Status Report on Key Salmon Rivers in the North Western River Basin District

2011

Iascach Intíre Éireann
Inland Fisheries Ireland

Published by Inland Fisheries Ireland

Compiled by
CENTRAL FISHERIES BOARD
NORTHERN REGIONAL FISHERIES BOARD

STATUS REPORT ON KEY SALMON RIVERS IN THE NORTHERN REGIONAL FISHERIES BOARD

with management recommendations

Published 2011

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Version 1.2

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Project Personnel

This report was written and researched by William Roche, Martin O'Grady, Karen Delanty, Ciara O'Leary and Paddy Gargan (all Central Fisheries Board). Fieldwork and technical support was provided by several different CFB staff over the duration of the project including Brian Foley, Martina Naughton, Brendan Duggan and Brian Coghlan.

The Northern Regional Fisheries Board (NRFB) staff, under the management of Harry Lloyd and Milton Matthews, and their Inspectors, Gerry Mc Cafferty, Peter Kelly and Hugh John Patton provided excellent support and information over the course of the project. The following NRFB staff contributed data or were involved with the fieldwork programme: Brendan Maguire, Cornelius McMullan, James Doherty, Seamus Bradley, John McGinley, Bill Ferry, Jim Gallagher, Thomas Mooney, Paul Burke, Paul Gallagher, Kevin McCloskey, John Hederman, Matt Wilson, Michael Patton, Lindsey Clarke, Derek Hemphill, Alan Mahon, William Bustard, Dara Timpson, Terry Frize and Hugh Mooney.

Summary

- In 2002, the NRFB, in conjunction with Donegal County Development Board, published a comprehensive consultation document which details a strategy to develop and manage angling in Donegal (Anon, 2002) which included a requirement to identify and describe the status of each fishery resource or catchment, in terms of habitat and fish stock. Within this broad framework, the Board decided to undertake an appraisal of the salmon resource within its remit, with a view to maximising sustainable juvenile salmon output in freshwater.
- A total of eleven catchments were identified for audit. These were: the Leannan, Lackagh, Clady, Crolly, Gweebarra, Owenea, Glen, Eany, Eske, Lough Melvin/Drowes and Duff catchments and the work programme entailed a detailed survey of habitat quantity/quality, analysis of redd counts and rod catches and an electrofishing survey of juvenile populations.
- The 11 systems investigated accounted for almost 5% of the total national accessible wetted production area for salmon (Mc Ginnitty et al., 2003) and 60% of the entire accessible wetted area salmon resource in the NRFB area. The Leannan accounts for 1% of the total national accessible resource.
- Gradient and water quality are two of the key drivers in juvenile salmon production. Gradient is effectively a proxy for biologically more meaningful hydromorphological entities such as stream riffles, glides and pools (Amiro, 1993). The combined total of the Letterkenny and Ballyshannon Districts medium gradient habitat (1.23%), the most productive salmon habitat, is ranked second only to the Waterford District total of 1.42%, which has the highest overall productive potential, which emphasizes the productive capacity potential of rivers in the NRFB Region for salmon, as a whole.
- An EPA Q value of Q3/4 or less has been identified as an impediment to optimal juvenile salmon production. A Q value of ≤ Q3 indicates a more severe impairment. Based on the 2003 quantitative analysis (Mc Ginnitty et al, 2003) only the Leannan and Glen Rivers and, to a lesser

extent, the Eske, displayed any level of water quality impairment. All of the remaining channels were classified as unimpaired. Water quality data for this period is presented here as it is the most relevant for fish monitoring over the period of this study.

- Juvenile salmon assessment through electrofishing and habitat quality assessment were the primary survey deliverables required to provide an appraisal of river health status. Habitat assessment was undertaken through direct observation from aerial photography of all systems, targeted on-site ground truthing assessment, collation of data from NRFB staff and direct observations at electrofishing sites. Aerial survey data provided data for zonation of the various river channels into discrete sections, identification of potential physical habitat problems or potential anthropogenic pressures, selection of representative electrofishing sites and suitable access, and for identification of potential barriers to migration. The entire suite of aerial photography has been transferred to the NRFB GIS system.
- Each catchment surveyed is reported individually, and each report incorporates EPA biological/water quality assessment, angling catch, salmon redd count and juvenile assessment data. Detailed habitat restoration or enhancement works, with supporting aerial photographs and mapping outputs, are incorporated.
- Rod catch statistics demonstrated a strong positive linear relationship which showed that, as fluvial habitat increases, rod catches are higher. Most catchments fitted the relationship with the exception of the poor catch in the Leannan which highlighted its poor performance index which is in agreement with SSC deliberations on the poor level of CL attainment for this fishery.
- The most productive angling fisheries are the larger systems, the Drowes, Eany, Owenea and Duff, and all differ with regard to abundance of spawning habitat. The Drowes and Owenea have abundant spawning areas while the Eany and Duff are less well endowed.

- Rod catch statistics show that the medium sized systems including the Gweebarra, Glen, Lackagh and Eske appear to be underperforming with rod catches equivalent to substantially smaller systems like the Clady and Crolly.
- Improvements to rod catch statistics including collecting consistent statistics, developing river specific rod catch exploitation rates, collecting salmon scale material and environmental data are made.
- The CFB has identified redd counts as an important potential method of indirect assessment of CL attainment (Gargan et al, 2008). While the exact relationship has to be developed it has been recommended to concentrate on systems with counters so that robust redd count statistics can be developed. Various recommendations including: training, consistency of approach (protocol development), concentrating on index systems and the use of remote sensing technology are made to enhance the application of redd counts to CL attainment.
- Extensive quantitative and semi-quantitiative electrofishing was carried out throughout all systems. Excellent 0+ salmon fry densities (> 1.15/m^2) were recorded in sites in several systems, the Owenea, Eske and Melvin but often in only a limited number of sites. A small proportion of systems have fry density profiles dominated by fair to good abundance ratings. The Owenea is a high status system as a salmon production unit based on its fry density profile and the Glen/Owenwee was also satisfactory (although the salmon rod catch is declining). The remaining systems are in the poor range in terms of overall 0+ density profiles, particularly the Leannan and the Lackagh systems.
- Applying a value of > 0.14/m^2 salmon parr, which is good in terms of results recorded by the survey team in other Irish catchments over the past 20 years, it is evident that several catchments are performing well. The Owenea is consistent for both fry and parr and is the most productive juvenile salmon producer of all catchments surveyed. Locally and nationally. Other good producers of salmon parr are the

Clady, Eany, Gweebarra and Melvin systems while the Leannan is a consistent underperformer. A four year programme of “catchment-wide electrofishing”, a rapid assessent method is recommended for the NRFB rivers surveyed.

- New barriers to salmon migration were identified in most rivers. These are mainly natural barriers and cannot be removed or altered. However, it is imperative to notify the barriers to the SSC in order to ensure that the accessible wetted area for each system is modified which will, in turn, lead to a decrease in the river –specific CL.
- Distribution and abundance data for trout, eel, three-spined stickleback, minnow, lamprey spp. and flounder are presented.
- The Owenea scored extremely positively for an index derived from salmon spawning escapement levels, redd counts and juvenile assessment while the Leannan fared very poorly and ranked lowest for most. The remaining catchments were positioned within these extreme boundaries (Table 7.2.1). Two divisions emerged from this index. An upper division comprising good performaers including the Owenea, Melvin, Gweebarra, Clady, and Duff and a lower division including the Eany, Glen, Lackagh, Crolly, Eske and Leannan. Recent counter and rod catch data from the Eany has identified a decline in salmon populations which may have been first manifested in low 0+ salmon fry densities recorded in 2005.
- This study has identified several catchments which are underperforming in terms of juvenile salmon production, several which are in the middle ground and some which are extremely satisfactory in terms of performance. The physical resource is generally satisfactory in terms of quantity and quality, although some specific problems were identified, and water quality, with some notable exceptions (parts of the Leannan), is also satisfactory. A prioritised habitat restoration/enhancement programme is presented. The extensive Glen and the Leannan catchments should be targeted for intensive programmes to restore their production capacities which have deteriorated over the past two decades for different reasons.

- One of the most influential factors in the decline of salmon nationally is likely to be reduced marine survival. For the past 15 years ICES has been reporting that marine survival indices remain low and are considered to be a key factor limiting salmon production. Marine survival is influenced by many factors and there are real concerns relating to factors causing mortality at sea including predation by seals, diseases and parasites and marine pollution. The multi-agency international SALSEA research programme, which is investigating marine mortality, will aid fishery managers to understand the likely factor(s) and this will improve understanding of the scale of the problem when it reports in due course. The NRFB will have to adopt a watching brief until understanding of this complex issue improves.
- For the foreseeable future the primary role of the NRFB, under its statutory function, is to continue to ensure that freshwater production units (i.e. salmon catchments) are fully functional in terms of habitat and water quality, and that juvenile and adult stocks are protected under the various national and international obligations which underpin salmon stock management in this country. Protection of the freshwater environment and maximising its potential, if any improvement in adult escapement occurs, must be the primary focus of the NRFB as it has been since its inception. Underpinning this primary role is the collection of baseline datasets and continued monitoring of stocks to detect any change in salmon stock status.

1. Introduction

The mission statement of the NRFB is “to conserve the inland fisheries and sea angling resources of the Region in its own right and to manage, restore, enhance and promote it in a sustainable manner for the benefit of our local communities and the national good". In 2002, the NRFB, in conjunction with Donegal County Development Board, published a comprehensive consultation document which details a strategy to develop and manage angling in Donegal (Anon, 2002). The requirement to identify and describe the status of each fishery resource or catchment, in terms of habitat and fish stock, was emphasised. Within this broad framework, the Board decided to undertake an appraisal of the salmon resource within its remit, with a view to maximising sustainable juvenile salmon output in freshwater. By maximizing the juvenile output the Board would be delivering on its functions and on its identified strategic role. In 2005, the Board identified eleven key salmon fishery catchments within its functional area. These were: the Leannan, Lackagh, Clady/Crolly, Gweebarra, Owenea, Glen, Eany, Eske. Lough Melvin/Drowes and Duff catchments. The majority are productive salmon rod fisheries and several are under State ownership or local cooperative type management.

Working with the Central Fisheries Board, an approach to delivering this programme was developed which identified the key datasets to be collected - information on current juvenile salmon levels and the current status of juvenile salmon habitat. Restoration or enhancement options for habitat were also identified as being important deliverables for the project.

The study was funded by the NRFB. This reports details the findings of the study and makes recommendations for delivery of the required work programme.

2. Project delivery process

An approach to project delivery was identified (Fig. 2.1) and subsequently developed into a rolling work programme. Because of the number of catchments involved it was decided to break the programme into discrete work packages covering one to four catchments annually (depending on catchment size). Field surveys commenced in 2005 and continued into 2008. The sequence of activity for the project was as follows:

- Data collection, analysis and interpretation
- Design a programme of measures
- Implement programme
- Monitor and adjust

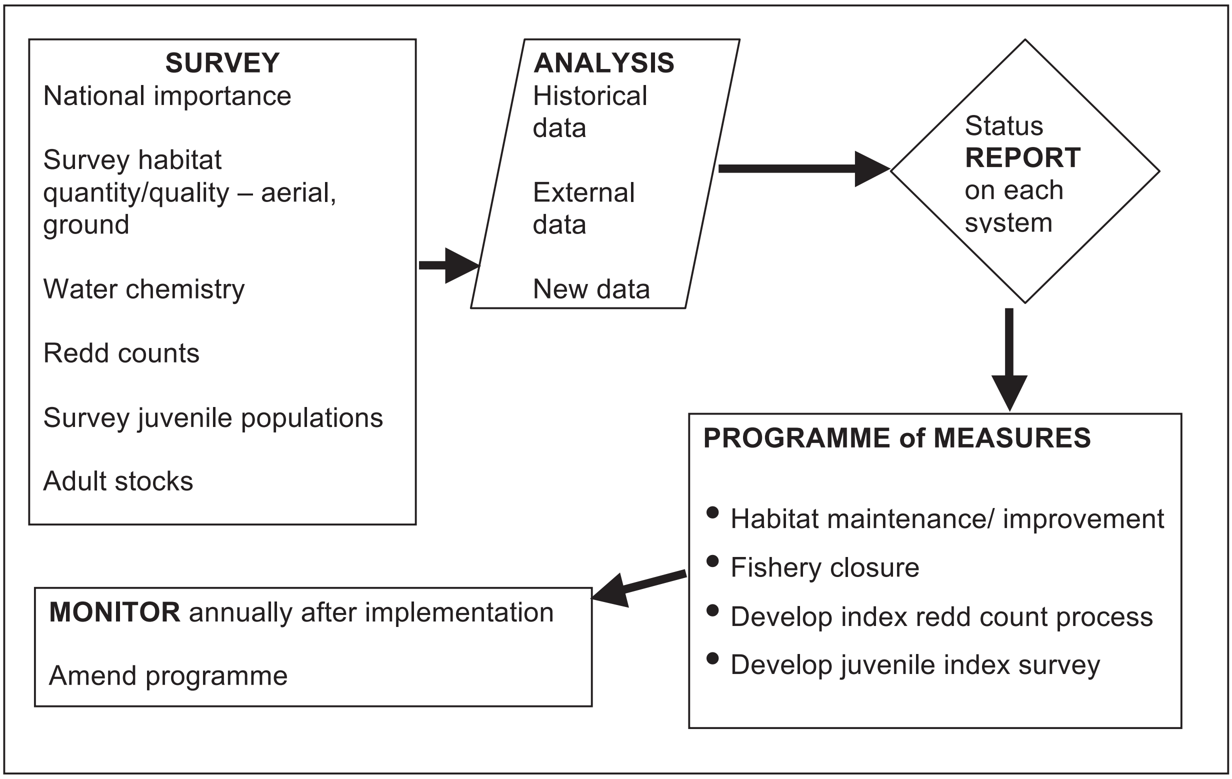


Fig 2.1. The NRFB Salmon Rivers Project approach

This report deals with data collection, analysis and interpretation and presents a programme of measures which essentially is Phase 1 of a two phase project.

3. Background information for individual catchments

An important part of the process was to examine the relative salmon production potential of each catchment (Fig. 3.1) in a national context and identify the quantity and quality of habitat available for salmon production. Catchment geology, land use and Special Areas of Conservation (SAC) are mapped in Appendix 1.

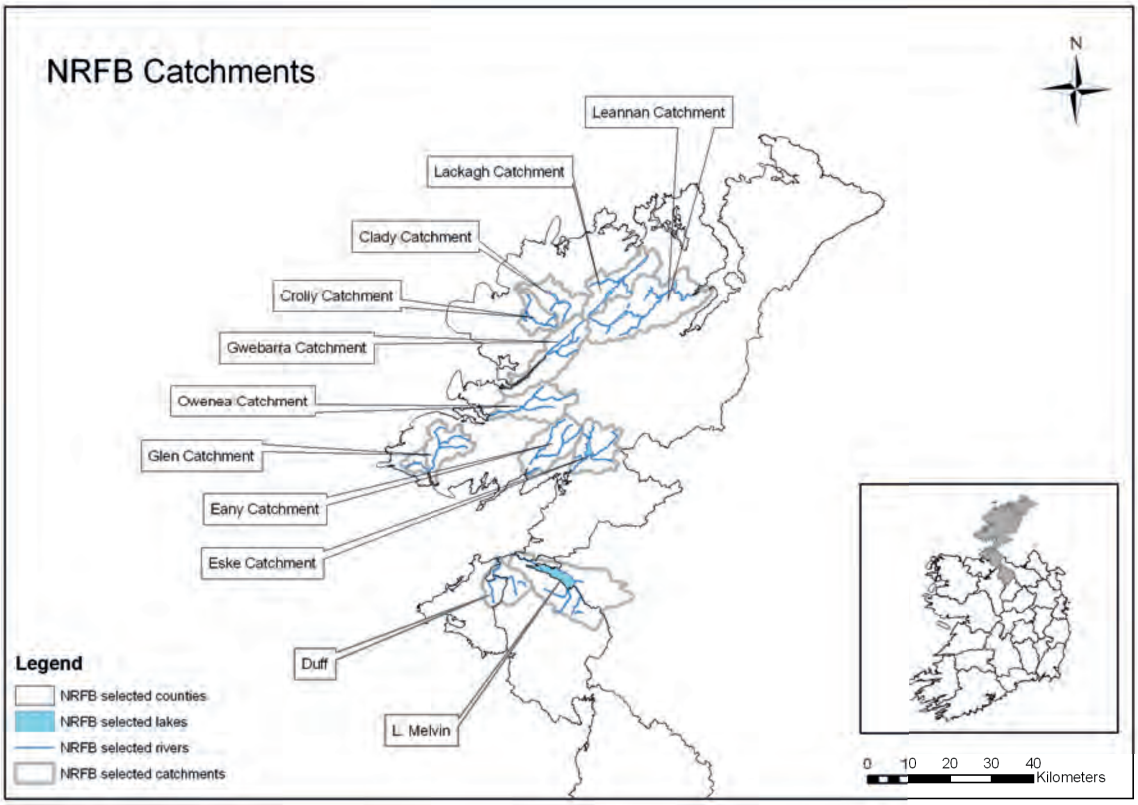


Fig. 3.1. Salmon catchments investigated 2005 - 2008

The fisheries examined over the course of the project are all salmon fisheries (Table 3.1). All have a 1SW or grilse component and the three star (***) grilse fisheries are very productive rod fisheries under the right conditions. Rod catch data is presented below in each individual river report. Several systems have a multi-sea-winter or spring salmon component. The Leannan and the Drowes are prime multi-sea-winter fisheries but only the Drowes currently continues to operate as a multi-sea-winter fishery as the Leannan is substantially under its Conservation Limit.

The Conservation Limit for Atlantic salmon is defined by NASCO as *"the spawning stock level that produces long term average maximum sustainable yield as derived from the adult to adult stock and recruitment relationship".* This equates to the stock level that maximizes the long-term average surplus.

Anon (2008), in the Standing Scientific Committee (SSC) report to the National Salmon Commission (NSC) described the background leading to the development of a comprehensive river-specific approach to salmon management in Ireland.

> Salmon home to their natal river to spawn and as the number of spawning fish increases, then the number of juveniles increases and, in turn, the number of migrating smolts increases, leading to improved returns of 1 SW or MSW salmon. However, there is a limit to the number of juvenile salmon any river can support - the carrying capacity - due to competition for food and space. Additional spawning salmon can reach a level at which their contribution will not lead to additional production of juveniles. These adult fish are surplus to the spawning requirements for the river and can be harvested in a sustainable manner. As each river holds a unique spawning population, which has evolved through adaptation, to survive best in that rivers environment, and little straying of salmon from river to river occurs, a Conservation Limit can be associated with each individual river stock.
>
> In the late 1990s, with the growing evidence, both nationally and internationally, of a widespread decline in salmon stocks the Irish Government initiated a process, involving all stakeholders, to develop a comprehensive management strategy for salmon in Ireland. Up to 2001, the Irish salmon fishery was managed by a combination of effort limitation and the application of technical conservation measures relating to size and type of fishing gear. While these measures regulated the efficiency of this mixed stock fishery, they were not sensitive to the stock available, and allowed the same level of fishing even when stocks were low. Prior to 2005, precautionary catch advice

was provided on a Fisheries District basis. District Conservation Limits i.e. aggregated river specific Conservation Limits, were calculated and compared to these average returns to assess whether stocks were above or below Conservation Limits at a district level and to provide an estimate of the surplus above the Conservation Limit available for harvest in each district.

In 2007 catch advice was provided, by river, arising from revised national objectives for salmon and national obligations and international obligations (e.g. EU Habitats Directive). Recognizing the conservation imperative the mixed fishery at sea was ceased in 2007.

River specific catch advice and management considerations have resulted in the closure of the Leannan, the Lackagh and the Eske salmon fisheries since 2007.

3.1. Salmon production potential of the NRFB

The extent of total ‘wetted surface of river’ is a measure of the area of rivers and lakes in a catchment that can be effectively accessed by salmon entering that catchment from the sea and that is therefore available for spawning and thus capable of producing juvenile fish. The ‘wetted surface of river’ can be considered as the width of the water surface measured at right angles to the direction of the flow at the time of the survey at the dry weather flow or DWF (DWF assumes that surface water is contributed entirely by groundwater sources).

Ireland’s freshwater Atlantic salmon habitat resource was quantified by Mc Ginnity et al., 2003. This report identified 173 discrete salmon river systems although this has been reduced to 148 rivers following a review in 2005. Within the original classification of 173 rivers, 160.5 million m^2 of river and stream ‘wetted surface area’ habitat was calculated of which 113.0 million m^2 is accessible and used by adult and juvenile salmon. A total of 40.1 million m^2 of river habitat is located above four major hydroelectric schemes. There are 105,600 hectares of lake surface area, of which 44,600 hectares are available for salmon production. Approximately 67.5% of the total accessible fluvial habitat available is within 20 river systems. In the NRFB area the 11 systems investigated in this study accounted for 4.63% of the total national accessible fluvial wetted area. The River Leannan which accounts for over 1% of the national total is the largest system of those surveyed in the current study.

The salmon catchments in the Letterkenny and Ballyshannon Districts combined account for **8,661,668 m^2** or 7.89% of the total national accessible wetted production area for salmon, which is the fourth ranked in the country after the Waterford, Limerick and Lismore Districts (Table 3.2 and Fig. 3.2). The rivers surveyed over the course of this survey account for 60.46% of the entire accessible wetted area salmon resource in NRFB area.

The Leannan is one of the largest salmon rivers in Ireland and is ranked 21st in the national listings for accessible habitat. It dominates the NRFB salmon resource, in terms of accessible wetted area (Figure 3.3.) The Eany, Owenea and Drowes/Melvin wetted areas each constitute about 0.5% of the national figure. The significance of individual salmon systems within the NRFB administrative area is highlighted in Table 3.3.

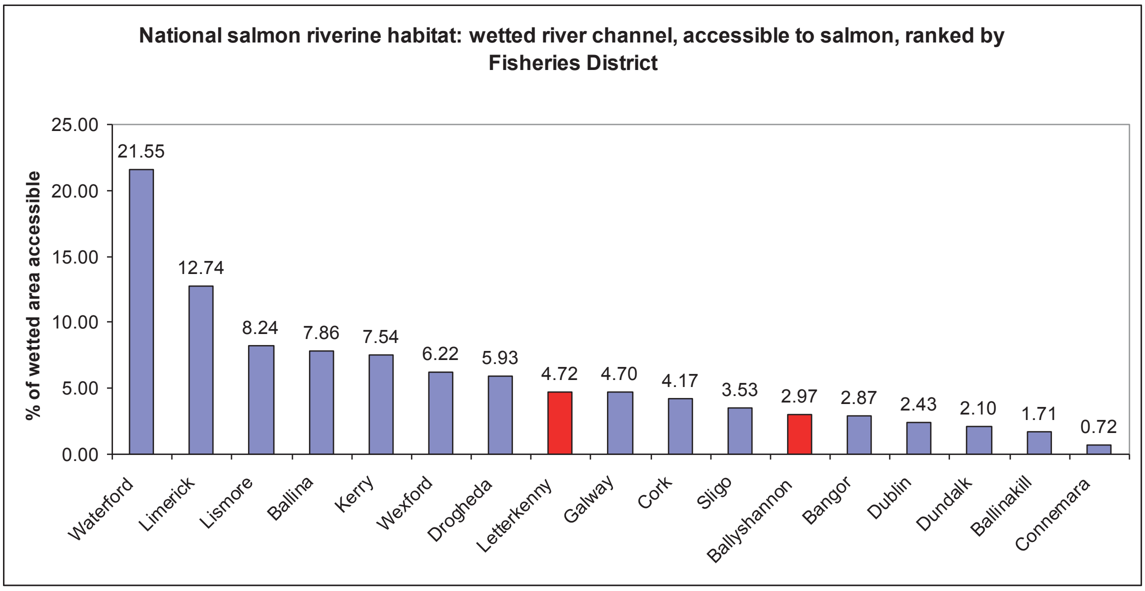


Fig. 3.2. National accessible salmon riverine habitat, ranked by District.

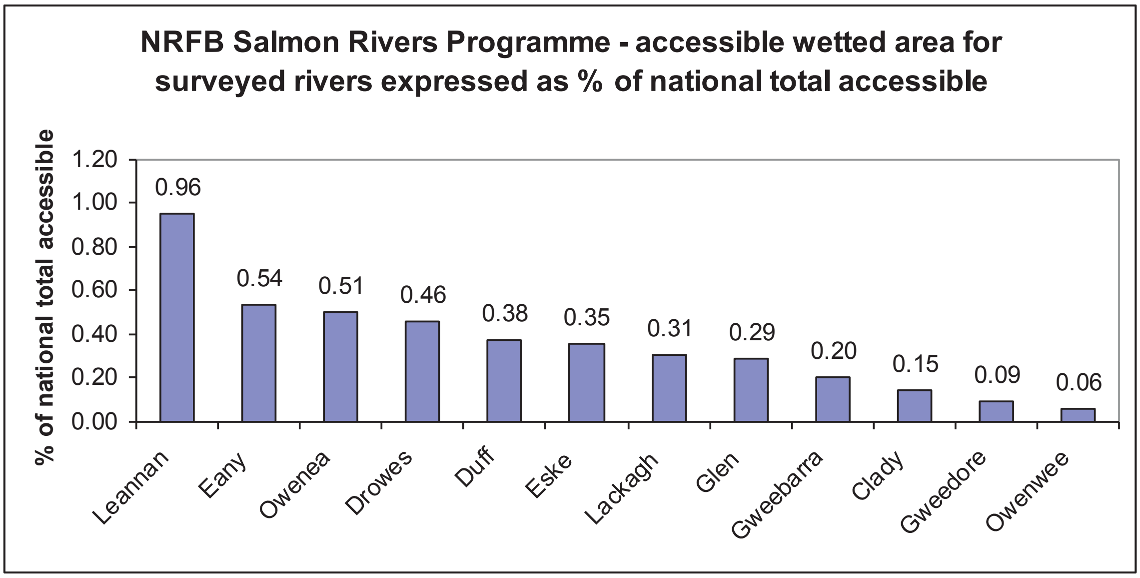


Fig. 3.3. Accessible wetted area for surveyed rivers as a percentage of the national accessible total

Table 3.1. Summary of angling fishery information for NRFB salmon fisheries surveyed

Catchment	Angling species available in fishery				Salmon fisheries type	Historical fishery quality		Current salmon exploitation status based on SSC outputs +
	MSW salmon	1 SW salmon	Sea trout	Brown trout		MSW salmon	1 SW salmon	
Leannan	yes	yes	small run	yes	River & lake	***	**	No surplus since 2007
Lackagh	yes	yes	yes		River & lake	**	**	No surplus since 2007
Clady		yes	yes	yes	River & lake		***	In surplus since 2007
Crolly		yes	yes	yes	River & lake		***	In surplus since 2007
Gweebarra	yes	yes	yes		River & lake	**	***	In surplus since 2007
Owenea	small run	yes	yes		River		***	In surplus since 2007
Glen/ Owenwee		yes	yes	yes	River & lake#		***	Glen – in surplus since 2007; Owenwee – no surplus since 2007
Eany		yes	yes	yes	River		***	In surplus since 2007
Eske	yes	yes	yes		River & lake		**	No surplus since 2007
Melvin/ Drowes	yes	yes		yes	River & lake	***	***	In surplus since 2007
Duff		yes			River		***	In surplus since 2007

limited lake angling for salmon + individual river advice provided by SSC since 2007

Table 3. 2. National salmon riverine habitat: wetted river channel, accessible to salmon, ranked by area (m2) in Fisheries Districts

FISHERIES DISTRICT	Salmon systems - riverine total	Salmon systems - riverine accessible	Non self sustaining portion of salmon bearing catchment*	% of National riverine accessible
Waterford	24,569,103	24,345,915		21.55
Limerick	46,450,964	14,394,975	30,895,619	12.74
Lismore	9,340,439	9,314,020		8.24
Ballina	9,301,174	8,881,629		7.86
Kerry	8,797,110	8,522,449		7.54
Wexford	7,161,341	7,032,752		6.22
Drogheda	6,695,412	6,695,412		5.93
Letterkenny	5,631,468	5,337,762		4.72
Galway	8,253,242	5,307,431		4.70
Cork	7,241,815	4,715,328	1,923,476	4.17
Sligo	4,200,104	3,990,574		3.53
Ballyshannon	10,178,849	3,361,359	6,457,264	2.97
Bangor	3,336,934	3,239,957		2.87
Dublin	3,967,758	2,741,828	830,129	2.43
Dundalk	2,436,340	2,372,751		2.10
Ballinakill	2,076,178	1,934,183		1.71
Connemara	867,759	811,701		0.72
TOTAL	160,505,990	113,000,026	40,106,488	100.00

* impaired due to presence of artificial barrier and salmon production is usually maintained by stocking

Table 3.3. NRFB salmon catchments ranked by accessible fluvial habitat wetted area

National Rank	Fishery system	Fisheries District	Total fluvial habitat (m^2)	Accessible fluvial habitat (m^2)	% of national total of fluvial habitat accessible to salmon	Catchments surveyed over course of study
21	Leannan	Letterkenny	1,167,125	1,167,125	1.03	yes
30	Eany	Ballyshannon	656,530	656,530	0.58	yes
33	Owenea	Letterkenny	630,856	616,966	0.55	yes
37	Drowes	Ballyshannon	611,703	562,314	0.5	yes
44	Duff	Ballyshannon	461,575	461,575	0.41	yes
49	Eske	Ballyshannon	496,658	431,848	0.38	yes
52	Crana	Letterkenny	433,536	383,036	0.34	
53	Swilly	Letterkenny	394,241	380,213	0.34	
54	Lackagh	Letterkenny	436,109	375,778	0.33	yes
56	Glen	Ballyshannon	359,004	356,998	0.32	yes
68	Gweebarra	Letterkenny	287,952	248,480	0.22	yes
77	Oily	Ballyshannon	210,618	210,618	0.19	
85	Isle (Burn)	Letterkenny	183,078	183,078	0.16	
86	Owentocker	Letterkenny	204,263	182,949	0.16	
87	Laghy	Ballyshannon	181,228	181,228	0.16	
89	Clady	Letterkenny	195,006	179,023	0.16	yes
96	Ballintra	Ballyshannon	392,356	158,131	0.14	
97	Bungosteen	Ballyshannon	175,143	154,911	0.14	
98	Clonmany	Letterkenny	151,703	151,703	0.13	
100	Ray	Letterkenny	168,605	146,332	0.13	
103	Donagh	Letterkenny	141,449	141,449	0.13	
108	Glennagannon	Letterkenny	126,111	120,435	0.11	
111	Gweedore/Crolly	Letterkenny	118,319	111,149	0.1	yes
115	Abbey	Ballyshannon	107,691	107,691	0.1	
119	Mill	Letterkenny	123,296	95,019	0.08	
128	Tullaghobegly	Letterkenny	78,626	78,626	0.07	
133	Glenna	Letterkenny	72,633	72,633	0.06	
136	Owenwee (Glen)	Ballyshannon	69,079	69,079	0.06	yes
139	Deryart	Letterkenny	65,102	65,102	0.06	
145	Faymore	Letterkenny	57,865	57,865	0.05	
146	Owencronahulla	Letterkenny	57,607	57,607	0.05	
148	Owennamarve	Letterkenny	56,359	56,359	0.05	
150	Drumhallagh	Letterkenny	53,740	53,740	0.05	
152	Owenerk	Letterkenny	51,945	51,945	0.05	
172	Erne	Letterkenny	6,457,264	10,436	0.01	
Eleven surveyed catchments totals			5,489,916	5,236,865		
% of national salmon rivers			**3.42**	**4.63**		
All NRFB salmon rivers			15,434,375	8,337,971		
% of national salmon rivers			9.62	7.38		

3.2. Habitat quality assessment

Gradient and water quality are two of the key drivers in juvenile salmon production. Gradient is effectively a proxy for biologically more meaningful hydromorphological entities such as stream riffles, glides and pools (Amiro, 1993). The wetted area report (Mc Ginnitty et al, 2003) generated these quantitative data for all salmon habitat in Ireland and provided fishery managers with the facility to assess habitat quality (viz. gradient characteristics and water quality).

Gradient

National accessible fluvial habitat (wetted area) was categorised using the eleven-class Amiro (1993) classification system for each District (Mc Ginnitty et al, 2003) which allowed comparison of the Letterkenny and Ballyshannon Districts with other Districts for this report. Habitat in each Fisheries District is divided into three categories, low gradient (classes 1, 2 & 3), medium gradient (classes 4, 5 & 6) and high gradient (classes 7, 8, 9, 10 & 11) and expressed as a percentage of total available accessible habitat nationally. 81.9% of national accessible fluvial habitat was classified as low gradient, 8.35% as medium gradient and 9.74% as high gradient (Figure 3.4). Medium gradient (classes 4, 5, 6) has been shown by Amiro (1993) to be potentially the habitat with the best capacity for the production of juvenile salmon. Individually, the Waterford, Limerick and Kerry Districts have the largest quantity of medium gradient habitat nationally indicating a higher potential for the production of juvenile salmon compared to other Districts. However, the combined total of the Letterkenny and Ballyshannon Districts medium gradient habitat (1.23%) is ranked second only to the Waterford District total of 1.42%, which has the highest overall productive potential, which emphasizes the productive capacity potential of rivers in the NRFB Region for salmon, as a whole.

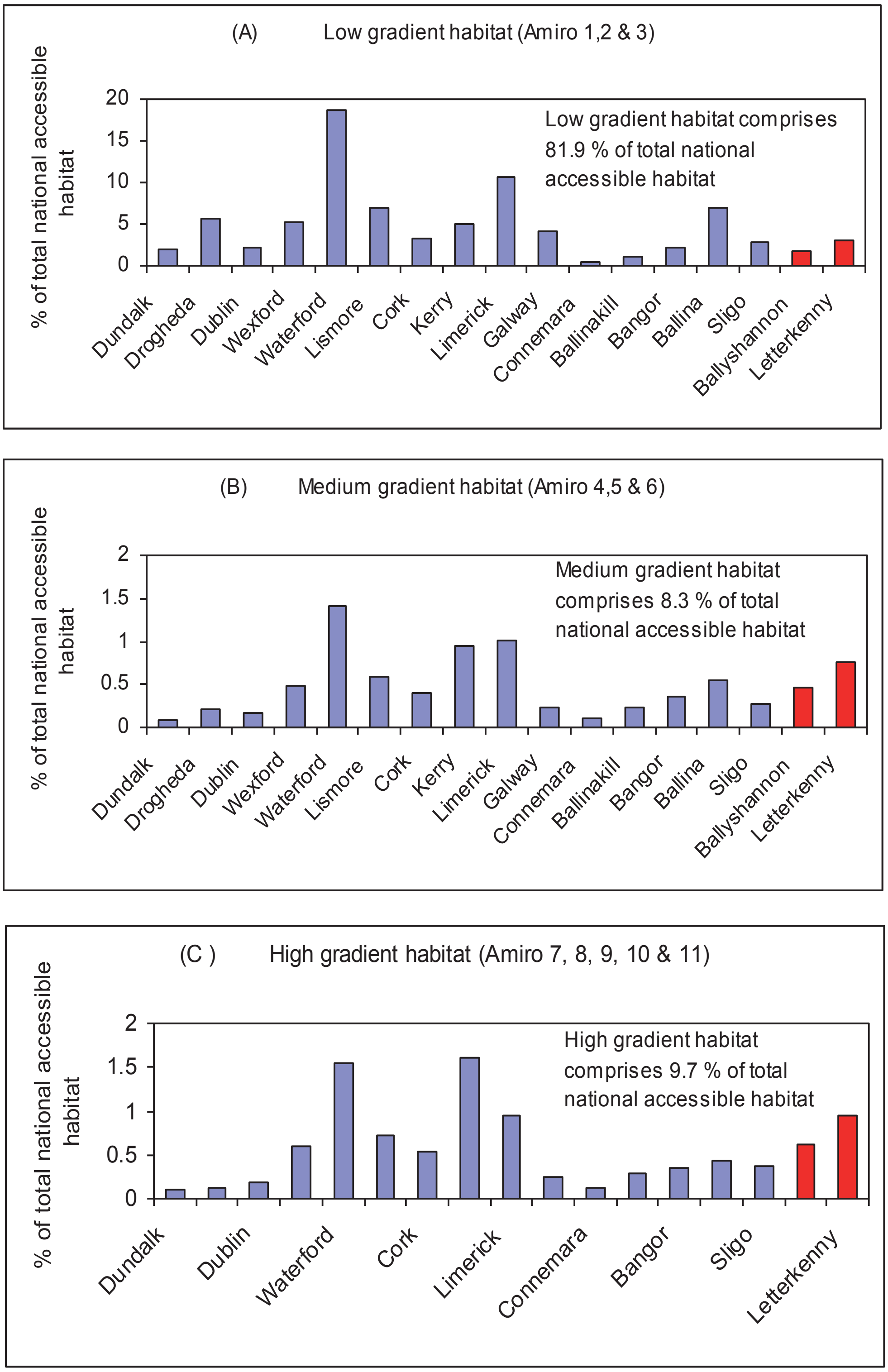


Fig. 3.4. Within District breakdown of low gradient (A), medium gradient (B) and high gradient (C) expressed as percentages of the total national fluvial accessible salmon habitat. NRFB District data in red. Note different scales in (B) and (C)

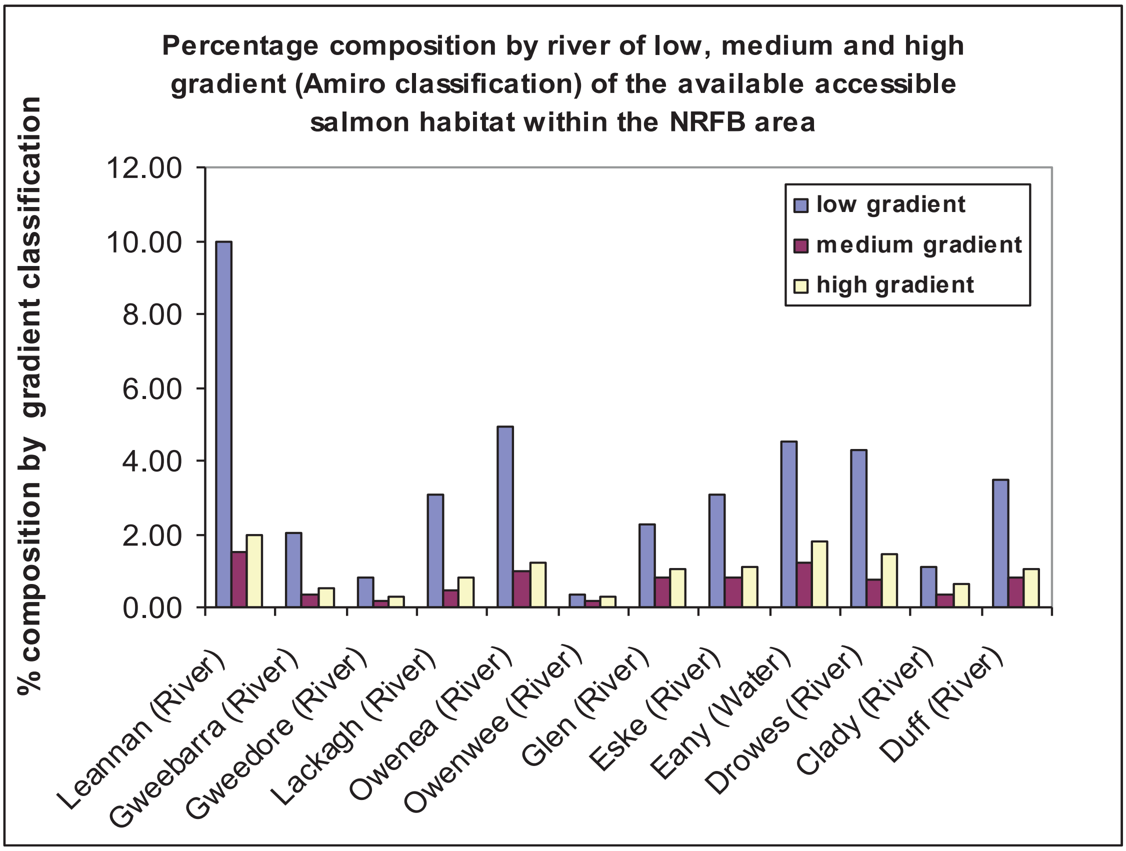


Fig. 3.5. Percentage composition of habitat in individual rivers etc the total area of accessible salmon habitat in NRFB area is 8,661,668 m^2 (Mc Ginnitty et al, 2003)

By virtue of overall catchment size, the Leannan has the highest percentage of the potentially more productive, medium gradient channel, but the Owenea, Glen, Eske, Eany, Drowes and Duff are prominent indicating their natural potential (Fig. 3.5).

Water Quality

Poor water quality impacts on the potential of rivers to produce salmon. The Environmental Protection Agency monitor water quality at over three thousand sites nationally from which a preliminary quantitative estimation of the area of channels with inadequate water quality was derived by Mc Ginnitty et al, (2003).

The EPA Q-value system is based on site analysis of macroinvertebrate communities. A Q value ranging from 1 to 5 is assigned to each site on each sampling occasion. A score of 5 represents pristine conditions with 1 illustrating grossly polluted conditions.

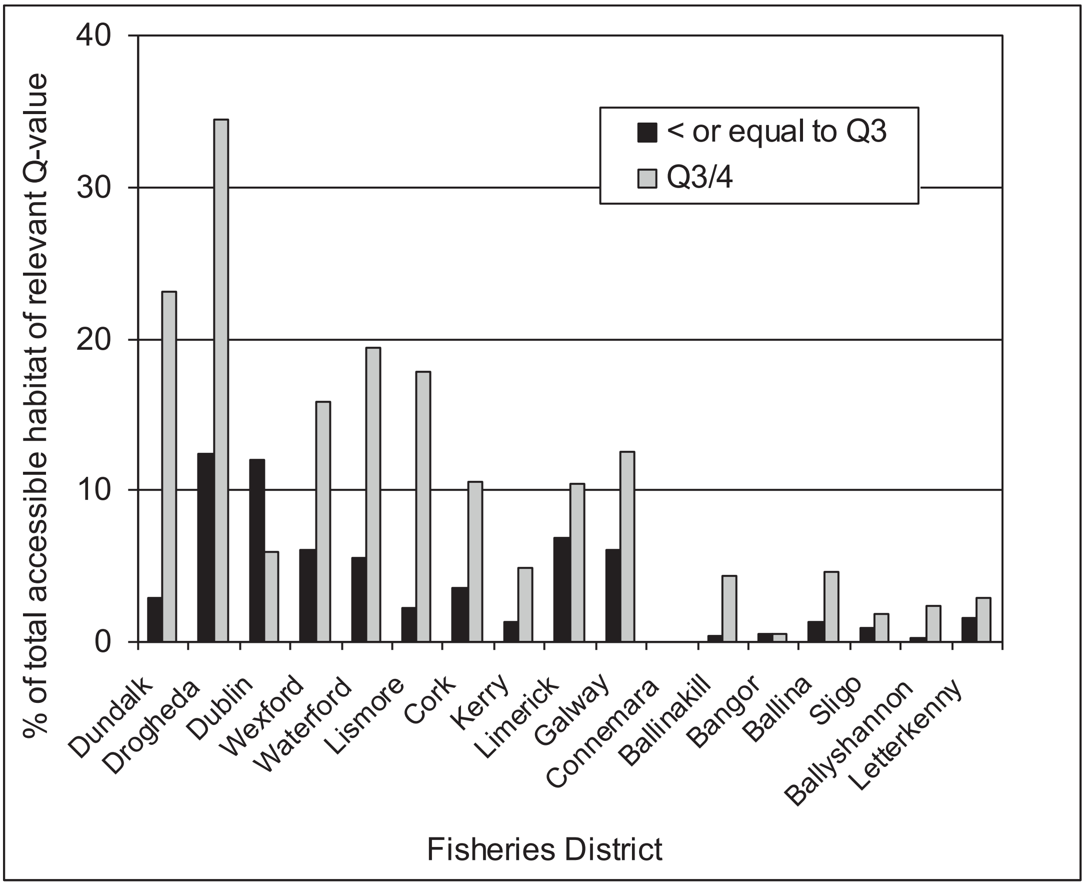


Fig. 3.6. The proportions (%) of accessible riverine habitat with biological quality ratings of: (a) ≤ Q3 (moderately to severely polluted) shown as open bars; and (b) Q3/4 (slightly polluted) shown as solid bars; on a District basis.

Data are presented on the quantity of habitat with a value of Q3 (moderately polluted) or less and a value of Q3/4 (slightly polluted) or less (Fig. 3.6). In national terms the Ballyshannon and Letterkenny Districts tend towards the lower end of the scales for poor water quality. Rivers in Districts along the East and Southeast coast (Dundalk to Waterford) had the highest proportion of moderately to severely polluted waters and also of slightly polluted waters.

Habitat with a Q value of Q3/4 or less has been identified as an impediment to optimal juvenile salmon production. A Q value of Q3 or less indicates a more severe impairment. Nationally, 4.5% of potential salmon habitat is estimated to have a Q value of Q3 or less and 17.3% of the habitat recorded a Q value of Q3/4 or less.

In two extensive Irish studies, Kelly *et al*, (2007) and O'Grady & O'Leary (2007) have shown that where Q values are ≤ 3/4, the river reach cannot support significant juvenile salmon numbers (Fig 3.7). A value of ≤ Q 3 indicates more severe impairment. Statistical analysis showed that water quality, as indicated by EPA Q-values, had a significant effect on the percentage composition of juvenile salmon, i.e. % composition of salmon increases as water quality increases. Percentage composition of 1+ & older salmon was significantly higher at Q-values above Q3-4.

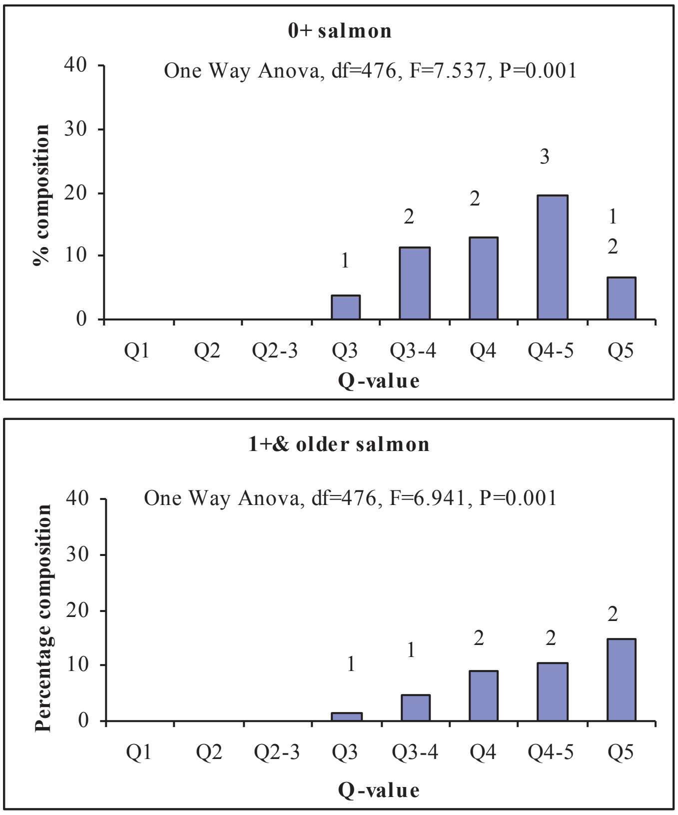


Fig. 3.7. Percentage composition of juvenile salmon in relation to water quality as indicated by Q-values. (From Kelly *et al*, 2007).

Based on the 2003 quantitative analysis (Mc Ginnitty et al, 2003) only the Leannan and Glen Rivers and, to a lesser extent, the Eske displayed any level of water quality impairment (Fig. 3.8). All of the remaining channels were classified as unimpaired. Water quality data for this period is presented here as it is the most relevant for fish monitoring over the period of this study.

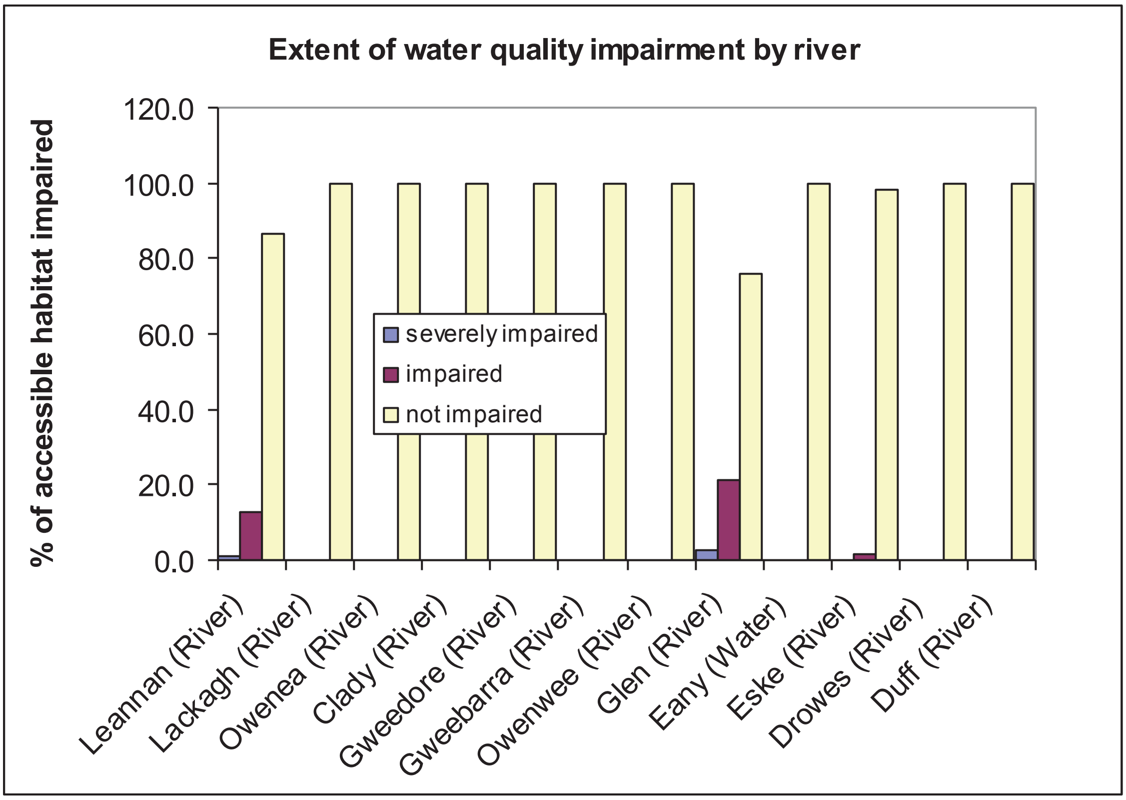


Fig. 3.8. Extent of water quality impairment by river based on EPA Q value analysis. Data from McGinnitty *et al*, 2003 and SSC. Severely impaired = < Q3, impaired = Q 3-4 and > Q 4 = not impaired.

However, recent EPA Q value data, presented as mapped interpretations by watercourse in individual river reports in this report and as site specific only data in tables indicate some water quality problems in other catchments (Appendix 2). Prompted by an inflated deterioration in Q vales for the Crow River in 2008 an aerial investigation by EPA and CFB staff identified a serious landslide problem in the upper reaches of the Crow River in winter 2008 (Plates 3.1 & 2).

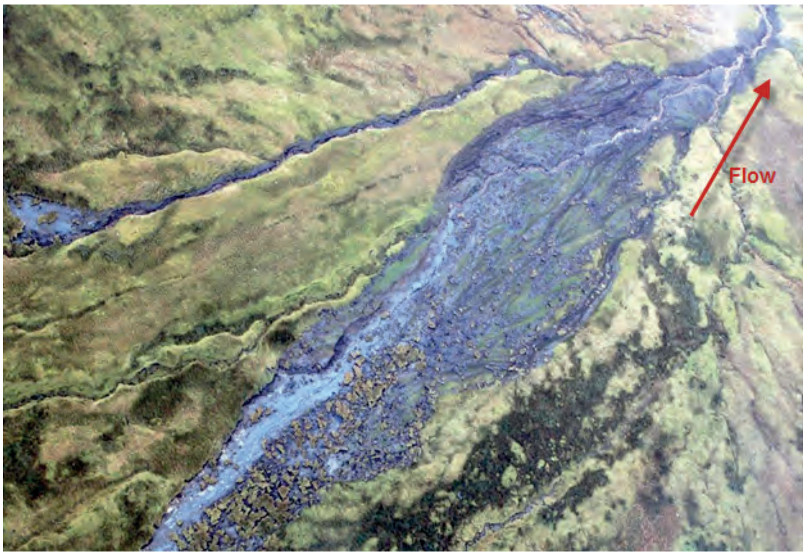


Plate 3.2.1. Landslide in upper Crow River, Winter 2008

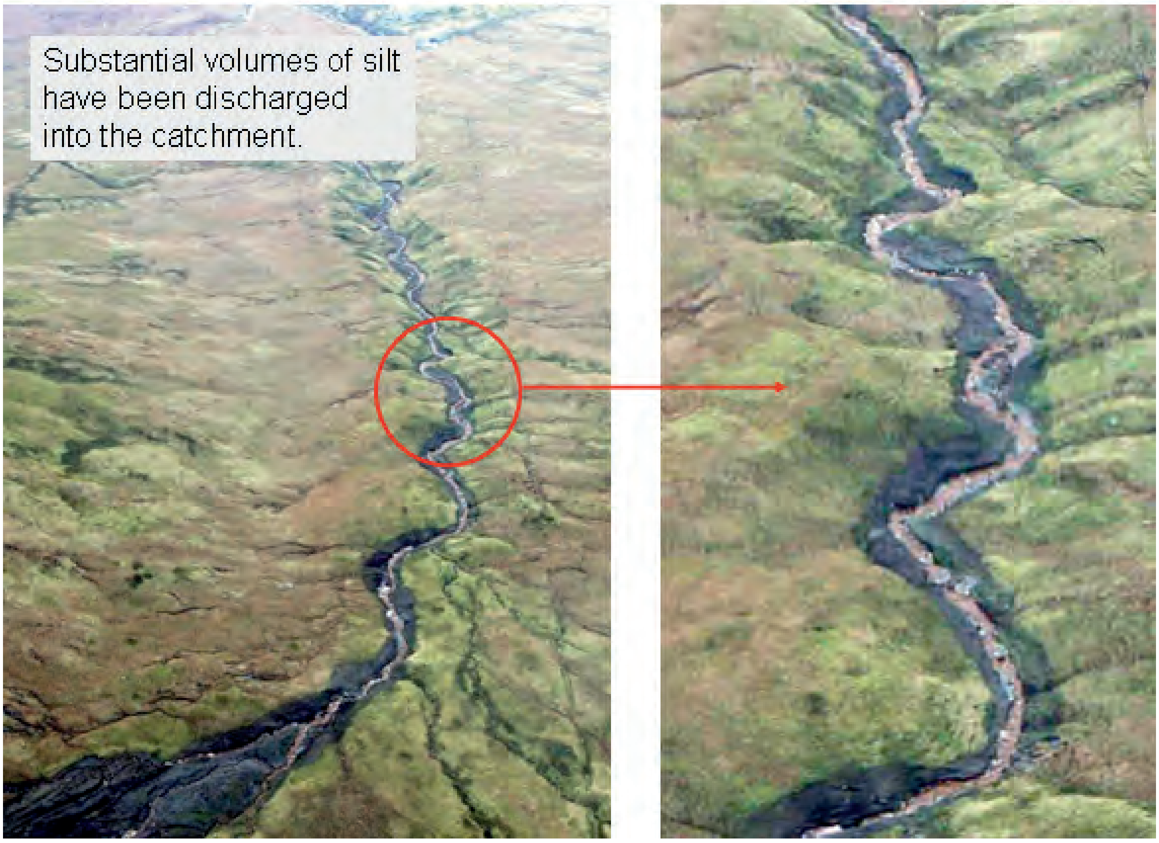


Plate 3.2.2. Extent of marginal deposition in upper Crow River, Winter 2008

4. Survey Methods

Juvenile salmon assessment and habitat quality assessment were the primary survey deliverables required to provide an appraisal of salmon stock status. The juvenile assessment, carried out using electrofishing apparatus, also provided data on the distribution of other fish populations. Habitat assessment was undertaken through direct observation from aerial photography, targeted on-site ground truthing assessment, collation of data from NRFB staff and direct observations at electrofishing sites.

