IP(09)14draft

Protection, Restoration and Enhancement of Salmon Habitat Focus Area Report

Northern Ireland

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NASCO

Focus Area Report on Protection, Restoration and Enhancement of Salmon Habitat

UK - Northern Ireland

CONTENTS

Page

I. INTRODUCTION

Northern Ireland's Atlantic salmon management strategy (NASCO Implementation Plan) was finalised in February 2008. The Department of Culture, Arts and Leisure (DCAL) has overall policy responsibility to ensure implementation of the strategy and took the lead in the preparation of the Fisheries Management Focus Area Report submitted in March 2008.

The current management approach and proposed actions to implement the NASCO resolutions and agreements pertaining to the protection, restoration and enhancement of salmon habitat are set out in the strategy. This describes that several different government departments and/or their agencies have responsibilities in this regard. A review of this approach and an in-depth assessment of measures that contribute to:

- Protection of the current productive capacity of the existing physical habitat of Atlantic salmon; and

- Restoration, in designated areas, of the productive capacity of Atlantic salmon habitat which has been adversely impacted,

has, therefore, required inputs, and collation of information, from DCAL, the Agri-Food and Biosciences Institute (AFBI), the Loughs Agency, the Northern Ireland Environment Agency (NIEA) and the Department of Agriculture and Rural Development (DARD).

In general terms, respective responsibilities are as follows:

DCAL

DCAL Inland Fisheries Group is responsible in Northern Ireland for the supervision and protection of salmon and inland fisheries and for fostering the establishment and development of those fisheries.

AFBI

The Agri-Food and Biosciences Institute (AFBI), is a leading provider of scientific research and services to government, non-government and commercial organisations. It has scientific capability in agriculture, animal health, food, environment, biosciences and economics and conducts a wide range of projects for both the public and private sectors including DCAL, Loughs Agency, DARD and NIEA.

Loughs Agency

The Loughs Agency is a cross-border body, exercising a statutory remit for conservation, protection and development across the Foyle and Carlingford catchments. Objectives for these river systems and sea areas include development of fisheries and aquaculture, conservation and protection of inland fisheries and sustainable development of marine tourism.

DARD

The Department of Agriculture and Rural Development (DARD) aims to promote sustainable economic growth and the development of the countryside in Northern Ireland. The Department assists the competitive development of the agri-food, fishing and forestry sectors of the Northern Ireland economy, having regard for the need of the consumers, the welfare of animals and the conservation and enhancement of the environment.

NIEA

NIEA takes the lead in advising on, and in implementing, the Government's environmental policy and strategy in Northern Ireland. The Agency carries out a range of activities, which promote the Government's key themes of sustainable development, biodiversity and climate change. Overall aims are to protect and conserve Northern Ireland's natural heritage and built environment, to control pollution and to promote the wider appreciation of the environment and best environmental practices.

This report seeks to distil information from these organisations to that which addresses, directly and indirectly, the elements identified in the NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat.

II. OVERVIEW OF SALMON RIVERS IN NORTHERN IRELAND AND THE CROSS BORDER FOYLE AND CARLINGFORD CATCHMENTS

Following NASCO definitions[1], there are 27 salmon rivers in the 2 fishery jurisdictions covering UK-NI. These are:

- Foyle
- Roe
- Faughan
- Bann
- Bush
- Ballycastle
- Glendun
- Glendall
- Glenariff
- Glencoy
- Carnlough
- Glenarm
- Inver
- Threemilewater
- Lagan
- Enler (Comber)
- Strangford Blackwater
- Quolie
- Moneycarragh
- Carrigs
- Shimna
- Annalong
- Kilkeel
- Whitewater
- Gahm
- Clanrye
- Erne

Information on the nature and extent of this resource, at finer sub-catchment scale, is provided at section 1.2 of the UK-NI NASCO Implementation Plan[2]. This information has been reviewed and is presented again below for each of the 2 fishery jurisdictions within UK-NI (Loughs Agency and Fisheries Conservancy Board).

[1] the NASCO system defines a river as "the main stem of the system of rivers and tributaries at the point, within the NASCO Convention area, where it reaches the sea" whereas a tributary is defined as "any river or stream which does not flow directly into the sea but flows into a river as defined above"

[2] Atlantic Salmon Management Strategy for Northern Ireland and the Cross Border Foyle and Carlingford catchments to meet the objectives of NASCO resolutions and agreements [2008 – 2012]

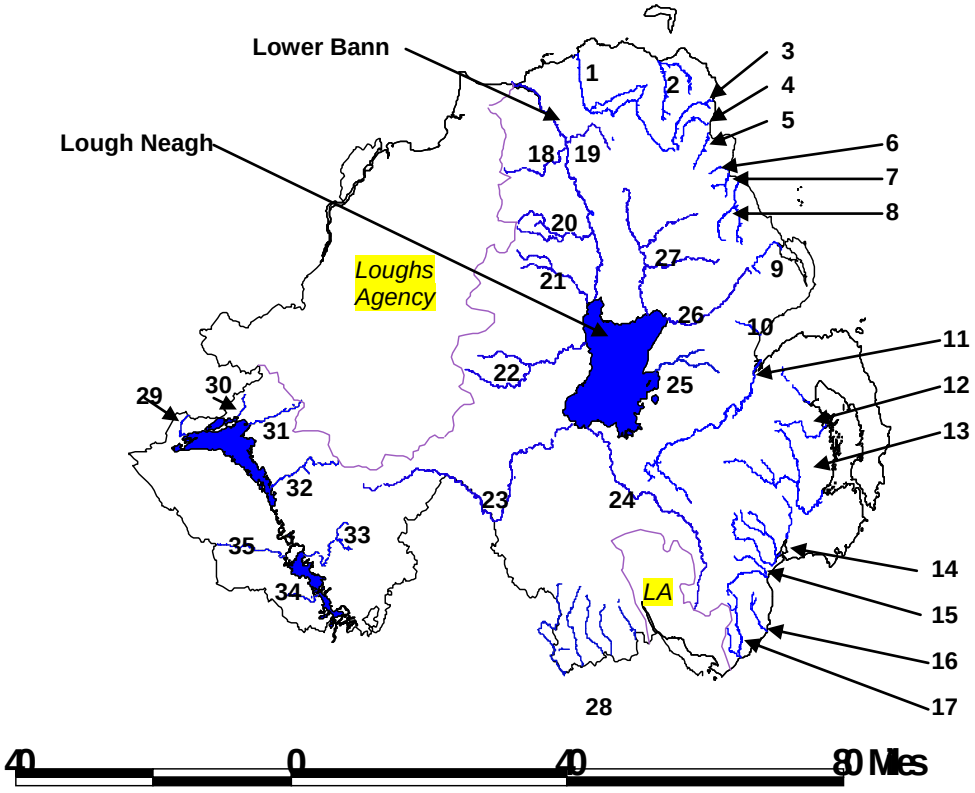


Figure 1. Main salmon producing rivers and tributaries in the FCB area of N. Ireland.

1 Bush, 2 Ballycastle, 3 Glendun, 4 Glendall, 5 Glenariff, 6 Glencoy, 7 Carnlough, 8 Glenarm, 9 Inver, 10 Threemilewater, 11 Lagan, 12 Enler (Comber) and Strangford Blackwater, 13 Quolie, 14 Moneycarragh & Carrigs, 15 Shimna, 16 Annalong, 17 Kilkeel, 18 Agivey, 19 Ballymoney, 20 Clady, 21 Moyola, 22 Ballinderry, 23 Blackwater, 24 Upper Bann, 25 Crumlin, 26 Sixmile, 27 Main, 28 South Armagh Tributaries, 29 Garvary, 30 Waterfoot, 31 Kesh, 32 Ballinamallard, 33 Colebrook, 34 Swanlinbar, 35 Sillees.

Main catchments and habitat assets within the FCB area

Due to the influence of Lough Neagh, many rivers that are by NASCO definitions "rivers" are relatively small whilst others that are defined as "tributaries" are larger by comparison and support larger salmon populations. The following descriptions reflect this.

Coastal Rivers 1-17

The coastal rivers represent a diverse grouping of river catchments extending from the Antrim Plateau to the Mourne Mountains.

The major catchments in this group are the Bush, Ballycastle, Glendun, Glenarm, Lagan, Quoile, Moneycarragh, Carrigs, Shimna, Annalong and Kilkeel.

Smaller rivers shown on the map are the Glendall, Glenarriff, Glencloy, Inver, Threemilewater, Enler (Comber) and Strangford Blackwater.

Other smaller rivers (not shown on the map due to limitations of scale) are the Blackstaff, Ardilea, Ballygalley, Glynn, Kilroot, Copeland and Woodburn.

Electric fishing surveys have indicated the presence of juvenile salmon stocks in all the major catchments and all of the smaller rivers except the Glencloy, Ballygalley, Glynn, Kilroot, Enler and the Strangford Blackwater.

Four index rivers are available in this area on the Bush, Glendun, Lagan and the Moneycarragh, although the Lagan population represents an anthropogenically restored stock which had been extinct for decades.

Neagh Bann Catchment 18-27

The major Lower Bann River draining Lough Neagh has 3 main sub-catchments; the Agivey, Ballymoney and Clady and 2 lesser catchments; the Articlave and Macosquin. Salmon are present in all these rivers and the Clady is currently being developed as an index for this bio-geographical area.

Seven main river catchments drain directly into Lough Neagh; the Moyola, Ballinderry, Blackwater, Upper Bann, Crumlin, Sixmile and Main. The Glenavy is a smaller river similar to the Crumlin.

Recent semi-quantitative electric fishing surveys have indicated the presence of juvenile salmon stocks in all these catchments with the exception of the Glenavy. Presently two index rivers are available in this area on the Blackwater and Main.

South Armagh Rivers 28

Several rivers straddle the border of Northern Ireland and the Republic of Ireland. These catchments include the River Fane and the Cleggan River.

Most contain salmon, although the main productive areas and fisheries on these systems are south of the border.

Erne Tributaries 29-35

Seven main rivers and 3 lesser rivers flow into Lough Erne within Northern Ireland; the Garvary, Waterfoot, Kesh, Ballinamallard, Colebrook, Swanlinbar, and Sillees; and the Bannagh, Termon and Arney.

Recent semi-quantitative electric fishing surveys have indicated the presence of juvenile salmon stocks in all of these catchments with the exception of the Sillees. It should be noted that large scale stocking of hatchery salmon is undertaken on the Erne system as a compensatory measure for 2 hydro-electric dams at the outfall of the Lough. It is not possible at present to differentiate between wild and stocked populations. The Garvary is being developed as an index river which will encompass a fish counter and annual juvenile surveys against a background of discontinued stocking.

Map and description of Rivers and Tributaries in the Loughs Agency Area

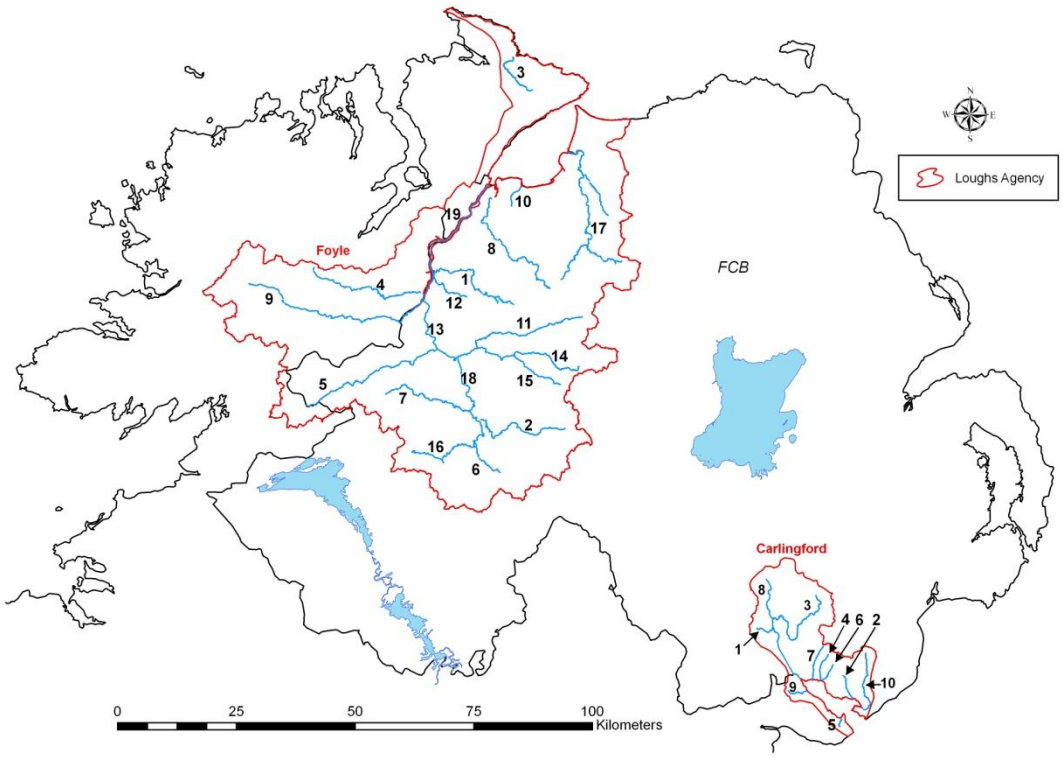


Figure 2. Main salmon producing rivers and tributaries in the Loughs Agency, Foyle and Carlingford areas. **Foyle** 1 Burn Dennet, 2 Camowen, 3 Culdaff, 4 Deele, 5 Derg, 6 Drumragh, 7 Fairywater, 8 Faughan, 9 Finn, 10 Muff, 11 Glenelly, 12 Glenmornan, 13 Mourne, 14 Owenkillew, 15 Owenreagh East, 16 Owenreagh South, 17 Roe, 18 Strule, 19 River Foyle (tidal). **Carlingford** Only the Whitewater (10) has a consistent population of Atlantic salmon present. 1 Bessbrook, 2 Cassy Water, 3 Clanrye, 4 Ghann, 5 Greenore, 6 Killbroney, 7 Moygannon, 8 Newry, 9 Ryland, 10 Whitewater

Coast, Lough Foyle and tidal River Foyle

There are a number of rivers within the Foyle area which enter in the tidal portion of the Foyle or seawards. The main ones are the Culdaff, Roe, Faughan, Burndennett and Deele. The Culdaff is a small river in Inishowen, Co. Donegal, Ireland which enters the North Atlantic directly while the Roe and Faughan are larger systems which drain into Lough Foyle on the eastern shore in N Ireland. The River Deele flows into the tidal portion of the River Foyle in Co. Donegal. The Roe is a Special Area of Conservation under the EU Habitats Directive with salmon listed as a feature and the River Faughan has recently been put forward for SAC status. Qualitative electrofishing on all of these catchments show salmon are present, while the Roe consistently has the highest recorded 0+ fry within the FCILC area. Both the Roe and Faughan have fish counting stations and are used as index catchments for the Foyle area.

River Finn

The River Finn rises in Co. Donegal and joins the River Mourne at Lifford/Strabane where they form the River Foyle. Qualitative electrofishing plus a fish counting station indicates the presence of salmon. The Finn is an index river. It is designated under the EU Habitats Directive as an SAC with salmon listed as a feature. The River is well known as a spring fishery but also has a substantial summer run of 1 sea winter fish.

Mourne and tributaries

The River Mourne is the main index site for the Foyle area and has a suite of regulations based on the counting site at Sion Mills to control exploitation by commercial fishing and recreational angling. Qualitative electrofishing indicates that salmon are widespread throughout the system and there are a further two counting facilities on tributaries upstream.

Carlingford Lough

From qualitative electrofishing salmon are present in the Whitewater River and in lower numbers the Clanrye River.

III. CURRENT STATUS OF SALMON HABITAT

Salmon specific data

FCB AREA

The FCB area of Northern Ireland has the benefit of a long term, local study of Atlantic salmon population dynamics conducted on the River Bush in County Antrim since 1973. The River Bush has experienced many of the difficulties and challenges faced by other salmonid producing catchments in Northern Ireland, including impacts from drainage schemes, intensive agriculture and water abstraction schemes. The catchment is therefore representative in character and challenge to many adjacent rivers and thus provides a useful index for the region. The stock-recruitment relationship derived from the River Bush has been examined and provides a model for the transport of conservation limits[3] to other rivers in the FCB area (Kennedy and Crozier, 1993, Crozier *et al*., 2003). The habitat resource of the R. Bush has been recorded by extensive walk over surveys using the Life Cycle Unit approach (Kennedy, 1984, O'Connor & Kennedy, 2002) through which habitat is classified according to type (nursery, holding, spawning) and quality (1 excellent – 4 marginal).

The River Bush was initially surveyed in 1983 during which the entire catchment was referenced according to the LCU approach. The catchment scale survey was repeated 15 years later in 1998. The main change evident between the two periods was a decline in the total quantity and quality of nursery habitat throughout the river (Fig 3). This decline in the amount and quality of juvenile habitat has been reflected in a general decline of productivity as measured by smolt production over the same period. The mean annual smolt production during the five year period 1980-1985 was around 25,668 smolts whereas the five year period 1996-2000 yielded an average of around 12,967 smolts per year.

