

SERIES OF ECOLOGICAL ASSESSMENTS ON ARTERIAL DRAINAGE MAINTENANCE No 5

Ecological Impact Assessment (EcIA) of the Effects of Statutory Arterial Drainage Maintenance Activities on Water Courses of Plain to Montane levels with Aquatic Vegetation (*Floating River Vegetation*)



**Office of Public Works
Environment Section
West Region Drainage Maintenance
Headford
Co. Galway**

**Telephone: +353 (0)93 35 456
Fax: +353 (0)93 35 631**

Version: 0607

Disclaimer

No part of this publication should be taken as a statement of Office of Public Works policy.

The views expressed by the author(s) are not necessarily those of the Office of Public Works. The user of this report assumes full responsibility for any policy decisions and for any action taken as a result of any conclusions contained herein. Neither the Office of Public Works, nor the author(s) may be held liable for the outcome of any policy decision or action taken by the users of this publication.

Foreword

This Ecological Impact Assessment follows on from the strategic approach outlined in

“Series of Ecological Assessment on Arterial Drainage Maintenance No. 1: Screening of NATURA 2000 Sites for Impacts of Arterial Drainage Maintenance Operations.”

It examines the impacts of statutory arterial drainage maintenance activities on water courses of plain to montane levels with aquatic vegetation (*floating river vegetation*), outlines measures to mitigate any negative impacts, and possible enhancement opportunities.



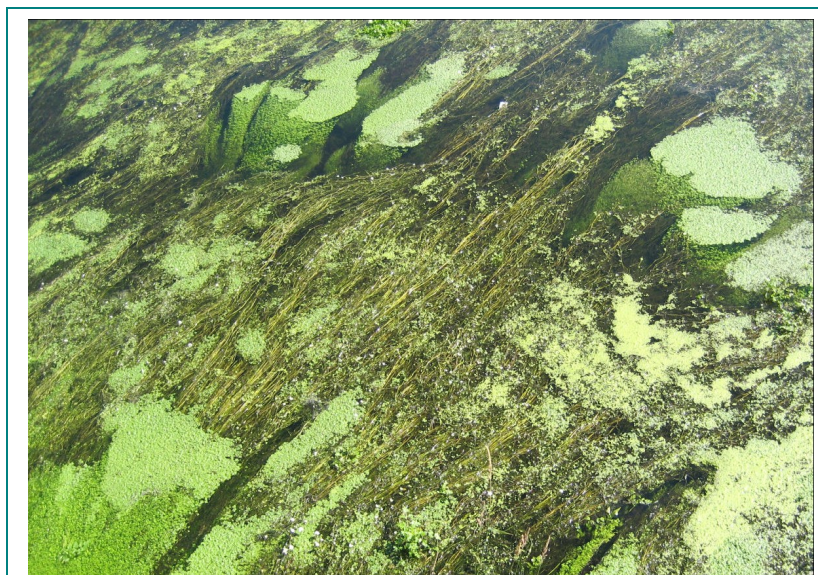
BBETTER
ENVIRONMENTAL &
ENGINEERING
SERVICES Ltd.

22 The Garden Village,
Portlaoise,
Co. Laois.

Tel/fax: 057 8672599
Mobile: 087-6968600
VAT No.: IE64201841

beesltd@eircom.net

**Ecological Impact Assessment (EcIA) of the Effects of
Statutory Arterial Drainage Maintenance Activities on
Water Courses of Plain to Montane Levels with Aquatic
Vegetation (Floating River Vegetation).**



Floating river vegetation on the Bandon River 2006

Directors:

N. Ní Bhroin
BSc (NUI)
PhD (NUI)

M. Castiaux
BSc (Geology)
MSc (Env. Science
& Management)
Company Secretary

Niamh Ní Bhroin BSc PhD

Better Environmental and Engineering Services Ltd.



Registered in Ireland No. 400184
Registered office 22 The Garden Village, Portlaoise, Co. Laois

Table of Contents

Executive Summary

<u>TABLE OF CONTENTS.....</u>	<u>2</u>
<u>1.0 INTRODUCTION.....</u>	<u>1</u>
1.1 HISTORICAL BACKGROUND AND FUNCTIONS OF STATUTORY ARTERIAL DRAINAGE.....	1
1.2 LEGAL AND POLICY CONTEXT FOR THIS ECOLOGICAL ASSESSMENT.....	2
1.3 OBJECTIVE AND SCOPE OF THE PROJECT.....	3
<u>2.0 DESCRIPTION OF THE SPECIAL AREAS OF CONSERVATION (SACS).....</u>	<u>4</u>
2.1 DESCRIPTION OF THE CONSERVATION ASPECTS.....	4
2.2 SITE ELEVATIONS	8
2.3 SITE INTEGRITY	9
2.4 IDENTIFY OTHER LINKED ENVIRONMENTALLY SENSITIVE ASPECTS.....	11
<u>3.0 ECOLOGICAL ASSESSMENT OF WATER COURSES OF PLAIN TO MONTANE LEVELS WITH AQUATIC VEGETATION EU 3260.....</u>	<u>13</u>
3.1 MONITORING AND MEASUREMENTS COMPLETED (METHODOLOGY).....	13
3.2 DISTRIBUTION AND EXTENT OF FLOATING RIVER VEGETATION.....	15
3.3 GENERAL GROWTH CHARACTERISTICS OF FLOATING RIVER VEGETATION.....	22
3.4 LIFE CYCLE OF FLOATING RIVER VEGETATION.....	24
3.5 PARAMETERS AFFECTING SPECIES DISTRIBUTION.....	26
3.6 GROENLANDIA DENSA ON THE BACK DRAINS OF THE RIVER SHANNON.....	27
<u>4.0 DESCRIPTION OF MAINTENANCE OPERATIONS CARRIED OUT BY THE OFFICE OF PUBLIC WORKS.....</u>	<u>31</u>
4.1 ENVIRONMENTAL DRAINAGE MAINTENANCE (EDM) PROGRAMME.....	31
4.2 METHODS OF AQUATIC WEED CONTROL EMPLOYED BY THE OFFICE OF PUBLIC WORKS.....	33
4.3 RIVER CORRIDOR WATER DYNAMICS.....	35
4.4 PHYSICAL, CHEMICAL AND BIOLOGICAL FEATURES OF WATERCOURSES WITH FLOATING RIVER VEGETATION..	39
<u>5.0 MITIGATION MEASURES.....</u>	<u>41</u>
5.1 MEASURES FOUND TO INFLUENCE FLOATING RIVER VEGETATION.....	42
5.2 INFLUENCE OF CURRENT ENVIRONMENTAL DRAINAGE MAINTENANCE WORK PRACTICES.....	44
5.3 SPECIFIC OFFICE OF WORKS MITIGATION MEASURES AND OTHER STATUTORY BODIES.....	45
5.4 THE IMPACT OF FLOATING RIVER VEGETATION ON RISING WATER LEVELS AND FLOW RATE.....	47
<u>6.0 CONCLUSION AND SUMMARY.....</u>	<u>53</u>
FURTHER STUDIES RECOMMENDED.....	54
APPENDIX A - SPECIAL AREAS OF CONSERVATION CLASSIFICATION OF HABITAT TYPE.....	I
APPENDIX B – SITE ELEVATIONS SURVEYED.....	IV
APPENDIX C – HABITAT CLASSIFICATION OF SURVEY SITES.....	VII
APPENDIX D – MAPPING OF FLOATING RIVER VEGETATION SURVEYED.....	X
APPENDIX E – PHYSICAL PARAMETERS RECORDED AT SURVEY SITES.....	XIX
APPENDIX F – DESCRIPTION OF FLOATING RIVER VEGETATION PLANT SPECIES.....	XXIII
APPENDIX G – ENVIRONMENTAL DRAINAGE MAINTENANCE GUIDANCE NOTES.....	XXVI

Executive Summary

This Ecological Impact Assessment examines the effects of statutory Arterial Drainage Maintenance activities on floating river vegetation (*Ranuncion fluitantis* and *Callitrichio-Batrachion*). The screening report published by the Office of Public Works has identified the study of floating river vegetation as part of a recommended Ecological Impact Assessment series to comply with the European Communities (Natural Habitat) Regulations, 1997. Habitat code 3260 Water Courses of Plain to Montane Levels with Aquatic Vegetation along with specific aquatic floral communities (floating river vegetation) are provided legal protection under EU law. The Screening Report has highlighted Floating River Vegetation as a conservation aspect in five candidate Special Areas of Conservation.

A number of features were recorded during the field survey for each river system. The surrounding habitat type, survey location and physical characteristics of each site including shade, riverbed, water depth and water turbidity. In biological terms floating river vegetation species diversity, abundance, extent, environmental adaptation, life cycle and growth characteristics were observed and recorded.

As part of the Ecological Impact Assessment it was important to understand the process of Arterial Drainage Maintenance carried out by the Office of Public Works. The collaborative initiative with the Central Fisheries Board known as the Environmental Drainage Maintenance (EDM) programme was assessed. Methods used by the Office of Public Works to remove aquatic vegetation were examined. Also considered was the influence of plant growth on riverine flow dynamics.

The survey showed that floating river vegetation was present in most of the river systems studied. No floating river vegetation was recorded on the River Mague, probably due to tidal influence and none on the Owenriff River due to rising floodwaters. Of the parameters investigated shade, water depth and water flow influenced community diversity while water quality, adjoining landuse, riverbed substrate and habitat encroachment by terrestrial plants affected floating river vegetation. The absence of flowering structures, at the time of the survey, on *Ranunculus* sp. in particular, resulted in the assignment of a provisional rather than a true identification.

The level of significance of the likely impacts of Arterial Drainage Maintenance on floating river vegetation was assessed. Arterial Drainage Works, which involve the excavation of the riverbed, are likely to cause a significant negative impact on floating river vegetation. Arterial drainage maintenance carried out in accordance with the Environmental Drainage Maintenance (EDM) programme causes a minor negative impact. The mitigation measures proposed will tend to lead to a minor positive impact.

1.0 Introduction

This study was commissioned by the Office of Public Works in 2006 to assess the ecological impact of Arterial Drainage maintenance activities on floating river vegetation associated with watercourses designated under European Habitat code 3260 (EU code 3260) as detailed in the framework document “Screening of Natura 2000 sites for Impacts of Arterial Drainage Maintenance Operations”, Office of Public Works, 2007. To fully appreciate the importance of this and other ecological impact assessments for the Office of Public Works, it is essential that the maintenance work undertaken by the Office of Public Works be clearly understood. In doing so this chapter will focus on the Office of Public Works past and present, provide an overview of the legal obligations and commitment to environmental policy to which the Office of Public Works operate and finally an overview of the objectives of this ecological impact assessment. Through the provision of a “bigger picture” in terms of environmental dynamics, it is hoped that Environmental Drainage Maintenance will continue to be developed in a progressive, pro-active manner to ensure arterial drainage maintenance works are performed in an environmentally friendly manner due to increased awareness of species diversity and practical habitat enhancement measures.

1.1 Historical Background and functions of statutory arterial drainage.

The Office of Public Works or the Board of Works as it was known at the time was established in an 1831 by an Act entitled An Act for the Extension and Promotion of Public Works in Ireland. As part of its new role it also took over that of the Directors General of Inland Navigation, the Fisheries Commissioners, the Postmaster General and Civil Buildings Commissioners. Not only did the Board of Works have a large expenditure of public funds but it also operated a lending agency to fund the establishment, extension and or improvements works.

Early inland navigation projects undertaken by the Board of Works included the Upper Shannon, Lough Ree, and Lough Derg along with the Tyrone, Maigue and Boyne navigations. In 1842 arterial drainage schemes were commenced; providing drainage loans to facilitate the drainage of land. The Great Famine of 1846 led to an increase in the rate of arterial drainage schemes, as did the Landed Property Improvement Act, 1847, in the West of Ireland. Severe flooding of the lands adjacent to the River Shannon in 1861 resulted in the Shannon Act of 1874 to bring about flood prevention (National Archives of Ireland).

The Drainage and Maintenance Act of 1924 identified with the need to carry out repair, maintenance and improvement of drainage works within Saorstát Éireann (National Archives of Ireland). Works completed between 1945 and 1995 include:

- 34 arterial drainage schemes on river catchments
- 5 estuarine embankment schemes (benefiting 650,000 acres of land)

- 11,505km of rivers and streams, collectively known as channels
- 733 km of tidal and river embankment
- 18,500 bridges. A significant portion of these bridges are road bridges where Local Authorities are responsible for the structural integrity and the Office of Public Works are responsible for flood conveyance.
- 742 sluices
- 9 pumping stations (Office of Public Works website).

175 years on, the work undertaken by the Commissioners of Public Works is evolving to meet the challenges of the 21st century. Along with the maintenance of drainage schemes, embankment systems, bridges, sluices and pumping stations, flood management and environmental drainage maintenance are elements of modern policy which the Commissioners are incorporating as part of arterial drainage maintenance programmes (Office of Public Works, 2007).

1.2 Legal and policy context for this ecological assessment

In an effort to maintain biological diversity within European Union member states, a series of Directives was put in place to ensure conservation and protection of endangered and rare species and their habitats. The following is a selection of the European and Irish laws adopted with respect to nature conservation. A function of the Wildlife Act, 1976 was to conserve and protect both flora and fauna by developing wildlife refuges associated with land, inland waterways and marine environments. Council Directive 79/409/EEC provided protection for wild birds naturally occurring in the European Union including birds, their eggs, nests and habitats i.e. Special Protection Areas (SPA). Article 3 of the Council Directive 92/43/EEC undertook the development of an ecological network of Special Areas of Conservation, namely Natura 2000 by placing an emphasis on habitat conservation. Together these Directives and Acts were transposed into Irish Law and became known as the European Communities (Natural Habitats) Regulations, 1997 i.e. the conservation of natural habitats and of wild fauna and flora (Habitats Directive).

As outlined in Section 31 of the Regulations it is required that all works undertaken by the State within a European site must undertake an appropriate assessment outlining the impact of the work with respect to the conservation aspect of the site. To comply with the above legislation the Office of Public Works has published a report titled “Screening of Natura 2000 Sites For Impacts of Arterial Drainage Maintenance Operations”.

The report aims to develop a strategic approach to fulfilling the legal requirement of environmental assessment prior to works undertaken by the Office of Public Works in European sites. By identifying channels that exist in European protected sites the Office of Public Works have identified a number of ecological impact assessments, which specifically relate to protected flora

and fauna. The OPW has a multi-annual programme of studies to meet the requirements identified in the screening report, including in this case floating river vegetation.

Under the Arterial Drainage Act, 1945 and the Arterial Drainage Amendment Act, 1995 the Office of Public Works has a legal duty to maintain all existing channels in “proper repair and effective condition”. In an effort to minimise environmental impact by maintenance work the Office of Public Works have developed an Environmental Drainage Maintenance (EDM) programme with a primary objective to:

“ Identify methods of operation which are both environmentally sensitive and effective from an arterial drainage maintenance viewpoint”. Environmental research undertaken to date in conjunction with the Central Fisheries Board has resulted in the production of guidelines identifying 10 Steps to Environmentally Friendly Maintenance.

1.3 Objective and scope of the project.

This ecological assessment entitled “Ecological Impact Assessment of the effects of statutory Arterial Drainage maintenance activities on Water Courses of Plain to Montane Levels with Aquatic vegetation (Floating River Vegetation) EU Code 3260” has been commissioned by the Office of Public Works in order to comply with European legislation, namely European Communities (Natural Habitats) Regulations, 1997. In keeping with the ethos of the Regulation which deals with the conservation of wild plant and animal species and their habitats, all work undertaken in Special Areas of Conservation (SAC) must lead to the maintenance and restoration of natural habitats along with the flora and fauna communities.

The objective of this ecological impact assessment was to determine the effects of statutory maintenance activities on European sites. The ecological impact assessment focused on floating river vegetation referred to as *Ranunculus fluitantis* and *Callitriche-Batrachion* vegetation which has been found on some of Ireland's freshwater watercourses of eroding / upland rivers FW1 (Fossitt, 2000). During the course of this ecological impact assessment a selection of randomly chosen channels both within and beyond the Special Areas of Conservation were surveyed along with some not maintained by the Office of Public Works. The survey noted a presence or absence of *Ranunculus fluitantis* and *Callitriche-Batrachion* vegetation (see Fig 1), a list of the species where present, surrounding landuse, evidence of recent channel maintenance work and any other observations which may have an impact on this protected habitat.

2.0 Description of the Special Areas of Conservation (SACs)

Special Areas of Conservation were legally established as nature refuges under Article 3 of the Habitats Directive (Council Directive 92/43/EEC). The purpose of this legislation was to develop an ecological network of Special Areas of Conservation across all European Union states that collectively would be known as Natura 2000. In ecological terms there was a legal obligation for each member state to identify, conserve and protect site(s) supporting rare or endangered plants, animals and their habitats (section 1.2). Designation of Irish sites was performed in accordance with the criteria set-out in Annex III of the Habitats Directive.

Some of the selection parameters used by the National Parks and Wildlife Services are:

- Importance of the site in terms of the habitats and species it supports
- Degree of representation of a habitat or habitats within a site to enhance, conserve and preserve habitat diversity.
- Extent of isolation of the population (the more isolated the population the greater the genetic divergence therefore greater genetic diversity).
- Degree of destruction if any that has occurred on the site
- Geographic distribution, frequency and distribution of habitats and / or protected and rare species, presence of a priority habitat and the presence of a habitat or species important or unique to Ireland (National Parks and Wildlife Services website).

Currently Ireland has proposed 420 sites as candidate Special Areas of Conservation to the European Commission accounting for 10,000 square kilometres of land. The Special Areas of Conservation include priority and important (but not priority) habitats along with protected plant and animal species.

2.1 Description of the conservation aspects

This study focuses on Special Areas of Conservation with the designated habitat of submerged or floating vegetation with low water level during summer and with typically *Ranunculum fluitantis* and *Callitriche-Batrachion* plant species or the bryophyte aquatic moss as a conservation aspect. Flora associated with habitat 3260 includes *Ranunculus saniculifolius*, *Ranunculus trichophyllus*, *Ranunculus fluitans*, *Ranunculus penicillatus* ssp. *penicillatus*, *Ranunculus penicillatus* ssp. *Pseudofluitantis*, *Ranunculus aquatilis*, *Myriophyllum* spp., *Callitriche* spp., *Sium erectum* (or *Berula erecta*), *Zannichellia palustris*, *Potamogeton* spp., and the moss *Fontinalis antipyretica*. *Groenlandia densa* (Opposite leaved pondweed) is also included in the list. The flowering rush *Butomus umbellatus* may be present as part of the bank flora where floating river vegetation has been identified. The occurrence of this species may be an indicator and should be noted (ENUIS website).

Currently twenty-one Special Areas of Conservation are listed on the EUNIS habitat listings that have floating river vegetation as a conservation aspect. Of the twenty-one, only five Special Areas of Conservation overlap with channels maintained by the Office of Public Works namely Lough Corrib IE 0000297, Lower River Suir IE 0002137, River Barrow and River Nore IE 0002162, Lower River Shannon IE 0002165 and the Bandon River IE 0002171 (Table 1).

Site Code	SAC Name	Arterial drainage scheme	Floating river vegetation
0297	Lough Corrib	Corrib Clare, Corrib Headford	Conservation aspect
2137	Lower River Suir	Carrick-on-Suir Flood Relief	Conservation aspect
2162	River Barrow & River Nore	Kilkenny Flood Relief Scheme	Conservation aspect
2165	Lower River Shannon	Ballynacclough, Bunratty-Rineanna, Bushy Island-Martin, Coonagh Embankment, Deel, Feale, Fergus, Foynes, Groody, Maigue Outfall, Mulkear-Ballymackeough, Newtown-Tervoe, Owengarney, Ringmoylan Mellon	Conservation aspect
2171	Bandon River	Dunmanway Flood Relief Scheme	Conservation aspect

Table 1 Information provided by Office of Public Works on drainage schemes in SACs listed.

Although floating river vegetation is a conservation aspect of the Lower River Suir and the River Barrow and River Nore SAC, only relatively short sections of the River Suir through Carrick-on-Suir and the River Nore through Kilkenny form part of the flood relief schemes. Although modification of the watercourses may have impacted upon their conservation status, the flood relief schemes were included in the survey. Details of Priority and Important habitats for each Special Area of Conservation are listed in Appendix A.

2.1.1 Lough Corrib Special Area of Conservation IE 0 000297.

Lough Corrib, situated north of Galway City, is the second largest lake in Ireland. Two diverse sections are evident in the Lake with shallow water on limestone to the south and deep water on granite schist, shale and sandstone substrate to the north. Landuse surrounding Lough Corrib includes agricultural grassland to the south and the east with bog and heath to the north and west. A minimum of six priority and ten important habitats have been identified within the Lough Corrib SAC including floating river vegetation habitat code EU 3260 (Natura 2000).

The main river systems within the Lough Corrib SAC are the River Clare, River Corrib, River Cregg and Owenriff River. Several rivers within the Lough Corrib SAC are known to support floating river vegetation of *Ranunculon fluitantis* and *Callitrichio-Batrachion* species and mosses

are also known to exist. The most documented is the River Corrib with pondweed species *Potamogeton lucens*, *Potamogeton perfoliatus* and *Potamogeton berchtoldii* the dominant floating river vegetation species (Mooney and O'Connell, 1990).

2.1.2 Lower River Suir Special Area of Conservation IE 0002137.

Lower River Suir Special Area of Conservation ranges from the freshwater stretch of river south of Thurles in Co. Tipperary to the point of contact between the three rivers; the River Suir, River Barrow and River Nore. Bedrock of the River Suir includes Upper Palaeozoic Rocks (Lower Carboniferous Visean and Tournaisian), Limestone and Devonian sandstone as the river flows from County Tipperary to County Waterford. A minimum of two priority and five important habitats have been identified on the Lower River Suir SAC including floating river vegetation habitat code EU 3260 (Natura 2000, National Parks and Wildlife Services website).

Tributaries of the River Suir include the Lingaun, Anner, Nier, Tar, Aherlow, Multeen and Clodiagh River. Floating river vegetation recorded on the River Suir west of Carrick-on-Suir includes Pondweed *Potamogeton perfoliatus*, *Potamogeton pectinatus*, *Potamogeton crispus*, Water crowfoot *Ranunculus peltatus* and Milfoil *Myriophyllum spicatum*. Other tributary rivers, the Lingaun and Pil Rivers (Co. Kilkenny) support *Ranunculus peltatus* with the Clodiagh River (Co. Waterford) supporting *Ranunculus peltatus* and *Fontinalis antipyretica* (Natura 2000).

2.1.3 River Barrow & River Nore Special Area of Conservation IE 0002162

River Barrow and River Nore SAC extends from the rivers' sources in the Slieve Bloom Mountain Range to Waterford Harbour crossing the counties of Offaly, Kildare, Laois, Carlow, Kilkenny, Tipperary, Wexford and Waterford. Both rivers cross Old Red Sandstone, Carboniferous shale and sandstone with the River Nore also traversing Limestone Plains, Old Red Sandstone (in the vicinity of Thomastown), and intrusive rocks poor in silica before joining the River Barrow. Landuse surrounding the River Barrow and River Nore SAC is dominated by agricultural activity of grazing and silage. Arable crop production, woodland and amenity areas are also present.

The River Barrow and River Nore SAC consist of two priority habitats and nine habitats of EU importance. Floating river vegetation on the River Barrow consists of Water Crowfoot *Ranunculus* species, Starworts *Callitriche* species, Milfoil *Myriophyllum* species, Pondweed varieties *Potamogeton perfoliatus*, *Potamogeton pectinatus*, *Potamogeton x nitens*, *Potamogeton natans*. As Natura 2000 River Barrow and River Nore SAC designation details were unavailable during the compilation of the report, only limited information was available on species diversity within the SAC (National Parks and Wildlife Services website).