4.1. Catchment characterization

Each catchment was characterized through an aerial survey carried out by CFB (Dr. Martin O'Grady) in conjunction with the Irish Air Corps. Surveys of the catchment were carried out on various dates over the course of the survey as Air Corps schedules permitted. The aerial survey allowed the survey team to generate the following information:

- Zonation of the various river channels into discrete sections, representing the range of habitat type, gradient and volume discharge encountered
- Identification of potential physical habitat problems or potential pressures arising from the likely principal sources (e.g. agricultural, forestry or industrial sources) within the catchments
- Selection of potentially representative electrofishing sites reflecting channel zonation or sites requiring assessment to gauge the impact of habitat problems
- Identification of potential barriers to migration
- Information on likely access points to potential sampling sites

The aerial survey generated a full set of oblique digital photographs for each main channel and its major tributaries. This information allowed a survey plan to be drawn up. Electrofishing sites were selected to represent the varying character/channel types within the catchment based on the aerial survey of all catchments and information from NRFB staff. Following an assessment of the aerial photography a ground assessment of the selected zones was carried out to determine site suitability and access.

The entire suite of aerial photography has been transferred to the NRFB GIS system and will prove valuable in any future initiatives in any of these catchments. It will provide the basis for direct visual comparison of changes occurring in the catchment through enhancement programmes, natural disasters (e.g. catastrophic flood events) or other habitat or land use changes. Other applications will include mapping of angling water, assessment of hydromorphological change, particularly in respect of the EU Water Framework Directive, review of planning applications, angling tourism support and for inclusion to support funding applications for river-specific projects.

4.2. Electrofishing

Representative sites were electrofished to provide an overview of the current status of fish stocks in each catchment. The fish stock assessments were carried by survey teams from the Central and NRFB between 2005 and 2007. Catchments surveyed were the Leannan, the Lackagh, the Clady/Crolly, the Gweebarra, the Owenea, the Glen/Owenwee, the Eany, the Eske and the Duff (Table 4.1). As several surveys had been carried out in the Lough Melvin (Drowes) catchment when the survey programme was first mooted it was decided to concentrate on the remaining catchments which had limited fish stock survey data. Comparisons are made with comparable data from any previous studies.

The survey was designed to provide quantitative data on fish stocks, particularly salmon, for assessment of stock status. Salmon fry were targeted as they provide a measure of adult spawning success within or close to the sampling site, which reflects the general status of the river and its habitat for salmon. Quantitative data provides the most reliable means of comparison within a catchment and with other similar catchments.

Fish within each survey site were captured using electrofishing apparatus. Fish were removed using bank-based electrofishing equipment consisting of a portable generator (220/240V) with an appropriate control (pulsed DC converter) unit attached. The number of units used varied and depended on the width of the river at the site being sampled. Stop nets were placed at the top and bottom of the sampling site to prevent escapement of fish from or into the sampling area. A number of passes were carried out in the contained area in an upstream direction from the bottom net. Fish from each pass were held in separate bins of water, sorted and processed. This provided individual counts for each pass. All fish were measured (fork length) within 1cm length groupings. Sets of scales from salmon and brown trout were taken from a representative range of sizes for back-calculation of length at age and examination of growth pattern at each site. All fish were held in a large bin of water after processing until they were fully recovered and then returned to the water.

Population estimates were calculated using the two pass depletion method of Seber & Le Cren (1967) or the three fishing pass method of Zippin (1958). Where confidence intervals were unacceptably high or, when only one pass was carried out (usually due to low densities), minimum densities (total no. of fish per year class/ area sampled m^2) were calculated (Crisp, Mann & McCormack, 1974). P-values were applied to fish numbers where single passes or where poor depletions were recorded using reliable p- value obtained from similar sites (Seber and Le Cren, 1967). This allowed site densities to be calculated.

A semi-quantitative electrofishing survey methodology, termed “catchment-wide electrofishing” was used in the Duff and Leannan catchments in October 2007 as water levels had curtailed quantitative sampling efforts earlier in the year. This technique involved one fishing operative sampling a riffle area continuously upstream using a single anode backpack for a standard 5 mins targeting 0+ salmonid fry (Crozier and Kennedy, 1994). No stop nets are used. The approach is discussed at length in Gargan et al. (2007) and primarily targets juvenile salmon in riffle areas to reflect adult spawning success. The exact relationship between fry numbers, adult spawning and Conservation Limit attainment is being investigated in the context of a major national assessment.

Data were recorded on standard survey sheets (Appendix 1). All species recorded within the site together with all relevant physical data and habitat data were documented.

Table 4.1. Summary of electrofishing survey programme 2005 to 2007 in the NRFB Salmon rivers programme

System	Year sampled	No. sites sampled quantitatively	No. sites sampled semi-quantitatively
Leannan	2007	19	9
Lackagh	2006	10	
Clady	2007	7	
Crolly	2007	6	
Gweebarra	2006	16	
Owenea	2006	14	
Glen	2007	19	
Eany	2005	19	
Eske	2006	9	
Duff	2007	3	11
TOTAL		**122**	**20**

Historical electrofishing survey data for the Leannan and Lough Melvin catchments were statistically compared as several of the sites sampled were repeated. The Leannan catchment was surveyed in 1992 and corresponding site salmonid densities from 2007 were compared. In Lough Melvin the 1992 and 2000 densities from the same sites were compared.

4.3. Habitat assessment

The aerial survey data enabled the survey to efficiently identify and target habitat problems for further investigation. Ground assessments were carried out once the fish density data for the site, or the immediate area, became available. Specific recommendations were developed by way of a works programme and additional ground photographs were taken to highlight the works required. The proposals were reviewed in consulation with senior NRFB staff and additional areas of concern have been incorporated.

5. Individual Catchment Report & Habitat Rehabilitation

Each catchment is reported individually, and each report incorporates EPA biological/water quality assessment, angling catch, salmon redd count and juvenile assessment data.

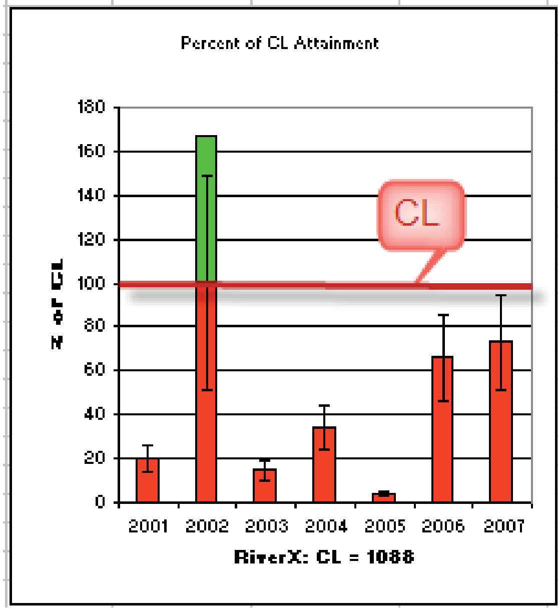
An assessment of Conservation Limit (CL) attainment is also presented to provide an indication of adult salmon abundance. The CL assessment presented in this report is the annual spawning escapement calculated from rod exploitation rates as follows:

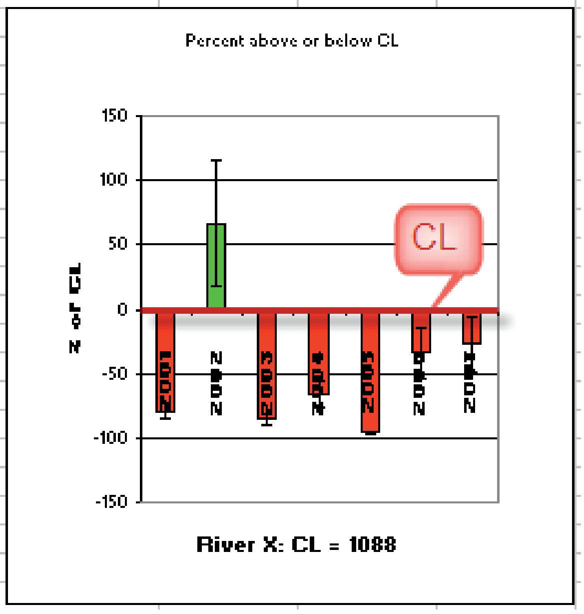
> **Annual spawning escapement = (annual total rod catch X 1/estimated national mean rod exploitation rate) – rod catch retained**

Catch and release (c & r) fish are included as part of the annual total rod catch and are added to the spawning escapement total. For the calculation it is assumed that c & r fish are not recaptured by anglers. A mean rod exploitation rate of 16% (minimum 12% and maximum 20%) was applied for grilse (1SW) fisheries. For the Leannan, which is primarily deemed a spring or multi-sea-winter (MSW) fishery, the mean value applied was 30% (Johnston, 2003; Youngson et al., 2007) with min – max values of 20 and 40% respectively. Although other fisheries like the Drowes/Melvin have a significant MSW component no reliable estimates of the breakdown between MSW and 1SW was available so the 1 SW spawning escapement was applied to all other systems reported here. Up to the end of 2007, which was during the life of this project, CL attainment was presented by the SSC on a District basis with no discrimination by river. It must be stressed that the CL attainment assessment presented here is not analogous to the Standing Scientific Committee CL assessment which is based on multiple inputs from all of the various factors driving production of recruits in an adult to adult cycle as derived from adult returns back to the rivers including commercial, angling and other factors. Regardless of the method of CL attainment calculation a harvest fishery is only advised where the stock exceeds the CL as shown in the table and images below for 2002 (in green). In all other years this notional system was under its CL and in many years it was substantially under this key threshold value. This simplistic model assumes that rod catch reflects stock levels.

Example of Grilse (1SW) Spawning Escapement calculations based on rod catch

Year	Rod Catch	Spawning Stock @ 12% exploitation	Spawning Stock @ 20% exploitation	Conservation Limit	Lower Attainment of CL %	Average Attainment of CL %	Upper Attainment of CL %
2001	39	286	156	1088	14	20	26
2002	320	2347	1280	1088	118	167	216
2003	28	205	112	1088	10	15	19
2004	66	484	264	1088	24	34	44
2005	8	59	32	1088	3	4	5
2006	127	931	508	1088	47	66	86
2007	140	1027	560	1088	51	73	94





To maintain integrity and coherence in each catchment report, any identified habitat problems and rehabilitation recommendations are also described below.

5.1. The Leannan Catchment

5.1.1 Introduction

Up to the 1980s the Leannan was a highly regarded spring salmon angling fishery. Following the introduction of the new national salmon management regime and individual river assessment in 2007 the fishery has been closed for salmon angling. It had not been achieving its Conservation Limit since the beginning of the decade (Fig. 5.1.1) despite an increased rod catch in recent years (Fig. 5.1.2).

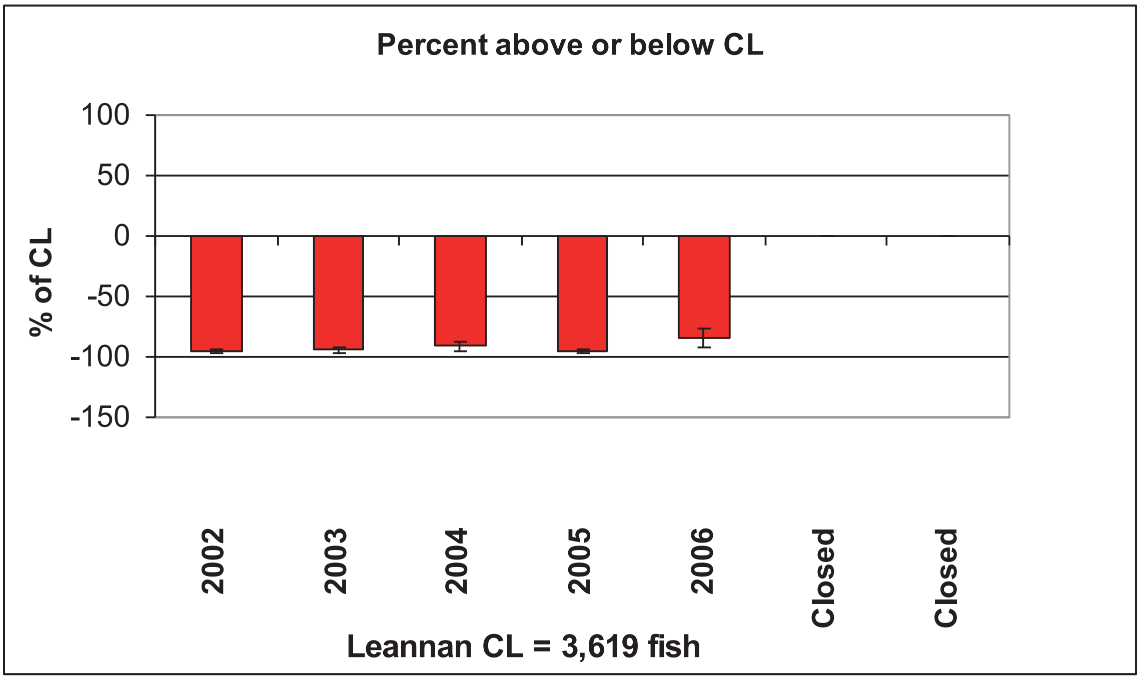


Fig. 5.1.1: Plot of MSW salmon spawning escapement for the Leannan River, expressed as percentage above or below the Conservation Limit

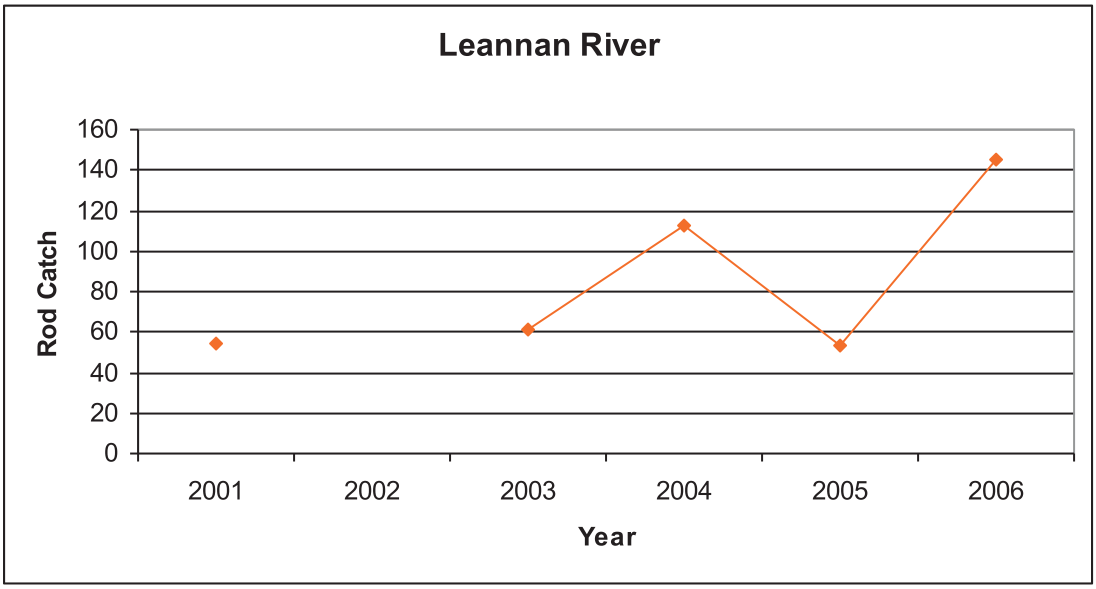


Fig. 5.1.2: Salmon harvest rod catch data for the Leannan River. No data were recorded in 2002.

The Leannan River flows from Lough Gartan to Lough Fern before it enters Lough Swilly at Ramelton. It has a catchment area of 257.7 km^2. The underlying geology is a mix of schist, gneiss, quartzite and granite. The land cover is mainly pasture and peat bog.

The main tributaries are the Bullaba, Lurgy, Glashagh upper and Glashagh lower. Sections within each of these are important salmon spawning areas in addition to the channel immediately downstream of Lough Gartan and other disparate main channel locations (Fig. 5.1.6). Several sections of the main channel and some tributaries are listed as SACs under Annex II of the EU Habitats Directive, mainly due to the presence of the Freshwater Pearl Mussel (*M. margaritifera*).

Salmon redd count data since 1990 (Fig. 5.1.3) shows relatively low redd counts in recent years apart from a high count in 2007/08. However, conditions for counting were poor in two of those years.

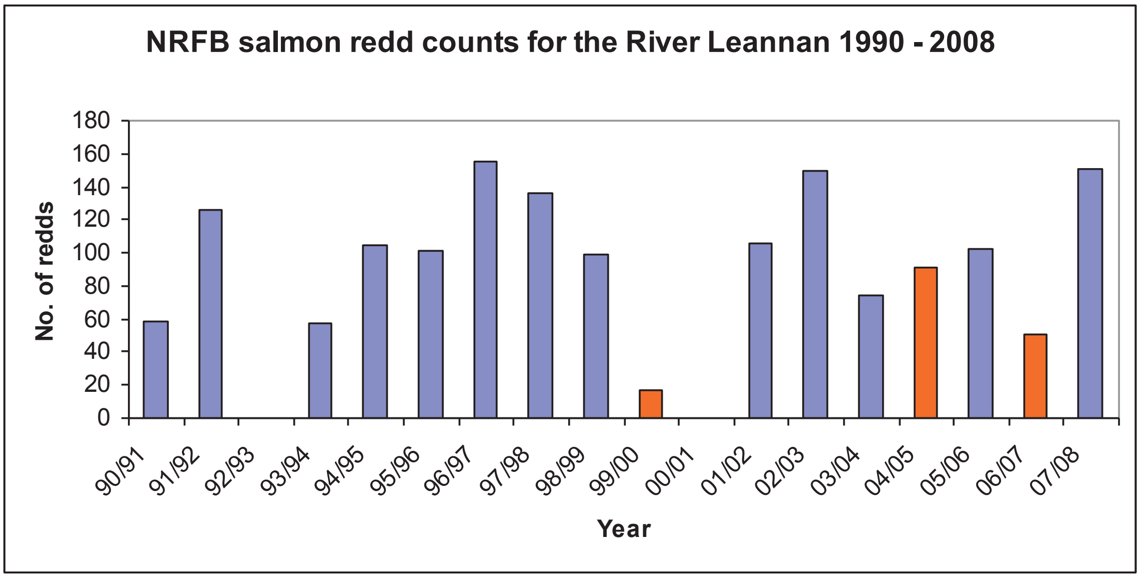


Fig. 5.1.3. Salmon redd count data for the Leannan River. No data for 1992/93 or 2000/01. High water levels resulted in poor counting efficiency in years with red shading.

5.1.2 Survey results

Nineteen sites were quantitatively surveyed in the Leannan Catchment in autumn 2007 (Fig. 5.1.6). Quantitative sampling was concentrated on the tributaries as the main channel water levels were excessively high during this phase of the survey programme which prohibited accurate sampling.

Juvenile salmon distribution was limited and densities were low in the Leannan catchment (Figs. 5.1.6 and 5.1.7). Salmon fry or parr were recorded at 11 of the 19 sites sampled. The highest 0+ densities in the catchment were recorded in two tributaries of the Bullaba (Appendix 4: Table 1), the principal spawning channel for the system, but overall juvenile salmon densities were poor (Figs 5.1.4 and 5.1.5) for fry and parr. Over 50% of the sites sampled held zero fry densities. Three of the sites where zero fry densities were recorded were low stream order channels (stream order 1), where that absence of salmon fry was not unexpected as adult salmon do not generally spawn in these lesser channels. However, channels with higher stream orders (3 and 4), where juvenile salmon would have been anticipated, held no juvenile salmon (Figs. 5.1.6 and 5.1.7). Apart from the Glashagh, none of these absences were related to the presence of barriers to migration.

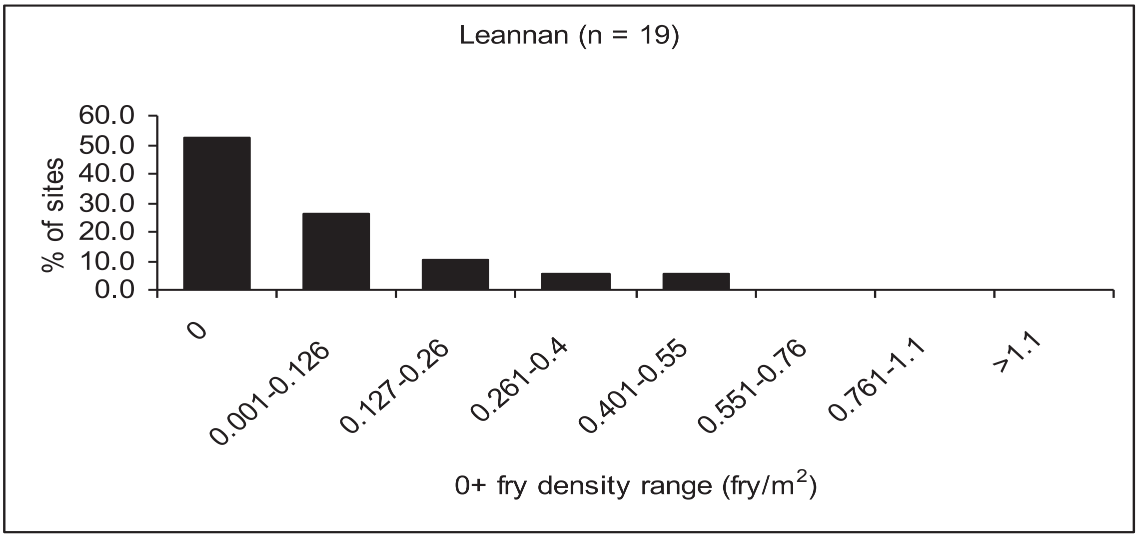


Fig. 5.1.4. Salmon fry density (no./m2) distribution for the Leannan catchment 2007

The Lurgy is one of the prime spawning channels but densities of fry and parr were very poor. Parr density estimates were, in general, low in the catchment

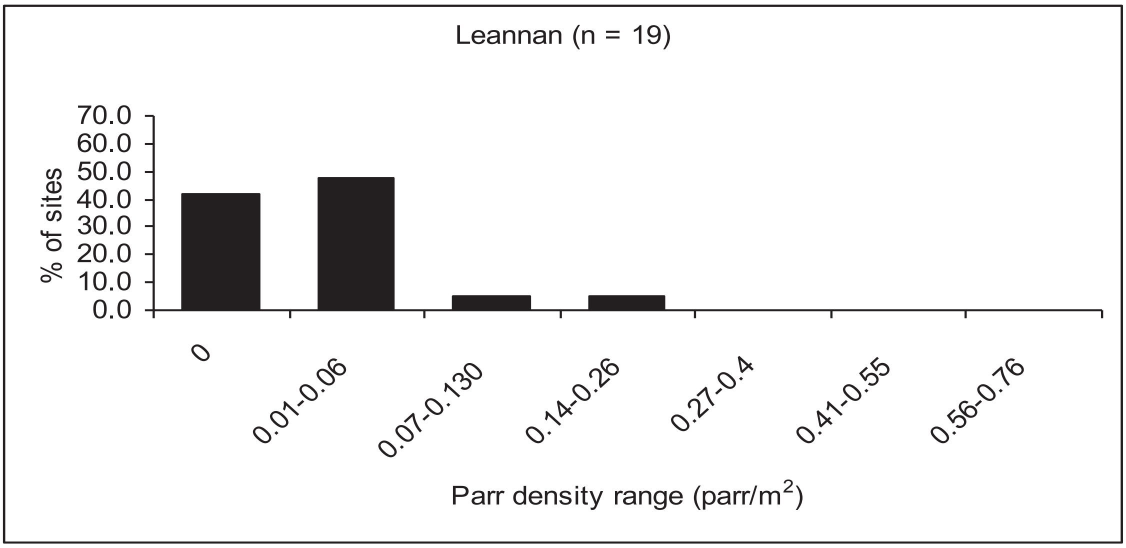


Fig. 5.1.5. Salmon parr density distribution for the Leannan catchment 2007

Trout were widely distributed throughout the Leannan catchment. Trout fry were recorded at every site sampled and parr at 18 of the 19 sampled. Densities estimates of trout fry varied greatly from high (0.82 fish/m^2) to low (0.04 fish/m^2) (Appendix 4: Table 1), and Fig. 5.1.8, and overall trout fry densities were substantially higher than those of salmon in the key salmon spawning catchments, the Bullaba and the Lurgy, indicating that the habitat was not significantly compromised and was capable of supporting juvenile salmonids. Trout parr numbers were poor overall (Fig. 5.1.9). Few deep pools are sampled which probably accounts for the low densities of older trout (Fig 5.1.10).

Eels and three-spined stickleback were recorded at disparate sites and in low numbers (Appendix 6: Table 1).

The Leannan main channel was electrofished in 2007 when water levels permitted. It was intended to carry out quantitative electrofishing in the all of the main channel but extended periods with high water levels precluded this. However, to assess main channel performance several main channel sites were sampled semi-quantitatively (using the catchment-wide electrofishing technique (Gargan *et al*, 2008)). In total nine sites were surveyed using this technique (Fig. 5.1.11 & Appendix 5: Table 1) which concentrates on salmonid fry numbers. Salmon fry abundance was generally satisfactory at single sites in the main spawning areas on the Bullaba, Lough Gartan outflow and near the Lurgy/Leannan confluence. However, low numbers were recorded in a spawning area in the upper Lurgy which supported the conclusion from the earlier quantitative survey.

5.1.3. Comparisons with 1992 electrofishing survey

In 1992 an electrofishing survey was carried out on the Leannan catchment (Roche et al, 1994). Survey data from 1992 is presented in Appendix 7. Densities from sites that corresponded with the 2007 survey were compared between years. Due to the non-normal distribution of biological data a non-parametric test (Wilcoxon signed rank test) was carried out using QED Statistics (Table 5.1.1). No significant difference was found in the densities of juvenile salmon and trout for the various life stages between the two years.

Table 5.1.1: Comparison of juvenile salmon and trout density estimates for comparable sites in 1992 and 2007 on the Leannan catchment using the Wilcoxon signed rank test (QED Statistics ver 1.1.2.441)

	Year	Min den	T	df	p	r
Salmon 0+	1992	0.014				
	2007	0.005	1.60	8	>0.05	0.38
Salmon >0+	1992	0.012				
	007	0.012	0.53	8	>0.05	0.13
Trout 0+	1992	0.152				
	2007	0.109	0.105	12	>0.05	0.02
Trout 1+	1992	0.065				
	2007	0.042	1.36	12	>0.05	0.27
Trout >1+	1992	0				
	2007	0.009	0	7	>0.05	0

5.1.4. Physical habitat assessment and recommendations for improvements

In the 1960s UDN was identified as a serious problem particularly for salmon in MSW fisheries in Ireland. It would seem that few stocks have ever recovered from the effects of this problem. The weir in the lower Leannan at Watt's Pool has been identified as a factor in allowing disease transfer as salmon tend to congregate for lengthy periods of time until suitable conditions for passage arise. This artificial structure should be removed or significantly modified to allow for rapid escapement of salmon into the wider catchment and ease the likelihood of disease transfer. This modification is justified under the EU Water Framework Directive, to improve river continuity, which is one of the factors involved in restoring water quality to "good status" in all catchments by 2015. Under the EU Habitats Directive the easement of fish passage to maximise the "favourable conservation status" of salmon, one of the primary objectives of the Directive, should also be addressed.

The weir should be replaced by a paired deflector similar to those installed in the Cathedral Beat in the Moy. These structures restrict the channel but create attractive salmon lies while affording fish a good opportunity to migrate unhindered. Angling opportunities are also enhanced by these structures.

Several habitat problems were identified in the Leannan tributaries which impair juvenile salmonid production.

Water quality is an issue in parts of the Leannan system and the system. Problems have occurred periodically in the Lurgy and the Glashagh. Farm surveys carried out by the NRFB in the Lurgy catchment have also identified specific problems and this direct approach will assist in ensuring that the risks of discharges are restricted.

LURGY RIVER

The Lurgy River, one of the prime spawning channels in the Leannan, was subjected to an arterial drainage scheme possibly 50 to 60 years ago. In morphological terms the channel has not recovered. Currently the physical form is largely a riffle/glide sequence with few well defined pools and few gravel shoals suited to salmon spawning purposes (Plate 5.1). This reach was drained several decades previously.

Plate 5.1. Typically uniform section of the Lurgy River near Kilmacrenan with riffle/glide sequence and heavy tree cover

Other habitat problems were observed. Observations suggest serious ongoing organic pollution problems. The paucity of juvenile salmon, while moderate to good brown trout populations are present, suggest impaired water quality (Fig. 5.1.12). In January 2008, an example of the type of water quality problem in this catchment was observed (Plate 5.2) while carrying out general survey work. The aerial photographic series of the Lurgy River showed that extensive channel reaches were tunnelled. Ground truthing confirmed that there was excessive shading in many reaches. A major shrub pruning programme is required over significant channel lengths in the Lurgy (Figure 5.1.13).

The primary step in this process must be to eliminate the pollution problems. Two recent major reports (Kelly *et al*, 2006 and O'Grady and O'Leary, 2007), relating Q levels to salmonid stock levels in Irish rivers, have shown that once the Q value is < Q 3/4 it is no longer capable of supporting juvenile salmon. At Q3 or less trout stocks will collapse. In the case of the Lurgy all of the survey data point to poor Q values < Q 3/4 as being one factor in limiting salmon production.

Plate 5.2. Ditch discharging effluent into a tributary of the Lurgy

While tunnelling and morphological imbalances caused by drainage are clearly depressing stocks there is little point in addressing these difficulties until the pollution problems are resolved. The second step in the process would be to address the major shrub tunnelling problem, the extent of which is illustrated in Figure 5.1.13. Once the shrub pruning programme has been addressed it will be feasible to measure the extent to which the drainage programme has caused morphological imbalances and thereafter, design a programme to address these problems. This is likely to involve the importation of large quantities of spawning gravels and the construction of many deflectors and vortex weirs. For the 5.35km of channel involved costs for this element of the programme will be ca. €107,000. Central Fisheries Board staff would be pleased to assist the NRFB in designing this project when it reaches this stage.

BULLABA RIVER

The Bullaba River is an extensive subcatchment and a significant salmon spawning resource. Excessive bank erosion, probably from overgrazing, is causing destabilisation of banks, deposition of eroded silt and reduction in habitat quality.

Plate 5.3. Typical reach of the Bullaba which requires fencing and tree planting

To combat erosion and re-establish the banks an extensive fencing and tree planting programme is required in the upper and middle reaches. A typical reach in this zone of the Bullaba River is illustrated (Plate 5.3). A tributary to the Bullaba, the Owenwee River is overgrazed in its lower (300m) reaches – from the lowermost bridge to its outfall to the Bullaba (Plate 5.4). This reach should be fenced off and planted but not as a priority as the extent of channel involved is limited. Compaction of gravels upstream of Reilly's Bridge on this system needs to be addressed and would be inexpensively achieved by using an excavator to turn the gravels in late summer.

GLASHAGH RIVER

The Glashagh is another valuable salmon spawning channel in the Leannan catchment. Like the Lurgy it was drained in the past and is now also very heavily tunnelled (Plate 5.5.). A major shrub pruning programme is required on this channel – details of the extent and location of same is provided in Figure 5.1.13. This river was also drained, possibly 50 to 60 years ago. It has not recovered in morphological terms and requires a major physical instream works programme. The cost of this element of a programme, from Drumbolloge Bridge downstream to its outfall (4.5km), is estimated at €90 k.

Plate 5.5. Tunnelling in the Lurgy and Glashagh catchments

Small numbers of juvenile salmon were recorded during the electrofishing survey in the middle and lower reaches of the Glashagh (Figs. 5.1.6 & 5.1.7, Appendix 4: Table 1). Densities were poor in comparison to other NRFB rivers sampled. Juvenile salmon were absent from the uppermost electrofishing site at Drumbolloge Bridge thus confirming the impassability of a barrier immediately downstream. The paucity of trout here suggests that there may be ongoing pollution problems in these reaches. Low EPA Q-values (Q3) have been recorded in recent years.

Plate 5.6. Glashagh River at Drumbolloge Br.

The Glashagh is one of the more problematical subcatchments in terms of water quality. The NRFB has identified suspended solids from quarrying operations and unsustainable agricultural practices as contributing to water quality problems in the catchment. Intensive farming which results in excessive stock on land with limited carrying capacity, or in slatted units, generates excessive waste and associated problems. While good progress has been achieved under the Fisheries Boards/IFA protocol (Anon, 2001) it is appropriate, with the relatively new environmental regulations being implemented, particularly emanating from the EU, the WFD, the Habitats Directive and the Nitrates Directive, which have lead to more enforcement issues, to advocate direct fisheries input into the grant-aiding process where it is evident that agricultural operations (e.g. erection and operation of slatted units) may impinge on water quality, thus impacting on fish.

The most desirable strategy to enhance salmon stocks in the Glashagh should parallel the programme already outlined for the Lurgy:

- Eliminate water quality problems
- Complete a pruning programme
- Design and implement an instream enhancement programme

The pruning and rehabilitation programmes should be confined to the channel downstream of Drumbolloge Br. (middle reaches of Glashagh) to the main channel of the Leannan.

5.1.5. Conclusions

Juvenile salmon populations in the Leannan catchment, formerly a renowned spring salmon fishery, and one of the largest salmon systems (by catchment size) in Ireland, are poor. Comparisons with juvenile densities from other catchments surveyed over the course of this project highlight that over 50% of sites quantitatively surveyed held no salmon fry (Fig. 5.1.6). Interestingly, a similar result was recorded for the Lackagh system, which is also well regarded as a spring salmon fishery. Both have been closed for salmon angling since 2007 as both are under their respective Conservation Limits. Juvenile salmon densities are low but relatively stable, based on a comparison of current data and a 1992 survey. However, indices such as low rod catch (2002 to 2006 mean = 89 fish) and the low juvenile densities highlight a system which is underperforming. Habitat problems have been identified in the tributaries, but the catchment is capable of supporting higher densities of juveniles based on the underlying habitat production potential and the extent of wetted area. Water quality, as indicated by the relevant EPA Q-values, for the Leannan system varies within the catchment and specific problem reaches have been identified. Resolution of these problems prior to initiating any enhancement programme is essential.

One of the primary aims of this project was to identify works programmes for restoration or enhancement of salmon spawning and nursery habitat. A comprehensive programme of works has been drawn up for all catchments and one of the main funding mechanisms for delivery of this work is the Salmon Conservation Stamp Fund. This funding measure is funded by an annual contribution from anglers. One of the principle criteria for determining the suitability of a project for funding is water quality status. Poor water quality, as has been observed in parts of the Leannan, will influence funding opportunities, thus impacting on restoration of the potential of the river. The tenuous presence of *M. margaritifera*, a slow-growing, long-lived bivalve species, protected under the Habitats Directive, with an extremely high conservation value, will confer additional importance on the requirement to improve water quality in the catchment. This will also benefit fish, the intermediate host for this organism, in addition to enhancing the likelihood of securing funding for fish related habitat works.

The priority for the fisheries manager in this catchment is to ensure that the freshwater habitat can sustain and be capable of maximizing juvenile salmon output. Marine survival indices for MSW stocks (ICES, 2008) are low and this will impact on all MSW fisheries. Apart from curtailing the harvest of MSW fish in freshwater management cannot directly influence marine survival. In this scenario, targeted measures to ensure that the freshwater environment is performing to its potential remain the most cost-effective delivery mechanism for management.

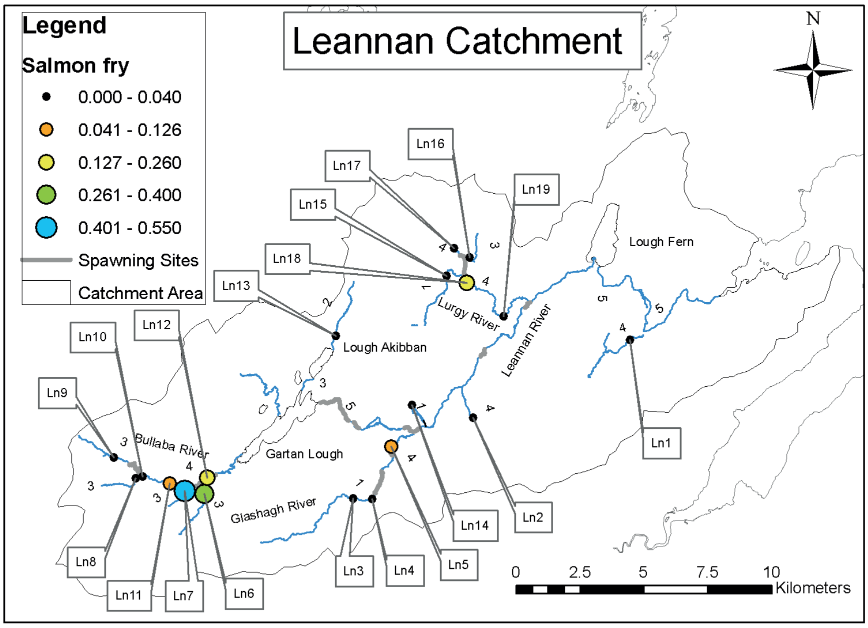


Fig. 5.1.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Leannan catchment. Numbers on map represent stream order and grey line represents spawning areas.

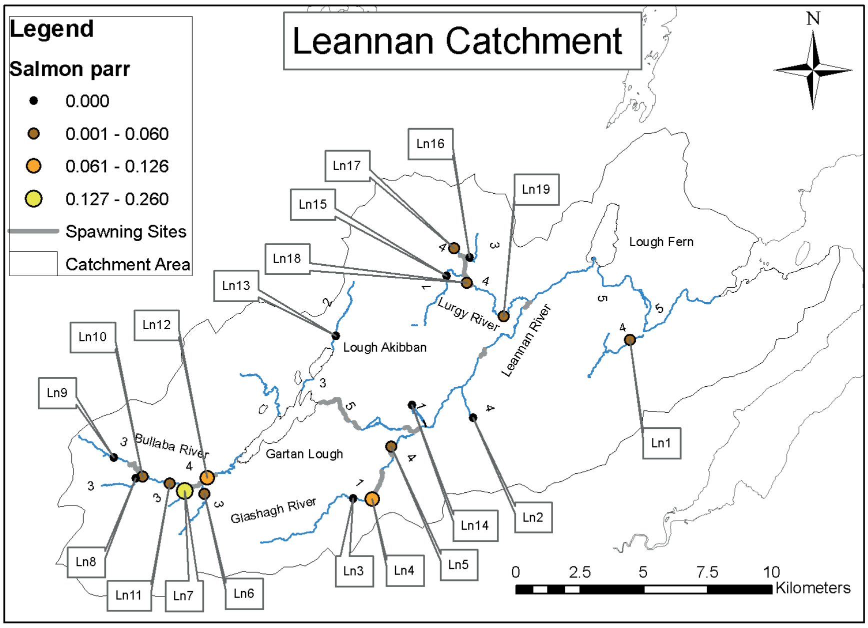


Fig. 5.1.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Leannan catchment. Numbers on map represent stream order and grey line represents spawning areas.

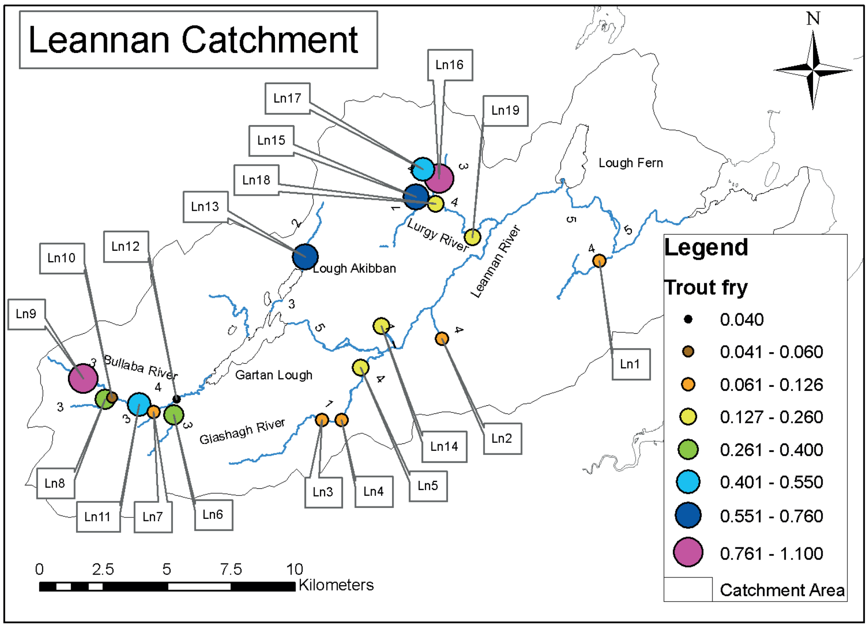


Fig. 5.1.8: Trout fry distribution and quantitative density estimates (no./m2) in the Leannan catchment. Numbers on map represent stream order and grey line represents spawning areas.

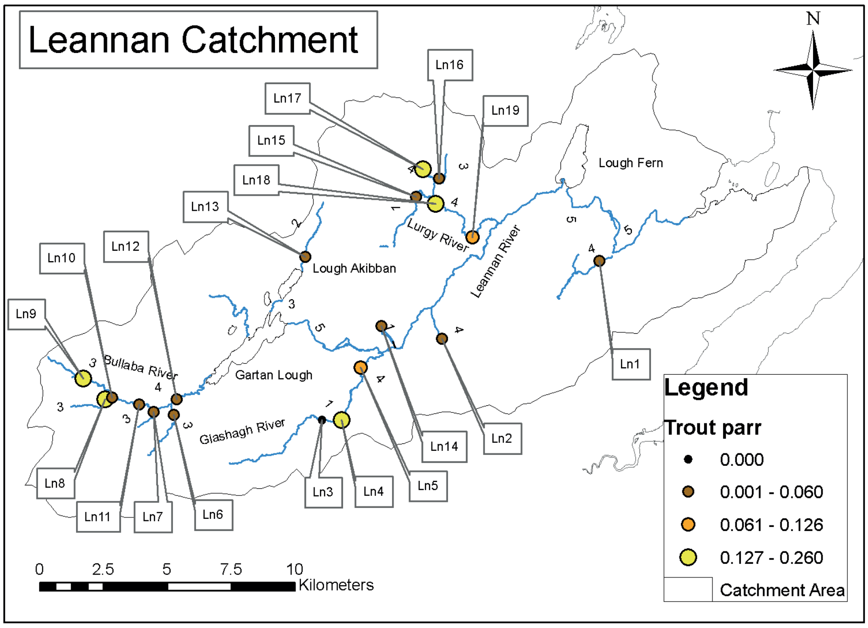


Fig. 5.1.9: Trout parr distribution and quantitative density estimates (no./m2) in the Leannan catchment. Numbers on map represent stream order and grey line represents spawning areas.

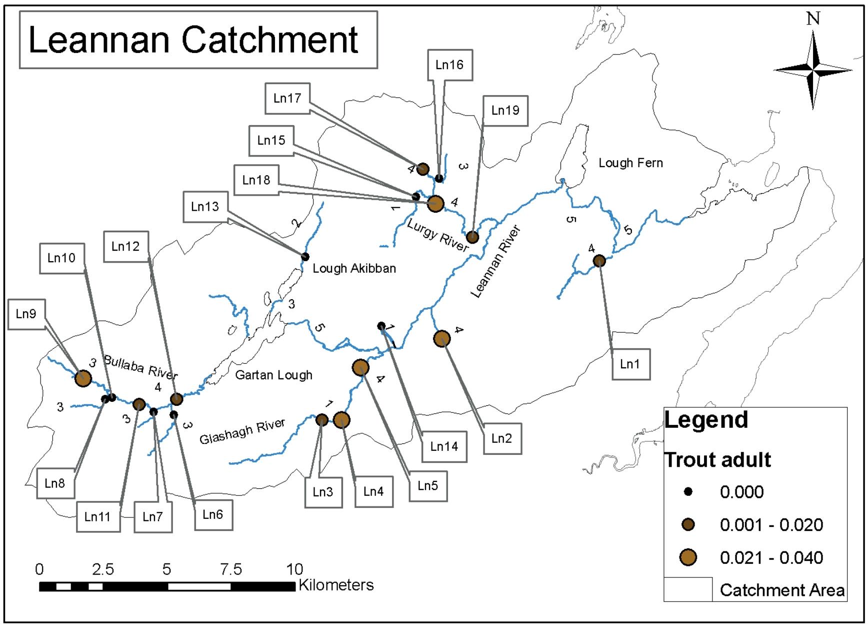


Fig. 5.1.10: Trout adult distribution and quantitative density estimates (no./m2) in the Leannan catchment. Numbers on map represent stream order and grey line represents spawning areas.

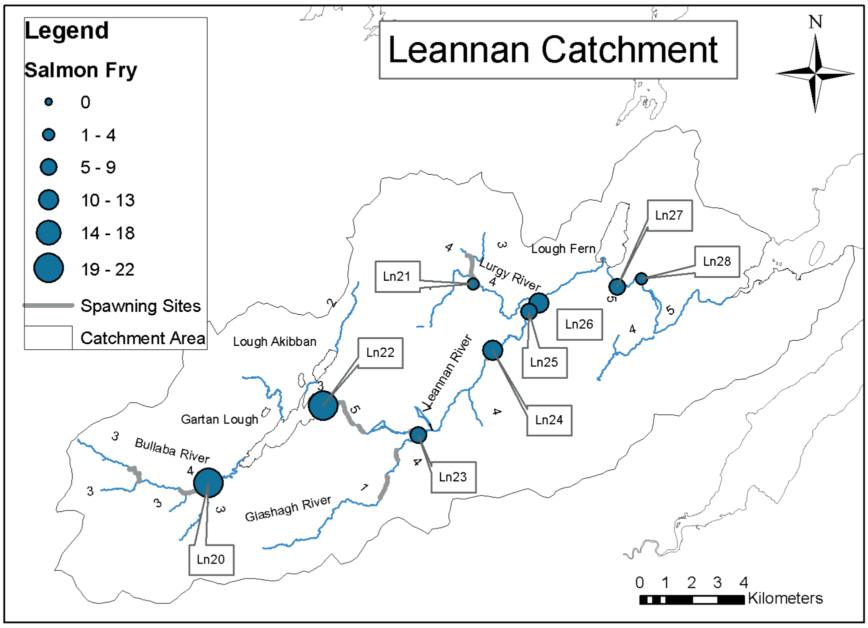


Fig. 5.1.11: Salmon fry abundance based on semi-quantitative electrofishing in the Leannan catchment

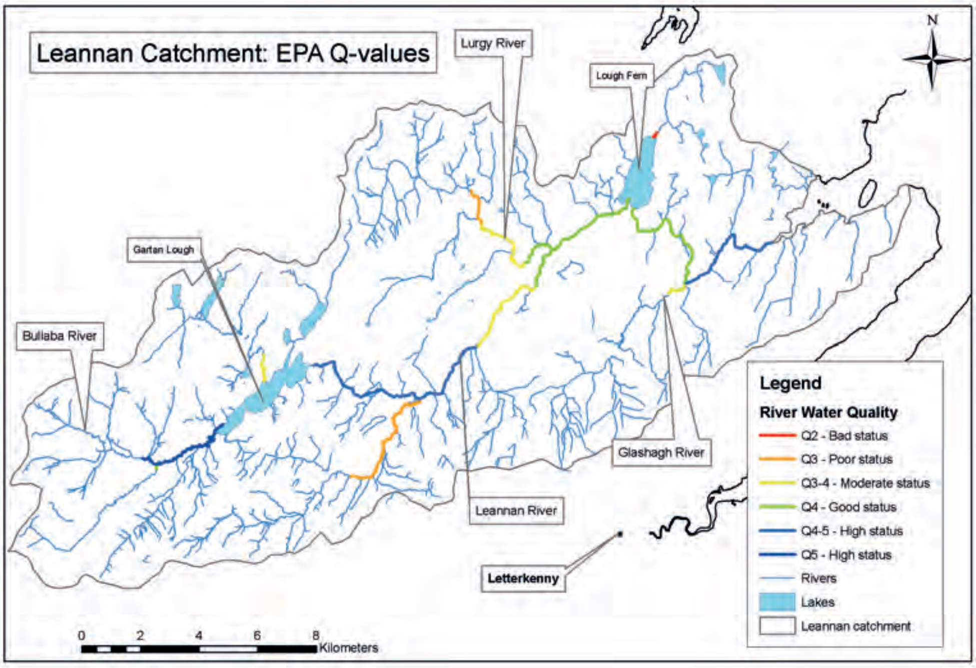


Fig. 5.1.12: EPA Q-values for the Leannan catchment

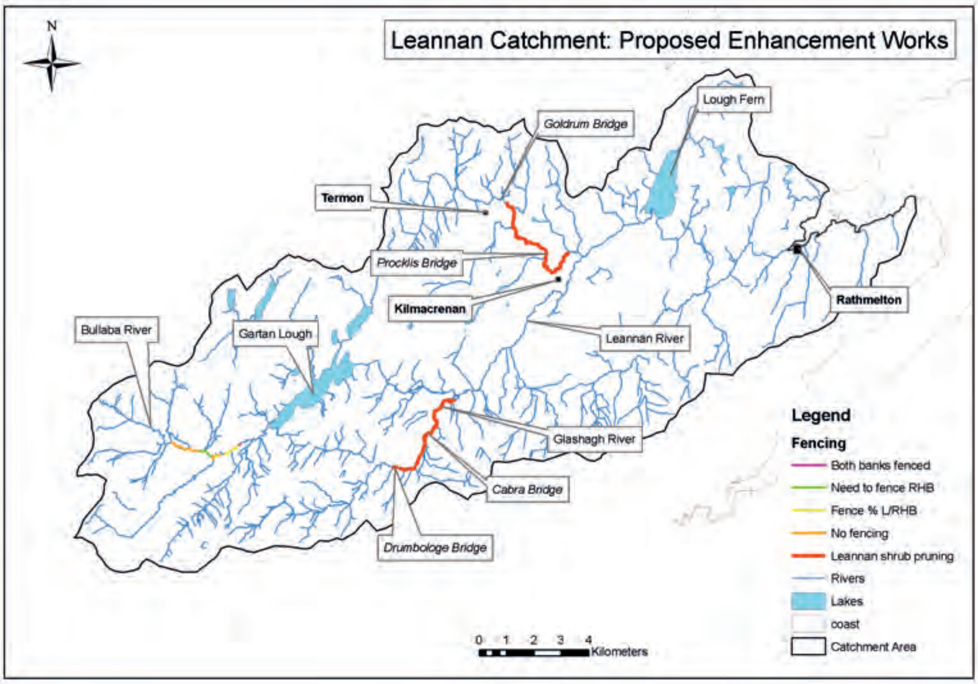


Fig. 5.1.13: Proposed enhancement works for the Leannan catchment - 5.4km of pruning required on the Lurgy River with 4.9km of pruning on the Glashagh River, and by 3km of fencing on the Bullaba River.

5.2. Lackagh Catchment

5.2.1. Introduction

The Lackagh is a spring salmon and grilse fishery which is dominated by two lakes, Glen Lake and Lough Veagh. Similar to the neighbouring Leannan catchment the Lackagh has not achieved its conservation limit since the start of the decade and was closed to all forms of salmon exploitation in 2007 and 2008 (Fig. 5.2.1). Rod catches averaged about 50 fish per annum over the period up to its closure (Fig. 5.2.2).

The Lackagh River rises in the Derryveagh Mountains of Glenveagh and passes through Lough Beagh and then Glen Lough before entering the sea near Drumlackagh (Sheephaven Bay). The Lackagh system drains an area of 126.4km^2. The geology is principally granite and land cover is mainly peat bog and natural grassland.