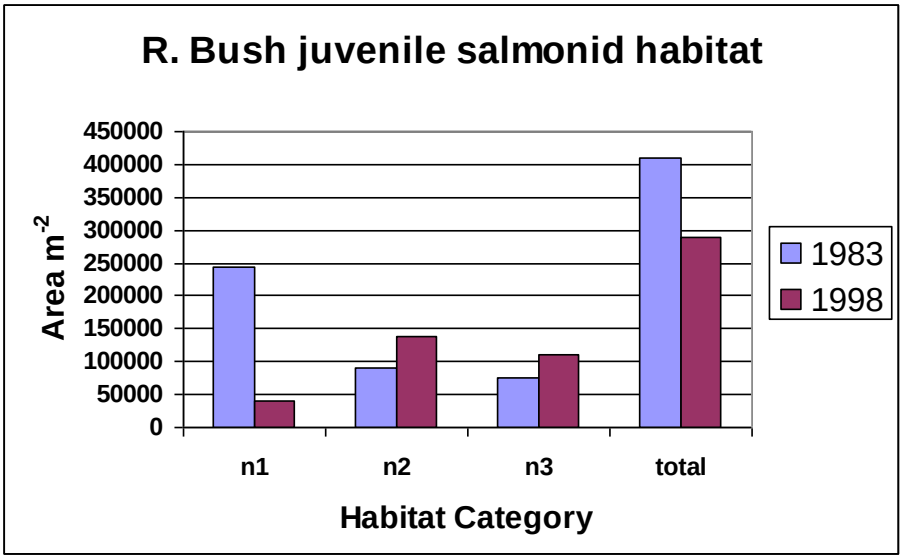


Figure 3 Changes in habitat quantity and quality on the River Bush between 1983-1998

[3] The spawning stock level that produces long term average maximum smolt production.

On the R. Bush, egg to smolt survival from the most recent fully-recruited ova deposition (2003) at 1.52% was above the levels recorded for 2002 (1.01%) and was in excess of the previous 10 year average (0.88%) (Fig. 4). Survival during the freshwater phase of the life cycle was significantly lower throughout the 1980s and 1990s, compared to the 1970s, and this was thought to reflect progressive habitat degradation, in particular siltation /compaction of spawning gravels, and additional effects of mammalian and avian predation. In the light of these data particular emphasis has been placed on in-river habitat rehabilitation works and predator control measures since the mid 1990's (see section 5).

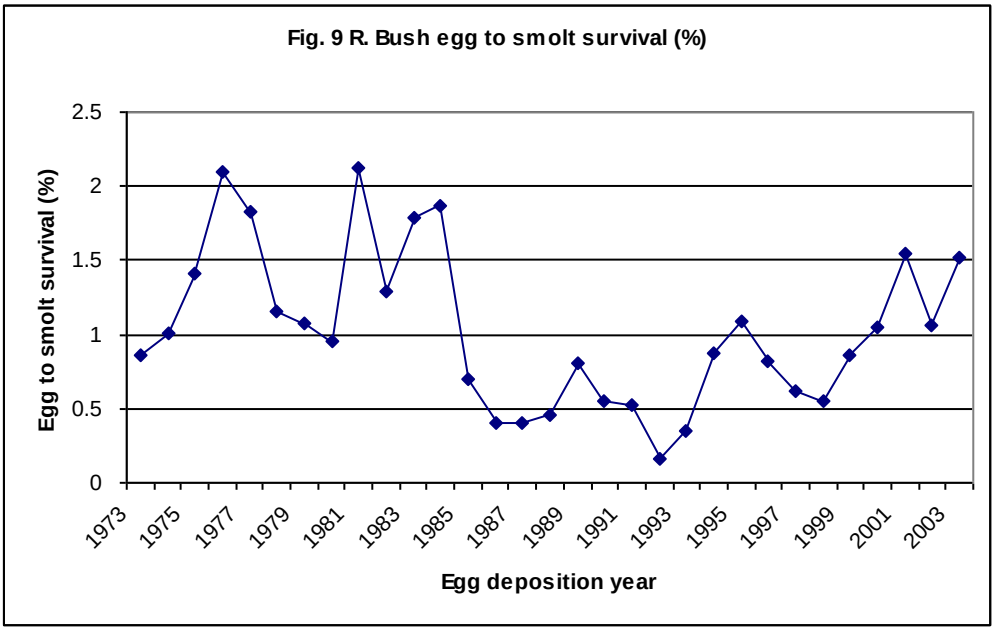


Figure 4. River Bush egg to smolt survival (%).

Salmon habitat surveys based on the LCU method have also been collated for a number of other rivers in the FCB area under the Salmon Management Plan (Fig. 5). This was the original habitat template used to reference habitat resources on the River Bush and has subsequently provided a transport mechanism to transfer the R. Bush CL on a per-unit area basis to other rivers. This information was collated and managed on a GIS system to provide rapid assessment of the physical extent of different grades and classes of habitat and to facilitate comparison with other geographically based datasets.

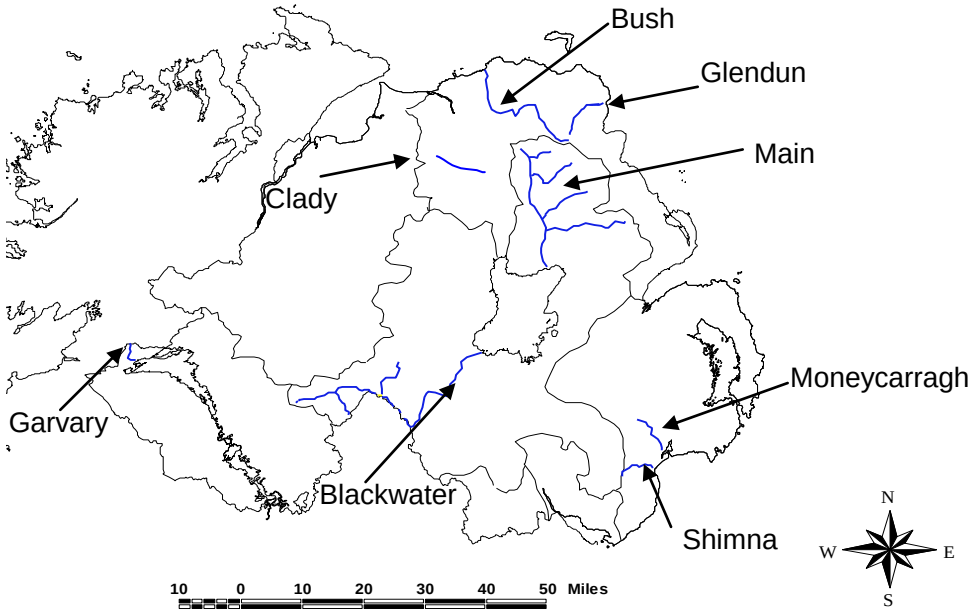


Figure 5. Salmon management plan catchments in the FCB area of UK Northern Ireland.

Although principally gathered for the derivation of CLs, the habitat inventories collated in the FCB area represent excellent geospatially referenced descriptions of the status of habitat on a particular catchment.

The overall status of habitat on a series of index rivers within the FCB area of Northern Ireland has been set out in Fig 6. This figure refers to the area of habitat normally used by spawning salmon on each catchment as measured by extensive catchment wide electric fishing surveys and sets out the proportion of habitat described by the LCU typology.

The Lough Neagh tributaries inclusive of the Rivers Main and Blackwater are typified by an abundance of deeper holding habitat reflecting the lowland character of much of these catchments in combination with the legacy of extensive arterial drainage schemes. Much of the 1st and 2nd grade habitat, particularly the nursery and spawning classifications are located in the lower stream order upland tributaries of these rivers which represent important areas for habitat conservation and protection.

The coastal rivers including the Dun, Moneycarragh and Shimna are relatively short, steeper spate streams with an abundance of fair to good grade nursery habitat. 0+ salmon recruitment in these streams tends to concentrate in the lower reaches where gradient diminishes and spawning substrata naturally settles out.

The Garvary River is a near pristine tributary of Lough Erne with a small number of naturally reproducing Atlantic salmon. Situated in un-drained, marginal agricultural land the rivers boasts an abundance of good quality nursery and spawning habitat.

The Clady River represents the index catchment on the Lower Bann. This river was drained towards the lower reaches which are typified by sluggish deeper channelised sections. The two main tributaries, (Grillagh and Knockneill) however, are composed of large quantities of excellent quality nursery habitat and exhibit good levels of 0+ salmon productivity in many areas.

Water quality data on these index catchments

Black water Local Management Area

As of 2007, 16% of river water bodies in the River Blackwater management area are at good classification. This is proposed to rise to 45% by 2015, 93% by 2021 and 100% by 2027. These water bodies include the Oona Water, the River Blackwater, the tall River and the River Rhone.

Many of the rivers failed to achieve good status due to elevated levels of phosphorous and impacted invertebrate populations.

Braid and Main Local Management Area

The Braid and Maine management area falls within the Lough Neagh Catchment that has been designated as a sensitive area under the Urban Waste Water Treatment Directive in relation to nutrients, specifically phosphorous.

40% of the river water bodies in the management area have been classified as less than good status. However, it is proposed that 94% of waterbodies would be classified at good status by 2015 and that this figure should reach 100% by 2021.

Many of the rivers failed to achieve good status due to elevated levels of phosphorous and Nitrate and impacted invertebrate communities.

Four of the rivers in the management area are designated as heavily modified, including Glenravel water, Artoges river, Glenwhirry river and Braid river. All should achieve good ecological potential by 2015. The Artoges and Glenwhirry rivers are modified due to their use as drinking water storage. The Braid is modified due to flood risk management. None of the modified rivers are classified as artificial.

Lower Neagh Bann Local Management Area

The Lower Bann is designated as a sensitive area under the Urban Waste Water Treatment Directive as the majority of rivers display characteristics symptomatic of eutrophic conditions and most of the remainder show signs of becoming eutrophic if protective action is not taken.

28% of the river water bodies in the management area are currently at good status. This is proposed to rise to 72% by 2015 and 90% by 2021. These waterbodies include the Macosquin river, the Agivey River, the Clady River and the Ballymoney River.

Many of the rivers failed to achieve good status due to elevated levels of phosphorous and impacted invertebrates.

The above three management areas are all contained within the Neagh Bann River Basin District that encompasses the Lough Neagh Catchment and in this district 82% of rivers complied with the salmonid requirements of the Fresh water Fish Directive (i.e. 1511 km complied out of 1848 km designated as salmonid)

South Down Local Management Area (Shimna and Moneycarragh)

Only one water body in this area is currently achieving good status, all other have been classed as less than good. However it is proposed that 66% will achieve good status by 2015, including Killough, Moneycarragh, Shimna and Annalong with 100% good status in 2021.

The main reason for failing to achieve good status is due to impacts on the invertebrate communities.

Glens Local Management Area

Around half of the river bodies within the Glens Management Area have been classified as being less than good status. However it is proposed that they all will achieve good status by 2015. One water body – Linford Water is currently been classified as high status.

The majority of rivers failing to achieve good status was due to impacts on the invertebrate communities.

Bush Local Management Area

The majority of river water bodies in the Bush Management Area have been classed as less than good status. However it is propose to achieve good status in 86% of these by 2015, including Doughery Water, Well Water, Moss-Side Water, Lower River Bush and 100% by 2021.

Many of the rivers failed to achieve good status due to impacted Invertebrate Communities.

Three river water bodies, River Bush Upper & Burn Gushet have been designated as Heavily Modified and it is proposed that they should all achieve good ecological potential by 2021, with the Upper Bush achieving this by 2015.

For the three management areas listed above all are contained within the North East River Basin District that encompasses the River Lagan catchment, those rivers draining to sea around Strangford , the Mournes and the Antrim coast down to Belfast Lough. In this district 96% of rivers complied with the salmonid requirements of the Fresh water Fish Directive (i.e. 600 km out of 625 km designated as salmonid complied)

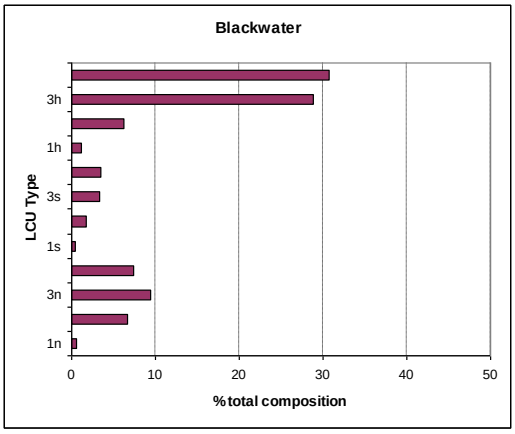
Lower Lough Erne Local Management Area

The Garvary River is located within Lower Lough Erne Management Area and for the 28 water bodies in this area, 3 have been classified as poor, 13 as moderate, and 10 as good, 2 unclassified. Both the water bodies associated with the Garvary river were classified as moderate status due mainly to copper levels and the fish population in one of the water bodies was only considered to be moderate. However, we propose to achieve good status in these and 23 others within the management area by 2015.

The Garvary River is contained within the North West River Basin District and encompasses the River Foyle catchment and Erne rivers and lakes system. In this district 89% of rivers complied with the salmonid requirements of the Fresh water Fish Directive (i.e. 1492 km out of 1682 km designated as salmonid complied.

Figure 6 Habitat composition of catchments in the FCB area of Northern Ireland. Life cycle unit (LCU) habitat classification; type : Holding h, Spawning s, Nursery n; Grade : 1 (best) to 4 (marginal).

[below]


Blackwater
LCU Type
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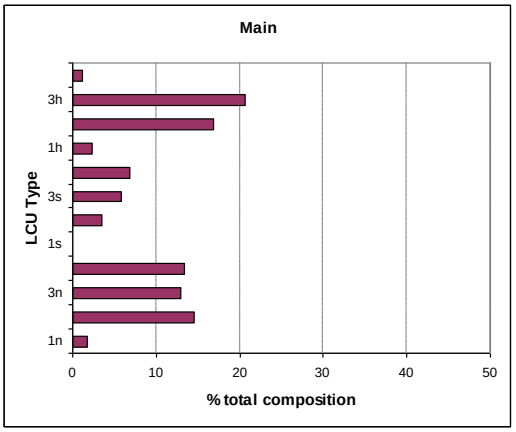
% total composition


Main
LCU Type
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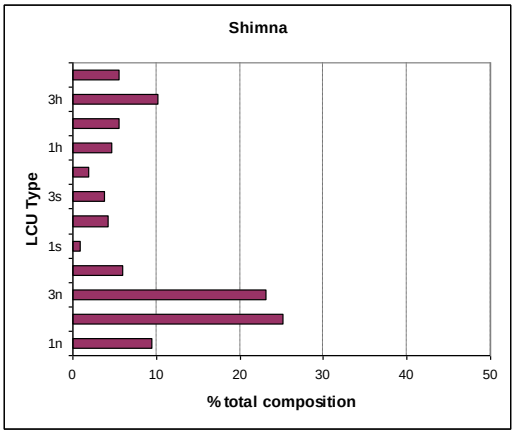
% total composition


Shimna
LCU Type
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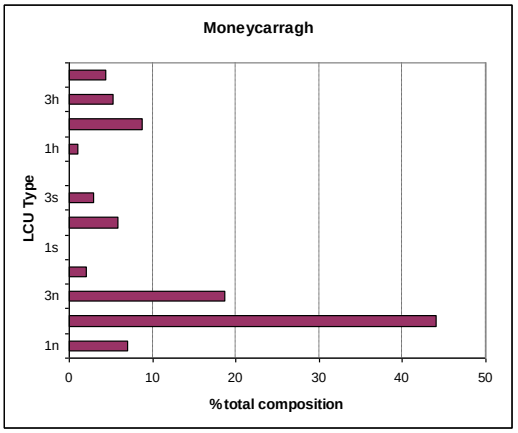
% total composition


Moneycarragh
LCU Type
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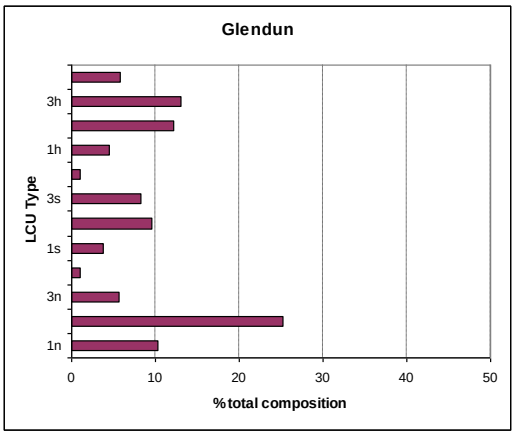
% total composition


Glendun
LCU Type
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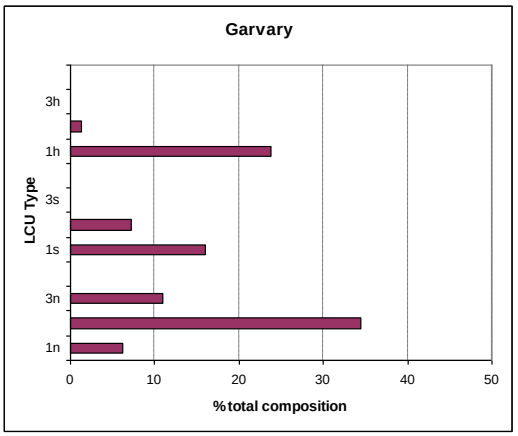
Garvary
LCU Type
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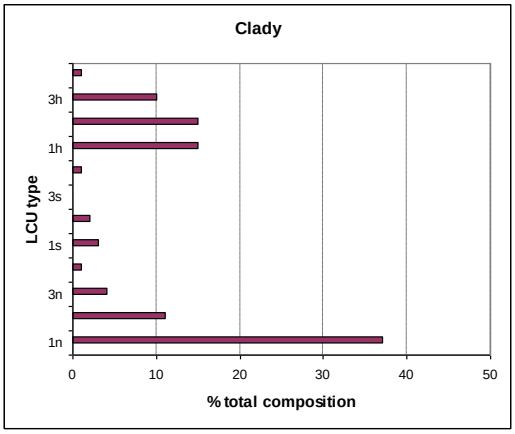
Clady
LCU type
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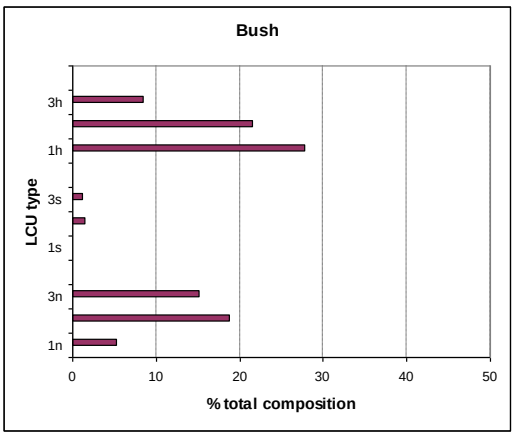
Bush
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% total composition

FCILC AREA

The Loughs Agency has undertaken extensive habitat surveys over the last 10 years primarily for use in the establishment of Conservation Limits but these have also been used in the identification of areas which would benefit from instream enhancement. The methodology adopted is similar to that used in N Ireland by the FCB / DCAL i.e. extensive walk over surveys using the Life Cycle Unit approach (Kennedy, 1984, O'Connor & Kennedy, 2002) through which habitat is classified according to type (nursery, holding, spawning) and quality (1 excellent – 4 marginal).