2.1.4 Lower River Shannon Special Area of Conservation IE 0002165

The Lower River Shannon SAC extends from Killaloe to Loop Head / Kerry Head covering one hundred and twenty kilometres. Within the Lower River Shannon SAC there are four significant river estuaries, namely the Shannon, Feale, Mulkear and Fergus along with stretches of freshwater between Killaloe and Limerick. The bedrock of both the River Shannon and the Fergus consist of Carboniferous limestone, Namurian shale, flagstones and Old Red Sandstone. Namurian Rocks and Carboniferous Limestone form the bedrock for the River Feale with Lower Palaeozoic Rocks, Namurian Rocks, Lower Carboniferous Shale and Carboniferous Limestone forming the bedrock of the Mulkear River (National Parks and Wildlife Services website)

Three main rivers flowing into the Lower Shannon Special Area of Conservation are the River Shannon, the Fergus River and the Cloon River. Some other rivers, included in the Lower River Shannon SAC, are the Mulkear and Kilmastulla River tributaries of the River Shannon, the River Feale and the River Maigue. Floating river vegetation recorded on the Lower Shannon SAC include Water Crowfoot *Ranunculus* species on the River Fergus, pondweed *Potamogeton* species and the protected pondweed *Groenlandia densa*. It is highly probable that water crowfoot species, (*Ranunculus* species) are present on the River Shannon but this is still unconfirmed. The aquatic moss *Fontinalis antipyretica* has been identified on all three-river systems (Natura, 2000).

2.1.5 Bandon River Special Area of Conservation IE 0002171

The Bandon River flows from a north to south direction east of the village of Dunmanway in West Cork. The Bandon River SAC encompasses both the Bandon River and a short adjoining section of the Caha River, a tributary of the Bandon River. To the north Old Red Sandstone is the dominant bedrock with Carboniferous Slate to the south of Dunmanway. Peat, podzols and skeletal soils are the main soil types north of the river with alluvial soils and brown Podzolics to the south. In the course of its journey the Bandon River cascades through narrow valleys to the north, meandering through fertile floodplains at Dunmanway and through a broad, flat valley with a reduced flow gradient to the south (National Parks and Wildlife Services website).

Floating river vegetation was identified as an important EU habitat on the Bandon River along with alluvial forest, a priority habitat. Recorded floating river vegetation includes Water Crowfoot *Ranunculus* spp., Milfoil *Myriophyllum alterniflorum*, Pondweed *Potamogeton natans*, four varieties of Starworts *Callitriche hamulata*, *Callitriche obtusangula*, *Callitriche platycarpa* and *Callitriche stagnalis* and the aquatic moss *Fontinalis antipyretica*. *Ranunculus* sp. is reported to be the dominant floating river vegetation on the Bandon River (Natura, 2000).

2.2 Site elevations

In order to assess and understand the habitat range for floating river vegetation, it was important to identify the nature of the watercourses that were chosen for this survey. To monitor river water quality in Ireland the Environmental Protection Agency (EPA) has assigned all significant watercourses a stream order based on the number of tributaries each watercourse has and the order of these tributaries. For those watercourses with no tributary the designation is one, one tributary the designation is two etc. A description of the habitat associated with floating river vegetation in Ireland is commonly associated with eroding / upland rivers. The EPA stream order is cross-referenced with observed floating river vegetation species in chapter 3. This provides an insight into the type of rivers, which provide a suitable habitat for floating river vegetation in Ireland.

The elevations were measured with a handheld GPS unit and so have an error in the order of +/- 5m. Elevations recorded for each watercourse surveyed are included in Appendix B.

2.2.1 Site elevations within the Lough Corrib SAC survey square

Site elevation in the Owenriff River survey square varied from 5M to 168M above sea level, which reflected the type of watercourses surveyed from mountain streams to lowland rivers.

A more lowland gradient was evident in the Clare Galway square from 0M to 13M above sea levels. Similar elevations were evident with the River Corrib and the Headford survey square.

The proximity to Lough Corrib and the demand for arterial drainage is evident due to the low elevations observed.

2.2.2 Site elevations within the Lower Suir SAC survey square.

The elevations recorded in the River Suir Square have a mixture of sea level readings and higher elevations. Similar to a valley system the River Suir square exhibits areas of high elevation namely the surrounding mountains and a lower point namely the valley floor. As the River Suir is influenced by tidal regimes sea level elevations were recorded for the River and some of its tributaries.

2.2.3 Site elevations within the River Barrow and River Nore SAC survey square.

Land elevations of watercourses surveyed in the vicinity of the River Nore recorded the River Nore as the lowest. Only two survey points were recorded as being substantially higher; the remaining survey points were of a relatively consistent elevation.

2.2.4 Site elevations within the Lower River Shannon SAC survey square.

For the most part the elevation of the Mulkear River catchment resembles that of a lowland / depositing river. As it progresses closer to the Shannon estuary the elevation drops to as low as 8M above sea level.

Situated in close proximity and as part of the Shannon Embankment scheme the elevation of the River Maigue at this section rarely rises above sea level. Based on the elevations alone it is very likely that this survey square above all the others will be highly influenced by tidal waters.

The River Feale sample square reflects the variety of land elevations often associated with Co. Kerry. Inland elevations were typical of mountainous areas with the lower elevations recorded at the point where the freshwater watercourses meet with tidal water becoming tidal rivers.

2.2.4 Site elevations of the Bandon River SAC survey square.

Channels surveyed in the River Bandon Square consist of upland sites of higher elevations.

2.3 Site integrity

Human activity and land use adjacent to survey channels has been classified according to the habitat classification described by Fossitt, 2000. Each habitat type found in Ireland has been provided with an identification code, a description of the fauna and flora associated with each habitat and the details of aspects of conservation, species or habitat protection. The full list of the habitats discussed in this section can be found in Appendix C.

2.3.1 Site integrity of the Lough Corrib SAC survey square.

Habitat identification surrounding channels of the Owenriff River catchment was dominated by upland blanket bog (PB2). This was also reflected in floodwaters, which had a characteristic brown peat appearance indicative of surface run-off of bog environments. For a portion of the channels surveyed in the Owenriff River catchment hedgerows (WL1) and scrub (WS1) dominated the riverbanks. Land management practices included improved agricultural grassland (GA1), mixed broadleaf woodland (WD1) and the built environment namely roads (BL3)

Agricultural practices were the primary landuse / land management of this survey square. The type of grassland varied from improved agricultural grassland (GA1) to wet grassland (GS4). Other habitats observed along survey channels included lowland blanket bog (PB3), marsh (GM1), scrub (WS1) and hedgerow (WL1). In general channels, which bordered agricultural grassland, showed signs of bank erosion due to livestock.

The built environment was the dominant habitat on the banks of the River Corrib flowing from the lake through Galway City. Some diverted channels from the main river system passed

through amenity grassland (GA2) for example National University of Ireland Galway green areas and green walkways through the city. Outside the city agriculture was the dominant land use varying from improved grassland (GA1) to wet grassland (GS4). Scrub (WS1) was the dominant shrub vegetation along the channel banks. Earth banks (BL2) were used to describe a riverbank that appeared as a ridge of earth indicative of channel maintenance activity.

2.3.2 Site integrity of the Lower River Suir SAC survey square.

A selection of habitats was observed within the River Suir survey square. Interestingly stone walls classified as stone walls and other stonework (BL1) habitats were frequently noted in association with rivers in this square. Also recorded along the banks of the River Suir in the town of Carrick-on-Suir was the presence of flowering rush (see section 2.1) along the river bank. Habitats designated as Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitriche-Batrachion* vegetation is occasionally associated with bank communities of flowering rush (EUNIS website).



Fig. 1 Flowering rush (*Butomus umbellatus*) on the banks of the River Suir.

2.3.3 Site integrity of the River Barrow and River Nore SAC survey square.

Riparian woodland (WN5), improved agricultural grassland (GA1) and amenity grassland (GA2) were the dominant habitats recorded in the River Nore square. Those riverbanks colonised by riparian woodland suggest the river environs have had little human interference in recent decades. Where agricultural activity was dominant, hedgerows (WL1) and improved grassland replace the riparian woodland. Approaching Kilkenny city the riverbanks especially of the River Nore were a valuable amenity resource as reflected in the habitat classification of scattered trees and parkland (WD5) and amenity grassland.

2.3.4 Site integrity of the Lower River Shannon SAC survey square.

Improved grasslands were the dominant habitat type of the Mulkear River banks. In urban areas amenity grassland (GA2) was the primary improved grassland habitat with improved agriculture grassland (GA1) more prevalent in rural areas. Riparian woodland (WN5) was the dominant woodland habitat along the rivers surveyed.

The River Maigue at this point is the lower part of the river as it flows into the Shannon estuary. As the lower reach of the river is influenced by the tide the river is a tidal river (CW1) rather than a freshwater upland eroding watercourse (FW1) or lowland depositing watercourse (FW2). The presence of reed and large sedge swamps (FS1) on the river margin is typical of tidal river habitat in this square.

A variety of habitats were observed on the riverbanks in the River Feale Square. The built environment (BL3), scrub (WS1) and hedgerows (WL1) were the dominant habitat types. Conifer plantations were evident in upland areas (WD4) while earth banks (BL2) were associated with a lowland river. Earth banks in this case are most likely the result of previous river maintenance works rather than the traditional earth banks used as field boundaries found in Co. Kerry.

2.3.5 Site integrity of the Bandon River SAC survey square.

Wet willow-alder-ash woodland (WN6) and wet pedunculate-oak-ash woodland (WN4) are the two habitat woodland types used to describe a section of woodland heading south along the Bandon River. Oak was not observed from the survey point within the wood but the woodland floor flora and tree diversity was similar to that described as wet pedunculate-oak-ash woodland. Alternatively, ash was a dominant tree species the habitat may be classified as wet-willow-alder-ash woodland. For the purpose of this study the habitat type is woodland with characteristics belonging to more than one woodland grouping. The two woodland types are used to describe the habitat.

2.4 Identify other linked environmentally sensitive aspects.

Described in this section are observations of an environmental nature that have an impact on floating river vegetation. Issues discussed will include invasive terrestrial plant species Rhododendron, Japanese Knotweed, Indian Balsam and Giant hogweed. Problematic species associated with aquatic environments include Parrot's feather milfoil (*Myriophyllum aquaticum*) and algae. The ability of cattle to walk into rivers and streams also needs to be mentioned.

At least one invasive / alien plant species was observed in each River square surveyed with all four species recorded in the River Feale square. The presence of Japanese knotweed colonising large stretches of riverbanks was especially worrying. Currently, the plant poses a threat to the ecological diversity to both aquatic and terrestrial systems and should the plant go unchecked, all

watercourses will require maintenance just to control this weed. A single incidence in the River Bandon square proved that hedge clippings of Japanese knotweed can result in the propagation of the plant in rivers at low water levels, typically rivers most suited to floating river vegetation.

Parrot's feather was a feature of watercourses in the Galway squares. The presence of the plant in drainage ditches along bogs illustrates the ease with which it can spread. Methods to control and isolate the species need to be investigated.

Another nuisance species observed in watercourses during the survey was algal growth. Varying from emerald green to a brown colour the algae was often observed wrapped around floating river vegetation. The algae that were wrapped around floating river vegetation appeared to reduce the capacity of floating river vegetation to photosynthesise, therefore reducing the ability of the plant to grow and regenerate. Eliminating the nutrient overloading of watercourses at source should bring about a reduction in algal growth.

For most watercourses surveyed cattle had unhindered access to the water. In one case cattle were seen paddling in shallow water. The channel in question was not a maintainable channel nor was it directly within a Special Area of Conservation (SAC) but the water level was low and four head of cattle were present in the water at the same time. It does illustrate the level of nutrient loading of some watercourse, which in turn can lead to excessive plant growth within aquatic environments (Fig. 2).



Fig. 2 Cattle accessing a recently maintained watercourse (**NOT** Office of Public Works channel).

3.0 Ecological Assessment of Water Courses of Plain to Montane Levels with Aquatic Vegetation EU 3260

Consultation with the National Parks and Wildlife Services and a literature review of Special Areas of Conservation to be assessed was undertaken prior to the survey of watercourses for floating river vegetation. The following are some of the items that arose during the survey and were addressed as part of the ecological assessment.

- Water Courses of Plain to Montane Levels with Aquatic Vegetation EU 3260 is not a priority habitat; therefore the level of knowledge associated with this habitat is not as extensive as for priority habitats.
- Species diversity is known for Special Areas of Conservation that have been designated as habitats for floating river vegetation; but little is known about floating river vegetation beyond these sites.
- Extent and knowledge of floating river vegetation in watercourses on a national basis is rather limited.
- Whether the habitat classification Water Courses of Plain to Montane Levels with Aquatic Vegetation extends to watercourses that support one of the listed floating river vegetation species or a particular combination of species requires clarification.
- From an Office of Public Works perspective an appropriate strategy should floating river vegetation occur beyond a Special Area of Conservation needs to be developed.
- Are there particular parameters that favour floating river vegetation more than others?
- Is the floating river vegetation sensitive or robust with respect to environmental changes? Are there time periods at which change can be buffered?
- A general understanding of the lifecycle of aquatic vegetation, nutrient requirements, and essential annual and seasonal parameters required for propagation, flowering and reproduction is required.
- The impact of Office of Public Work maintenance activity on aquatic vegetation.

3.1 Monitoring and measurements completed (Methodology)

In an effort to provide an informative overview of the extent, abundance and species diversity of aquatic vegetation the following survey was employed. The design of the survey also had to be capable of providing a clear understanding of the ecological impact of arterial drainage maintenance work undertaken on watercourses both within and outside designated Special Areas of Conservation. It was also important that the survey recorded environmental, ecological and physical parameters, which might affect aquatic vegetation.

All five Special Areas of Conservation with floating river vegetation as a conservation aspect, namely Lough Corrib (0297), Lower River Suir (2137), River Barrow and River Nore (2162), Lower River Shannon (2165) and the Bandon River (2171) were assessed for this study as they overlapped with Office of Public Work arterial drainage channels. For each SAC in the study, one or more 10km squares were selected for sampling. The main channel maintained by the OPW within the SAC (including the limited extent of the River Nore and the River Suir) along with a number of other channels was surveyed. Sites assessed in the broader sense assisted in the gathering of conservation information and the understanding of floating river vegetation. Channels were selected from an EPA database of channels, based on the Ordnance Survey Discovery vector series. All channels within a 10km square were assigned a random number. The channels were grouped by stream order and, starting with the highest stream order in the square, the channel with the highest random value was selected. Each stream order present was selected in decreasing order and the process was repeated until 10 sample sites had been selected for each square. The survey was carried out between August and September 2006.

An exception was the Headford and River Corrib survey square. A series of channels were selected surrounding the Black River, the main channel in the Headford square. As the Black River is predominantly on the County Mayo side of the Lough Corrib SAC, the River Corrib was surveyed as the main channel to conform with ecological methodology. While every attempt was made to survey each site identified on the 10 km survey map some watercourses were inaccessible by foot and could not be surveyed. In such cases an adjacent river of the same stream order was chosen instead. Occasionally, alternative rivers of the same stream order were unavailable reducing the number of sites surveyed within a 10 km square. During the course of the survey the length of each Office of Public Works main channel was walked. Where access to sections of the main channel within the Special Area of Conservation was possible these were also investigated for comparative purposes.

GPS locations were determined using a hand held GPS unit (Magellan GPS 315). In the absence of a signal, coordinates for the surveyed watercourses were obtained from an Ordnance Survey Discovery series map. All digital images were obtained using a Canon digital IXUS 65 digital camera.

A survey of the back drains of the Ballynaclogh River maintained by the Office of Public Works, which was reported to contain *Groenlandia densa*, was undertaken on the 26th February 2007. While the primary objective of the survey was to confirm the presence of *G.densa* in back drains maintained by the Office of Public Works, other information collected included habitats present, plant distribution, general growth characteristics and the physical parameters of the watercourse colonised by *G.densa*.

3.2 Distribution and extent of floating river vegetation

Floating river vegetation was found in a large range of watercourses, however, individual species were restricted in their distribution while other species were ubiquitous. Similarly, a species presence didn't necessarily mean that it was found in abundance in a given habitat. For all watercourses surveyed floating river vegetation diversity was recorded and the dominant species noted for each system.

Both maps and identification table have been employed to provide a comprehensive overview of the distribution of floating river vegetation and information on individual plant species identified. Fig. 3 below provides an overview of the sites survey and the presence or absence of floating river vegetation.

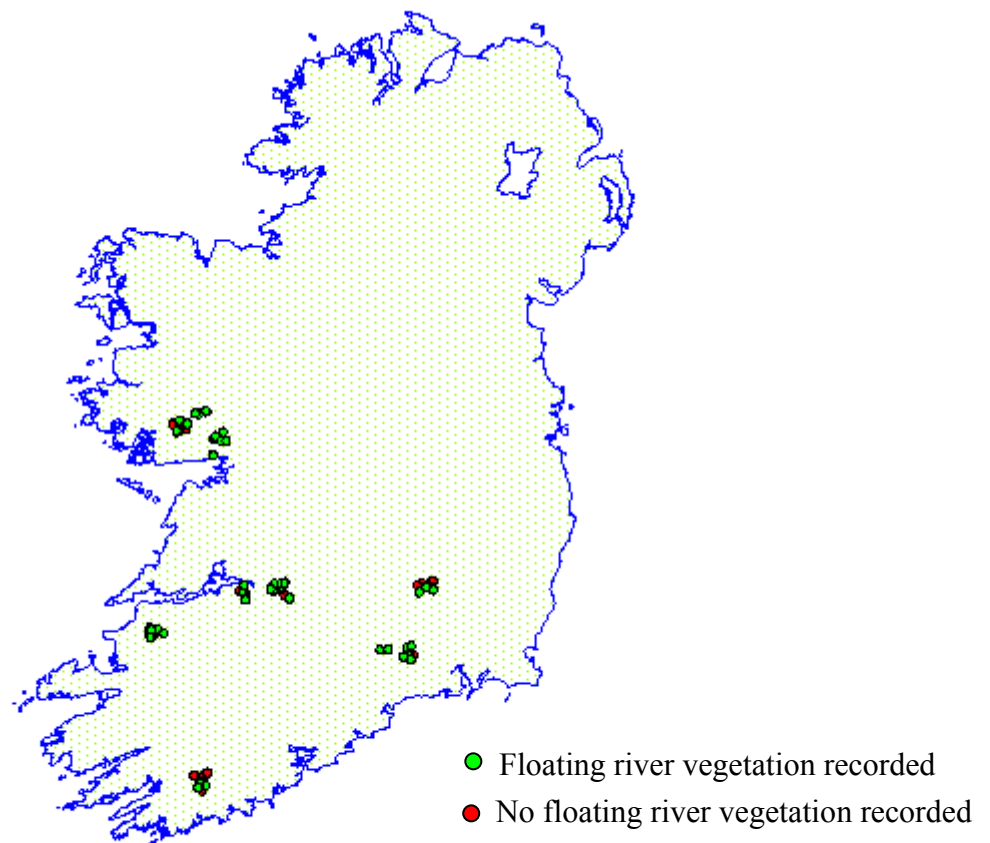


Fig. 3 An overview map of survey sites assessed for floating river vegetation

A collective map of the provinces of Munster, Connaught and Leinster providing a more detailed overview of the presence or absence of floating river vegetation is illustrated in Fig. 4. De-

tailed ordnance survey maps identifying survey sites assessed for floating river vegetation and the species recorded at each location can be found in Appendix D.



Fig. 4 Distribution of floating river vegetation recorded in each province surveyed

3.2.1 Floating river vegetation of the Lough Corrib SAC survey square

Channel name	Floating River Vegetation	OPW channel	SAC status
Owenriff River Main scheme	None visible – river in flood	√	√
Site (1)	None visible – river in flood		
Site (2)	None visible – river in flood	√	
Site (3)	None visible – river in flood		
Site (4)	<i>Callitriche stagnalis</i>		√
Loughseecon (Site 5)	<i>Fontinalis antipyretica</i>		
Owenriff River (Site 6)	None visible – river in flood	√	√
Site (7)	None visible – river in flood		
Site (8)	<i>Potamogeton polygonifolius</i> , <i>Callitriche stagnalis</i>		
Site (9)	<i>Potamogeton polygonifolius</i>		

Table 2 Floating river vegetation distribution of the Owenriff River survey square

* River was in flood at the time of the survey therefore no floating river vegetation evident during the survey.

Of the ten sites surveyed six were in flood and the other four were positive for floating river vegetation. In the case of site 8 and site 9 excess rainfall was beneficial to the growth of floating river vegetation by providing mountain streams with a prolonged level of water to support aquatic growth. A simple observation of the surrounding landscape of upland bog (section 2.3), would indicate a drier than average summer season in 2006.

Channel name	Floating River Vegetation	OPW channel	SAC status
Clare River Main scheme	<i>Potamogeton perfoliatus</i> , <i>Fontinalis antipyretica</i>	√	
Cregg River (Site 1)	<i>Potamogeton natans</i> , <i>Callitriche stagnalis</i>	√	√
Cregg River (Site 2)	<i>Potamogeton natans</i> , <i>Callitriche stagnalis</i>	√	√
Cregg River (Site 3)	<i>Ranunculus trichophyllus</i> , <i>Potamogeton natans</i> , <i>Callitriche stagnalis</i> , <i>Berula erecta</i> , <i>Fontinalis antipyretica</i>	√	
Waterdale River (Site 4)	None	√	
Clare River (Site 5)	<i>Potamogeton natans</i>	√	

Table 3 Floating river vegetation distribution of the Clare River survey square

Floating river vegetation was evident in abundance at site three. One element of each floating river vegetation group was present. Also evident was unprotected *Ranunculus* species and fools watercress commonly found in habitats alongside and often confused or mistaken for lesser water parsnip. Pondweed and starwort species were the most frequently recorded floating river

vegetation of the Clare River square.

Channel name	Floating River Vegetation	OPW channel	SAC status
River Corrib Main scheme	<i>Ranunculus aquatilis</i> , <i>Myriophyllum alterniflorum</i>		√
Black trib. (Site 1)	<i>Potamogeton praelongus</i> , <i>Callitriche platycarp</i> , <i>Berula erecta</i> , <i>Fontinalis antipyretica</i>	√	
Black trib. (Site 2)	<i>Potamogeton natans</i> , <i>Berula erecta</i>	√	
Black trib. (Site 3)	None	√	
Black River (Site 4)	<i>Callitriche platycarpa</i>	√	
Black trib. (Site 5)	<i>Potamogeton natans</i>	√	
Black River (Site 6)	<i>Potamogeton praelongus</i>	√	√

Table 4 Floating river vegetation distributions of the River Corrib and the Headford survey square

The River Corrib was the only site to be positively identified for Milfoil species. Rising water levels during the course of the survey of the River Corrib provided an insight into the vegetative reproduction of floating river vegetation. Developing rooting structures were evident on weather beaten *Ranunculus* and pondweed vegetation similar to that of vegetative reproduction process of terrestrial plant species. Watercourses in this square were deeper than other sites surveyed favouring pondweed species capable of growing in deeper water.

3.2.2 Floating river vegetation of the Lower River Suir SAC survey square

Channel name	Floating River Vegetation	OPW channel	SAC status
River Suir Main scheme	<i>Ranunculus penicillatus</i> , <i>Potamogeton perfoliate</i> , <i>Berula erecta</i> Note: <i>Butomus umbellatus</i> (Flowering Rush)	√	
Suir trib. (Site 1)	<i>Fontinalis antipyretica</i>		
Glen River (Site 3)	<i>Ranunculus aquatilis</i> , <i>Fontinalis antipyretica</i>		
Suir trib. (Site 4)	None		
Lingaun River (Site 5)	<i>Ranunculus aquatilis</i> , <i>Ranunculus peltatus</i> , <i>Fontinalis antipyretica</i>		√
Clodiagh trib. (Site 6)	<i>Ranunculus aquatilis</i>		
River Suir (Site 7)	<i>Ranunculus</i> sp.		√
River Suir (Site 8)	<i>Ranunculus</i> sp.		√

Table 5 Floating river vegetation distribution of the River Suir survey square

Ranunculus species was the dominant floating river vegetation of watercourses surveyed in the River Suir square. Flowering rush was observed along the banks of the River Suir, a plant species noted to be associated with habitats of watercourses of plain to montane levels with aquatic vegetation EU 3260. The shallow channels surveyed in the River Suir square were ideal habitats for

aquatic moss.