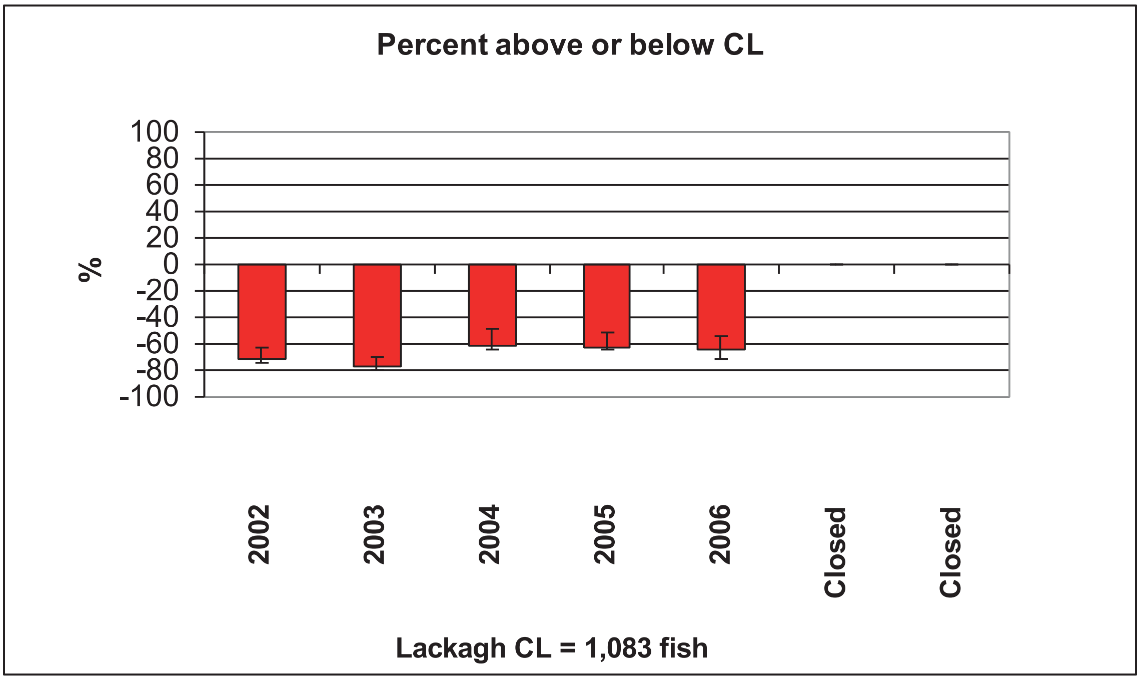


Fig. 5.2.1: Plot of salmon spawning escapement for the Lackagh River, expressed as percentage above or below the Conservation Limit

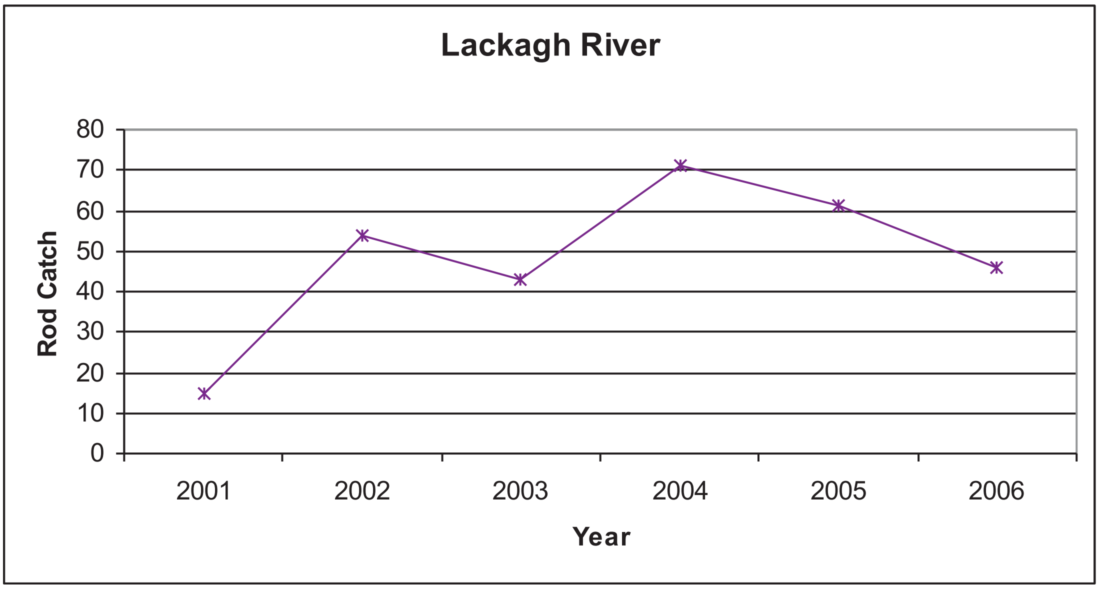


Fig. 5.2.2: Salmon harvest rod catch data for the Lackagh.

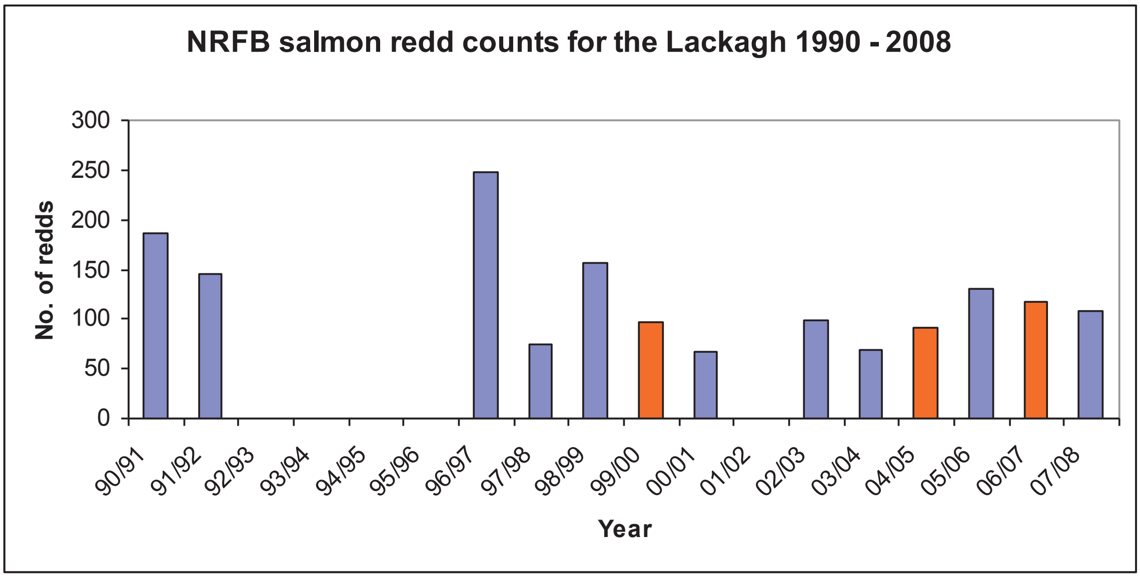


Fig. 5.2.3. Salmon redd count data for the Lackagh system. No data for 1992/93 to 1995/96 or 2000/01. High water levels resulted in poor counting efficiency in years with red shading.

The Lackagh River is ranked fifty fourth with 0.33% of the national total accessible salmon fluvial habitat in Ireland (McGinnity *et al.* 2003).

Redd count data for the catchment shows moderate counts in recent years although data gaps and poor counting conditions in other years may confound any analysis.

5.2.2. Survey results

The Lackagh is dominated by lakes and the stream network principally comprises small tributaries flowing directly into the lakes, and three large channels – the Glen, the Owenacarrow and the River Barra. Ten sites were quantitatively surveyed in summer 2006 (Fig. 5.2.6). Juvenile salmon were absent at six sites (60% of all sampled) (Fig. 5.2.4); two of these were above impassable barriers. Salmon were not widely distributed in the Lackagh catchment with production being limited to two of the main spawning areas, the River Barra (main inflowing channel to L. Beagh) and the Glen River (tributary to Glen Lough). Salmon fry densities were generally high in both (Fig. 5.2.6 and Appendix 4: Table 2). Salmon parr were more widely distributed and densities were poor to good (Figs. 5.2.5 and 5.2.7).

Trout were widely distributed in the catchment. Trout fry densities were low to moderate (Figs. 5.2.8 and 5.2.9). Trout parr were found in good densities at two sites (Lk3 and Lk4 - Appendix 4: Table 2) and poor to moderate in the remaining sites. The Lackagh system has an excellent reputation as a sea trout fishery but no tributary had high trout fry densities (≥ 1.5 fry/m2) often associated with a lake tributary.

Eels and stickleback were recorded in the catchment (Appendix 6: Table 2). Eel distribution was limited to five sites – one of these sites, Lk 9, is upstream of a barrier impassable to salmonids.

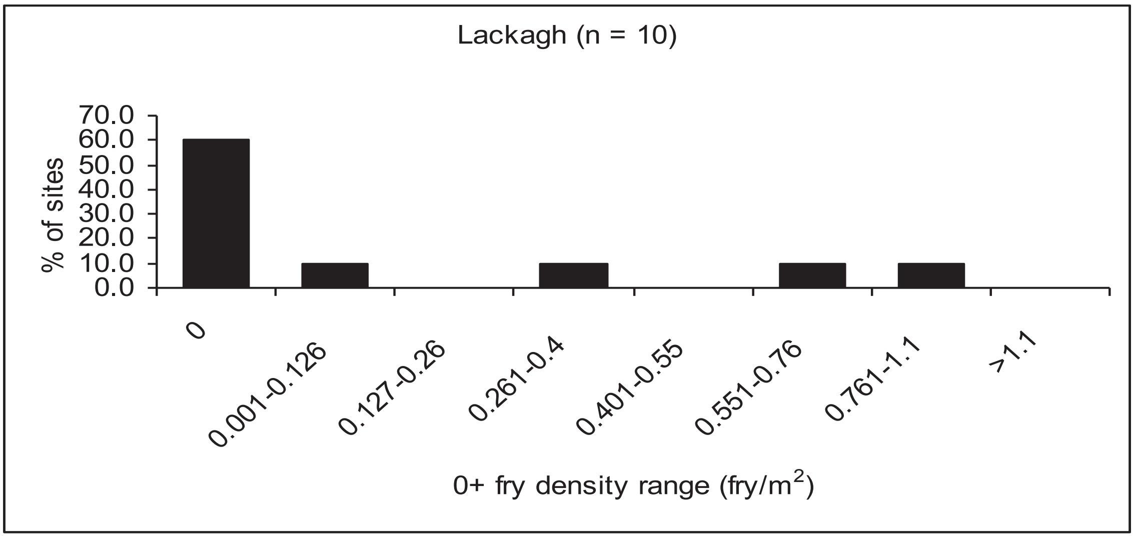


Fig. 5.2.4. Salmon fry density distribution for the Lackagh catchment 2006

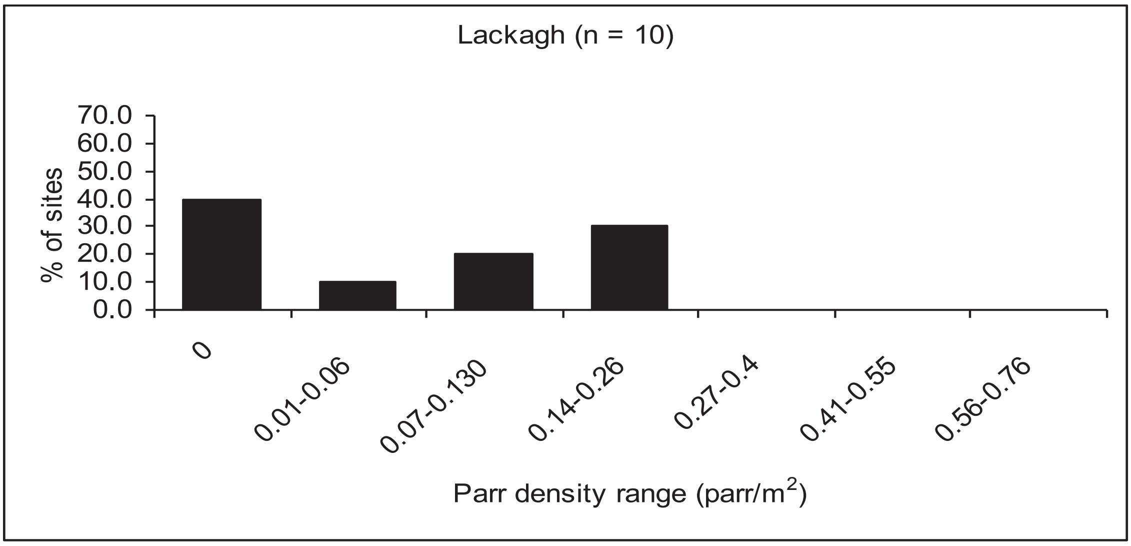


Fig. 5.2.5. Salmon parr density distribution for the Lackagh catchment 2006

5.2.3 Comparison with 1993 electrofishing survey

The Lackagh catchment was surveyed in 1993 by Boylan and Sheridan (Appendix 7: Table 2 and Fig. 2). Good agreement was observed between the results regarding the distribution of high densities of juvenile salmon in 1993 and 2006 with the Glen River and the Owenacarrow River prominent. However, overall densities were lower in 2006. Boylan and Sheridan recorded a wider distribution of juvenile salmon with high densities in the lower reaches of several first order streams discharging into Lough Beagh and lesser tributaries throughout the catchment. This suggests that salmon spawning may have contracted in the catchment which may be a further indication of poorer adult runs and loss of juvenile production. Higher salmon parr densities were recorded in 2006.

5.2.4. Physical habitat assessment and recommendations for improvements

Aerial photography, electrofishing data and an on-site assessment identified a limited number of potential restoration/enhancement works for this catchment. EPA Q-value data shows that the catchment has high status with Q values mainly in the 4-5 range (Fig. 5.2.11 and Appendix 2: Table 2). The River Barra (also known as the upper Owenacarrow), which discharges into Lough Beagh, is an almost pristine salmon production entity due to the natural riparian zone stability and benign land management practices carried out by the National Parks and Wildlife Service, and requires no remedial or enhancement work. A major tributary, the Calabber, which joins the Owenacarrow downstream of Lough Veagh, has some serious bank erosion problems in its upper and middle reaches, but the channel is largely inaccessible to salmon due to the presence of two major natural falls. No works are recommended because of the scale of the problem and the limited physical impact on the lower reaches where salmon can access. Because of the stability of much of the catchment and the excellent water quality limited enhancement works are required in the Lackagh catchment. However, two channels where works are recommended are:

GLEN RIVER

This is an important salmon spawning tributary and a 400m reach (2 x 200m zone upstream and downstream of Lagantrean Bridge), previously drained, and is also tunnelled. Although good densities of salmon fry and parr were recorded, the combination of these two problems is limiting the quality of this reach as salmon nursery water. An instream physical enhancement programme with a shrub pruning element is required. A series of vortex stone weirs should be constructed to both provide pool areas and encourage gravel deposition which would enhance spawning and nursery opportunities.

GLENREARAGH RIVER

A major shrub pruning operation is required in the lower reaches of this stream which discharges into Glen Lough. In excess of 500m of channel in the lower reaches require pruning which should significantly improve salmon parr production which is currently poor (Appendix 4: Table 2).

5.2.5. Conclusions

Much of the Lackagh catchment drains an SAC and the aquatic habitat is stable with few problems observed in the salmon bearing habitat. The Lackagh catchment is relatively pristine apart from the severely eroded Calabber River. Water quality based on EPA Q-values has been consistently high for several decades and good juvenile salmon production occurs in the prime spawning areas. However, juvenile salmon densities outside the prime areas are low and the carrying capacity of the catchment is not being fully realized. The additional available habitat is not being exploited by juvenile trout, migratory or non-migratory. Another index, adult salmon returns based on rod catch, is substantially below the catchment Conservation Limit. No obvious major factor can be identified in freshwater that may be limiting juvenile production although some works are proposed to improve some habitat.

Marine survival indices for Southern European MSW stocks remain low (ICES, 2008) and are considered to be a key factor limiting salmon production. This stock complex which covers salmon originating from rivers in Ireland, United Kingdom, France and Spain, is expected to continue to decline in the short-term. This scenario is likely to result in maintenance of the current management regime (fishery closure) on the Lackagh, which aims to conserve and build up stocks.

All works specified for this catchment in previous restoration/enhancement programmes have been implemented. Water quality is good but fish numbers remain below the CL threshold. NRFB has identified a fish counter as a priority management measure and it will be installed in the short-term.

Like the Leannan, the Lackagh and other MSW systems (where MSW salmon dominate or comprise a significant proportion of the main escapements of salmon into the system), deserve special attention. This component of the Irish salmon stock needs to intensively studied across several geographically widely distributed catchments to better understand its dynamics in freshwater. If differences between 1SW and MSW habitat and its ecology are observed, cogniscence by way of special designation or further regulation of potentially harmful activities must be afforded to this vulnerable component of Irish salmon stocks.

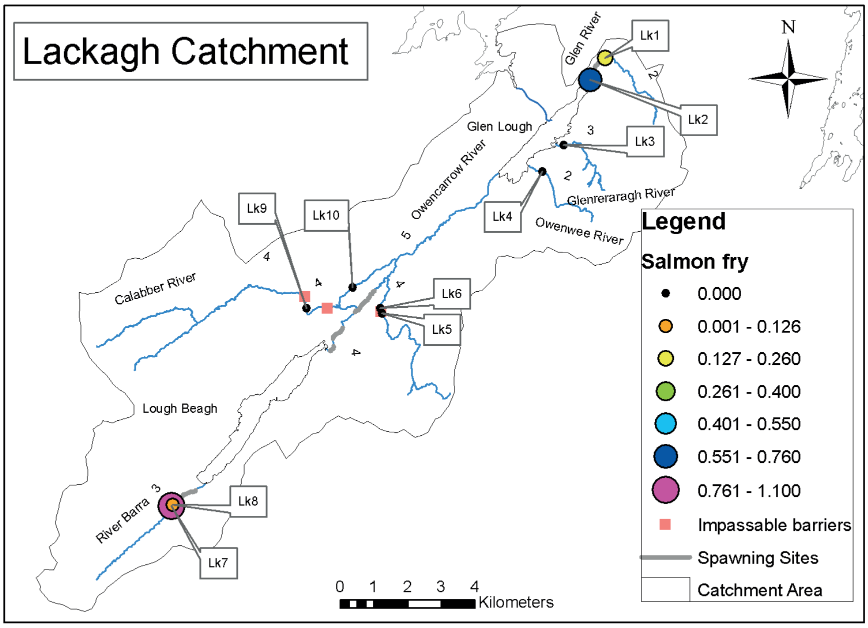


Fig. 5.2.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Lackagh catchment. Numbers on map represent stream order and grey line represents spawning areas.

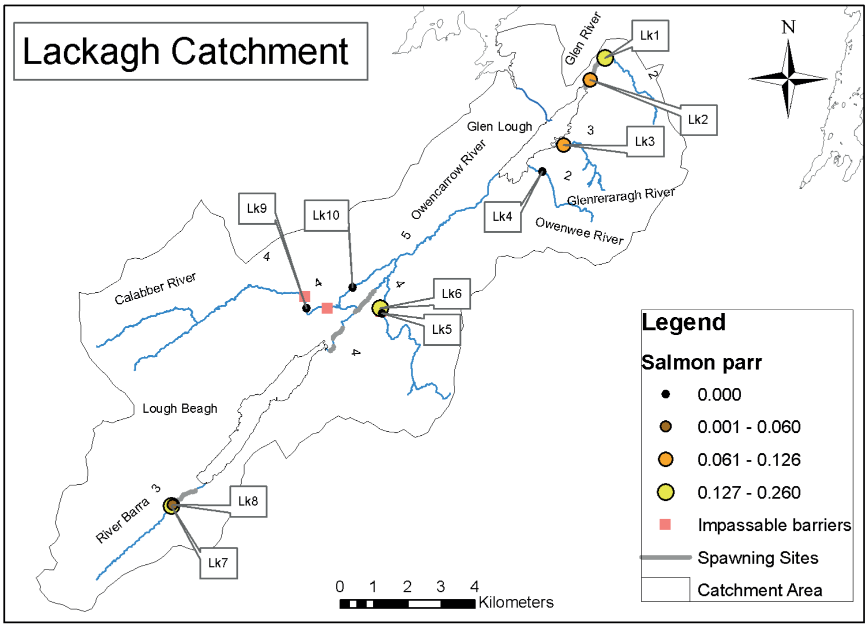


Fig. 5.2.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Lackagh catchment. Numbers on map represent stream order and grey line represents spawning areas.

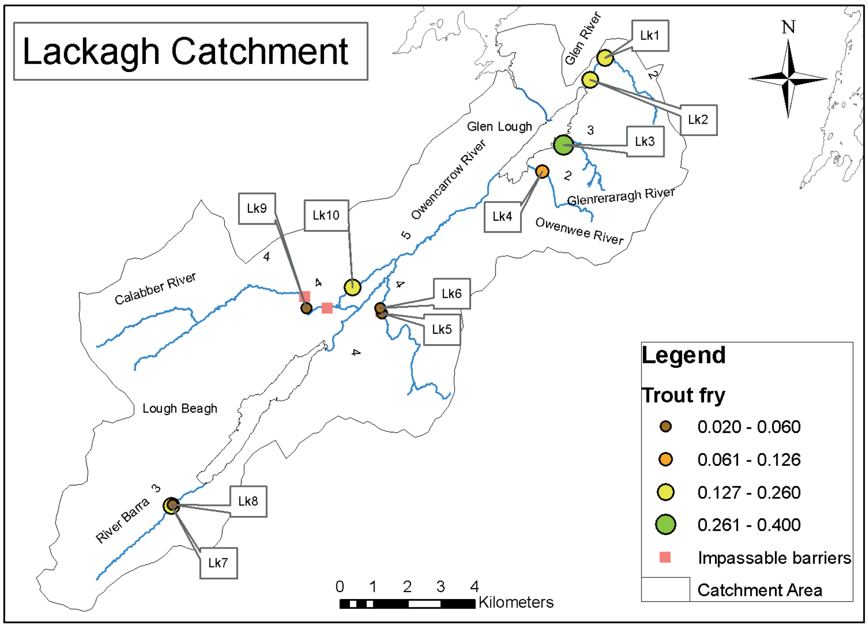


Fig. 5.2.8: Trout fry distribution and quantitative density estimates (no./m2) in the Lackagh catchment. Numbers on map represent stream order and grey line represents spawning areas.

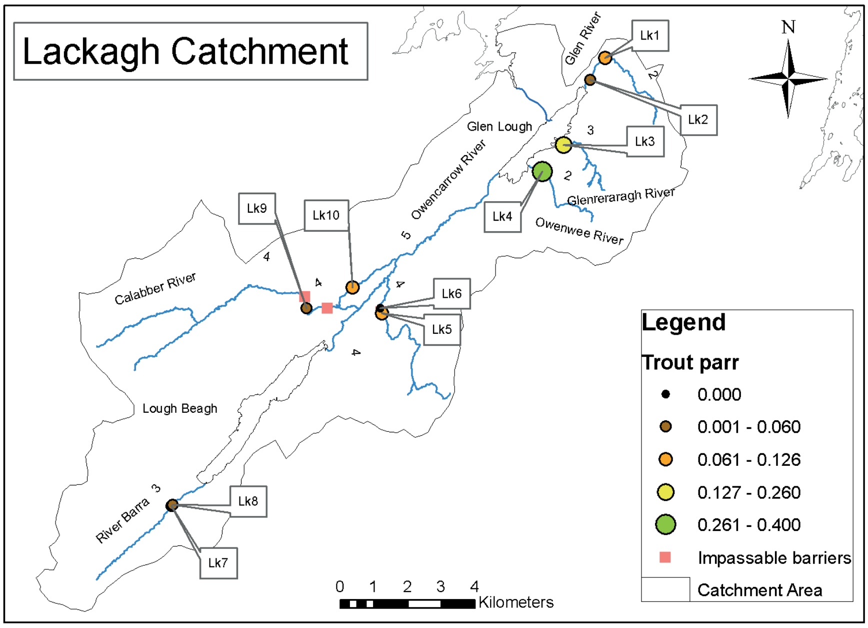


Fig. 5.2.9.: Trout parr distribution and quantitative density estimates (no./m2) in the Lackagh catchment. Numbers on map represent stream order and grey line represents spawning areas.

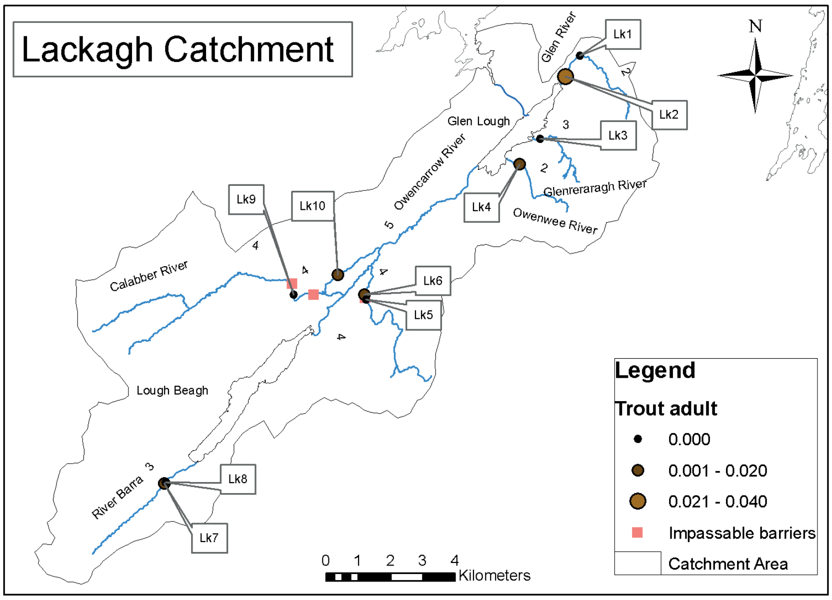


Fig. 5.2.10: Trout adult distribution and quantitative density estimates (no./m2) in the Lackagh catchment. Numbers on map represent stream order and grey line represents spawning areas.

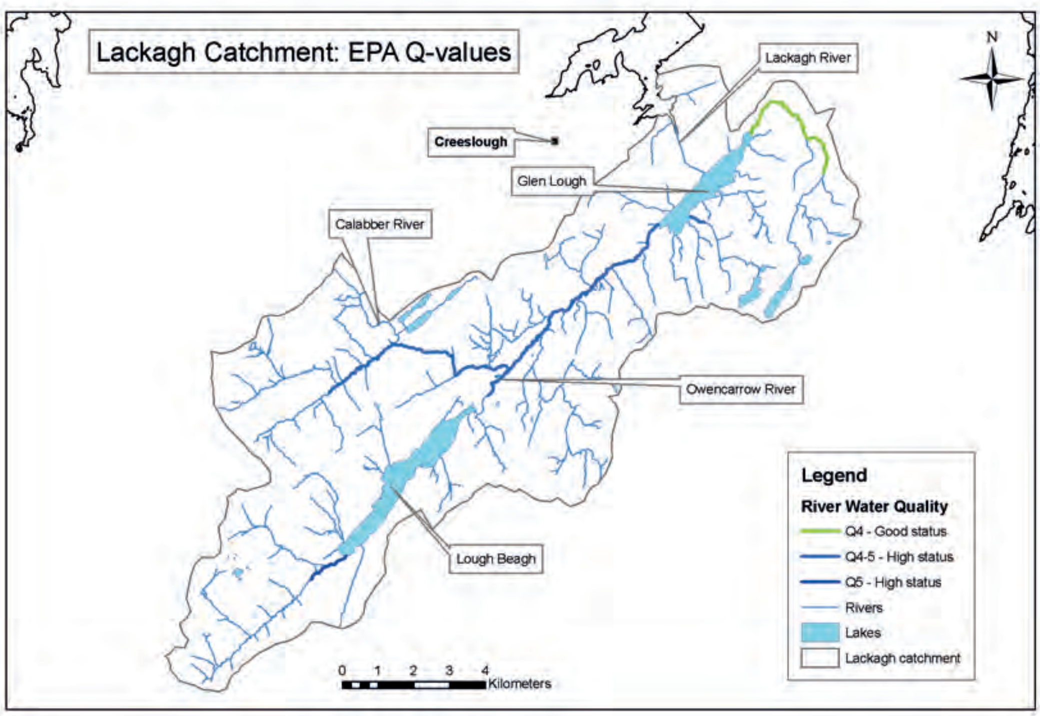


Fig. 5.2.11: Plot of EPA Q-values for the Lackagh catchment.

5.3. The Clady Catchment

5.3.1. Introduction

The Clady River is harnessed for the generation of electricity and the Clady and neighbouring Crolly systems have been under the management of the ESB since the 1950's and the fishery is managed by ESB Fisheries Conservation. The ESB generating scheme established in the 1950s involved harnessing the 60 m head between Lough Nacung and the sea by installing a fixed regulating weir near Gweedore. Water is diverted from the weir via a 3km canal to the generating station situated on the Crolly River which discharges into the Crolly estuary (Plate 5.3.1.). To compensate for the diversion of water to the Crolly estuary the ESB allow controlled releases of water down the Clady main channel on a daily basis, mainly throughout the summer months. The area around Lough Nacung, Fawnboy bog, has been designated as a Special Area of Conservation (SAC) under Annex I and II of the EU Habitats Directive. A healthy population of the Pearl Mussel (*Margaritifera margaritifera*) was observed within the main channel during the course of fieldwork.

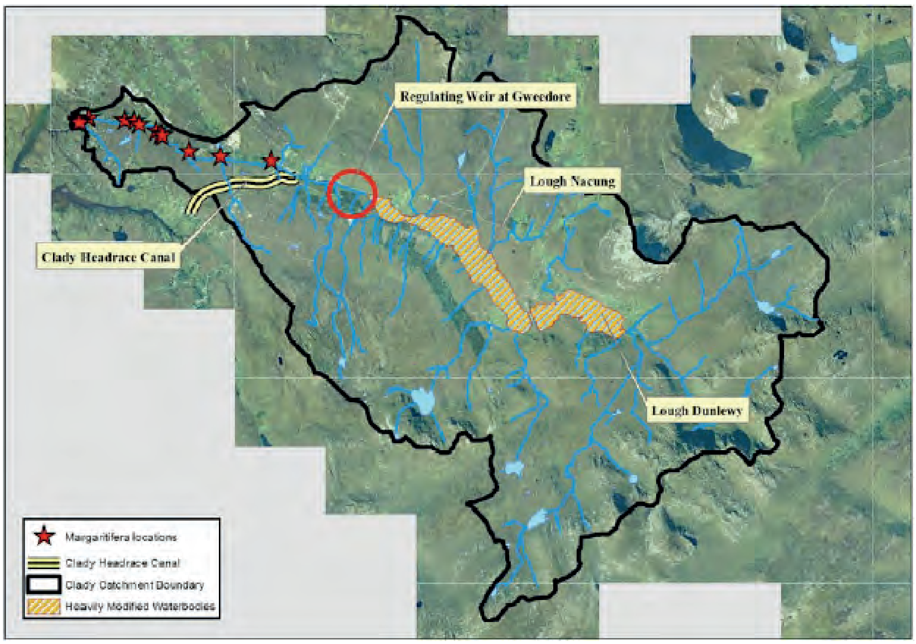


Plate 5.3.1. The Clady catchment showing the diversion canal to the Crolly (from Moorkens, 2010)

The Clady rises in the Derryveagh Mountains and flows in a westerly direction through Lough Nacung and Dunlewy Lake, before entering the Gweedore estuary at Bunbeg. The Clady drains an area of 87.8km^2. The geology of the catchment is dominated by quartzite and smaller amounts of schist, gneiss and other silica-rich rocks. The principle land use is peat bog with lesser amounts of coniferous forest, pasture and mixed forest also present.

The Clady, based on rod catch derived total return to river assessment, has achieved or often exceeded its salmon Conservation Limit (Fig. 5.3.1) in recent years. Rod catch statistics suggest that a rod catch of approximately 90 fish per annum (Fig. 5.3.2) will result in the Clady achieving its CL annually. Current scientific advice, which is very precautionary, is based on a model which uses a 5 year average.

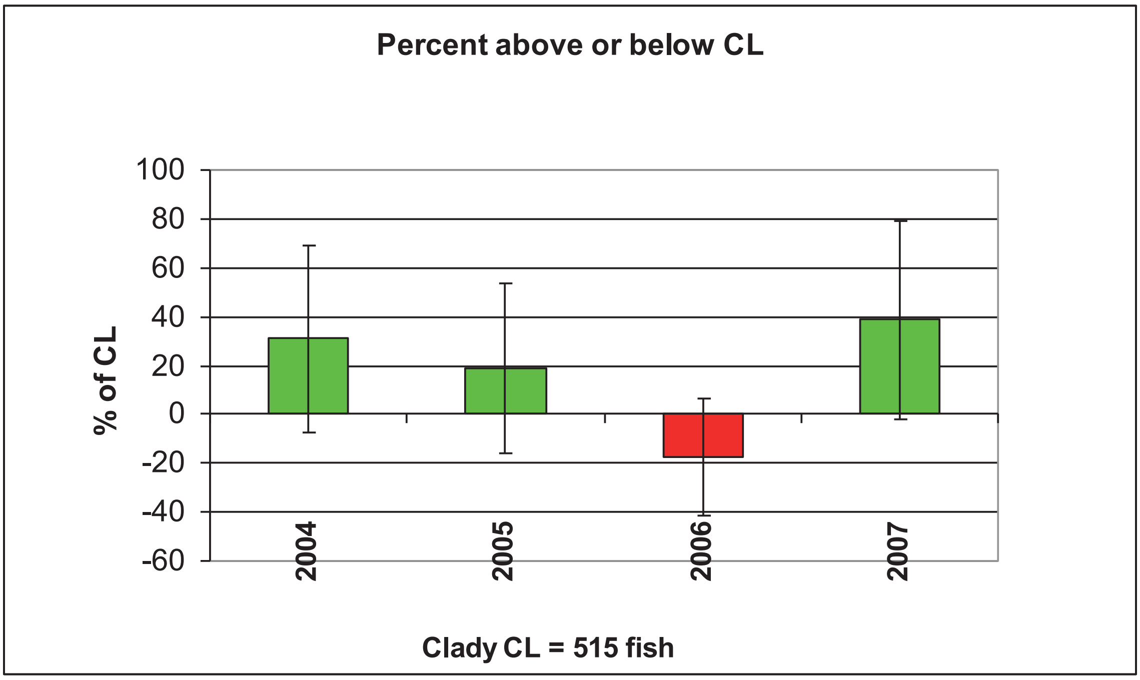


Fig. 5.3.1: Plot of salmon spawning escapement for Clady River, expressed as percentage above or below the Conservation Limit

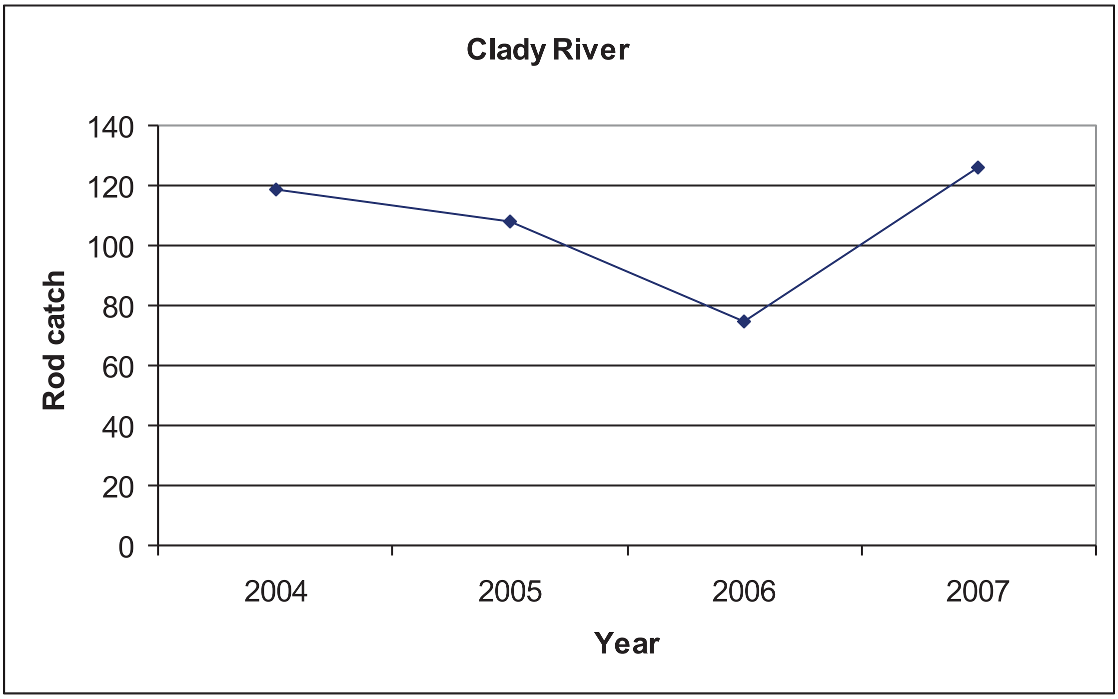


Fig. 5.3.2: Salmon harvest rod catch data for the Clady River.

The Clady River is ranked eighty-ninth with 0.16% of the national total fluvial habitat accessible to salmon (McGinnity *et al.* 2003; Table 40). The Clady and Crolly are separated by the Derryveagh Mountains and four impassable barriers have been identified on channels draining the southern side of the Clady catchment along this mountain range.

Spawning areas are very discrete in the Clady catchment primarily due to the presence of the major lakes on the system which define these areas. The Clady River lower, the Devlin River (upstream of Dunlewy Lake) and the tributary on the northern shore of Lough Nacung are the key spawning areas. Consistent redd counts have been observed in recent years with higher average counts compared to the 1990s (Fig. 5.3.3).

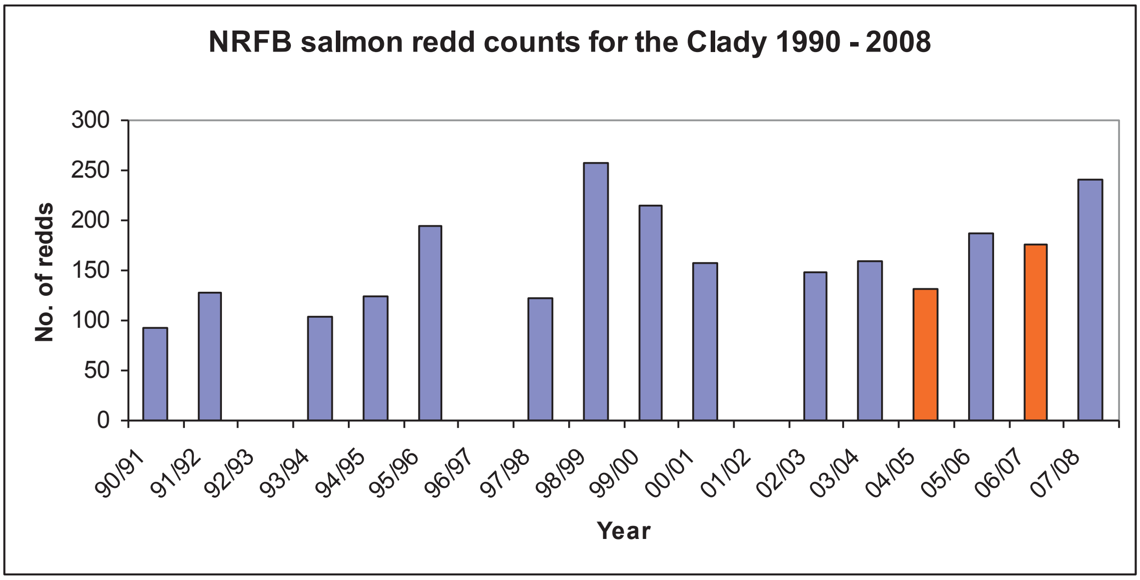


Fig. 5.3.3. Salmon redd count data for the Clady catchment 1990 to 2008. No data for 1992/93 or 1996/97. High water levels resulted in poor counting efficiency in years shaded in red.

5.3.2 Electrofishing survey results

Seven sites were electrofished throughout this catchment in summer 2007. One main channel site and six sites on five tributaries were assessed (Fig. 5.4.6 and Appendix 4: Table 3). Juvenile salmon were widely distributed throughout the catchment, being present in six sites electrofished (Figs. 5.4.6 & 5.4.7). In general, good densities of both fry and parr were recorded (Figs. 5.3.4 and 5.3.5) with the highest densities being recorded in the known spawning areas which include the Clady main channel and the lower Devlin River. High densities were also recorded in .the Glentoman River. Despite its apparent production potential no salmon were recorded in the Altmore stream – the substratum in this channel is largely peat and unsuitable for production. Juvenile salmon stocking is not carried out by ESB in the Clady catchment (Doherty *pers. comm.*).

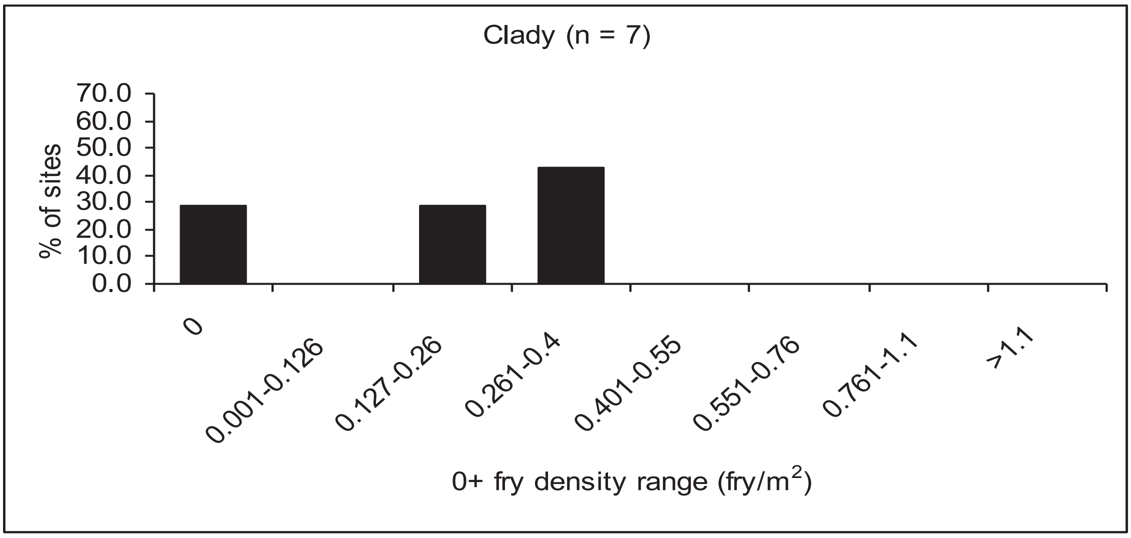


Fig. 5.3.4. Salmon fry density distribution for the Clady catchment 2007

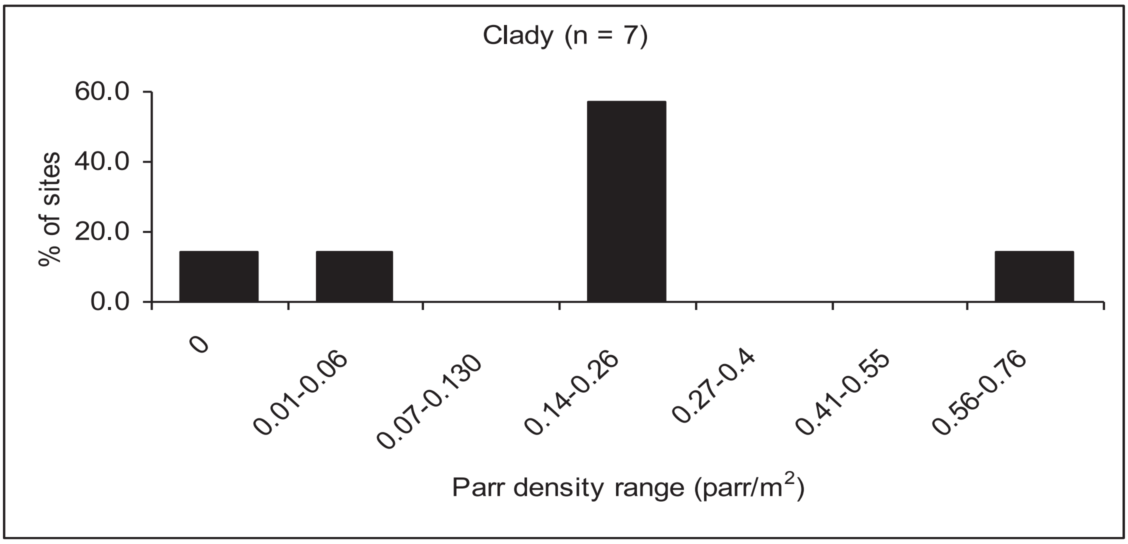


Fig. 5.3.5. Salmon parr density distribution for the Clady catchment 2007

Trout fry densities were low in the Clady catchment overall (Figs. 5.4.7 and 5.4.8 and Appendix 4: Table 3). Trout parr densities were low to moderate. The low trout fry densities recorded were atypical for this type of lake dominated catchment where high fry densities are often recorded in minor channels discharging into lakes.

The only other fish species recorded in the catchment was eels. Their distribution was limited and numbers were poor (Appendix 6: Table 3).

5.3.3. Comparison with 1989 electrofishing survey

The Clady catchment was surveyed in 1989 by Gargan and Whelan when sampling concentrated on the tributary streams (Appendix 7: Table 3 and Fig. 3). In 1990 low densities of salmon fry were recorded in the catchment with salmon fry limited to the Devlin River and two small tributaries on the northern shore of Lough Nacung. No comparable sites were sampled but, in general, salmon fry and parr distribution and densities in the same channels were substantially higher in 2007. There has been an increase in both salmon fry (0+) and parr (1+) densities compared to the 1990 survey. Similar densities were recorded for trout fry (0+) and parr (1+). In the 1990 survey trout parr and older parr (trout ≥1) are reported together.

5.3.4. Physical habitat assessment and recommendation for improvement

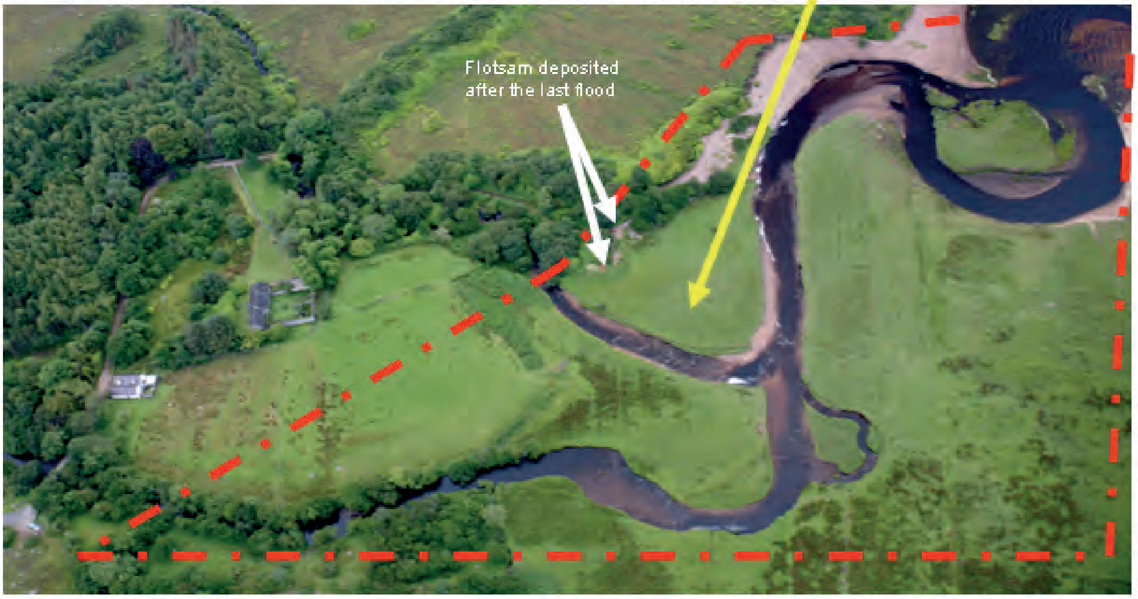
The Clady is relatively stable and few habitat problems were observed from aerial photography or in the course of surveying. Consistently good water quality, based on EPA Q-values (Fig. 5.4.11 and Appendix 2: Table 3), is a feature of this catchment. The sole focus of the rehabilitation programme for the Clady is the lower reaches of the Devlin River where it discharges into the regulated Dunlewey Lake. The channel reach, immediately upstream of Dunlewey Lake (Plate 5.3.1.), is a one of the three identified salmon spawning and nursery areas in the catchment and currently supports moderate to good juvenile salmon stocks (Figs. 5.4.6 and 5.4.7 and Appendix 4: Table 3).

Lake water levels greatly influence activity in this part of the catchment. The riparian area in the lower reaches of the inflow provides prime grazing area, due to regular inundation and deposition, which is heavily grazed by deer and domestic livestock. Prolonged high water levels diminish grazing opportunities and can limit spawning opportunities. Working with NRFB the ESB manages water levels to ensure moderate water levels during the spawning period so that spawning can occur in this particular reach. The lake is also a productive salmon rod fishery where anglers can be diverted to when water levels are low in the river fishery. For this reason maintenance of good juvenile production levels to ensure good adult returns to the lake is important to the rod fishery in the catchment as a whole.

Bank erosion due to overgrazing in this zone is excessive and will lead to the formation of a braided channel. It is not feasible to fence off this particular area – the periodic rise and fall in this regulated lake floods this area episodically thereby preventing construction of a long-term viable fence. Consideration should be given to compensating the landowner/s to permanently remove all livestock from this area (within the red dashed line area in Plate 5.3.1). Subsequently a riparian tree planting programme could be undertaken and general bankside vegetation recovery would occur naturally.

As this area does not constitute the primary spawning area in the catchment (Kelly pers. comm.) - the majority of spawning occurs in the river below the weir on Lough Nacung - the rehabilitation option should not be regarded as high priority. The Devlin has been subject to this meandering, changing regime since regulation began in the 1950s. However, water level fluctuation in the Devlin River should be monitored and a formal agreement should be agreed with ESB to guarantee appropriate water level /discharges ensure that fish passage at the dam and water levels during the spawning period are appropriate to sustain adequate spawning levels.

Plate 5.3.1. Clady system: Devlin River upstream of Dunlewey Lake



5.3.5. Conclusions

Good water and habitat quality are features of the Clady catchment. The system is consistently achieving its CL and has provided reliable salmon angling for anglers up to 2007. Juvenile salmon densities were substantially higher in 2007 than those recorded in 1989. Salmon parr densities were extremely high at most sites. The Clady, despite being regulated for hydropower generation, has a self-sustaining salmon population and is performing well. One habitat problem, in an important spawning and nursery channel, the lower reaches of the Devlin River, requires an innovative solution to stabilize an extensive gravel-laden, mobile river mouth. However, it should not be considered a priority measure as the system is performing satisfactorily in terms of salmon production.

5.4. The Crolly (Gweedore) Catchment

5.4.1. Introduction

The fishing rights for salmon and sea-trout in this system is under the management of the ESB. The Crolly catchment is primarily a grilse catchment. Apart from 2002 the Crolly has been under its CL each year since 2003 (Fig. 5.4.1) and was closed to angling in 2007 and 2008.

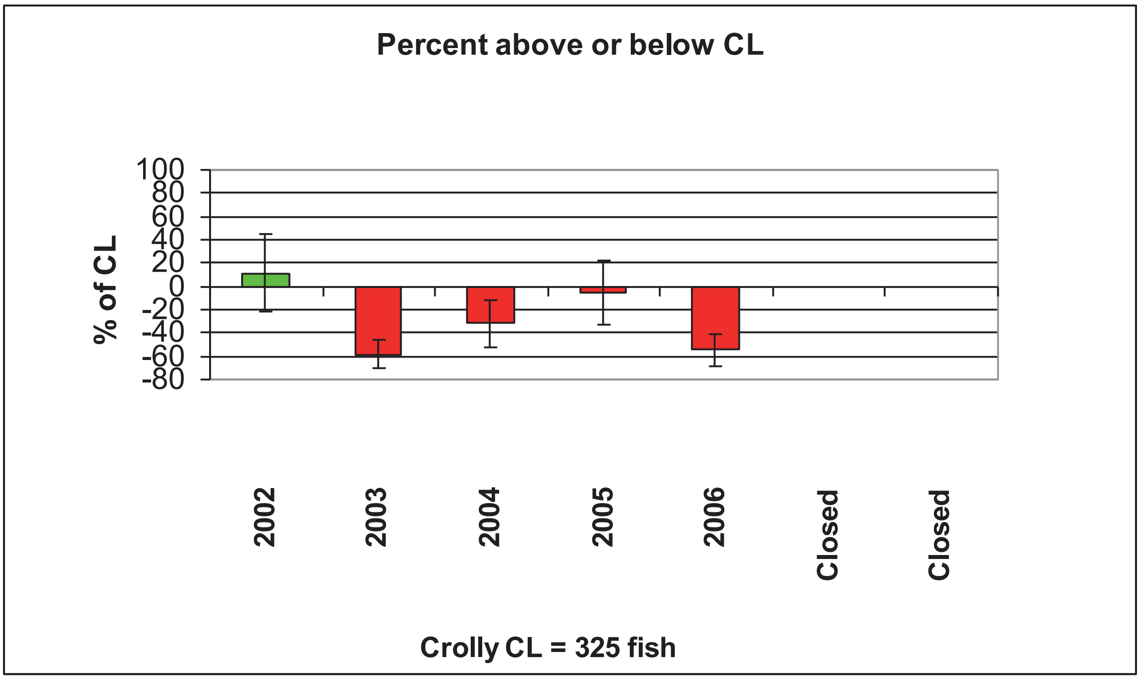


Fig. 5.4.1: Plot of salmon spawning escapement for Crolly River, expressed as percentage above or below the Conservation Limit

The Crolly catchment drains an area of 59.2km^2; it has one large lake - Lough Anure. The Crolly or Gweedore main channel flows in a northerly direction entering the sea at Gweedore Bay. The geology of the Crolly catchment is granite, felsite and other intrusive rocks rich in silica. The land use is mainly peat bog, moors, heath land and pasture. The Crolly (Gweedore River) was ranked 111th of 173 national salmon catchments and accounts for 0.1% of the total national fluvial habitat accessible to salmon (McGinnity *et al.* 2003).