The overall status of habitat on a sample of Foyle rivers is given in Fig. 7. This figure refers to the area of habitat normally used by spawning salmon on each catchment as measured by extensive catchment wide electric fishing surveys and sets out the proportion of habitat described by the LCU typology.

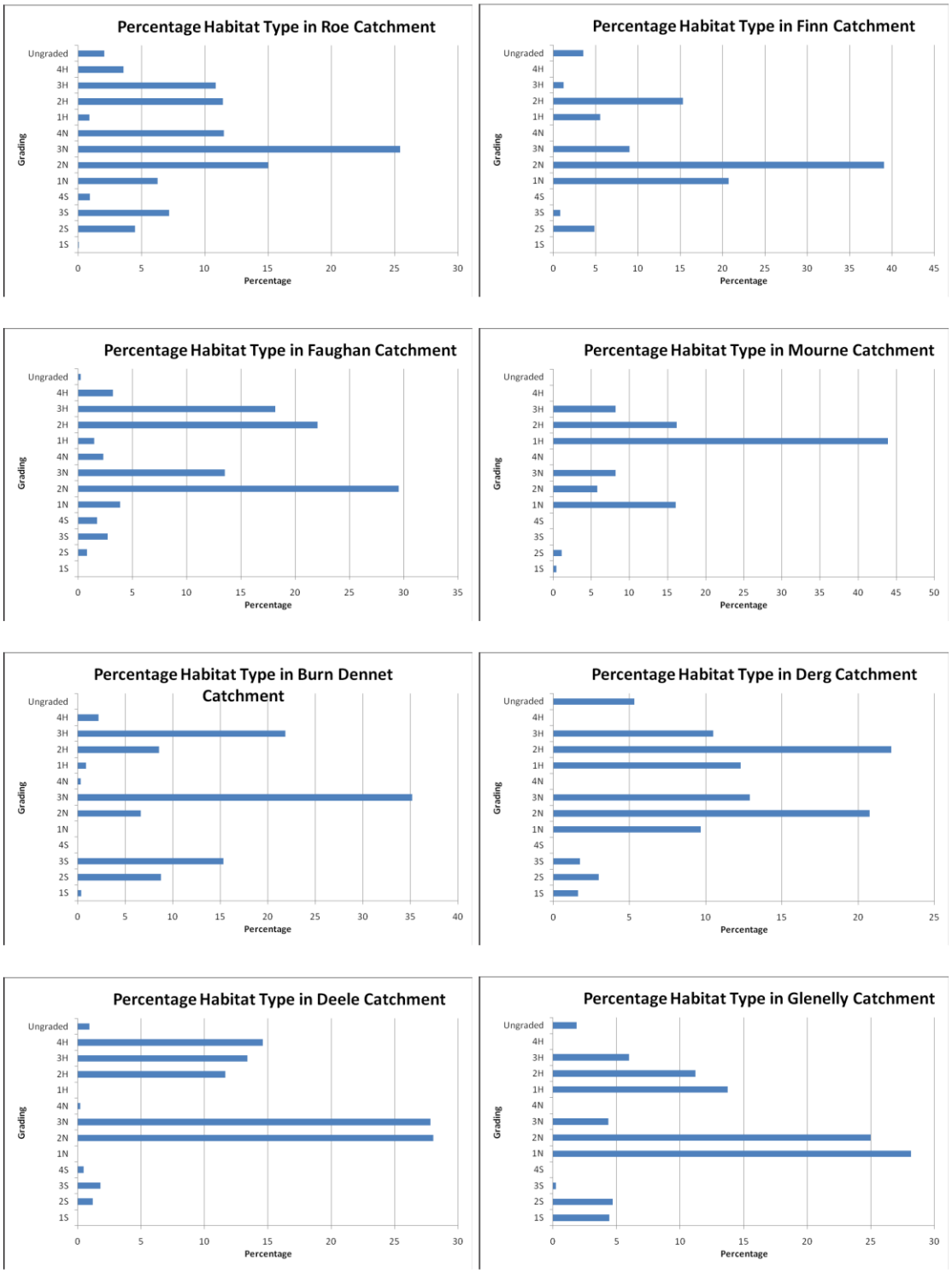


Figure 7 **Habitat composition of catchments in the Loughs Agency area (cross border Foyle and Carlingford catchments). Life cycle unit (LCU) habitat classification; type : Holding h, Spawning s, Nursery n; Grade : 1 (best) to 4 (marginal).**

Wider water quality in Northern Ireland

Compliance with Freshwater Fish Directive

The length of designated rivers in Northern Ireland has increased from 1,191 km in 2003 to 4,280 km in 2004. From 1995 to 2004, compliance failures decreased from 40% for salmonids (game fish) and 30% for cyprinids (coarse fish) to 7% and 15% respectively. For salmonid waters the greatest change occurred in the late 1990s, with a 30% reduction in failures between 1995 and 2000.

Phosphorus in Rivers

Results from the monitoring data collected between 1995 and 2005 show that the percentage of river lengths with annual means greater than 0.1mg P/l was highest in 2001 at 27%, and in 2005 was 22%. This coincides with reduced levels of fertiliser application. The quantity of fertilisers purchased between 1999 and 2006 has decreased from 470,000 tonnes to 314,000 tonnes.

GQA Chemical Classification for Rivers

The GQA System is a river quality assessment system primarily looking at organic pollution using Biochemical Oxygen Demand, Dissolved Oxygen and Ammonia to classify river reaches into six discrete classes ranging from Very Good (A) to Bad (F), on a rolling three year sampling period.

Class comparisons from 1995 to 2005 show that there has been a small increase in the percentage of river lengths in class A and B, with the greatest proportion of rivers found in class B. The smallest percentage of river lengths is found in Class F (bad quality). In 2005, 63% of river lengths in Northern Ireland were in the top two classes (A and B).

GQA Biological Classification for Rivers (1995-2005)

Biological monitoring of rivers provides a more integrated and comprehensive picture of river health as the results can show the effects of pollution that may not be detected by intermittent chemical monitoring, and has been regularly reported in Northern Ireland since 1990. Once damaged by a pollution event the biological status recovers slowly and hence historic pollution events can be detected months after they have occurred.

The biological monitoring for GQA classification involves determination of the diversity of the macroinvertebrates that live in the river, to score quality from Class A (Very Good) through to Class F (Bad) quality.
Between 1995 and 2005, there has been a 15% decrease in the percentage of Class A river lengths. Since 1999, when EHS started assessing small vulnerable streams including those in urban catchments, a small proportion of river lengths have been graded as Class F (Bad).

Full details of physical, chemical and biological water quality issues generally in Northern Ireland are available at:

http://www.ni-environment.gov.uk/stateoftheenvironmentreportfornorthernirelandwater.pdf

http://www.ni-environment.gov.uk/water/quality.htm

IV. PROCESSES TO IDENTIFY AND DESIGNATE KEY HABITAT AREAS OR ISSUES.

FCB AREA

Datasets and Research

The SMP approach generates a variety of data from key rivers throughout N. Ireland inclusive of habitat inventories, spawning run enumeration, exploitation estimates and juvenile stock assessments (Fig 7). The habitat inventories provide an accurate GIS based description of habitat resources throughout a catchment. The position of sub optimal habitat, extensive areas of poor habitat or unbalanced habitat can be rapidly detailed for a river using GIS. Additional value is gained through the integration of other datasets, such as juvenile density data, to provide additional context to assist in the identification of potential limitations or threats to productivity.

The habitat database has also provided useful data for the design of habitat improvement/ rehabilitation schemes, provides a reference point for habitat status (which has been used successfully in enforcement/prosecution actions such as the illegal removal of spawning gravel) and informs other areas of fishery interest (for example comments for planning applications).

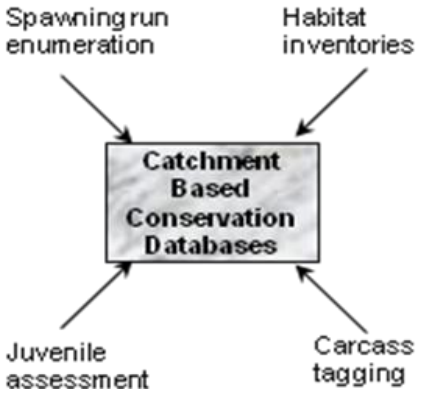


Figure 7 Salmon management plan databases collated for index rivers.

The fisheries datasets available through the SMP in N. Ireland have enhanced understanding of the many factors influencing fish population dynamics on a range of index catchments. Additional information is available from a range of other statutory and non-governmental groups; most significantly the Northern Ireland Environment Agency who hold important data on areas such as water chemistry and macroinvertebrates (see section II above).

Identification of impacts, pressures and bottlenecks to productivity

Integration and analysis of the fishery datasets with other available information and expertise will highlight particular catchment pressures or limitations to productivity. For example, good nursery habitat shown on the habitat database may exhibit low or absent juvenile fish stocks, indicating a potential problem such as lack of spawner

access or persistent low level pollution (Fig 8) which can then be targeted through the appropriate management or enforcement action.

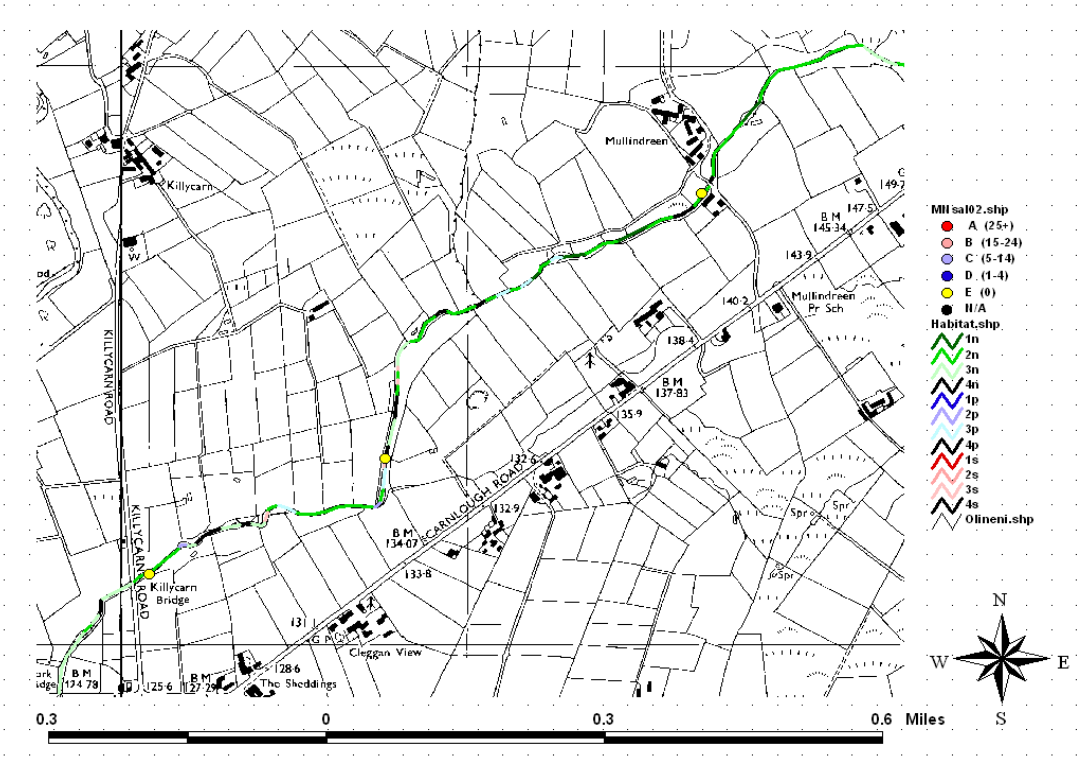


Figure 8 GIS map indicating a section of the River Main with an abundance of good quality nursery habitat (green linear areas) but with no 0+ salmon recruitment (represented by yellow circles). This area was subsequently targeted by fisheries enforcement activities and identified as suffering from two point pollution sources which were previously unknown.

The SMP datasets have been used to identify a range of pressures on a number of rivers which has facilitated the development of appropriate management/enforcement actions. Examples include;

- Through identification of limitations imposed by poor or unbalanced habitat, appropriate management actions involving habitat enhancement have been taken in a number of rivers including the Rivers Bush, Main and Blackwater.

- Removal of potential migratory barriers, for example the on Douglas Burn (R. Main).

- Identification and rectification of low level pollution point sources. Actions have been taken on the River Main.

- Identification of persistent underproduction in specific areas, for example on the Ballygawley Water and Bush which has been attributed to siltation of spawning substratum and resulted in widespread gravel cleaning and identificaion of bank erosion problems.

- Identification of illegal disruption to instream salmonid habitat, for example cases were discovered on the River Blackwater.

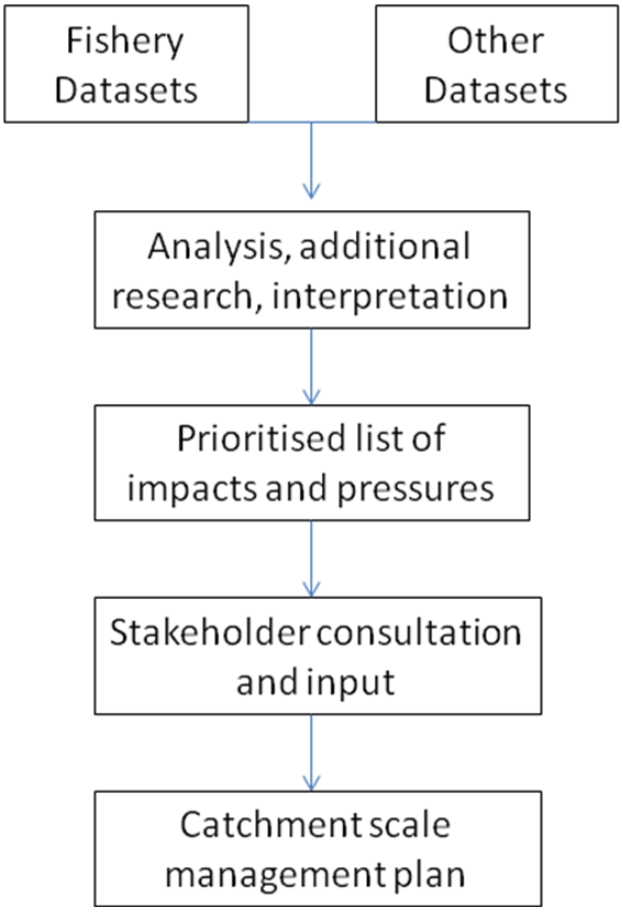
Some of these pressures can be small scale or focused (e.g. pollution point source) requiring a specific targeted response whilst others represent catchment scale impacts which may require a longer term, more strategic approach (e.g. extensive bank erosion and siltation).