3.2.3 Floating river vegetation of the River Barrow and River Nore SAC survey square

Channel name	Floating River Vegetation	OPW channel	SAC status
River Nore Main scheme	<i>Ranunculus</i> sp., <i>Potamogeton praelongus</i> , <i>Callitriche stagnalis</i> , <i>Berula erecta</i>	√	
Breaghagh river (Site 1)	<i>Berula erecta</i>		
Site (2)	None		
Site (3)	None		
Stoney stream (Site 4)	None		
Breaghagh river (Site 5)	<i>Ranunculus aquatilis</i> , <i>Callitriche stagnalis</i> , <i>Berula erecta</i>	√	
River Nore	None		
Pococke trib. (Site 7)	None		
River Nore (Site 8/9)	<i>Potamogeton praelongus</i>		√
Pococke river (Site 10)	<i>Callitriche stagnalis</i> , <i>Berula erecta</i>		√

Table 6 Floating river vegetation distribution of the River Nore survey square

Although the above table suggests that very little floating river vegetation was present in the River Nore square, low water levels would have had a large impact on aquatic vegetation. Watercourses with shallow water such, as site 10, were favourable for the colonisation of water parsnip. The growth of water parsnip was not evident in smaller channels surveyed.

3.2.4 Floating river vegetation of the Lower River Shannon SAC survey square

Channel name	Surrounding habitat	OPW channel	SAC status
Mulkear River Main scheme	<i>Ranunculus aquatilis</i> , <i>Potamogeton perfoliatus</i> , <i>Zannichellia palustris</i>	√	
Mulkear trib. (Site 1)	None		
Killeenagarraff River (Site 2)	<i>Fontinalis antipyretica</i>	√	√
Killeenagarraff trib. (Site 3)	<i>Callitriche stagnalis</i>		
Killeenagarraff River (Site 4)	<i>Ranunculus aquatilis</i> , <i>Potamogeton</i> sp.	√	
Killeenagarraff River (Site 5)	<i>Ranunculus aquatilis</i>	√	√
Killeenagarraff trib. (Site 6)	<i>Ranunculus aquatilis</i> , <i>Fontinalis antipyretica</i>	√	
Mulkear River (Site 7)	<i>Berula erecta</i>		√
Mulkear trib. (Site 8)	None		
Groody River (Site 9)	<i>Ranunculus aquatilis</i> , <i>Berula erecta</i>	√	
Groody River (Site 10)	<i>Fontinalis antipyretica</i>	√	

Table 7 Floating river vegetation distribution of the Mulkear River survey square

A diversity of floating river vegetation was evident in the Mulkear River square. *Ranunculus* was the dominant aquatic vegetation within the survey square. All channels maintained by the

Office of Public Works supported at least one species of aquatic vegetation. Floating river vegetation species were found within and beyond Special Areas of Conservation.

Channel name	Surrounding habitat	OPW channel	SAC status
River Maigue Main scheme	None	√	√
Site (1)	None	√	
Site (2)	<i>Berula erecta</i>	√	
Maigue trib. (Site 3)	None	√	
Site (5)	None		
River Maigue (Site 6)	<i>Berula erecta</i>		
Maigue trib (Site 7)	<i>Berula erecta</i>		√

Table 8 Floating river vegetation distribution of the River Maigue survey square

A single species of floating river vegetation was observed in the River Maigue square. Water parsnip was confined to drainage ditches and smaller watercourses where freshwater is found. The absence of floating river vegetation species corresponds with patterns of tidal inundation. Habitat classification of adjacent lands to the Maigue River (section 2.3) is typical of coastal environments. The influence of the seawater may be the primary element influencing floating river vegetation species.

Channel name	Floating River Vegetation	OPW channel	SAC status
River Feale Main scheme	<i>Fontinalis antipyretica</i>	√	
Feale trib. (Site 2)	None		
Feale trib. (Site 3)	<i>Callitriche stagnalis</i>	√	
Feale trib. (Site 4)	<i>Potamogeton gramineus</i>	√	
River Feale (Site 5)	None	√	√
Galey River (Site 6)	<i>Ranunculus aquatilis</i>		
Galey trib. (Site 7)	<i>Fontinalis antipyretica</i>	√	
Feale trib. (Site 8)	None	√	√
Smearlagh River (Site 9)	<i>Fontinalis antipyretica</i>		√

Table 9 Floating river vegetation distribution of the River Feale survey square

Very little floating river vegetation was recorded in the River Feale square. Moss was the most frequently occurring aquatic vegetation recorded with a single incidence of starwort, pondweed and *Ranunculus*. Water parsnip and milfoil species were not found in the River Feale square. Tidal inundation and low water levels may have influenced species diversity and abundance.

3.2.5 Floating river vegetation within the Bandon River SAC survey square

Channel identification	Surrounding habitat	OPW channel	SAC status
Bandon River Main scheme	<i>Ranunculus penicillatus</i> , <i>Ranunculus pencillatus</i> ssp. <i>pencillatus</i> <i>Potamogeton natans</i> , <i>Zannichellia palustris</i> , <i>Fontinalis antipyretica</i>	√	√
Bandon River (Site 1)	<i>Ranunculus pencillatus</i> ssp. <i>pencillatus</i> , <i>Ranunculus aquitilis</i> , <i>Callitriche hamulata</i> , <i>Callitriche obtusangula</i> , <i>Callitriche platycarpa</i> , <i>Callitriche stagnalis</i> , <i>Fontinalis antipyretica</i>		√
Dirty River (Site 2)	<i>Ranunculus aquitilis</i> , <i>Callitriche stagnalis</i>		
Brewery River (Site 3)	<i>Callitriche stagnalis</i>		
Kealrootha trib. (Site 4)	None		
Glasheenahielan trib. (Site 5)	None		
Garrown River (Site 6)	None		
Bandon River (Site 7)	None		√
Blackwater trib. (Site10)	None		

Table 10 Floating river vegetation distribution of the Bandon River survey square

Ranunculus sp. and *Callitriche* sp. dominated the Bandon River. More than one species of *Ranunculus* was observed growing on the River Bandon section flowing through Dunmanway. Further downstream beyond the town limits the character of the River Bandon changed, with plumes of green starwort observed. Watercourses surveyed beyond the River Bandon showed little or no floating river vegetation. Physical parameters such as shade rather than biological characteristics may be influential in the development of floating river vegetation.

3.3 General growth characteristics of floating river vegetation

Described below are some of the general identification characteristics of frequently observed floating river vegetation during the course of the survey. Milfoil, *Myriophyllum* spp. and Horned Pondweed, *Zannichellia palustris* have not been included as they were only seen at one and two locations, respectively.

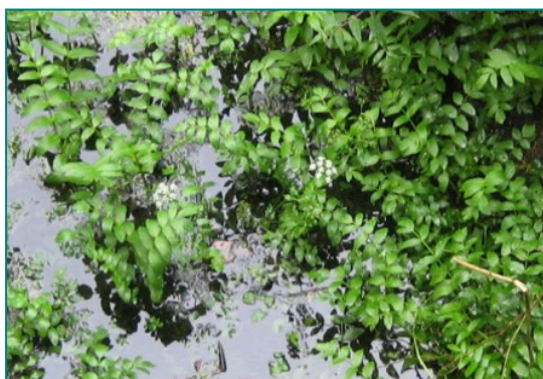
Water Crowfoot, *Ranunculus* species

- Colonisers of gravel riverbeds with limited quantities of deposited sands.
- River flow for certain species must be fast, others tolerate slow water.
- Flowers are similar in shape to a buttercup but with white petal and yellow middle.
- Ranunculus* can possess two types of leaves especially during flowering.
- Flowering period May to June with vegetative roots development along the stem in August.
- Vegetative reproduction takes place in autumn with rising water levels of high flow rate that mechanically break rooted sections of plant stems.



Water Parsnip, *Berula erecta*

- Found frequently in maintained drainage ditches.
- Along rivers in areas with silt or mud deposits - in the middle of rivers or at the waters edge.
- Prefers shallow slow flowing or still water.
- Flowers August to September - small white flowers that form a white ball shape.
- Can be easily mistaken for Fool's Watercress, which is often found in same habitat.
- Smells of carrots when leaves are crushed.



Starwort, *Callitriche* species

- Rooted to channel bases with stems floating upwards.
- Starwort resembles a star shape as it grows underwater.
- On breaking the water's surface starworts take on a multi-layered star-shaped flower that gently rests on the water surface.
- Not to be confused with duckweed which is light green and free floating.
- Starworts form a mat in the surface usually dark green.
- Frequently found in drainage ditches, slow moving streams and rivers.
- Evidence of reproduction by vegetative means – mechanical shearing of rooted stem.



Pondweed, *Potamogeton* species

- Most varied distribution of all the species in terms of water depth.
- Pondweed was the only floating river vegetation recorded in deep waters.
- Broadleaved pondweed was the most frequently observed pondweed species.
- Flowering structures were evident on deep-water species between August to September.
- Not all pondweed species had floating leaves; some species remained completely submerged.
- Evidence of reproduction by vegetative means – mechanical shearing of rooted stem.



Aquatic moss, *Fontinalis antipyretica*

- Dark green moss growth completely submerged.
- Circular domed moss shape.
- Found in shallow slow flowing water.
- Grows on gravel riverbeds or attached to submerged aggregate material.
- Can tolerate shade but requires sunlight to penetrate the water surface.



An overview of ecological characteristics associated with floating river vegetation recorded or sighted in Ireland has been compiled in Table 34. The similarity between plant spp. illustrates the similarity in leaf structure and habitat requirements. Although a probable identification can be made based on leaf, seed capsule and habitat an absolute identification requires a flower head. This was particularly evident with *Ranunculus* spp. in the absence of flowering structures during the course of the survey (section 3.2).

3.4 Life cycle of floating river vegetation

To minimise the impact of channel maintenance on floating river vegetation it is essential that plant reproduction and colonisation be understood. By focusing on plant regeneration the nature and level of maintenance work required, the timing of the works and the appropriate environmental drainage maintenance systems can be selected to provide favourable habitats for floating river vegetation post maintenance works.

Essentially two forms of reproduction can be used by plants, firstly seed production and secondly vegetative growth (Fig.16). Seed production is the preferred option for species survival and genetic diversity since it is the result of pollination by two different plants and is referred to as sexual reproduction. Asexual reproduction is the cloning of the mother plant by the production of spare roots from a growing section of the plant vegetation. The new root section breaks from the mother plant and develops as a new plant possessing the same genetic make-up as the initial plant.

Each form of reproduction requires very different environmental parameters, but both processes can be used to ensure plant survival. For sexual reproduction the flower is the most important structure. Flower colour is the primary attraction for pollen carrying insects and it is within the flower structure that the seed vesicles are formed. As the flower is the most delicate part of any plant the lower water levels of watercourses during summer months facilitates the floating of flowering structures on the water surface.

Asexual reproduction for floating river vegetation is the optimisation of plant reproduction through an environmental adaptation. It is possible that low summer water levels trigger the development of rooting material observed on vegetation stems of *Ranunculus* and Milfoil species in late summer. Rapidly rising water level early autumn appear to serve two purposes, firstly the rising water levels cause the plant growth to break into smaller pieces with separate rooting systems and secondly that the faster flowing water carries the rooted sections further along the channel. Unlike seeds, which require germination prior to growing, the rooted plant material has an advantage that it can anchor and grow more quickly in rising water levels.

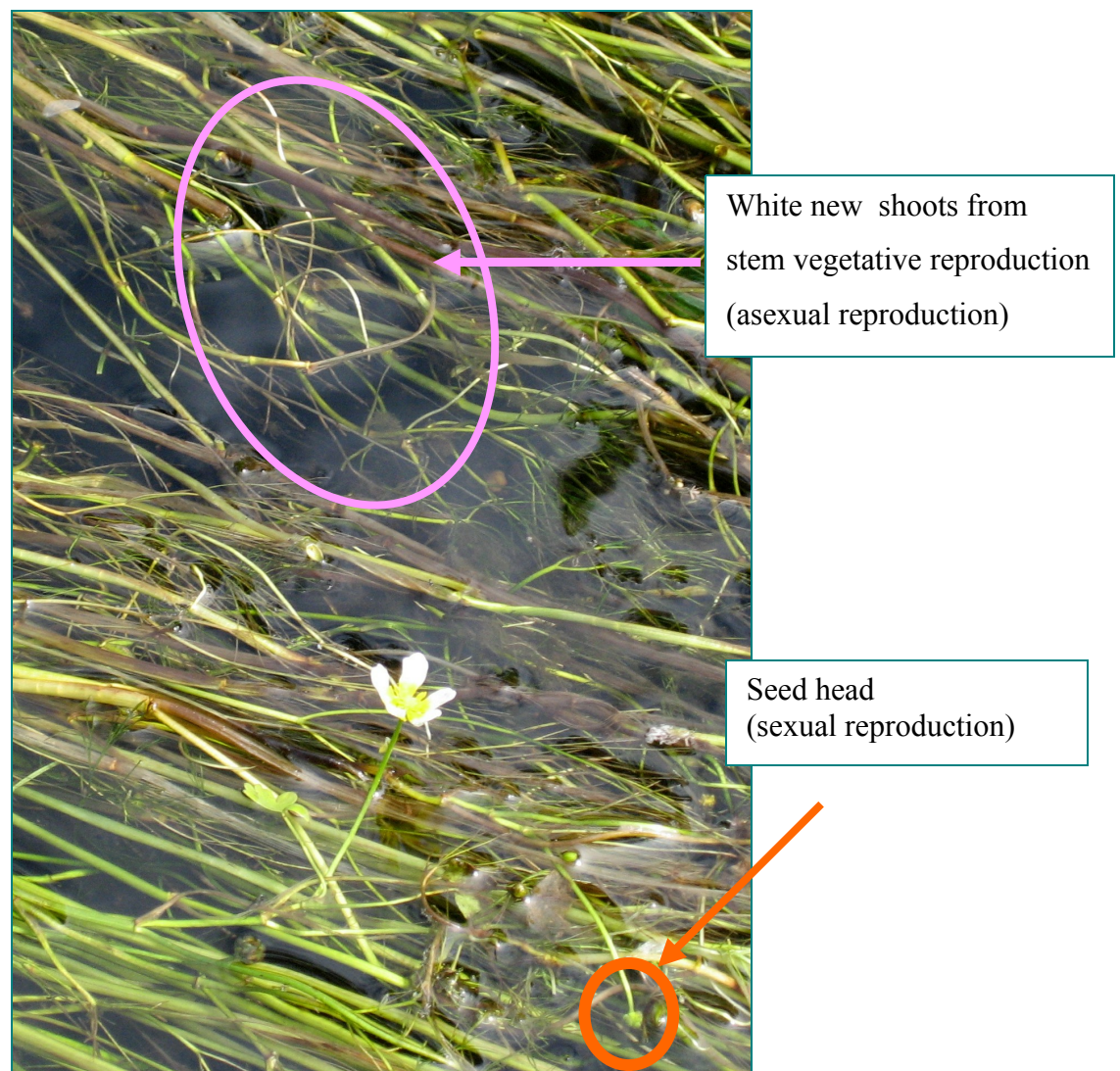


Fig. 5 Floating river vegetation observed for *Ranunculus* species.

3.5 Parameters affecting species distribution

As described in the habitat classification of Water Courses of Plain to Montane Levels with Aquatic Vegetation EU 3260 a characteristic of watercourses supporting floating river vegetation is the periodic rise and fall in water level in winter and summer, respectively. Low water levels in summer provide aquatic plant species an opportunity to flower and also an opportunity for terrestrial species to colonise aquatic environments. Low water levels reduce the competitive advantage aquatic plants possess in aquatic environments.

The following dataset is a correlation between the physical parameters observed on-site at each sampling point with that of floating river vegetation. Survey sites containing floating river vegetation have been highlighted in blue in the tables in Appendix E.

During the survey of the Owenriff River square the majority of the watercourses surveyed were found to be in flood. Not alone was the water flowing at a fast rate but it also had a brown peat colour similar in colour to peat (probably surface run-off from surrounding habitats, see table 2.3). Those watercourses not in flood did possess floating river vegetation. It is highly probable that the gravel base of the Owenriff River would support floating river vegetation but the shade recorded at some of the sites surveyed would not favour aquatic growth.

Floating river vegetation was recorded in all but one watercourse in the Clare River square. All watercourses in this survey square are maintained by the Office of Public Works and are not shaded. Depth and river base did vary between survey sites. The survey site in the middle of a bog (section 2.3) was the only site without floating river vegetation. Recent work on the watercourse and the acidity of the surrounding bog habitat may have prevented floating river vegetation growth.

As with the River Clare square floating was recorded in all but one watercourse. All watercourses in this survey square are maintained by the Office of Public Works and are not excessively shaded. A selection of riverbed substrates and water depth was recorded. Site 2 was the only site where water was not evident as the channel was colonised by a selection of tall aquatic vegetation growth. The presence of water parsnip would indicate that still and / or shallow water was present. Colonisation of site 3 with scrub vegetation such as willow would not favour aquatic species and was the only site that did not support floating river vegetation.

Shade appeared to be a significant parameter influencing the growth of floating river vegetation. Although partial shade was noted for site 1 and site 3, considerably less light (morning eastern sun) was available at site 1. This was reflected in the growth of moss only as opposed to water crowfoot, *Ranunculus*, and moss recorded at site 3. Site 4 comprised of a small cascading stream that collected in pools. The watercourse was surrounded with tall woodland trees providing constant shade. No aquatic vegetation was recorded at the site, not even moss as observed in site 1 (section 3.2). Though slight turbidity was noted due to the cascading water it unlikely that this

prevented aquatic growth.

Water levels in the River Nore survey square were low and often absent for many of the smaller watercourses surveyed. In watercourses with water depth described as a trickle the fine sand or mud deposits of the river bed were too dry to support floating river vegetation. Deeper waters were dominated with larger pondweed species.

Floating river vegetation was observed on the majority of the survey sites within the Mulkear River square. Stone, gravel and fine sand were the dominant channel substrate recorded. Shade and partial shade were noted for site 1 and site 8. Floating river vegetation was observed on all sites maintained by the Office of Public Works along with two channels not maintained by the Office of Public Works.

Watercourses within the River Mague survey square consisted of mud and fine sands and were often heavily colonised by aquatic vegetation including floating river vegetation. Of the watercourses surveyed over fifty percent were maintained by the Office of Public Works with site 2 supporting floating river vegetation. Site 3 was the only site to experience shade. It did not support floating river vegetation.

Not all of the watercourses maintained by the Office of Public Works supported floating river vegetation. Partial shade may be responsible for the absence of floating river vegetation at site 8 while low water levels on the River Feale may also be a factor. Stone and peat base was the dominant substrate in the River Feale survey square supporting floating river vegetation.

Only four watercourses survey in the Bandon River square supported floating river vegetation. Although partial shade was recorded for the remaining watercourses colonisation with dense aquatic vegetation and terrestrial plant species reduced the sunlight penetrating the water surface. The bed of the Bandon River at Dunmanway supported a sizeable population of floating river vegetation.

3.6 *Groenlandia densa* on the back drains of the River Shannon

Groenlandia densa (Opposite leaved pondweed) is a legally protected plant species classified as endangered and vulnerable in the Irish Red Data Book (Curtis & McGough, 1988). Originally recorded at thirty-two sites across the republic of Ireland, sites in recent times the number has decreased to a total of three sites in counties Limerick, Laois and Dublin. *Groenlandia densa* (*G. densa*) colonises deposited mud on the bottom of ditches, streams, ponds and canals. It has been suggested that the decline of the species in Ireland is due to land drainage and reclamation, pollution, peat run-off and loss of habitat due to infilling of watercourses.

According to the EUNIS website four candidate Special Areas of Conservation (cSAC) in Ireland have identified *G. densa* as part of their protected flora and these are tabulated below. Of

particular interest in this chapter is the *G.densa* found on the back drains of the River Shannon that flows through Limerick City.

Site Code	SAC Name	Arterial drainage scheme
0216	River Shannon Callow	Brosna drainage scheme
0458	Killala Bay / Moy Estuary	Moy drainage scheme
2137	Lower River Suir	Carrick-on-Suir Flood Relief
2162	River Barrow & River Nore	Kilkenny Flood Relief Scheme
2165	Lower River Shannon	Ballynacloagh, Bunratty-Rineanna, Bushy Island-Martin, Coonagh Embankment, Deel, Feale, Fergus, Foynes, Groody, Maigne Outfall, Mulkear-Ballymackeough, Newtown-Tervoe, Owengarney, Ringmoylan Mellon

Table 11 Listed cSAC sites associated with *Groenlandia densa*, EUNIS website

The back drains (i.e. of the River Shannon) are a series of channels at the rear of an embankment that drain the surrounding lands and are normally sluiced through the embankment into the main watercourse. Consequently, vegetation growing in a back drains have adapted to an environment consisting of fluctuations in water levels and large amounts of silt deposition (in the form of land run-off).

Habitats adjoining the back drains were described in accordance with Fossitt, 2000. All habitats observed within close proximity to the back drains were recorded. The dominant land habitat type was that of wet grassland (GS4). Field boundaries were denoted by overgrown hedgerows (WL1). Areas of developing scrub predominantly of willow and brambles were observed. To the north west of the back drains are the embankments (ED2) associated with the Ballynacloagh River (FW1). An urban environment consisting of housing estates dominated the east to south side of the back drains.

Channel name	Surrounding habitat	OPW channel	SAC status
Back drains of the Ballynacloagh River	FW1, ED2, GS4, WL1, WS1, BL3	√	

Table 12 Habitat identification adjacent to the back drains colonised by *G.densa*.

G.densa was the dominant floating river vegetation observed on the back drains of the Ballynaclogh River. Large sections of the back drains were found to support *G.densa* vegetation. Watercourse sections less densely populated by *G.densa* vegetation were observed supporting other types of floating river vegetation. A single *Ranunculus* species with submerged leaves, consistently branching into three would strongly suggest a possible identification of *R. trichophyllus*. The presence of flowering structure would be needed to confirm the identification. Starworts (*Callitriche stagnalis*) and water parsnip (*Berula erecta*) were also observed growing in the back drains.

Channel identification	Floating river vegetation	OPW channel	SAC status
Back drains of the Ballynaclogh River	<i>Ranunculus trichophyllus</i> , <i>Callitriche stagnalis</i> , <i>Berula erecta</i> , <i>Groenlandia densa</i>	√	

Table 13 Floating river vegetation observed in back drains.

General growth characteristics of *G.densa* during the survey are listed below.

- Wavy leaves are oppositely paired along the stem
- Dark green leaves contrast with light green / white stems
- New leaf growth appears as a tuft of leaves at the tip of the stem
- All leaves are submerged
- Coloniser of fine mud sediments
- Can develop as a dark green mat close to the water surface.

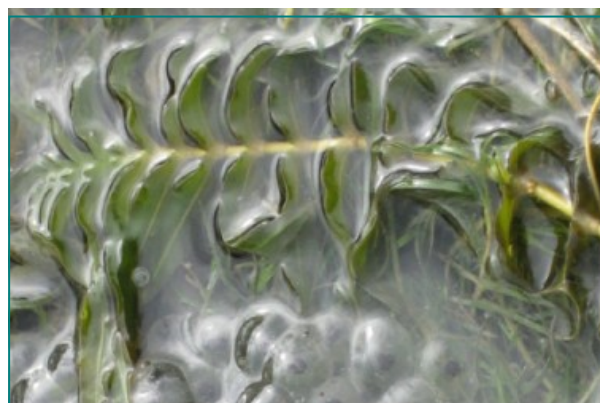


Fig. 6 Photograph on the left *G.densa* in its natural habitat (with starworts in bright green). On the right a stem of *G.densa* beside frog spawn. Note the opposite paired wavy leaves.

