertebrate sampling be repeated at Site 2 at the next appropriate date (from June 2009) in order to compare these results and also rule out a seasonal influence on this result.

4.5 Fisheries Assessment

Due to the highly apparent differences in character above and below Naul, the Delvin River could perhaps be described as having a 'dual personality' although this condition has largely been created by anthropogenic actions undertaken since the 1880's. Many facets of the rivers character change at Naul and for the purposes of this assessment the Delvin has been divided into two sections:

- From Source to Naul (Upper Delvin)
- From Naul to Estuary (Lower Delvin)

From Source to Naul (Upper Delvin)

The Delvin River has a very limited value in respect of indigenous fish species upstream from Naul. There are two waterfalls downstream from Naul within close proximity to each other which are total upstream migration barriers for all indigenous fish species. The impact of the migration barriers renders wild populations of fish upstream vulnerable to extinction as natural recruitment through migration would be impossible should a serious pollution incident occur. However, it is important to realise the genetic importance of isolated fish communities and such communities should be afforded protection.

Data on fish stocks above Naul is very limited. It was not possible to undertake an electrofishing study on the Delvin River due to legal seasonal constraints and references to species distribution and population densities are based on historical information, visual observations and personal communications with local landowners.

The Delvin River upstream of Naul has been subjected to intense manipulation since the end of the 19th Century and this will have had a serious impact on indigenous fish populations and all aquatic flora and fauna. Subsequent maintenance and extensive arterial drainage have compounded the impact on the river and in conjunction with agricultural point and non-point pollution it is evident that the diversity and numbers of fish present are minimal.

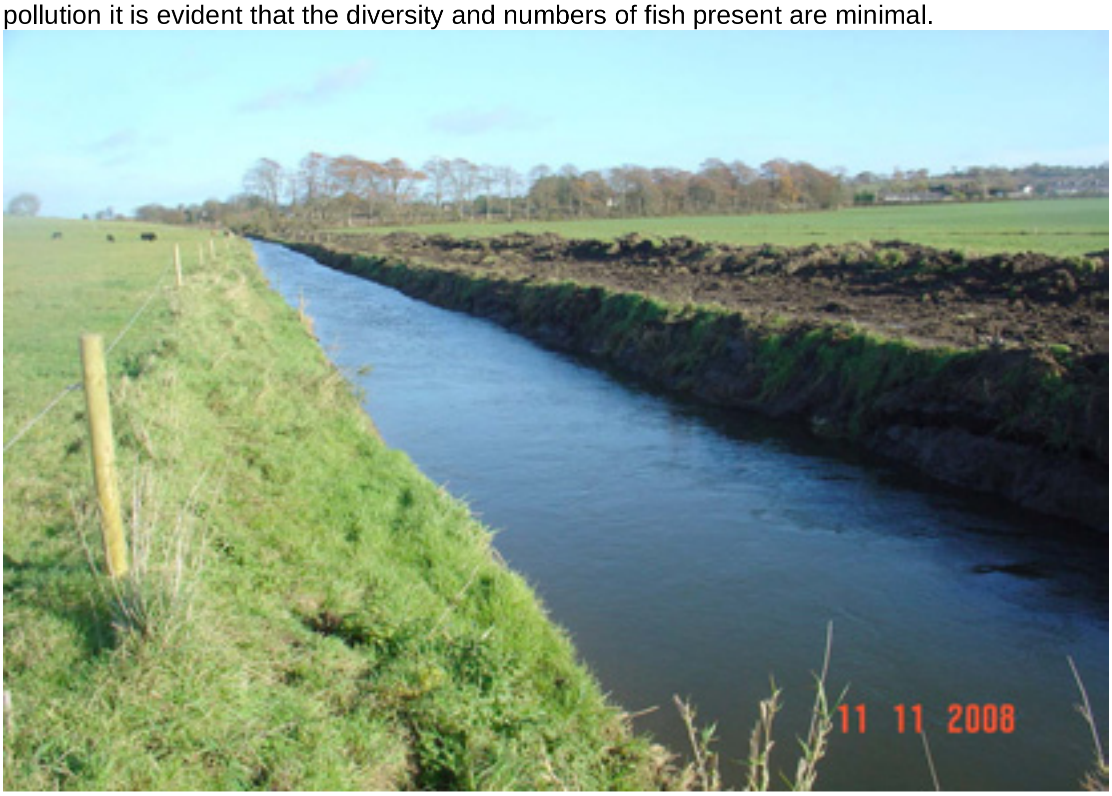

Fig 4.85: Recent drainage maintenance work undertaken upstream from Naul at Bodingtown.

In the course of the walk-over survey only three-spined stickleback (*Gasterosteus aculeatus)* were noted, this was despite walking every kilometre from the source to Naul with Polaroid glasses. No herons or cormorants were noted in this section of the river, though a kingfisher was seen on near the Commons Lower RHS site. This 'evidence' however, is highly subjective, and in terms of accurately assessing fish stocks it is important to establish if any populations of salmonids, lamprey sp. or white clawed crayfish exist in this section by applying standardised survey methodologies such as electrofishing and drift dive surveys.

When discussing the river with local landowners, it is apparent that trout were present in this section of river in modest numbers over thirty years ago, but most farmers reported that they had not witnessed trout in this section of the river in recent years.

It is unlikely that salmonids would be able to survive in many reaches of the upper Delvin. There is insufficient gravel for spawning in the main channel and it is apparent that piecemeal drainage actions have been undertaken on most of the smaller tributaries entering the river. Large sections of the upper catchment have excessive macrophyte growth and in summer, reduced flow and elevated water temperatures in conjunction with the oxygen demand of the instream macrophytes at night would create very difficult conditions for salmonids to survive.