Management Actions

The rationalisation of local and catchment scale pressures into a list or inventory allows managers to develop potential solutions, consider additional research requirements and set management targets. Additionally the different pressures can be prioritised to ensure the most significant impacts can be targeted in the context of available resources. Central to this approach is the involvement of stakeholders in the consideration of potential pressures, management responses and priorities. A flow model has been included below (Fig 9) to illustrate the processes involved in the drafting of catchment management inventories in N. Ireland. Examples of these inventories are provided in section 5 where the pressures, management actions and future plans for two FCB rivers (Bush and Main) are documented.

Figure 9 Flow chart indicating the development of management plans to address catchment impacts and pressures on salmon populations

[below]



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In order to develop this approach in line with proposals in the NI Implementation Plan, DCAL have very recently commissioned a full independent review of all management information and strategies, programmes and plans in NI. The consultants involved have produced a comprehensive report that defines and determines an approach to Salmon Catchment Management Plans. DCAL shall work with the NIEA to deliver these as supplementary but component plans of the wider River Basin Management Plans for NI.

The executive summary of this report is appended at annex 3

LOUGHS AGENCY AREA

Datasets and Research

The Loughs Agency operate a systematic audit based approach to the management of salmon within the Foyle and Carlingford areas. This approach is built around the collection of data at key life stages starting at spawning time (redd counts), to juvenile electrofishing surveys, habitat surveys, smolt tagging and returning adult assessment

through the use of electronic fish counters on a number of key tributaries. Additional information on chemical water quality and macroinvertebrate assessment which the Agency collects at approx 80 sites are also included. This information is compiled centrally on a Geographical Information System (GIS). The habitat data is used to identify potential areas for improvement and is cross checked against the other datasets in order to prioritise these and rank them. In addition, following consultation with agency field staff and stakeholders additional areas not identified may be considered following desktop and onsite appraisal.

Identification of impacts, pressures and bottlenecks to productivity

These data are interrogated through the use of GIS. Potential sites for enhancement are identified and ranked in order of priority. Ongoing pollution prevention control by Agency field staff identifies potential impacts on productivity in addition to ongoing habitat surveys, walking of river banks and Loughs Agency legislation which requires the issuing of a permit for the removal of substrate from a stream bed. The Agency's extensive water and biological monitoring programmes also are used to identify potential pressure points.

Management Actions

The Agency is in the process of rolling out Catchment Status Reports for the FCILC area. These summarise the data held by the agency and any other publically available information of relevance. They also include a series of recommended actions. These reports are circulated to other government agencies and stakeholders for consultation and discussion. Following this actions are confirmed and prioritised. In case of pollution this would be dealt with directly by agency staff in collaboration with sister organisations if required in both jurisdictions. Where habitat enhancement was identified as a priority this would be undertaken in partnership with local stakeholders e.g. River Faughan enhancement work in 2007.

Protected Areas for Salmon

- Special Areas of Conservation (SACs) for Atlantic Salmon have been established in accordance with Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive). This Directive requires Member States to maintain or restore habitats and species to favourable conservation status.

- SACs are afforded particular protection and are managed under national legislation entitled the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (the Habitats Regulations). The subject areas are also routinely declared Areas of Special Scientific Interest in accordance with the Environment (Northern Ireland) Order 2002, which also provides for appropriate management, and the regulation of potentially damaging activities that may adversely impact on this protected species.

- Sites are selected as candidate SACs on a United Kingdom basis by the Joint Nature Conservation Committee (which is the Government's advisors in such matters) in collaboration with NIEA, and the other statutory conservation agencies in Great Britain as regards sites within their respective countries. Following consultation with the owners and occupiers of lands affected, and other interested parties such as government departments and nature conservation bodies, candidate SACs are submitted by the UK Government to the EC for adoption as Sites of Community Importance (SCIs) in accordance with the Habitats Directive. Once adopted, SCIs are required to be designated as SACs as soon as possible thereafter, and within a period of 6 years at most.

- The criteria used in the selection procedure and that adapted in the Quercus Reviews include population size and stability, naturalness (stocking history), genetic distinctiveness and geographical coverage.

- As its contribution to the UK's suite of SACs for Atlantic Salmon, NIEA has designated the River Foyle and Tributaries as an,SAC, the River Roe and Tributaries have been adopted as a SCI, and the River Faughan and Tributaries have been submitted to the EC as a candidate SAC.

V. ACTIVITIES AND APPROACHES TO SHARE AND EXCHANGE INFORMATION ON HABITAT ISSUES AND BEST MANAGEMENT PRACTICES BETWEEN RELEVANT BODIES

The 1952 Foyle Fisheries Act and 1966 Fisheries Act in N. Ireland represent the end of processes that brought together information on the issues that impact upon salmon and their habitats and made provisions to control them. Amendments to these Acts since have reflected that this process has been ongoing and reactive to emerging issues. Through enforcement of these provisions by the Foyle Fisheries Commission (now the Loughs Agency) and the Fisheries Conservancy Board (soon to be assimilated into DCAL), stakeholders have become aware of them.

Information on the physical habitat requirements of salmon began to be assembled as the research and monitoring work on the dynamics of the River Bush population progressed in the 1970's. Following a period of experimental work to demonstrate the LCU components (spawning, nursery and holding areas) described above, this information was shared with Fisheries Officers who began to use it to exert influence on regulators of activities that impacted this habitat. Arrangements with the drainage authority, now Rivers Agency, were quickly put in place whereby advice was, and still is, provided to engineers to avoid or mitigate impacts on salmon habitat units and, where practicable, to restore or enhance them during drainage maintenance operations.

This base of knowledge, skills and experience was used very successfully to assist angling clubs, fishery owners and river enhancement groups to implement salmon habitat improvement schemes during the early 1990's. A grant scheme, known as the "Salmon Enhancement Programme", was administered by the then Department of Agriculture which provided the funding and led to dissemination of information amongst the stakeholder community. A leaflet was produced which became the reference guide for these groups in implementing small habitat improvement schemes at the local level [http://www.dcal-fishingni.gov.uk/leaf-2.pdf]. A further grant scheme from 2001 – 2006 built upon this approach and delivered further habitat projects.

Information, knowledge, skills and experience relating primarily to physical habitat gained through the development of salmon management plans in both the FCB and Loughs Agency areas since the 1970's is now routinely used to inform drainage maintenance programmes, planning applications and associated environmental assessments, and consents to discharge or abstract water.

Somewhat in parallel to the building and dissemination of information on physical habitat, the then Department of the Environment in NI began monitoring chemical water quality and developing controls on the discharge of water from industry, commerce and agriculture. Of most direct application to salmon habitat has been the implementation of the EU Freshwater Fish Directive. Through enforcement and advice, awareness of the chemical water quality requirements of salmon has been

shared between regulators and users of the water environment where salmon breed, grow and migrate.

Arising from a need to find the most appropriate implementation of the EU "Nitrates Directive" in NI, a forum was established comprising a wide range of stakeholders from the agriculture, industry, commerce, regulator and environmental sectors. This Consultative Forum on the Environmental Impact of Agriculture developed and agreed proposals for implementing the Directive in NI and in doing so researched, commissioned and shared a lot of detailed technical information. Of note was the work done on the causes of eutrophication in NI waterbodies. Awareness of the impacts of this and the full range of farming and other practices that affect salmon populations was considerably raised and solutions found. The success of this large forum in bringing together sectors with conflicting requirements for water use has been very helpful in developing river basin and catchment planning initiatives now underway.

Perhaps the major trigger for the continued development of this integrated approach to the protection, improvement and sustainable use of the water environment in NI has been the EU Water Framework Directive (WFD).

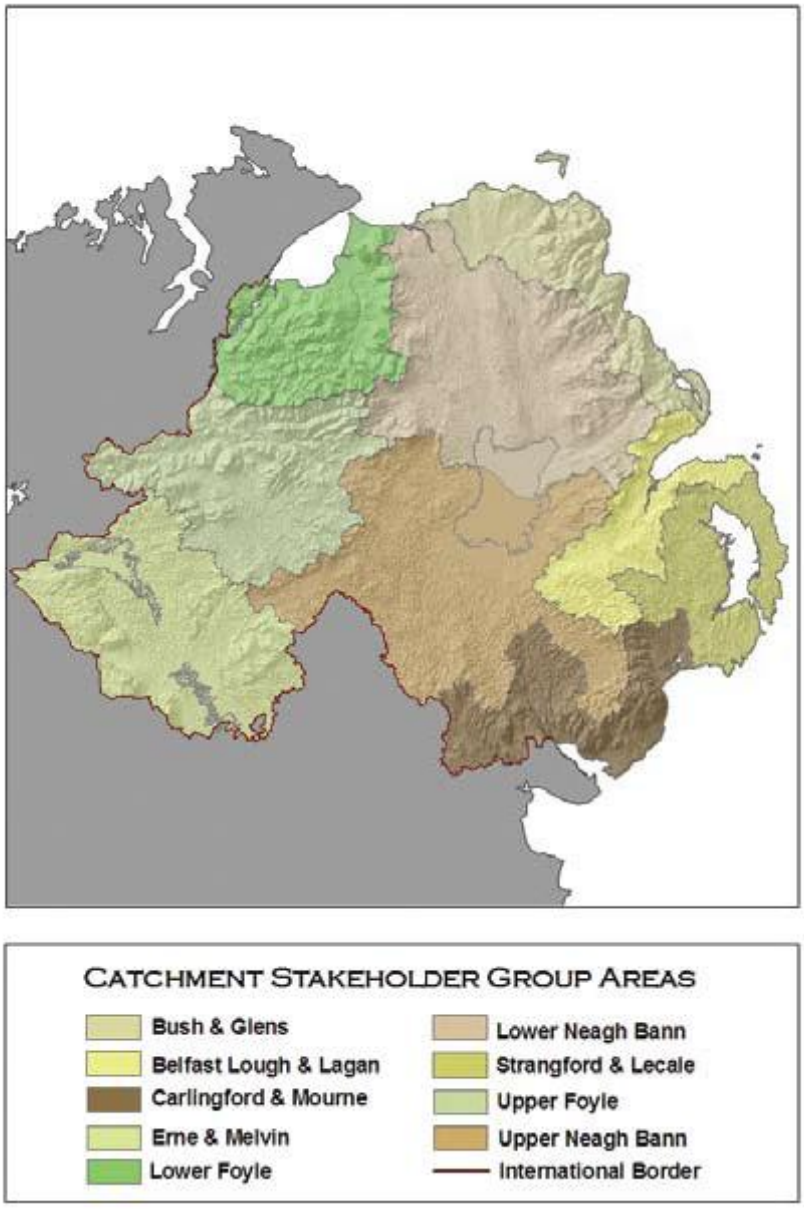
WFD was established in law in Northern Ireland on 22 December 2003 through the Water Environment (WFD) Regulations (Northern Ireland) 2003. These regulations identified the Department of the Environment as the competent authority for each river basin district within Northern Ireland. The Department of the Environment is required to coordinate the implementation of the Directive. Northern Ireland Environment Agency, an agency within the Department, is the lead body on the technical work required for implementation of the WFD. Delivery of the WFD rests with the Department of the Environment, in partnership with the Department of Agriculture and Rural Development, the Department of Culture, Arts and Leisure and the Department for Regional Development. An Inter-departmental Board has been established to oversee and coordinate strategic implementation of the Directive. The Board has established an Implementation Working Group to coordinate the activities of government departments and agencies that will be delivering the requirements of the Directive.

The responsible bodies, north and south, are coordinating their water actions through a North-South working group on Water Quality. This group is supported by the North - South Technical Advisory Group. A project, NS SHARE (www.nsshare.com), funded under the INTERREG IIIA programme, was set up to enhance the coordination of implementation of the Directive. Within the UK, government has set up a number of technical working groups to ensure that the Directive is implemented as consistently as is appropriate within the devolved administrations across the UK. The UK Technical Advisory Group (www.wfduk.org) is a partnership of the UK environment and conservation agencies. It also includes partners from Ireland.

The river basin planning process seeks to involve everyone who is interested in, or may be affected by, the water environment and the way it is managed. The production of the draft Plan has been coordinated by the Northern Ireland Environment Agency but has involved a wide a range of organisations that have an interest in the water

environment including those with a direct interest in salmon fisheries and conservation.

Northern Ireland has a layered approach to consultation and public involvement, based on a Northern Ireland WFD Stakeholder Forum, which is linked to a network of 9 Catchment Stakeholder Groups. The Groups include representatives from agriculture, businesses, planning authorities, environmental organisations and other water users. They provide a forum for anyone interested in local water issues to raise their concerns with, and have them addressed by, both statutory agencies and non-governmental organisations at a local level. Fisheries Officers and Fisheries scientists from DCAL, Loughs Agency and AFBI are involved on these groups. Indeed, area operational boundaries have been adjusted to ensure consistency with fisheries conservation and wider water management issues.



Catchment Stakeholder Group Areas

The NI Atlantic Salmon Management Strategy (NASCO Implementation Plan) and the process embarked upon to develop Salmon Catchment Management Plans sits within the WFD process and will be the basis to sharing and exchanging information and best management practices on salmon habitat, and for focussing the development of measures to directly and indirectly protect, restore and enhance that habitat in NI.

VI. WORK UNDERTAKEN AND PLANNED TO PROTECT, RESTORE AND ENHANCE SALMON HABITAT

Arising from the adoption of the NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat, DCAL led a bid for funding from the NI Executive to develop Salmon Habitat Restoration Plans. Whist this bid was unsuccessful, it set the framework for subsequent plans and projects in this regard, some of which are described below.

A copy of the supplementary information submitted with that bid is attached at Annex 2.

Examples of Habitat Protection, Restoration and Enhancement Plans

River Bush, County Antrim

Datasets and research

A range of baseline fisheries data have been collated for the River Bush since the initiation of the R. Bush project in 1973. Datasets are available on adult returns, smolt production and survival metrics. Additionally extensive habitat surveys have been conducted (see section 2) and annual electric fishing surveys are performed at over 136 sites throughout the catchment. In addition a range of research has been commissioned to identify and understand the potential impacts to productivity on the river.

Important work was commissioned and delivered examining the impact of predation on juvenile salmon in the River Bush (Kennedy & Greer, 1988). Other work has focused on the legacy of historical drainage schemes (Kennedy & Crozier, 1995), and compaction and siltation of spawning gravels and processes and impacts associated with sedimentary dynamics within the catchment (O'Connor & Andrew, 1998).

The Bush Integrated Monitoring Project was initiated in 2000 to act as a pilot monitoring study for other Northern Irish catchments. Collation of environmental data from the Bush into a GIS host formed the first phase of this work (Moore, 2001). The project was then developed from a geomorphological perspective to further examine the potential associations between salmonid recruitment, sedimentation and water quality and to produce a substantive list of impacts and pressures with associated potential management responses (Evans and Gibson, 2004). A copy of the executive summary of this report is appended at annex 1. It remains an important reference for the future development of a Salmon Catchment Management Plan for the catchment.

Impacts and Pressures

The Bush system was subject to a major arterial drainage programme in the 1950's, opening more land to increasingly intensive agricultural practices. Routine drainage maintenance programmes are presently continuing on the Bush, although these are mainly restricted to flood relief and bank repair. However this type of activity,

together with agricultural erosion, may serve to exacerbate the suspended solids in the river (O'Connor & Andrew 1998).

The over-use of chemicals, such as fertilisers, in modern agriculture has led to nutrient enhancement of many waterways. O'Connor (1998) reported that this type of enrichment on the R Bush had resulted in increased macrophyte growth (*Rannuculus pencillatus*) and algal growth. During the spring and summer months the biomass of *Rannuculus* can be extremely high, especially in areas of low water depth such as spawning fords. Excessive weed growth can reduce flow velocity and facilitate the settlement of suspended solids and ultimately results in the accumulation of sediment deposits in the immediate vacinity of the weedbed. Over a period of time this siltation of spawning gravel leads to the gravel becoming compacted and sub optimal for salmon spawning. O'Connor, (1998) noted that the majority of spawning fords sampled on the River Bush had substrates well suited for spawning salmonids except that the levels of fine sediment in the gravel were detrimental to egg survival and alevin emergence.

Evans and Gibson (2004) indicated that some parts of the River Bush suffered from a relatively high sediment load. At some sampling sites, loads were controlled by river flow ($r^2 = 0.68$ for Altarichard suspended sediment) and bed shear stress ($r^2 = 0.69$ for Conogher bed sediment) indicating that transport was a load limiting factor. Temporal variations in sediment load were also controlled by sediment source availability with bank highest in regions of the catchment with the least cohesive bank materials during high flow conditions (e.g. mean of 38.1 mm $storm^{-1}$ at Magherahoney). Livestock poaching exacerbated damage to banks at a localised scale and led to selective patches of bare land being susceptible to further erosion. Drainage maintenance work, forest clearfell and dieback of macrophyte beds were also shown to influence the quantity of sediment transported through the study channels. Preferential transport of fine sand, silt and clay sized material (<0.250 mm) was observed during these periods. The timing of this increase in the proportion of mobile fine material was particularly crucial in the River Bush as it occurred during the same period as salmon spawning.