Physical parameters of the back drains were recorded similar to those of other watercourses surveyed for floating river vegetation (see section 3.5).

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
Back drains Ballynaclough River	√	1	-	Fine mud and sand base with some large stones	0.1 m with deeper areas	Clear

Table 14 Physical parameters associated with the back drains supporting *G.densa*

The base of the back drains consisted of a fine mud and sand deposit. Large stones surrounded by a deposit of fine sediment were evident in some sections along the back drains. Regular drainage maintenance of the back drains may be responsible for regulating sediment build-up and reducing the impact of shade associated with the growth of riparian woodland along the banks of watercourses. The depth of the back drains varied from 0.1m to approximately 0.3m based solely on observations of *G.densa* during the course of the survey. All water in the back drains were clear and free from turbidity enabling the base of the watercourse to be viewed in the absence of dense floating river vegetation and other aquatic plant growth.

Encroachment of reed vegetation at a single point along the back drains provided a contrasting habitat where floating river vegetation was not recorded. At this section little or no free moving water was evident. The invasive growth of the reeds reduced the surface area of available light and surface water required by floating river vegetation. In contrast to the aquatic environment supporting *G.densa*, which in turn provided a habitat for frogspawn, areas colonised by reeds resembled a terrestrial environment and was not suitable for frog development. Drainage maintenance undertaken by the Office of Public Works is responsible for controlling the sediment build-up and consequently reed growth. Extraction of the sediment deposits is executed on a five-year maintenance cycle to a single depth and no deeper (Technical Staff OPW Limerick, Personal communication). It would appear that work undertaken by the Office of Public Works favours the growth of *G.densa*.

4.0 Description of maintenance operations carried out by the Office of Public Works

The Office of Public Works is obliged under the Arterial Drainage Acts 1945 and 1995 to maintain drainage works in “proper repair and effective condition”. Channel maintenance includes:

- Removal of deposited material in watercourse systems
- Extraction of vegetation impeding water flow in riverine systems
- Regrading or profiling of channel banks as a result of bank slippage or erosion
- Management of riparian vegetation encroaching on watercourses
- Removal of vegetation or debris collecting on urban bridges (Office of Public Works, 2007).

4.1 Environmental Drainage Maintenance (EDM) Programme

An Environmental Drainage Maintenance (EDM) programme has been established in conjunction with the Central Fisheries Board to provide and develop a series of environmental steps that can be undertaken to rehabilitate and enhance a suitable habitat for salmonoid fish following channel maintenance. The 10 steps Environmental Drainage Maintenance Programme include:

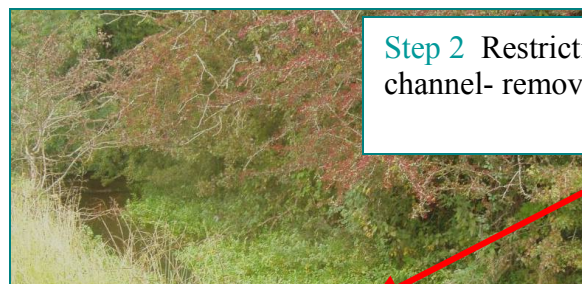
1. Protection of channel bank slopes

Step 1 Bank protection vegetation retention



Step 3 Deposition of spoil material

2. Restriction of maintenance to the wetted channel



Step 2 Restriction of maintenance to channel- removal of instream vegetation

3. Placement of extracted debris

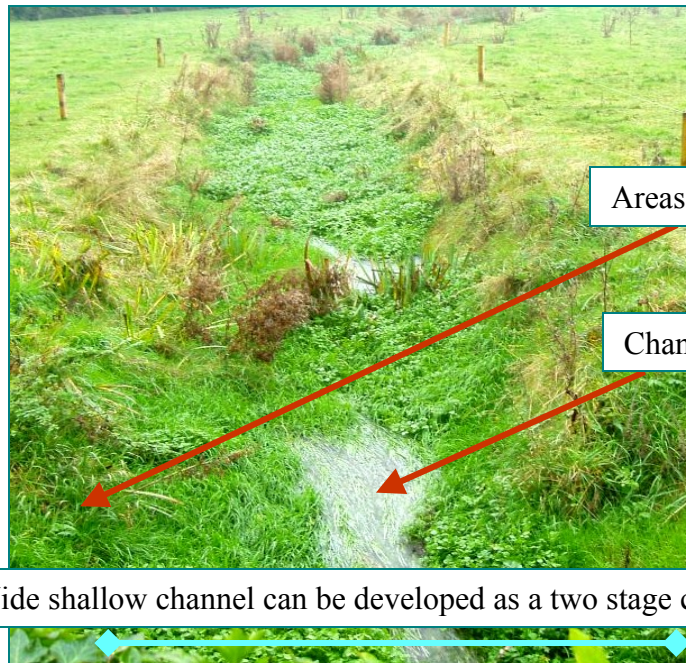
4. Selective removal of vegetation



Step 4 Selective vegetation removal i.e. Bulrush



5. Assess the need to maintain a channel section or leave as is
6. Management of trees along channel banks
7. Placement and management of berms



Areas of reduced flow

Channel with flow

Wide shallow channel can be developed as a two stage channel

8. Replace or add boulders to specific watercourses
9. Loosen bed gravels
10. Excavate pools



Step 5 Leave section untouched or
Step 6 Management of trees

Step 8 Placement of boulders
Step 9 Loosen of gravel bed
Step 10 Excavate pools

Steps 1- 4 are carried out as s performed in

consultation with the Foreman / Technician of the Office of Public Works and steps 9-10 are undertaken after consultation with the staff from the Regional Fisheries Board.

Maintenance of channels is on a rotational basis generally speaking on a four to six year cycle. Depending on the nature and quantity of deposited material, proximity to an urban setting, probability of flooding or ecologically sensitive issues, maintenance may be of a more frequent nature. A site visit was carried to observe arterial drainage maintenance work on the River Inny channel C27, fifteen years since the last maintenance, to provide an enhanced aquatic environment for fish species (Fig. 19).

4.2 Methods of aquatic weed control employed by the Office of Public Works.

Three types of maintenance regimes are employed by the Office of Works to manage aquatic vegetation. The first is by channel maintenance, removal of deposited silt and aquatic vegetation under the 10-step Environmental Drainage Maintenance (EDM) programme (section 4.1). Secondly, using a hydraulic excavator with a weed cutting blade attached, ideal for channels with suitable access for large machinery and not too wide to prevent the bucket reaching the opposite bank.



Fig. 7 Weed cutting bucket operated by a hydraulic machine (photo courtesy Office of Public Works)

Thirdly, a boat-mounted hydraulic excavator is used in narrow channels, which endeavours to clear the vegetation completely.



machinery or
The following
aquatic

Fig. 8 Weed cutting blade operated from a boat (photo courtesy Office of Public Works)

The removal of silt deposits from channels brings about the removal of nutrient enriched soils and root material of aquatic vegetation. Through the removal of vegetation and root material the growth capacity of plants is reduced. Extraction of root and aerial material also reduces the quantity of plant biomass degraded in watercourses during winter months. Therefore the Phosphate and Nitrogen quantity released into the water column as a consequence of plant tissue breakdown results in less nutrient availability for the following season growth. In such cases the drainage maintenance regime may be spread out over a couple of years.

Use of hydraulic machinery with a weed cutting bucket attached enables weed control to be performed without disturbing the riverbed. The bucket of the hydraulic machine can be used to cut weeds just above the sediment layer. On exiting the water the weed cutting bucket with slits in the back curve collects the vegetation and allows excess water to drain from the bucket. Weed material is deposited on the adjacent channel bank. Cutting and removal of aquatic vegetation will firstly, reduce the plants ability to grow by eliminating plant photosynthetic capacity. Secondly, the initial regrowth after cutting, which is dependent on energy stored in plant roots, will produce weaker plant growth and also deplete plant energy reserves for the forthcoming season.

Aquatic vegetation cut using the weed cutting boat brings about a slightly different dynamic. The weed is cut above the channel bed but unlike the weed cutting bucket of the hydraulic machine, the boat bucket is not designed to collect cut vegetation. Some or all of the cut vegetation therefore floats on the water surface until it re-enters the water column through degradation of plant material or sinks to the bottom channel bed. All nutrients are not removed from the water column and are therefore readily absorbed by the regrowth. As weed cutting occurs in the summer months when water levels are lowest and the oxygen capacity of the system is reduced (compared to winter months), therefore the uncollected cut vegetation could be favouring opportunistic aquatic flora.

4.3 River corridor water dynamics

A feature associated with Water Courses of Plain to Montane Levels with Aquatic vegetation (Floating River Vegetation) EU Code 3260 are watercourses with lower water levels during summer months and increased water levels in winter (EUNIS website). Plant identification keys show that watercourses supporting floating river vegetation have specific river flow, water depth and water quality. The characteristics of each watercourse therefore can influence aquatic species diversity.

Information on the flow rate of the main channels surveyed for floating river vegetation was compiled from the Office of Public Work hydrometric data available (OPW website). Three flow rates were selected for comparison, namely 1% corresponding to the flow in cubic metre per second (m^3/s) exceeded only 1% of the time 3 - 4 days per year on average, 50% an approximate average flow and 99% the flow exceeded only 1% of the time in cubic metre per second (m^3/s). Also detailed are the summer months when flow was at its lowest and most constant from the graphed information over a number of recent years.

River Name	1% m^3/s	50% m^3/s	99% m^3/s	Low and even flow rates during summer period (Months)
Owenriff (Oughterard)	No flow rate data available			
Clare River (Corrofin)	72.0	10.7	0.97	(2003) April – Mid May, Mid June-Mid July
River Corrib (Gal- way)	No flow rate data available			
River Suir (Clonmel)	184	33.2	3.60	(2005) Insufficient data
River Nore (John's Bridge)	112	17.6	2.47	(1999) Mid June – Mid September (2000) Mid May – Mid September
Mulkear River (Annacotty)	83.9	10.4	1.53	(2005) May - September
Maigue (Castleroberts)	70.2	7.46	0.7	(2005) May - September
River Feale (Lis- towel)	162	9.43	0.81	(2004) Mid May – June (2005) Mid June – Mid July
Bandon River (Carranure)	79.8	9.44	0.84	(2004) May – September (2005) June, Mid July, Mid August - September

Table 15 Flow rates of main channels surveyed for floating river vegetation.

With the exception of the Owenriff River and the River Corrib where no flow rate data was available, all the other rivers showed elevated flow rates in winter time which were substantially reduced in summer months. The only rivers not to possess a period of low flow without significant floods lasting more than a month during the summer were the River Feale and the Clare River. A period of consistently low flow rate was evident for all other main channels from May to July or May to September.

Similarly to flow rate, data for water levels for the main channels surveyed data was also collated from the Office of Public Work hydrometric data. Three levels were selected for comparison, namely 1% corresponding to a very high water level, recorded in metres above ordnance survey datum, 50% an approximate average water level and 99% a very low water level, recorded in metres above ordnance survey datum. The Poolbeg datum is used by OPW, mean sea level is about 2.7m. Also detailed is the summer months when water level was at its lowest and most constant from the graphed information.

River Name	1% mAOD	50% mAOD	99% mAOD	Description of water level during summer months
Owenriff (Oughterard)	10.86	10.43	10.30	(2003) erratic
Clare River (Corrofin)	27.91	25.97	25.17	(2003) April – Mid May, Mid June-Mid July
River Corrib (Galway)	No data available			
River Suir (Clonmel)	19.2 7	17.50	16.83	(2005) Mid June-July, August - September
Nore (John's Bridge)	45.7	44.8	44.6	(1999) Mid June – September (2000) Mid May – August (2001) Mid May – Mid August
Mulkear River (Annacotty)	12.7 9	10.87	10.57	(2004) Mid May – Mid August (2005) May-July
Maigne (Castleroberts)	10.7 2	9.81	9.03	(2005) June - September
River Feale (Listowel)	18.1 2	17.03	16.75	(2003) erratic (2004) Mid May – Mid June (2005) Mid June - July
Bandon River (Carranure)	8.28	7.42	7.04	(2004) May – Mid June (2005) Mid June – Mid July.

Table 16 Water levels of main channels surveyed for floating river vegetation.
mAOD – metres above ordnance datum

Not shown in the above data set is the effect of weirs on water levels, which may be estimated based on the hydrometric point data and the consistent water level throughout the year. For floating river vegetation the above data illustrates that a rise and fall in water levels occurs on the main channels surveyed. A direct comparison cannot be made between changes in water levels during summer and winter months, which are characteristic of Habitat EU 3260, as weirs are influential in regulating the water levels of some watercourses, colonised by aquatic vegetation. It is apparent that other factors are more important for determining floating river vegetation.

Water quality of the main channels (Table 17) and a selection of tributary rivers (Table 18) surveyed for floating river vegetation was compiled from the EPA river water quality map noting the location of the EPA sample site, the water quality status and the year in which the sampling took place. Where possible a selection of sites was chosen for each river.

River Name	Location	Pollution Rating	Year
Owenriff River	Bridge upstream Lough Corrib	Unpolluted	2002
	1km upstream Oughterard Bridge	Unpolluted	2002
	1km downstream Lough Affard	Unpolluted	2002
Clare River	Corrofin Bridge	Moderately Polluted	2003
	Bridge South of Turloughmore	Unpolluted	2003
	Clare Galway Bridge	Slightly polluted	2003
River Corrib	Salmon Weir Bridge Galway	Unpolluted	2000
River Suir	Marlfield upstream Clonmel	Unpolluted	2005
	Kilsheelin Bridge & 1.5km upstream Carrick	Moderately polluted	2005
River Nore	1 km upstream Green's Bridge	Unpolluted	2004
	Fennessy's Mill (Ossory Bridge)	Slightly polluted	2004
	North East of Warrington	Slightly polluted	2004
Mulkear River	Annacotty Bridge & 2km downstream station	Unpolluted	2002
	Ford downstream of Killeengarriff River	Unpolluted	2002
River Maigue	Howardstown Bridge	Slightly polluted	2002
	Bridge in Croom & Castleroberts Bridge	Moderately polluted	2002
River Feale	2km Downstream Listowel RHS	Unpolluted	2005
	Listowel Bridge	Unpolluted	2005
	Finuge Bridge	Moderately Polluted	2005
Bandon River	Bridge 3km South East of Dunmanway & Manch Bridge	Slightly polluted	2003
	Bridge upstream Bandon River	Unpolluted	2003

Table 17 Water quality of main channels. Rivers with floating river vegetation highlighted (yellow).

The water quality of main channels varied from unpolluted to moderately polluted.

Unpolluted rivers included the Owenriff River (2002), the River Corrib (2000) and the Mulkear River (2002). Both the River Nore (2004) and the Bandon River (2003) consisted of unpolluted and slightly polluted sections of waterway, while the River Clare (2003), River Suir (2005), River Maigue (2002) and the River Feale (2005) had stretches of moderately polluted water. Ideally details of the water quality status of 2005/ 2006 would be better for correlating water quality and floating river vegetation recorded at each site.

Table 18 lists the water quality status of a selection of tributary rivers associated with a number of the main channels listed above. Although each river supported floating river vegetation, those highlighted in yellow recorded one or more species of Water Crowfoot (*Ranunculus*).

River Name	Location	Pollution Rating	Year
Cregg River	Bridge South of Addergoole	Unpolluted	2000
(Headford and Corrib)	Bridge near Drumgriffin	Unpolluted	2000
Lingaun River	Lingaun Bridge	Slightly polluted	2005
(Suir survey square)	Bridge near Annasborough House	Unpolluted	2005
	The three rivers bridge	Unpolluted	2005
Breaghagh River	Brewery bridge	Moderately polluted	2005
(Nore survey square)	Bridge North West Aughtanny	Slightly polluted	2005
Brownstown Stream	Bridge South of Brownstown	Slightly polluted	2005
(Nore survey square)	First bridge upstream of Nore River	Slightly polluted	2005
Groody River	Bridge 2km North Caherconlish	Moderately polluted	2002
(Mulkear survey square)	Lullonan Bridge	Moderately polluted	2002
Killeengarriff River	Bridge downstream Annagh Bridge	Unpolluted	2005
(Mulkear survey square)	100m upstream Annagh Bridge	Unpolluted	2005
Dirty River	Bridge upstream Bandon	Slightly polluted	2003
	Bridge South West of Woodbrook	Unpolluted	2003

Table 18 Water quality status of tributary rivers associated with main channels.

Water crowfoot (*Ranunculus*) was present on watercourses with unpolluted or slightly polluted status. In the case of the River Breaghagh, Water crowfoot (*Ranunculus*) was evident on a stretch of river between the two sampling points. The moderately polluted status would not be applicable, only the slightly polluted status which would be in keeping with the other rivers supporting Water crowfoot (*Ranunculus*). It must be understood that correlating water quality data and floating river vegetation growth in the absence of 2005/ 2006 data must be undertaken with care as the status of some of the moderately and slightly polluted rivers may have improved since the data presented was collected.

4.4 Physical, chemical and biological features of watercourses with floating river vegetation.

A review of Irish and international reports was undertaken to obtain an overview of the physical, chemical and biological characteristics associated with watercourses supporting floating river vegetation. Measures to create a greater awareness of the causes and threats to habitat destruction along with conservation, management and rehabilitation regimes are documented.

Studies in the United Kingdom based on watercourse characteristics and the floating river vegetation found has been classified into six potential aquatic vegetation groupings (Hatton-Ellis & Grieve, 2003). Although the survey included protected and non-protected aquatic vegetation, non-protected species have been abstracted and a summary of the classes and protected floating river species are listed in Table 19.

Group	River Characteristics	Floating river vegetation
1	Large lowland rivers, slow flowing, river bed of silt or clay	<i>R.penicillatus</i> ssp. <i>Pseudofluitans</i> , <i>R.fluitans</i> , <i>P.pectinatus</i> , <i>P.crispus</i> , <i>P.lucens</i> , <i>P.natans</i> , <i>P.perfoliatus</i> , <i>C.platycarpa</i> , <i>C.stagnalis</i> , <i>M.spicatum</i> , <i>Z.palustris</i> , <i>F.antipyretica</i>
2	Small lowland rivers, bedrock is chalk and oolitic limestone, river bed consists of sand, gravel and stones	<i>R.penicillatus</i> ssp. <i>Pseudofluitans</i> , <i>P.crispus</i> , <i>P.natans</i> , <i>C.platycarpa</i> , <i>C.stagnalis</i> , <i>C.obtusangula</i> , <i>Z. Palustris</i> <i>F.antipyretica</i>
3	Large river more than 20m wide of variable flow, bedrock of sandstone or hard limestone, alkaline, fair to nutrient rich	<i>Ranunculus penicillatus</i> ssp. <i>pseudofluitans</i> , <i>Ranunculus fluitans</i> , <i>P.pectinatus</i> , <i>P.perfoliatus</i> , <i>P.crispus</i> , <i>Z.palustris</i> , <i>F.antipyretica</i>
4	River or streams usually tributaries of large rivers, variable of geological bedrock, alkaline waters, variable flow and shading	<i>R.penicillatus</i> ssp. <i>Pseudofluitans</i> <i>P.crispus</i> , <i>P.natans</i> , <i>C.humalata</i> , <i>C.platycarpa</i> , <i>C.stagnalis</i> , <i>M.alterniflorum</i> , <i>F.antipyretica</i>
5	Upland rivers, riverbed substrate consists of gravel, stones and large stones or boulders, prone to spate flow, acidic, fairly nutrient rich	<i>R.penicillatus</i> ssp. <i>Pseudofluitans</i> <i>P.crispus</i> , <i>C.humalata</i> , <i>C.stagnalis</i> , <i>M.alterniflorum</i> , <i>F.antipyretica</i>
6	Rivers of a low gradient, acidic, often associated with raised bog habitats	<i>P.polygonifolius</i> , <i>P.natans</i> , <i>C.hamulata</i> , <i>C.stagnalis</i> , <i>M.alterniflorum</i> , <i>F.antipyretica</i>
	Upland fast flowing rivers, bedrock consisting of hard rock, stable riverbed, acidic	<i>P.polygonifolius</i> , <i>C.hamulata</i> , <i>C.stagnalis</i> , <i>M.alterniflorum</i> , <i>F.antipyretica</i>

Table 19 Categories of watercourses in the United Kingdom supporting floating river vegetation (data abstracted and interpreted from Hatton-Ellis & Grieve, 2003).

Of interest in the above groupings is the presence of only two species of Water crowfoot

(*Ranunculus*) species namely *R. penicillatus* ssp. *Pseudofluitans*, *R. fluitans*. If the above diversity is the typical trend across Europe, it explains the reasoning for emphasizing water crowfoot species when classifying habitat EU 2360, watercourses of plain to montane levels, with submerged or floating vegetation. The presence of *R. penicillatus* ssp. *Pseudofluitans* in five of the six groupings suggests that it is a species that has either successfully adapted to a number of different riverine habitats or all watercourses have been subjected to substantially the same modification regime. To highlight and prevent the decline in floating river vegetation across the United Kingdom a series of Local Biodiversity Area Plans have been compiled identifying threats to aquatic vegetation and action to be taken to reduce loss. Threats to floating river vegetation include:

- Modification of watercourse depth and flow.
- Over abstraction of groundwater
- Water quality, by agricultural run-off, and cattle loafing and industrial pollution
- Increase in suspended solids within the water column
- Engineering and construction works
- Physical damage to plants by human activity
- Excessive shading by overgrown hedgerows especially on smaller watercourses.

Modification of watercourses by changing width, depth and flow of rivers has contributed to an increase in siltation of some rivers during summer months as water levels drop.

Over abstraction of groundwater can result in lower water levels and drier watercourses, increased risk of pollution and higher rates of siltation.

Reduction in water quality and the nutrient loading of watercourses can favour the growth of other aquatic vegetation. It has been reported that *R. fluitans* can tolerate slight pollution but is intolerant of water turbidity (Northern Ireland Species Action Plan).

Engineering work including the building of bridges and reservoirs can alter the flow of watercourses. It has suggested that the use of concrete and cement components in aquatic environments impacts on the physical and chemical characteristics of watercourses (Hatton-Ellis & Grieve, 2003).

Human leisure activities can cause shearing and hence damage to floating river vegetation (Cheshire-biodiversity, Northern Ireland Species Action Plan).

Excess shading from hedgerows, riparian woodland or managed woodland has also been identified as a threat to floating river vegetation by reducing the availability of sunlight (O' Grady, 2006).

Management and conservation strategies for the preservation of existing floating river vegetation habitats and habitat enhancement include:

- Survey watercourses to determine the extent of floating river vegetation
- Promote floating river vegetation as part of watercourse management plans
- Increase awareness of floating river vegetation
- Restrict livestock access to watercourses
- Restoration of watercourses with riffles and pools
- Emphasis on hedgerow species and management
- Management of floating river vegetation

It is estimated that twenty percent of Europe's *R.fluitans* can be found in the United Kingdom, with a single *R.fluitans* occurrence recorded in Ireland on the Six Mile River in Co. Antrim (Curtis, & McGough, 1988, Cheshire-biodiversity, Northern Ireland Species Action Plan).

As habitat EU 3260 is not a priority habitat the extent of floating river vegetation, especially *R.fluitans* may be greatly underestimated. Further surveys of watercourses for floating river vegetation are needed to confirm species diversity.

The Water Framework Directive requires that all watercourses obtain good ecological status by 2015. As part of the on going monitoring of water quality monitoring local, regional and national strategies should support and promote the development of floating river vegetation, thus increasing awareness. Restricting livestock will benefit watercourses by protecting banks against erosion, eliminating the grazing of aquatic vegetation and reducing agricultural waste product loading of freshwater habitats. (European Water Framework Directive).