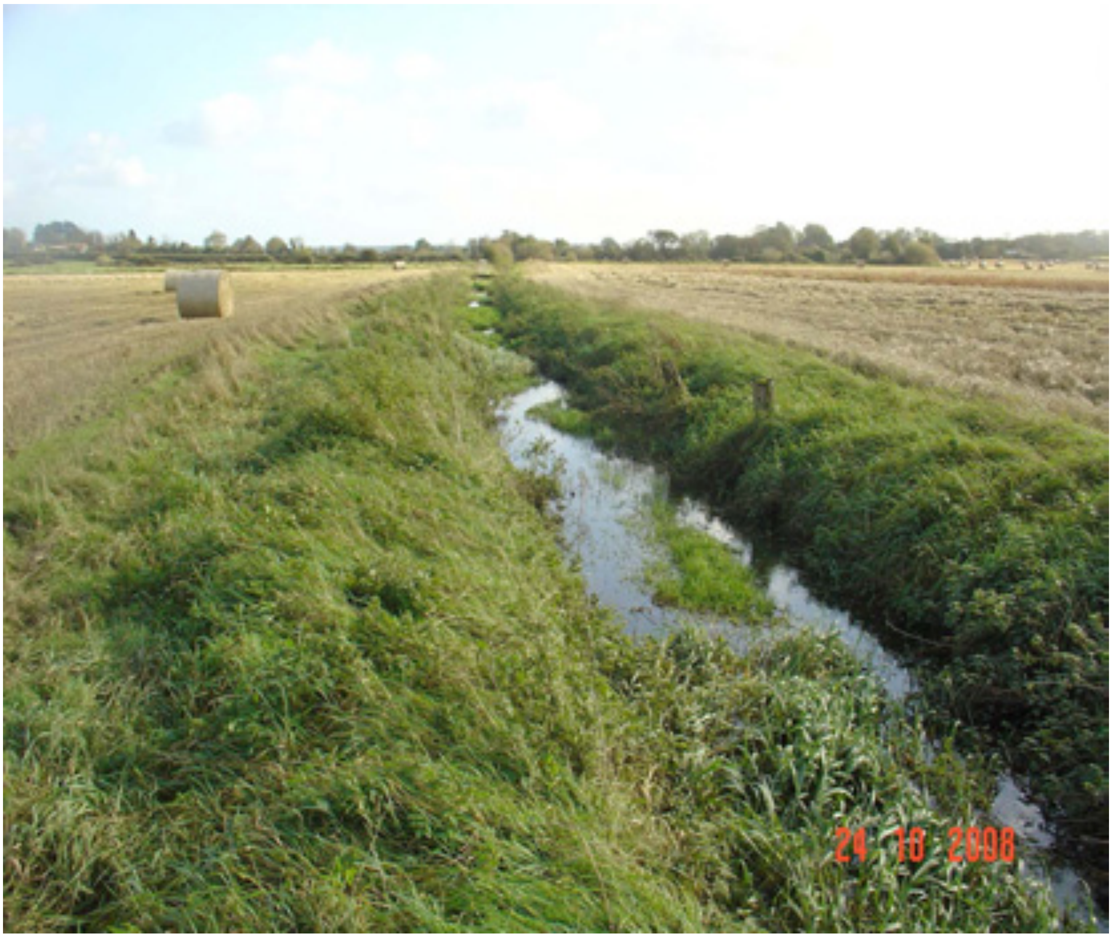

Fig 4.86: This section of the Delvin River upstream of Garristown Bridge exhibits many indicators of poor riverine habitat. This represents very poor habitat for most indigenous fish species and it would be financially prohibitive to undertake remedial action in this section. It would benefit from fencing and planting of willow slips in the medium to long term.

In reference to actions relating to fisheries management, this section (Source to Naul) would be low priority due to the combination of deleterious factors previously mentioned. It is advisable that any financial and management resources available are directed towards protection and enhancement of the river environment and fish stocks below Naul.

Naul to Estuary (Lower Delvin)

From Naul downstream, the river is primarily semi-natural with occasional channel resectioning and bank reinforcement. The diversity of instream, riparian and floodplain habitat from Naul to the sea indicates a productive environment for indigenous fish, particularly brook lamprey (*Lampetra planeri),* river lamprey *(Lampetra fluviatilis)*, brown trout (*Salmo trutta)* and sea trout (*Salmo trutta*). There is no recent or historical evidence to suggest that Atlantic salmon *(Salmo salar*) have ever been present in the Delvin River.

The absence of any hard data on fish species distribution and population estimations does make analysis of the fisheries communities difficult to assess and again it is vital that quantitative and qualitative electrofishing surveys are undertaken at some time in the future.