Kennedy & Greer (1988) indicated that predation of outward migrating smolts was a major pressure on the R. Bush with a significant proportion of the smolt run predated by piscivorous birds.

Management Actions

A series of habitat restoration projects and works have been undertaken to address the impacts identified from research work and a summary of such actions over the last two decades is documented in Table 1.

Table 1 Habitat assessment, restoration and enhancement programmes conducted on the River Bush since 1990.

Location	**Date**	**Impact Addressed**	**Measure**	**Evaluation**
Clontyfinian	October 2008	Siltation of existing spawning gravels & lack of spawning substratum in upper catchment	Weed & silt removed from spawning channel, 150^{+} tons gravel added.	Annual 5 min electric fishing survey. Some transect based habitat assessment
Altnahinch experimental stream	October 2008	Investigation of stability of added gravel in higher gradient channels	Experimental spawning channel dug & gravel added.	Semi quantitative (SQ) electric fishing Tracer gravel included to measure stability
Rangerford	July 2006.	Siltation and compaction of existing spawning gravels	Weed removal. Lifted & turned gravel and added 7.5 ton 2" gravel	Annual 5 min (SQ) electric fishing surveys focused on 2007 & 2008
Stanocum Bridge, Chestnuts and Fork Ford.	Aug 2006	Siltation and compaction of existing spawning gravels	Weed removal. Lifted & turned gravel	Annual 5 min (SQ) electric fishing surveys 2007 & 2008
Various location	2000-02	Erosion of riparian areas	Fencing and tree planting programme	n/a
Conogher, Stranocum, Livery Hill, Peacocks Weir, Doughery Water & Mosswater	1997-2000	Gravel siltation and compaction. Unbalanced habitat (i.e. lack of optimal pool-spawning-nursery habitat sequences)	Creation of sequential habitat units (pool-riffle sections)	Annual 5 min (SQ) electric fishing surveys, freeze core sampling of gravel and transect assessment of substratum
Magherahoney	1991	Poor quality nursery habitat	Addition of boulders and rubble mats	Depletion electric fishing surveys
Bottom main stem	1990-	Cormorant predation	Predator disturbance	Ongoing research

Future Management Plans

A survey of the important spawning areas on the main River Bush was undertaken in December 2007, during the peak reproductive period of the local salmon stock. The survey was undertaken by AFBI staff from the River Bush Salmon Station and was

conducted during low flow conditions to facilitate access and examination of the spawning fords. The survey had three aims;

- To identify areas used by spawning salmon in the River Bush which achieved conservation limit in 2007.
- To carry out a redd count.
- To subjectively assess the condition of spawning areas and identify potential remedial measures.

Future plans for the river Bush include the enhancement and maintainance of spawning habitat following the river wide spawning audit. The spawning audit report detailed a series of targeted enhancement actions with priority ranking associated with each action (table 2).

An audit of rearing habitat will be conducted during 2009-10. Future advisory documents will focus on juvenile nursery habitat in the River Bush catchment and examine the spatial distribution of rearing habitat in relation to spawning and holding resources. The abundance and quality of nursery habitat will be analysed to identify potential limitations to salmonid productivity in the catchment and to develop future options for enhancement work.

Table 2 Example of spawning audit recommedations for the River Bush. This section indicates a number of main spawning areas surveyed in 2007, indicating condition of habitat, redd count, relevant electrofishing 0+ catch and potential action with priority rating (1 High -3 Low).

Spawning Ford (Map ID)	**Grid Ref**	**0+ Abundance 2007**	**Condition**	**No Redds 2007**	**Action**	**Priority**
Fork Ford (7)	0342 3142	Poor	Main spawning area denuded of gravel due to extraction.	9	*Gravel addition to replenish excavated gravel, tree planting to provide future shading*	*1*
Peat Ford (8)	0326 3134	Poor	Heavy weed cover approx. 80%; major limitation to spawning potential	3	*Weed control priority area*	*1*
Chestnuts (9)	0282 3075	Good	Weed removal & gravel cleaning, DCAL 2006. Currently sparse weed cover; good spawning potential	8	Monitor recruitment and weed recolonisation	3
Bullock hole (10)	0268 3066	Good	Weed removal & gravel cleaning by Rivers Agency in 2007. Currently sparse weed cover; good spawning potential	10	Monitor recruitment and weed recolonisation	3
Clay hole (11)	0275 3044	Good	Significant weed cover, High silt load.	5	Monitor recruitment	3

River Main, County Antrim.

Datasets and Research

The River Main is an SMP index river catchment and is subject to extensive, catchment wide fisheries monitoring and data collection. These data include an annual semi quantitative electric fishing programme surveying at around 180 sites, a baseline habitat inventory and spawning run enumeration from a fish counting station.

Impacts and Pressures

The available data was drawn together and interrogated to identify the key habitat issues and pressures impacting productivity on the catchment. These pressures were diverse inclusive of local and diverse habitat issues (Table 3). A series of appropriate management responses were identified and prioritised. This process has been summarised in Table 3 and indicates the various pressures, their priority status, potential management actions, timescales for target actions and the relevant statutory and stakeholder involvement.

Management Actions

A number of the habitat pressures and limitations to productivity on the River Main were addressed through a targeted habitat restoration project. A package of funding was secured from the Financial Instrument of the European Economic Area (EEA) to facilitate an extensive enhancement and management programme and involved a partnership approach across a range of government agencies, non-departmental public bodies, private companies and angling associations. A range of habitat enhancement techniques were utilised during the programme with in-river works conducted between 2005-07. Individual sites were designed with reference to baseline data through a preliminary study which sought to identify potential habitat shortcomings and local limitations to productivity.
The specific enhancement techniques employed have been listed in Table 4 and included the use of hard engineering solutions such as Vortex Weirs and D Wing deflectors as well as extensive soft engineering options such as the installation of conifer revetment or the erection of stockproof fencing. Overall around 9 km of channel length were improved through the programme.

An extensive monitoring regime was designed to assess the impact of the various habitat improvement works on local fish populations. Fully quantitative electric fishing surveys (Kennedy & Strange, 1981) were conducted at most rehabilitation sites and at a number of adjacent control sites prior to the commencement of improvement works. Subsequent surveys were undertaken from 1 year after completion of the work.

Preliminary results have indicated a significant increase in salmonid densities at many of the rehabilitation sites. Figure 10 reveals the substantial increase in salmon parr noted at two sites on the River Main in comparison with a control site situated on unmodified habitat between the two rehabilitation sites. Figure 11 illustrates a typical stretch pre and post enhancement work.

River	Section Ref.	Objective	Action	Length (m)
Main	Clough 1	Increase 1+ habitat Improve adult holding	RB, RM, F, DW, RA, TP.	250
	Clough 2	Increase 0+ and 1+ habitat	RB, RM	250
	Clough 3-5	Increase 1+ habitat	RB	750
	Braid 1	Generate spawning habitat, increase 0+ and 1+ habitat	DD, SG, DW, F, TP, CD	150
	Braid 2	Generate spawning habitat, increase 0+ and 1+ habitat Improve adult holding	VW, PE, DW, SG, RM, RB, F, TP	300
	Braid 3-5	Increase 1+ habitat	RB, F	460
	Killagan 1	Generate and improve spawning habitat, increase 0+ and 1+ habitat Improve adult holding	RB, SG, GC, VW, CR, TP, DW.	800
	Killagan 2	Improve 1+ habitat and adult holding	F	500
	Killagan 3	Generate spawning habitat, increase 0+ and 1+ habitat Improve adult holding	F, CD, RM, LS, SG, RB	500
	Glenwhirry 1	Improve 1+ habitat and adult holding	DW, F.	100
	Main 1-2	Improve 1+ habitat and adult holding	RB, RM	400

Table 3. Summary of habitat rehabilitation work conducted on the River Main, exhibiting section by section breakdown of improvement actions undertaken; where actions include; RB random boulders, VW vortex weir, RM rubble mat, SG spawning gravel addition, F fencing, DW D-groynes, DD double deflectors, RA rock armour, CR conifer revetment, TP tree planting, PE pool excavation, CD cattle drinkers, LS half log shelters, GC Gravel cleaning

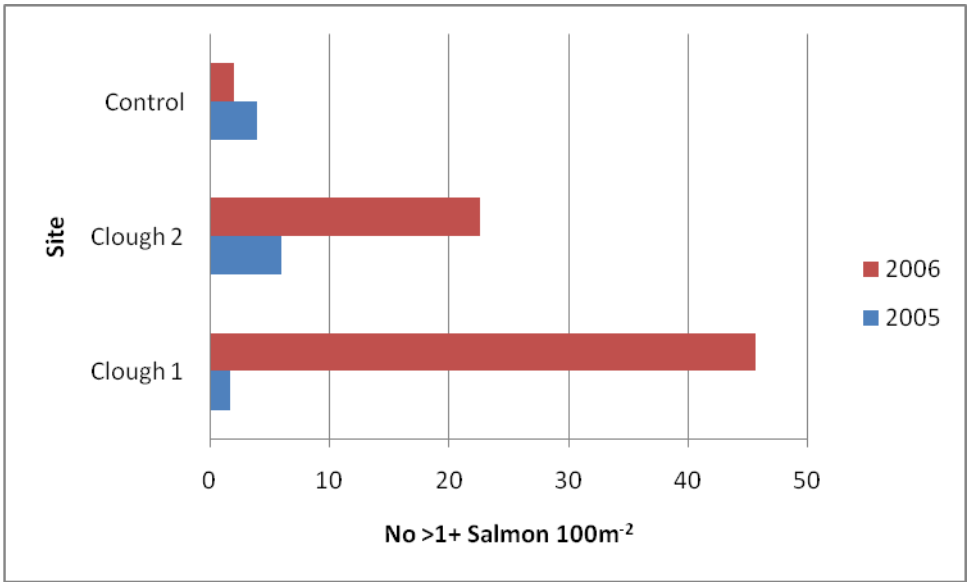


Figure 10. Bar chart showing density of 1+ salmon at two rehabilitation sites and a control site on the River Main before works in 2005 and 1 year post habitat improvement works (2006).

Figure 11.LHS Section of the River Main prior to enhancement work, this site was characterised by a lack of quality nursery habitat with limited stream bed cover, inadequate depth at summer flow levels and extensive bank erosion on the right hand bank.RHS Same section of the River Main after enhancement works. Flow deflectors, random boulders and fencing had been utilised to improve local salmonid nursery habitat

Pressure	***Priority 1(high)-4(low)***	***Management Objective***	***Management Action***	***Timescale***	***Responsible***	***Cost***
1a (Adult salmon)Broodstock abundance. Catchment has been below CL for last 5 years.	1	Restore stock numbers above CL	• Exploitation control • Eliminate poaching/illegal fishing • Improve/restore/refurbish habitat (refer to section 2) • Monitor spawning escapement through fish counter	2008-9	DCAL/FCB	?
1b (Adult salmon) Exploitation. Angling exploitation ranges have varied from 10-30% in last 5 years	2	Increase escapement by in river exploitation reduction	• Consider impact of conservation policies • Continue to monitor exploitation through SMP	2008-	DCAL/FCB/AFBI	?
2a (Habitat) Habitat quality. Habitat degradation evident in some lower tributaries and main stem often assoc. with drainage activities. Extensive bank erosion in	1	Areas to be targeted identified through SMP. Through restoration increase the productivity of degraded habitat.	• EEA habitat improvement scheme completed, effects should be evaluated • Further resources/funds mobilised to continue restoration work	2002-07 EEA scheme completed. 07-09	DCAL/FCB/AFBI/ Angling groups	150,000

some areas due to livestock poaching.						
2b (Habitat) Habitat quantity. Lack of suitable habitat and balance of habitat represents a limitation in some areas	1	Identify further areas to be targeted. Improve quantity/balance of available habitat in appropriate areas.	• EEA habitat improvement scheme completed, effects should be evaluated • Further resources/funds mobilised to continue restoration work	2002-07 EEA scheme completed. 07-09	DCAL/FCB/AFBI/ Angling groups	150,000
2c (Habitat) Spawner access/obstructions. Access to some smaller tributaries (e.g. Benvoire, Cargan) restricted by waterfalls. Access to others inhibited by anthropogenic influences.	3	Identify all target areas around the catchment. Develop plan to improve spawner access.	• Undertake enforcement action where appropriate • Develop scheme to open inaccessible habitat	2007-	DCAL/FCB/AFBI	?
2d (Habitat) Channel Structure	2					?
2e (Habitat) Siltation	3	Gather data	• Identify funds to undertake assessments	2007-	DCAL/AFBI	?
3a Communication	1	Agree and	• Establish catchment	2007-	DCAL/FCB/AFBI/Angling	?

formal production of Catchment management plan		develop catchment based plan.	management plan, agree priority actions		Groups/ Rivers Agency/EHS	
3b Communication between stakeholders & statutory agencies	1	Develop effective information exchange between statutory agencies and stakeholders to enhance management plans/actions	• Establish links/forum between agencies/stakeholders • Annual SMP Main catchment meeting with angling groups • Review options & consider input from other agencies (RA)	2007-	DCAL/FCB/AFBI/Angling Groups/ Rivers Agency/EHS	?
4a Water quality	2	Improve water quality in key areas Monitor recruitment patterns	• Inform enforcement actions through SMP • Interact with other agencies (EHS)	2007-	DCAL/FCB/AFBI/EHS	?
4b Water quantity	4	Monitor for potential impacts	• Improve hydrological information • Interact with other agencies (EHS)	2007-		?
5a Stocking policies	2	Advise local salmonid stocking	• Inform stocking actions through SMP • Develop universal stocking	2008-	DCAL/AFBI	?

		programmes through SMP databases and policy directives	policy			

LOUGHS AGENCY AREA

Datasets and Research

In the Foyle area baseline fisheries and habitat data has been collected and recorded as part of an integrated system since 1998. Specific fishery data in relation to catch returns and spawning counts has been recorded since 1952. The Carlingford area came under the jurisdiction of the Loughs Agency in 2000 and comparable fishery information have been recorded since.

Data sets include recreational and commercial catch returns, adult returns recorded by a number of electronic fish counters, catchment wide habitat surveys, annual semi quantitative electrofishing surveys (573 sites were surveyed in 2007, 487 in the Foyle area and 86 in the Carlingford area), catchment specific redd counts and water quality and biological monitoring. In addition, as part of a study into the Pre Fishery Abundance of the Foyle area juvenile indices of abundance linked to habitat quality are being developed with the intention of applying these across the Foyle area.

Recently, the Loughs Agency has been monitoring the impact of a number of habitat improvement projects and will continue to develop further in-channel and riparian habitat improvement programmes.

Impacts and Pressures

The Foyle and Carlingford areas were subject to significant post war arterial drainage programmes aimed at improving agricultural productivity. However it is described as having a natural river structure particularly in its headwaters were arterial drainage programmes were not conducted. Ongoing drainage maintenance programmes continue to be undertaken within the Foyle and Carlingford areas. These have been shown to potentially have some negative effects on salmon production through the possibility of increased suspended sediment load, direct habitat removal etc.

Agricultural practices including unfenced areas adjacent to watercourses can have a significant impact on spawning and nursery habitat as bank erosion may clog spawning gravels by the deposition of suspended sediment and the resultant compaction of previously suitable habitat.

Impacts on water quality from both point and diffuse sources have significant impacts on aquatic habitats. Sources of particular note include public waste water treatment works, industrial discharges, domestic discharges, forestry including clear felling and a variety of agricultural inputs. The CORINE 2000 land cover classification map collected using remotely sensed images from Landsat Thematic Mapper has in addition to the Northern Ireland Countryside surveys highlighted the small area of land covered by native tree species in the Foyle and Carlingford areas.

Barriers and partial barriers to migration are known to impact on the migration of salmon. Invasive species are also known to offer potential risk to salmon not achieving their potential.

Management Actions

Corrective measures within the Foyle and Carlingford areas have taken many forms and future plans are being developed to ensure the continued conservation and protection of Atlantic salmon habitat. Traditional habitat protection methods have included enforcement under the Foyle Fisheries Act 1952 and of the Foyle and Carlingford Fisheries Act/Order 2007 (covers RoI and NI respectively). In addition to these the Loughs Agency is keen to develop and promote partnership working and participation as additional tools to ensure effective habitat protection across both areas.

Many of the Foyle area rivers and tributaries are designated as Special Areas of Conservation (SAC) under the EU Habitats Directive. The River Foyle and Tributaries, River Roe and Tributaries, Faughan River, River Finn and Owenkillew River are all fully designated SAC's, Sites of Community Interest or Candidate SAC's, all have the protection of designated SAC's.

The Loughs Agency promotes partnership approaches with both statutory and non statutory partners as it feels that these offer the most effective strategy for dealing with the broad spectrum of anthropogenic influences impacting on freshwater aquatic ecosystems and therefore Atlantic salmon habitat. Under the EU LIFE instrument, the LIFE in UK rivers project has developed a series of guidance documents aimed at improving and restoring designated rivers by adopting partnership approaches to develop integrated planning. The Loughs Agency is aware of the potential benefits to the entire freshwater environment by adopting such partnership approaches to developing conservation strategies. All the Foyle SAC's have Atlantic salmon as a qualifying feature.