Introduction of riffles and pools to modified or maintained rivers may encourage the growth of floating river vegetation. In some cases replanting of aquatic species downstream has been undertaken in watercourses to benefit fish species (Wild Trout Trust).

The relationship between hedgerow height and density to river width must also be considered. Excessive shade will reduce and eliminate floating river vegetation species diversity (O'Grady, 2006, Hatton-Ellis & Grieve, 2003).

5.0 Mitigation measures

Habitats supporting designated floating river vegetation species *Ranunculus trichophyllus*,

Ranunculus fluitans, *Ranunculus peltatus*, *Ranunculus penicillatus*, *Ranunculus penicillatus* ssp. *penicillatus*, *Ranunculus aquatilis*, *Myriophyllum* spp., *Callitriche* spp., *Berula erecta*, *Zannichellia palustris*, *Potamogeton* spp., *Fontinalis antipyretica* are provided legal protection under the European Communities (Natural Habitats) Regulations, 1997. A survey of Office of Public Works main channels found that all five watercourses had floating river vegetation present. Only three of the five main channels had floating river vegetation as a conservation aspect. From an ecological perspective floating river vegetation has been identified as an important and valuable habitat for freshwater invertebrates including shrimp, snail, insect larvae and nymph (Northumberland National Park). To provide protection and shelter for fish, replanting of floating river vegetation as part of Conservation Plans has been undertaken in the United Kingdom (The Wild Trout Trust).

Currently, the Environmental Drainage Maintenance (EDM) Programme, in conjunction with the Central Fisheries Board (section 4.1) is addressing the needs of fish species and their habitat. Since fish and vegetation differ from each other so do their requirements. As this survey has been commissioned to investigate the ecological impact of statutory Arterial Drainage maintenance activities on watercourses supporting floating river vegetation (section 1.3) this chapter will endeavour to highlight some of the environmental dynamics that favour floating river vegetation and measures to minimise disturbance to and the impact of arterial drainage upon plant species.

5.1 Measures found to influence floating river vegetation

•Consideration of river depth, width, flow

The growth of floating river vegetation and ultimately species diversity is dependent on river depth, width and flow. Some species of pondweed prefer deep water, slow shallow water favours aquatic moss, *R.fluitans* and *R.penicillatus* require fast flows while *R.peltatus*, *P.natans* and *C.stagnalis* thrive in slow or still water. However, not all watercourses are suited to floating river vegetation growth. Watercourses prone to rapidly rising and dropping flood levels especially during summer months do not favour floating river vegetation (see section 4.3). Maintenance work can influence species diversity depending on work undertaken. In the long-term channel enhancement should include pools and riffles thereby improving instream channel bed diversity.

•Riverbed substrate and bedrock.

The primary riverbed substrate of watercourses favouring water crowfoot (*Ranunculus*) species consisted of stone, gravel and sand. Channels with high levels of silt deposition were frequently colonised by water parsnip or pondweed species in deeper waters. A combination of stone, gravel, sand and some silt provided a habitat that could support a greater diversity of floating river vegetation (section 4.3). Limestone bedrock is more favourable to the growth of floating river vegetation in comparison to acidic environments. Care should be taken not to remove all silt deposited in watercourses during arterial drainage works especially if floating river vegetation has been identified upstream, on-site or downstream of works. Silt is a root medium, a source of minerals and a potential seed bank for aquatic plants.

- Water quality

Factors affecting water quality include total suspended solids, turbidity and nutrient loading leading to eutrophication. Water status is measured at a range sites by the EPA. A comparison between water status and the presence of floating river vegetation (section 4.3) indicated that water classified as slightly polluted can be tolerated by some species of water crowfoot. It has been reported in other work that water crowfoot is less tolerant of turbid water (Hatton-Ellis & Grieve, 2003). It is important; therefore, that arterial drainage maintenance work undertaken ensures that a minimal amount of suspended solids is generated, thereby reducing the turbidity of waters supporting floating river vegetation during summer months. It is recognised that floods cause naturally high turbidity levels. A four to six year maintenance cycle should manage the level of turbidity and impact positively on floating river vegetation plant communities.

- Rate of siltation

High rates of silt deposition are detrimental to the survival of aquatic vegetation. An increase in the riverbed level reduces the aquatic nature of a watercourse by limiting water dynamics in terms of flow, level and depth. Changing these factors allows the invasion of terrestrial plant species resulting in the conversion from an aquatic to a terrestrial habitat through the rapid rate of sedimentation. Controlling the level of silt build-up in watercourses under the Environmental Drainage Maintenance (EDM) Programme (section 4.1) will ensure that floating river vegetation can compete successfully in an appropriate aquatic environment.

- Shade/ sunlight availability

As discussed in chapters 3.5 and 4.4 shade has been found to reduce floating river diversity. Riparian woodland habitats on the banks of large, wide watercourses do not appear to affect floating river vegetation. Large hedgerows on smaller watercourses will cause shade and reduce floating

river diversity. Under REPS 3, measure 5 option 3b new hedgerow replanting is encouraged. To prevent excessive shading of watercourses and provision of access for maintenance machinery, unplanted sections should be left in the proposed hedgerow rather than planting a continuous hedgerow. Hedgerow management should include coppicing to provide variation in hedgerow density shape and height. Management of trees during watercourse maintenance would be beneficial to floating river vegetation.

5.2 Influence of current Environmental Drainage Maintenance work practices

The current drainage maintenance under the guidance of the Environmental Drainage Maintenance Programme is and will be beneficial for floating river vegetation. For the most part the 10 step recommendations for fish species are also applicable to floating river vegetation. To benefit floating river vegetation the following adjustments to the current Environmental Drainage Maintenance Programme should be considered.

- Removal of vegetation should not be restricted to instream vegetation. Marginal vegetation may need to be removed especially if there is encroachment by terrestrial plant species from the river bank. Plant species such as watercress and foals watercress may also require controlling.
- Phragmites, Bulrush, Bur-reed, Water celery and large marginal grasses need to be contained or removed during maintenance. Excessive growth of these plants will lead to a greater rate of siltation, reducing the aquatic environment for floating river vegetation.
- Riparian woodland on wide rivers was not found to interfere with the colonisation and growth of floating river vegetation. Dense sections of Willow and overgrown hedgerows on channels of less than three metres wide did reduce the level of sunlight reaching the watercourse floor. Without sunlight plants cannot produce food through photosynthesis to sustain growth. Appropriate tree management should allow sunlight penetrate the riverbed.
- Development of two stage channels could be beneficial to floating river vegetation. A fast flowing slightly deeper section of gravel base would favour water crowfoot species. Deep sections of river would facilitate some species of pondweed. Shallow areas of slow flow prone to sedimentation would be ideal for the water parsnip.
- Placement of boulders in channels following maintenance will also be beneficial for the propagation and colonisation of floating river vegetation especially if there is evidence of floating river vegetation species upstream.
- There would be an element of concern regarding the loosening of channel bed gravel between mid June to mid August. Seeds associated with floating river vegetation would be present on the channel bed and or may be in the process of germination for the following year. Loosening gravel may cause the seed to be buried beneath a gravel layer or be washed away. Should the

gravel require loosening assess the abundance of floating river vegetation upstream and downstream of the site. High levels of suspended solids due to gravel loosening at the time of flowering will impact negatively on *Ranunculus fluitans* especially. Where there is an abundance of floating river vegetation the plant species should be able to cope and adapt to loosening of channel gravel. It may also be worth considering that the presence of *Ranunculus* species growing in gravel on the channel bed may be indicative of a healthy gravel base with plenty of aeration, nutrient cycling and loose gravel base, elements essential for plant growth.

- It is essential to note that floating river vegetation growth is seasonal. Local knowledge and cross reference with Regional Fisheries Board requirements on channel clearing or river bed aeration prior to the commencement of maintenance would be highly recommended.

5.3 Specific Office of Works mitigation measures and other Statutory Bodies

The following mitigation measures have been separated into those measures that can be directly adopted by the Office of Public Works; and those that involve other Statutory Bodies.

Office of Public Works: At present the Office of Public Works have developed a ten step Environmental Drainage Maintenance programme to provide appropriate habitats for fish. On a long term basis a similar programme needs to be developed to identify floating river vegetation. While this ecological assessment has made every effort to provide the reader with a detailed overview of floating river diversity this needs to be developed further through training.

- On-site training and awareness of Office of Public Works staff members is essential for habitat recognition and plant identification of floating river vegetation communities.

Office of Public Works: Arterial drainage work, undertaken in or adjacent to urban environments, on watercourses supporting floating river vegetation should facilitate a rise in water levels during winter months and the fall in water levels in summer. The cyclical change in level between flood and low water levels is a necessary dynamic of floating river vegetation habitat. Fresh silt deposition provides a renewed growing medium while the mechanical force of rising water facilitates plant reproduction and distribution during rising water levels. A drop in water levels during summer months favours the production of flowering structures (section 3.4).

- Variation in water levels through the year should be facilitated in the operation of existing works and considered in the design of new works.

Office of Public Works: In horticulture $\frac{1}{2}$ to $\frac{2}{3}$ of the plant material may be removed (Spence, I. 2001) without adversely affecting the growth of plants. This rule of thumb for the removal or

extraction of floating river vegetation during channel maintenance should be applied where a large amount of floating river vegetation exists especially in watercourses of high nutrient levels. This approach has successfully worked for reed beds (Ní Bhroin, 2004) and should work for channel maintenance. Removal of root material provides expansion space for remaining roots therefore reducing overcrowding, encouraging regeneration of root material resulting in improved nutrient cycling and reducing the likelihood of disease or stressed plant growth.

- In the case of large amounts of floating river vegetation growth especially in watercourses of high nutrient levels $\frac{1}{2}$ to $\frac{2}{3}$ of the plant material should be removed and placed away from the watercourse to prevent leaching of the nutrients back into the watercourse.
- In the case of a moderate amount of floating river vegetation less than half should be removed on watercourses with low nutrient levels.
- In the case of limited occurrence of protected plant species it would be advisable to retain all growth present.

Other Statutory Bodies: In accordance to REPS 3 Measure 3 “The Protection and Maintenance of Waterbodies and Wells” the emphasis is on the maintenance of channels with option 3a referring to the proximity of livestock to watercourses. During the course of the survey a number of smaller channels, outside the remit of the Office of Public Works, were found to be recently regraded, widened and deepened. Raising awareness of the nature and methodology of regrading and silt removal work carried out by the Office of Public Works under the Environmental Drainage Maintenance Programme is essential. Incorrect maintenance upstream may impact negatively on arterial drainage channels downstream.

- The Central Fisheries Board / Office of Public Works Environmental Drainage Maintenance Programme should be extended to all drainage work on watercourses. This might be implemented through REPS.

Other Statutory Bodies: Restricting access of livestock to watercourses will reduce the possibility of eutrophication, destruction of riverbed by compaction, the prospect of floating river vegetation being eaten by livestock and the erosion of riverbanks (important for water parsnip) by excessive trampling (Northern Ireland Action Plan, O’Grady, 2006, Hatton-Ellis & Grieve, 2003). In fields not supplied with piped water supplying access to water at the waters edge which is fenced on all sides (drinking slips) is an acceptable compromise (REPS 3). River banks eroded by livestock were observed favouring terrestrial plant species and not aquatic species. Damage to channel banks appeared to produce the same effect as the build-up of large silt deposits.

- Livestock should be restricted from entering watercourses except at fenced drinking slips.
This is a measure under REPS 3 and should be extended to other landholdings.

5.4 The impact of floating river vegetation on rising water levels and flow rate.

Identifying floating river vegetation, which may be impacting negatively upon water flow, may not always be obvious. Since arterial drainage maintenance is typically on a four to six year rotation (section 4.2), areas of floating river vegetation should be noted and recorded during summer months and a similar assessment undertaken during the winter months (comparative digital images would suffice) prior to the undertaking of arterial maintenance work. Such an undertaking will assist in the selection of floating river vegetation impacting negatively on water flow during winter months. It may be that non-floating river vegetation species may be impacting on water dynamics, which in turn impacts negatively on floating river vegetation communities. The initial impact may simply be a change in the pattern of floating river vegetation growth. Obstructions by non-floating river vegetation is indicated in Fig. 9 by the rippling of the water flow and the divergence of the floating river vegetation to either side of the restriction.

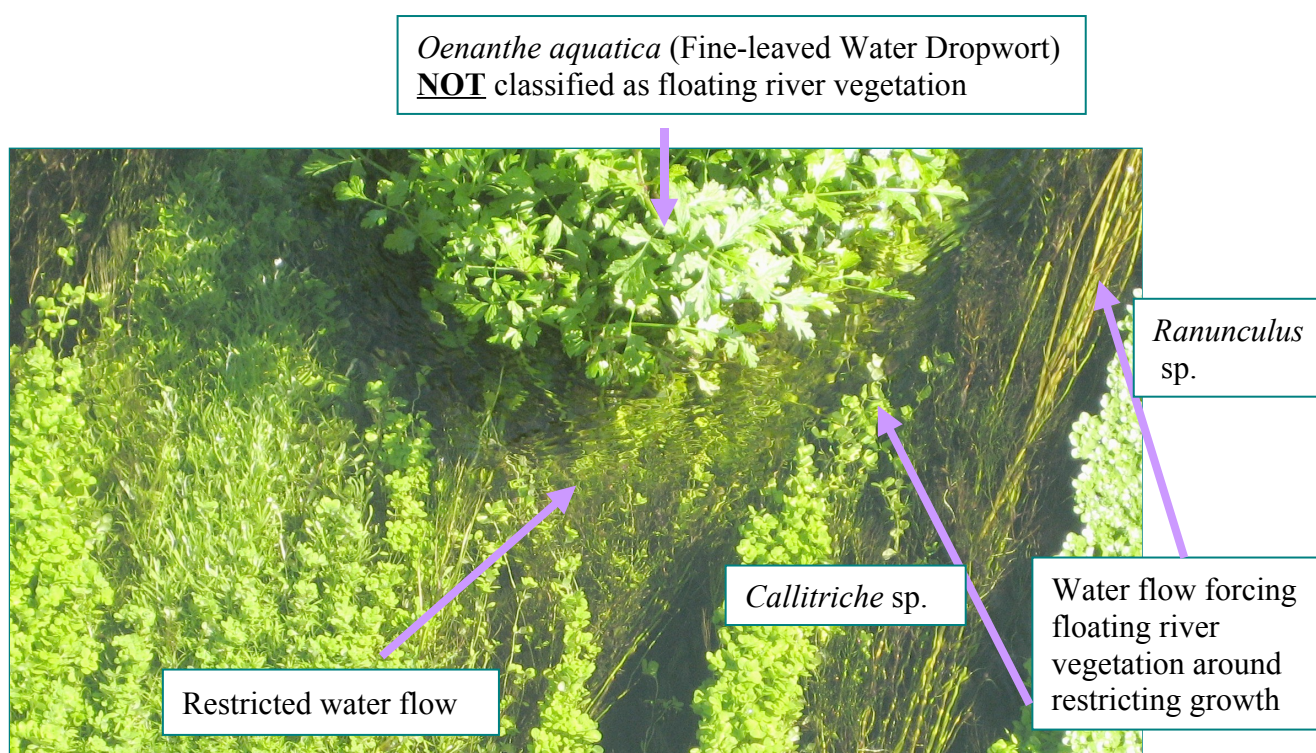


Fig. 9 Impact of *Oenanthe aquatica* on surrounding floating river vegetation and water flow.

A comparison between summer flow and winter flow suggests that the location of some floating river vegetation may interfere or change flow capacity at higher water levels. Fig. 21 shows photographs of the River Breaghagh in Kilkenny during the summer with floating river vegetation

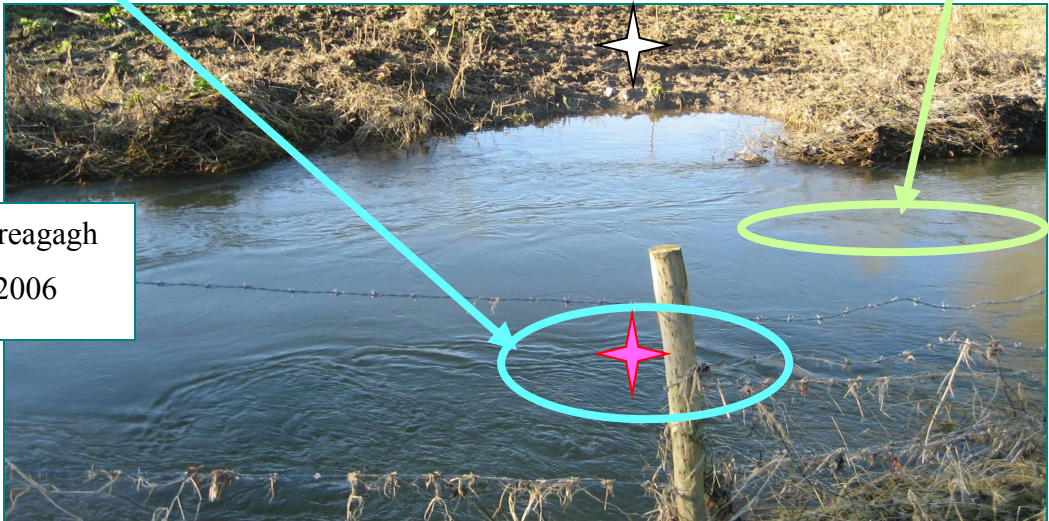
and in winter with the river in flood (Summer and Winter 2006)

River Breagagh
Summer 2006

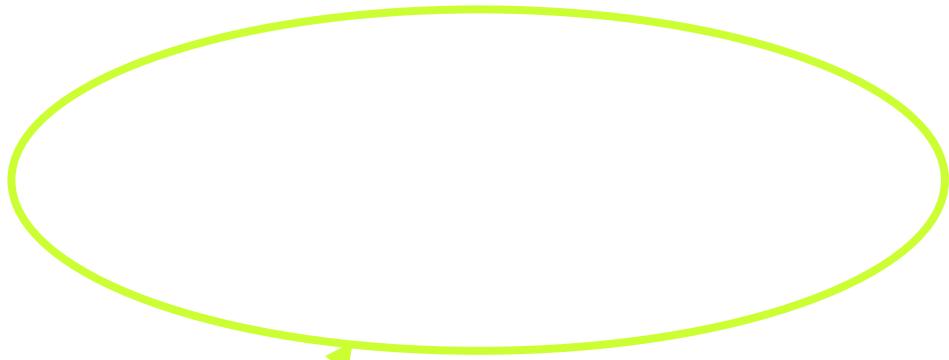


River colonised by Water Parsnip growth

River Breagagh
Winter 2006



River Breagagh
Summer 2006



River colonised by Ranunculation growth

River Breagagh
Winter 2006



✧ Corresponding points in summer and winter

River Breagagh
Summer 2006

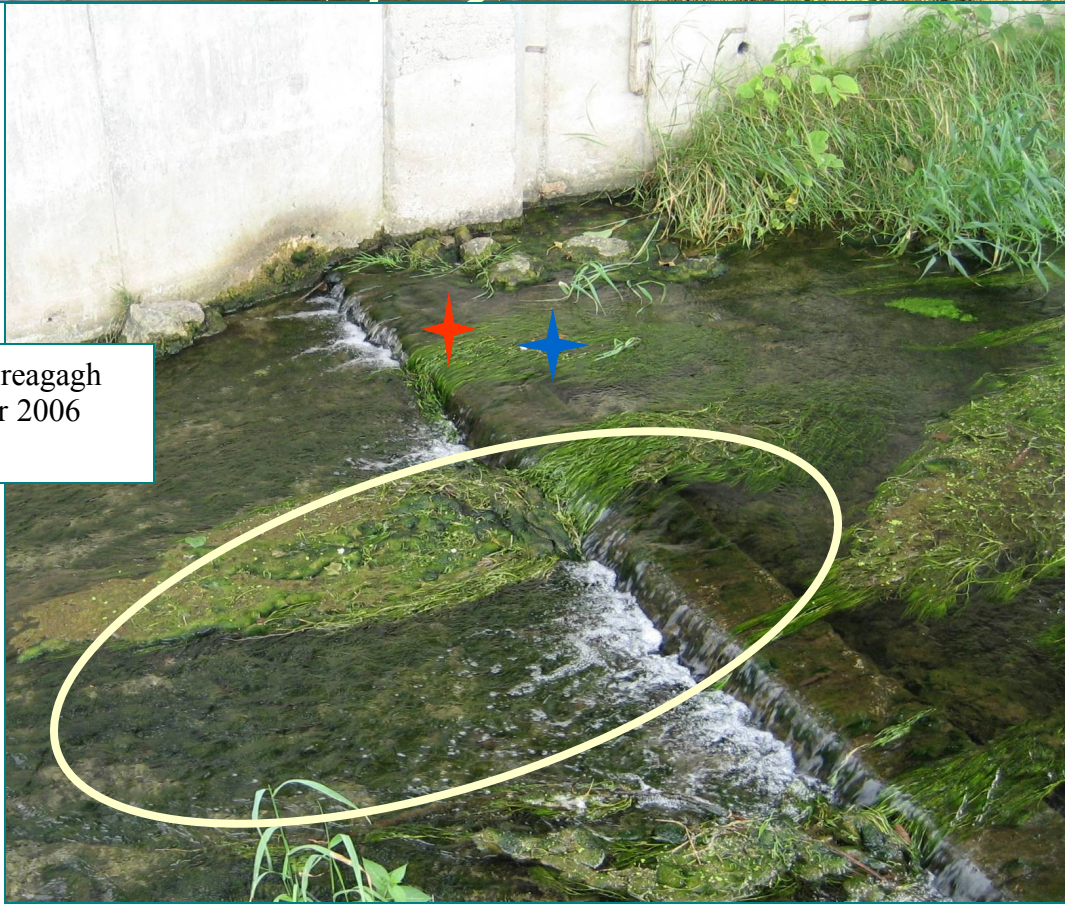


Absence of floating river vegetation during summer months due to excess shading

River Breagagh
Winter 2006



River Breagagh
Summer 2006



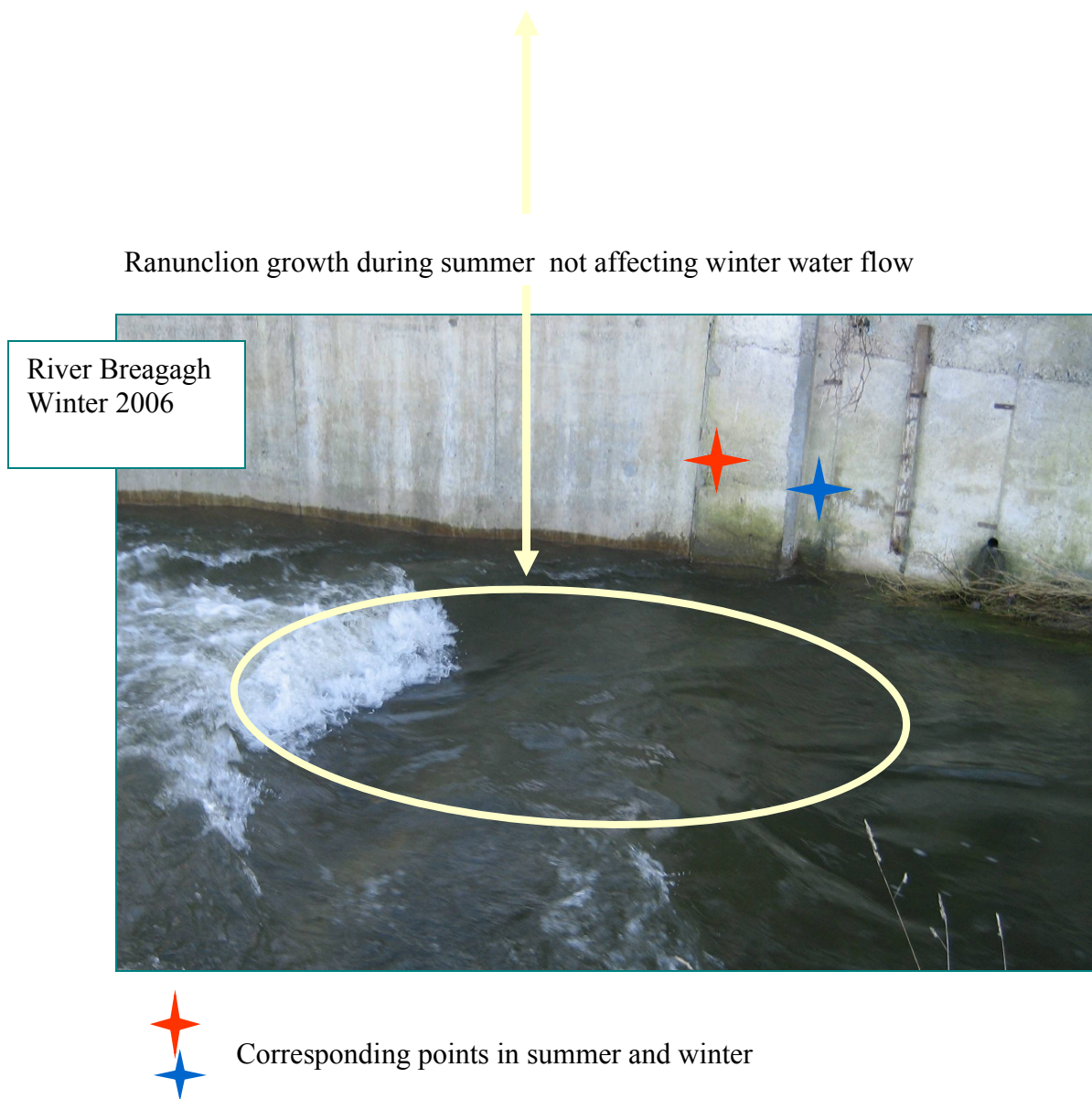


Fig. 10 Effect of floating river vegetation growth on winter water flow on the River Breagagh (Site 5) survey site.