Salmon redd count data on the Crolly are incomplete but show a substantial improvement in the past two spawning seasons following a steady decline in the early part of this decade (Fig. 5.4.3).

No salmon stocking is carried out by ESB in the Crolly catchment (D. Doherty, pers. comm.)

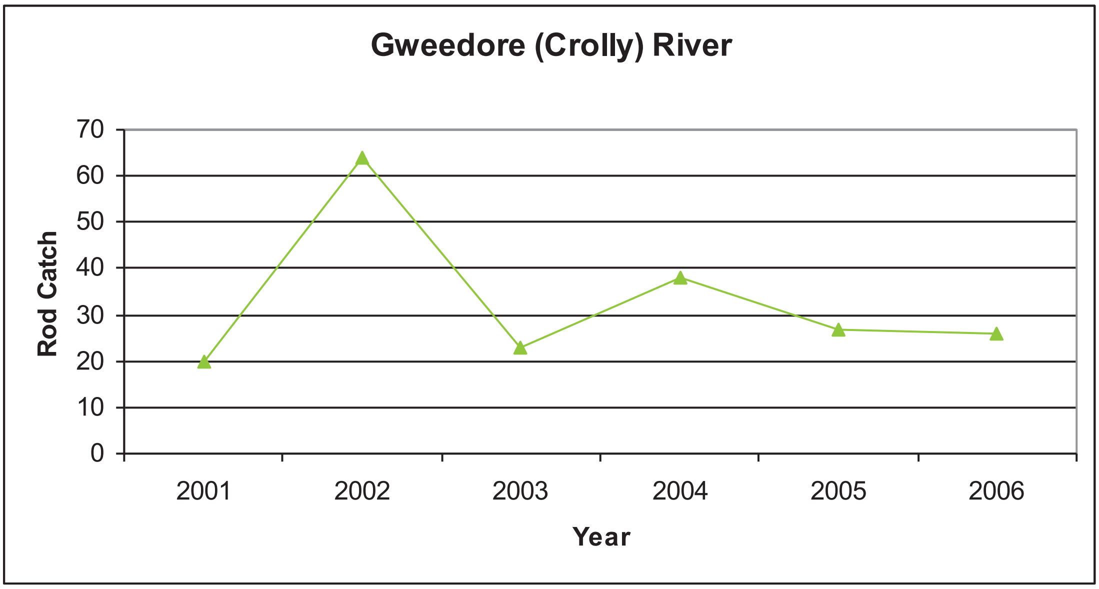


Fig. 5.4.2: Salmon harvest rod catch data for the Crolly/Gweedore River.

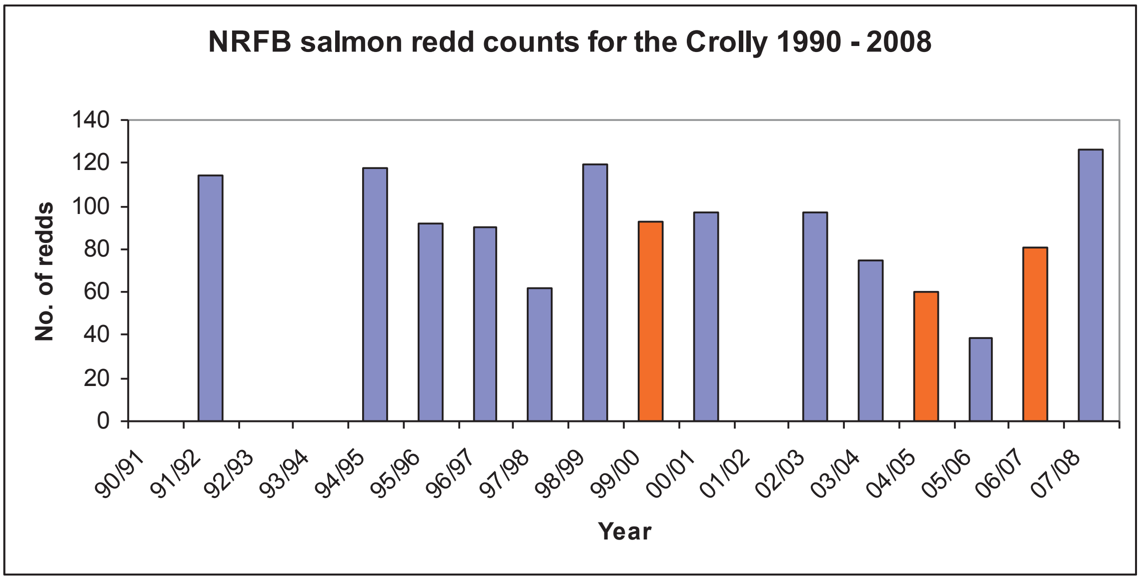


Fig. 5.4.3. Salmon redd count data for the Crolly catchment 1990 to 2008. No data for 1990/91, 1992 to 1993 and 2001/2002. High water levels resulted in poor counting efficiency in years with red shading.

5.4.2. Electrofishing survey results

Six sites in the Crolly system were surveyed during the summer of 2007 (Fig. 5.4.6). The survey was limited as road access to much of the catchment is poor.

Fish species were recorded including juvenile salmon, trout, sea trout, eels and minnow. Juvenile salmon were recorded at all sites except Site Cr 1 (L. Keel outflow) (Appendix 4: Table 4).

Good densities of salmon fry were recorded at two of the three sites sampled on the Owenator, the main spawning tributary, but densities were poor in the other site located in the upper reaches and the remainder of the catchment (Figs. 5.4.6). Salmon parr densities were also high in the Owenator highlighting its spawning and nursery significance in the catchment as a whole (Fig. 5.4.7).

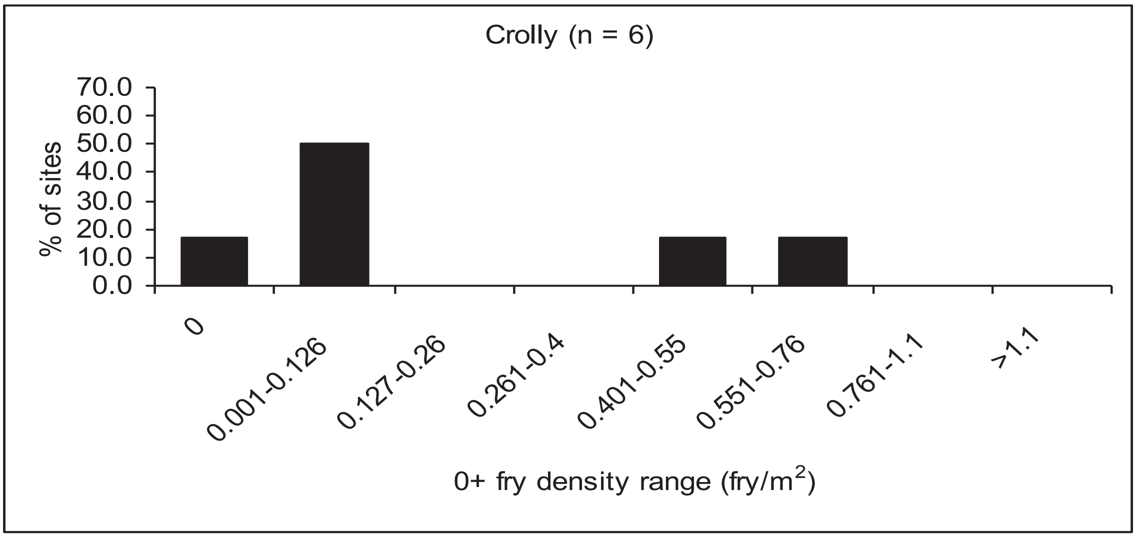


Fig. 5.4.4. Salmon fry density distribution for the Crolly catchment 2007

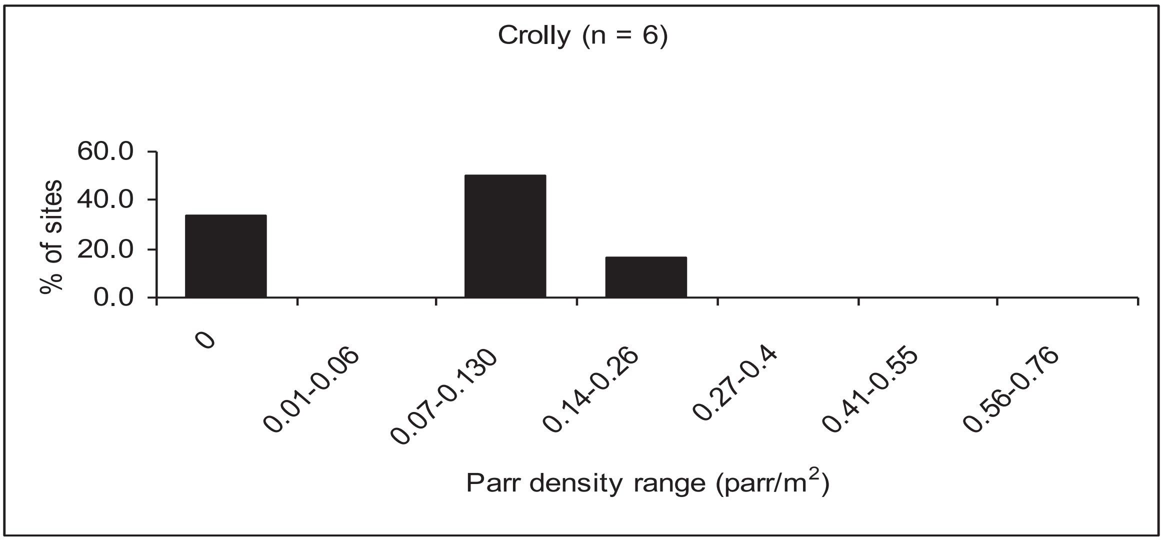


Fig. 5.4.5. Salmon parr density distribution for the Crolly catchment 2007

The salmon fry and parr density distributions (Figs. 5.4.4 and 5.4.5) emphasise the importance of the Owenator River which account for virtually all of the higher values in the distributions.

Although present at all sites, trout densities were generally low in the Crolly catchment (Figs. 5.4.8 and 5.4.9). A small number of older trout (>1+) (Fig. 5.4.10) and small numbers of sea trout were also encountered.

Eels were recorded at three sites and numbers were low. A high abundance of minnow was observed in the lower reaches of the Owenator River and in another tributary to Lough Anure (Appendix 6: Table 4).

5.4.3. Physical habitat assessment and recommendations for improvements

No obvious physical habitat problems were observed in the Crolly catchment over the course of this survey. EPA Q value data for the Crolly catchment show a good rating of 4-5 (Fig. 5.4.11 & Appendix 2: Table 4) for the majority of the catchment. However, the Keel Lough outflow has some serious water quality problems with low values recorded consistently since the late 1990s. Dead trout were observed a short distance downstream of the water treatment plant in the course of the electrofishing survey in this catchment and few live fish were recorded (Plate 5.4.1.). It is likely that discharges from the water treatment plant are causing periodic and significant pollution problems which require attention.

Plate 5.4.1. Middle reaches of Keel Lough outflow

5.4.4. Conclusions

Comparisons with rod catches from the other rivers assessed during this study show that the Crolly has the lowest rod catch which is a linked its small catchment size. However, it has consistently failed to meet its CL in recent years. One tributary, the Owenator dominates salmon production in the catchment and no obvious habitat problems were identified. Water quality may be an issue in one tributary but it is unlikely to be impacting significantly on the catchment. One possible influencing factor is the regular discharges to the estuary of Clady River water which may deter or confound salmon produced in the Crolly from re-entering the system. Stocking carried out by the ESB in previous decades may also have contributed to the decline of the native stock which may have become diluted by introgression with hatchery reared fish. Detailed genetic stock identification studies would assist in defining the problem.

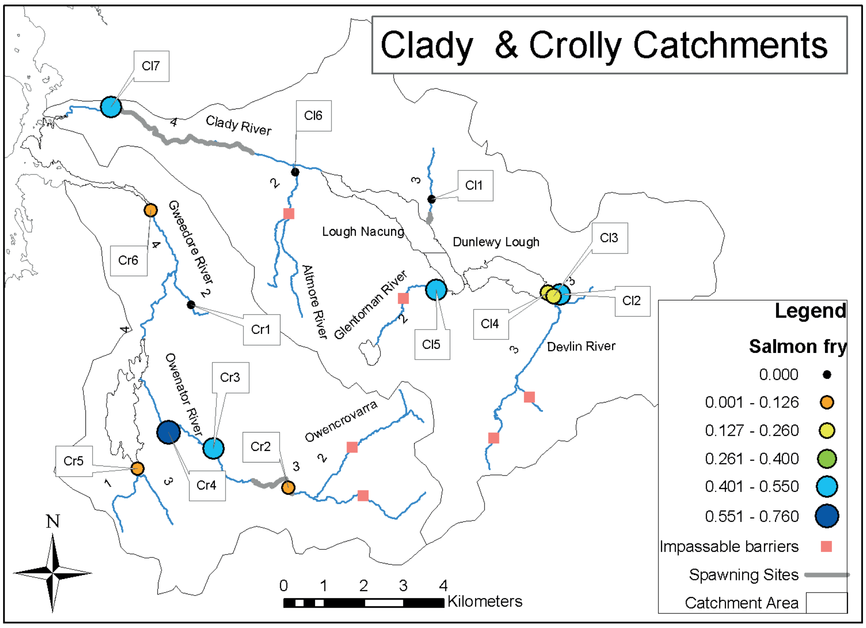


Fig. 5.4.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Clady & Crolly catchments. Numbers on map represent stream order and grey line represents spawning areas.

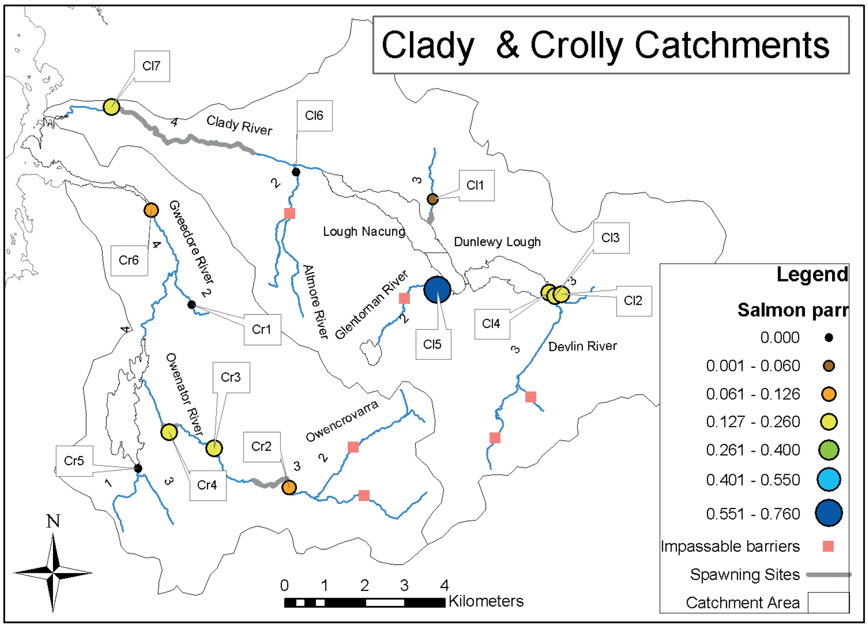


Fig. 5.4.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Clady and Crolly catchments. Numbers on map represent stream order and grey line represents spawning areas.

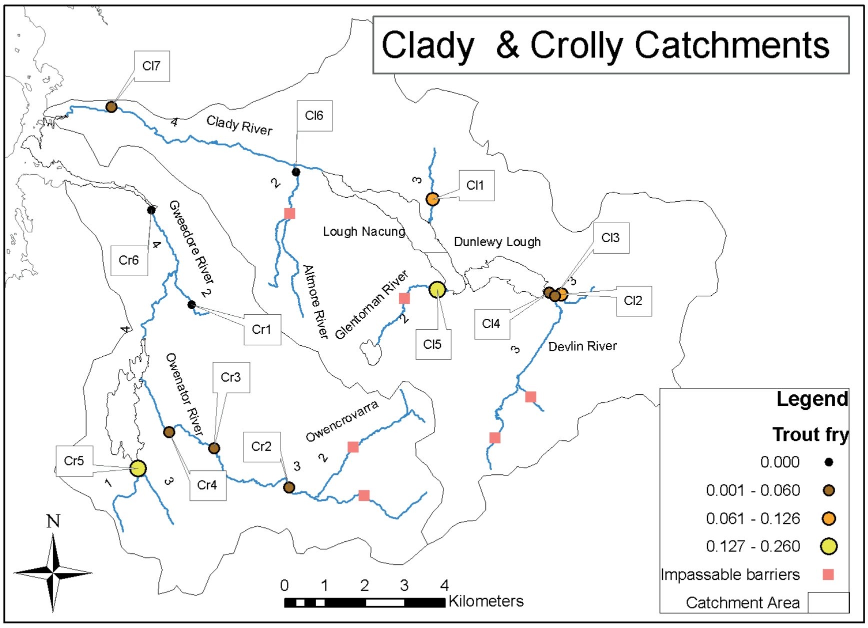


Fig. 5.4.8: Trout fry distribution and quantitative density estimates (no./m2) in the Clady & Crolly catchments. Numbers on map represent stream order and grey line represents spawning areas.

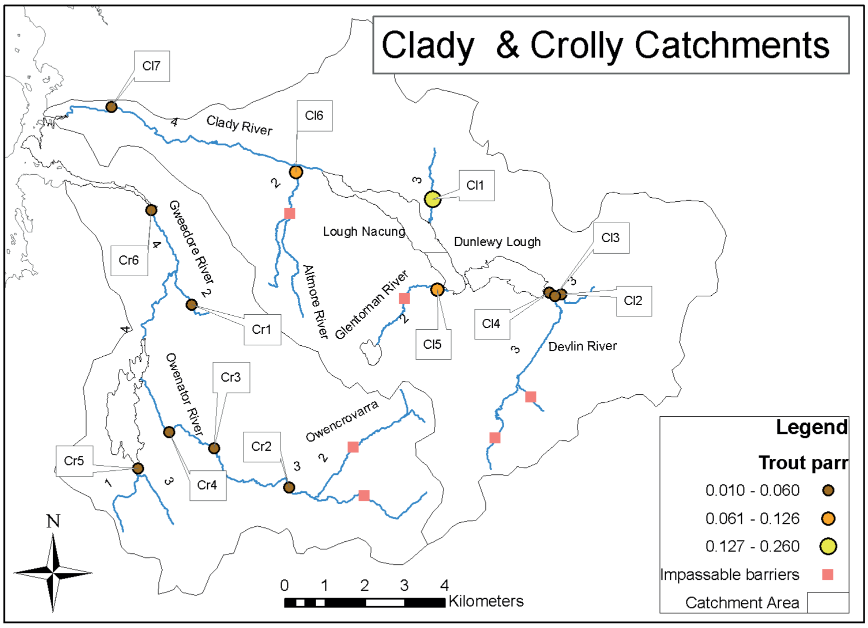


Fig. 5.4.9: Trout parr distribution and quantitative density estimates (no./m2) in the Clady & Crolly catchments. Numbers on map represent stream order and grey line represents spawning areas.

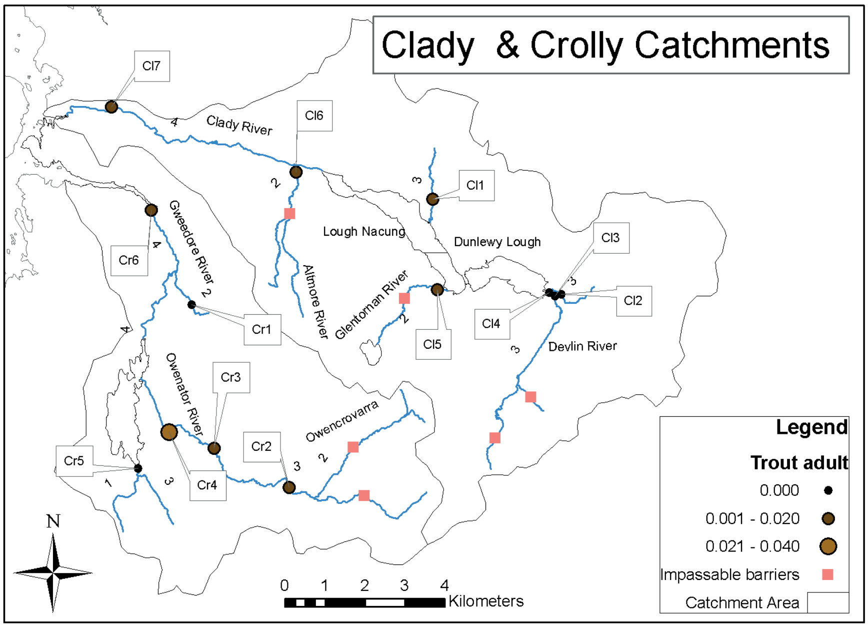


Fig. 5.4.10: Trout adult distribution and quantitative density estimates (no./m2) in the Clady & Crolly catchments. Numbers on map represent stream order and grey line represents spawning areas.

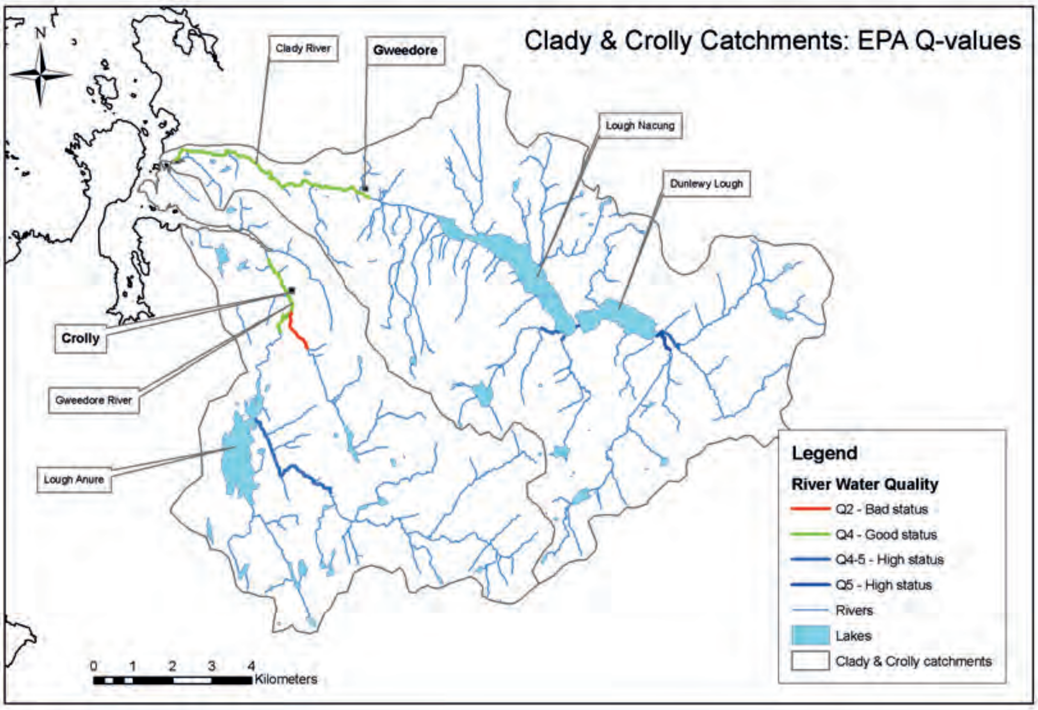


Fig. 5.4.11: EPA Q-values for the Clady and Crolly catchments.

5.5. The Gweebarra catchment

5.5.1. Introduction

Regarded by anglers as one of the best salmon rivers in Donegal, the Gweebarra River flows through a remote valley and has poor angler access. It rises in the Glendowan Mountains and flows in a southwesterly direction into Gweebarra Bay. Draining a catchment area of 148.4km^2 the system has one large lake, Lough Barra, which can offer some reasonable angling periodically. The Gweebarra River is ranked sixty eight in terms of accessible fluvial salmon habitat comprising 0.22% of the national total (McGinnity *et al.* 2003). Granite dominates the geology and the principle land cover is peat bog. Much of the catchment has been designated an SAC and NHA under Annex I and II of the Habitats Directive.

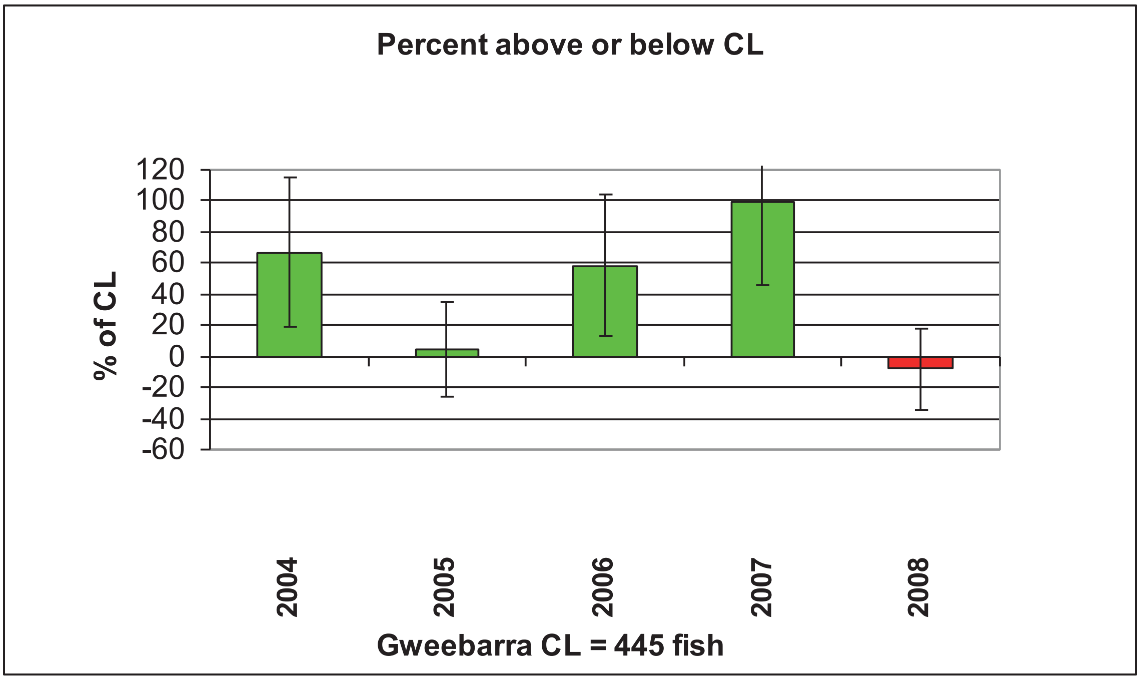


Fig. 5.5.1: Plot of salmon spawning escapement for the Gweebarra River, expressed as percentage above or below the Conservation Limit

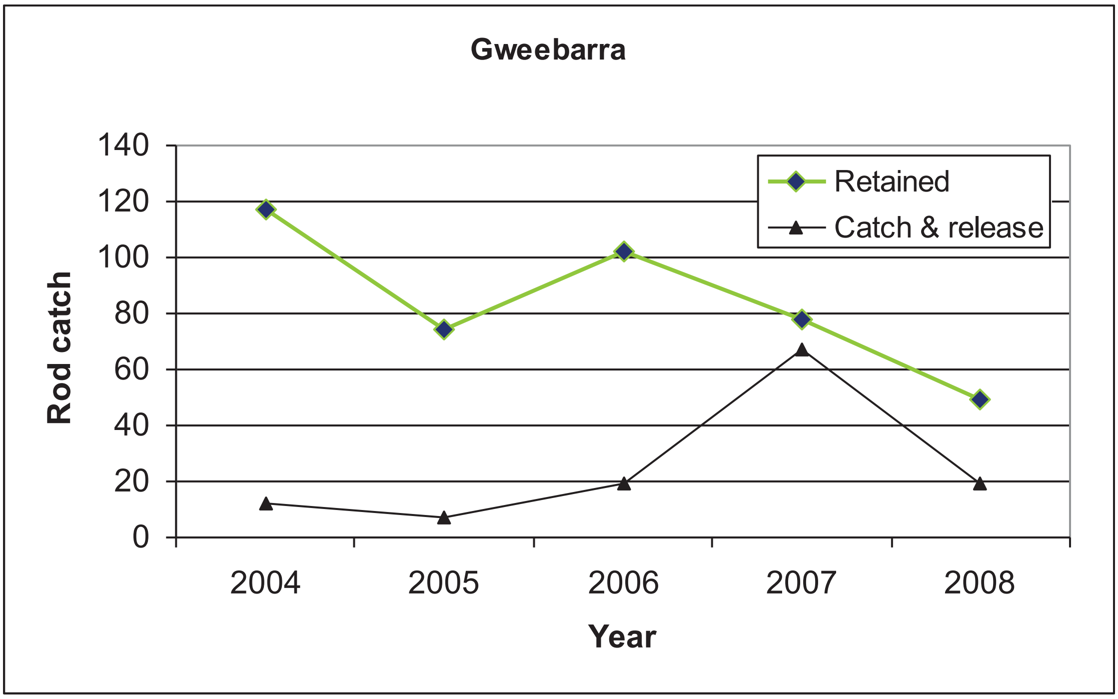


Fig. 5.5.2.: Salmon rod catch data for the Gweebarra River

Since the early part of the decade the Gweebarra has generally achieved its Conservation Limit (Fig. 5.5.1) with good surpluses in 2004, 2006 and 2007 reflecting good rod catches in those years (Fig. 5.5.2). Reduced effort in 2008 due to a local dispute is likely to have impacted on overall catch rates and may not accurately reflect actual escapement.

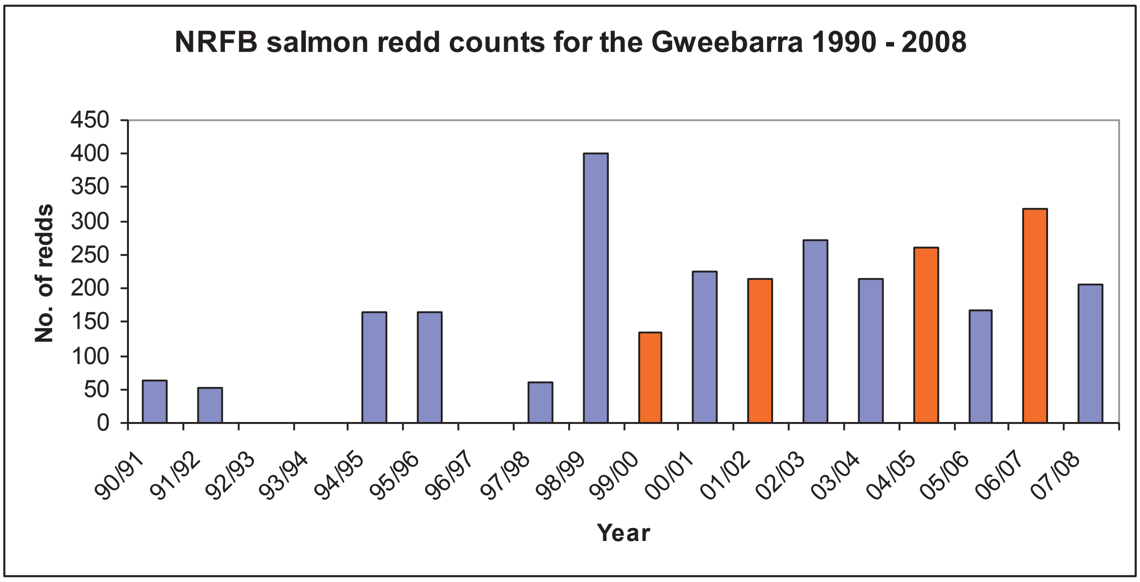


Fig. 5.5.3. Redd count data for the Gweebarra. **Red shading = poor counting efficiency**

One of the highest ever redd counts in the Letterkenny District was recorded in 1998/99 spawning season in the Gweebarra (Fig. 5.5.3). Counts in subsequent years have never exceeded this total but a count of 200 redds is achieved regularly even under poor counting conditions.

5.5.2. Electrofishing survey results

Sixteen sites were surveyed in the Gweebarra catchment in summer 2006 (Fig. 5.5.6). Low conductivity (< 50 μ S/cm) values, particularly in larger sampling sites like the main channel, may have resulted in underestimation of juvenile densities due to inefficient electrofishing.

Juvenile salmon were widespread in the Gweebarra catchment and were recorded in all but four sites (Gw4, Gw5, Gw7 & GW10) (Figs. 5.5.6 and 5.5.7). Gw5 and Gw7 were located upstream of impassible barriers and sites Gw4 and GW 10 are in headwaters at the extremity of the catchment. Interestingly, juvenile salmon (fry and parr) were recorded upstream of a barrier deemed impassable on the Owenree, which indicates that the barrier is consistently passable. Salmon fry density estimates ranged between 1.08 and 0.02 fish/m^2 with the majority of sites having moderate densities (Fig. 5.5.4 and Appendix 4: Table 5). The Glenleheen stream was the exception and high salmon densities were a feature of this subcatchment. The data showed that the Glenleheen, the lower reaches of the Owenree and the River Barra lower (Lough Barra inflow) were the important production units in the catchment. However, despite recording lower densities, the main channel is a very important production unit because of its total productive area. The high salmon parr densities (> 0.1 m2) recorded at the majority of sites sampled (Fig. 5.5.5) emphasise the capacity of the Gweebarra system to produce salmon.

The modal length value for salmon fry was 4cm and salmon parr were 7cm (Section 6.7). Parr in this catchment were small by typical Irish standards and reflect the low alkalinity, as proxied by conductivity, in the catchment.

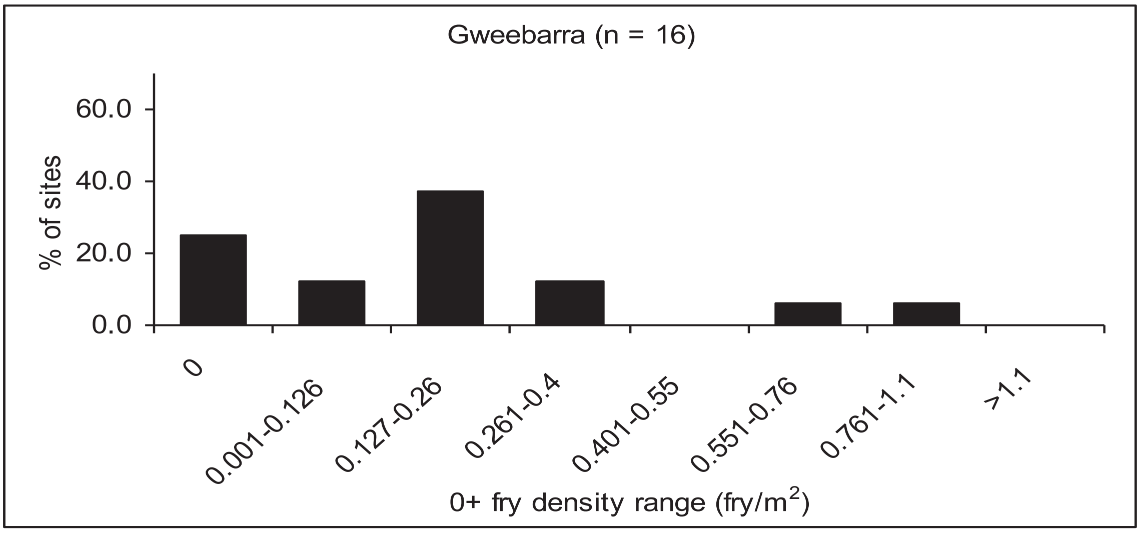


Fig.5.5.4. Salmon fry density distribution for the Gweebarra catchment 2006

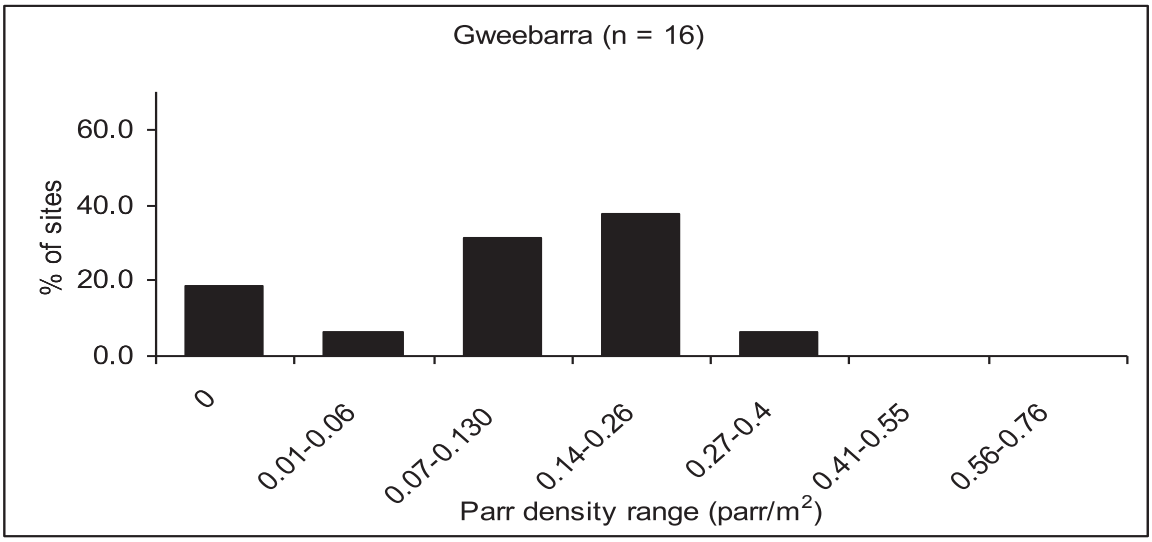


Fig. 5.5.5. Salmon parr density distribution for the Gweebarra catchment 2006

Trout were well distributed throughout the catchment. However, densities were generally poor at all life stages (Figs 5.5.8, 5.5.9 and 5.5.10) and the Gweebarra was dominated by juvenile salmon. Eels were reasonably well distributed being present at 13 of the 16 Gweebarra survey sites (Appendix 6: Table 5).

5.5.3. Physical habitat assessment and recommendations for improvements

Several potential habitat issues were identified from aerial photography, electrofishing and subsequent on-the-ground assessment. Three EPA Q-value water quality classifications, from high to moderate, are reported for the catchment (Fig. 5.5.11). High status was observed for the Owenwee and the main channel upstream of Lough Barra. The Glenleheen has good status and is impaired physically. One section of the main channel upstream of the confluence with the Glenleheen has moderate status. The deviation from high status was unexpected given the remoteness of this catchment but some physical works should assist in restoring it to high status throughout thus assisting salmon production. Two channels require some physical intervention – the River Barra and the Glenleheen.

RIVER BARRA

This is one of the prime salmon spawning units in this catchment. Artificially high levels of erosion are evident in the reach of the River Barra immediately upstream of Lough Barra because of overgrazing and bank trampling by livestock. The large deposit of sand in Lough Barra at the outfall of this river illustrates the high level of erosion (Plate 5.5.1). A large scale bank revetment project is recommended, using logs, coniferous tree tops and root wads in the bank, from the lake upstream towards the first road bridge and also in the lower reaches of the tributary which discharges to the right bank of this reach (Plate 5.5.2 and Fig. 5.5.6.). The upper part of this reach has a significantly higher gradient and is equally disturbed in morphological terms. The use of stone rip rap as a bank revetment option is more appropriate to ensure bank stability in a more extreme situation. A series of vortex weirs, circa 5 channel widths in distance apart, require to be constructed at this point primarily to dissipate the energy of flow in this steep channel. Although salmon parr densities were high, salmon fry densities were moderate. Greater instream stability would assist in maximising salmon output from this channel.

Plate 5.5.1. Upper Barra River discharging to Lough Barra

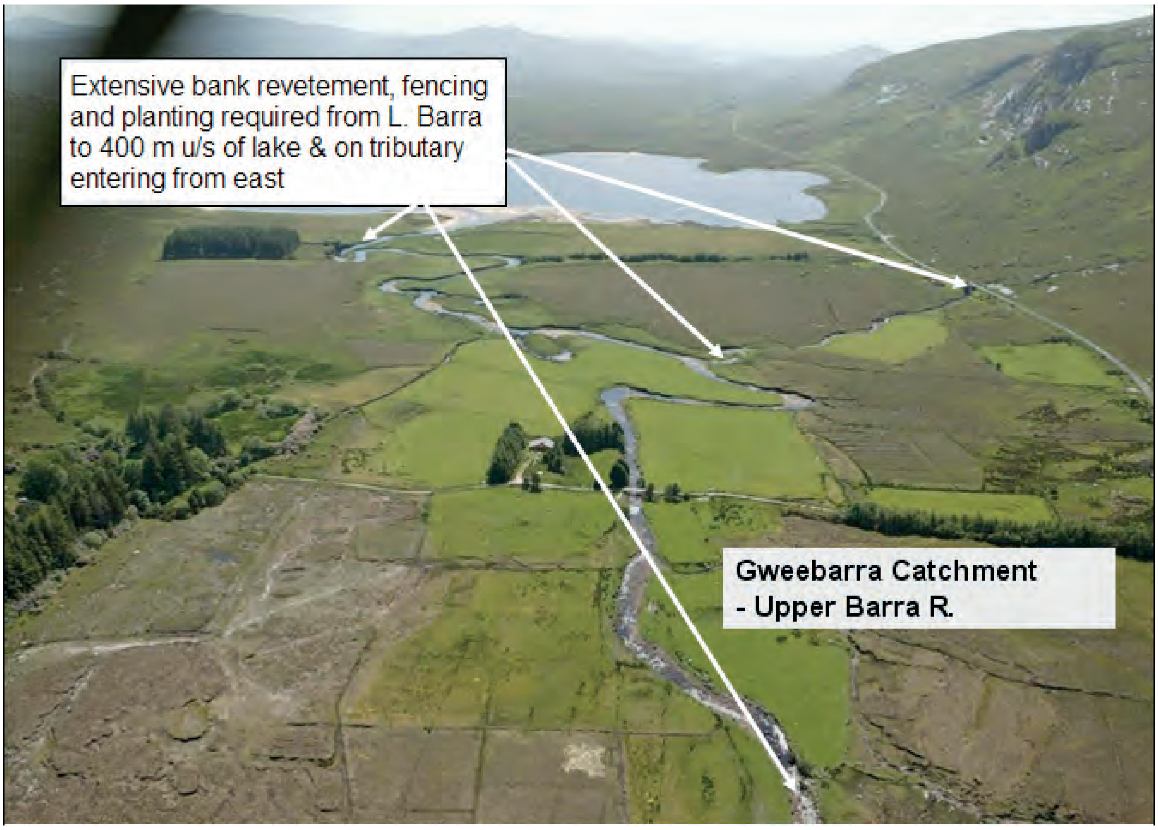


PLATE 5.5.2. Upper Barra River rehabilitation works

Compaction of gravels has also been identified as an issue and a gravel tossing programme is merited. This can be achieved easily by a trained operator using a hydraulic machine in late summer after salmonid fry have become sufficiently large to evade instream works activity. Although fencing and bank revetment is required to stabilise the highly erosive areas gravel recruitment from the ongoing natural erosion should be allowed to continue given that the channel remains very productive for spawning as evidenced by good redd counts (Kelly pers. comm) and generally high juvenile densities.

GLENLEHEEN RIVER

This channel was the most productive salmon fry unit in the Gweebarra catchment. Salmon parr production was also high. The lower reaches drain productive reclaimed agricultural land and the riparian zone is badly affected by bank erosion (Plate 5.5.3). Production could be improved through a works programme in the Glenleheen downstream of Glenleheen Bridge. The channel has been drained, the riparian zone has been completely denuded of vegetation and the effects of bank trampling by sheep was observed. A programme of works would include:

- Fencing out stock
- Planting with deciduous trees
- An instream works programme involving the construction of lateral scour pools on bends and vortex stone weirs at gradient breakpoints on straight reaches

Plate 5.5.2. This important salmon spawning and nursery channel requires a log/ coniferous tree revetment programme plus fencing and planting to alleviate bank erosion problems

5.5.4. Conclusions

Rod catches and generally high CL attainment levels characterize this system. Although water quality is not pristine, which could reasonably be expected in a remote catchment like the Gweebarra, juvenile salmon densities were very satisfactory, particularly in the known salmon spawning areas. Salmon parr densities were consistently high where juvenile salmon were recorded.

Sections of the two prime spawning channels, the L. Barra inflow and the Glenleheen River, are compromised in terms of habitat degradation and require substantive remedial works to maximize all potential production in freshwater.

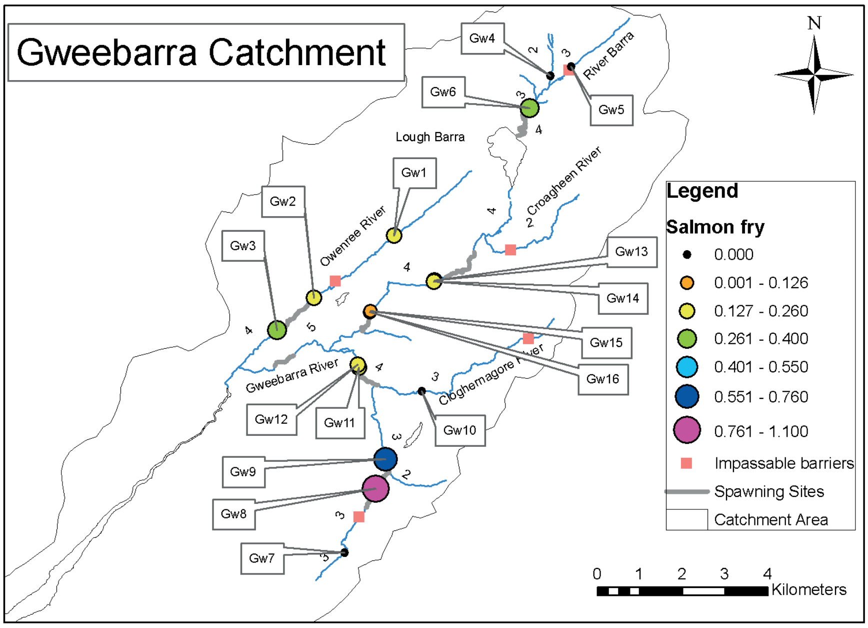


Fig. 5.5.6.: Salmon fry distribution and quantitative density estimates (no./m2) in the Gweebarra catchment. Numbers on map represent stream order and grey line represents spawning areas.

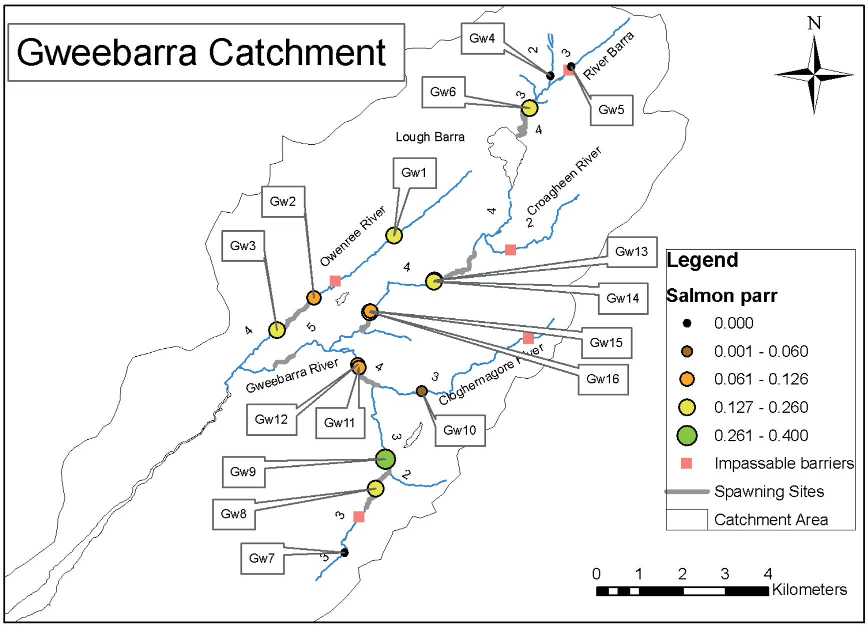


Fig. 5.5.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Gweebarra catchment. Numbers on map represent stream order and grey line represents spawning areas.

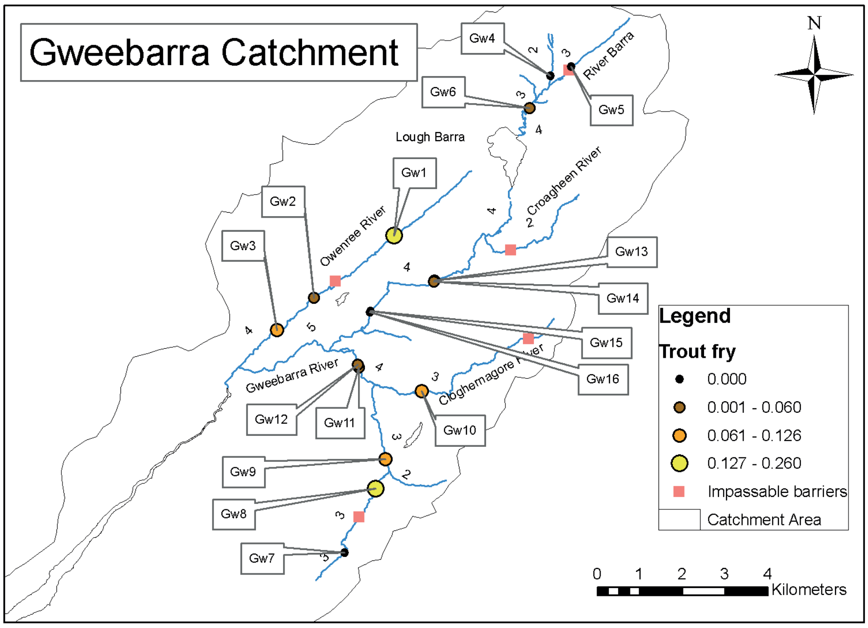


Fig. 5.5.8: Trout fry distribution and quantitative density estimates (no./m2) in the Gweebarra catchment. Numbers on map represent stream order and grey line represents spawning areas.

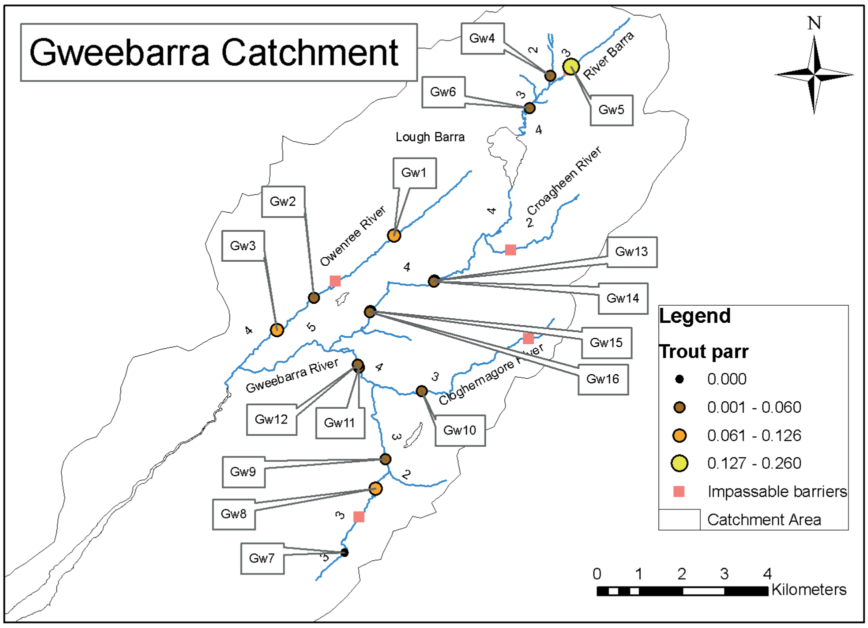


Fig. 5.5.9: Trout parr distribution and quantitative density estimates (no./m2) in the Gweebarra catchment. Numbers on map represent stream order and grey line represents spawning areas.

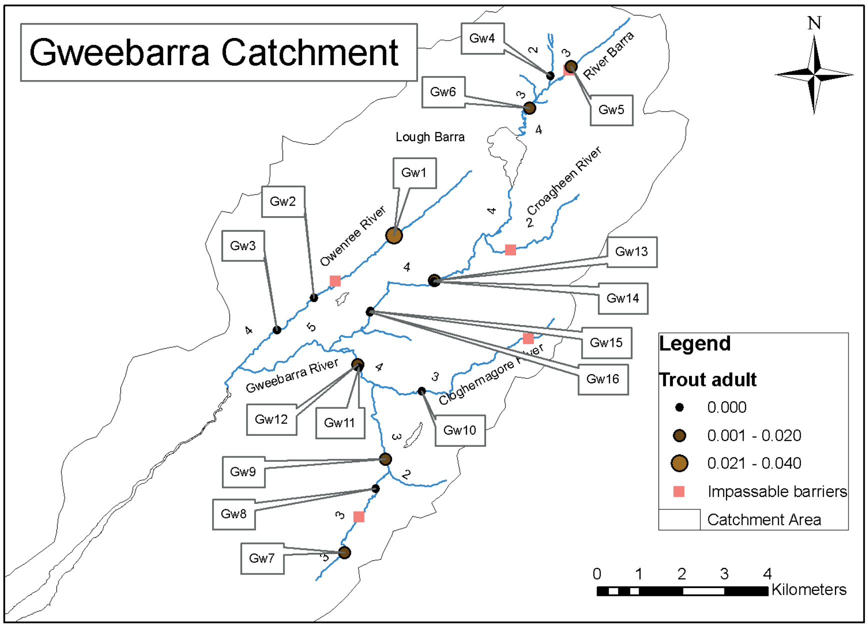


Fig. 5.5.10: Trout adult distribution and quantitative density estimates (no./m2) in the Gweebarra catchment. Numbers on map represent stream order and grey line represents spawning areas.