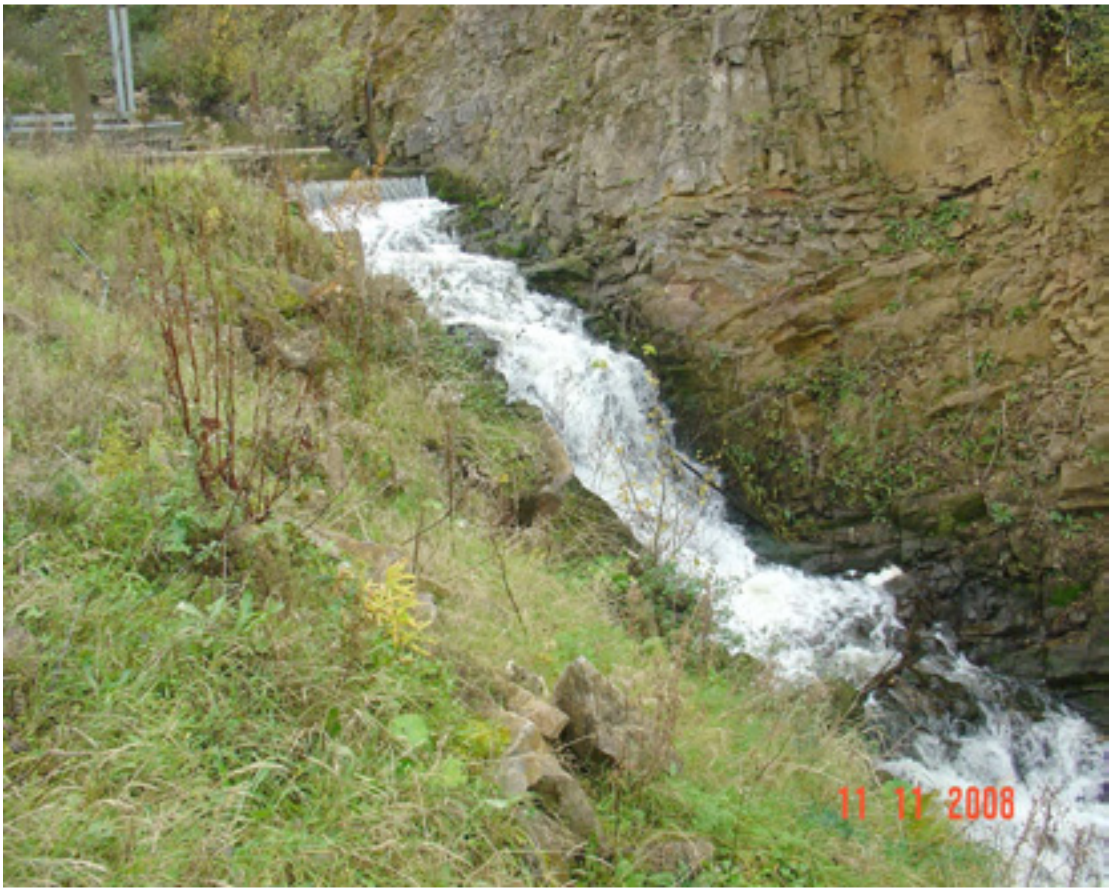

Fig 4.87: The second waterfall NGR 13464 61173

The river's progress to the sea is relatively unimpeded from this point on with no serious barriers to migration present. Some small weirs may be classed as temporal barriers and may delay fish movement during extended periods of low flow.

The main point of concern relative to indigenous fish communities in the Delvin River from Naul to the Estuary is water quality. The river has a good diversity of riffles, pools and glides, riparian vegetation is generally well established, banks are predominantly stable and the range of instream habitat is very good from Reynoldstown North downstream. Indigenous fish communities in the middle to lower end of the Delvin catchment should at least be well established and in reality, thriving. The main parameter that is negatively impacting the food chain from invertebrates to fish is the poor quality of the water and the main thrust of any action to assist all aquatic fauna will be the addressing of the water quality.

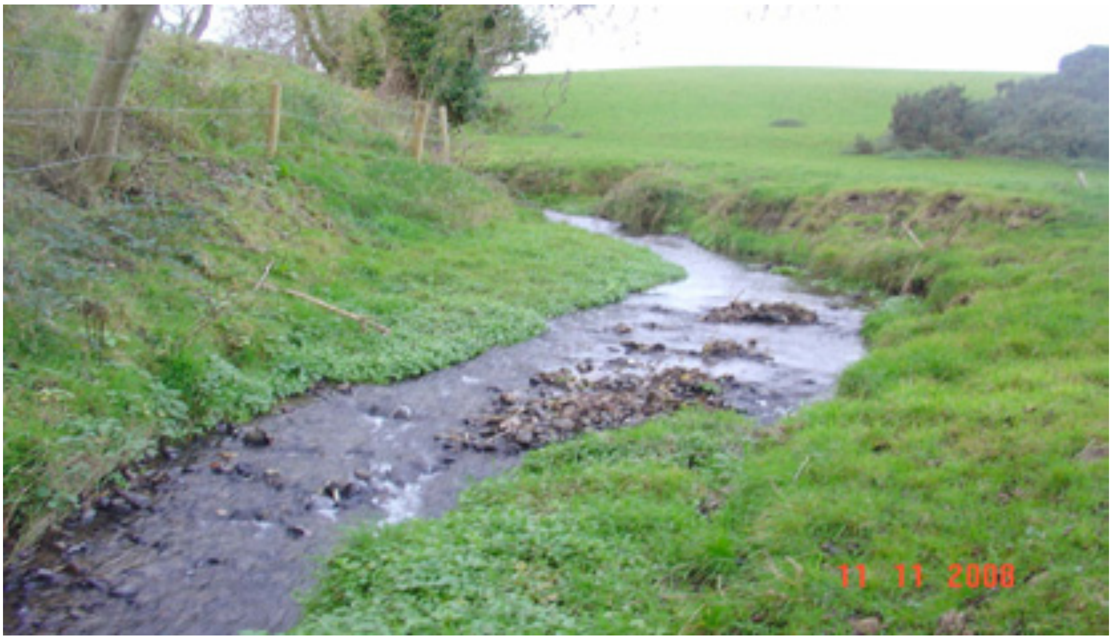

Fig 4.88: An example of good quality spawning and nursery habitat on a tributary d/s of Naul. These tributaries require protection from indiscriminate dredging and drainage

The Delvin will never be a 'Blue Ribbon' trout fishery but it does have the potential to be a reasonable recreational facility for the communities that live along its banks. Fishing is a very productive medium to teach children and adults alike of the ecology of rivers and give them a role in protecting their environment. The Gormanston and District Anglers have an open policy of admitting anyone from the communities that live along the banks of the Delvin. However there are issues over access and there appears to be a number of disputes over fishing rights along the Delvin River. It would be a useful exercise to clarify who owns the fishing rights on the Delvin and increase the access along its banks to the angling association. This will involve careful negotiation but it would be time and money well spent as they appear to be a well organised group that have the river's well-being as a priority.

4.6 Recommendations for River Management: Actions and Strategies

4.6.1 Introduction and Context

In the field of ecology, rivers and streams may be seen to serve as a form of circulatory system. The study of these watercourses, like the study of blood, can diagnose the health not only of the rivers themselves but also of their surrounding environments. The overall quality and functioning of aquatic ecosystems as healthy systems is key to the objectives of the Water Framework Directive (European Union, 2000).

When reviewing the negative impacts on the ecosystem of the Delvin River, it may readily be seen that all of the major limiting factors, with the exception of the natural waterfall at Naul, are anthropogenic.

This following section of the report seeks to propose (and structure) management protocols in such as way as to have the maximum effect and also be achievable in both financial and socio-economic terms. The main thrust is to address the anthropogenic factors that are responsible for the deterioration of the vast majority of both the physical and chemical properties of the Delvin and ultimately where possible adopt strategies that highlight the resilience of river systems and their ability to self-regenerate.