Water crowfoot adjacent to the weir does not appear to interfere with winter flow. Further upstream the eroded riverbank that supported water parsnip is totally submerged. Its location is illustrated by a series of vortices evident on the water surface. An alternative situation is occurring on the bend of the river, the area supporting the water crowfoot during the summer months is depicted as an area of minimal energy flow. Whether the vegetation has adapted to a section on the river where the flow has differed due to some environmental dynamic or that the vegetation has exerted a regime on the water flow is not entirely clear. It is likely that a difference in flow dynamic has enabled the colonisation of floating river vegetation and consequently the presence of the plant growth is facilitating further change in the surrounding environment (Fig. 10) which, if unmaintained would result in silt build-up and replacement by different plant species over time. In

ecological terms this is known as “succession”.

6.0 Conclusion and summary

- Arterial drainage works, which involve excavation of the riverbed, are likely to cause a significant negative impact on floating river vegetation and their habitats. If hydraulic conditions are suitable floating river vegetation may recolonise the watercourse.
- Arterial drainage maintenance carried out in accordance with the Environmental Drainage Maintenance (EDM) Programme causes a minor negative impact or a minor positive impact on habitats supporting floating river vegetation. The mitigation measures proposed will tend to lead to a minor positive impact. In certain cases excessive floating river vegetation growth may occur and additional maintenance may be required in these circumstances.
- Floating river vegetation was present on most Office of Public Works main channels. No floating river was evident on the River Maigue. It is uncertain whether floating river vegetation was present on the Owenriff River due to flood waters observed during the survey.
- Parameters influencing the diversity of floating river vegetation include shade, water depth and water flow. Other parameters that affect growth are water quality, adjoining land use, riverbed substrate and habitat encroachment by terrestrial plant species.
- In general terms deep waters were inhabited by Pondweed species. Fast water flow favoured some water crowfoot species; slow water flow favoured other water crowfoot species, starworts, and some pondweed species. Shallow water supported aquatic moss and sections of watercourses with silt deposits were colonised by water parsnip.
- Although no confirmed identification of *R. fluitans* was recorded during the course of this survey, the true species identification of *Ranunculus* spp. could not be undertaken due to the absence of flowering structures.

Further studies recommended.

- Very strongly recommended is an addendum to this report to confirm the identification of *Ranunculus* sp. during the flowering season May -early June. The presence of flowering structures is essential for the definitive identification of species.
- Habitat mapping of all Office of Public Works channels is recommended using the framework identified by Fossitt, 2000. Knowledge of the habitats of channels could be used to predict areas at risk of flooding, environmentally sensitive habitats and changes in land use and is strongly recommended.
- Assessment of species diversity and distribution of alien plant species with emphasis on the Japanese knotweed (terrestrial environments) and the Parrot milfoil (aquatic environments) is strongly recommended. Control measures are likely to be required for these species in the near future.
- A study to correlate floating river vegetation with water quality and the identification of an indicator species of eutrophic conditions is recommended.
- A Heritage study of the natural environment focusing on landscape change and land management practices in the last twenty years that would have had an impact on OPW channels is recommended.
- A biodiversity assessment of sensitive channels on a seasonal basis to monitor diversity over a period of 12 months is recommended.

References

- Blamey, M., Fritter, R. and Fritter A. (2003). *Wild Flowers of Britain & Ireland*. A&C Black London.
- Cheshire Local Biodiversity Action Plan. River Water-Crowfoot (*Ranunculus fluitans*) www.cheshire-biodiversity.org.uk
- Council Directive 92/43/EEC On The Conservation Of Natural Habitats And Of Wild Fauna And Flora.
- Curtis, T.G.F. & McGough, H.N. (1988) *1 Vascular plants. The red Irish Data Book*. The Stationary Office, Dublin.
- Environmental Protection Agency. River Water Quality at <http://maps.epa.ie>
- EUNIS. Habitats-factsheet at <http://eunis.eea.europa.eu>
- European Water Framework Directive www.wfdireland.ie
- Farmer's Handbook For REPS 3 at www.agriculture.gov.ie
- Fossitt, J. A (2000). A Guide to Habitats in. Ireland. The Heritage Council, Kilkenny
- Hale, A. Mosses and Liverworts in Wales at <http://home.clara.net>
- Hatton-Ellis TW & Grieve N (2003). *Ecology of Watercourses Characterised by Ranunculus fluitans and Callitriche-Batrachium Vegetation*. Conserving Natura 2000 Rivers Ecology Series No. 11. English Nature, Peterborough.
- Mooney, E. P. & O Connell, M. (1990). The Phytosociology and Ecology of the Aquatic and the Wetland Plant Communities of the Lower Corrib Basin, Co. Galway. Proceedings of the Royal Irish Academy **90B** (5).
- National Parks and Wildlife Services. Conservation Sites at www.npws.ie
- Natura, (2000). Interpretation Manual of European Union Habitats. European Commission, DG Environment, Nature and Biodiversity.
- Ní Bhroin, N. (2004). Methods For Sludge Disposal. Unpublished report for Offaly County Council.
- Northern Ireland Species Action Plan (2005). River Water Crowfoot *Ranunculus fluitans* at www.ehnsi.gov.uk/riverwatercrowfoot.pdf
- Northumberland National Park. Water Crowfoot at www.northumberland-national-park.org.uk
- Office of Public Works (2007). *Screening of Natura 2000 Sites for Impacts of Arterial Drainage Maintenance Operations*. Series of Ecological Assessments on Arterial Drainage Maintenance No. 1. Environment Section, Office of Public Works.
- Office of Public Works. Engineering Service at www.opw.ie
- O' Grady, M. F. (2006). *Channels & Challenges. Enhancing Salmonid River*. Irish Freshwater

Ecology & Management Series: Number 4, Central Fisheries Board, Dublin, Ireland.

- Personal Communication (Mr. Brian O' Neill) Technical Staff, Office of Public Works, Limerick.
- Statutory Instrument No. 3/1945 Arterial Drainage Act, 1945
- Statutory Instrument No. 39/1976 Wildlife Act, 1976
- Statutory Instrument No. 14/1995 Arterial Drainage (Amendment) Act, 1995
- Statutory Instrument No. 94/1997 European Communities (Natural Habitats) Regulations 1997
- Statutory Instrument No. 233/1998 European Communities (Natural Habitats) (Amendment) Regulations 1998 (commonly referred to as the Habitats Directive).
- Spence, I (2001). *Gardening Through the Year*. A Dorling Kindersley Book.
- Spink, A. (1992). *The Ecological Strategies of Aquatic Ranunculus species*. PhD Thesis, University of Glasgow.
- The National Archives of Ireland. Office of Public Works at www.nationalarchives.ie
- The Wild Trout Trust. Water crowfoot re-introduction Project (River Coln -Oxfordshire) at www.wildtrout.org
- Webb, D.A., Parnell, J. & Doogue, D. (1996) *An Irish Flora*. Dundalgan Press, Dundalk.

Appendix A - Special Areas of Conservation classification of habitat type

Lough Corrib Special Areas of Conservation

European Union classification		Status	Irish habitat classification	
Code	Description		Code	Description
6210	Semi-Natural Dry Grassland and Scrubland Facies on Calcareous Substrates	Priority	GS1	Dry calcareous and neutral grassland
7110	Active Raised Bogs	Priority	PB1	Raised bog
7210	Calcareous Fens with <i>Cladium mariscus</i>	Priority	PF1	Rich fen and flush
7220	Petrifying Springs with Tufa Formation	Priority	FP1	Calcareous springs
8240	Limestone Pavements	Priority	ER2	Exposed calcareous rock
91D0	Bog Woodland	Priority	WN7	Bog woodland
3110	Oligotrophic Waters containing very few minerals of Sandy Plains	Important	FL2	Acid oligotrophic lakes
3140	Hard Oligo-Mesotrophic Waters with Benthic Vegetation of <i>Chara</i> Spp.	Important	FL3	Limestone / marl lakes
3260	Water Courses of Plain to Montane Levels with Aquatic Vegetation	Important	FW1	Eroding / upland rivers
6410	<i>Molinia</i> Meadows on Calcareous, Peaty or Clayey-Silt-Laden Soils	Important	GS4	Wet grassland
7120	Degraded Raised Bogs Still Capable of Natural Regeneration	Important	PB1	Raised Bog
7150	Depression on Peat Substrates of the Rhynchosporion.	Important	PB1	Raised Bog
7230	Alkaline Fens	Important	PF1	Rich fen and flush
91A0	Old Sessile Oak Woods with <i>Ilex</i> and <i>Blechnum</i> in British Isles	Important	WN1	Oak-birch-holly woodland

Lower River Suir Special Areas of Conservation

European Union classification		Status	Irish habitat classification	
Code	Description		Code	Description
91E0	Alluvial Forest	Priority	WN4	Wet-pedunculate oak-ash woodland
91J0	<i>Taxus baccata</i> Woods of the British Isles	Priority	WN3	Yew woodland
1330	Atlantic Salt Meadows	Important	CM1 / CM2	Lower salt marsh / Upper marsh
1410	Mediterranean Salt Meadows	Important	CM2	Marram dunes
3150	Natural Eutrophic Lakes	Important	FL5	Eutrophic lakes
3260	Water Courses of Plain to Montane Levels with Aquatic Vegetation	Important	FW1	Eroding / upland rivers
91A0	Old Sessile Oak Woods with <i>Ilex</i> and <i>Blechnum</i> in British Isles	Important	WN1	Oak-birch-holly woodland

River Barrow and River Nore Special Areas of Conservation

European Union classification		Status	Irish habitat classification	
Code	Description		Code	Description
91E0	Alluvial Forest	Priority	WN4	Wet-pedunculate oak-ash woodland
7220	Petrifying Springs with Tufa Formation	Priority	FP1	Calcareous springs
1130	Estuaries	Important	SS2/ SS3	Infralittoral muddy sands/ Infralittoral muds
1140	Mudflats and Sandflats not covered by seawater at low tide	Important	LS2	Sand shores
1310	Salicornia and other Annuals Colonizing Mud and Sand	Important	CM1	Lower salt marsh
1330	Atlantic Salt Meadows	Important	CM1 / CM2	Lower salt marsh Upper marsh
1410	Mediterranean Salt Meadows	Important	CM2	Marram dunes
3150	Natural Eutrophic Lakes	Important	FL5	Eutrophic lakes
3260	Water Courses of Plain to Montane Levels with Aquatic Vegetation	Important	FW1	Eroding / upland rivers
4030	European Dry Heaths	Important	HH1	Dry siliceous heath
91A0	Old Sessile Oak Woods with <i>Ilex</i> and <i>Blechnum</i> in British Isles	Important	WN1	Oak-birch-holly woodland

Lower River Shannon Special Areas of Conservation

European Union classification		Status	Irish habitat classification	
Code	Description		Code	Description
1150	Coastal Lagoons	Priority	CW1	Lagoons and saline lakes
91E0	Alluvial Forest	Important	WN4	Wet-pedunculate oak-ash woodland
1110	Sand Banks which are slightly covered by sea water at all times	Important	SS1	Infralittoral gravels and sands
1130	Estuaries	Important	SS2/ SS3	Infralittoral muddy sands/ Infralittoral muds
1140	Mudflats and Sandflats not covered by seawater at low tide	Important	LS2	Sand shores
1160	Large Shallow Inlets and Bays	Important	MW2	Sea inlets and bays
1170	Reefs	Important	SR1	Exposed infralittoral rock
1220	Perennial Vegetation of Stony Banks	Important	CB1	Shingle and gravel bank
1230	Vegetated Sea Cliffs of the Atlantic and Baltic Coasts	Important	CS2	Sea stacks and islets
1310	Salicornia and other Annuals Colonizing Mud and Sand	Important	CM1	Lower salt marsh
1410	Mediterranean Salt Meadows	Important	CM2	Marram dunes
3260	Water Courses of Plain to Montane Levels with Aquatic Vegetation	Important	FW1	Eroding / upland rivers
6410	<i>Molinia</i> Meadows on Calcareous, Peaty or Clayey-Silt-Laden Soils	Important	GS4	Wet grassland

Bandon River Special Areas of Conservation

European Union classification		Status	Irish habitat classification	
Code	Description		Code	Description
91E0	Alluvial Forest	Priority	WN4	Wet-pedunculate oak-ash woodland
3260	Water Courses of Plain to Montane Levels with Aquatic Vegetation	Important	FW1	Eroding / upland rivers

Appendix B – Site elevations surveyed

Lough Corrib Special Area of Conservation - Owenriff River survey square

Channel reference	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
Owenriff River - Main scheme	M 11610,42625	14m	4	√
Site (1)	M 14732, 38968	25m	1	
Site (2)	M 14524, 40557	10m	3	√
Site (3)	M 14850,40550	10m	4	
Site (4)	M 15108, 41974	5m	1	
Loughseecon (Site 5)	M 10059, 38445	22m	2	
Owenriff River (Site 6)	M 06945, 41994	35m	4	√
Site (7)	M 10059, 38445	147m	1	
Site (8)	M 08251, 38093	168m	2	
Site (9)	M 08120, 38083	167m	1	

Lough Corrib Special Area of Conservation – Clare River survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
Clare River - Main scheme	M 37218, 33108	13m	5	√
Cregg River (Site 1)	M 30172, 34510	0m	3	√
Cregg River (Site 2)	M 31264, 35820	3m	3	√
Cregg River (Site 3)	M 35365, 37837	12m	2	√
Waterdale River (Site 4)	M 36510, 35614	6m	2	√
Clare River (Site 5)	M 34573, 33145	5m	1	√

Lough Corrib Special Area of Conservation – River Corrib and Headford survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
River Corrib - Main scheme	M 29690, 27875	4m		√
Black trib. (Site 1)	M 25573, 49097	10m	4	√
Black trib. (Site 2)	M 25431, 48518	7m	2	√
Black trib. (Site 3)	M 25229, 48747	8m	1	√
Black River (Site 4)	M 25925, 48715	7m	2	√
Black trib. (Site 5)	M 21650, 47590	8m	2	√
Black River (Site 6)	M 19545, 47611	2m	4	√

Lower Suir Special Area of Conservation – River Suir survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
River Suir - Main scheme	S 40375, 21502	0m	6	√
Suir trib. (Site 1)	S 37057, 19352	77m	3	
Glen River (Site 3)	S 39711, 21900	11m	3	
Suir trib. (Site 4)	S 42950, 20122	68m	2	
Lingaun River (Site 5)	S 41399, 24790	12m	4	
Clodiagh trib. (Site 6)	S 41208, 17889	74m	2	
River Suir (Site 7)	S 28646, 23210	9m	6	
River Suir (Site 8)	S 23909, 22857	12m	6	

River Barrow and River Nore Special Area of Conservation – River Suir survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
River Nore - Main scheme	S 54209, 54105	37m	6	√
Breaghagh river (Site 1)	S 45983, 53348	75m	2	
Site (2)	S 48979, 55710	52m	3	
Site (3)	S 48194, 56959	109m	2	
Stoney stream (Site 4)	S 444794, 56843	121m	1	
Breaghagh river (Site 5)	S 50064, 56077	45m	4	√
River Nore (Site 6)	S 53036, 55005	52m	1	
Pocock trib. (Site 7)	S 52974, 59158	62m	1	
River Nore (Site 8/9)	S 53038, 54618	38m	6	
Pococke river(Site 10)	S 52982, 55417	60m	4	

Lower River Shannon Special Area of Conservation – Mulkear River survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
Mulkear River - Main scheme	R 64315, 57441	8m	6	√
Mulkear trib. (Site 1)	R 66233, 57104	18m	2	
Killeenagarraiff River (Site 2)	R 67875, 54940	20m	5	√
Killeenagarraiff trib. (Site 3)	R 68854, 55815	34m	1	
Killeenagarraiff River (Site 4)	R 68234, 56368	26m	5	√
Killeenagarraiff River (Site 5)	R 68337, 57818	24m	4	√
Killeenagarraiff trib. (Site 6)	R 70167, 58664	49m	3	√
Mulkear River (Site 7)	R 72192, 50799	34m	6	
Mulkear trib. (Site 8)	R 70052, 51729	31m	2	
Groody River (Site 9)	R 63561, 54313	27m	4	√
Groody River (Site 10)	R 62427, 55157	14m	4	√

Lower River Shannon Special Area of Conservation – River Maigue survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
River Maigue - Main scheme	R 48244, 52404	0m	6	√
Site (1)	R 45488, 53618	0m	2	√
Site (2)	R 46367, 54118	1m	1	√
Maigue trib.(Site 3)	R 47163, 53072	1m	1	√
Site (5)	R 44837, 54174	4m		
River Maigue (Site 6)	R 47068,56974	8m		
Maigue trib (Site 7)	R 47466,50590	1m		

Lower River Shannon Special Area of Conservation – River Feale survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
River Feale - Main scheme	Q 98606, 33800	17m	6	√
Feale trib. (Site 2)	Q 95871, 30499	2m	2	
Feale trib. (Site 3)	Q 94383, 29820	1m	3	√
Feale trib. (Site 4)	Q 92957, 31141	5m	3	√
River Feale (Site 5)	Q 95142, 32071	19m	6	√
Galey River (Site 6)	Q 94120, 34382	0m	4	
Galey trib. (Site 7)	Q 94955, 33755	0m	1	√
Feale trib. (Site 8)	Q 93731, 30937	1m	4	√
Smearlagh River (Site 9)	R 02470, 32376	31m	5	

Bandon River Special Area of Conservation – Bandon River survey square

Channel name	Location coordinates	Elevation (approx.)	EPA stream order	OPW channel
Bandon River Main scheme	W 24037, 53056	53m	5	√
Bandon River (Site 1)	W 25680, 51306	43m	6	
Dirty River (Site 2)	W 22415, 52238	51m	5	
Brewery River (Site 3)	W 21349, 50166	77m	3	
Kealrootha trib. (Site 4)	W 22306, 49650	121m	1	
Glasheenahielan trib. (Site 5)	W 23536, 48564	120m	2	
Garrown River (Site 6)	W 11908, 56681	99m	3	
Bandon River (Site 7)	W 24488, 56522	75m	4	
Blackwater trib. (Site10)	W 26635, 58044	124m	1	

Appendix C – Habitat classification of survey sites

Lough Corrib Special Area of Conservation – Owenriff River survey square

Channel name	Surrounding habitat	OPW channel	SAC status
Owenriff River - Main scheme	WL1, WS1, BL3	√	√
Site (1)	WD1		
Site (2)	WS1, WL1	√	
Site (3)	WS1, WL1		
Site (4)	WS1, WD1		√
Loughseecon (Site 5)	WL1, GA1		
Owenriff River (Site 6)	WS1, PB2	√	√
Site (7)	PB2		
Site (8)	PB2		
Site (9)	PB2, BL3		

Lough Corrib Special Area of Conservation – Clare River survey square

Channel name	Surrounding habitat	OPW channel	SAC status
Clare River - Main scheme	GA1, WS1	√	
Cregg River (Site 1)	GS4	√	√
Cregg River (Site 2)	GS4, GM1	√	√
Cregg River (Site 3)	GA1, WL1	√	
Waterdale River (Site 4)	PB3	√	
Clare River (Site 5)	GS4	√	

Lough Corrib Special Area of Conservation – River Corrib and Headford survey square

Channel name	Surrounding habitat	OPW channel	SAC status
River Corrib - Main scheme	BL3, GA2		√
Black trib. (Site 1)	GA1, WS1	√	
Black trib. (Site 2)	GS4, BL2	√	
Black trib. (Site 3)	GS4, WS1	√	
Black River (Site 4)	WS1	√	
Black trib. (Site 5)	GA1	√	
Black River (Site 6)	GS4	√	√

Lower River Suir Special Area of Conservation – River Suir survey square

Channel reference	Surrounding habitat	OPW channel	SAC status
River Suir - Main scheme	BL1, BL3, WN5, GA2	√	
Suir trib. (Site 1)	WN5, GA1, BL1		
Glen River (Site 3)	BL1, ED3, WS1, BL3		
Suir trib. (Site 4)	WS3		
Lingaun River (Site 5)	WN5		√
Clodiagh trib. (Site 6)	GA1, BL1, WL1, WS3,		
River Suir (Site 7)	BL1, GA2, WD1		√
River Suir (Site 8)	GA1, GA2, WN5, BL1, WL2		√

River Barrow and River Nore Special Area of Conservation – River Nore survey square

Channel name	Surrounding habitat	OPW channel	SAC status
River Nore - Main scheme	GA2, BL3,WD5, WN5	√	
Breaghagh river (Site 1)	WN5, GA2, WD5		
Site (2)	WS1, GA2, BL3		
Site (3)	WN5, GA1		
Stoney stream (Site 4)	WL1, GA1		
Breaghagh river (Site 5)	GA1, WN5, BL1	√	
River Nore (Site 6)	WL1, GA1		
Pococke trib. (Site 7)	WL1, GA1		
River Nore (Site 8/9)	WN5, ED3, GA2, WD5		√
Pococke river(Site 10)	GA2		√

Lower River Shannon Special Area of Conservation – Mulkear River survey square

Channel name	Surrounding habitat	OPW channel	SAC status
Mulkear River - Main scheme	GA1, GA2, BL3, WN5,	√	
Mulkear trib. (Site 1)	WL2, GA2, GS4		
Killeenagarraiff River (Site 2)	BL1, WN5, GA2, GS4	√	√
Killeenagarraiff trib. (Site 3)	GA2, GS4		
Killeenagarraiff River (Site 4)	BL2, WS1, WN5, ED3	√	
Killeenagarraiff River (Site 5)	ED3, WN5, WL1	√	√
Killeenagarraiff trib. (Site 6)	GA1, WN5	√	
Mulkear River (Site 7)	GA1, WL1		√
Mulkear trib. (Site 8)	WS3		
Groody River (Site 9)	GA1, WL1, BL3	√	
Groody River (Site 10)	GA1, WN5, BL3, WD5	√	