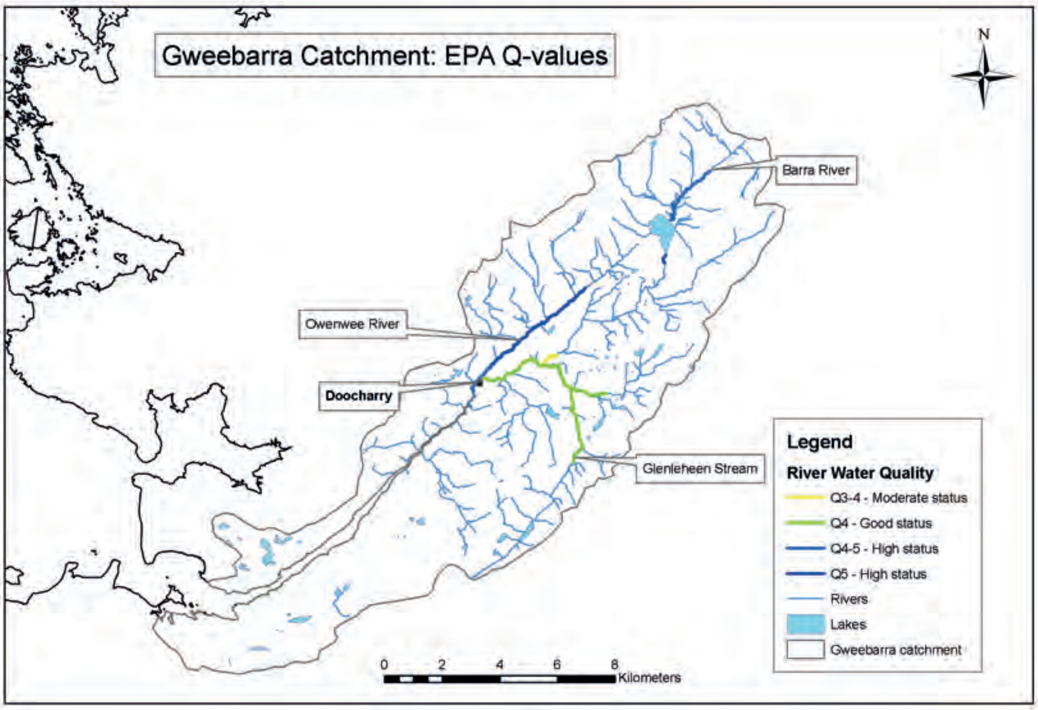


Fig. 5.5.11: Plot of EPA Q-values for the Gweebarra catchment

5.6. The Owenea Catchment

5.6.1. Introduction

The Owenea is an extremely productive fishery which regularly produces 300 salmon to the rod (Fig. 5.6.2). Access and infrastructure are excellent and the NRFB have operated a fishery management regime for many years.

The upper catchment is dotted with small lakes, the main one being Lough Ea. It has two major tributaries, the Shallogen and Stracashel Rivers. The main river flows in a southwesterly direction entering the sea north of Ardara at Loughros Bay. It has a catchment area of 126.4km^2 and the principle geology is schist, gneiss and quartzite. The dominant land cover is peat bog, pasture with some pasture following the river valley.

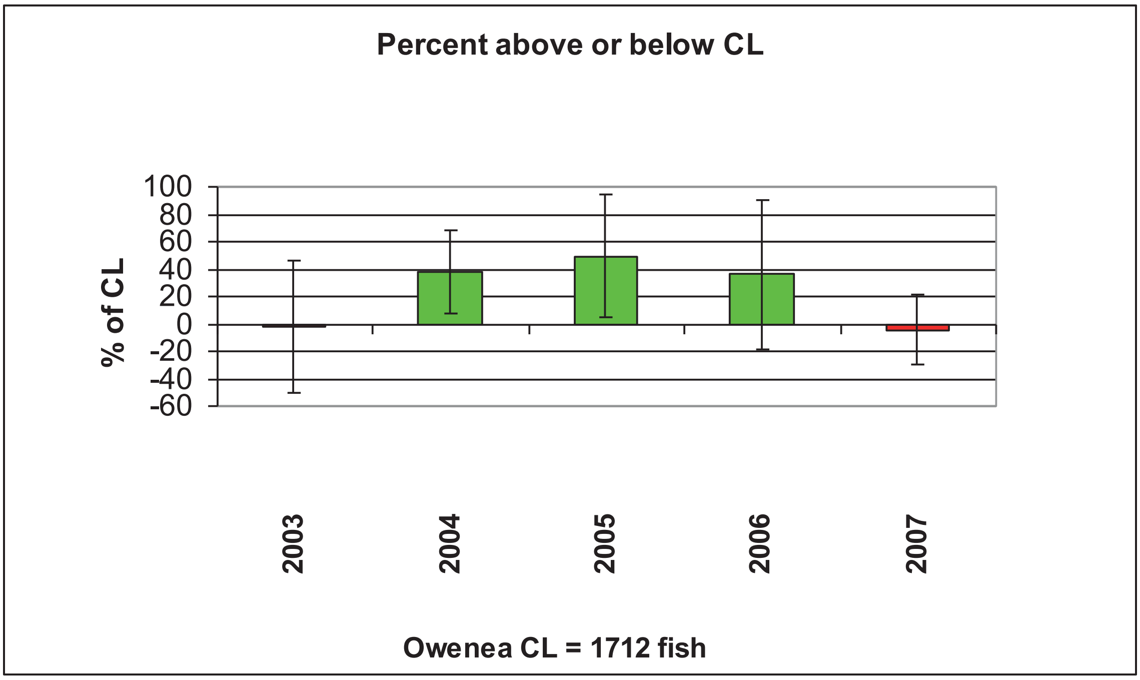


Fig. 5.6.1: Plot of salmon spawning escapement for the Owenea River, expressed as percentage above or below the Conservation Limit

The Owenea River is ranked at 33 of 173 catchments, accounting for 0.55% of the national fluvial habitat accessible to salmon, and is the third highest ranked catchment in terms of accessible habitat in the Ballyshannon and Letterkenny Fisheries Districts. Although the salmon rod catch has declined in recent years (Fig. 54) (which may, in part, be due to catch restrictions) the

Owenea catchment has comfortably achieved its Conservation Limit since the river-specific salmon management system was imposed in 2007 (Fig. 5.6.2).

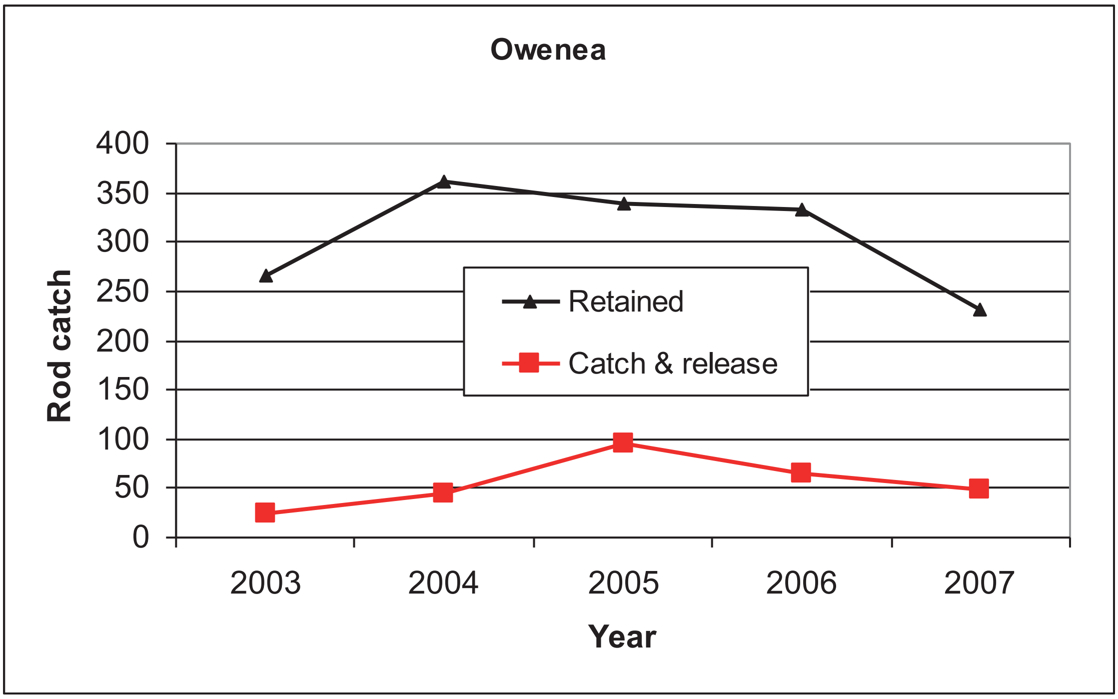


Fig. 5.6.2: Rod catch data for the Owenea River.

The Owenea has the greatest extent of salmon spawning of the eleven systems surveyed with extensive lengths of suitable channel throughout the lower and middle catchment. Between 1990 and 2008 the total redd count for the Owenea accounted for 25% on average of the Letterkenny District total (range 10 – 40%). Counts peaked in the mid to late 1990s and in recent years counts have only been about 50% of those recorded in the peak years suggesting a substantial decline in salmon escapement. However, the high densities of juvenile salmon throughout much of the catchment indicate very satisfactory levels of salmon production in the system which does not support the redd count trend.

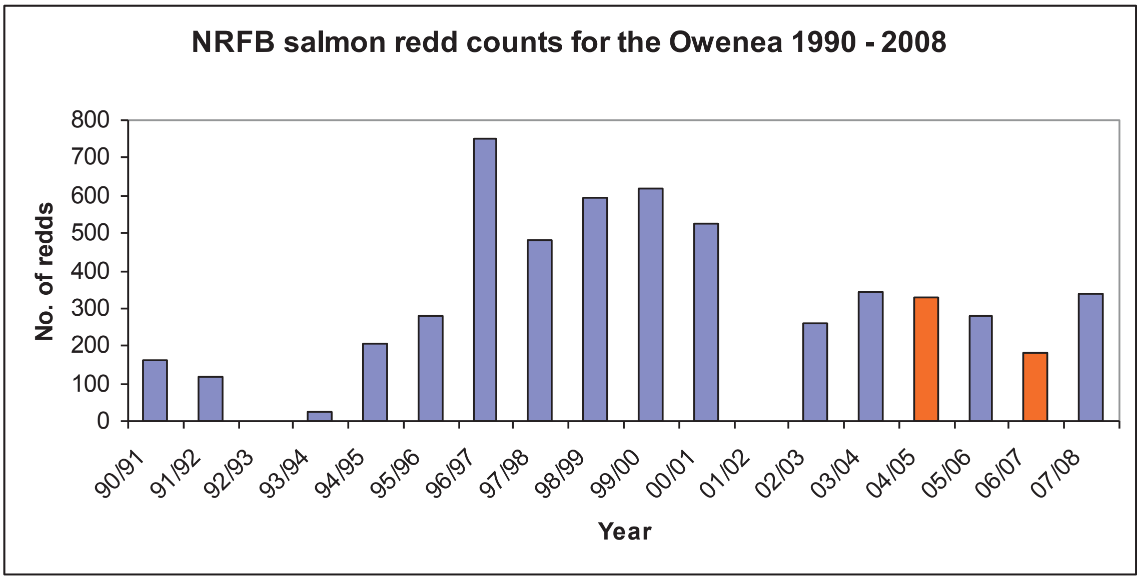


Fig. 5.6.3. Salmon redd count data for the Clady catchment 1990 to 2008. No data for 1992/93 or 1996/97. High water levels resulted in poor counting efficiency in years are shaded in red.

5.6.2. Electrofishing results

Fourteen sites were surveyed in the Owenea catchment in summer 2006 (Fig. 5.6.6). Juvenile salmon were recorded at 12 sites; one absence (Ow 13) was due to an impassable natural barrier (Owengarve river) while the remaining site, Ow2, was in an apparently accessible site in the middle reaches of the Stracashel River (Appendix 4: Table 6). Apart from the sites where zero densities were recorded, salmon fry and parr densities were exceptionally high at virtually all sites in the catchment and amongst the highest recorded over the period of the entire survey (Figs. 5.6.6 & 5.6.7).

There is an abundance of quality salmon spawning areas in the Owenea catchment. The extensive Stracashel/Shallogen complex and the upper and middle reaches of the Owenea are extremely productive for salmon fry. Nursery habitat quality in these channels is also excellent. The quality of the habitat and good adult spawning escapement is reflected in the salmon density distributions in Figs. 5.6.4 and 5.6.5 which are tending to the highest values in both.

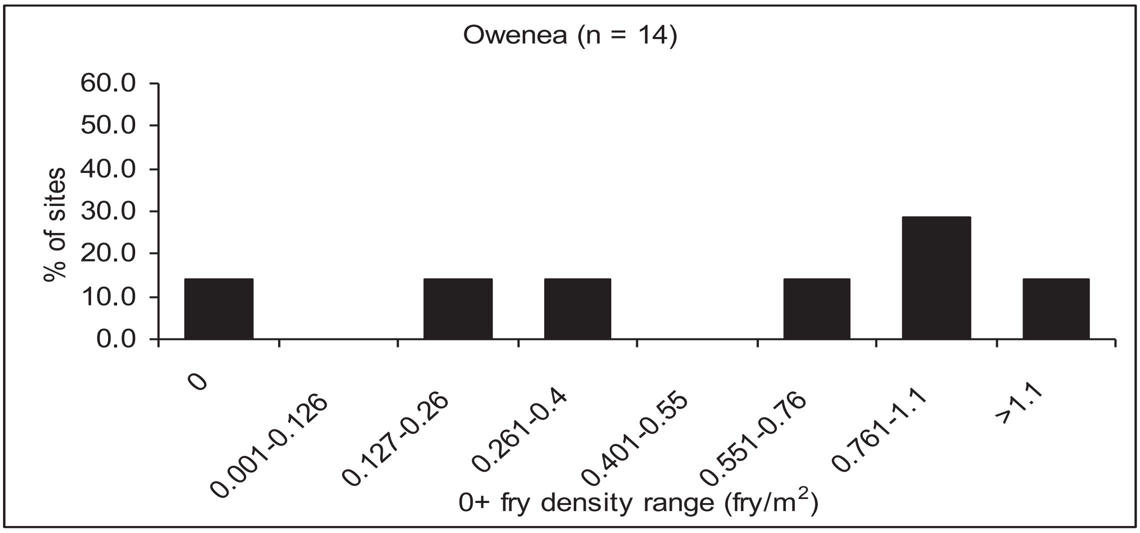


Fig. 5.6.4. Salmon fry density distribution for the Owenea catchment 2006

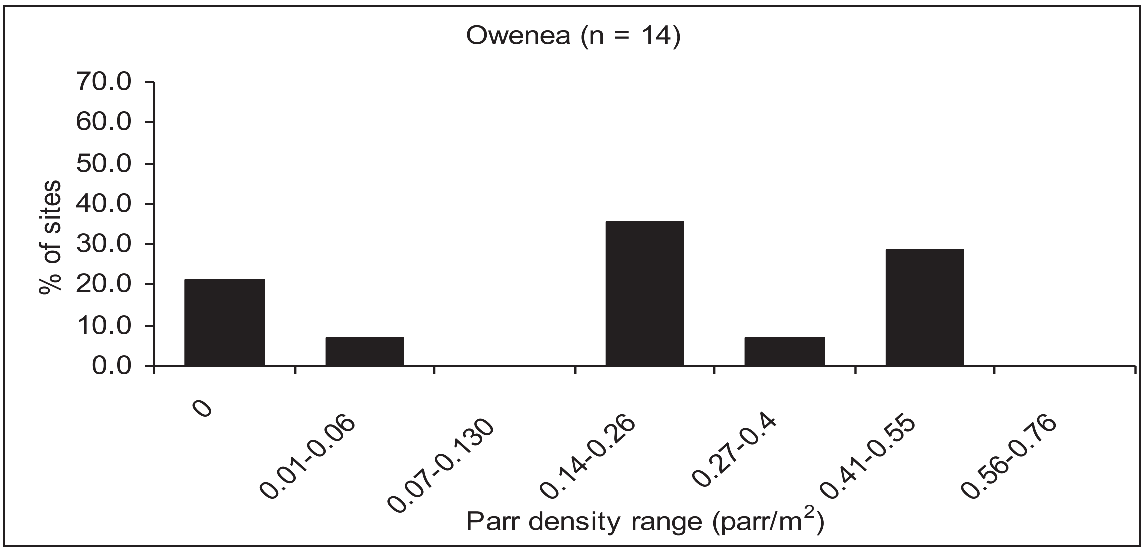


Fig. 5.6.5. Salmon parr density distribution for the Owenea catchment 2006

Trout were well distributed throughout the catchment but trout fry densities were low. Trout parr densities were moderate to poor (Figs. 5.6.8 & 5.6.9). The highest juvenile trout densities were in the extremities of the catchment which are less favoured by salmon and interspecific competition between salmon and trout is consequently reduced.

A small number of sea trout were also encountered. Other fish species recorded included eels and lamprey (Appendix 6: Table 6).

5.6.3. Comparison with previous survey

Total juvenile salmon densities (fry and parr) ranging from 0.3 to 0.36 salmon/m2 in the Stracashel and 0.02 to 0.2 salmon/m2 in the upper Owenea main channel were recorded by Mc Carthy (1972) at 3 sites in successive summers between 1968-1970 (Appendix 7: Table 4 & Fig. 4). Although the historical data are scant it is evident that the substantially higher densities of salmon and trout recorded during the current survey indicate a major improvement in production since that time. Sampling effort was a single electrofishing unit when this earlier study was carried out and this may have resulted in relatively low densities being recorded.

5.6.4. Physical habitat assessment and recommendations for improvements

The Owenea is a prime salmon fishery which has the greatest extent of spawning channel of all the channels surveyed over the course of this project. Water quality based on EPA Q-values show high and good status (> Q 4) prevail but poor status was observed for the lower Striate and this has been a feature of this part of the catchment in the past five years (Fig. 5.6.11 & Appendix 2: Table 6). Several discrete habitat problems were identified and recommendations to alleviate these are presented below:

OWENEA main channel

1. In the main Owenea channel excessive bank erosion is evident at intervals over a 6.2km length of channel (Figure 5.6.12 – aerial photography shows extensive examples of this erosion). This should be addressed by fencing out stock. A secure fencing programme at this location, without additional revetment works, should be adequate to address this problem. An illustration of the extent of bank erosion in this particular reach is provided (Plate 5.6.1).
2. In the middle reaches of the Owenea channel, upstream of its confluence with the Stracashel River, there are lengthy reaches with a uniform sandy bed devoid of aquatic vegetation. Some of these zones could be enhanced, to improve salmon parr carrying capacity by providing rubble mats at intervals. An example of one such typical

reach is provided (Plate 5.6.2). In the same channel zone masonry from an old bridge which has fallen into the channel has formed an ideal rubble mat with the stones being heavily colonised by aquatic mosses – forming ideal juvenile salmon habitat (Plate 5.6.3). Extremely high salmon fry and parr densities were recorded in reaches upstream of this zone suggesting that large numbers of juvenile salmon are available to recruit into new rubble mat areas downstream.

Given the novel nature of this proposal it is recommended that NRFB initially construct a small number of rubble mats (6) and monitor their effectiveness in relation to maximising juvenile salmon production. After four years of monitoring their relative effectiveness will be evident. Subsequently an assessment of cost effectiveness can be made and a broader programme of works could be undertaken assuming that the returns from the investment are considered viable.

Broken quarried rock, where the individual pieces would be 20cm to 25cm in diameter, are ideal stone to construct rubble mats in this channel. Angular broken rock pieces “lock together” better than round cobbles and are less vulnerable to flushing in flood flows.

The aerial photographic series suggested that some reaches of the Owenea, in the vicinity of McDevitts Bridge, were tunnelled. A visual examination of the channel, at low flows in wintertime, found substantial aquatic moss colonies on the boulders and stable cobbles despite the heavy tree cover (Plate 5.6.4) indicating no tunnelling impact.

Plate 5.6.1. Owenea River Catchment : main channel rehabilitation works

Plate 5.6.2: Middle reaches of the Owenea River u/s of the Stracashel R. confluence where extensive lengths of channel have an unproductive sandy bed incapable of supporting large stocks of juvenile salmonids. The construction of rubble mats in these areas would increase their carrying capacity.

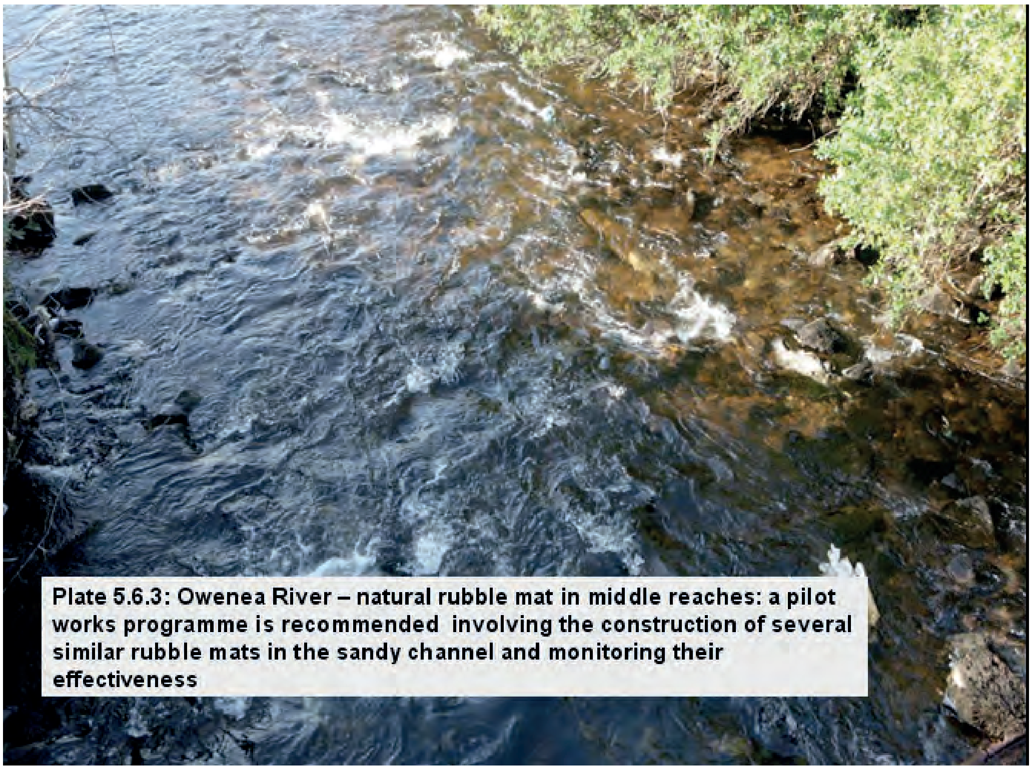


Plate 5.6.3: Owenea River – natural rubble mat in middle reaches: a pilot works programme is recommended involving the construction of several similar rubble mats in the sandy channel and monitoring their effectiveness

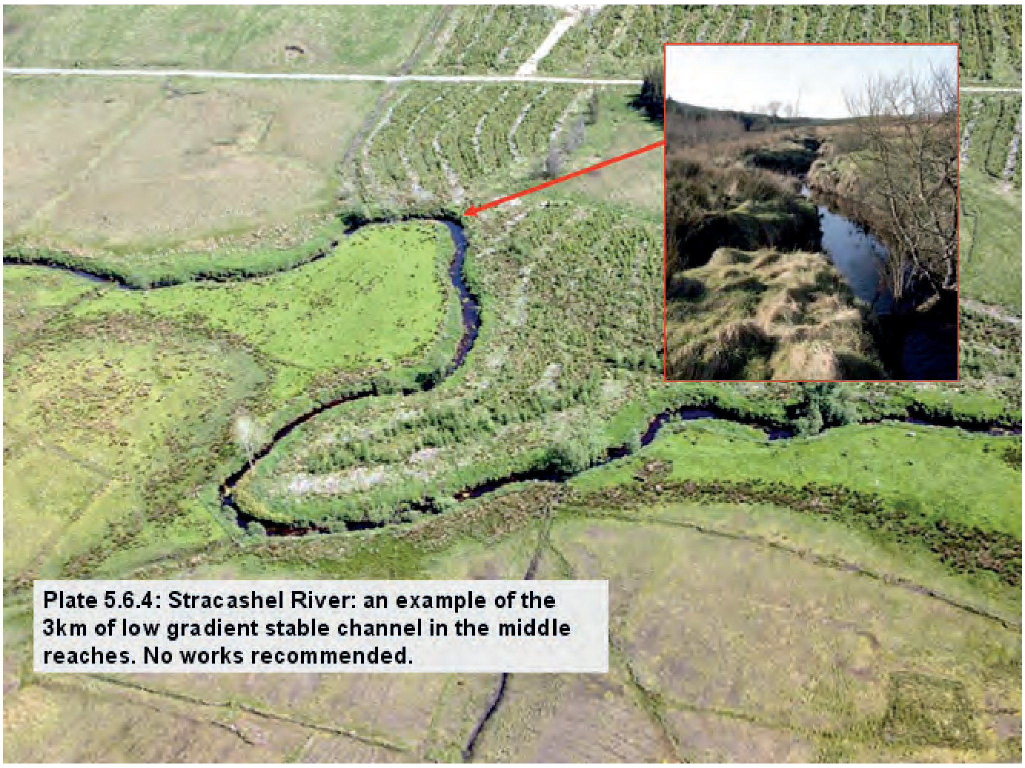


Plate 5.6.4: Stracashel River: an example of the 3km of low gradient stable channel in the middle reaches. No works recommended.

STRACASHEL RIVER (OWENEA TRIBUTARY)

The Stracashel is an extensive spawning and nursery tributary which includes the Shallogen River. No major enhancement works are recommended for the Stracashel main channel as the channel is very stable and juvenile production is excellent where the habitat is suitable.

No juvenile salmon were recorded in the uppermost site on this subcatchment which indicates that one of a series of bed rock cascades, downstream of the site (near Graffy Bridge), is impassable to adult salmon.

In the middle reaches approximately 3 km of the Stracashel has a very low gradient as it traverses a flat valley floor (Plate 5.6.4) and has no enhancement potential.

Aerial photography shows that a 2km reach upstream of the Mink Farm requires fencing to maintain bank integrity (detailed fencing requirements are illustrated in Figure 5.6.12).

THE SHALLOGEN STREAM

This channel, a tributary of the Stracashel River, is a very important salmon spawning and nursery unit – some of the highest salmon fry densities recorded in all of the NRFB rivers surveyed over the course of this project were noted in this channel (> $1.0/m^2$). However, the upper reaches of this tributary are currently the most physically unstable channel of the systems surveyed. As a result salmon parr production levels are lower than would be anticipated in a productive stable channel.

The aerial photography series illustrates the degree and extent of the physical instability. The river is unstable from the point where it reaches the valley floor (upstream of the Ruadan plant) in its upper reaches continuing downstream for approximately 2 km. The B type channel (Rosgen, 1994) in the headwaters drain a very steep mountain valley (Plate 5.6.5). The channel is unstable, having altered its course on numerous occasions in recent centuries. This instability has clearly been exacerbated by the drainage of the mountainside to accommodate afforestation programmes. Such drainage systems accelerate flood flows, increase erosion levels and contribute to the physical instability in the valley downstream.


Plate 5.6.5.Owenea Catchment – stable headwaters of the Shallogen River

The extent of this gross instability is clearly evident (Plate 5.6.6) - as the river reaches the valley floor the gravel load is deposited resulting in the creation of a braided channel which will change its form after every flood event. From this point downstream for 2 km this channel is extremely unstable. In time, unless corrected this serious instability could extend downstream into the Stracashel. There is evidence of this occurring in the middle reaches presently (Plate 5.6.7).

Plate 5.6.6. Extensive erosion and deposition in the upper Shallogen River – at rear of Ruadan Teo.


Plate 5.6.7. (a) middle reaches of the Shallogen Stream


Plate 5.6.7. (b) lower reaches of the Shallogen Stream

The following schedule is proposed to restore stability to the Shallogen thereby significantly increasing salmon parr production:

i. Construct a large gravel trap in the channel where the River Sruhanacrow enters the flood plain (Plate 5.6.6). This trap will capture a major portion of the mobile substratum in one location where it can be removed periodically. Removing this material will assist in stabilising the channel downstream by limiting excessive mobile substrate recruitment thus limiting the likelihood of further consequential erosion. It will be essential that this trap is well maintained and regularly serviced to ensure its functionality. The channel upstream of the proposed trap is very steep, braided and probably of very little value as either a salmon spawning or nursery channel. Therefore, fish passage through the gravel trap does not need to be accommodated.

ii. Following (i) above the river channel downstream should be allowed to stabilise for a three to four year period. Thereafter a substantial bank revetment/fencing/planting programme should be drawn up. This cannot be done presently due to the major bed sediment movement and the uncertainty regarding the likely channel flow regime. The exact restoration requirements will become more evident, easier to cost and implement once sediment movement has been restored to normal levels.

5.6.5. Conclusions

The Owenea is a prime grilse fishery which is managed by the NRFB. With a high rod catch and exceedence of its CL it is a consistent fishery. The Owenea and its extensive subcatchments have extensive spawning and nursery areas and the catchment is well populated with juvenile salmon. Very high densities of salmon fry and parr were recorded at the majority of sites sampled – the Owenea was the most productive catchment for juvenile salmon over the course of this study.

Two previously undocumented impassable barriers were identified and these will be reported to the Standing Scientific Committee as this will impact on the calculation of wetted area thus reducing the CL for the system.

Several highly specific habitat problems were identified. Erosion in the main channel requires attention but the most significant problem is the erosion and substrate mobility in the uppermost reaches of the Shallogan. Stabilisation of this productive habitat is a priority to secure this channel and further enhance its production levels. The programme for this reach (2 km) entails installation of a gravel trap which will require regular maintenance to be effective.

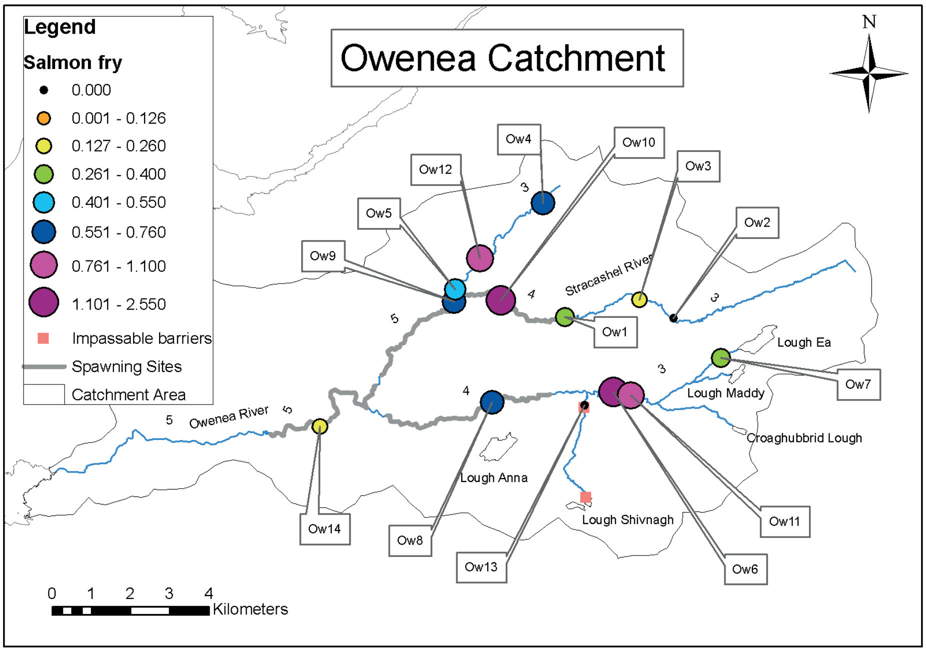


Fig. 5.6.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Owenea catchment. Numbers on map represent stream order and grey line represents spawning areas.

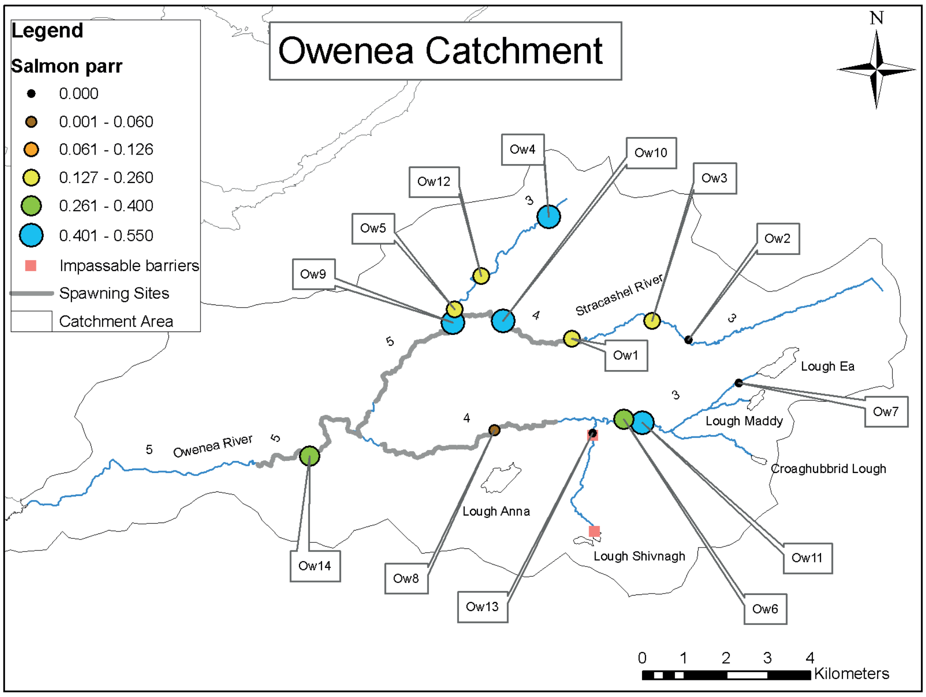


Fig. 5.6.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Owenea catchment. Numbers on map represent stream order and grey line represents spawning areas.

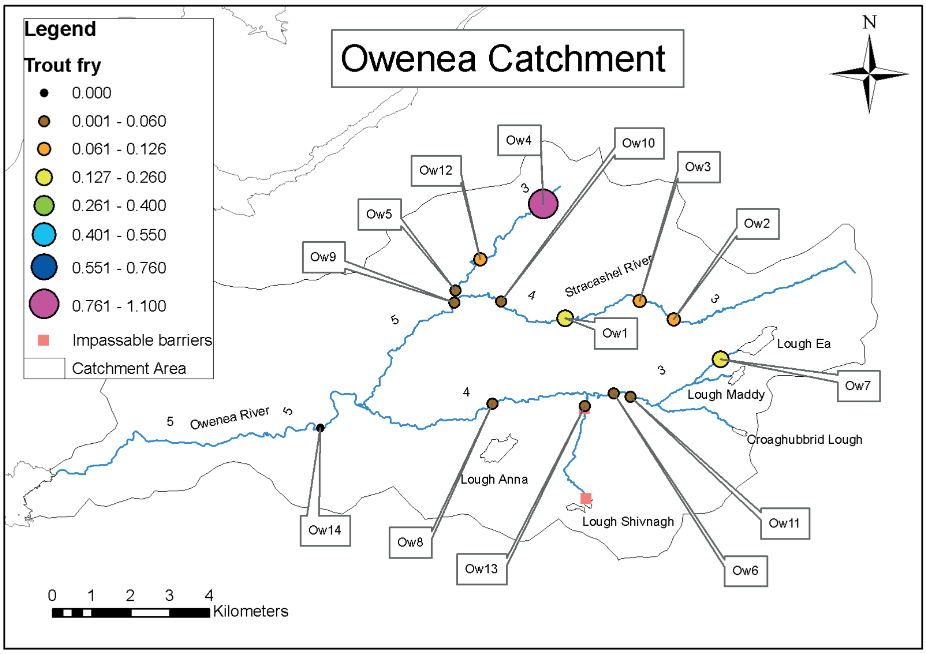


Fig. 5.6.8: Trout fry distribution and quantitative density estimates (no./m2) in the Owenea catchment. Numbers on map represent stream order and grey line represents spawning areas.

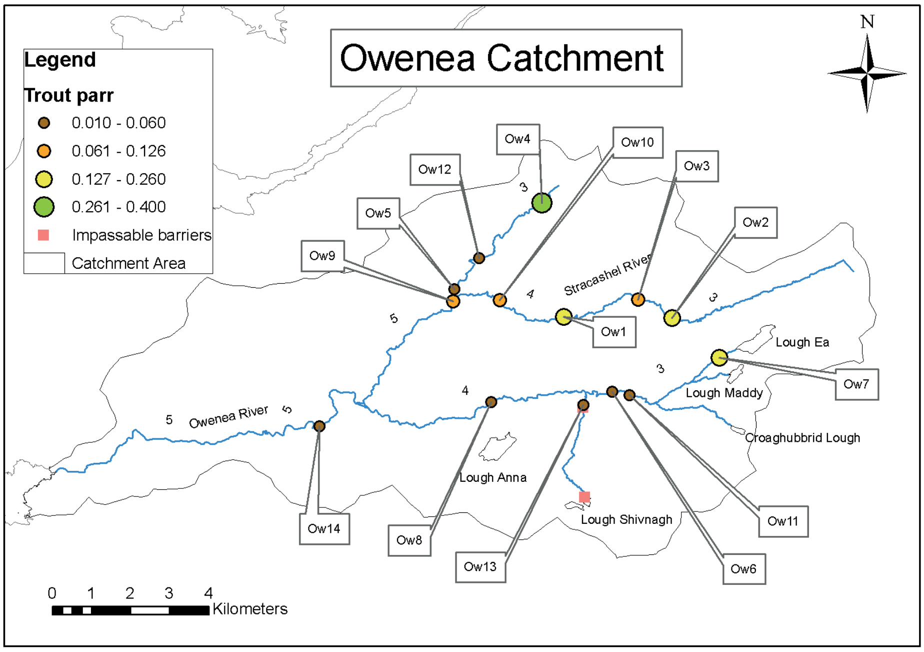


Fig. 5.6.9: Trout parr distribution and quantitative density estimates (no./m2) in the Owenea catchment. Numbers on map represent stream order and grey line represents spawning areas.

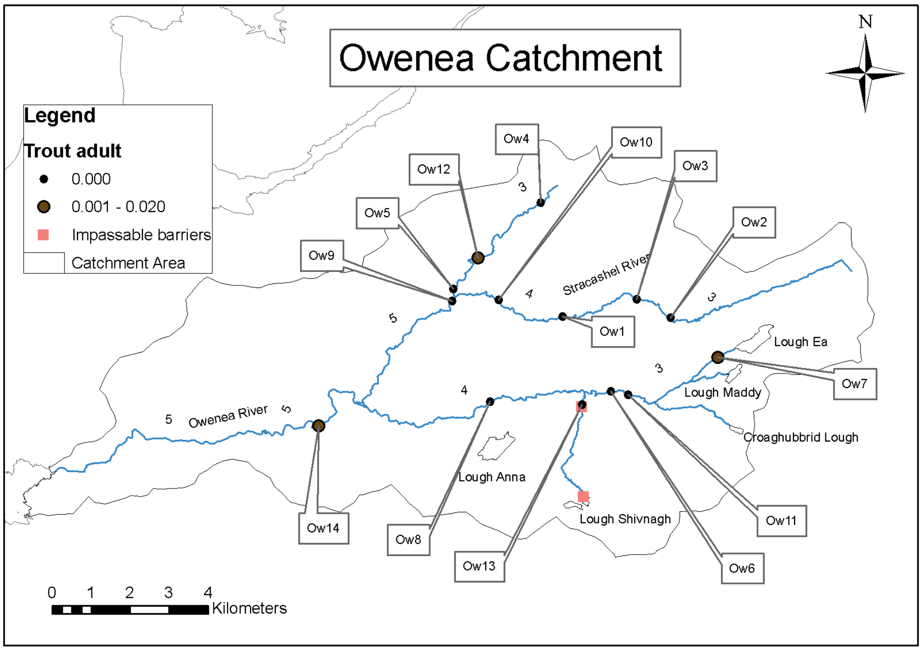


Fig. 5.6.10: Trout adult distribution and quantitative density estimates (no./m2) in the Owenea catchment. Numbers on map represent stream order and grey line represents spawning areas.

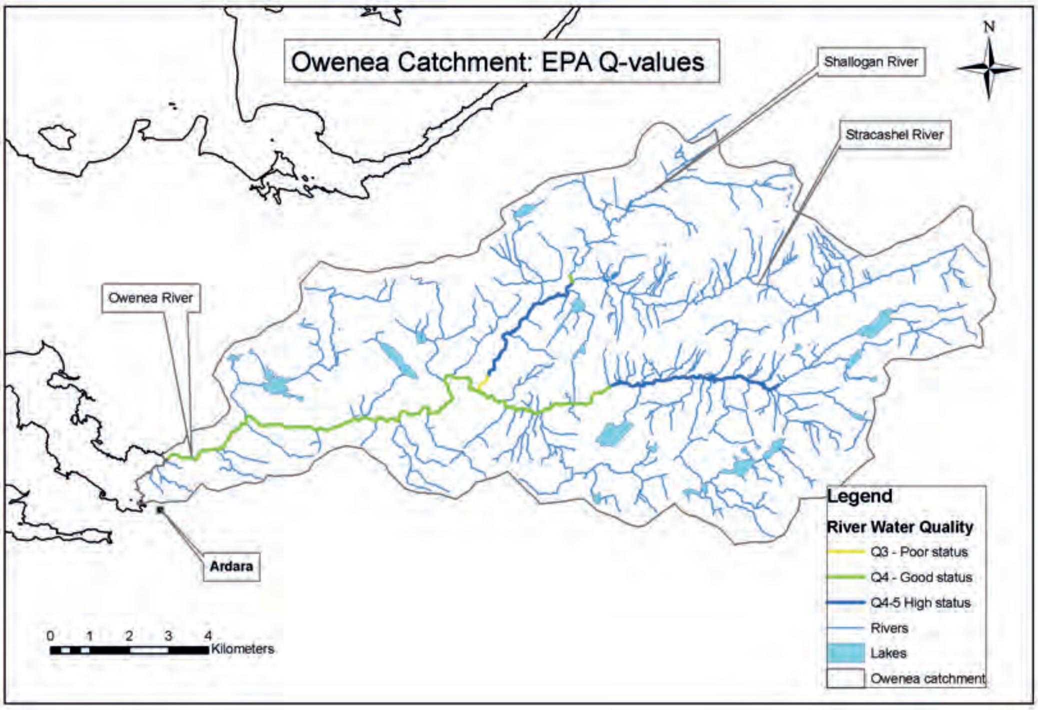


Fig. 5.6.11: Plot of EPA Q-values for the Owenea catchment.

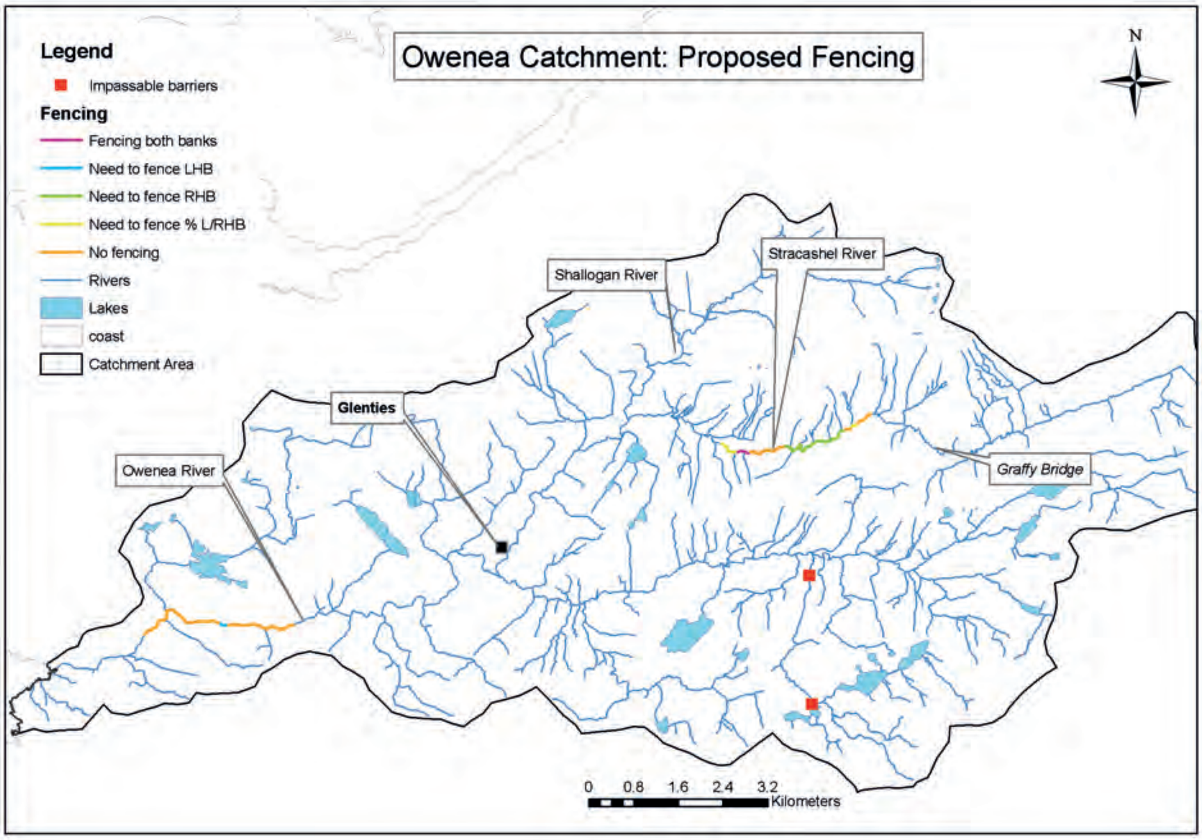


Fig. 5.6.12. Plot of the proposed fencing for the Owenea catchment with 3.5km of fencing required.

5.7. Glen & Owenwee Catchments

5.7.1. Introduction

The Glen and the Owenwee were regarded as discrete catchments in the wetted area report (Mc Ginnitty *et al*, 2003) because both discharge independently into the upper part of the estuary near Teelin. Both are productive grilse fisheries which differ physically. The Owenwee is a short, cascading spate river, with some pools, which drains several small lakes. In contrast, the Glen is a relatively large river, which flows through an exposed productive moorland valley over a moderate gradient, with many large pools. Its main tributaries, the Owenteskiny and the Crow Rivers are high gradient, boulder-dominated channels. In 2009 the Owenwee River was reclassified by the SSC and is now regarded as a tributary of the Glen system (SSC, 2009.).

The Glen River system rises in the mountains of Slevetooey and Crockuna and flows in a southerly direction entering the sea near the village of Carrick. The Glen catchment has an area of 123.2km^2. The dominant geology is schist, gneiss and quartzite. The land cover is mainly peat bog with some pasture and natural vegetation. Large sections of this catchment have been designated as NHA due to its habitat type and flora and fauna.

The Glen River is ranked 56 of 173 salmon rivers accounting for 0.32% of the national total of accessible fluvial salmon habitat (McGinnity *et al.* 2003; Table 40) and is ranked 10th of all salmon rivers in the Ballyshannon and Letterkenny Districts. Rod catch has been decreasing since 2002 (Fig. 44) but has leveled off in recent years averaging approximately 100 per annum. The Glen catchment has not reached its conservation limit since 2002.

No rod catch has been attributed to the Owenwee since catch data have been assigned on an individual basis. Consequently it has been closed to angling. This may be an artifact of non-reporting or a failure by anglers to identify the Owenwee as a separate system with a requirement for some means of stock assessment.

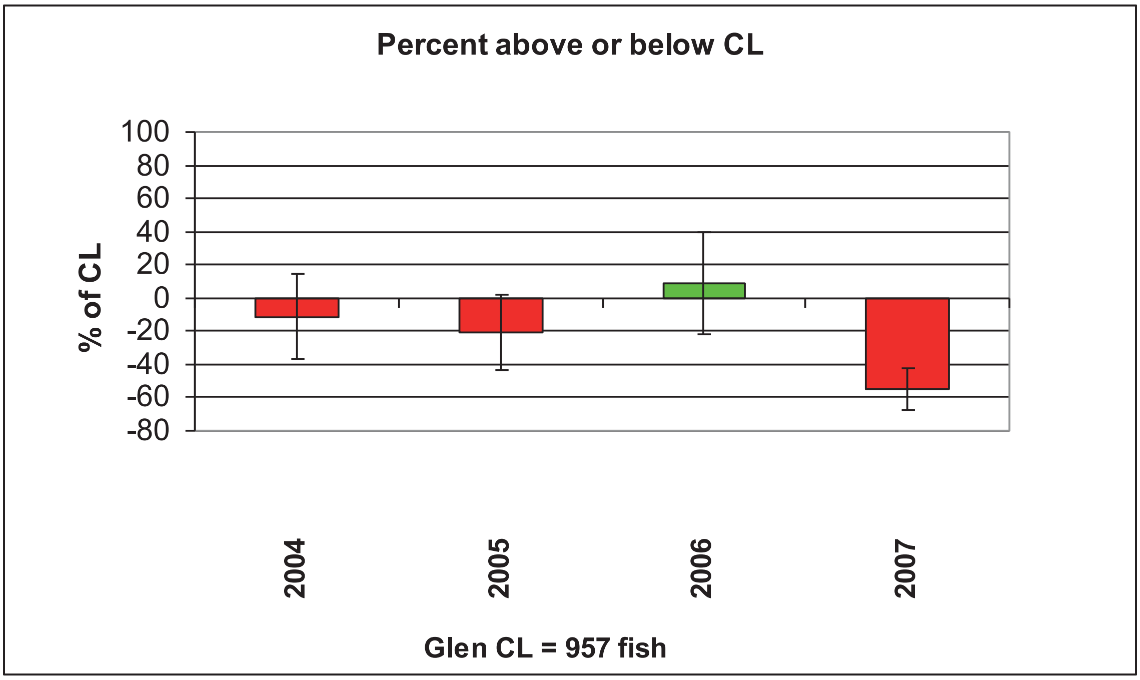


Fig. 5.7.1: Plot of salmon spawning escapement for the Glen River, expressed as percentage above or below the Conservation Limit

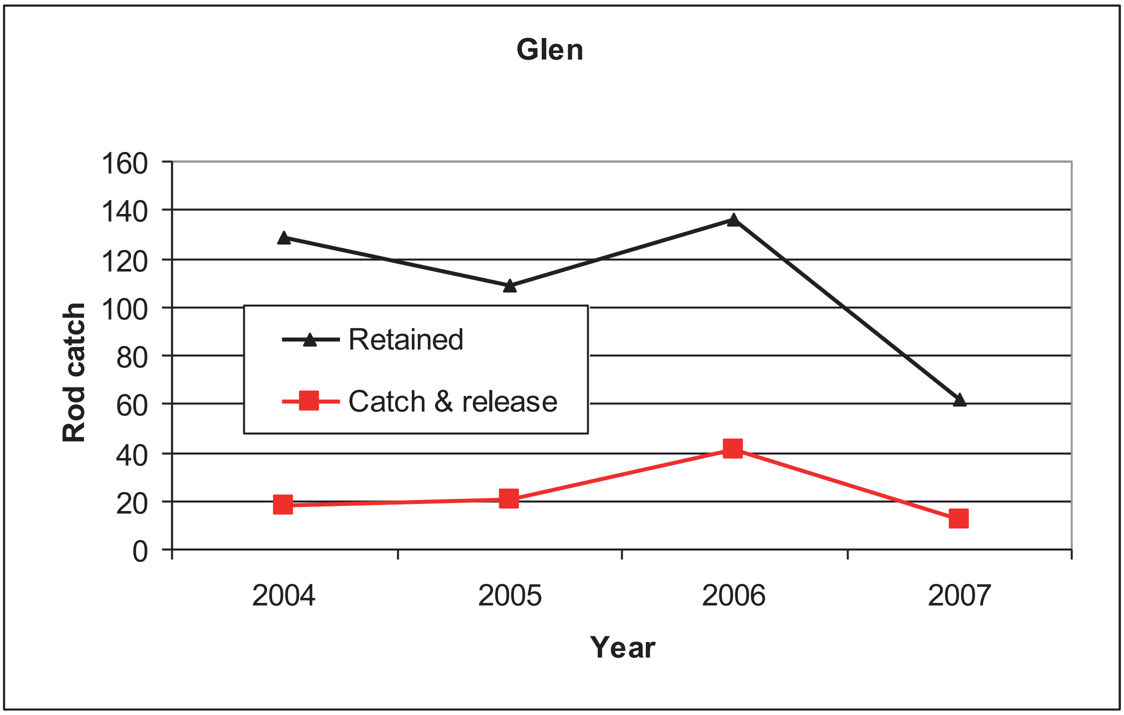


Fig. 5.7.2: Salmon rod catch data for the Glen River

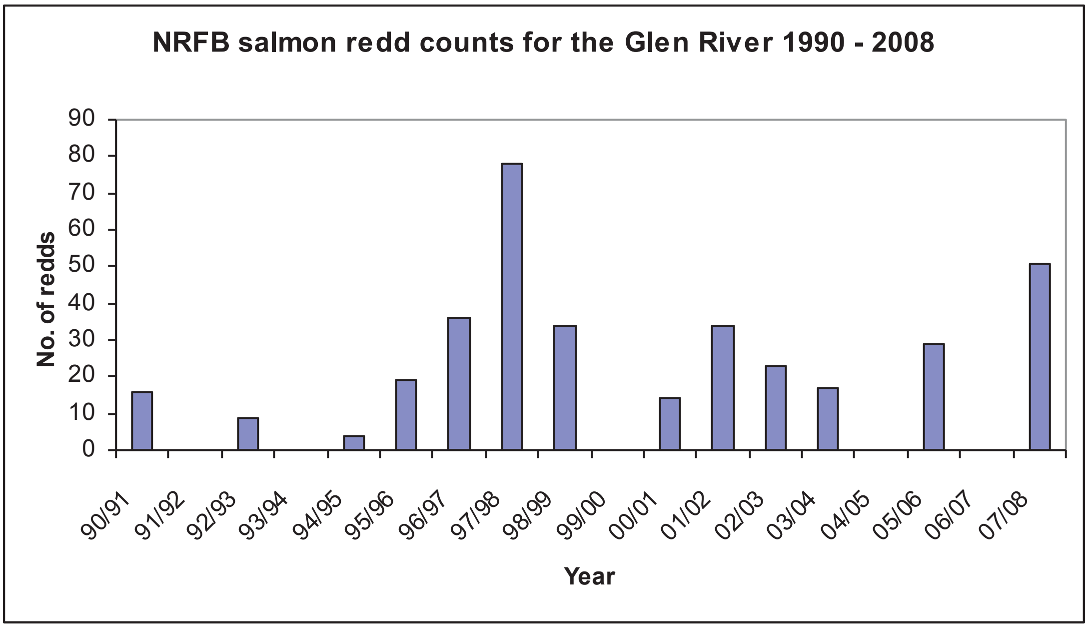


Fig. 5.7.3. Salmon redd count data for the Glen catchment 1990 to 2008. No data available for periods with zero counts.