As a general recommendation, the authors would strongly urge that a management plan be drawn up for the Delvin. Whilst this would be prepared with a strong emphasis on the recovery of its ecological well-being, it should also address key maintenance, drainage and landowner issues that might otherwise be seen to be outside the remit of a local authority Parks Department or Biodiversity Office.

4.6.2 Potential Management Policy: Stream Ecosystem Resilience and Passive Restoration

Resilience is the capacity of a system to recover to or toward a pre-disturbance state. Obviously, some disturbances can be so catastrophic that stream ecosystems do not soon recover without intervention. Such disturbances include; large scale landslides, exceptional floods, and some massive, durable actions by humans (such as encasing streams in concrete). However, stream ecosystems have remarkable abilities to 'snap back' from many kinds of disturbance.

Increasingly, many ecologists appreciate the natural resiliency of rivers, their *self*-regenerative or *self*-healing capacities. Putting rivers in position to restore themselves is the best scenario wherever possible. Natural interactive disturbances by water flow, soil processes, and riparian plants and animals formed the rivers' habitat in the first place and, given the chance, will do so again. Often, simply inhibiting grazing or other harmful activity back from a river just enough to allow a functioning riparian zone, puts the stream in position to exert its resistivity. Reducing abuses elsewhere in the catchment can, of course, help further.

Allowing the river and indigenous self-starting riparian plants do the work may not get such immediate results as the building of structures or planting trees, but usually prove less expensive and, in the long-term, more effective. No construction costs are incurred and maintenance, if any required, is low. Intermediate options may often be reasonable, e.g. adding spawning gravel to resectioned/dredged channels where it would otherwise take many years (if at all in the case of the upper reaches of the Delvin catchment) for natural river transportation processes to reseed. Another example which may be cited is bank stabilisation in areas with a high erosion rate. Though generally it is a particular anthropogenic action that has caused the bank failure in the first place.

In assisting self-regeneration, the key approach, is to change *human* activity, rather than manage fish or habitat. The traditional terms, 'fish management' and 'habitat management',

may be misleading as they imply 'management *of* fish' and '*of* habitat'. Policy based on these last interpretations has not proven to be effective. Greater benefit in the longer term should come from an approach based upon management *for* fish and *for* improved habitat function.

In the upper reaches of the Delvin catchment where the river once had proper habitat for wild salmonids; it now has a mono-featured canalised river corridor. The causes have almost exclusively been generated by humans. Historically, solutions to such problems have often been centred upon 'habitat fixes' rather than attempting to alter the behaviour and practices that have initially created the problems.

4.6.3 Physical / Morphological Issues

Human activities have altered the physical habitats in rivers of all sizes. Extensive canalisation and dredging of the upper Delvin catchment for flood control and conveyance are the primary causes for losing many secondary channels, backwaters, and oxbows, which were important habitats for many juvenile fish and aquatic fauna. Activities within the Delvin catchment, whether natural or anthropogenic (human-induced), have influenced the most basic aspects of the hydrologic cycle, which in turn, have directly impacted upon the habitat distribution, trophic structure, physical and biological processes (such as sediment transport, nitrogen cycling, and primary production), and demography of the diverse biological communities.

The maintenance and removal of flood protection embankments a complex issue and one that should be reviewed at length with a number of bodies. The following should, however, be noted: When a river has been resectioned, dredged and embanked as has the Delvin in some sections, it increases the conveyance capacity of the river channel in particular areas. However, it also puts pinch points such as urbanised areas or places where the river does not have the necessary flood protection under pressure, greatly enhancing the risk of flooding at those points. Rivers need to release their energy across floodplains to alleviate pressure on river banks, bed substrate and associated physical structures.

It is common across many rivers in Ireland that the upper reaches of the catchment have been subjugated to organised dredging and drainage by statutory authorities or through piecemeal operations by local landowners. The impact of this, is that during flood events a large volume of water is quickly conveyed from the top of the catchment and then meets either urbanised pinch points or changes in river topography that force a large amount of water out of the river corridor causing flooding. In many cases this practice of resectioning and dredging the upper reaches of large river catchments in combination with urbanised encroachment of floodplains in the mid to lower sections of the catchment has had devastating results.

It is impossible to 'contain' large flood events within embankments unless large scale modifications have been made to the river corridor and there is a change in many European countries and the United States in relation to flood prevention. There is a move towards allowing the river to flood into prescribed floodplains and rather than building walls to contain the flood, pressure is released across a series of floodplains throughout the catchment.

The embankments and the river modifications currently employed in the Delvin catchment are primarily to assist agricultural practices and it is arguable how effective these practices are for agriculture relative to the long term impacts on the environment and the associated natural processes of the river. In many instances, the impact of the river temporarily flooding across agricultural land on productivity is negligible in the long-term.

4.6.4 Water Quality Issues

The primary chronic (and indeed at times acute) problem impacting the Delvin River is poor water quality, principally arising from the eutrophication of the river through agricultural and domestic nutrient enrichment. Estimates of nutrient input into waters in the catchment indicate that agriculture produces up to 40% of the yearly phosphorus load.

There is also evidence to suggest that the river has been used as a mixing site for biocides and it may be assumed that the use of said biocides has had a deleterious effect on much stream biota (Clabby et al., 1998).

In order to address the above problem, a farm nutrients study of the immediate Delvin catchment is recommended. This would provide valuable 'baseline' data that could be used as key reference material in the management plan outlined above, its ongoing initiatives and in dealings with landowners. Such a study would also help to concentrate resources wisely.

It is also recommended that the ecological reference sites utilised in this study are used as permanent monitoring sites. The installation of data-loggers would make this a relatively cost-effective measure. The ability of the local authority to produce up-to-date results may be key in tackling the ongoing water quality issues in this river and charting improvements. Timely provision of such data to relevant groups and individuals would also be recommended.

Further studies, including those that were disallowed by the timing of this survey should be carried out. These should include a fisheries survey using electro-fishing techniques when permitted and a further diatom study of the reference sites during a summer month.