The Agency intends to further develop its existing conservation and protection role by developing river conservation strategies within the Foyle and Carlingford areas focusing on Atlantic salmon and their habitat utilising the Catchment Status Reports as the basis for these.

The Loughs Agency has implemented and is currently developing further habitat improvement/enhancement projects to address previously outlined impacts. The location, habitat improvement measures and evaluation methods of implemented habitat improvement projects are outlined in the table below.

Area/Catchment/ Tributary	Date	Impact Addressed	Measure	Evaluation
Foyle/River Roe/ Woodburn	2006	Cattle poaching of banks and damage to habitat by drinking cattle	Stock Proof fencing, gravel and nursery stone added	Timed electrofishing
Foyle/River Roe/ Bovevagh	2006	Dredged and straightened channel	In channel deflectors, boulders and	Timed electrofishing

			rubble mats	
Foyle/Burn Dennet/Camus Burn	2006	Cattle poaching, straightened channel, poor in-stream habitat	Stock proof fencing and cattle crossing, gravel and nursery habitat added. Low level vortex weirs (Habitat units)	Timed electrofishing
Carlingford/Ryland	2006	Bank erosion	Bank protection and gravel/nursery stone added	Timed electrofishing
Foyle/Deele River	2007	Dredged and straightened channel	In-channel deflectors and nursery stone added	Removal sampling (Quantitative electrofishing)
Carlingford/Clanrye River	2007	Poaching by cattle, dredged and straightened channel	Bank protection, gravel and nursery stone added and fencing	Timed electrofishing/ removal sampling(Quantitative electrofishing)
Foyle/River Faughan/Bonds Glen	2007	Poaching by cattle, spawning gravel compaction/ siltation, poor nursery habitat	Fencing, gravel and nursery stone added (Habitat units)	Removal sampling(Quantitative electrofishing)
Foyle/River Faughan/Foreglen	2007	Dredged channel	Gravel and nursery stone added	Removal sampling(Quantitative electrofishing)
Foyle/Drumragh River/Fintona River	2007	Cattle poaching, gravel silted and compacted	Fencing and gravel added	Timed electrofishing
Foyle/Drumragh River/Seskinore River	2007	Cattle poaching, gravel silted and compacted	Fencing and gravel added	Timed electrofishing
Foyle/River Derg	2007	Unauthorised river works, compacted gravel	Gravel Added	Timed electrofishing

In 2008 a trial was undertaken of a Barriers to Migration assessment protocol on the River Faughan. At the same time a survey was also carried out on the invasive species present in the riparian zone. These are currently being analysed.

The Agency operates the Riverwatch visitor centre where messages including the importance of habitat protection are conveyed to members of the public, school children and tourists through a series of mediums including videos, workshops and outreach programmes.

A series of catchment status reports outline fishery data collected at the catchment scale and identifies the main issues with regard to Atlantic salmon and associated habitat. A number of recommendations are included. These are aimed at both statutory and non statutory stakeholders and form an important part of the Loughs Agency communication strategy.

Future Management

Future management plans include assimilation of annual catchment wide redd survey data and habitat survey data. This assimilated data will provide an atlas of actively utilised spawning habitat and underutilised habitat which may be able to be improved. Analysis of this data using the Loughs Agency GIS in addition to further supplementary data collected on riparian fencing and bank stability will facilitate an integrated programme of spawning habitat protection facilitating conservation works to be targeted at areas most at risk.

The recent baseline genetic survey and resurvey conducted within the Foyle catchment have highlighted the genetically diverse populations present both between and within the Foyle rivers. The practical implementation of this knowledge will be to conserve the habitat at a similar or greater scale to ensure the preservation of the wild biodiversity of Atlantic salmon.

Future work will be targeted at ensuring habitat protection and improvement is promoted by the Loughs Agency grant aid programme through its sustainable development fund, by implementing recommendations within the catchment status reports and by implementing the Programmes of Measures under the Water Framework Directive.

It is intended to roll out the assessment of Barriers to Migration survey within the Foyle and Carlingford areas. In addition any such surveys will incorporate an assessment of invasive species. The results of the work which was undertaken on the R Faughan in 2008 will be incorporated into the Catchment Status Reports as a series of recommendations for discussion with stakeholders and other statutory bodies for action.

In relation to placing the burden of proof on proponents of an activity which may have an impact on habitat the Loughs Agency has a number of approaches to dealing with this. The Agency is a statutory consultee on all planning applications that are likely to have an impact on the aquatic environment. The Agency assesses individual planning applications and comments on likely impacts and recommends all potential impacts

are mitigated or if the development is likely to cause an offence under Loughs Agency legislation that this is highlighted and conditions outlined for consideration by the planning authorities. In addition the requirement for article VI Appropriate Assessments as required under the EU Habitats Directive in designated river sites for Atlantic salmon are highlighted.

Under the Foyle Fisheries Acts1952 and the Foyle and Carlingford Fisheries Act/Order 2007 there are various legislative requirements and offences including under the 2007 legislation a new offence of removal of any bed material from the freshwater portion of any river in the Foyle or Carlingford areas without consent of the Loughs Agency.

The concept of integrating socio-economic implications into Atlantic salmon habitat protection, restoration and improvement/enhancement plans while of significant importance is difficult to quantify. The Loughs Agency has a requirement to produce business cases for any substantive works. These attempt to address cost benefit analysis through comparison of salmonid production against the projected lifespan of the development. However, as so many other variables can influence the outcome of projects it is difficult to manage the level of risk associated. In particular, putting a financial cost on the value of the biodiversity of wild salmon is difficult and the Agency would value information on how to best assimilate such considerations fully into future programmes. As outlined previously the Loughs Agency promote partnership working with parties interested in habitat improvement projects and will advise groups on project development. At times external groups will have secured funding for such projects. The Loughs Agency aims to work in the context of sustainable development both directly on in-house projects and through its sustainable development grant aid programme.

If direct habitat protection projects are implemented within specific catchments in the Foyle and Carlingford areas all relevant permits and permissions will be sought from the relevant statutory bodies and landowners. If the site is with a designated site such as an SAC or ASSI both Art VI Appropriate Assessments and relevant consents will be completed and submitted to the relevant organisations for comment. The wider implications and impacts on both riparian and aquatic organisms including other fish species is considered as part of the project design.

In order to fully take into consideration all biodiversity a partnership involving relevant stakeholders is undertaken and the Agency is involved in both freshwater and Marine biodiversity groups in RoI and NI. The Loughs Agency collect and provide data for inclusion into Water Framework Directive classifications and for SAC site condition assessment.

Water Framework Directive draft River Basin Management Plans

Broader programmes of measures that consider all types of pressures affecting the water environment have been developed as the means to try and achieve the environmental objectives set out in the draft NI River Basin Management Plans published in December 2009.

These plans set out a programme that addresses the key pressures and describes:

• measures that are already being taken in river basin districts and the improvements expected from those measures; and

• new measures proposed for each sector in order to deliver the objectives of this plan.

These issues have previously been agreed with our stakeholders to be the most significant. In summary the pressure types are:

• abstraction and flow regulation;

• diffuse and point source pollution;

• changes to morphology (physical habitat);

• invasive alien (non-native) species.

It is noted in the Plans that Fisheries as a sector is impacted by all identified pressure types. It follows that an integrated approach to addressing thse pressures will improve salmon habitat in the broad sense of the NASCO definition. It is hoped that restoration, and particularly enhancement of salmon habitats at the finer scale will be achieved by developing Salmon Catchment Management Plans within the context of, and integrated with, the River Basin Management Plans.

Full details of the draft WFD programmes of measures by sector is available at www.ni-environment.gov.uk/wfd

The draft programmes specific to freshwater morphology and fisheries which are perhaps the most directly relevant to salmon habitat protection, improvement and enhancement of salmon habitat and which have been developed through the collaborative processes outlined at section IV above are available at 5.8 and 5.11 of http://www.ni-environment.gov.uk/neaghbann_draftrbmp_tier2.pdf

Land use changes

The emphasis of agricultural policy has moved from maximising output to adopting environmentally sustainable farming methods. The DARD Strategic Plan 2006 – 2011 addresses this in that one of the strategic goals is to develop a more sustainable environment. This is being tackled through a combination of regulation, advice and financial incentive.

The Nitrates Directive

The Nitrates Directive seeks to reduce or prevent diffuse water pollution caused by the application and storage of manure and inorganic fertiliser on farmland. It is designed both to safeguard drinking water supplies and to prevent wider ecological damage in the form of the eutrophication of freshwater.

Seven small Nitrate Vulnerable Zones (NVZs), covering a total of 120 farms, were designated in 1999 and 2003. However, the requirement to apply a Nitrates Action Programme across NI (total territory) was established in October 2004 following a public consultation.

DARD and DOE developed an Action Programme of measures designed to control and/or prevent the run-off of both nitrates and phosphorus to the water environment from agricultural sources, which lead to nutrient enrichment. Stakeholders were actively involved in the development of the proposals and a regulation declaring a 'total territory' approach to the Nitrates Directive came into operation on 29 October 2004, meaning that an Action Programme of measures would apply across the whole of NI.

The Nitrates Directive Action Programme Regulations were agreed and came into operation on 1 January 2007. Key measures include a closed period for spreading slurry during the winter months, a minimum slurry storage capacity requirement for livestock farms and limits on the amount of slurry/manure and chemical fertiliser that can be applied to farm land. In addition, manures and chemical fertiliser can only be applied when the location is acceptable and conditions are suitable. The accompanying Phosphorus Regulations require that chemical fertilisers containing Phosphorus are only applied where a soil test demonstrates a crop need for additional phosphorus.

Cross Compliance

Cross Compliance requires all recipients of the Single Farm Payment, and all farmers receiving funding under 'Axis 2' of the current Rural Development Plan (improving the environment and countryside), to abide by certain environmental standards as a condition of funding. Maintaining land in Good Agricultural and Environmental Condition (GAEC) and complying with 19 European regulatory requirements, referred to as statutory management requirements (SMRs), are the two aspects to Cross-Compliance. SMRs relating to water pollution include the Nitrates Directive and Groundwater Regulations.

Code of Good Agricultural Practice

A Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil (the Code) was developed by DARD prior to the designation of the first Nitrate Vulnerable Zones in Northern Ireland (NI) in 1999. It outlined management practices for preventing pollution of water, air and soil. The Code, comprising two booklets, one of which applied specifically to water and the other to air and soil was

revised and updated in 2002. DARD issued this revised Code to 32,500 farmers in March 2003.

Since 2003, various pieces of legislation and regulation have been introduced and implemented to protect the environment, including the Nitrates Directive Action Programme. This programme has a key role in improving water quality and the Directive requires Member States to produce and promote a Code of Practice. The Code has now been fully revised and updated to take account of these changes.

The latest 'Code' outlines legislative requirements for farmers regarding water, air and soil. It combines these with practical advice on management practices designed to reduce any negative impact from agricultural activities on the environment. It is reader friendly in that it is activity based rather than guidance for a specific piece of legislation. It will also serve as a reference document to those involved in providing pollution control advice to farmers.

Environmental training for farmers

DARD also provides agri-environment training for farmers through the Farm Advisory System. Since 2005 the College of Agriculture, Food and Rural Enterprise (CAFRE) has delivered over 600 workshops dealing with nutrient and farm waste management issues. These include complying with Nitrates and Phosphorus Regulations, nutrient management planning and dealing with farm wastes.

Agri-environment schemes

DARD agri-environment schemes have been developed to encourage farmers use agricultural methods compatible with the requirements for the protection of the environment. A priority target in the Northern Ireland (NI) Programme for Government 2008 – 2011 is to increase to 50% the area of agricultural land covered by environmental enhancement agreements by 2013. This will allow up to 18,000 farmers to participate in agri-environment schemes. By December 2006 some 13,000 farmers, farming 40% of NI agricultural land, were participating in these schemes.

Managing farm nutrients and effective pollution control are key requirements for agri-environment scheme participants and all receive farm nutrient and pollution control advice as part of the application process. The most recent agri-environment scheme launched in 2008, the Northern Ireland Countryside Management Scheme (NICMS), further enhances the agri-environment programme's ability to improve water quality on farms. Participants must draw up farm waste management plans and in addition have the option of taking up new farm waterway and riparian zone management measures. These aim to enhance river and riverbank biodiversity and help the agriculture industry meet the requirements of the EU Water Framework Directive.

Capital grants

Capital grants to improve facilities on farms have been an important element of schemes, particularly in the 1970s and 1980s. More recently the Farm Nutrient Management Scheme (FNMS) was launched in January 2005 to assist farmers invest

in new or improved slurry and manure storage facilities to assist compliance. The FNMS closed at the end of 2008 and over 3900 projects have been completed. Total investment through the FNMS has exceeded £200m. This represents a major improvement in farm infrastructure to ensure environmental compliance and enable environmentally sustainable farming practice. The average investment has been approximately £50k per farm.

VI. OVERVIEW OF ONGOING HABITAT ACTIVITIES

The scope of the information on and activities associated with the protection, restoration and enhancement of salmon habitat has meant that this Focus Area Report has only been able to give an overview of the approach to, and progress with, plans in this regard in NI and the cross border Foyle and Carlingford catchments.

The NI NASCO Implementation Plan has ambitiously set out a timetable for the development of Salmon Catchment Management Plans and associated habitat management activities.

The approach to delivering these has been outlined above and is summarised again below in table form:

Summary of historical habitat enhancement activities in UK N. Ireland

FCB AREA

River	**Habitat Enhancement Activity**	**Measure**	**Post work monitoring**
Bush	Various schemes including gravel rehabilitation, creation of complete habitat units, fencing and tree planting.	DANI	FQ and SQ electric fishing, freeze core analysis of gravel and habitat assessments
Ballycastle	Bank protection, pools and groynes on Glenshesk	SEP	No
Dun	Weirs added to improve holding habitat	SEP	No
Glenarriff	Weirs added to improve holding habitat	SEP	No
Inver	Weirs and groynes installed to improve holding habitat	SEP	No
Threemilewater	Addition of spawning gravels, creation/improvement of holding and nursery habitat	Peace 2, SEP & Angling association	Limited SQ electric fishing
Lagan	Salmon restoration programme inclusive of restorative	DANI	FQ and SQ electric fishing

	breeding project		
Moneycarragh	Weirs added to improve holding habitat	SEP	No
Shimna	Groynes, vortex weirs and rubble mats installed on Burren River to improve nursery habitat	SEP & Angling association	?
Kilkeel	Pool deepening and nursery improvement at Hannas Close	EU peace	No
Agivey			
Clady	Weirs added to improve holding habitat	SEP	No
Moyola	Nursery and spawning improvement	Angling association	
Ballinderry	Spawning, nursery and holding habitat rehabilitation	Ballinderry Enhancement Partnership	
Lower Bann Tributaries	Enhancement of minor tributaries for spawning salmon through installation of gravel retaining weirs	Bann systems	Semi quantitative electric fishing
Blackwater	Stones weirs, addition of nursery and spawning habitat, flow deflectors, bank protection and fencing	Post drainage rehabilitation, SEP, INTERREG	FQ and SQ electric fishing, freeze core analysis of gravel and habitat assessments
Upper Bann			
Crumlin	Installation of fish pass		
Sixmile	Stone weirs, bank protection, fencing.	SEP	No
Main	Various projects including flow deflectors, bank protection, addition of spawning gravels, vortex weirs	SEP & EEA	FQ and SQ electric fishing and habitat assessments
South Armagh Tributaries	Bank stabilisation on the County water and nursery rehabilitation	PEACE 2	FQ and SQ electric fishing and habitat

	on Fane River		assessments
Erne Catchment	Various projects often focusing on gravel addition	SEP	SQ electric fishing

LOUGHS AGENCY AREA

The Loughs Agency target for 2009 is to develop two habitat improvement schemes utilising best practice. In addition to this the Loughs Agency will continue to participate in the process of developing programmes of measures to be implemented under the EU Water Framework Directive with specific focus on river habitat. It is also hoped that partnership working can be developed through a pilot catchment conservation strategy incorporating habitat protection, restoration and enhancement plans.

Future management plans will include the active spawning area protection programme, ongoing habitat improvement projects, continued water quality monitoring.

All projects will be evaluated using a combination of redd counting, timed electrofishing surveys, habitat resurvey and removal sampling at improved sites and control sites to demonstrate the quantitative effects on the salmon populations in response to habitat improvement works.