Low salmon redd counts (Fig. 5.7.3) are a feature of the Glen River and no specific redd count data are available for the Owenwee.

5.7.2. Electrofishing results

In summer 2007, a total of 19 sites were surveyed in the Glen and Owenwee catchments combined (Fig. 5.7.6). Salmon were widely distributed throughout the catchments extending into the uppermost reaches of each major tributary (≥ stream order 3) up to the three identified natural barriers on these systems (Figs. 5.7.6 and 5.7.7). No salmon were recorded at four sites – all were situated above these barriers. The widespread presence of salmon fry throughout showed that adult salmon are accessing the Glen and Owenwee catchments up to the limit of the accessible habitat. It also suggests that the spawning areas are more extensive than the currently identified segments of the main channels of both catchments. Spawning is likely to be more widespread, possibly in isolated pockets of gravel throughout the catchments and this may account for the relatively low and fluctuating redd counts over the past two decades (Fig. 5.7.3). Overall, the majority of salmon fry densities were in the moderate to high range, although low densities were recorded in a small number of sites (Fig. 5.7.4.) Salmon parr were not as widely distributed as salmon fry, being restricted to the middle and lower reaches of the tributaries and the main channel, where suitable habitat - shallow pools and glides - was available. Densities of parr were generally moderate to high (Appendix 4: Table 7 and Fig. 5.7.5).

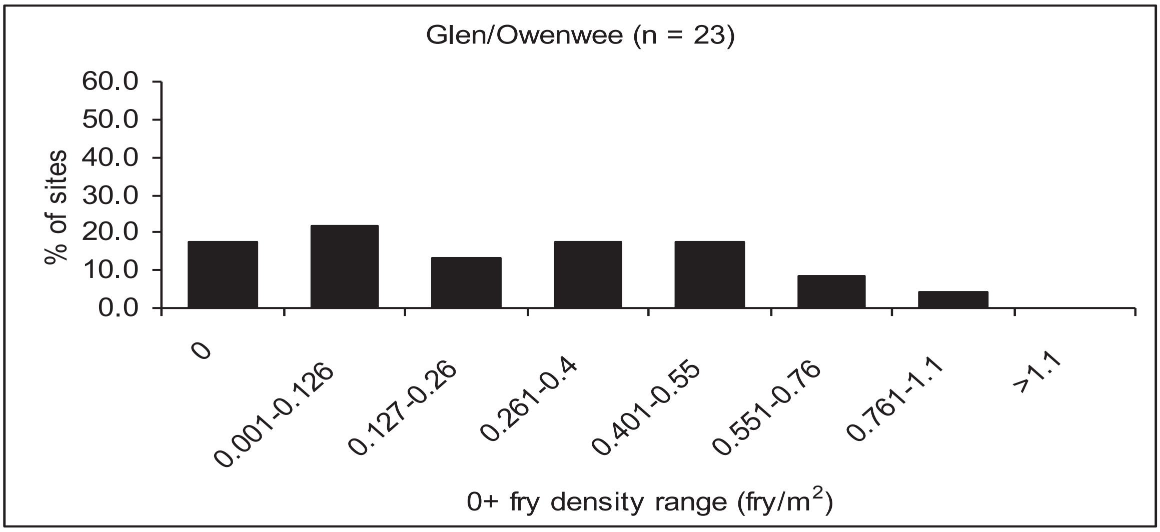


Fig. 5.7.4. Salmon fry density distribution for the Glen/Owenwee catchment 2007

Trout fry and parr were recorded at virtually every site in the two catchments. Trout fry densities were generally low (≤ 0.1 m2), with the exception of a high density (0.69/m2) recorded from a tributary flowing into Lougheraherk lake, situated at the top of the Glen system. High trout fry densities are often a feature of such tributaries, where the lake stream network may be limited. Trout parr densities were generally low with few exceptions.

Approximately 0.5km downstream of Lougheraherk, in the uppermost reaches of the Glen River a natural rock sill, immediately downstream of a minor road bridge, forms an impassable barrier for migrating salmon. Historically sea trout are known to have ascended these falls and migrate upstream to the lake (Boylan and Sheridan 1994).

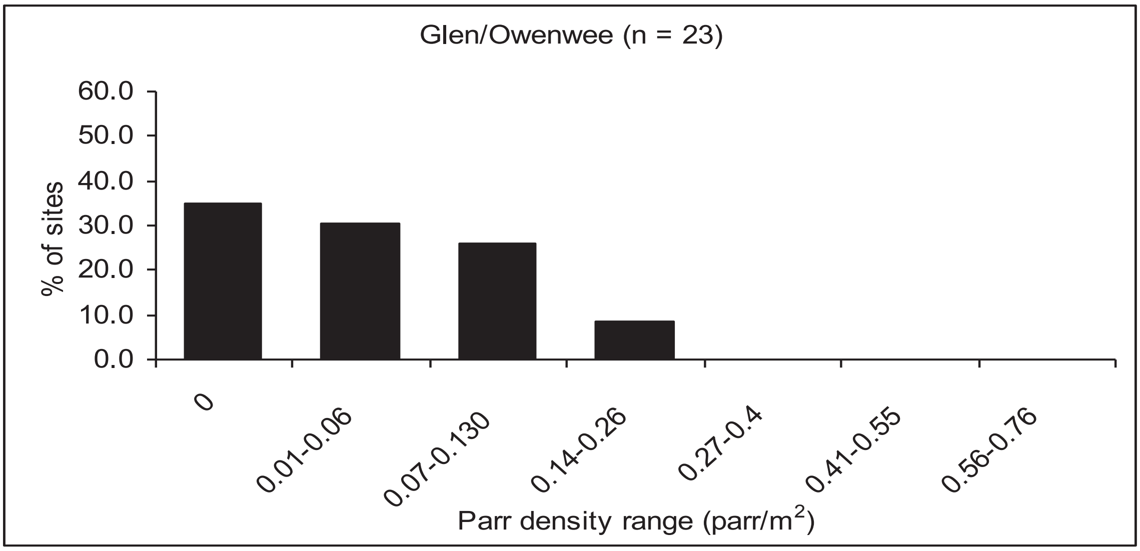


Fig. 5.7.5. Salmon parr density distribution for the Glen/Owenwee catchment 2007

Eels were recorded at 8 of the 19 sites sampled in the Glen and Owenwee catchments. Eel distribution was limited to sites in the lower reaches of the Owenwee, the Crow River and the middle and lower reaches of the Glen main channel (Appendix 6: Table 7). This is typical of the expected distribution pattern for eels.

EPA Q-values indicated good water quality in the Crow and Owenteskinny Rivers, while unsatisfactory conditions were noted for the lower Glen main channel (Appendix 2: Table 7 & Fig. 5.7.11).

The Glen catchment was surveyed in 1993 by Boylan and Sheridan and in general salmon fry (0+) and parr (1+) densities were higher in 2007 (Appendix 7). However, trout fry (0+), parr & greater (≥1) showed an overall decrease in densities.

5.7.4. Physical habitat assessment and recommendations for improvements

The Glen catchment has two relatively large tributary subcatchments – the Owenteskiny and the Crow. Electro fishing data indicated that the entire main stem and the two major tributaries and the Owenwee are important in terms of providing salmon spawning and nursery zones. Survey data indicated specific problems in defined areas of each of these channels.

Water quality, based on EPA Q value data, is likely to be compromising juvenile salmon production with much of the main channel affected. This ongoing situation has to be resolved to ensure maximum benefit arising from any enhancement works that may be undertaken.

GLEN RIVER (MAIN CHANNEL)

An extensive reach (3.5 km) in the lower main stem of the Glen River, from Meenaneary downstream almost to Arddrin, was drained several decades ago. Aerial photograph (Plate 5.7.1) shows a typical zone within this reach characterised by drainage embankments, the absence of a balanced riparian zone and the unnatural uniform nature of the channel.

Plate 5.7.1. Glen River main channel d/s Meenaneary. Channel was drained as evidenced by straightened channel and low embankments

A major physical instream works programme would benefit this channel from a salmon spawning, nursery and angling perspective. The construction of alternating and paired stone deflectors and vortex weirs, together with installation of random boulders and spawning gravels, would significantly enhance this channel reach in spawning, nursery and angling terms. A tree planting programme is also recommended. A substantial increase in smolt production is feasible based on the current parr production levels together with a significant increase in the angling value of this section.

Although the main channel of the Glen has been drained it is not maintained by the Office of Public Works and does not come under their remit. Consequently the onus will rest on NRFB to carry out any habitat rehabilitation work.

The lower reaches of the river, particularly the Salmon Leap, are heavily targeted by anglers and produce the majority of salmon to the rod. Consideration should be given to ponding out the falls to improve escapement at this particular fish bottleneck where exploitation can be particularly heavy. Boylan and Sheridan (1994) previously identified this as a priority action for the catchment.

Poor water quality from the fish processing plant in the middle reaches of the main channel (Appendix 2) was a problem some 10 years ago in the Glen catchment. The installation of a treatment plant has had a very positive effect on water quality and salmon are observed spawning in the vicinity of the plant (Mc Cafferty pers. comm.). High suspended solids arising from quarrying is another factor identified by NRFB staff as a significant factor impacting water quality – the recent downturn in the construction industry has reduced the impact of this activity. Regulation of quarrying activity in terms of discharges to watercourses requires attention particularly in the Glen catchment.

In the uppermost reaches of the main channel upstream of Lougheraherk a bogslide in 2009 affecting circa 1.5 ha of land threatened a major trout spawning stream in this lake fishery. Stabilisation by revegetating the area with natural grasses is recommended. Easement of fish passage on the falls at the lake outflow is not recommended although the lake is accessible only to sea trout.

OWENTESKINY RIVER

There are a number of discrete problems in this sub-catchment.

- **Major bank slippages**

Severe overgrazing is evident in the lower reaches on the hillside over the river (Plate 5.7.2). Major slippages of silt and cobble into the channel have occurred. Significant potential exists for one or more major landslides to occur following which, the lower Owenteskiny, would be severely compromised as a salmonid resource, from this location downstream to its outfall with the Glen River – a distance of some 1.2km. Such an event would result in the lower reaches of this river becoming a braided channel constantly changing its morphology after every flood. Such instability would limit ecological recovery and virtually eliminate salmonid stocks – similar events have been noted by O'Grady in some of the Connemara rivers. Electrofishing data for this reach illustrate the presence of moderate salmon fry ($0.19/m^2$) and good salmon parr densities ($0.08/m^2$). Any additional physical degradation would result in a significant loss in salmon production.

Plate 5.7.2. Owenteskiny River: severe overgrazing evident with significant likelihood for landslides leading to losses in juvenile salmonid production

A programme of works should be undertaken, as a priority measure, to prevent the aforementioned problem. Measures required include: fencing off the river reach from stock both alongside the river in the valley floor and 20m back from the top of the steep hillside and draping and pinning a layer of hession type cladding over the exposed sections of cliff face. The hessian cloth should be impregnated with suitable grass seed. Once the grass has become established planting with willow slips should be undertaken to stabilise the problem.

- **Specific bank erosion problems on the Owenteskiny**

Significant levels of bank erosion were observed at one particular reach (Plate 5.7.3). The length of the relevant section is outlined in Figure 4.1. Log/coniferous tree revetments, in combination with root wads,

Plate 5.7.3. Owenteskiny River: severely eroded reach within a degraded zone in this important tributary

should be used here to provide bank protection and restore bank stability. Liaison and cooperation with the forestry plantation management will be essential for the NRFB to deliver this project in a cost efficient manner. The benefits of this proposal are difficult to quantify. Primarily it would improve the quality of habitat in zones downstream by reducing the silt load in the river.

- **General overgrazing problems**

Long reaches of the Owenteskiny, Crow and Owenwee Rivers, all within the Glen catchment, are overgrazed. This has lead to excessive, though not yet severe, bank erosion in many reaches. Plate 5.7.4 illustrates a reach from the Crow River which is typical of these three rivers. Bankside vegetation is almost completely absent over many kilometres of channel. The excessive level of overgrazing on adjacent hillsides which will inevitably lead to faster runoff rates and increased siltation of the river channel. An extensive fencing and planting programme is required in each subcatchment to recreate a natural riparian zone, restore natural bankside stabilisation rates and entrap silt runoff from the hills.

Plate 5.7.4. A typical reach of the Crow River which is similar in channel type and land usage to the Owenteskiny and Owenwee channels. Key features are the lack of riparian vegetation, overgrazing and associated bank erosion,

The locations and extent of fencing required on all three channels is highlighted in Figs 5.7.12 and 5.7.13.

- **Regulating weir on the Loughnalughraman outfall**

Following the installation of a regulating weir on the Loughnalugraman outflow within the past decade the dynamics of this stream have changed (Mc

Cafferty pers. comm.). NRFB data show that the lower reaches of the outflow was an important salmon spawning area and good juvenile salmon production was recorded (Boylan and Sheridan, 1994). The relationship between compensation flow, redd counts and juvenile production in this outflow needs to be established with appropriate modification to flow to be instituted if required to restore the fishery value of this channel.

The Owenteskiny has been identified as an important producer of salmon in the catchment but it has been compromised. Although transport and placement of heavy materials (logs and coniferous tree tops) on eroded sections in the catchment is difficult due to the terrain and poor access this work should be carried out where feasible. For the same reasons fencing is also difficult but some fencing measures already delivered in this catchment have been shown to be successful.

CROW RIVER

The Crow River has also experienced water quality problems over this period. The bog-slide in the upper and middle reaches, which occurred in Winter 2008, has had no visible residual effect based on NRFB observations in November 2009. However, it is likely that one or two cohorts of salmonids from this lengthy tributary have been lost and fish monitoring is required. A regular fish and invertebrate monitoring programme to track the recolonisation process should be undertaken. Although EPA monitor this channel as part of the triennial Q values programme a sustained annual programme will be required to monitor the gradual recovery of this important tributary.

Fencing has been identified as a priority for the Glen catchment. To ensure best value for money the sites to be fenced should be carefully selected by the NRFB Inspector. As sheep numbers are at an all time low in this region due to the changes in the EU grant-aid structure it is likely that the impacts of overgrazing on watercourses will become a lesser issue. Nonetheless regrowth of marginal vegetation to stabilise margins will be enhanced by fencing and should be targeted at high-risk and severely impacted areas.

One of the aims of this project was to identify works programmes for restoration or enhancement of salmon spawning and nursery habitat. A comprehensive programme of works has been drawn up for all catchments and one of the main funding mechanisms for delivery of this work is the Salmon Conservation Stamp Fund. This funding measure is funded by an annual contribution from anglers. One of the principle criteria for determining the suitability of a project for funding is water quality status. Poor water quality, as has been observed in the Glen periodically, will influence funding opportunities thus impacting on restoration of the potential of the river.

5.7.5. Conclusions

Several of the various indices available (rod catch, spawning escapement and redd counts) indicate that salmon populations in the Glen, and most likely the Owenwee, are in decline. However, juvenile salmon densities were generally satisfactory in the Glen. The Owenwee was not extensively sampled as the main channel where salmon are confined to due to the presence of a barrier is a high gradient channel, predominated by high gradient riffle (60%) (Boylan & Sheridan, 1994) which is difficult to sample.

One likely factor in the decline of the fishery is heavy angler exploitation in recent decades. It would be appropriate to advise the SSC to apply a heavier exploitation rate to the Glen to reflect more realistic levels of CL attainment. The channel up to and including the Salmon Leap is heavily angled and there are parallels with exploitation rates in the Bunduff Pool on the Duff river. The Glen has suffered a significant decline and measures must be taken to improve management. A management plan is required to ensure that the salmon resource is managed for conservation and delivery of a sustainable angling product.

Boylan and Sheridan (1994) identified significant bank erosion problems throughout the Glen, Crow, Owenteskiny and sections of the Owenwee River. The current study observed similar levels of habitat degradation with no evidence of any natural improvement despite reductions in sheep numbers and overgrazing arising from destocking measures associated with designation of all Natura 2000 sites (SAC’s , SPAs, pSACs and including commonages in Donegal and Leitrim). Direct action, in the form of rehabilitation programmes, is required to assist in the stabilization of these channels to maintain and improve the important spawning and nursery habitat. Priority should be given to the Owenteskiny and the Crow systems. A severe landslide in the upper Crow Plates 3.2.1 and 3.2.2) in 2008 has not physically impacted on the middle and lower Crow (Mc Cafferty, *pers. comm.)* but juvenile stocks should be monitored to assess if fish populations and other biota were impacted.

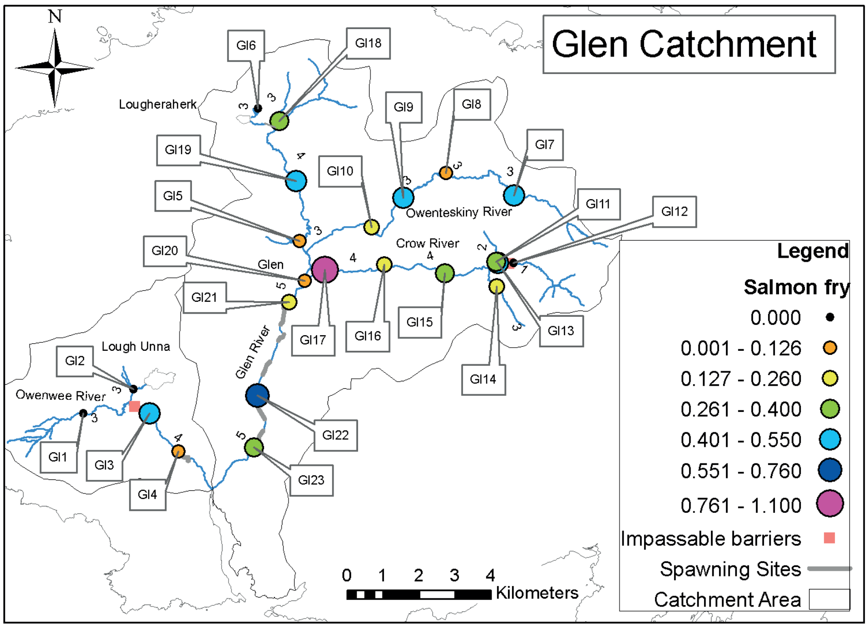


Fig. 5.7.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Glen/Owenwee catchments. Numbers on map represent stream order and grey line represents spawning areas.

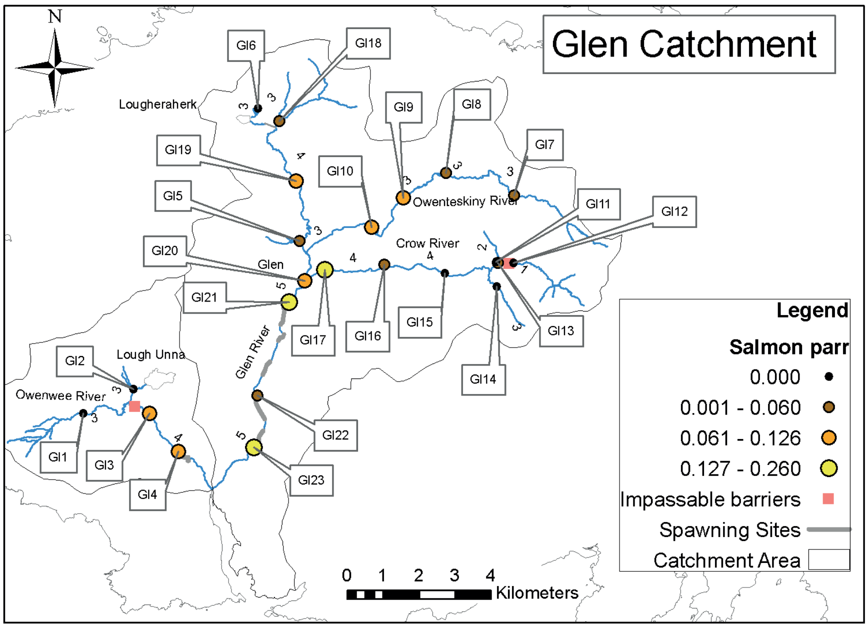


Fig. 5.7.7.: Salmon parr distribution and quantitative density estimates (no./m2) in the Glen/Owenwee catchments. Numbers on map represent stream order and grey line represents spawning areas.

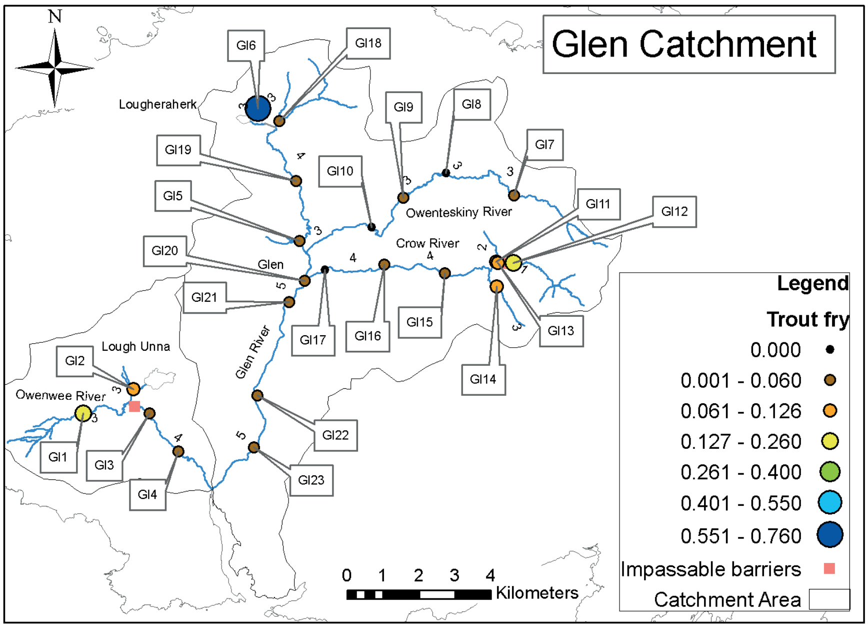


Fig. 5.7.8: Trout fry distribution and quantitative density estimates (no./m2) in the Glen/Owenwee catchments. Numbers on map represent stream order and grey line represents spawning areas.

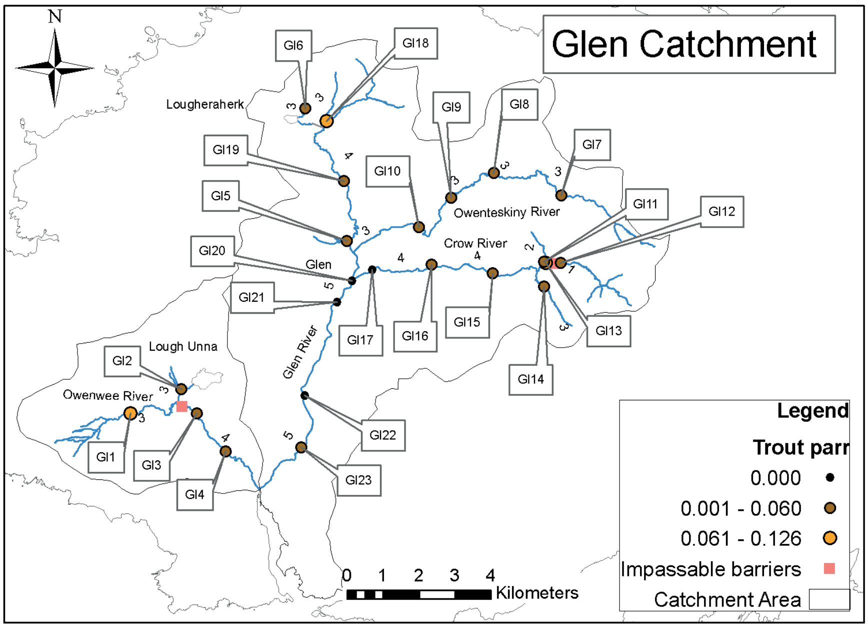


Fig. 5.7.9: Trout parr distribution and quantitative density estimates (no./m2) in the Glen/Owenwee catchments. Numbers on map represent stream order and grey line represents spawning areas.

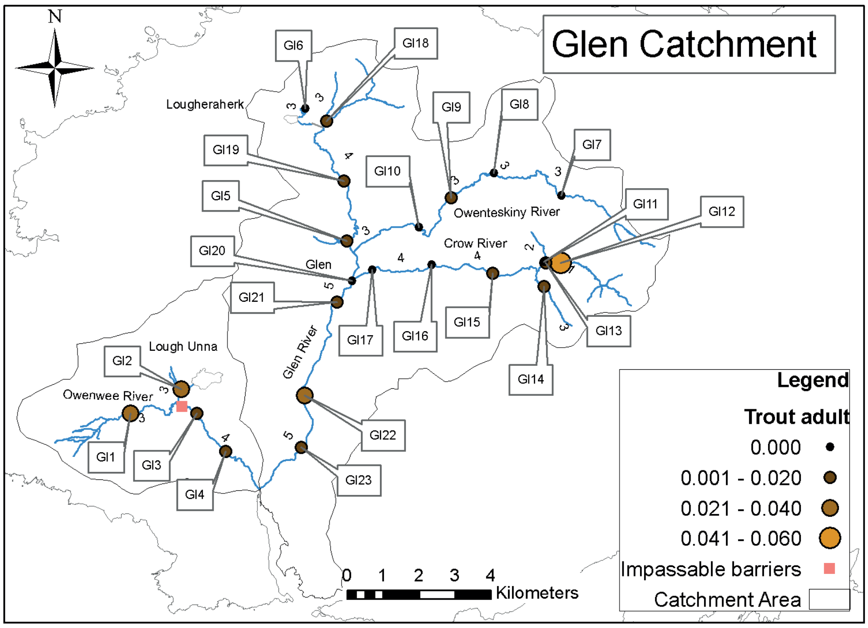


Fig. 5.7.10: Trout adult distribution and quantitative density estimates (no./m2) in the Glen/Owenwee catchments. Numbers on map represent stream order and grey line represents spawning areas.

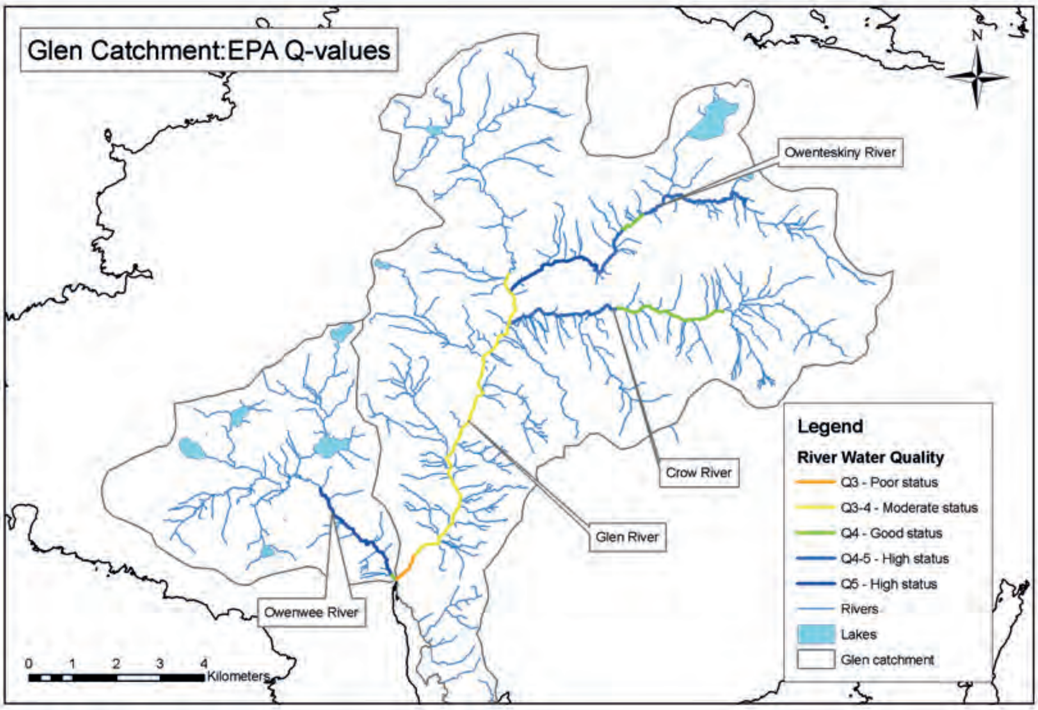


Fig. 5.7.11: Plot of EPA Q-values for the Glen catchment.

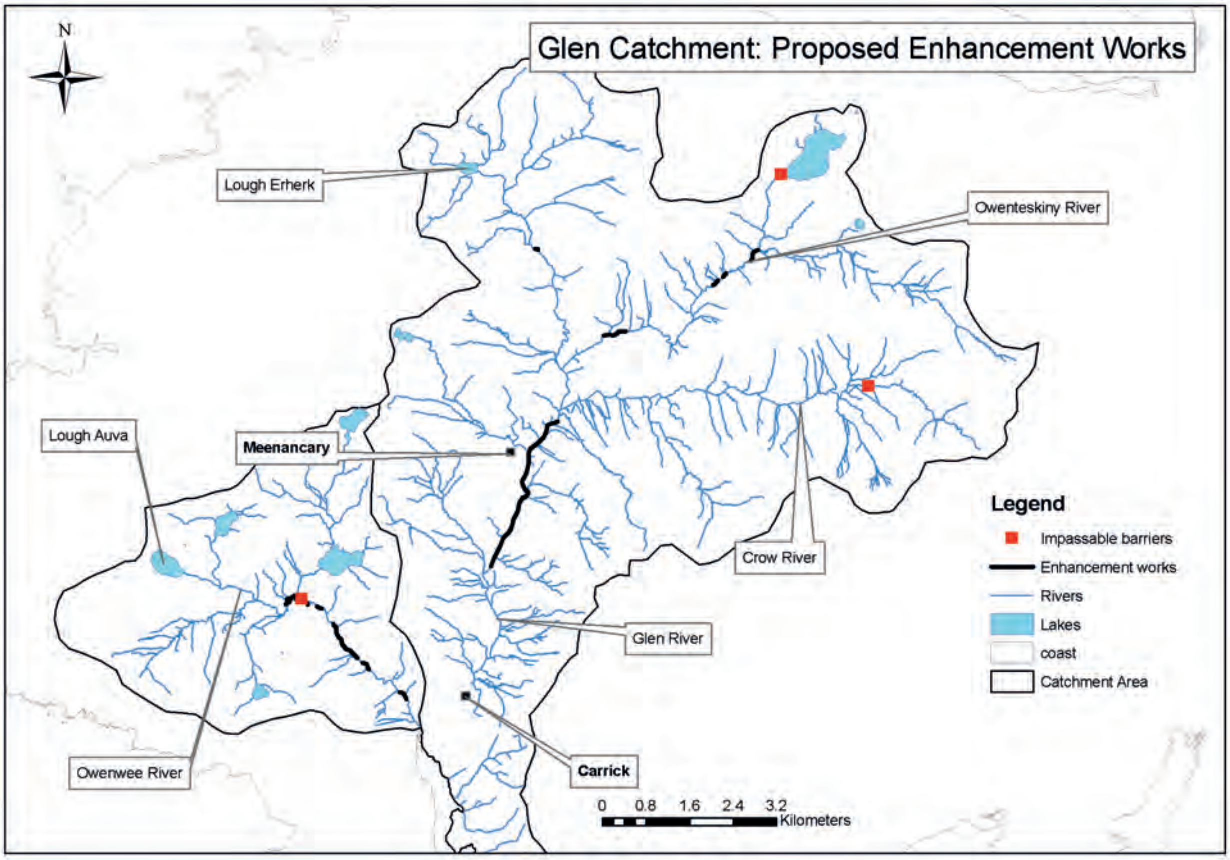


Fig. 5.7.12 Plot of proposed enhancement works for the Glen catchment. There is 3.2km of the Glen Main Channel requiring enhancement works, 0.9km on the Owenteskiny River and 1.9km on the Owenwee River.

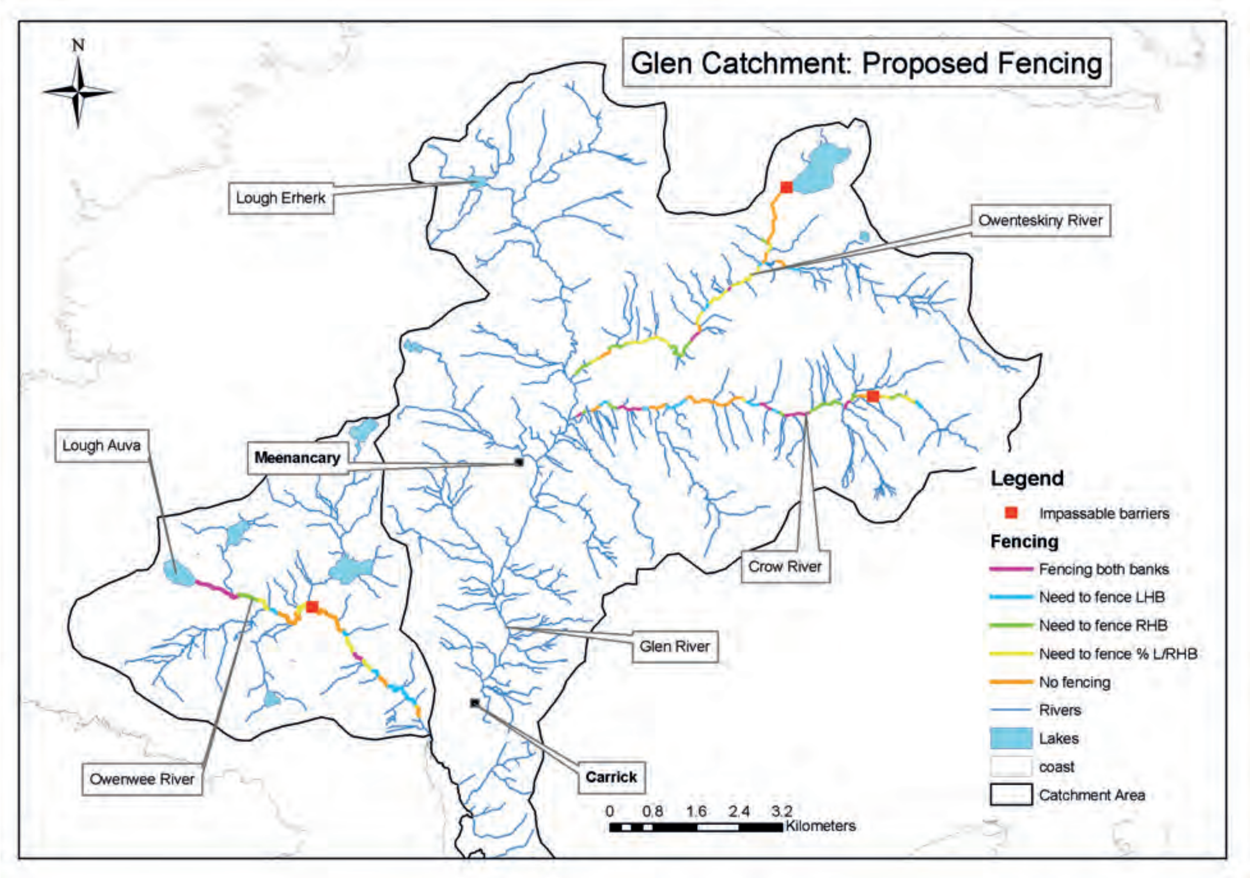


Fig. 5.7.13. Plot of proposed fencing of the Glen Catchment. 7.2km of fencing is required on the Owenteskiny River, 7.3km on the Crow River and 4.7km on the Owenwee River.

5.8. Eany Catchment

5.8.1. Introduction

The Eany River rises in the Blue Stack Mountains and flows in a southwesterly direction flowing into the sea at Inver. It is primarily a spate river and is one of the more productive salmon fisheries in the Northern Fisheries Board Region. The Eany is directly managed by the NRFB to provide a quality angling product. The river provides grilse angling in summer and the NRFB have invested heavily in angling infrastructure and improvements including a fish counter. Apart from 2004, when a reduced rod catch was recorded, the Eany has exceeded its Conservation Limit consistently (Fig 5.8.1) up to 2007. Recent counter data (NRFB reports, 2007-2010) have demonstrated a steady decline in upstream runs since 2007 which is a major concern for this fishery.

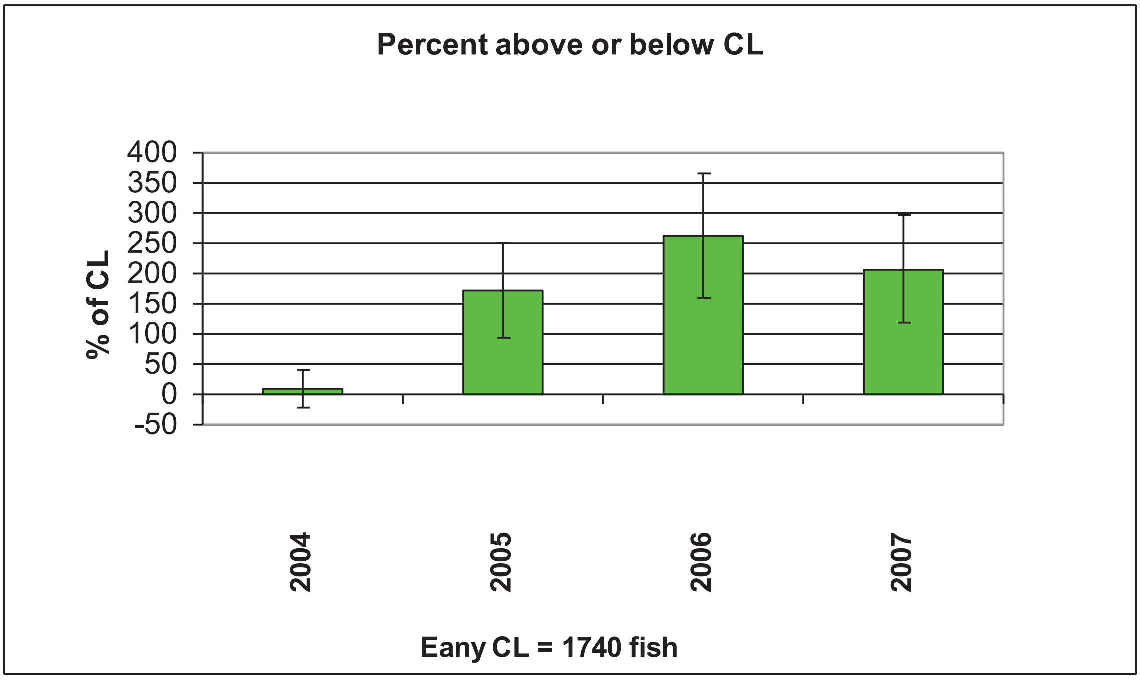


Fig. 5.8.1. Plot of salmon spawning escapement for the Eany River, expressed as percentage above or below the Conservation Limit

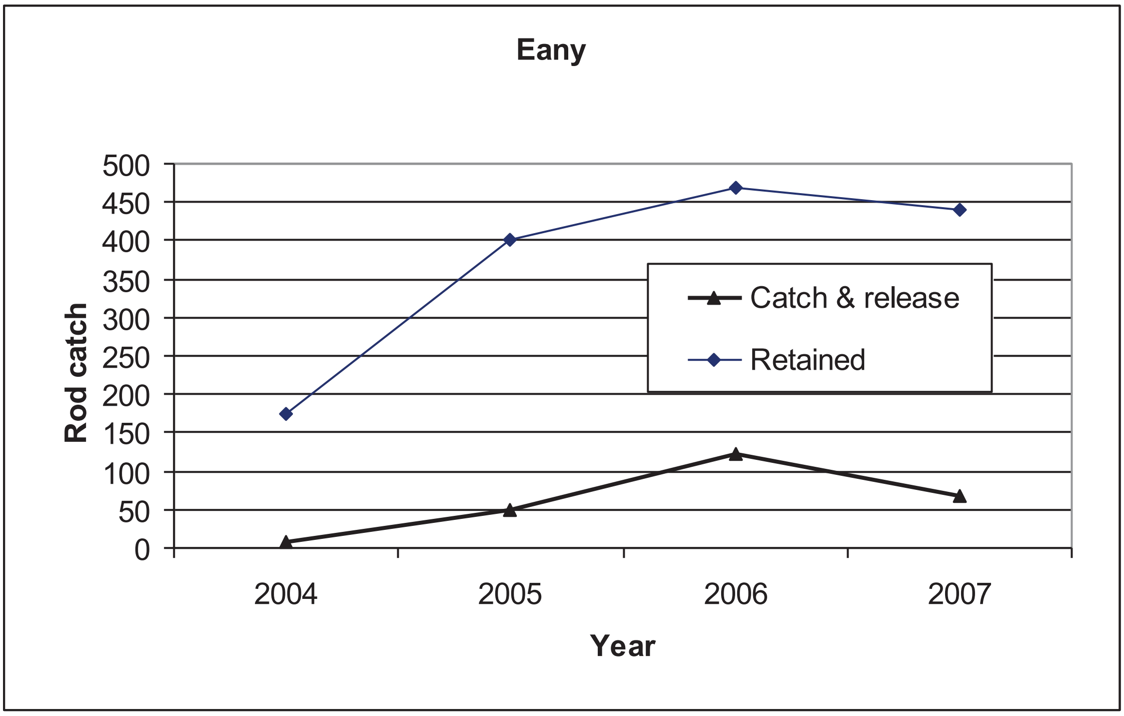


Fig. 5.8.2: Salmon rod catch data for the Eany River.

The Eany system drains an area of 119.3km^2. Its main branches are the Eanybeg, Sruell and Eglish rivers. The dominant geology of the Eany catchment is carboniferous limestone with smaller amounts of schists and gneiss also found. Land use is mainly peat bog and agricultural/natural vegetative. In the headwaters of the Eanybeg and Eanymore the Meenaguse/Ardbane bog is a Special Area of Conservation (SAC) (Annex I; EU Habitats Directive). Within the NRFB area, the Eany River is ranked second after the Leannan with 656,530m^2 of habitat accessible to salmon.

Over the past two decades salmon redd counts < 100 per annum have been frequently recorded with notable exceptions in 1996/97 and 2001/2002 when higher numbers were observed (Fig. 5.8.3). Discounting the poor counting conditions in two recent spawning periods (2004/05 and 2006/07) and the exceptionally high outlier in 1996/97 the redd count data suggest that the Eany salmon populations are trending towards a low *status quo*. These data are inconsistent with the rod catch and counter data up tp 2007 and the positive Conservation Limit attainment assessment. The implication for redd counting as a monitoring technique is further discussed in the Conclusions and Recommendations section of this report.

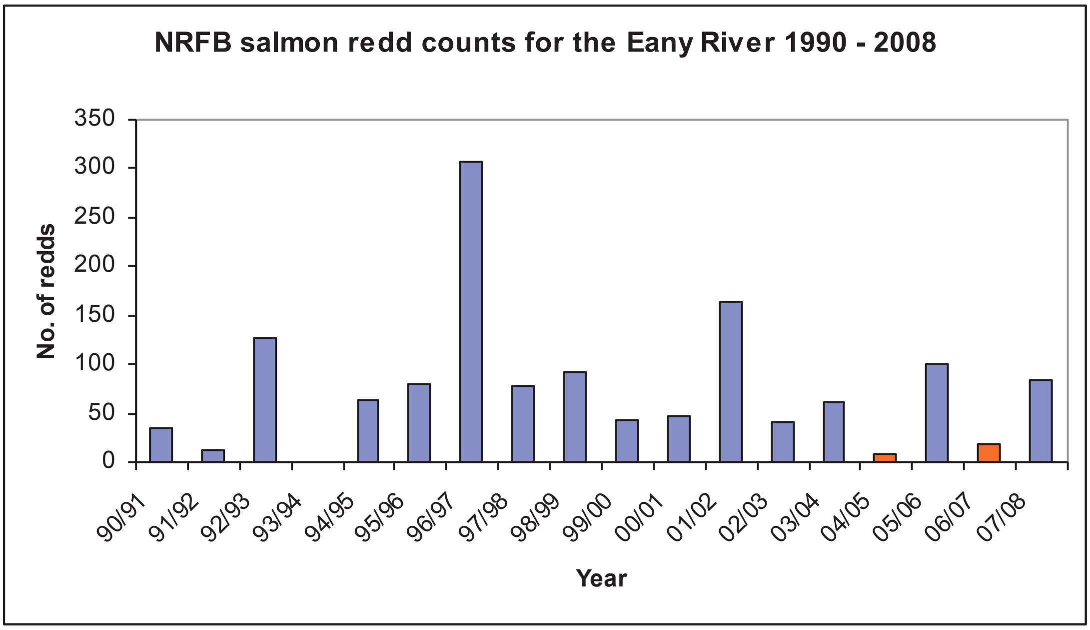


Fig. 5.8.3. Salmon redd count data for the Eany catchment 1990 to 2008. No data for 1992/93 or 1996/97. High water levels resulted in poor counting efficiency in years are shaded in red.

5.8.2. Electrofishing survey results

Nineteen sites were surveyed throughout the Eany catchment in summer 2005 (Fig. 5.8.6). Juvenile salmon were widely distributed in the catchment and were recorded to the limit of their potential distribution as defined by the presence of three natural barriers. The exception was the Eglish River where no physical barrier was identified yet salmon distribution was limited to its middle reaches. Salmon were absent from four sites (En1, En11, En13, and En15). The absences at En 11 and En15 were unexpected as juvenile salmon were recorded at sites upstream and downstream. Trout were recorded at both sites which indicated no localized water quality problems.

For the remaining sites 0+ salmon density estimates ranged from 0.03 and 1.09 fish/m^2 (Appendix 4: Table 8). In general, 0+ densities were low with only three sites recording high densities (> 0.5/m2) (Sites En8, En14 and En 18). However, as with several other catchments surveyed the extent of the distribution of salmon fry in this large riverine catchment and the availability of habitat result in high overall juvenile production levels. This was reflected in salmon parr densities which were moderate to extremely high throughout the catchment (apart from the isolated zero density sites). Parr densities ranged from 0.07 and 0.67 fish/m^2 (Appendix 4: Table 8) and parr were well distributed in the catchment. Many sites recorded parr densities > 0.1/m2 (Fig. 5.8.7) as also indicated in the catchment site density distribution graph (Fig. 5.8.5).

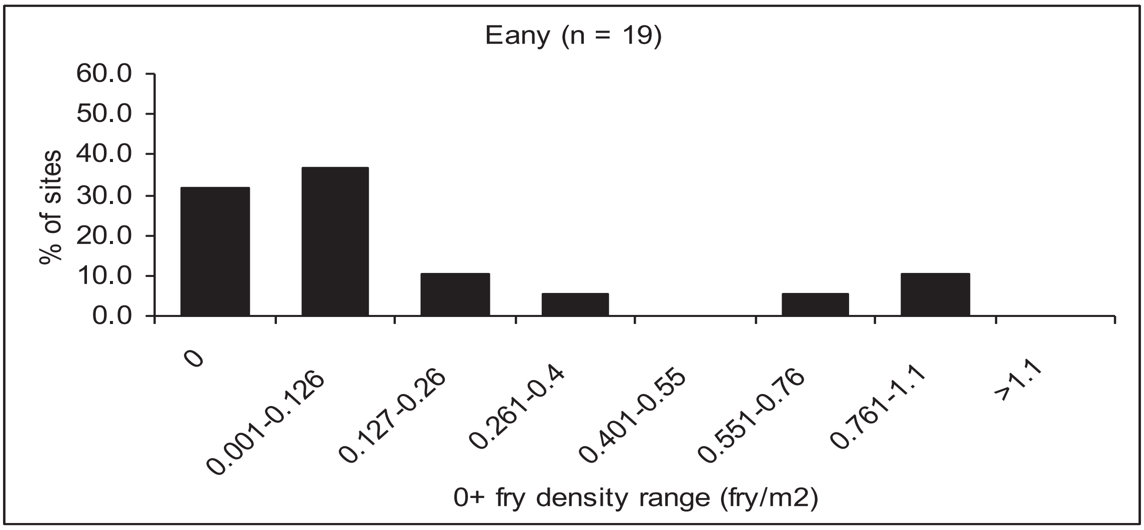


Fig. 5.8.4. Salmon fry density distribution for the Eany catchment 2005

Trout were recorded at all sites electrofished although not all life stages were encountered. Densities of trout fry were generally low with the highest densities restricted to the extremities of the catchment (Fig. 5.8.8). Trout parr densities were also low with some moderate densities in the extremities (Fig. 5.8.9). Other fish species recorded were eels, 3 spined stickleback, flounder and lamprey (Appendix 6: Table 8). Eels were collected at every site while the distribution of other species varied throughout the catchment. The latest EPA Q-values indicate good water quality for the Eany catchment with a rating of 4-5 in 1999 (Table 15; Fig. 41).

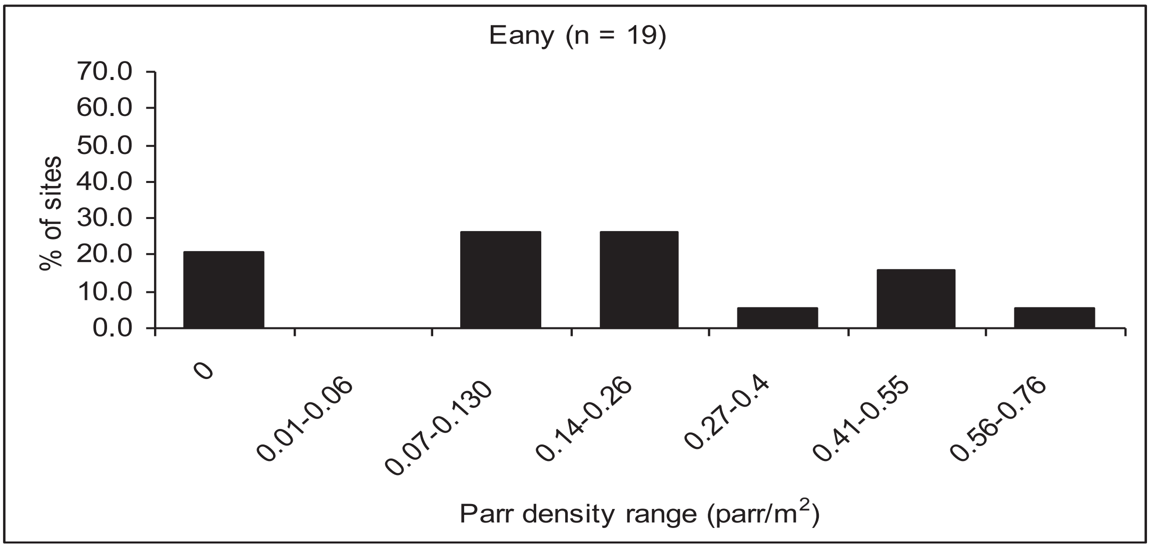


Fig. 5.8.5. Salmon parr density distribution for the Eany catchment 2005

5.8.3. Physical habitat assessment and recommendations for improvements

Various indices indicate that the Eany system is a productive salmon catchment. Significant stocks of salmon fry and parr were noted at many locations although high fry densities were not consistently recorded.

Survey data suggest one experimental enhancement option for selected sections of the Eany More Water. Many reaches of this particular channel are dominated by smooth sheet bed rock (Plate 5.8.1) which is of limited value particularly for salmonid fry. From a fisheries perspective this habitat is extremely unproductive supporting few aquatic plants or macroinvertebrates. Salmonids have limited resting areas and production is low.

The proposal is to deploy a rockbreaker to break up selected sections of the sheet bedrock, thereby creating additional highly productive salmon nursery areas (as shown in Fig 5.8.12). The process would involve excavating a thalweg

Plate 5.8.1. Eany More upstream of Letterbarra Br. with smooth sheet bedrock substratum which dominates the channel in these reaches

through the sheet bedrock leaving a rough rubble strewn bed in this zone (Plate 5.8.2). Some of the larger pieces of broken rock could be used to build deflectors to confine summer flows within the revised thalweg and accelerate flows. The altered bed type and increased flow velocities should create additional highly productive salmon parr nursery areas. Given the high stock densities of salmon fry recorded in the Eany More there are likely to be surplus fry to occupy such areas, thereby ultimately increasing smolt output. This proposal would alter one of the most unproductive salmon habitat types into productive water. Similar artificial channels in the Moy Catchment, excavated for drainage purposes, are among the most productive salmon parr waters in Ireland.

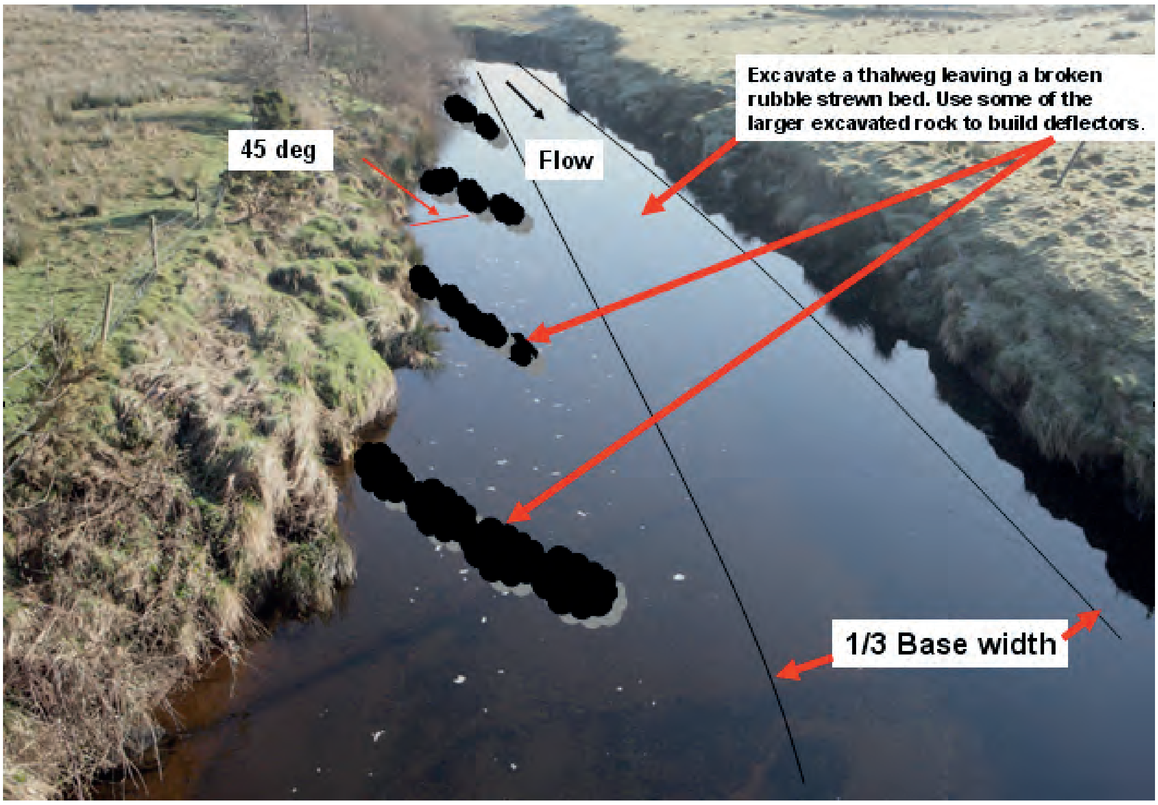


Plate 5.8.2. Schematic plan for proposed experimental habitat enhancement in the Eany More upstream of Letterbarra Br.