4.6.5 Specific Actions Proposed (Per Reach)

Reach 1 and 2

The key actions primarily required in these reaches are establishment of a riparian buffer zone through fencing and the education of landowners relative to fluvial processes associated with the river. It is important for farmers to understand that maintenance dredging does not stop flooding it merely alleviates it. An understanding should be sought on representative values put on the loss of biodiversity versus a proportion of a field being flooded for a short period of time.

There are two plausible financial options open to farmers/landowners when establishing buffer zones on their land. There is REPS and NPWS Farm Plan Scheme. In reference to the size of buffer zones, the reality is that farmers will often only undertake what is necessary under the rules of relevant schemes. There are a range of buffer zone designs relative to differing landuse practices within river catchments though it is applicable in the case of the upper Delvin that a 10m buffer zone would be adequate to assist in protecting both the physical and chemical properties of the river channel.

Through Teagasc, a REPS 4 payment is available on River Special Areas of Conservation **or any river where salmon or trout breed**, through the Riparian Zone Supplementary Measure paying €850 / hectare up to 4 hectares.

<u>Outline of Buffer Zone Methodology</u>

A buffer zone where no agricultural activity takes place is fenced off. This extends between 10 – 30 metres with a maximum area of 4 hectares in the case of salmonid and freshwater crayfish rivers. The area must be permanently fenced by the end of year one (non-electric) to exclude livestock but with suitable entry points by hung gates to facilitate machine entry for maintenance work and stiles for access to fishing. Riparian zones cannot be established on commonage, scrub, woodland or other areas not currently under agricultural use. Areas designated under this measure cannot receive either REPS basic payment or Natura rate payment. They cannot be included as forage area under Single Farm Payment applications.

<u>Maintenance</u>

The scheme is to permit vegetation to develop naturally within the zone. Farmers are not allowed to apply fertiliser or pesticide except with the permission of the National Parks and

Wildlife Service or Central Fisheries Board. Vegetation such as alder and scrub should be controlled to prevent closure across the channel canopy. Tree planting on up to 50% of the riparian zone with the following species is recommended - oak, beech, willow, birch, ash, whitethorn, blackthorn or elder. Conifers cannot be planted.

NPWS have their Farm Plan Scheme, which offers more flexibility for farmers than the REPS scheme. Information on this scheme is available on their website at www.npws.ie.

The use of fertilisers, the management of slurry, animal and domestic effluent and the use of biocides in the upper reaches of the catchment is also a major limiting factor not just for the upper reaches, but it is believed, for the entire river. Prosecution of farmers or landowner failing to comply with legislation may be an effective deterrent.

The Bartramstown River has been dredged and resectioned in the lower end of the watershed where it joins the Delvin River; however upstream the river has a natural riffle-pool-glide configuration with adequate gravels for salmonid spawning. Protection would primarily be focused on the physical attributes of the river and any dredging or resectioning would have a devastating impact on all instream biota and the riparian zone. It would be advisable to monitor all work on tributaries of the Delvin as it is a regular occurrence for piecemeal drainage and dredging to be undertaken on these small watersheds with no forethought to the long term damage done. In many cases extreme drainage in small streams does irreparable damage and generally these streams will not regenerate without physical work which is both time consuming and financially unviable. The recommendation is to alert farmers and landowners that no piecemeal resectioning/dredging should be undertaken without notification and approval of Fingal County Council.

Reach 3

The impact of the two waterfalls is the isolation of fish and aquatic communities upstream of the obstructions. The primary limiting factor of the falls relates to fish kills, habitat abuse and chronic water quality problems upstream of the falls that may have caused some species to no longer exist and the restriction of migration to re-colonise.

There is no action that can be taken to alleviate the physical influence of the falls. However, should future management policies prevent or reverse negative influences in the upper reaches of the catchment (and subject to electrofishing surveys showing the absence of salmonids), there may be merits in the re-introduction of brown trout.

This measure may also serve as an interesting public-relations exercise to highlight the critical state of the river's biodiversity and stimulate public and landowner interest.

Reach 4

A key management strategy, as previously discussed, is non-structural natural recovery. However, Reach 4 is the main exception to this policy. The quarry works and associated site use demands that active intervention is employed to prevent further damage to the watercourse. It is imperative that a structured plan involving re-profiling, revetment and landuse is undertaken to stabilise embankments and riverbanks in the impacted area. Immediate management should involve silt/sediment interception and within 2009, the embankments should be adequately stabilised and the riverbanks planted with suitable species. Bank revetment works are recommended here and natural materials should be used in order to provide both bank and stream protection but also a long-term living bank area.

Reach 5

The careful management of present and future landuse and associated practices is the key to maintaining the quality of the physical habitat within this reach as well as and improving the factors impacting negatively upon the chemical properties of the river. This will ensure at a minimum, the maintenance of the current status of the reach and over time will improve the biodiversity of the river, riparian zone and floodplain habitats.

The landuse throughout reach 5 is predominantly grazing of cattle and horses. Currently, landuse practices are not seriously impacting upon the physical nature of the river and the landowners are adapting their agricultural practices to the natural processes of the river. This situation must be maintained and could be improved by the farmers/landowners entering and / or strictly adhering to the terms and conditions of REPS or the NPWS Farm Plan Scheme. There will certainly be nutrient rich run-off arising from the surrounding land post-fertilisation and through stock, and these chemical impacts would be greatly reduced by an established buffer zone of 10m or more.

There is a high degree of natural channel sinuosity in this Reach and it is imperative that this is maintained to conserve both instream and riparian habitat diversity. Any physical modification of this section will have both specific and cumulative negative effects on the Delvin River not just in this Reach, but also the remainder of the catchment. Effectively, farmers should be praised for not attempting to modify the river in this section and encouraged to join a scheme that will enable payments for the establishment and maintenance of buffer zones.

Reach 6

In general this reach is providing a wildlife corridor through the village of Stamullin, and has not suffered extensively from the pressure of urbanisation. However there are sections, particularly at the rear of an apartment development, wherein the connectivity has been disturbed and efforts could thus be made to enhance the riparian zone for the movement of animals.

In respect of landuse, the paintball business proprietors have a requirement to address the impact of participants on the bank of the river. A substantial length of the bank top has been poached and simply requires an exclusion zone adjacent to the river.