Lower River Shannon Special Area of Conservation – River Maigue survey square

Channel name	Surrounding habitat	OPW channel	SAC status
River Maigue - Min scheme	FS1, WL1, GS4	√	√
Site (1)	WN5, WS1, WL2	√	
Site (2)	FS1, WS1, GS4, WL1	√	
Maigue trib.(Site 3)	WS3	√	
Site (5)	GA1, GS4, WL2, FW4		
River Maigue (Site 6)	BL3, WS3		
Maigue trib. (Site 7)	GS4		√

Lower River Shannon Special Area of Conservation – Feale River survey square

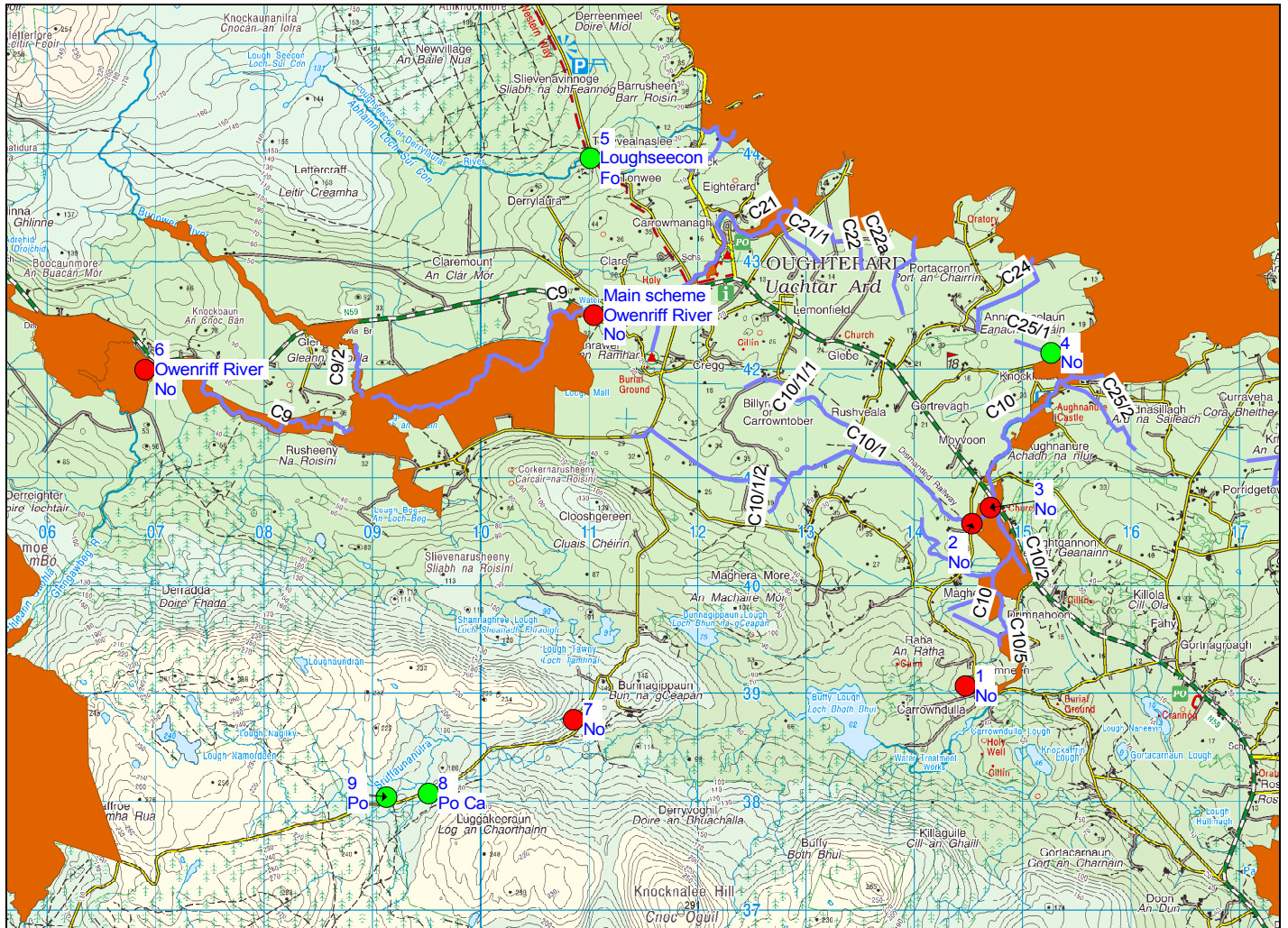
Channel name	Surrounding habitat	OPW channel	SAC status
River Feale - Main scheme	BL3, GA2, WD5, WN5	√	
Feale trib. (Site 2)	WD4, WL1, GA1		
Feale trib. (Site 3)	WS1, GS4	√	
Feale trib. (Site 4)	BL3, WS1, GA1, FW4	√	
River Feale (Site 5)	WL1, BL3, GA1	√	√
Galey River (Site 6)	BL2, GA1		
Galey trib. (Site 7)	WS1, BL3, WL1	√	
Feale trib. (Site 8)	WL1, GA1, ED2	√	√
Smearlagh River (Site 9)	WN5, GS4		√

Bandon River Special Area of Conservation – Bandon River survey square

Channel name	Surrounding habitat	OPW channel	SAC status
Bandon River - Main scheme	WS1, GA1, WN5, WN4/ WN6	√	√
Bandon River (Site 1)	WN5, GA1, BL3, FS1		√
Dirty River (Site 2)	GA2, BL3, WN5		
Brewery River (Site 3)	GA2, WN5, WL1		
Kealrootha trib. (Site 4)	WS1, WN5, GA1		
Glasheenahielan trib. (Site 5)	WL1, GA1, WL2, WN5		
Garrown River (Site 6)	WN5		
Bandon River (Site 7)	GM1, WN5		√
Blackwater trib. (Site10)	GM1, WN5		

Appendix D – Mapping of floating river vegetation surveyed

Lough Corrib Special Area of Conservation – Owenriff River survey square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po – *Potamogeton* spp.

Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

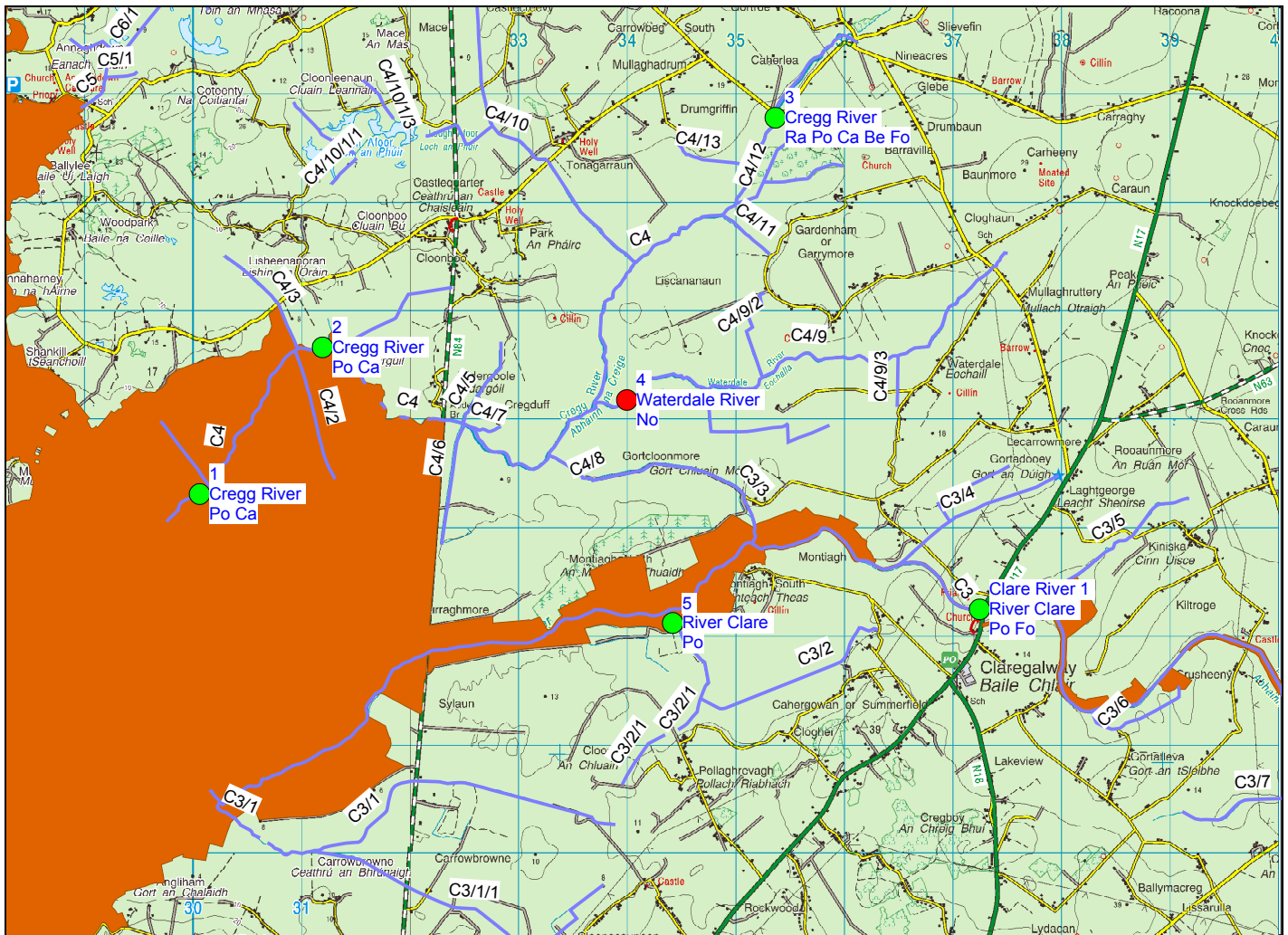
Be – *Berula erecta*

Fo - *Fontinalis antipyretica*

No – no vegetation recorded

● Vegetation present
● No vegetation present

Lough Corrib Special Area of Conservation – Clare River survey square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po – *Potamogeton* spp.

Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

Be – *Berula erecta*

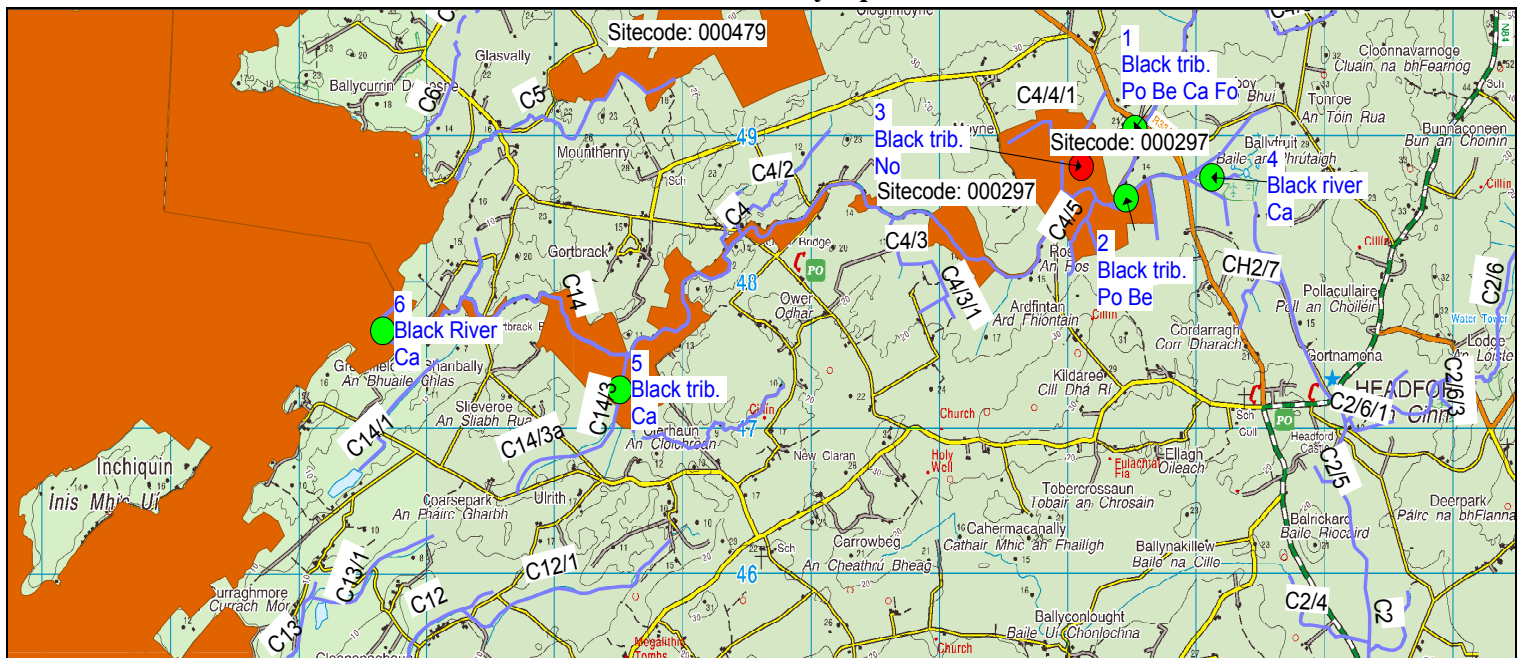
Fo - *Fontinalis antipyretica*

No – no vegetation recorded

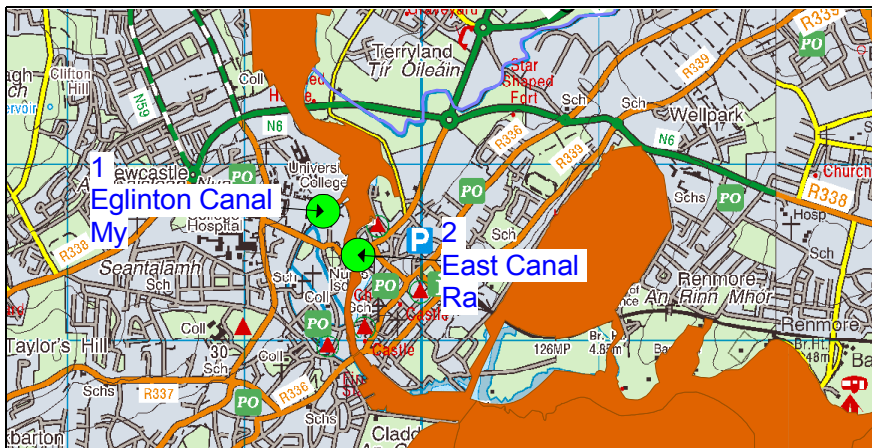
- Vegetation present
- No vegetation present

Lough Corrib Special Area of Conservation – River Corrib and Headford Survey Square

Headford survey square



River Corrib Galway

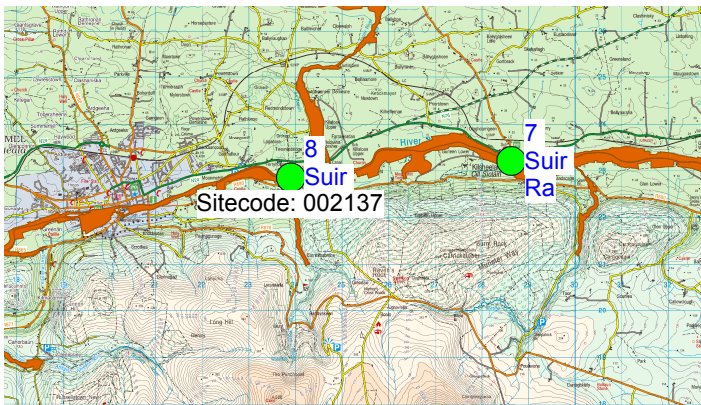


Floating river vegetation legend

- Ra - *Ranunculus* spp.
- Po – *Potamogeton* spp.
- Ca – *Callitriche* spp.
- Za – *Zannichellia palustris*
- Be – *Berula erecta*
- Fo - *Fontinalis antipyretica*
- No – no vegetation recorded

- Vegetation present
- No vegetation present

Lower River Suir Special Area of Conservation – River Suir Survey Square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po - *Potamogeton* spp.

Ca - *Callitriche* spp.

Za - *Zannichellia palustris*

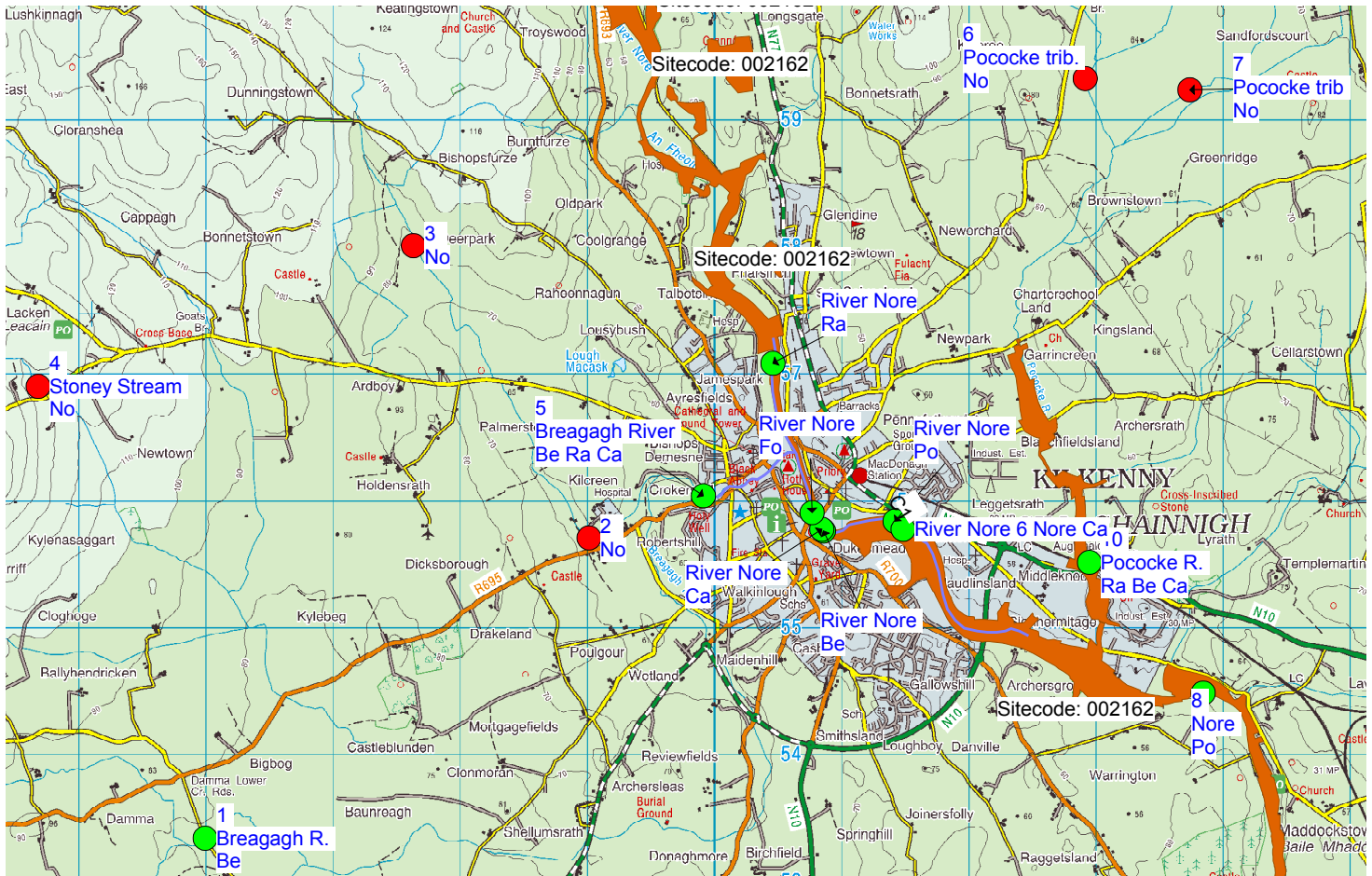
Be - *Berula erecta*

Fo - *Fontinalis antipyretica*

No - no vegetation recorded

- Vegetation present
- No vegetation present

River Barrow and River Nore Special Area of Conservation – River Nore Survey Square



Floating river vegetation legend

Ra - *Ranunculus* spp.Po – *Potamogeton* spp.Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

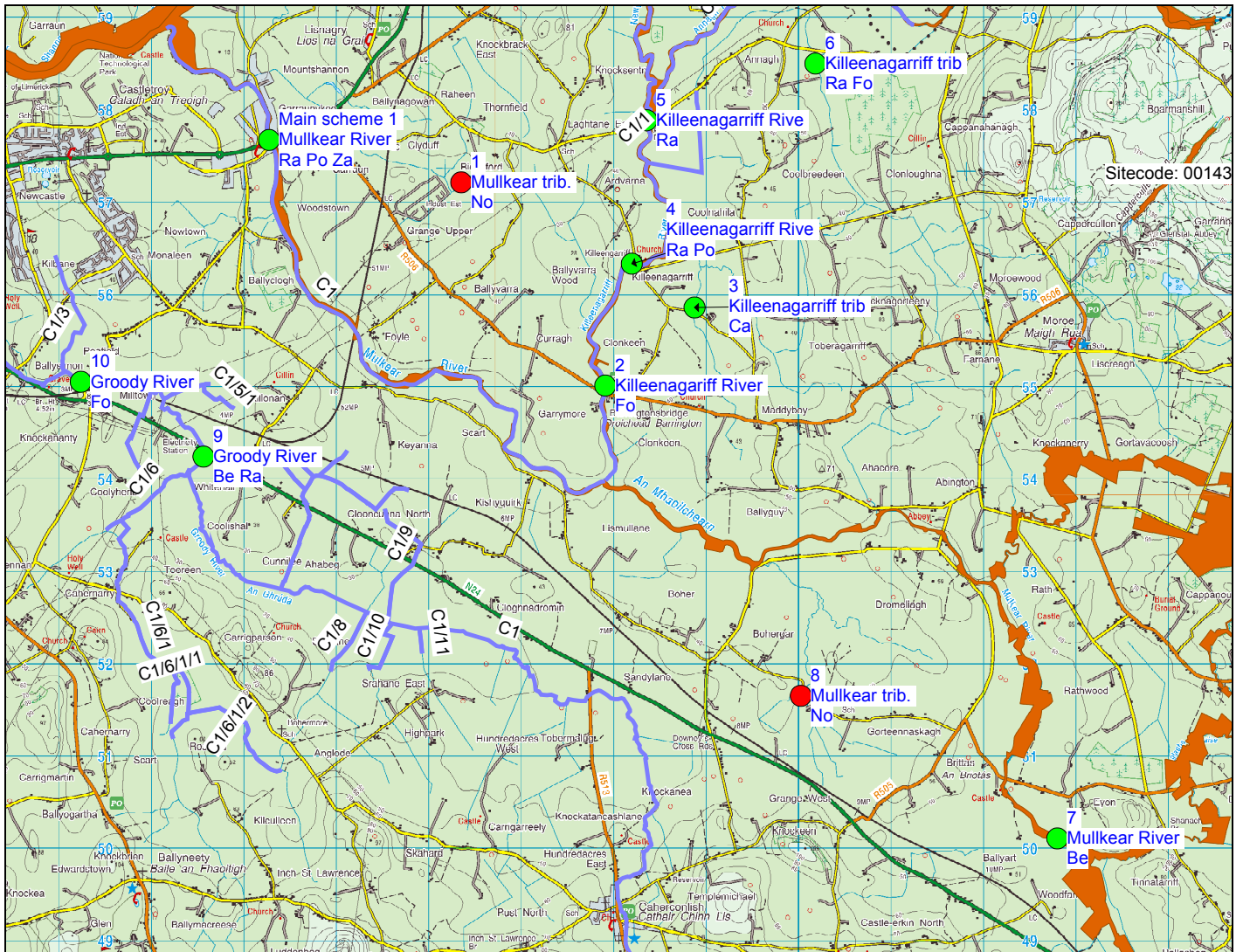
Be – *Berula erecta*Fo - *Fontinalis antipyretica*

No – no vegetation recorded

- Vegetation present

- No vegetation present

Lower River Shannon Special Area of Conservation – Mulkear River Survey Square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po – *Potamogeton* spp.

Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

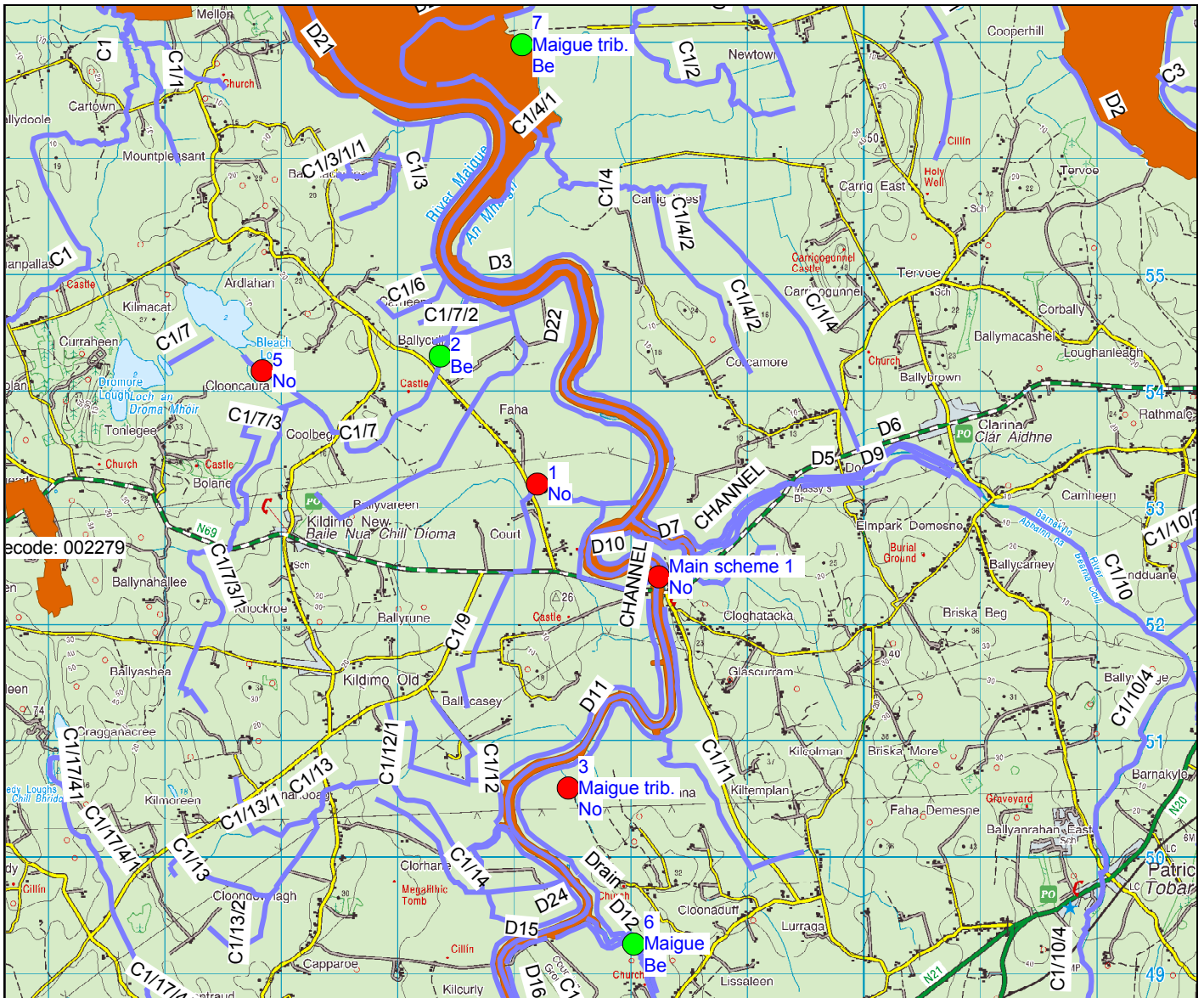
Be – *Berula erecta*

Fo - *Fontinalis antipyretica*

No – no vegetation recorded

- Vegetation present
- No vegetation present

Lower River Shannon Special Area of Conservation –River Maigue Survey Square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po – *Potamogeton* spp.

Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

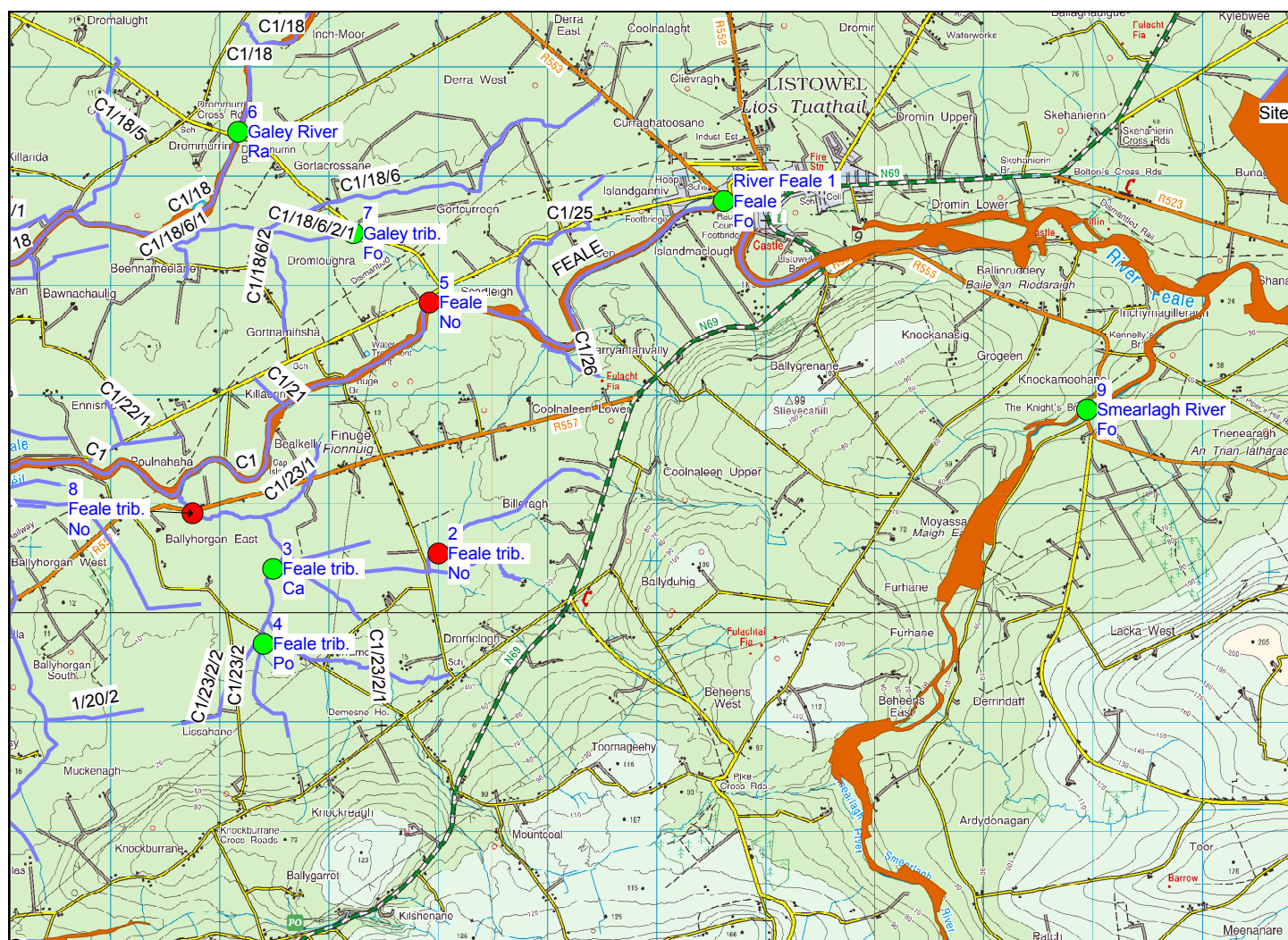
Be – *Berula erecta*

Fo - *Fontinalis antipyretica*

No – no vegetation recorded

- Vegetation present
- No vegetation present

Lower River Shannon Special Area of Conservation –River Feale Survey Square



Floating river vegetation legend

Ra - *Ranunculus* spp.

Po – *Potamogeton* spp.

Ca – *Callitriche* spp.

Za – *Zannichellia palustris*

Be – *Berula erecta*

Fo - *Fontinalis antipyretica*

No – no vegetation recorded

- Vegetation present
- No vegetation present

River Bandon Special Area of Conservation –River Bandon Survey Square



- Vegetation present
- No vegetation present

Appendix E – Physical parameters recorded at survey sites

Lough Corrib Special Area of Conservation –Owenriff River survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
Owenriff River Main scheme	√	4	-	Gravel and stone	~ 0.1 m	* Clear - peat colour
Site (1)		1	√	Gravel base	~ 0.2 m	* Clear - peat colour
Site (2)	√	3	√	Stone and fine clay	~ 0.2 m	* Clear - peat colour
Site (3)		4	√	Unknown	Deep	* Clear - peat colour
Site (4)		1	-	Unknown	< 1.0 m	Clear - dark peat colour
Loughseecon (Site 5)		2	Partial	Large stones	~ 0.3 m	Clear - peat colour
Owenriff River (Site 6)	√	4	-	Unknown	Deep	* Clear - peat colour
Site (7)		1	-	Large stones	~ 0.1 m	* Clear - peat colour
Site (8)		2	-	Peat	~ 0.2 m	Clear
Site (9)		1	-	Peat	> 0.1 m	Clear

*River was in flood at the time of the survey and this was probably the main reason for the lack of floating river vegetation and the brown discolouration in the water, caused by particulate peat run-off from the surrounding land.

Lough Corrib Special Area of Conservation –ClareRiver survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
Clare River Main scheme	√	5	-	Stone base	~ 1.2 m	Clear – peat colour
Cregg River (Site 1)	√	3	-	Unknown	Deep	Clear
Cregg River (Site 2)	√	3	-	Unknown	Deep	Clear
Cregg River (Site 3)	√	2	-	Gravel base	~ 0.1 m	Clear
Waterdale River (Site 4)	√	2	-	Peat base	~ 0.1 m	Clear - peat colour
Clare River (Site 5)	√	1	-	Clay base	~ 0.2 m	Clear

— Floating River Vegetation recorded at this site

Lough Corrib Special Area of Conservation –Corrib River and Headford survey square

Channel name	OPW Channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
River Corrib Main scheme	√		-	Stone and fine sand	~ 0.1 m	Clear
Black trib. (Site 1)	√	4	-	Stone and gravel	~ 0.2 m	Clear
Black trib. (Site 2)	√	2	Partial	Unknown	Unknown	N/A
Black trib. (Site 3)	√	1	-	Unknown	~ 0.2 m	Clear
Black River (Site 4)	√	2	-	Stone base	~ 0.1 m	Clear
Black trib. (Site 5)	√	2	-	Peat and clay base	Deep	Clear
Black River (Site 6)	√	4	Partial	Unknown	> 0.1 m	Clear

Lower River Suir Special Area of Conservation – River Suir survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
River Suir Main scheme	√	6	-	Stone and mud base	~ 0.5 m	clear
Suir trib. (Site 1)		3	Partial	Stone and fine sand	> 0.1 m	clear
Glen River (Site 3)		3	Partial	Stone and fine sand	~ 0.1 m	clear
Suir trib. (Site 4)		2	√	Large stones and fine sand	Pool forms	Slight turbidity
Lingaun River (Site 5)		4	-	Gravel and small stone	~ 0.1 m	clear
Clodiagh trib. (Site 6)		2	-	Stone and fine sand	~ 0.1 m	clear
River Suir (Site 7)		6	-	Stone and sand base	~ 0.3 m	clear
River Suir (Site 8)		6	-	Stone and sand base	~ 1.0 m	clear

 Floating River Vegetation recorded at this site

River Barrow and River Nore Special Area of Conservation – River Nore survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
River Nore Main scheme	√	6	-	Stone and mud base	~ 0.4 m	clear
Breaghagh river (Site 1)		2	√	Gravel and fine sand	Trickle water	clear
Site (2)		3		Concrete base, walls, stone base	No water	
Site (3)		2	√	Mud base	Trickle water	High turbidity
Stoney stream (Site 4)		1	√	Stone base	No water	
Breaghagh river (Site 5)	√	4	Partial	Concrete bed, walls Stone ,fine sand silt deposits at edge	~ 0.1 m	clear
River Nore		1	√	Stone and fine sand	> 0.1 m	clear
Pocock trib. (Site 7)		1	√	Drainage ditch	No water	
River Nore (Site 8/9)		6	-	Unknown	Deep water	clear
Pococke river (Site 10)		4	-	Stone and fine mud deposits	> 0.1 m	clear

Lower River Shannon Special Area of Conservation – Mulkear River survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
Mulkear River Main scheme	√	6	-	Stone and gravel	~ 0.1 m +	Clear
Mulkear trib. (Site 1)		2	√	Unknown	No water	Clear
Killeenagarraiff River (Site 2)	√	5	-	Stone and fine sand	Deep	N/A
Killeenagarraiff trib. (Site 3)		1	-	Mud base	> 0.1 m	Clear
Killeenagarraiff River (Site 4)	√	5	-	Gravel and fine sand	~ 0.1 m	Clear
Killeenagarraiff River (Site 5)	√	4	-	Gravel	~ 0.1 m	Clear
Killeenagarraiff trib. (Site 6)	√	3	—	Stone and fine sand	~ 0.2 m	Clear
Mulkear River (Site 7)		6	partial	Stone base	> 0.1 m	Clear
Mulkear trib. (Site 8)		2	partial	Stone and fine sand	~ 0.1 m	Clear
Groody River (Site 9)	√	4	-	Stone and fine sand	> 0.1 m	Clear
Groody River (Site 10)	√	4	-	Stone, gravel and fine sand	> 0.1 m	Clear

— Floating River Vegetation recorded at this site

Lower River Shannon Special Area of Conservation – River Maigue survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
River Maigue Min scheme	√	6	-	Unknown	deep	Slight turbidity
Site (1)	√	2	partial	Fine sand and mud	> 0.1 m	Clear
Site (2)	√	1	-	Fine sand and mud	~ 0.1 m	clear
Maigue trib.(Site 3)	√	1	√	Mud base	> 0.1 m	Slight turbidity
Site (5)			-	Unknown	water	N/A
River Maigue (Site 6)			Partial	Fine sand	> 0.1 m	clear
Maigue trib (Site 7)			-	Unknown	> 0.1 m	clear

Lower River Shannon Special Area of Conservation – River Feale survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
River Feale Main scheme	√	6	-	Stone base	0.1 m +	Clear
Feale trib. (Site 2)		2	-	Unknown	No water	N/A
Feale trib. (Site 3)	√	3	-	Unknown	> 0.1 m	Turbidity
Feale trib. (Site 4)	√	3	-	Fine sand	~ 0.1 m	Clear
River Feale (Site 5)	√	6	-	Stone base	~ 0.1 m	Clear
Galey River (Site 6)		4	-	Stone, peat base	~ 0.1 m	Clear
Galey trib. (Site 7)	√	1	Partial	Stone, peat base	~ 0.1 m	Clear
Feale trib. (Site 8)	√	4	Partial	Stone, fine sand	> 0.1 m	Clear
Smearlagh River (Site 9)		5	-	Stone, peat base	> 0.1 m	Clear – peat colour

Bandon River Special Area of Conservation – Bandon River survey square

Channel name	OPW channel	EPA stream order	Shade	Channel substrate	Water depth	Water turbidity
Bandon River Main scheme	√	5	-	Stone and fine sand	0.1 m +	Clear
Bandon River (Site 1)		6	-	Stone and mud	Deep	Clear
Dirty River (Site 2)		5	-	Stone and fine sand	~ 0.2 m	Clear
Brewery River (Site 3)		3	Partial	Stone and fine sand	~ 0.2 m	Clear
Kealrootha trib. (Site 4)		1	Partial	Stone and fine sand	> 0.1 m	Clear
Glasheenahielan trib. (Site 5)		2	Partial	Unknown	Unknown	N/A
Garrown River (Site 6)		3	Partial	Stone and fine mud	~ 0.1 m	Clear
Bandon River (Site 7)		4	Shade	Unknown	Unknown	N/A
Blackwater trib. (Site 10)		1	Partial	Gravel base	> 0.1 m	Clear

 Floating River Vegetation recorded at this site

Appendix F – Description of floating river vegetation plant species

Latin Name	<i>Ranunculus aquatilis</i>	<i>Ranunculus fluitans</i>	<i>Ranunculus peltatus</i>	<i>Ranunculus pencillatus</i>	<i>Ranunculus pencillatus</i> sp. <i>pencillatus</i>	<i>Ranunculus trichophyllus</i>
English Name	Common Water Crowfoot	River Water Crowfoot	Pond Water Crowfoot	Chalk-stream Water Crowfoot	Stream Water Crowfoot	Thread Water Crowfoot
Habitat	Slow flowing river or ponds	Fast flowing rivers	Slow flowing rivers or ponds	Fast flowing rivers	Shallow moderate flowing rivers	Slow flowing rivers
Leaf Description	Floating lobed Submerged segmented	Submerged segmented leaves only	Floating lobed Submerged segmented	Submerged segmented Floating lobed	Submerged segmented leaves only	Submerged segmented leaves tassel appearance
Flower Description	Small five petals 10-20 mm diameter	Five to eight petals 14-26 mm diameter	Large five petals 24-30 mm diameter	Large five petals 20-30mm diameter	Large five petals 24-30 mm diameter	Five petals that don't overlap
Water type	Acid, lime, neutral,	Avoid lime	Lime	Lime	Lime	Nutrient –rich habitats
Distinguishing Feature		Flowers 5-8 petals	Nutrient –rich conditions	Long trailing tresses	Acid, lime, neutral	

Latin Name	<i>Callitriche brutia</i>	<i>Callitriche hamulata</i>	<i>Callitriche hermaphrodita</i>	<i>Callitriche obtusangula</i>	<i>Callitriche platycarpa</i>	<i>Callitriche stagnalis</i>
English Name	Pedunculate Water Starwort	Intermediate Water Starwort	Autumnal Water Starwort	Blunt fruited Water Starwort	Various-leaved Water Starwort	Common Water Starwort
Habitat	Freshwater shallow pool that dry out in summer	Lakes, rivers, streams, ditches slow, still water	Lakes and occasionally rivers	Rivers, streams, ditches, can be in lakes, wet mud	Sometimes brackish water	Still slow water, on wet mud can be on fast rivers
Leaf Description	Leaf tips shaped like spanner	Leaves dark green like earwig pincers	All leaves submerged yellow/ green colour	Yellow green colour, angled spoon shape	Aerial leaves dull or slightly blue green	Aerial leaves fresh green colour
Flower Description	Tiny green flowers	Tiny green flowers	Flowers with colourless anthers	Flowers with yellow anthers	Flowers with yellow anthers	Flowers with yellow anthers
Water type	Freshwater	Acid	Freshwater	Lime	Freshwater	Lime
Distinguishing Feature			Stem yellow colour			

Callitriche pulchra Although it is mentioned as a plant sighted in Ireland (according to the EUNIS website) this species is usually associated with Libya. A single positive identification from one location was recorded in Greece.

Latin Name	<i>Potamogeton alpinus</i>	<i>Potamogeton berchtoldii</i>	<i>Potamogeton crispus</i>	<i>Potamogeton coloratus</i>	<i>Potamogeton filiformis</i>
English Name	(Red Pondweed)	(Small Pondweed)	(Curled Pondweed)	(Fen Pondweed)	(Slender-leaved Pondweed)
Habitat	Still or slow flowing water, canals or ditches	Still or slow flowing freshwater	Deep still flowing freshwater	Shallow water especially fens	Shallow still water near the sea
Leaf Description	Narrow pointed leaves sometimes floating	Slender dark – pale green leaves	Wavy toothed narrow oblong leaves	Broad oval red leaves floating or submerged	Blunt tipped leaves often in tufts
Flower Description	Short green flower spike	Small flower spike	Small flower spike	Small flower spike	Submerged flowers
Water type	Avoids lime	Lime	Avoids acid	Lime	Brackish water
Distinguishing Feature	Dried leaves are red colour.	Stems slightly flattened			Flattened stems

Latin Name	<i>Potamogeton freseii</i>	<i>Potamogeton gramineus</i>	<i>Potamogeton lucens</i>	<i>Potamogeton natans</i>	<i>Potamogeton obtusifolius</i>
English Name	(Flat-stalked Pondweed)	(Various-leaved Pondweed)	(Shining Pondweed)	(Broad-leaved Pondweed)	(Blunt-leaved Pondweed)
Habitat	Still water canals, ditches, rivers, lakes	Shallow water fens, ditches, canals	Still slow moving water	Still or slow moving water	Shallow ponds or lakes
Leaf Description	Narrow pointed leaves	Floating oval leaves, narrow submerged leaf	Broad wavy submerged leaves	Floating leaves long broad elliptical or oval	Blunt laves 2.5-3.5mm wide
Flower Description	Thickened flower stalk	Flower on short spike	Long stout flower spike		
Water type	Lime	Acid	Lime	Freshwater	Acid
Distinguishing Feature	Flattened stems			Most common pondweed	

Latin Name	<i>Potamogeton pectinatus</i>	<i>Potamogeton perfoliatus</i>	<i>Potamogeton polygonifolius</i>	<i>Potamogeton praelongus</i>	<i>Potamogeton pusillus</i>
English Name	Fennel Pondweed	Perfoliate Pondweed	Bog Pondweed	Long-stalked Pondweed	Lesser Pondweed
Habitat	Still/ slow flowing rivers, or brackish water	Deep still or slow flowing water	Shallow water and bog flushes	Deep lakes and rivers	Sometimes brackish water
Leaf Description	Dark green pointed leaves 4mm – 1m long	Stem embraced by submerged oval leaves	Floating oval leaves with tint red.	Submerged wavy leaf arranged zig zag on stem	Sharply pointed leaves 1-2mm wide
Flower Description	Compact flower	Long stalked flower spike	Small dense flower spike	Aerial flower spike	Small flower spike
Water type	Lime	Freshwater	Acid	Lime	Avoids acid
Distinguishing Feature	Can cope with pollution				

Latin Name	<i>Berula erecta</i>	<i>Zannichellia paultris</i>	<i>Groenlandia densa</i>	<i>Fontinalis antipyretica</i>	
English Name	Lesser Water Parsnip	Horned Pondweed	Opposite leaved pondweed	Aquatic Moss	
Habitat	Still water, ditches, fens and marshes.	Still, slow water ponds, lakes or brackish water	Rivers and canals	Shallow slow flowing rivers and streams	
Leaf Description	From five to nineteen leaf pairings along leaf stalk	Submerged filament leaves	Short wavy submerged leaves arranged oppositely along the stem	Dark green leaves in three rows along stem slightly overlapping	
Flower Description	Large white flower head of multiple tiny flowers	Submerged green tiny flower no petals	Small stalked flower head green brown colour curves downwards	No flowers spores produced instead	
Water type	Freshwater	Lime	Lime	Slightly acidic	
Distinguishing Feature					

A summary of the ecological characteristics of floating river vegetation geographically distributed in Ireland (Blamey *et al.*, 2003, EUNIS website, Hale, A., Spink, 1992, Webb *et al.*, 1996)

Appendix G – Environmental Drainage Maintenance Guidance Notes