Based on current (2006) salmon parr stock densities in the Eany catchment it is likely that this type of new habitat might support circa 0.6 x 1+ parr/m^2. Offsetting costs against likely gains, with a capital write-off over 20 years, additional smolts produced would probably cost circa €0.5 per fish.

There are numerous reaches in the Eany More where this type of enhancement programme could be considered. The most productive works could be undertaken, at intervals, from Drumboarty Bridge downstream to Drumagraa Bridge.

Given the experimental nature of this proposal it is recommended that the NRFB carry out a pilot programme in this area which should be monitored closely over three years to assess both the effectiveness and cost of such a programme.

5.8.5. Conclusions

The physical habitat in the Eany system is extremely stable. Based on electrofishing data this extensive catchment is very productive for salmon parr and this is reflected in consistently high rod catches which translate into regular attainment of CL. Salmon fry were widespread but densities were generally low – the highest densities were recorded in close proximity to spawning areas only. Low redd counts are a feature of the Eany catchment dataset – this probably reflects widespread redd distribution in isolated pockets in sections of the catchment rather than densely populated spawning areas which may be difficult or too disparate to count properly. The creation of additional spawning areas could be warranted but as gravels are highly mobile in spatey catchments their introduction may create erosion problems where none currently exist and a do-nothing option is preferable.

Counter data suggest that the high parr densities in 2005 were reflected by good runs of grilse in 2007. Equally, the low fry densities recorded at that time appear to be relected by poor grilse runs and relatively low rod catches in 2009.

Elective habitat works are recommended to enhance parr production capacity. These works should be undertaken on an experimental basis initially and monitored before proceeding with a full scale programme. The Eany programme is not a priority given the catchment's stability, as previously reported by Roche (2002), which, in turn, has generated high annual rod catch up to 2007. However, the recent decline may lead to a revision of this status and close monitoring of the counter data and associated juvenile productivity levels is warranted.

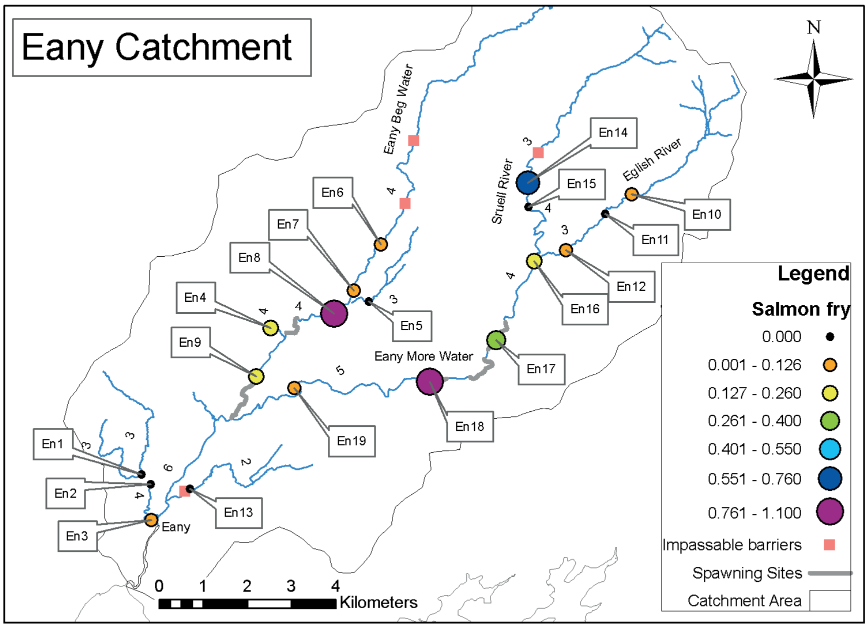


Fig. 5.8.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Eany catchment. Numbers on map represent stream order and grey line represents spawning areas.

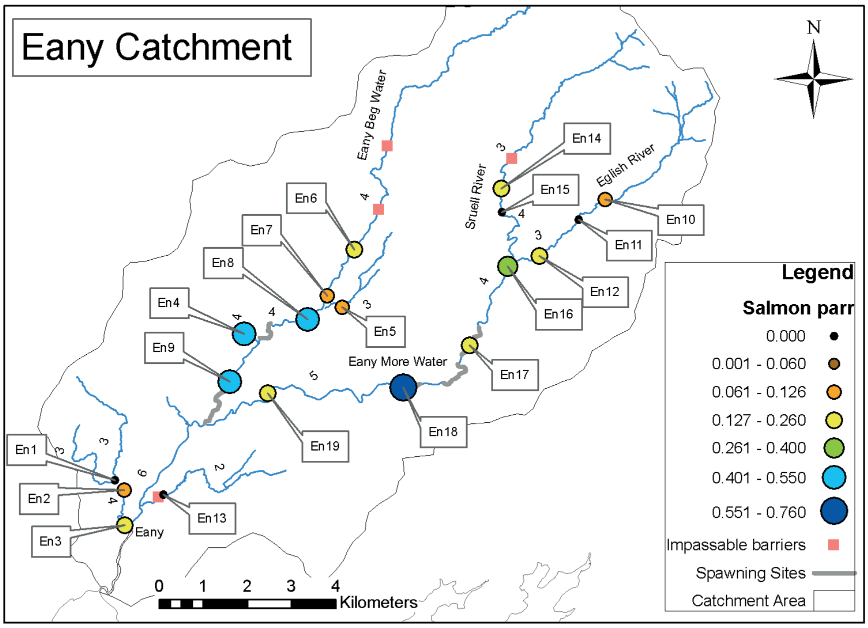


Fig. 5.8.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Eany catchment. Numbers on map represent stream order and grey line represents spawning areas.

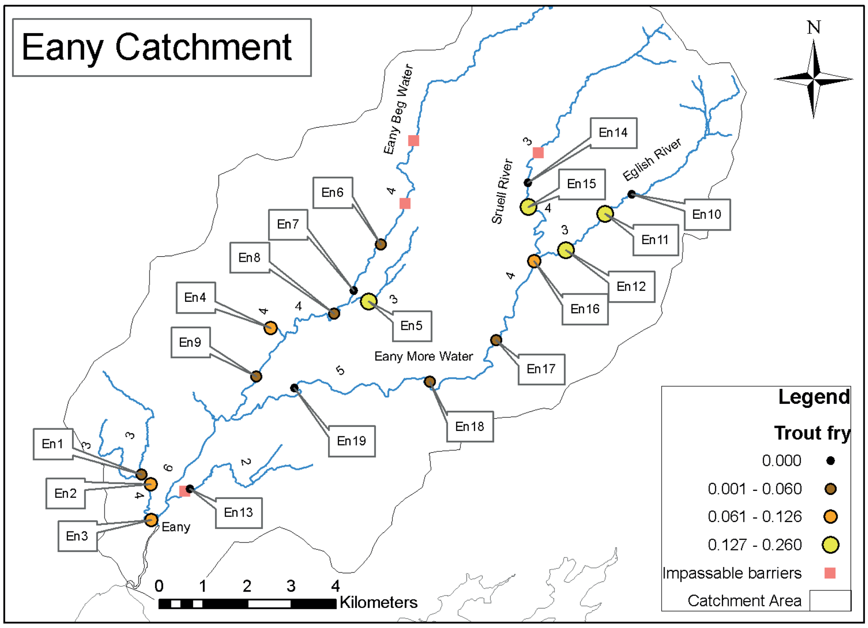


Fig. 5.8.8: Trout fry distribution and quantitative density estimates (no./m2) in the Eany catchment. Numbers on map represent stream order and grey line represents spawning areas

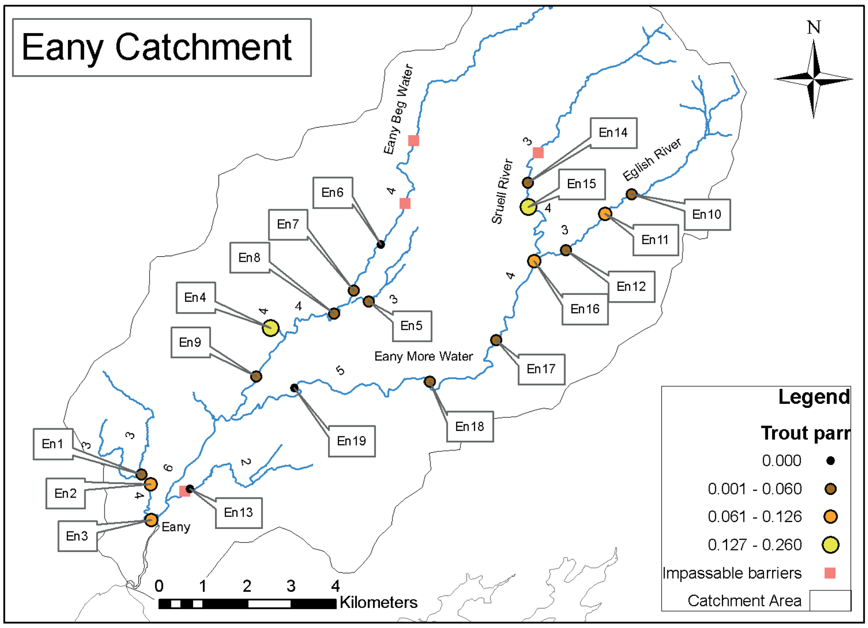


Fig. 5.8.9: Trout parr distribution and quantitative density estimates (no./m2) in the Eany catchment. Numbers on map represent stream order and grey line represents spawning areas.

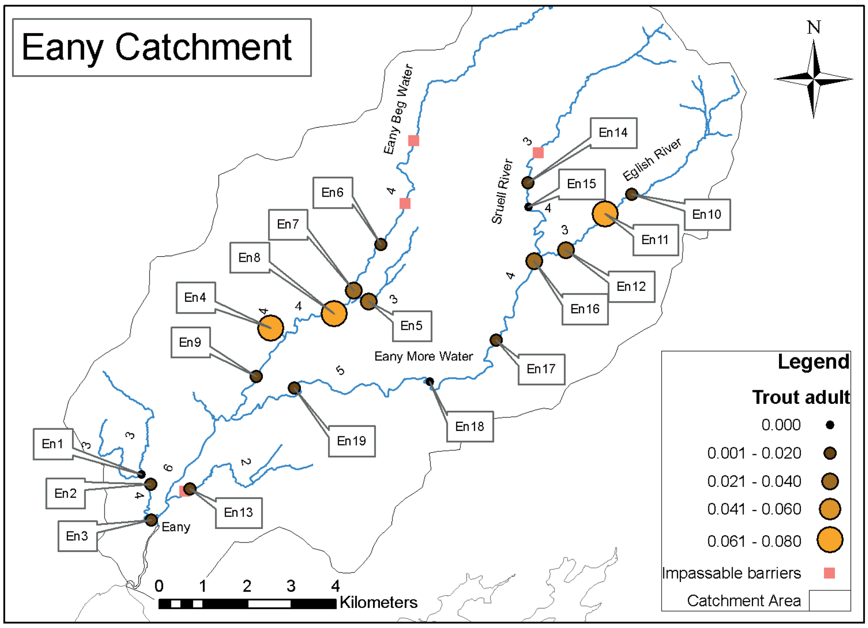


Fig. 5.8.10: Trout adult distribution and quantitative density estimates (no./m2) in the Eany catchment. Numbers on map represent stream order and grey line represents spawning areas.

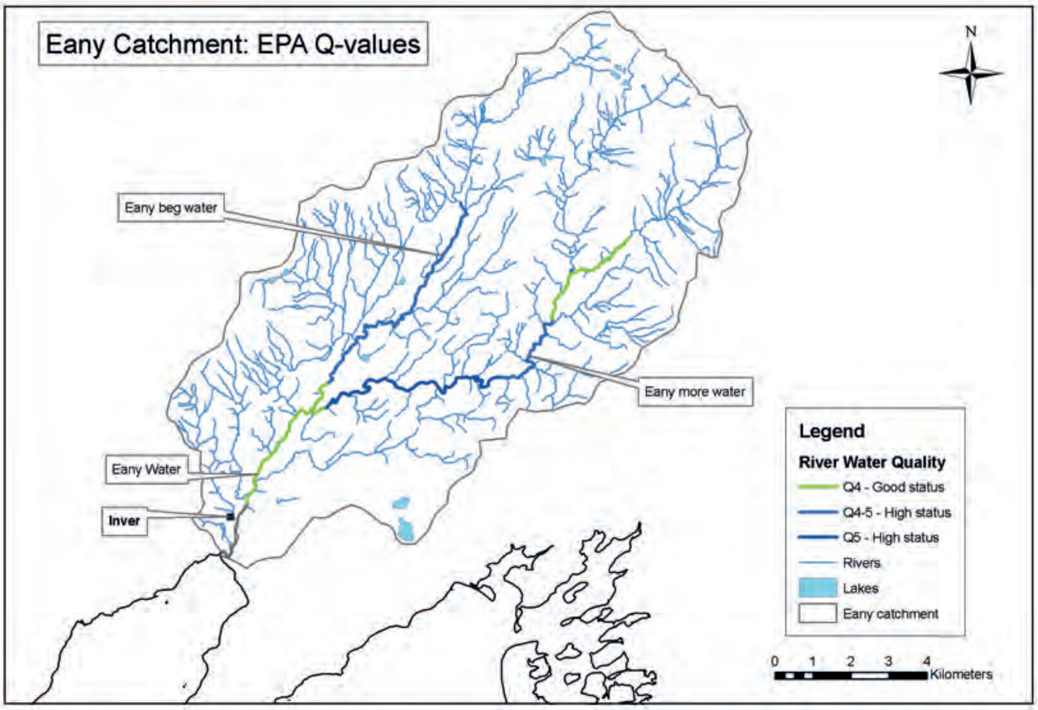


Fig. 5.8.11: Plot of EPA Q-values for the Eany catchment.

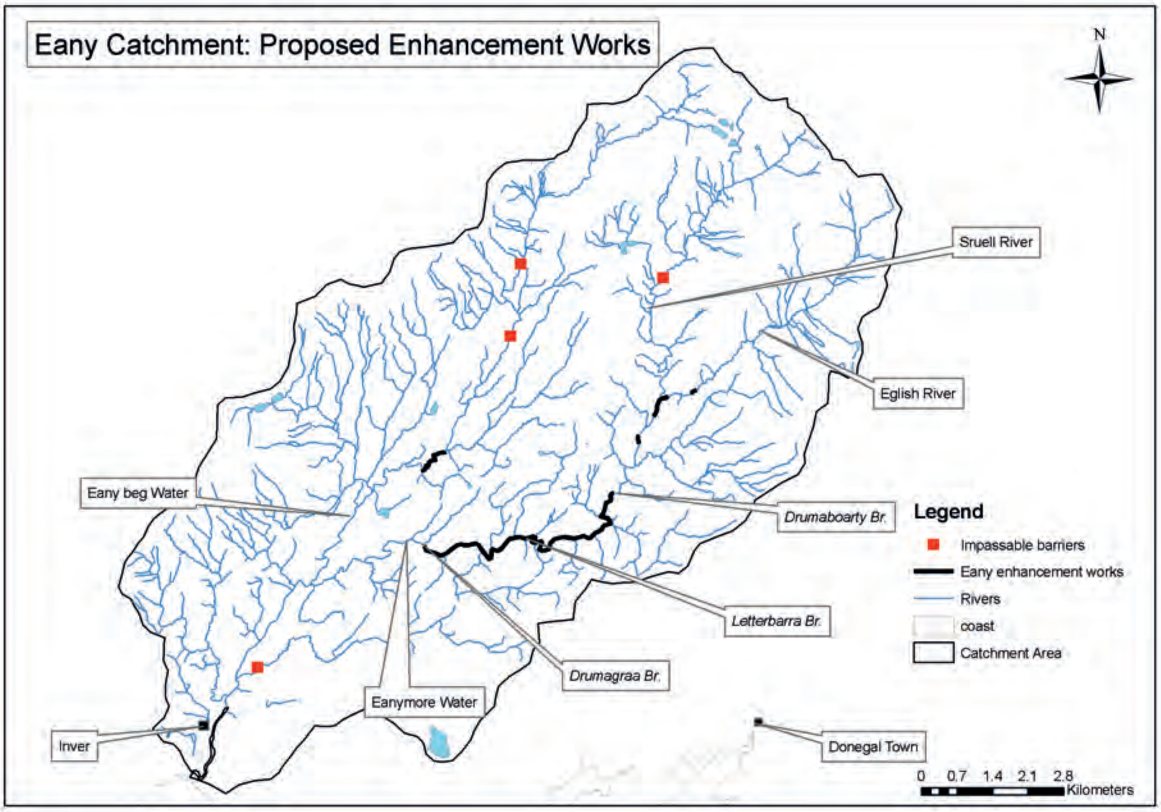


Fig. 5.8.12: Plot of proposed enhancement works for the Eany catchment with 7.5kms of channel requiring works.

5.9. Eske Catchment

5.9.1. Introduction

The Eske system, which drains a catchment area of 112.5km^2, rises in the Blue Stack and Tawnawully Mountains and flows in a southwesterly direction entering the sea at Donegal Town.

Comprising Lough Eske, an oligotrophic lake and a productive mixed fishery with some spring salmon, grilse, sea trout and brown trout, and the River Eske downstream of the lake, this fishery is directly managed by the NRFB. The river provides grilse angling in summer and the NRFB have invested heavily in angling infrastructure and improvements including a fish counter.

A fish pass was installed (modified in 2007) on a natural barrier on a major tributary, the Lowerymore River, following the installation of a hydropower facility. This has increased available salmon spawning and nursery habitat in the catchment significantly.

The underlying geology is quite varied with large areas of schist and gneiss but also limestone and smaller amounts of granite and shales. The principle land use is pasture, especially within the lower reaches of the system but also natural vegetation and peat bogs, are commonplace. Lough Eske, together with large stretches of the main channel and several tributaries, are listed as an SAC under Annex I and II of the EU Habitats Directive.

Accounting for 0.38% of the national accessible wetted area total (McGinnity *et al.* 2003 ;) the Eske catchment is ranked 49th of 173 catchments. Regionally it is ranked 6th with 431,848m^2 of habitat accessible to salmon.

Rod catches have improved steadily on the Eske but the system is consistently underperforming in terms of Conservation Limit attainment.

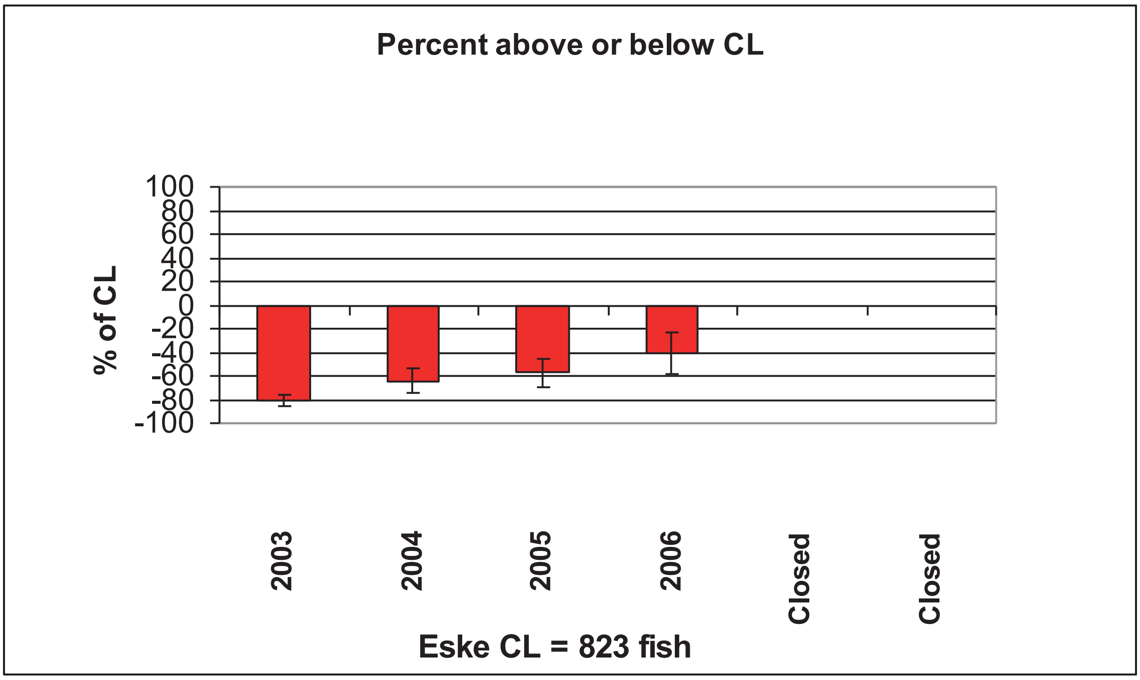


Fig. 5.9.1: Plot of salmon spawning escapement for the Eske system, expressed as percentage above or below the Conservation Limit

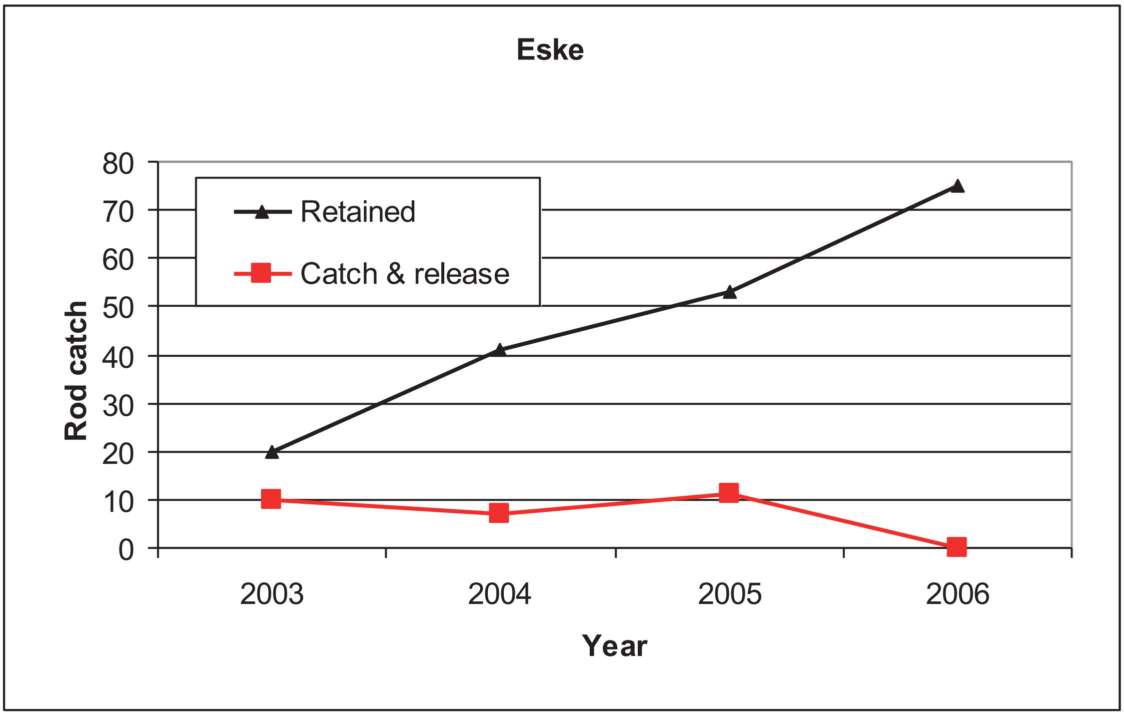


Fig. 5.9.2: Salmon rod catch data for the Eske catchment.

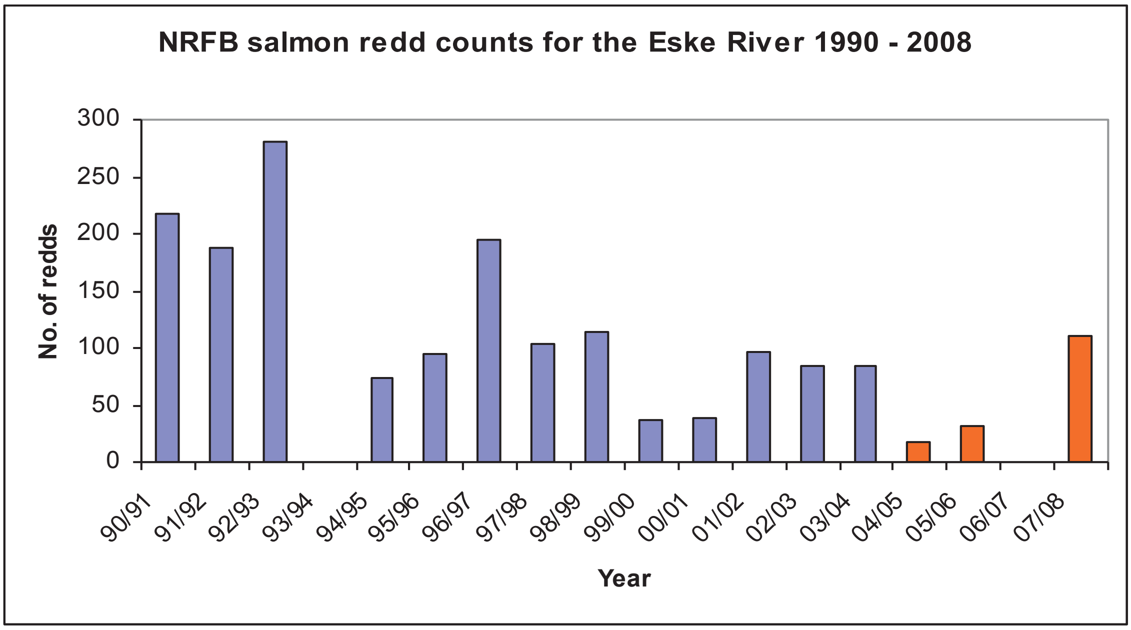


Fig. 5.9.3. Salmon redd counts for the Eske River. **Red shading = poor counting efficiency**

Redd counts for the Eske over the past two decades show two distinct phases. In the early 1990s, for a period of three years, counts ranged from 187 to 280 redds (average 228 per annum) (Fig. 5.9.3). Subsequently counts were low averaging about 80 redds (range 18 – 114). Poor counting conditions underestimated counts for the past four years but the decline is marked.

5.9.2. Electrofishing survey results

A total of eight sites were surveyed in the Eske catchment in summer 2006 (Fig. 5.9.6). Juvenile salmon were recorded in each of the larger tributaries but their distribution was limited to the middle and lower reaches. Where salmon were recorded densities were generally poor apart from the lower Lowerymore and its tributary the Clogher River, where some exceptionally high 0+ estimates were obtained (Appendix 4: Table 9; Figs. 5.9.4 & 5.9.5). These high densities were recorded in the lower reaches of this extensive subcatchment and demonstrated the significance of this prime spawning area to the Eske catchment. No salmon fry were recorded at three sites and the absence of salmon parr at one of these (Ek5) on the Clogher River, suggests the presence of a previously unknown impassable barrier. In the Corabber, where anadromy is curtailed by natural barriers, low densities were recorded in enhanced habitat (Site Ek2) which should support higher densities of juveniles.

Sampling the main channel of the Eske was attempted but rising water levels limited electrofishing efficiency so the data are not presented. One indicator of poor juvenile salmon numbers in the main channel was the lower than average numbers of juvenile salmon, based on catch of fry and parr per unit effort of time, recorded from the artificial spawning bed situated at the Lough Eske outflow in the course of genetic sampling of juvenile salmon in 2006.

Trout were widely distributed. In general, densities of fry and parr were low (Figs. 5.9.8 & 5.9.9). The exception was the Drummenny River where good fry and exceptionally high parr densities were recorded. Four finnock were recorded during the Eske survey and three of which were captured at Site Ek 8 in the lower Drumenny. Preliminary observations of sea trout populations suggest that these migrants tend to migrate en masse into the first major tributary in a system which may account for the high trout densities in the Drumenny. High densities of trout were also anticipated for the lesser tributaries discharging directly into Lough Eske as is the norm for similar catchments but this was not observed.

Other fish species recorded in this system were eels and flounder (Appendix 6: Table 9). Eel distribution was widespread but numbers were poor.

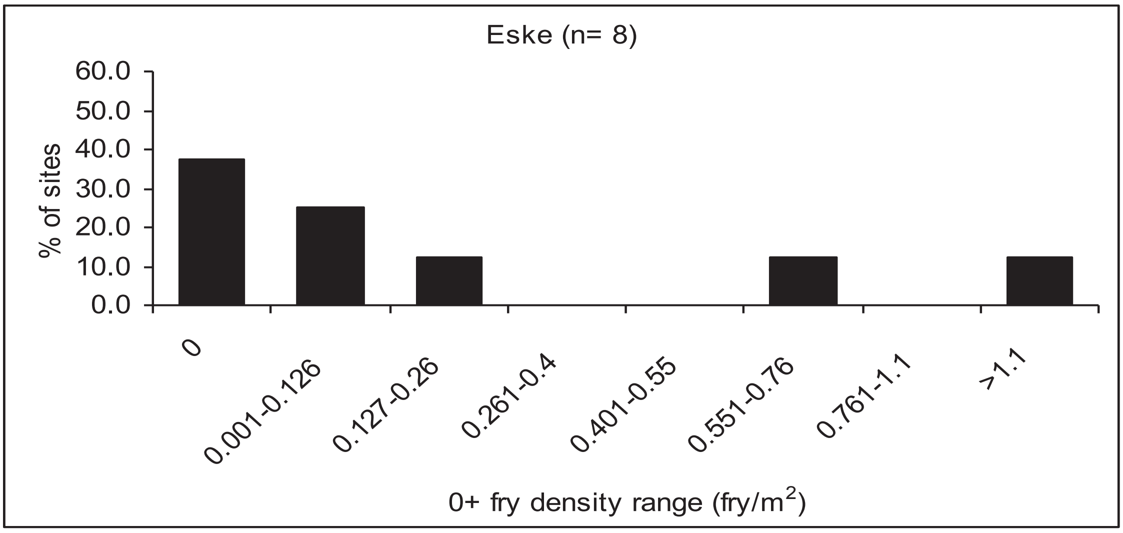


Fig. 5.9.4. Salmon fry density distribution for the Eske catchment 2006

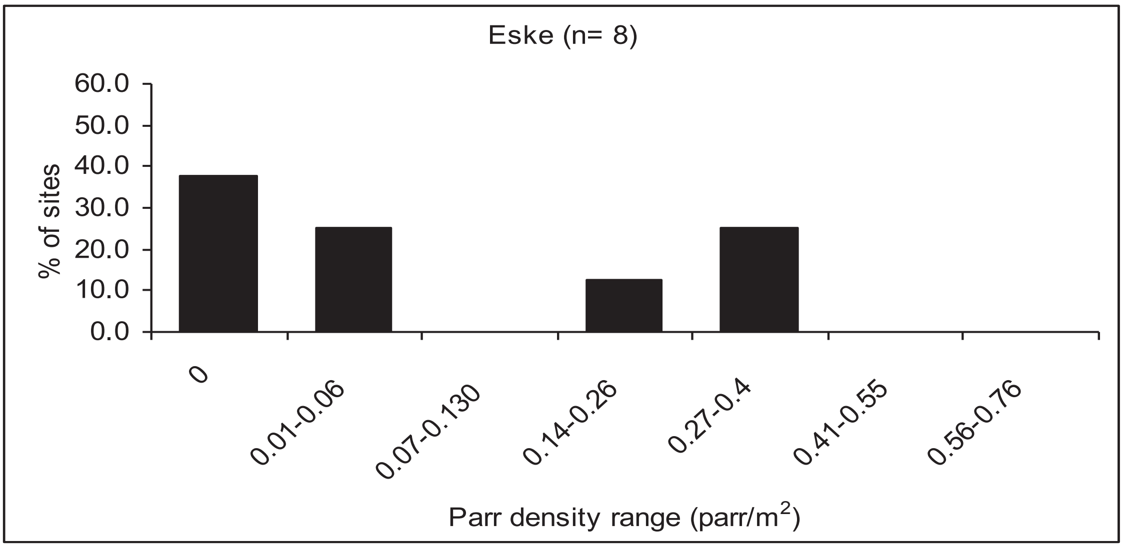


Fig. 5.9.5. Salmon parr density distribution for the Eske catchment 2006

The Eske catchment was surveyed in 1993 by Boylan and Sheridan to establish the status of salmonids stocks (Appendix 7: Table 4; Fig. 6). Similar densities were collected in the 1993 data for both trout and salmon as in the 2006 survey, indicating relatively stable populations. However, there is potential to increase the population with a detailed enhancement program improving the habitat availability for salmonids.

5.9.3. Physical habitat assessment and recommendations for improvements

EPA Q-value data show good water quality for the Eske catchment with an average Q of 4-5 (Appendix 2: Table 9; Fig. 5.9.11). Lower quality was evident in the Corrabber and at Donegal town.

In terms of physical habitat the Eske catchment displays extremes. The majority of channels, including the main channel, are stable with an extensive riparian zone and little erosion. The extreme is the Lowerymore tributary – this extensive subcatchment is subject to major bank erosion problems due to a combination of severe flows which occur naturally and regularly and overgrazing. Vulnerable banks are being continuously eroded. Significant improvements in salmon and trout production could be achieved by implementing the following works programme in a number of specific areas:

- **Shrub pruning programme**

Extensive shrub pruning in the Lowerymore, from the Lowerymore falls to Lough Eske would increase salmonid productivity. The extent of shrub pruning required on the Lowerymore and other channels in the Eske catchment is shown in Figure 5.9.12. Typical examples of the extent of shading are provided for the Lowerymore and Drummenny streams in Plate 5.9.1. Shading is also a feature of the lower reaches of the Clogher River from Clogher Bridge to its confluence with the lower Lowerymore. Exceptionally high densities of salmon fry were recorded in this channel where the distribution of salmon is limited to the lower reaches. The extent of this dense shade is also very evident in the aerial photographic series for the Lowerymore (Plate 5.9.2). Shrub pruning would also be of benefit in the lower reaches of the other minor tributaries flowing directly into Lough Eske. Electrofishing data suggest that trout, not salmon, would be the major beneficiaries of a pruning programme.

Plate 5.9.1. Shading in the lower Lowerymore (left) and the lower Drumenny (below left) Rivers, tributaries of the Eske system.

- **Rip-rap programme**

In contrast, in the upper reaches of the Lowerymore, above the falls, a completely different ecological imbalance is evident (Plate 5.9.2). Serious degradation of channel morphology and a complete absence of vegetation in the riparian zone characterise this extensive length of channel. As salmon can now migrate upstream due to the improved fish pass at the falls it is crucial that extensive works be carried out in the upper Lowerymore to improve both the ecology and morphology of this reach. Two key measures are required:

- Extensive use of rip-rap to restore bank stability in areas where there is very severe erosion

- A major fencing programme to exclude all livestock from the immediate river corridor followed by a tree planting programme (Figure 5.9.12 and 5.9.13).

5.9.2. Shading in mid-summer in the lower Lowerymore (left) downstream of the now passable Lowerymore falls. A typical reach of the Lowerymore (below left) with severely degraded habitat which extends downstream of Barnesmore Gap for 3km.

Major ecological and physical imbalances are evident in the most important salmonid spawning and nursery subcatchment in the Eske System, the Lowerymore. Following completion of the proposed enhancement programme available data suggest that a four- to five- fold increase in salmon smolt production levels and a significant increase in sea trout smolt production are achievable.

5.9.4. Conclusions

Salmon densities were generally poor in the Eske catchment apart from two sites (Figs. 5.9.6 and 5.9.7). Difficulties were encountered in sampling the main channel due to high water levels but observations from genetic sampling in 2007 (Roche, pers. comm.) indicated that juvenile salmon populations were low in the artificial spawning area downstream of the lake which appears to be consistent with the general observations about the salmon stock in the system. Other indices like the redd count support this finding. Despite significant investment in the fishery in enhancement works including fish passage and instream works the Eske is underperforming in terms of salmon production.

Interestingly low densities of juvenile trout were also observed in the tributaries to Lough Eske. Typically, in lesser tributaries discharging directly into trout lakes, densities are usually extremely high. These tributaries would normally be utilized by either resident brown trout and/or sea trout for spawning. The coincidence of low densities of juvenile salmon (with two notable exceptions) and trout is noteworthy and may be indicative of a more substantive problem. Sea lice emanating from marine salmon cages has been linked with the demise of sea trout populations in the West of Ireland (Gargan et al, 2003) and more a recent study (Gargan pers. comm.) suggests that this problem may be a factor in salmon smolt mortality also. Gargan and his co-workers found that the release of SLICE®-treated and control groups of hatchery-reared salmon smolts into aquaculture bays allowed for assessment of the potential impact of sea lice induced marine mortality. Analysis of tag recaptures showed that SLICE-treated smolts experienced increased survivorship over untreated controls in all seven releases when farm net-pens were in production. The data also indicate that un-treated smolts experienced reduced marine growth compared to treated groups, perhaps due to sub-lethal effects of early infestation of salmon smolts by larval sea lice. Experimental results are being prepared for publication.

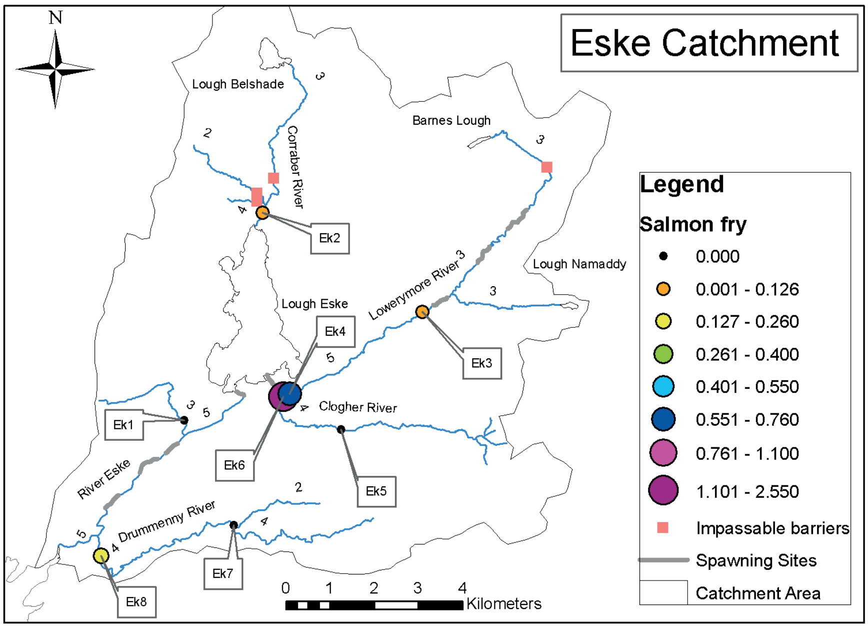


Fig. 5.9.6: Salmon fry distribution and quantitative density estimates (no./m2) in the Eske catchment. Numbers on map represent stream order and grey line represents spawning areas.

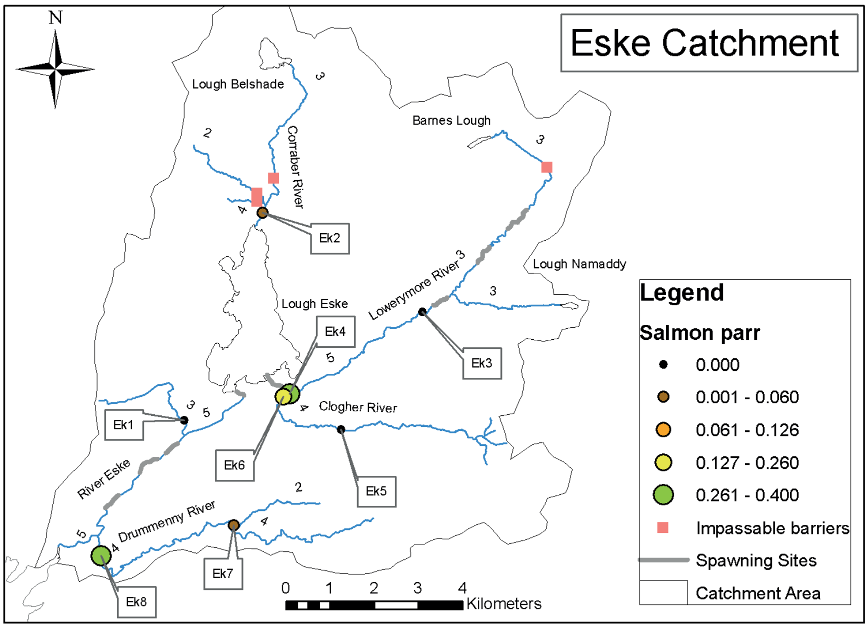


Fig. 5.9.7: Salmon parr distribution and quantitative density estimates (no./m2) in the Eske catchment. Numbers on map represent stream order and grey line represents spawning areas.

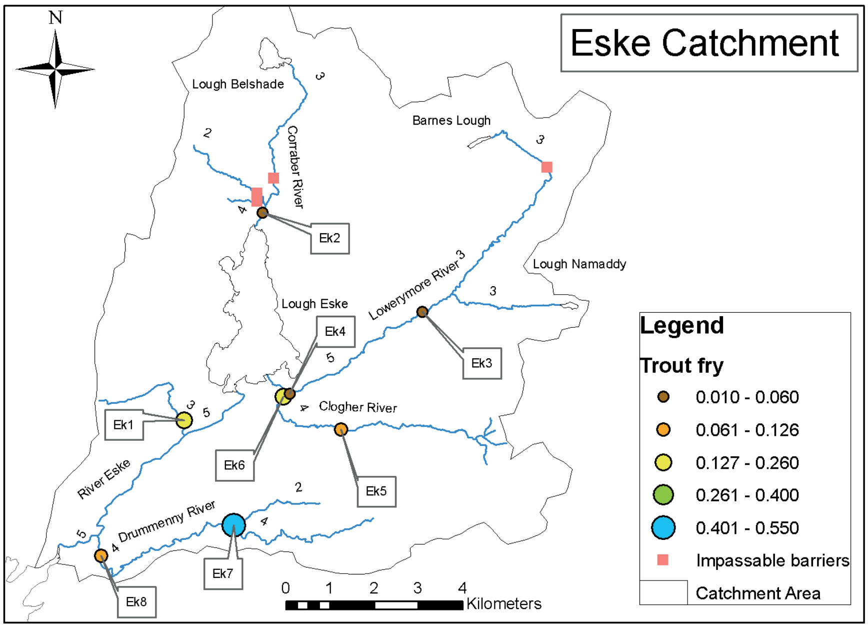


Fig. 5.9.8: Trout fry distribution and quantitative density estimates (no./m2) in the Eske catchment. Numbers on map represent stream order and grey line represents spawning areas

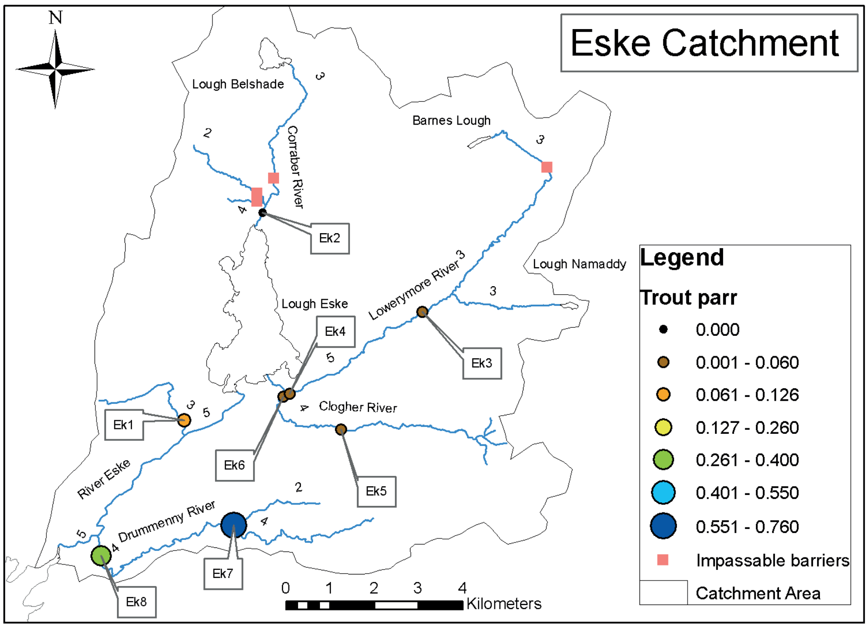


Fig. 5.9.9: Trout parr distribution and quantitative density estimates (no./m2) in the Eske catchment. Numbers on map represent stream order and grey line represents spawning areas

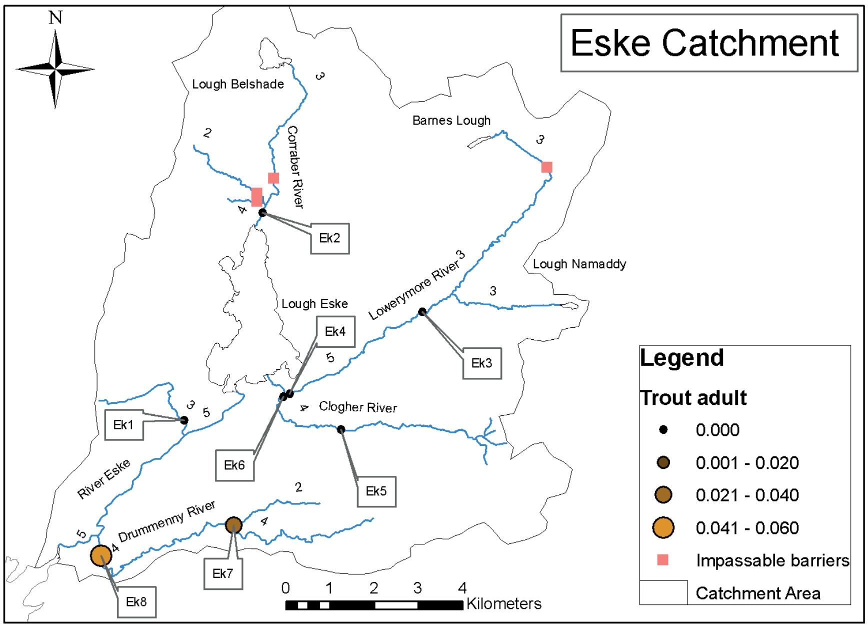


Fig. 5.9.10: Trout adult distribution and quantitative density estimates (no./m2) in the Eske catchment. Numbers on map represent stream order and grey line represents spawning areas

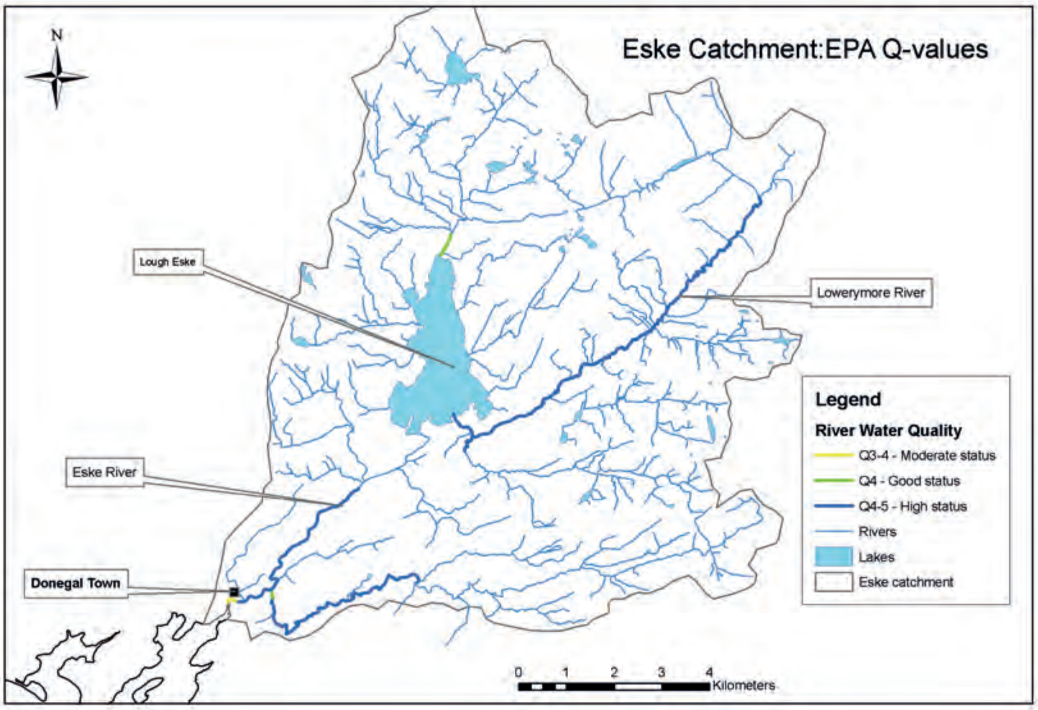


Fig. 5.9.11: Plot of EPA Q-values for the Eske catchment.

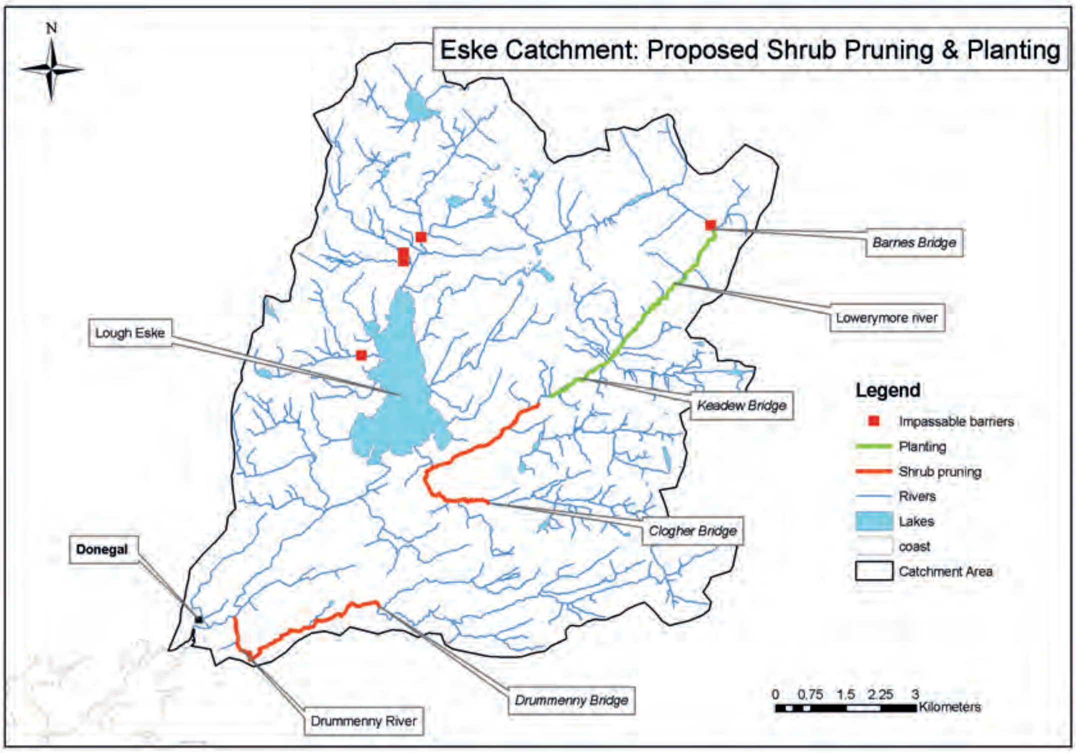


Fig. 5.9.12. The Eske catchment with proposed enhancement works. A total of 5.85km of shrub planting and 9.77km of shrub pruning.

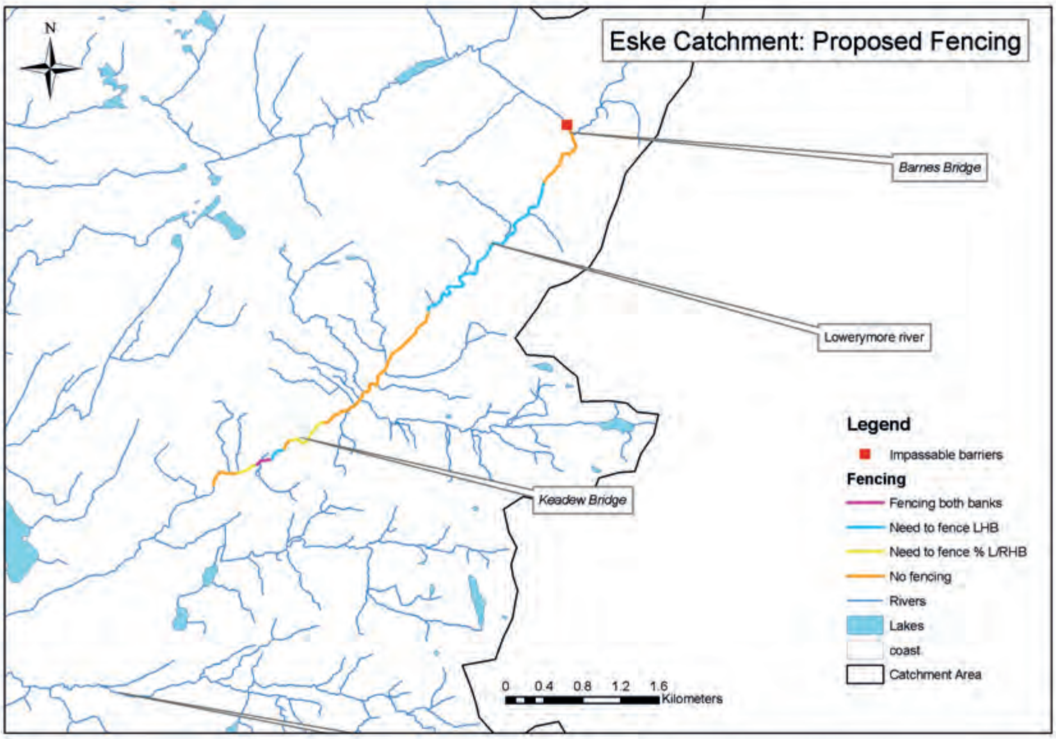


Fig. 5.9.13: Plot of the proposed 6.19kms of fencing on the Lowerymore River in the Eske catchment.