Again, protection of the river, the riparian zone and the floodplain from human interference will be the key to preserving and enhancing the river corridor. The establishment of a buffer zone as outlined for Reaches 1 and 2 would be of great benefit in several areas of this reach. Careful fencing of areas close to human population could allow for the naturalistion of some riparian areas that will serve as sites of pleasing aesthetics as well as functioning habitats.

Reach 7

Human actions, though easily reversible, may once more be regarded as the primary contributors to physical habitat degradation in this reach.

The establishment of buffer zones through adequate fencing and changes in maintenance protocols will benefit both the stability of the bankside structure and increase species diversity. Fencing for such a buffer zone needs to be a minimum of 2m back from the bank-top, this is to facilitate realistic management objectives that may be implemented by the landowner/s. Should the landowner/s wish to enter either REPS or the Farm Plan Scheme then extensive buffer zones may be established. The management protocols for the buffer zones are clearly delineated by both Teagasc and NPWS. It is important that these buffer zones are maintained (i.e. selective pruning/pollarding of trees) to prevent tunnelling of the river channel which can also create erosion problems due to lack of vegetation on bankside through over-shading.

Removal of conifers within the immediate vicinity of the river bank is a specific task that should also be undertaken

Reach 8

From Gormanston Bridge to the estuary, the physical condition of the river and associated habitats are relatively good. There may be a necessity to improve indigenous vegetation by establishing buffer zones in some sections. However, it is more immediately important to monitor landuse and landuse changes within this area.

4.6.6 Establishment/Maintenance of Wildlife Corridors on the Delvin Catchment

Throughout the catchment, significant pressures on the land from agriculture (intensive in places) and urban development have (in some sections) restricted wildlife to discrete areas. This has resulted in small populations of animals and plants, unable to move within the landscape, thus vulnerable to the threat of extinction at any one site.

Wildlife corridors are a means of physically linking habitats, which allow species to move between otherwise isolated areas. Such corridors can provide shelter, food and possibly breeding sites and enable species to cross hostile areas, expand their range and colonise new sites.

As part of the survey, the authors identified areas of more valuable habitat to riparian species and important to the future ecological well-being of the Delvin. These are briefly described below.

- In Reach 2 - from the top of the reach at Glebe East to the freshly dredged section above Bodingtown Bridge; the river channel, riparian zone and floodplain are connected and the associated habitats are attracting a diversity of flora and fauna which is generally absent throughout Reach 1 and the lower end of Reach 2. This area has a high value in terms of species mixture and habitat.

- Reach 3 (the waterfalls) does have merits as a ‘stepping stone’ as a section of the river channel has been formed into a lake and the water has been impounded from the lower waterfall to the bottom of the waterfall opposite the sewage treatment plant. The riparian zone is primarily mature broadleaved woodland with steep sided valley slopes and is an interesting habitat due to topography, vegetation and river flow dynamics. This area may attract a range of species that are adapted to a lacustrine environment, though the impact of the migration barriers may denote assistance required to kick-start certain aquatic species.

- Throughout most of Reach 5, there is vegetation providing good structural integrity to the river channel. However, the lower end of Reach 5 approaching Stamullin, has an established floodplain with wetland areas on the LHB. This area runs from Gibblockstown to the bridge crossing the Delvin at the townland of Milestown to the south of Stamullin.

- In Reach 6 there is an area of impounded channel and associated wetland immediately to the south of Stamullin village at the rear of a housing development. This area is very important in promoting biodiversity within the river corridor in an urbanised area. There may also be options to increase the range of the wetland habitat throughout the floodplain in this section.

- Within Reach 8 (Knocknagin) there are areas of well established buffer zones along the river that are providing not only a buffer against agricultural practices but also a refuge for a diversity of flora and fauna and physical protection for the river channel. These should be protected and encouraged and any opportunity to expand these zones through Teagasc or NPWS grant initiatives should be pursued.

The Delvin River is particularly suited to the role of wildlife corridor as it is generally the only significant semi-natural environment in intensively farmed or urbanised areas. Thus, a river rehabilitation project will help to maintain and improve these connections in the landscape.

Habitat fragmentation has been an important cause of decline for many key biodiversity species. Effective landuse policies and practices need to be designed to make it easier for wild plants and animals to thrive in, and move through sections of the Delvin catchment. The Fingal Biodiversity Plan represents an opportunity to address landuse issues within this catchment and to create and maintain viable wildlife corridors. These may also be significant in relation to impending climate change – species need to be able to adapt by moving to new areas which can provide their ecological requirements, in order to survive.

4.6.7 Invasive Species

Non-native invasive plant species can negatively impact upon the biodiversity of an area. In Ireland, three of the more common are Japanese knotweed (*Fallopia japonica*), giant hogweed (*Heraclium mantegazzianum*) and Himalayan balsam (*Impatiens grandiflora*). Giant hogweed is also a danger to human health as the sap is phototoxic, i.e. injuries can be caused to the skin when the sap is exposed to sunlight.

Although three species, Japanese knotweed, giant hogweed and cherry laurel were present on the Delvin River, it would be misrepresentative to state that these plants were currently having a highly negative impact. The plants were either isolated or in discrete clumps such as the Japanese knotweed and cherry laurel immediately above the bridge in Naul. It is recommended that these areas are suitably treated and that vigilance is maintained to prevent further colonisation.

5. Conclusion

5.1 Walkover Study Conclusion

Extensive modification, some dating from the late 19th century is a feature of the upper reaches of the Delvin. There has been severe habitat loss through activities such as straightening and over-deepening. Strong evidence of nutrient enrichment was observed on several of the upper reach sections. Drainage, lack of riparian habitat and cultivation close to the channel would account for much of this. The substrate of the upper reaches was frequently found to be unsuitable for salmonid habitat. However, some naturalisation of the corridor was observed and a number of different habitats such as treelines re-establishing. As the river approaches Naul, habitat improves but is threatened by major dredging works that were observed. A natural waterfall is a key feature of the river, serving to create distinct riverine environments above and below it. This would prevent migration of instream fauna as well as isolate existing communities. There is however, opportunity for hydroelectricity to be generated here. A wastewater treatment plant discharges below the waterfall but it is not thought to have severe impacts upon water quality. Below this, the river has been artificially modified to create a pond, waterfall and thus power a private hydroelectric scheme. The legitimacy of this should be investigated, as this feature will also have a negative impact on the stream.