Area/Catchment/ Tributary	Date	Impact Addressed	Measure	Evaluation
Foyle/River Roe/ Woodburn	2006	Cattle poaching of banks and damage to habitat by drinking cattle	Stock Proof fencing, gravel and nursery stone added	Timed electrofishing
Foyle/River Roe/ Bovevagh	2006	Dredged and straightened channel	In channel deflectors, boulders and rubble mats	Timed electrofishing
Foyle/Burn Dennet/Camus Burn	2006	Cattle poaching, straightened channel, poor in-stream habitat	Stock proof fencing and cattle crossing, gravel and nursery habitat added. Low level vortex weirs (Habitat units)	Timed electrofishing

Carlingford/Ryland	2006	Bank erosion	Bank protection and gravel/nursery stone added	Timed electrofishing
Foyle/Deele River	2007	Dredged and straightened channel	In-channel deflectors and nursery stone added	Removal sampling (Quantitative electrofishing)
Carlingford/Clanry e River	2007	Poaching by cattle, dredged and straightened channel	Bank protection, gravel and nursery stone added and fencing	Timed electrofishing/ removal sampling(Qua ntitative electrofishing)
Foyle/River Faughan/Bonds Glen	2007	Poaching by cattle, spawning gravel compaction/ siltation, poor nursery habitat	Fencing, gravel and nursery stone added (Habitat units)	Removal sampling(Qua ntitative electrofishing)
Foyle/River Faughan/Foreglen	2007	Dredged channel	Gravel and nursery stone added	Removal sampling(Qua ntitative electrofishing)
Foyle/Drumragh River/Fintona River	2007	Cattle poaching, gravel silted and compacted	Fencing and gravel added	Timed electrofishing
Foyle/Drumragh River/Seskinore River	2007	Cattle poaching, gravel silted and compacted	Fencing and gravel added	Timed electrofishing
Foyle/River Derg	2007	Unauthorised river works, compacted gravel	Gravel Added	Timed electrofishing

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Bush Integrated Monitoring Project

Executive summary and catchment management recommendations

The Bush Integrated Monitoring Project was initiated to act as a pilot monitoring study for other Northern Irish catchments. Collation of environmental data from the Bush into a GIS host was the first phase of this work (Moore, 2001). This reported declining salmon populations and failure to meet some water quality objectives targeted at compliance with the Water Framework Directive (EC/2000/60/EC).

Section 1 of this report describes the features of the Bush catchment from a geomorphological perspective and reviews current knowledge on salmonid recruitment, sedimentation and water quality particularly with respect to the River Bush.

The Bush Integrated Monitoring Project committee approved a field-based study with the following aims which are justified in **Section 2**:

1. Quantify fine sediment loads
2. Trace fine sediment sources
3. Monitor coarse sediment transport
4. Identify the factors controlling instream oxygen dynamics

The ultimate goal of this project was to use this data to recommend improved management strategies (particularly with respect to addressing fine sediment content and oxygen concentrations in the river system).

The data collection portion of this project was completed over a one-year period from July 2002 to July 2003 at four sampling sites. Details of the methodology used and the study site locations are given in **Section 3**.

The study could not find evidence for any change in the hydrological regime of the river over the past 30 years (as discussed in **Section 4.1**). However, the long-term record was not of a sufficient length (since 1973) to judge the effect of arterial drainage upon river flows in the catchment. Anecdotal evidence and studies in other catchments would suggest that drainage has caused an increase in both the magnitude and frequency of peak flows during heavy rainfall in conjunction with a decrease in low flows during dry periods.

This perceived change in hydrological regime has important implications for sediment transport in the catchment. **Section 4.2** described the temporal and spatial variations in fine sediments (<5 mm) transported through the channel in suspension (median value range of 0.025- 0.625 kg $m^{-1}week^{-1}$) and along the bed (median value range of 0.025-6.15 kg $m^{-1}week^{-1}$) at the four sampling sites. This indicated that some parts of the river suffered from a relatively high sediment load. At some sampling sites, loads were controlled by river flow ($r^2 = 0.68$ for Altarichard suspended sediment) and bed

shear stress (r^2 = 0.69 for Conogher bed sediment) indicating that transport was a load limiting factor.

However, temporal variations in sediment load were also controlled by sediment source availability (as discussed in **Section 5**). Bank erosion was highest in regions of the catchment with the least cohesive bank materials during high flow conditions (e.g. mean of 38.1 mm storm^{-1} at Magherahoney). Livestock poaching exacerbated damage to banks at a localised scale and led to selective patches of bare land being susceptible to further erosion. Drainage maintenance work, forest clearfell and dieback of macrophyte beds were also shown to influence the quantity of sediment transported through the study channels. Preferential transport of fine sand, silt and clay sized material (<0.250 mm) was observed during these periods. The timing of this increase in the proportion of mobile fine material was particularly crucial in the River Bush as it occurred during the same period as salmon spawning.

Coarse sediment transport (size range 10-160mm) was monitored at the Magherahoney sampling site. **Section 4.3** showed that maximum transport distances of >200m were recorded over a five month period. This indicates that "seeding" of specific reaches with stones suitable for salmon spawning would not be sustainable on a long-term basis. Non-selective transport was observed with weak relationships between transport distance and tracer pebble volume (r^2 0.21 and 0.47) and tracer pebble mass (r^2 0.28 and 0.44). This suggested that the size of pebbles only partially governed bed stability within the channel.

Section 6 investigated the important controls upon dissolved oxygen levels in the River Bush. Lowest oxygen values were noted in the lower reaches of the river (e.g. annual mean of 92.7% saturation at Conogher) during the summer period. This was due to a combination of lower reaeration rates and higher biochemical oxygen demand (caused by sewage treatment effluent, macrophyte beds and phytoplankton). Diurnal variation in oxygen saturation during the summer period was large (range 72-168%) with average concentrations at midday. This reflected high photosynthetic activity (mean 1.6 mg l^{-1} day^{-1}) which has important implications for the timing of weekly sampling campaigns for statutory purposes and the stress placed upon river-dwelling organisms in the Bush.

Dissemination of the data collated in this project has occurred at a regional, national and international level (**Appendix 3**).

Management recommendations

(a) Introduction
Best management practices to re-dress the habitat degradation in the River Bush are justified by the quantitative field data collected in connection with this project. A five-point conceptual framework was devised within the Bush catchment aiming to reduce fine sediment loads and improve water quality (in accordance with Mainstone *et al*., 2000). This is shown in a tabulated form in **Appendix 4**. Instream fine sediment load, sediment source and water quality data (points 1 and 2 below) were used to guide a management plan (points 3-5 below):

1. Identify areas with high instream fine sediment loads and low oxygen values
2. Identify the source(s) of sediment and the parameters controlling oxygen concentration within these channels
3. Identify best management practices (BMP), which might be appropriate for each sediment source/land use/river channel change
4. Assign a level of efficiency for each BMP to identify the minimum combination required to achieve the target suspended solids load/dissolved oxygen level in the river
5. Compare the cost effectiveness of each BMP to obtain the minimum cost to achieve the target

Established, successful catchment management schemes should be used as a guide to habitat improvement in the Bush as the problems encountered in these catchments can be largely redressed by generic strategies (e.g. Wye Habitat Improvement Scheme and the Tarland Initiative). Generic solutions to combat some of the processes contributing to high sediment loads, poor water quality and practical application in the Bush catchment are shown in **Appendix 4.1**.

In addition to this, the authors of this project strongly recommend some catchment specific solutions to improving habitat quality in the River Bush (details of these are available in **Appendix 4.2**):

(b) Key Actions

KEY ACTION 1 - The immediate cessation of drainage maintenance. It is suggested that it should be the responsibility of the Rivers Agency to justify the need for such work for controlling land flooding at *specific sites* rather than it being applied to the large regions of the lower catchment on an indiscriminate basis (in conjunction with wetland restoration projects – see Appendix 4, Section 4.1.4, Action B).

KEY ACTION 2 – Development of a clear strategy prior to the initiation of felling of conifer plantations in the upper Bush catchment over the next twenty years to reduce undesirable impacts for hydrology/sediment dynamics on the River Bush.

KEY ACTION 3 - Restricting livestock access to the riverbanks and channels. Fencing field boundaries would be cost prohibitive for individual farmers so creating a funding mechanism for such work might set the precedent for the success of this strategy.

KEY ACTION 4 – Macrophyte management in stretches of heavy colonisation every year. Clearance by hand is essential to prevent damage to banks and the riverbed.

KEY ACTION 5 – Expansion of the current FCB DCAL river warden role to cover cross-departmental requirements (DCAL, EHS and DARD). Employment/training of a "custodian" with responsibility for water pollution detection, land management issues and representation of policies to local stakeholders within the Bush catchment.

KEY ACTION 6 – Dissemination of the project recommendations to the public in the Bush catchment via a press release, giving reference to more detailed information brochures that (available by post and in a PDF format on the web). This should aim to

improve education and awareness of the importance of Northern Irish rivers and the water quality issues they face (with particular reference to the Bush catchment).

(c) Implementation of key actions
These actions address both the causes of the habitat degradation in the River Bush and some of the symptoms. Although the recommendations focus on low cost methods, a significant effort will have to be put into visiting large numbers of farmers in the catchment and persuading them to change their practices – a role that could be filled by a "river warden". It might take a long time for benefits from some of these schemes to become apparent because of the storage of large quantities of fine sediment within the channel.
The same BMPs are applicable to generic problems within other Northern Irish catchments. However, diffuse pollution in the Bush results from a number of different practices spread across land all over the catchment so a range of BMPs will be required and these should be applied in an integrated fashion. Hence, working hard with one farmer to clear all the problems on his farm is unlikely to deliver a major benefit to the river. All the farms in the catchment will need to be improved.

Report conclusions and the future

Hydrological trend, sediment source characterisation and water quality controls reported here are important when assessing salmonid embryo survival and spawning in relation to the dynamic nature of sediment transport processes in natural channels. The temporal and spatial variability in survival rates are highly dependant on the delivery of fine sediment infiltrating a coarse framework and the size of material that accumulates in spawning gravels.

Feasibility studies to evaluate sites where BMPs can be applied to give the maximum benefit to fine sediment reduction have been suggested. Such sediment reduction schemes will concomitantly reduce input of sediment bound contaminants (e.g. phosphorus, pesticides, fertilizers). This will provide additional benefits to the River Bush such as reduction in invasive macrophyte growth, reduction in phytoplankton concentrations and improvement in oxygen concentrations (all due to lower nutrient input). A complete cost-benefit analysis will be required to complement the management recommendations.

This report has detailed the first step towards combating further habitat degradation in the River Bush. However, the next stage will be to implement recommendations justified by this monitoring data into an integrated catchment management plan. The success of this will depend upon providing a framework for funding and legislation to encourage uptake of the plan – a slower and far more challenging process.

Annex 2

Application for support from the Executive Programme Fund (EPF): SALMON HABITAT RESTORATION PLANS

Supplementary information

Introduction

In spite of restrictive management measures introduced both nationally and internationally in recent years, Atlantic salmon stocks remain at seriously low levels.

The North Atlantic Salmon Conservation Organisation (NASCO), an inter-governmental body established by treaty, has adopted a Plan of Action with the objective of "*maintaining and, where possible, increasing the current productive capacity of Atlantic salmon habitat"*

In practical terms, this now commits contracting parties (in this case the EU) and their relevant jurisdictions to:

- *Measuring and improving progress in meeting the above objectives by establishing inventories of rivers and regularly updating these inventories;*

- *Establish comprehensive salmon habitat protection and restoration plans, identifying and prioritising the requirements for salmon habitat restoration needs;*

- *Develop and implement these inventories and plans.*

This document outlines a strategy for identifying and prioritising the requirements for salmon habitat protection and restoration in Northern Ireland and seeks funding in support of its implementation. DCAL will lead the proposed programme. DARD, DOE, FCILC and FCB have indicated their support for the bid and there will be extensive liaison between parties in its implementation.

Background

The Department has been aware for some time that major habitat improvement works were required to restore salmon stocks.

Approximately 2 years ago the statutory bodies with responsibility for the management, protection and conservation of fish stocks in the FCB area of N Ireland formed a joint Working Party with the community groups who are the principal stakeholders in the salmon resource. This Working Party produced a Salmon Management Plan (SMP) as an agreed way forward. This scientifically based plan was developed around the core concept that salmon spawning targets can be established for N Ireland at river, regional and national levels. The central aim of the plan is to ensure that sufficient adult salmon are spawning in areas with optimum spawning and nursery habitat conditions to maximise the output of smolts from freshwater.

The fundamental requirements of the SMP are for the acquisition of key databases on spawning, nursery and adult holding habitat for salmon, on recruitment (as measured by counts of adult spawners and juvenile densities) and on exploitation - both in the rivers and at sea. Management action can then be triggered to target production bottlenecks. The long term aim of the plan is to achieve spawning targets in each catchment, and as databases become more extensive, control of exploitation - even within season - may be used to complement refurbishment and mitigation measures.

This approach is also being developed within the Loughs Agency area of N Ireland for the Foyle and Carlingford areas.

The Challenge

The NASCO Plan of Action aligns well with the Salmon Management Plan. It provides a framework within which to develop current work on identifying salmon habitat to provide a consistent, rational approach to protection and restoration of that habitat. The challenge will be to implement a strategy to not only quantify existing habitat, but then to protect this habitat and restore as much as possible of lost and degraded habitat.

The present position and rationale with regard to quantifying habitat is described in Annex I.

Methodology for identification of habitat restoration requirements, restoration methodology and economic aspects are described in Annex II.

Survey techniques and applications to management are outlined in Appendix III.

Resources required to fulfil the habitat inventory and baseline production requirements of the NASCO Action Plan together with indicative costs of habitat improvement works likely to be required during the programme are detailed in Appendix IV.

Work programme: Expected progress and outputs

An indication of the expected development of the work programme is outlined below, under the main headings of the NASCO plan, together with projected major outputs

Inventories/database/baseline production estimation

Yr1 Establish database with existing fishery/habitat data; field survey 2000 km river; 1st report to NASCO 2002 meeting (June 2002)

Yr2 Field survey 2500 km river; update database; report to NASCO

Yr3 Field survey 2500 km river; revisit restored areas and review habitat models update database; report to NASCO

Habitat action plans

Yr1 Establish draft NI habitat action plan based on current data, circulate to NI bodies; 1st report to NASCO 2002 meeting

Yr2 Prioritise new plan of works/restoration, secure agreement for works etc; report to NASCO

Yr3 Revise/update action plan, circulate to NI bodies, report to NASCO

Capital works

Yr1 Install fish counters in 2 new catchments (1 FCB, 1 Loughs Agency); commence habitat works in catchments where need is already identified.

Yr2 Install fish counter in 4 new FCB catchments and additional counter on existing site (R. Main); commence habitat works on next prioritised catchment; complete works on Yr1 catchments.

Yr3 Install fish counter in 1 new FCB catchment; complete priority habitat works on catchment identified in yr2; commence habitat works on 2 new prioritised catchments

General

Incorporate scientific assessment on habitat areas restored/improved throughout period and assess changes to levels of production.

Yrs 1-3 As each catchment is surveyed and baseline production established, publish details for other agencies/departments and stakeholders involved at catchment level.

Yr 3 DCAL will publish the details of all the inventory and database work carried out, together with details of habitat restoration works carried out at the end of 3 years, as a publicly available document.

Yr 3 Assess extent of degraded habitat identified by the survey work and if necessary make a continuation bid for EPF funds to complete outstanding restoration works at these sites.

Exit strategy

Central to the NASCO guiding principles for habitat protection and restoration is the compilation and collation of salmon habitat data. Work to date and planned in this regard is described in the Annexes. The survey work planned for the programme period will contribute significant data to this database. However, due to parameters such as flow regime, sediment transport and land use, the morphology of a river system is constantly changing and this has a direct influence on the status of salmon habitat. Therefore, any such 'inventory' of habitat will need to be regularly updated, perhaps every 3 - 5 years. This will then provide the basis for describing the history of the resource, tracking habitat change and quantifying the effects of management actions including those undertaken to restore habitat during the programme period. Accordingly, it is planned to continue to refresh the database beyond the programme period as the basis to modelling the sensitivity of habitats to impacts and planning the most appropriate ameliorative action.

It must also be stressed than the implementation of habitat restoration cannot be viewed as a single event but rather the initiation of a long-term programme of habitat maintenance. The 3 year programme period will provide much information on where restoration will yield benefits. It will be important to continue to resource ongoing rehabilitation work required to realise these benefits.

This implies that some capital and running costs may be needed beyond the programme period. It is anticipated that Departments, the FCB and Loughs Agency will be able to revise and update the habitat plans and maintain the databases. Indeed, it may be the case that this work is resourced in the context of implementing the requirements of the EU Water Framework Directive. As indicated above it may be necessary, depending on the extent of degraded habitat identified, to make a further bid in 2003 for capital funds to continue with restoration work in line with commitments to NASCO.

The Present Position of GIS Habitat Databases in Northern Ireland

Work on the GIS habitat database has progressed on three fronts to date:

(i) Two staff were funded for 18 months (up to December 2001) to develop GIS habitat models in priority catchments in the FCB area, and to develop advisory links to community groups and angling clubs for habitat restoration projects on these rivers. Despite a hold up due to the Foot and Mouth outbreak, good progress was made, and a GIS database was established on a number of catchments. Habitat identification and classification techniques were standardised with other agencies involved in this work throughout N Ireland and in the Republic of Ireland. Ground truthing through extensive field surveys was undertaken in four catchments. Full GIS habitat models of the Maine and Glendun rivers have been completed, the model of the R Bush is at an advanced stage and the field survey of the R Blackwater is presently in progress. It is estimated that completion of the habitat models on all seven priority SMP catchments will require a further 6 man years (i.e., approximately 3 years for two survey staff). Modelling of salmon habitat in the other main N I rivers in the FCB area will require more than four times this level of effort (i.e., eight survey staff for 3+ years). The staff currently employed under the Peace II funding have already identified a number of habitat areas requiring restoration. Liaison with angling clubs on the Blackwater and Maine systems have resulted in plans being devised for minor habitat restoration works on those catchments. In addition small-scale rehabilitation schemes have also been initiated on the River Bush and its tributaries.