A quarry and associated waste site north of Naul poses a real risk to the river quality downstream. This risk is immediate and could involve the discharge of silt and sediment into the river during heavy rain or spate. The site requires immediate investigation. As the river approaches Stamullin, the highest quality habitats are found. This is evidenced by unmodified channel, diverse vegetation and stream configurations. The lack of sightings of any fish species is of some concern. The water quality at this site, arising from inputs upstream is thought to be the major limiting factor in this area. The extent of natural and maintained buffer zones in this area was noteworthy. Landowners should be encouraged to maintain or improve this situation.

As the river passes Stamullin, the greatest proximity of the Delvin to a built-up area is found. Impacts from this area do not appear to be high and a buffer zone of riparian vegetation exists for some part of this. Some reinforcement exist here in the form of gabions which are rare throughout the river corridor. A sluice gate here maintains a wetland area in use by wildfowl. A fish pass may be added to this. Northeast of Stamullin, erosion by livestock was recorded, along with the effects of this negative impact. Bank erosion and poor riparian habitat were noted within the grounds of Gormanston College. In both of the above instances, the establishment of buffer zones and replanting would greatly benefit the river.

A good diversity of instream and riparian habitats were observed between Gormanston and Knocknagin. Although some reinforcement works have taken place, these appear not to have impacted negatively. Spawning beds and nursery areas are present in this stretch and it is likely that seatrout spawn here. This was the only area where any evidence of angling pressure, albeit of little significant impact, was observed.

It is worthwhile to summarise some of the above findings as follows:

- The upper reaches of the river (above Naul) have been highly modified and much habitat lost;
- Although some habitat regeneration was seen, water quality remains a serious limiting factor; due to drainage from adjacent lands
- An earthworks facility requires immediate action as it has been poorly finished and maintained and threatens the river;

- Two waterfalls exist which serve to isolate the upper and lower reaches. One of these requires investigation.

- Habitat quality downstream of Naul is generally far higher than in the upper reach. Despite this, water quality appears to be limiting the value of the river for fisheries.

5.2 RHS Conclusion

The first three sites surveyed in the upper reaches of the river showed the most extensive and drastic modification and consequent habitat loss. This was most severe at Site 3 (Cockles Bridge) where the channel was cut to a uniform shape in bedrock and preventing any natural configuration. Excessive overhanging shade compounded the lack of natural components of this site. By contrast, management work at the previous site (2) has led to excessive instream macrophyte growth. Sites 4 and 5 show signs of modification which include a manmade waterfall at the end of Site 5. These sites do show signs of naturalisation and a better substrate. Several invasive or otherwise nuisance species of alien plants were found at Site 5.

Sites 6-8 show the highest quality habitat which includes mature trees and treelines, a complex configuration pattern and variety of habitat types which form a buffer zone. Cattle poaching was seen at Site 7 which could have impacts on spawning in and around Site 8. The river has been modified during its course through Gormanstown College and Site 9. The channel has been reinforced and possibly resectioned here. Although uses of the land here are not intensive, improvements could be made for the protection of the stream such as creation of buffer zone. Site 10 showed some evidence of reinforcement but no remaining negative impacts from this were observed. The vegetation at this site was semi-natural and an informal buffer zone exists through the existence of this in several areas. There were many mature trees noted. The configuration within the channel includes pools, riffles and suitable salmonid spawning areas.

5.3 Water Quality Review

The biological sampling of the river undertaken by the EPA has consistently shown slight or moderate pollution throughout the course of the river. The site at Bodingtown Bridge has been found to be moderately polluted on most occasions. Downstream at Gormanstown Bridge the river was classed as Q4 (slightly polluted) on two occasions since 1998 . The mid-river site northwest of Forty Acres (Site 0250) however, has been classed as Q4 on the three most recent of the four sampling events. A sustained improvement in overall water quality is suggested by these results.

A substantial body of physicochemical water quality statistics was reviewed for the Delvin River from programmes from 1998-2008. Most recent data on Phosphate (P) concentrations show that the river has exceeded target quality values several times and at all monitoring sites. While an improvement over the last four years (since 2004) has been noted, the river has yet to achieve target standards. Data over a wider range of parameters based on (WFD) sampling in 2008 showed a broad improvement over the preceding year (2007) when nutrient levels (e.g. P and Nitrite) were recorded as being in excess of those required for salmonid species. Monitoring of dangerous substances from 2006-2008 showed no evidence of pollution with these substances. Data from the National Rivers Monitoring Programme (from 2004) showed that while evidence of organic pollution existed at several sites, this was not serious in nature and generally allowed for suitable quality habitat for salmonid species. Data from the same programme over the preceding period (2001-2003) showed further evidence of organic pollution. Nitrites in particular, exceeded salmonid standards throughout this period and two trends which indicate (organic) pollution events were noted. For the period from 1998 to 2000, data from Meath County Council showed that organic pollution was common, with nitrite and ammonium exceeding guide limits on many occasions.

5.4 Habitat Assessment at Reference Sites

While some degree of habitat modification can be seen at all sites, this is least pronounced at Site 3 (Stamullin). The other sites showed evidence of channel works and this was refected in the vegetation communities surveyed at each. Water levels at time of survey did not allow for sufficient macrophyte and lower plants to be observed and assessed. Bankside vegetation was seen to be most diverse and well-developed at Site 3. A mature treeline, tree and shrub regeneration and a greater surface area of bank all contribute to the quality of this part of the river corridor. There is also a 'buffer zone' on both banks in the form of wet grassland (left bank) and a shallow embanked area on the right. Site 1 (Moorepark) showed the poorest habitat quality overall. This is largely a result of channel modification but also landuse on one of the banks and the incumbent grazing pressure. Habitat quality at Site 2. (Bodingtown Bridge) was slightly higher, having a more developed in-stream flora and a more diverse community of plants on margins and banks. Earthworks including sand and gravel extraction have taken place at this site but these works do not appear to have had a significant impact on stream habitat quality.