(ii) In the Loughs Agency area, habitat surveys are at an advanced stage on the River Foyle. Habitat classification is compatible with that carried out in the FCB area, and was ground-truthed by core funded LA staff. A GIS model of the habitat database for the Foyle catchment is at an advanced stage with habitat surveys having been completed on 90% of the streams down to two metres width. This data has been inputted to GIS and is currently being used to set salmon management targets and also to identify areas where remedial works can be most effective.

(iii) GIS based catchment modelling has been initiated and funded by D.O.E. (EHS) to archive historical environmental information - including fisheries and river habitat information - gathered by a wide range of agencies. This GIS model has been completed for the R Bush, and liaison and exchange of information will continue to further the development of these broadly based catchment models. This inter-departmental initiative will provide an overall framework for the identification of external factors impacting on fisheries habitats, and for the co-ordination of regional and watershed planning.

One of the major responsibilities for the database manager identified in the resourcing section of the bid is to ensure that the fishery-driven GIS habitat databases link to and are compatible with other databases being established for the purposes of

catchment management. This requirement is one of the drivers behind the cross-departmental aspects of the bid.

The need for baseline habitat data

NASCO has recognised the need to quantify Atlantic salmon habitat resources in rivers, which still support wild salmon populations. The production of river specific habitat inventories enables fishery managers to assess the present status of river habitat, from which future gains or losses can be determined and, critically, drives the habitat action plans. Under the NASCO recommendations it is anticipated that all river catchments that currently support populations of Atlantic salmon should be surveyed and a habitat inventory compiled for each. The inventory should be composed of baseline habitat data, which reflects the nature and quality of in-river salmonid habitat.

In fulfilling this need, the GIS platform enables fishery managers to view the habitat status of a river or river section at a glance whilst further interrogation of the data can then highlight areas which may profit from habitat restoration. The system also allows other geographically referenced, or time series data (such as habitat composition at 5-year intervals) to be overlaid, compared and contrasted. The efficient collection of geographically referenced salmonid habitat data, generated for use in a GIS database, has already been researched and developed in Northern Ireland. Fisheries Conservancy Board staff have developed a Semi-Quantitative habitat assessment technique. This technique enables two field staff to survey approximately 6-8km of river per day, investing the minimum amount of time and resources for the maximum return of good quality data. In such a fashion it is possible to survey entire river catchments within realistic amounts of time. For example, despite disruption of work schedules due to foot and mouth restrictions, two staff were able to cover over 500 km river during an 18 month contract period.

The fisheries agencies within Northern Ireland are currently at an advanced level as regards salmonid habitat assessment, with data collection and management techniques developed and operational and surveys completed on a number of important catchments. Provided that funding is available the Province is in a strong position to fulfil the NASCO recommendations on habitat assessment.

Baseline levels of salmon production

Apart from identifying and quantifying habitat characteristics and feeding these data into both habitat inventories and habitat action plans, NASCO requires that the river inventory should be used for *"establishing the baseline level of salmon production, against which changes may be assessed; such changes may be caused by a range of factors, including habitat degradation or improvement".* In other words, there is a requirement to assess baseline levels of stock production in the rivers and relate this to the physical status of the habitat. While the existing and future planned adult counting facilities outlined above can fulfil this role at catchment level for a number of index

catchments, it will never be possible to install these in all the rivers in NI. Hence, there is a requirement for additional and alternative production estimates in the other (non-counter) rivers. This is the role of the juvenile electrofishing surveys allowed for under the resources section of this bid, where a rolling programme is planned to provide coverage of as many NI rivers as possible. Details of the survey technique and applications to management are given in Appendix II.

Identification of areas for habitat restoration

For over a century salmonid habitat has been degraded by a wide variety of activities – drainage, road building, forestry, agricultural practices and pollution, both chemical and sedimentary. These types of activity have greatly contributed to the deterioration and, in many instances, the complete loss of productive salmonid habitat. To prevent further loss of this important resource, and also to ameliorate the damage which has already occurred, it is necessary to institute a programme of habitat protection and restoration.

The initial identification of habitat areas in need of restoration normally occurs during the semi-quantitative river survey. These ground truthing exercises permit a basic assessment of the current status of the habitat unit and also an initial indication regarding the nature of any rehabilitative measures. Following the initial identification, further data measurement may be required prior to formulating a plan of restorative works. For example, it may be necessary to establish the gradient of a site before installing any type of in-stream structure or perhaps verify the substrate/macrophyte cover in juvenile areas.

The initial identification of areas for habitat restoration requires not only the assimilation of accurate scientific data but also a sound cost-benefit analysis of implementing such measures (see below). Whilst the habitat in most salmon rivers would benefit from some degree of restoration, the level of degradation in many areas is such that rehabilitation would not be a viable option. Therefore, funding should be carefully targeted in those areas where the data have defined that juvenile production could be significantly improved. The importance of historical data must also be stressed. Retrospective information on the historical nature of habitat should play a fundamental role in the formulation of future restoration plans and therefore an emphasis must be placed on liaising with local anglers/community groups.

Restoration methodology

A wide array of techniques can be employed to restore salmonid habitat to optimal productivity. Many of these techniques are founded on traditional practices established generations ago, whilst other methods require a complex engineering basis. In addressing a particular habitat problem it is essential that the chosen restorative technique be selected to achieve a well-defined goal. The use of low-key, biologically based restorative methodology is the preferred approach, with large scale engineering solutions being selected only when absolutely necessary. The latter approach requires close cooperation between the biologist and the river engineer to limit potential collateral damage to the riparian environment. In most situations there is rarely a single solution to the restoration of degraded habitat, but rather the measured application of several techniques to maximize the potential productivity of the resource.

Restoration Techniques

Detailed below are some examples of practices currently employed to restore degraded salmon habitat.

a) Bank protection/stabilization.

- *Fencing.* One of the main sources of sediment pollution is the erosion of riverbank material occasioned by farm animals grazing on unfenced riparian land. Fencing agricultural land significantly reduces the sedimentation of salmon spawning gravel and is a simple, yet fundamental, method of protecting habitat.

- *Planting.* Many riverbanks in Northern Ireland are completely devoid of trees or even large scrubs. Planting trees, such as willow, not only helps to consolidate bank material, thus preventing erosion, but also provides sustainable supply of organic to the stream. Shading produced by trees brings essential cover to aquatic life and is also a useful method of controlling unwanted macrophyte growth (see below).

- *L*og *revetment*. The use of logs, built in a stockade style, is both a practical and an aesthetic technique for protecting large areas of eroding banks. Willow slips are usually nailed to the logs which, when fully matured, produces a very effective and natural barrier to erosion.

- *Rock rip-rap*. This technique is employed to protect severely eroding riverbanks, particularly on bends or the outside of meanders. Large boulders are built high up the bank and back-filled with smaller rubble to stabilize the bank in high flow situations.

b) In-stream structures.

- *Key stones.* A simple method of introducing heterogeneity to a river with uniform flow patterns. Large protruding boulders can be placed in either singular, triangular or diamond shaped arrangements to provide flow diversity, cover for fish and habitat for invertebrate life.

- *Rubble mats*. This technique is also aimed at restoring juvenile habitat in homogeneous channels which have been degraded by arterial drainage. The ‘mats’ consist of large rubble particles placed bank to bank below the surface and are normally 2-3 channel widths in length. Again these structures introduce diverse flow characteristics and provide cover for young salmonids. Rubble mats are also an excellent method of promoting invertebrate life within impoverished watercourses.

- *Flow deflectors*. These structures are used to create sinuosity within drained and straightened channels. The deflectors, extending from the bank across half the channel width, are constructed above the water surface using large rocks and rubble. These structures are normally

constructed in pairs on alternate banks and are especially suited to smaller rivers.

- *Weirs/groynes*. The loss of deep holding pools, suitable for adult salmon, is one of the most notable degradations caused by channelization. The introduction of low level weirs and groynes is an efficient technique for producing scour pools to create depth and also encourages the accumulation of spawning gravel at the tail of the pool. These structures can be constructed from a variety of materials, such as boulders and logs, and are built in several forms, for example vortex weirs, to suit the channel morphology.

c) Gravel restoration

- *Gravel scouring*. The accumulation of fine sediment within salmon spawning gravel reduces the level of oxygen permeating to the deposited eggs, resulting in decreased egg-to-fry survival. The use of a mechanical excavator to scour the gravel bed breaks up surface compaction and releases fine sediment, thus increasing the spawning productivity of the habitat. Wherever possible the machinery should be kept out of the river by using 'long-reach' excavator arm if required.

- *High volume water flushing*. This method utilizes modified water pumps to flush fine sediment from spawning gravel fords. This is a particularly efficient technique for de-silting spawning substrate which is well suited for use in smaller streams and tributaries.

- *Gravel introduction*. In certain situations, for example when spawning gravels have been completely removed during channelization, the introduction of new gravel to a river system may provide opportunities for spawning salmon which otherwise may not have existed. This exercise involves depositing considerable amounts of gravel into the river system, but *only* in those areas where spawning fords have historically been found. Dependent on the flow regime, this technique may be complement by the use of low-level groynes to retain the introduced substrate.

d) Macrophyte control

- *Bankside shading*. This is the most effective and environmentally sensitive long-term method of controlling aquatic macrophyte. Many of these plants have high photosynthetic capabilities and therefore the elimination of light can significantly reduce their biomass. Wherever possible, suitable tree species are planted in a pattern which will provide shading over half the width of the channel.

- *Macrophyte cutting*. River- keepers have practised this traditional technique for several centuries. The rationale is to selectively control the plants rather than completely eliminating them from the watercourse. This maintains a free flowing channel whilst retaining the benefits, such as juvenile cover and invertebrate habitat, which these plants can provide.

Cutting is most efficient when undertaken in a 'checker-board' pattern during the autumn months.

- *Herbicide spraying*. There are a limited number of herbicides which can be safely used to control macrophytic growth in salmonid watercourses. These chemicals can be used to eliminate target species without endangering fish and other aquatic life. Individual plants can be selectively treated although water chemistry can reduce the efficacy of the herbicide.

Economic Appraisal of Habitat Restoration

The Value of Habitat Restoration

The restoration of degraded in-stream habitat can greatly increase the productivity of a river or river section, improving local fish densities and subsequently enhancing the angling value of the area. Many of the works associated with restoration projects, such as tree planting for bank stabilisation, also result in significant gains to local biodiversity and natural heritage.

The first step towards the improvement of habitat in a specific catchment involves assessing and documenting the existing habitat resources and noting the areas where improvements may be required. It is equally important to ensure that no remedial work is undertaken in areas where adequate natural habitat is evident. The fishery agencies in Northern Ireland have a head start in this area as habitat inventories have already been produced for a number of FCB catchments through the SMP. Following survey work a discrete package of remedial measures can be tailored for a river section depending on its specific limitations and requirements.

The financial cost of any prospective restoration programme can be subjected to cost-benefit analysis. This involves comparing the total cost of the remedial works package against the likely value of increased fish productivity in the restored area, usually by considering the percentage increase in 1+ (one year old) fish. Since any improvement in habitat will impact the river for a considerable length of time, fish productivity is often assessed over a 25 year time span.

Example of Large Scale Cost-Benefit Analysis on an FCB index catchment.

The River Main is a major river system in County Antrim which supports stocks of Atlantic salmon and migratory dollaghan trout; it was subject to an extensive arterial drainage programme in the 1970-80's. A salmonid habitat inventory was compiled for this river by FCB staff, which indicated the presence of 17.52km (232,280m^2) of grade 3 nursery habitat (3n) throughout the system. Grade 3 nursery represents poor habitat with limited productivity, which may profit from restoration works. Although

restoration techniques are best structured on a smaller scale, a cost-benefit analysis will be applied to the upgrade of 3n habitat throughout the entire catchment. Several other factors must be determined before the analysis can be completed; these include information on existent fish densities in the areas to be upgraded, the percentage increase in productivity post works, the average value of a 1+ salmonid and the cost of the remedial works (per km). These values were determined after a period of consultation and are listed below;

- Density of 1+ trout/salmon in a drained catchment in Northern Ireland, *8.35 trout/ 4 salmon 100m-2 nursery habitat*[4].
- Average % increase in productivity of 1+ salmonids post full restoration works, *350%*[2].
- Value of 1+ salmonid as purely financial unit, *£0.30*[2].
- Maximum cost of all major habitat restoration works, *£30,000 per km*[2].

Based on the information detailed above a cost-benefit matrix can be calculated:

[4] Kennedy et. al., (1983). The effects of a Land drainage scheme on the Salmonid Populations of the River Camowen, Co. Tyrone. Fish. Mgmt. **14**, No. 1.

[2] M. O'Grady, Central Fisheries Board, scientific advisor on the River Moy enhancement programme.

Factor	Cost (£)	Notes
Remedial Works on 17.52km of river	£525,600.00	Based on £30,000/km
Present value of current 3n habitat resources (1+ fish/year)	Trout £5,818.61 Salmon £2,787.36	
Projected value of restored habitat (1+ fish/year)	Trout £20,365.15 Salmon £9,755.76	
Increase in value of restored habitat (1+ fish/year)	Trout £14,546.54 Salmon £6,968.40	
Total value of restored habitat over 25 years	£537,873.50	This figure does not account for inflation
Balance	+£12,273.50	

Population surveys of juvenile salmonids

Assessment of juvenile salmonid densities and their distribution in streams has a number of objectives:

- As a retrospective assessment of spawning activity - both in terms of the distribution of spawning and the relative production from various spawning sites.

- As a measure of recruitment to and utilisation of nursery habitat in different areas of a catchment.

- As an indication of the suitability of nursery habitat for salmon holding and production
  (a) for comparison with habitat survey models
  (b) for evaluation of the impact of natural or anthropogenic effects on habitat or water quality
  (c) for the assessment of the impacts of habitat restoration measures

- As a means of detecting trends over periods of time as an indication of temporal or geographical change in recruitment and production within a catchment.

- As an indicator of future recruitment to the marine phase of the life cycle.

Juvenile population surveys are a fundamental part of both the SMP and the LA management strategy as an annual baseline measure of whether adult escapement through counters is matched by actual in-stream recruitment. The semi-quantitative electrofishing survey techniques developed on the R Bush are suitable for this, and are in widespread use throughout N Ireland and elsewhere. Where adult escapement meets spawning targets, but juvenile surveys indicate lack of recruitment, management action can be triggered to identify and remedy the habitat / water quality / fish passage or other problem.

Within the context of the present proposal, electrofishing is therefore a key tool for both the identification of under performing areas of habitat (which may be suitable for restoration), and as a means of evaluating the effectiveness of refurbishment measures which have been implemented. The protocols developed on the R Bush indicate that between 100 and 150 semi-quantitative electrofishing sites per 300 - 400km2 catchment is the appropriate target for annual surveys. Two man electrofishing teams can fulfil this level of sampling within about ten working days during the summer period (given suitable weather conditions). Additional staff resourcing will be required for this work on a seasonal basis. It is therefore proposed that funding for temporary seasonal or student placement staff be made available for this purpose.

Department of Culture, Arts and Leisure

Best practice, protocols and background information for the development of Salmonid Catchment Management Plans for Northern Ireland

Executive Summary

This report sets out the rationale, process, content and format for preparing Salmonid Catchment Management Plans (SCMPs) in Northern Ireland, with supporting technical guidance. SCMPs are river specific documents prepared by DCAL staff. They are to be developed to a timetable as part of the over-arching National Salmon Plan for Northern Ireland and contain the management actions for salmon and sea trout fisheries as developed in consultation with stakeholders. Fisheries and related environmental management responsibilities currently lie across several NI Executive departments (principally DCAL, DARD and the NIEA) and their agents, leading to potential disconnection and inefficiencies. SCMPs show the areas where cohesive, coordinated actions are needed to protect and enhance fisheries in order to maximise their socio-economic benefits to communities and the country. Through the National salmon Plan, the information and data on salmon stocks and their habitats will be reported to the North Atlantic Salmon Conservation Organisation as part of the obligations to the NASCO agreement, to which Northern Ireland is a signatory through the UK and EU delegation. A feature of the plans lies in the use of Conservation Limits (annual egg deposition in each catchment) as reference points against which to assess stocks annually. This process is based upon many years continuous monitoring of stocks on the River Bush, supported since 2001 by a network of index rivers generating data essential for quantitative stock assessment and management decisions.

While salmon are the focus for SCMPs, because of the international drivers, other fish species (and indeed other taxa) are of importance to ecosystem function, biodiversity and socio-economic value and the SCMPs make appropriate reference to these. The EU Water Framework Directive (WFD), to be implemented from 2009, has ecosystem health as its principle index of environmental quality. The River Basin Management Plans of the WFD will be the main national vehicles for resolving aquatic environmental problems, through their Programme of Measures (PoMs). SCMPs will form a crucial role in providing the technical rationale for the PoM actions necessary to protect migratory salmonids and offer a framework for integrated management of fisheries and environmental resources.