Despite modifications, substrate quality was sufficiently high to allow for representative kick-sampling to be carried out at each site. The results of this sampling also reflected the higher habitat quality at Site 3, the sample gained from this site had a significantly greater number of species/taxa represented than the other reference sites. This sample also contained proportionately more C Group invertebrates than the other two sites, as well as the only B Group invertebrates recorded in the project. This part of the watercourse was therefore assigned a value of Q3. While more taxa were found in Site 2 than at Site 1, the majority of these (a little over 52%) were tolerant (Group D) and some more pollution-tolerant species were also recorded. While the overall classification which may be inferred from the data is Q2 (indicating heavily polluted waters), it should be noted that a wide range of Group C invertebrates which would not be associated with such pollution levels were present albeit in smaller numbers. The kick sample gained from Moorepark indicated low levels of organic pollution or enrichment and Group C invertebrates were by far in abundance. This site was assigned a value of Q3.

It is highly likely that the dredging works upstream of Site 2 have had a significant negative impact upon the macroinvertebrate populations. This could have arisen as a result of substrate siltation causing oxygen depletion, coating of stones, blockage of spaces between substrate materials reducing the respiration and feeding ability of some insect larvae. These effects could well have contributed to the relatively poor invertebrate fauna found at this site.

An analysis of the macroinvertebrate taxa found per site indicate that ecosystem functioning is poor. There appears to be a crucial lack of diversity both within and between the feeding groups. Enrichment is indicated which, in tandem with habitat modification and loss appears to be a limiting factor in terms of maintaining ecosystem function.

The low macroinvertebrate diversity of the Delvin was illustrated by the poor correlation of the macroinvertebrate species and taxa found with those recorded in the RIVTYPE programme. Site 3 showed the best correlation but this too was weak, just under 18% of the RIVTYPE reference species or groups being found at this site.

The assemblages of benthic diatoms analysed for all three sites indicate excessive enrichment of the watercourse. A relatively low number of species or taxa were found by comparison with the reference taxa listed by the EPA for Type 32 rivers. This poor correlation reinforces the poor ecological quality and indeed potential in the short-term for the Delvin.

Insufficient species of macro-algae were found in analysis for comparison with RIVTYPE reference conditions. It is believed that extremely high rainfall levels during the summer of 2008 as well as scouring effects from recent river spates contributed to this low sample yield.

5.5 Protected Species

Sightings of characteristic riverine species such as kingfisher, otter, grey wagtail and dipper were far lower than might be expected when it is considered that the entire river corridor was studied. All of these species (and several others) are highly dependant upon areas of undisturbed river bank for breeding and refuge. Based upon the results of the RHS and walkover study it is believed that the modifications to the banks of the Delvin in the upper reaches are the main contributor to lack of utilsation of this river corridor by the species under survey. Lesser contributing factors are believed to be a shortage of prey species due to both physical and physicochemical factors. These latter factors though are believed to be the over-riding factor for the low numbers of these species observed. The otter is unlikely to be found upstream of the waterfall at ING 13464 / 61173 as this is a major barrier to the migration of both fish and invertebrate species. However, its absence from the lower reaches is an alarming indicator of the Delvin's inability to support a significant fishery and thus a larger predator.

5.6 Bats

A dedicated bat survey was undertaken at 11 no. points along the Delvin at the end of September 2008. This survey revealed four common species, the most widespread of these, the common pipistrelle was found at 5 no. bridges. The soprano pipistrelle was found to be next most widespread, found at 4 no. bridges. The other two species, Daubenton's bat and Leisler's bat were both only noted at one part of the river. Bat species was described as moderate, finding four of the ten known Irish species. Daubenton's bat in particular was thought to be underrepresented in this present work. Overall, results were found to show low individual numbers of bats.

5.7 Fisheries

Only one fish species, the three-spined stickleback was observed during all of the survey works undertaken on the river. Although there were reports (Pers. Comms: Var.) of trout in the upper (above Naul) reaches of the and attempting to pass the (lower) waterfall, there was no evidence of these found. Indeed, little salmonid habitat exists in the upper reaches. No crayfish were observed at any of the reaches.

The significantly better habitat of the lower reaches make the river below Naul suitable for a range of fish species including salmonids. However, poor water quality appears to prevent this part of the river being a productive environment for indigenous species. Anglers have reported some catches of trout and seatrout in the Knocknagin area. They have also released fish stocks (of trout) in this area. It is recommended that as part of any river improvement works that the local authorities work in co-operation with these anglers as the participation of groups such as these greatly improves chances of project success.

5.8 Recommendations for River Management: Actions and Strategies

A summary of the actions required to improve the ecological situation of the Delvin is given in tabular format. Of these five of these are 'Priority 1' actions. That is, it is recommended that these be undertaken within one year of the issue of this report. Two are to be undertaken within two years of issue and four within three years.

Actions were submitted in the context of overall ecosystem functions as well as economic feasibility of the measures. The main aim of the proposed actions is to address the negative anthropogenic activities while maximising the regenerative capacity of the river corridor. For example, bank stabilisation through revetment using native tree species is proposed on a reach where the bank has been compromised and siltation and sedimentation are a threat.

Encouragement of farmers and other landowners to actively participate in biodiversity enhancement or conservation measures is recommended. Prosecution of offending landowners, in particular where water quality is directly impacted upon may be required. Some land managers and users (e.g. at Gormanstown College) may be encouraged to take

an active part in ensuring bank protection with the installation of buffer zones. Existing buffer zones (e.g. at Reference Site 3 at Stamullin) should be maintained through positive cooperation with the farmers of the adjacent lands.

Scope exists to create and maintain wildlife corridors at several locations. Local cooperation should be sought in this. The Delvin presents itself as an ideal medium for such a corridor, providing much semi-natural and naturalising habitat within areas of agriculture and urban use.

Management of exotic invasive species is not a priority for the management of the Delvin. However, removal of some isolated assemblages of plants such as Japanese knotweed and Himalayan balsam is recommended in the medium term. Vigilance will be required to ensure that such species do not become a threat to the future biodiversity of the Delvin.

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