5.10. Drowes Catchment & Lough Melvin

5.10.1. Introduction

The Lough Melvin catchment is dominated by two productive fisheries. The outflow, the River Drowes, is one of the most prolific spring and summer salmon fisheries in Ireland. Lough Melvin is a prime salmon and trout fishery and one of the most important lake fisheries in the country. The system has comfortably exceeded its Conservation Limit in recent years (Figs. 5.10.1 a&b) and produces 450 to 700 salmon to the rod annually (Fig. 5.10.2).

Although the Drowes/Melvin catchment is one of the largest catchments (161.8km^2) in the Ballyshannon District the extent of accessible fluvial salmon habitat is limited accounting for 0.5% of the national total (McGinnity *et al.* 2003; Table 40). This is due to the presence of a large lake, Lough Melvin, and the dominance of the catchment by lesser tributaries (stream order ≤ 3).

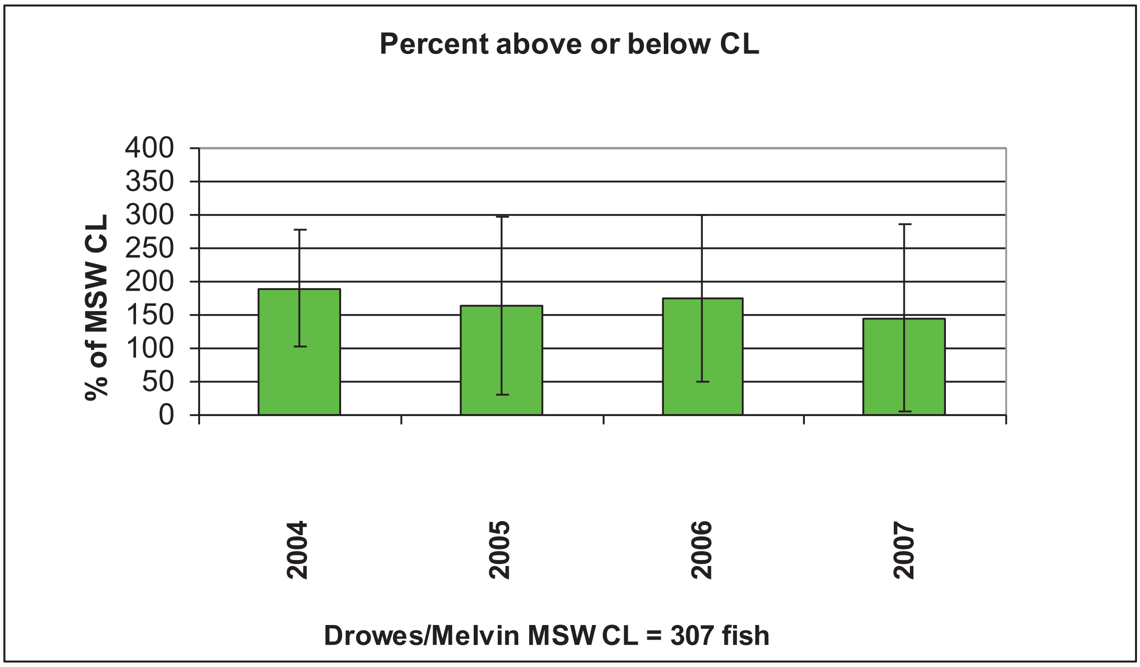


Fig. 5.10.1a: Plot of MSW salmon (spring) spawning escapement for the Drowes/Melvin system, expressed as percentage above or below the Conservation Limit

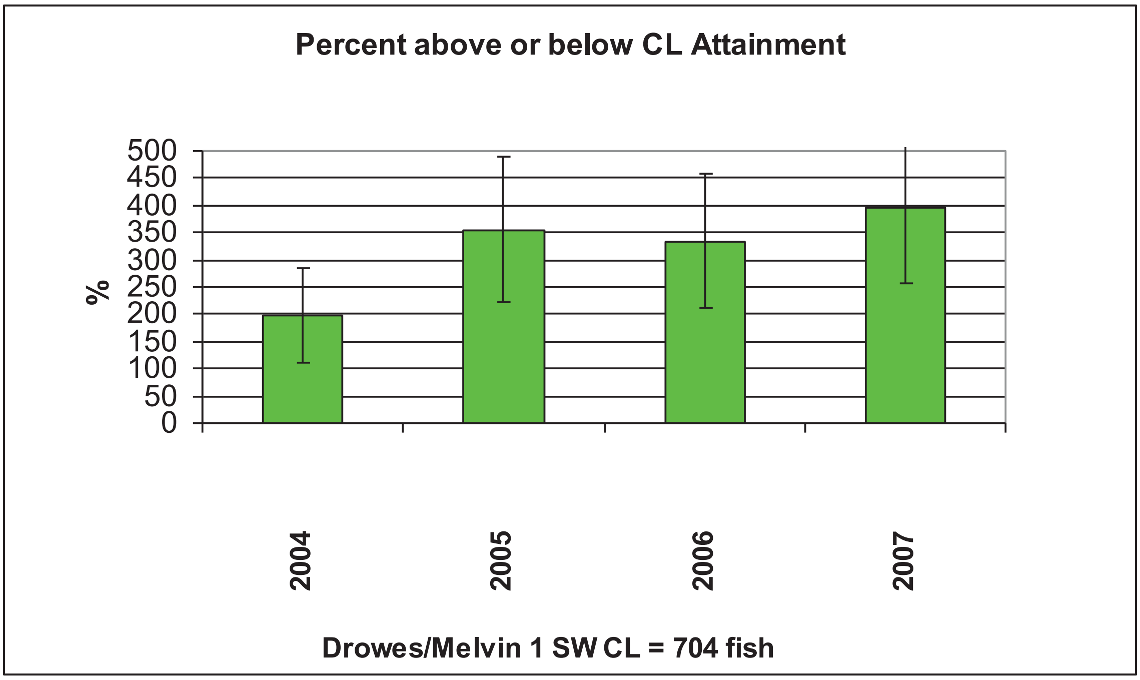


Fig. 5.10.1b: Plot of 1SW salmon spawning escapement for the Drowes/Melvin system, expressed as percentage above or below the Conservation Limit

Salmon redd count data for the past two decades are incomplete as no data are available from 1998 to 2001. However, this gap delineates a significant deterioration in redd numbers. The average count was 408 from 1990 to 1998. Between 2001 and 2008 the average is 103. The principal tributaries of Lough Melvin are the Glenaniff, the Ballagh, the County and the Roogagh Rivers. Individual redd count data are presented for the key spawning channels, the Drowes, the Ballagh and the Glenanniff Rivers in Fig. 5.10.3 . Redd counts in the Ballagh and Glenanniff have declined over the period whereas the Drowes has maintained a variable redd count but has become the dominant spawning channel based on these data. It should be noted that poor counting conditions have resulted in low counts since 2005 but this primary index suggests a decline in populations. The decline in redds is directly countered by stable rod catches and suggests that redd counting may require re-evaluation as a tool for salmon stock assessment.

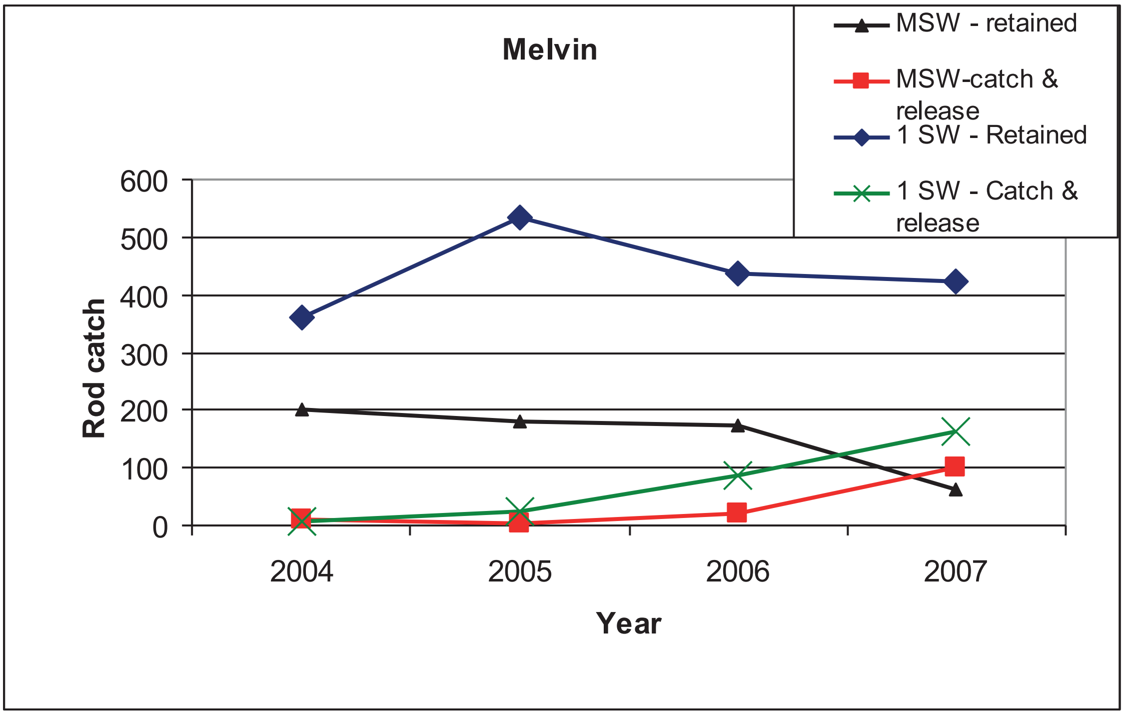


Fig. 5.10.2: Salmon rod catch data for the Drowes/Melvin system.

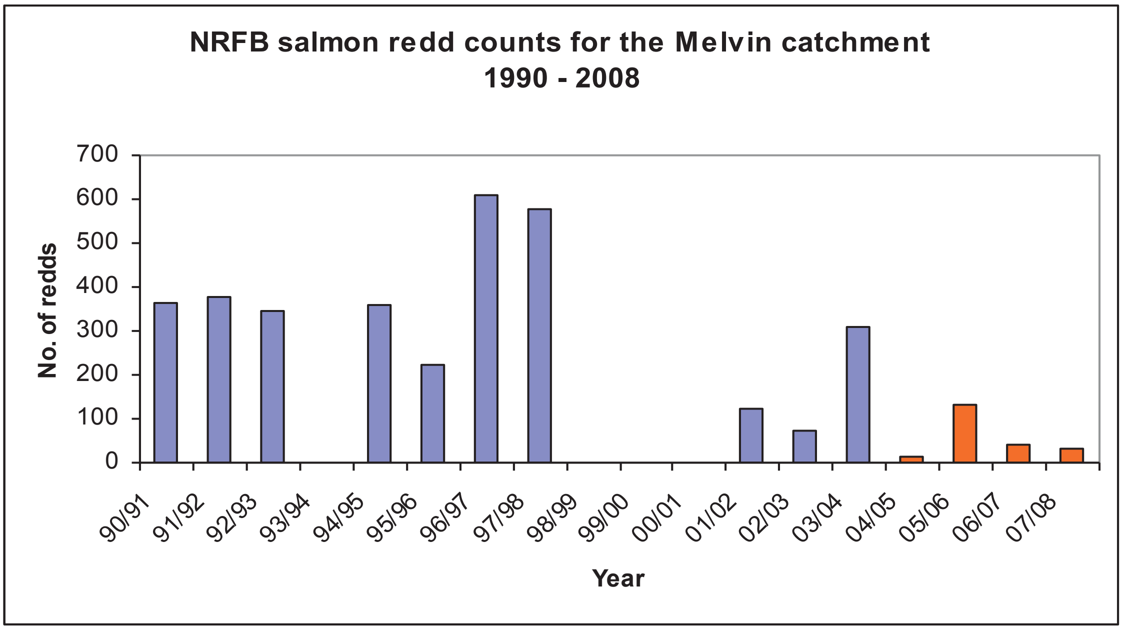


Fig. 5.10.3. Salmon redd counts for the Melvin/Drowes catchment Red shading = poor counting efficiency

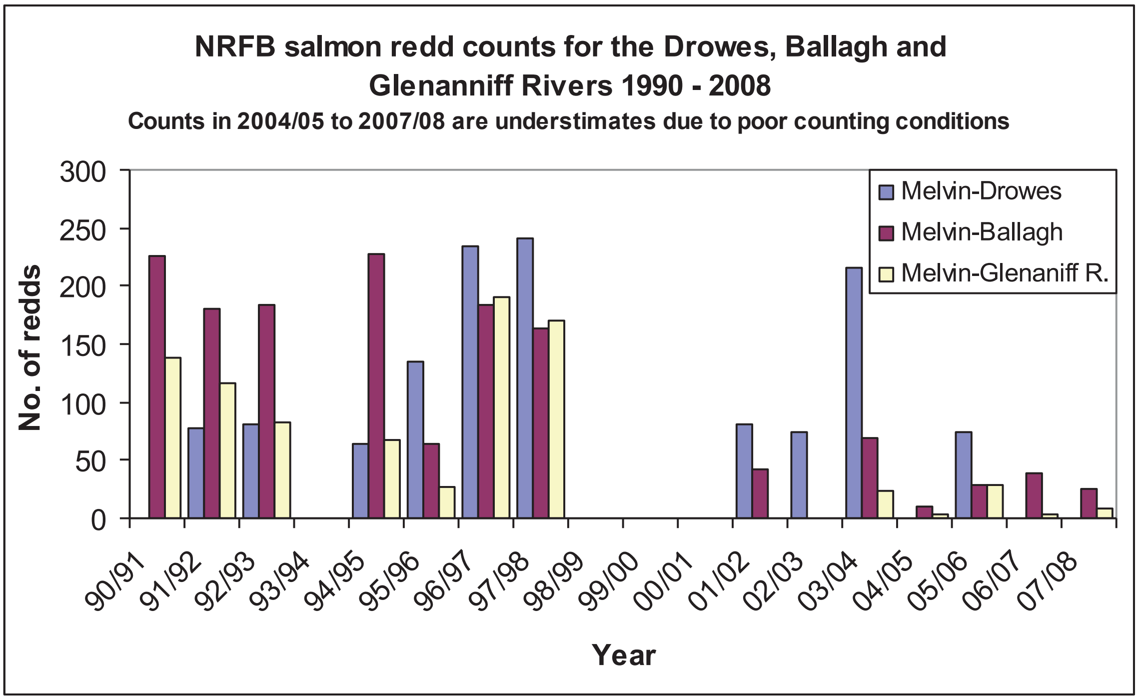


Fig. 5.10.4. Salmon redd counts by tributary in the Melvin/Drowes catchment

5.10.2. Electrofishing data

Because of the healthy status of the salmon rod fishery and the availability of extensive recent CFB/NRFB electrofishing data (2000 and 2001) it was decided on a value for money basis, when this extensive NRFB salmon rivers project was initiated in 2005, to combine these electrofishing data to present an overall assessment of juvenile stocks in the catchment.

In 1992 fourteen sites on the Glenaniff and Ballagh Rivers, the principal spawning channels, were surveyed (Gargan *et al.* 1993). In 2000 Gargan *et al.* (2001) resurveyed the majority of these sites and in 2001 fourteen sites on the County and Roogagh Rivers were surveyed to determine the status of the salmon and trout stocks in the catchment. These juvenile salmon density data for 2000 and 2001 are combined in Figs 5.10.7 & 5.10.8.

High densities of salmon fry were recorded in the Ballagh in 2000, ranging from 0.22 to 3.8/m^2 and densities moderated with progression of sites upstream. Densities in the Glenanniff were more variable but very satisfactory. Salmon parr densities were extremely high in both highlighting the importance of these two channels as spawning and nursery units (Appendix 4: Table 10; Fig. 17 & 18).

Over 43% of all sites sampled in the Melvin catchment held no salmon fry (Fig. 5.10.5). This statistic refers primarily to the County and Roogagh Rivers which were sampled extensively in 2001. One site in each, in the lower reaches, had good densities of fry and parr which indicated regular annual spawning activity in these reaches. Interestingly, salmon parr (Fig. 5.10.6) were recorded in moderate densities at many of the sites where fry were absent in the County and Roogagh, which suggests some penetration by adult salmon into the middle and upper reaches of both catchments in some years, probably when water levels allow passage over the array of natural rock sills in the catchments.

Exceptionally high densities were recorded at several sites in the main spawning channels as shown in the juvenile salmon density distributions. Salmon parr densities were high (>0.1 m2) at 40% of sites sampled over the period. Trout densities were moderate to good (Fig. 5.10.9 and 5.10.10).

No significant difference was found between the salmon fry and parr and trout fry from 1992 and 2000 (Wilcoxon signed rank test, $p > 0.05$) for sites which were resampled. A decrease in densities of trout ≥ 1+ was observed in 2000 (Table 5.10.1).

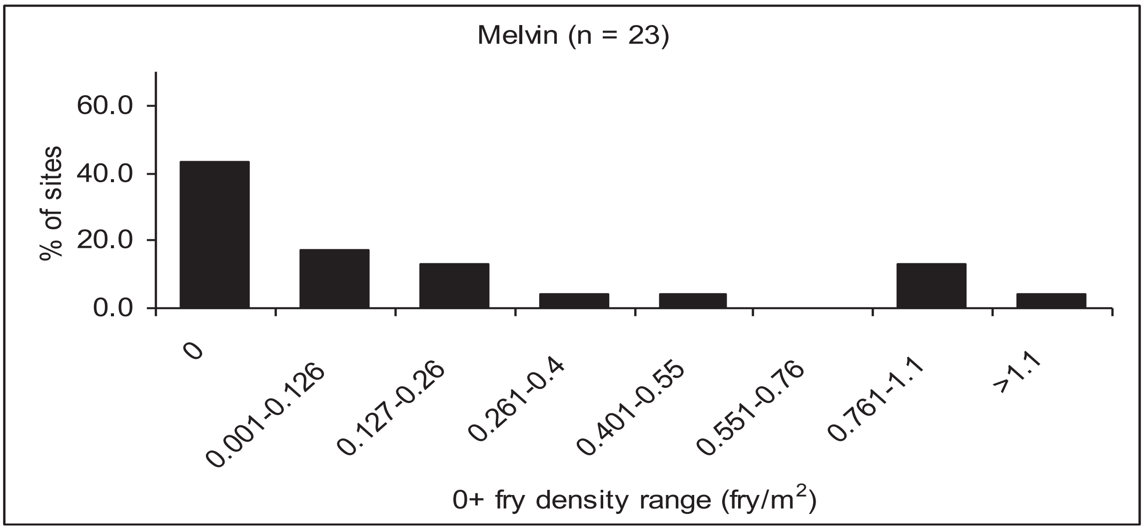


Fig. 5.10.5. Salmon fry density distributions for the Melvin catchment 2000 and 2001 combined.

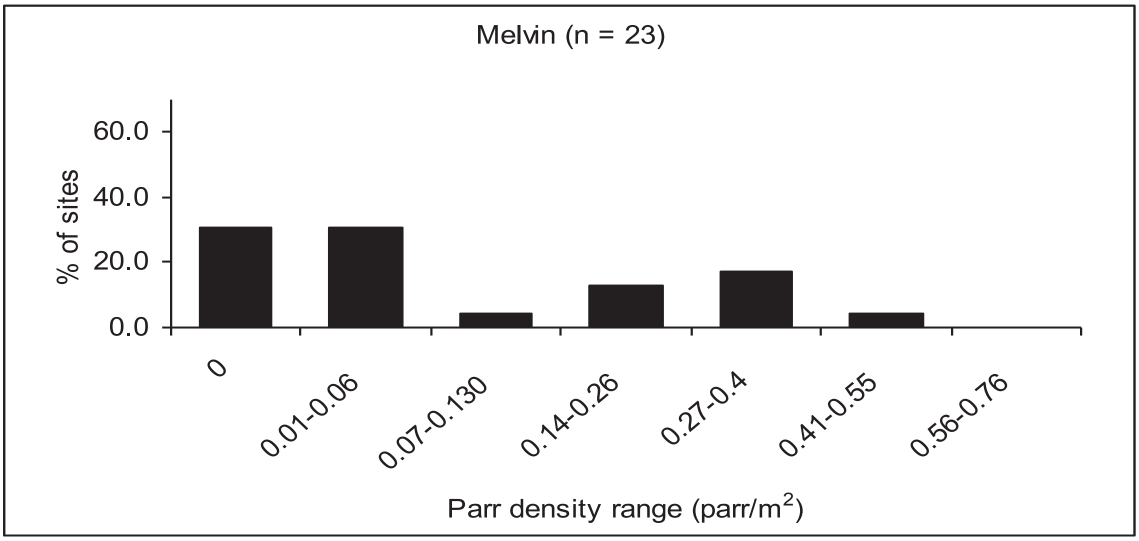


Fig. 5.10.6. Salmon parr density distributions for the Melvin catchment 2000 and 2001 combined.

Table 5.10.1: Wilcoxon signed rank (QED Statistics ver 1.1.2.441)

	Year	M dn	T	df	p	r
Salmon fry	1992	0.359				
	2000	0.314	0.30	8	>0.05	0.07
Salmon parr	1992	0.331				
	2000	0.206	1.24	8	>0.05	0.29
Trout fry	1992	0.333				
	2000	0.227	1.48	8	>0.05	0.35
Trout parr	1992	0.215				
	2000	0.177	2.07	8	<0.05	0.49
Trout adult	1992	0.011				
	2000	0.007	2.02	6	<0.05	0.54

5.10.3. Physical habitat assessment and recommendations for improvements

Juvenile salmonid habitat in the catchment is physically stable and has good water quality. The Drowes, one of the prime spawning areas, is a very stable channel due to flows being moderated by the lake.

The only enhancement measure recommended from this report is selective shrub pruning over riffle areas on the south bank of the tunnelled Ballagh River. This programme was carried out previously following an extensive study of the catchment (Gargan et al, 1993) but requires to be repeated every five years due to the vigour of tree growth in the riparian area.

Bedrock underlies several lengthy reaches of the Melvin tributaries and an experimental rock-breaking programme, similar to that recommended for the Eany, to create additional parr water would be merited. The additional parr water in the Ballagh and Glenaniff would accommodate excess fry which migrate from these tributaries due to density dependent factors.

5.10.4. Conclusions

The Melvin/Drowes system is one of the most prolific salmon fisheries in Ireland.

The Ballagh and Glenanniff are relatively short highly productive channels with significant impassable natural barriers in their middle reaches. Two other tributaries which discharge into the northeastern portion of the lake currently contribute little to salmon populations in the system due to passage problems and limited suitability for spawning.

Salmon spawning escapement levels are excellent and belie the poor redd counts recorded over the past decade.

The requirement for a physical works programme is limited and in the context of the excellent performance of this system compared to others surveyed over the course of this study should not be considered a priority.

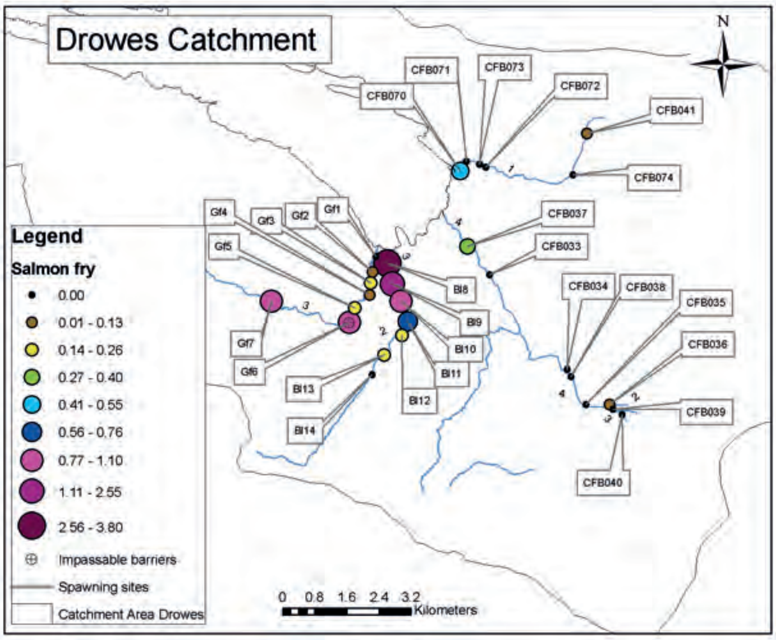


Fig. 5.10.7: Salmon fry distribution and quantitative density estimates (no./m2) in the Drowes catchment. Numbers on map represent stream order and grey line represents spawning areas

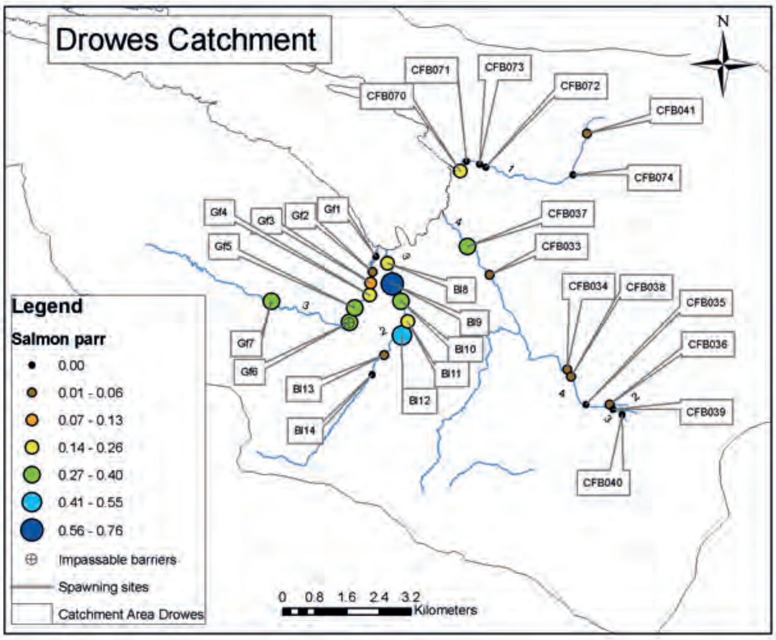


Fig. 5.10.8.: Salmon parr distribution and quantitative density estimates (no./m2) in the Drowes catchment. Numbers on map represent stream order and grey line represents spawning areas

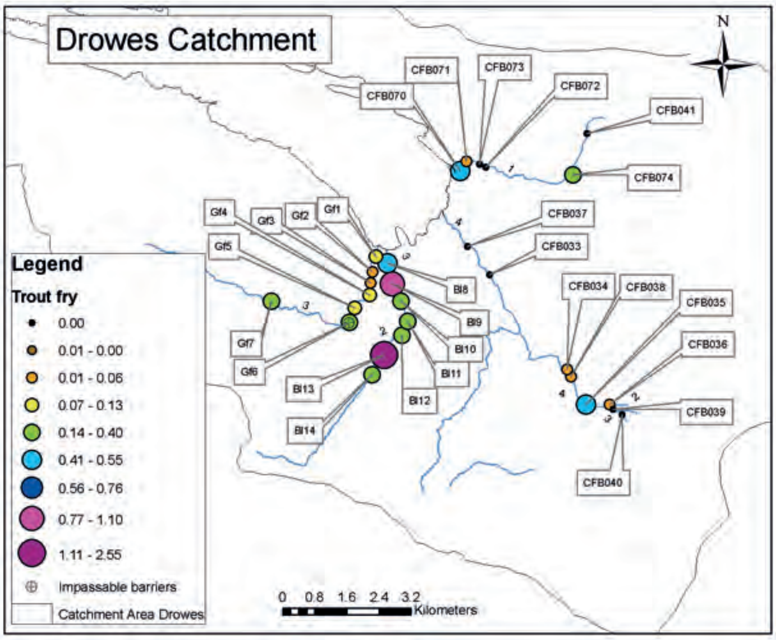


Fig. 5.10.9: Trout fry distribution and quantitative density estimates (no./m2) in the Drowes catchment. Numbers on map represent stream order and grey line represents spawning areas

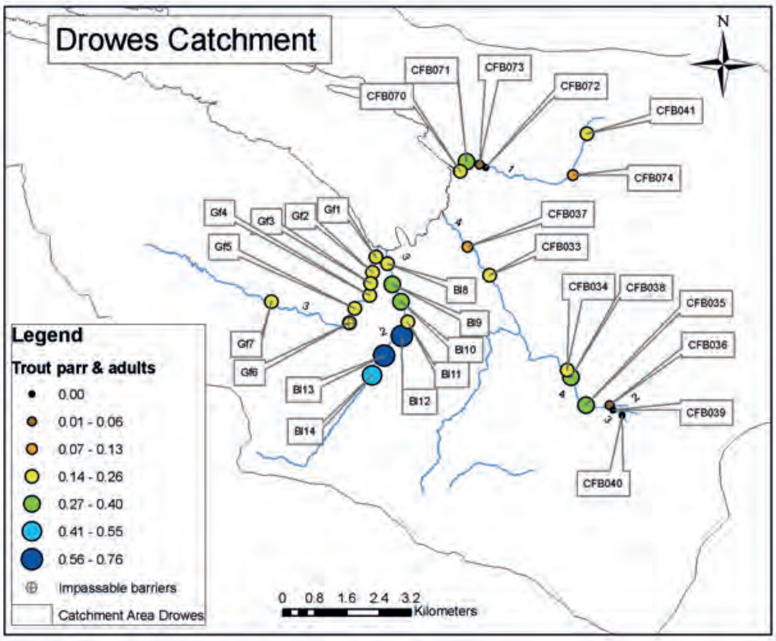


Fig. 5.10.10: Trout parr and older distribution and quantitative density estimates (no./m2) in the Drowes catchment. Numbers on map represent stream order and grey line represents spawning areas

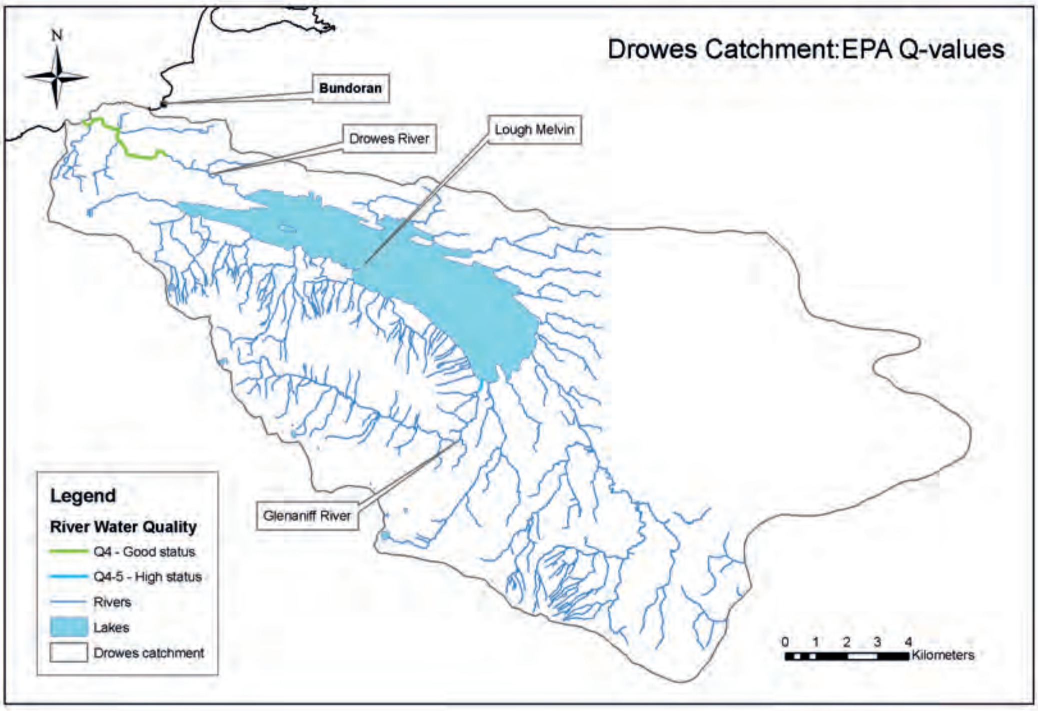


Fig. 5.10.11: Plot of EPA Q-values for the Drowes catchment.

5.11. The Duff Catchment

5.11.1. Introduction

The Duff River is a productive spate salmon fishery which flows in a northwesterly direction from Truskmore Mountain, entering the sea just north of Mullaghmore. It is a relatively small catchment (catchment area of 87.9km^2) which has a good run of grilse and summer salmon. Angling is concentrated at the Bunduff Pool located below the significant waterfall in the lower reaches of the catchment (Plate 5.11.1).

Plate 5.11.1: The Bunduff Pool in the lower Duff River

The salmon rod catch is substantive and the Duff is one of the most productive fisheries in the NRFB region with recorded catches ranging from 200 to 400 fish per annum (Fig. 5.11.1). The Duff catchment has comfortably achieved its Conservation Limit based on rod catch analysis (Figs. 5.11.2).

In terms of the national salmon resource and accessible fluvial habitat the Duff River is ranked forty fourth of 173 salmon rivers (constituting 0.41% of the national total (McGinnity *et al.* 2003; Table 3.3). In the combined

Ballyshannon and Letterkenny Fisheries Districts the Duff River is ranked fifth with 461,575m^2 of salmon habitat.

The entire Duff catchment, except for the headwaters, was subjected to an arterial drainage scheme in the early 1960s. This scheme is currently maintained, from a drainage perspective, by the Office of Public Works. The current OPW maintenance operation involves desilting the very low gradient reaches of the Duff main channel from Muckrum Bridge downstream to the Ballaghnatrillick confluence which have a very limited juvenile salmon production function being mainly comprised of deep glide (Plate 5.11.2).

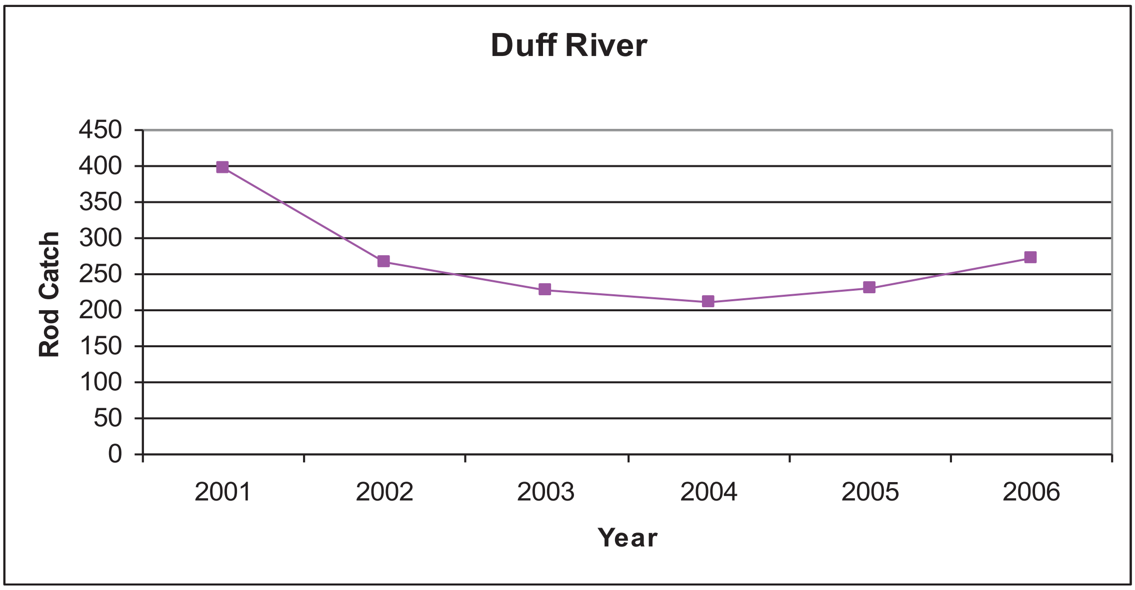


Fig. 5.11.1: Salmon rod catch for the Duff River

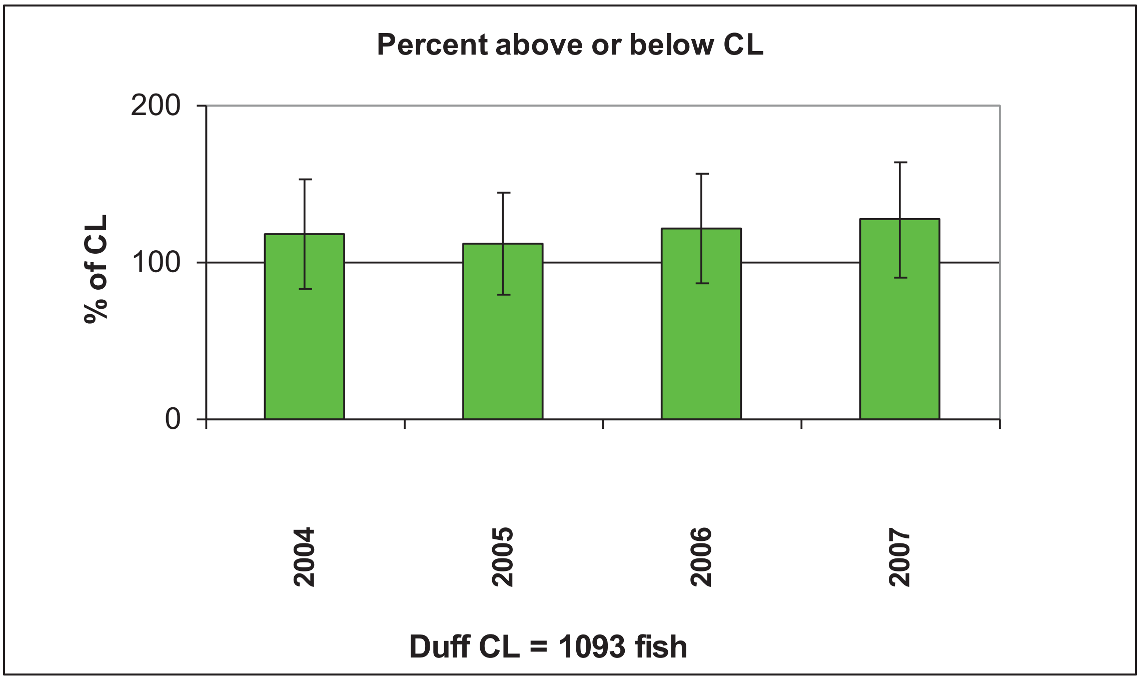


Fig. 5.11.2.: Plot of 1SW salmon spawning escapement for the Duff system, expressed as percentage above or below the Conservation Limit

Plate 5.11.2. Drainage maintenance on a typical low gradient reach in the middle reaches of the Duff main channel which extends from Muckrum Bridge to the Ballaghnatrillick confluence

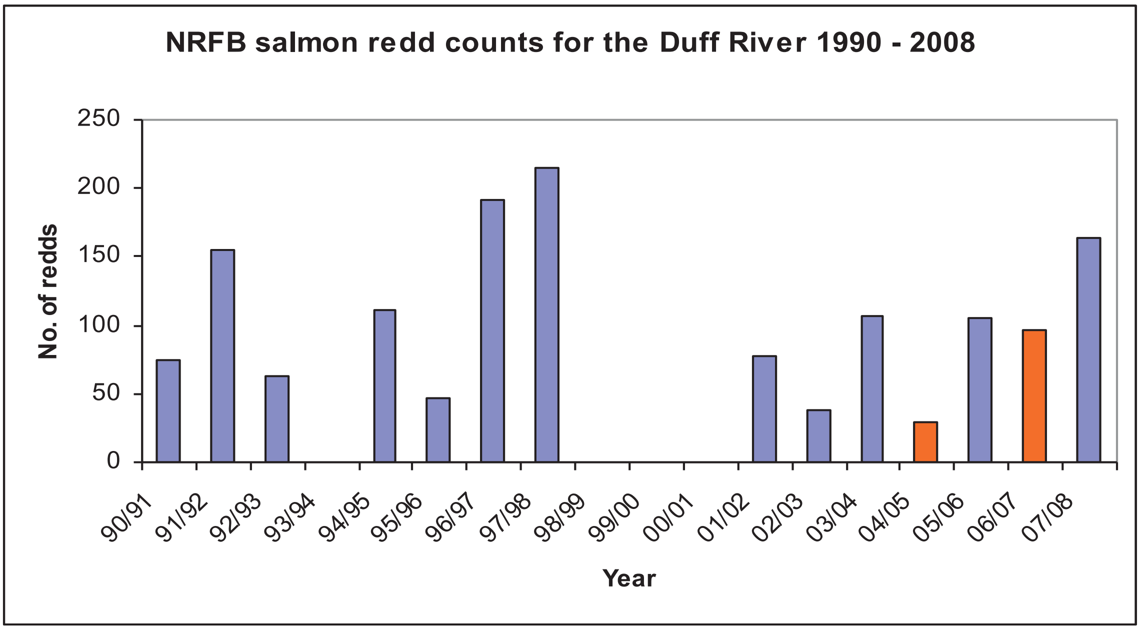


Fig. 5.11.3. Salmon redd counts for the River Duff. **Red shading = poor counting efficiency**

No trend is evident from redd count data for the Duff (Fig. 5.11.3). The dataset is incomplete but some annual variation is evident. Counts from the 1990s average 122 per annum while recent counts average 88. However, the difference was not significant (t-test $p > 0.05$).

5.11.2. Electrofishing survey

Three sites in the upper reaches of the Duff catchment were fished qualitatively during summer 2007. Trout were present at all three sites but no salmon were recorded (Appendix 4: Table 11). Quantitative electrofishing results revealed an absence of salmon fry and parr in the upper reaches of the main channel and the extensive Ballaghnatrillick River and suggest that adult salmon anadromy is limited in both. An impassable barrier directly upstream of Ballaghnatrillick Bridge and an unknown barrier, near Largydonnell on the main channel, redefine the extent of anadromy on this catchment.

The spatey nature of the Duff and high water conditions limited opportunities for quantitative sampling and an alternative approach had to be used to ensure an assessment was achieved. An emerging approach to juvenile salmon assessment, 'catchment-wide electrofishing' (Gargan *et al.*, 2008) was used and sampling was mainly limited to sites downstream of the newly identified barriers (Fig. 6.5.1).

Salmon fry (0+) were recorded at 9 of the 11 sites sampled on the River Duff and were widely distributed throughout the catchment. The average number was 8 sal fry/5-min with a range of 0-20 sal fry/5-min (Appendix 5: Table 2). Salmon fry numbers were low throughout most of the main channel although a maximum of 20 sal fry/5min was recorded at Conwal Bridge, a known spawning area. Salmon fry numbers were also low on the Ballaghnatrillick River. The low numbers of salmon fry recorded on the Duff River may have been influenced by sampling being carried out in October. Ideally sampling using this technique should occur between late June to mid September but due to high water levels in summer 2007 sampling was delayed. However, the Duff has a consistent surplus for exploitation which was not reflected by correspondingly high fry abundance.

Trout were widely distributed throughout the catchment. Stickleback was the only other species recorded and some crayfish were also noted at some sites.

The quantitative electrofishing failed to record eels at the three sites sampled which further indicates the impassability of both barriers to upstream migrants. As the catchment-wide electrofishing technique concentrates on salmonid fry and sampling is limited to riffled areas, it is not a reliable technique for eel assessment. Therefore the status of eels is unknown downstream of both.

EPA Q-value indicates good water quality with a consistent rating of 4-5 throughout (Appendix 2: Table 3 & Fig. 12).

5.11.3. Physical habitat assessment and recommendations for improvements

A number of priority projects are proposed for the Duff catchment:

Reconfiguration of the Bunduff Falls

Gargan *et al*, (2008) reported that salmon fry numbers in the River Duff in 2007 fell significantly short of the expected level to conform with the rod catch derived Conservation Limit for this catchment. The mean numbers of salmon fry captured per site fell well below the threshold value set for rivers like the Duff where a surplus of fish was available for angling. Gargan *et al* (2008) noted that the poor fry average was at variance with the angling returns for this fishery in 2007. This suggests that the angler exploitation rate of salmon may have greatly exceeded the norm. This is most likely due to a delay in the upstream movement of adults over the falls in the lower reaches of the river (Plate 5.11.1) and their increased vulnerability to capture by anglers.

It is recommended that a bypass channel is constructed around this falls or, alternatively, the falls should be stepped out to ease the passage of migratory fish. In developmental terms this proposal should be considered the priority for the Duff system. A detailed plan for this site has been drawn up (Plates 5.11.5 & 5.11.6).

Plate 5.11.3. Salmon attempting to ascend the Bunduff Falls

Office of Public Works (OPW) programmes

The OPW have responsibility for drainage maintenance of the Duff catchment. Their current maintenance operation involves regular desilting of the very low gradient reaches of the Duff main channel.

The second OPW maintenance operation involves pruning shrubbery in selected areas where it is impeding flood flows. This is of benefit in fishery management terms because the tunnelling effect of dense shrubbery depresses salmonid production. An expansion of this programme would be of benefit to this river as a salmon fishery. The extent of tunnelled channel in salmon bearing areas is illustrated in Fig. 5.11.9. The current tunnelled areas are principally in the Ballaghnatrillick tributary and in the section of the Duff downstream of their confluence. These are, potentially, the most important salmon production areas in the entire catchment.

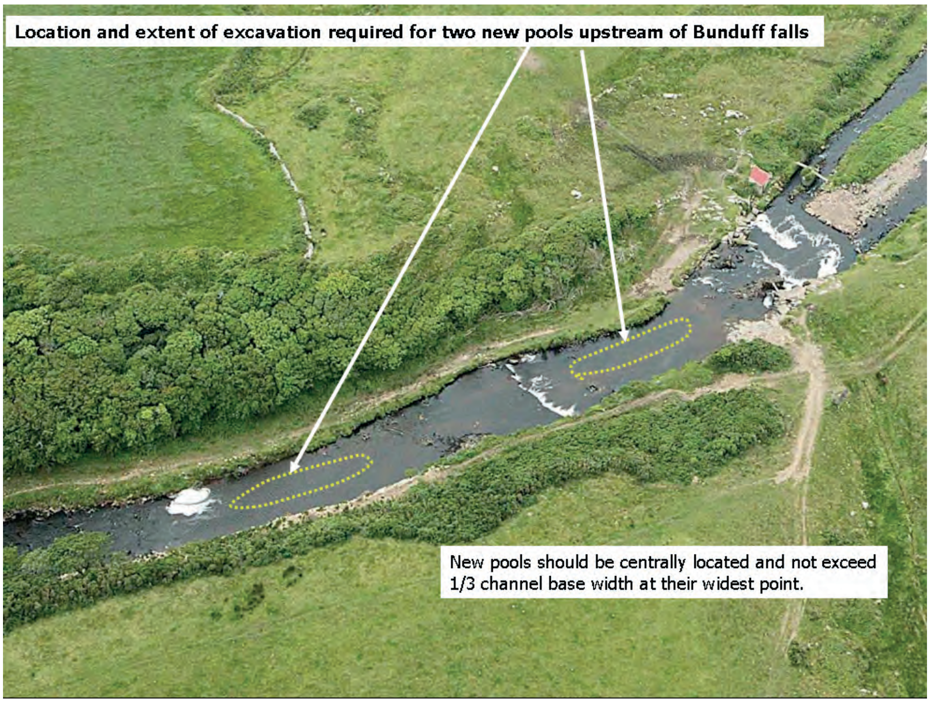
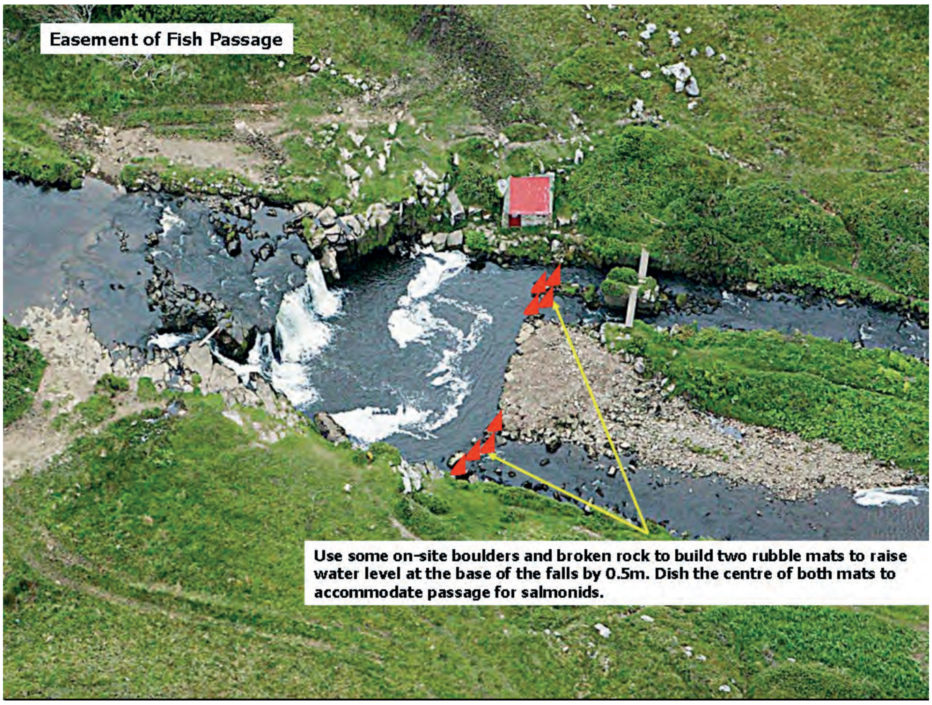
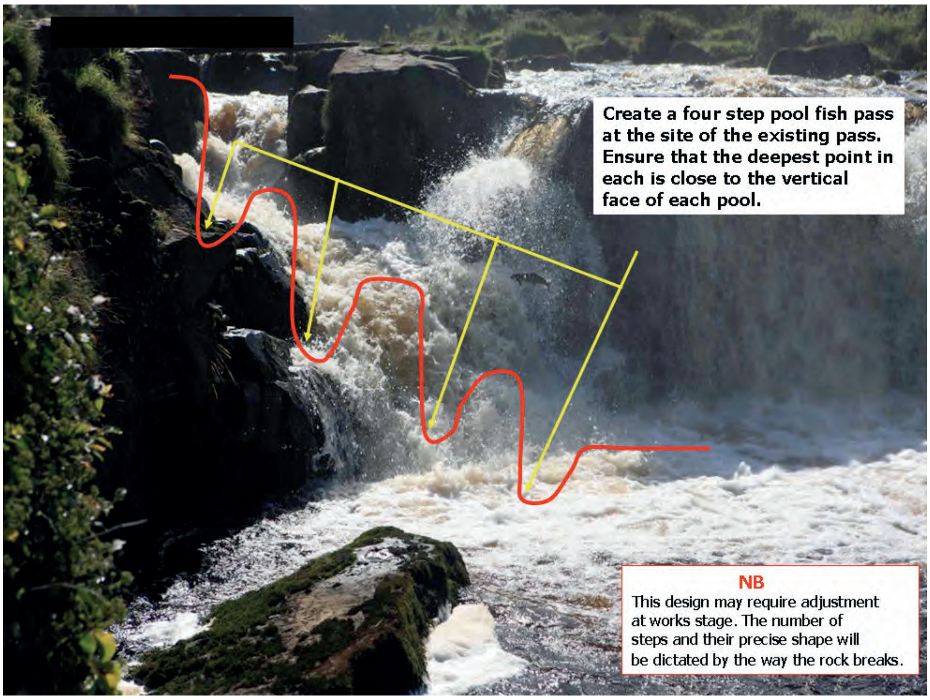


Plate 5.11.4. Pool development option upstream of Bunduff Falls.





Plates 5.11.5 and 5.11.6 showing proposed plan for easement at Bunduff Falls

The potentially productive salmon areas in the Duff Catchment, mentioned above, have not recovered completely in morphological terms from the arterial drainage programme. A review of the aerial photographic series and direct visual observations indicate a dearth of pool areas and the presence of some artificially wide shallow reaches (Plate 5.11.7). The full extent of morphological problems cannot be seen currently because of the tunnelling problem. It is likely that major physical works are required, at intervals, from Ballaghnatrillick Bridge downstream to its confluence with the Duff and downstream on the main Duff channel to the sea. The Duff main channel reach, from the outfall of the Ballaghnatrillick tributary upstream to Muckrum Bridge is a very low gradient reach incapable of producing salmon. The Duff, upstream of Muckrum Bridge is a salmon bearing channel. Although drained in the past it has recovered well in morphological terms and does not warrant a major enhancement programme.

Plate 5.11.7. Excessive tree cover in the Duff.

Plate 5.11.8. Bridge apron at Ballaghnatrillick Bridge.

The bridge apron at Ballaghnatrillick Bridge is impassable to migratory fish. However, a short distance (<50m) upstream of this bridge a natural rock sill is equally impassable in addition to several similar structures in the reaches upstream of this point (Plate 5.11.9). Restructuring the bridge apron is not warranted as there would be limited gain in terms of productive channel. The removal of these impassable rock sills is also contrary to the terms of the EU Water Framework Directive.

Plate 5.11.9. Rock sills upstream of Ballaghnatrillick Br.

In 2007 the OPW gave an undertaking to enhance all drained salmonid rivers in Ireland under their remit. This includes the Duff system which means that costs for this programme relating to ecosystem damage caused by the arterial drainage programme will be met from OPW resources. A sample of the programme design is shown in Plate 5.11.10.

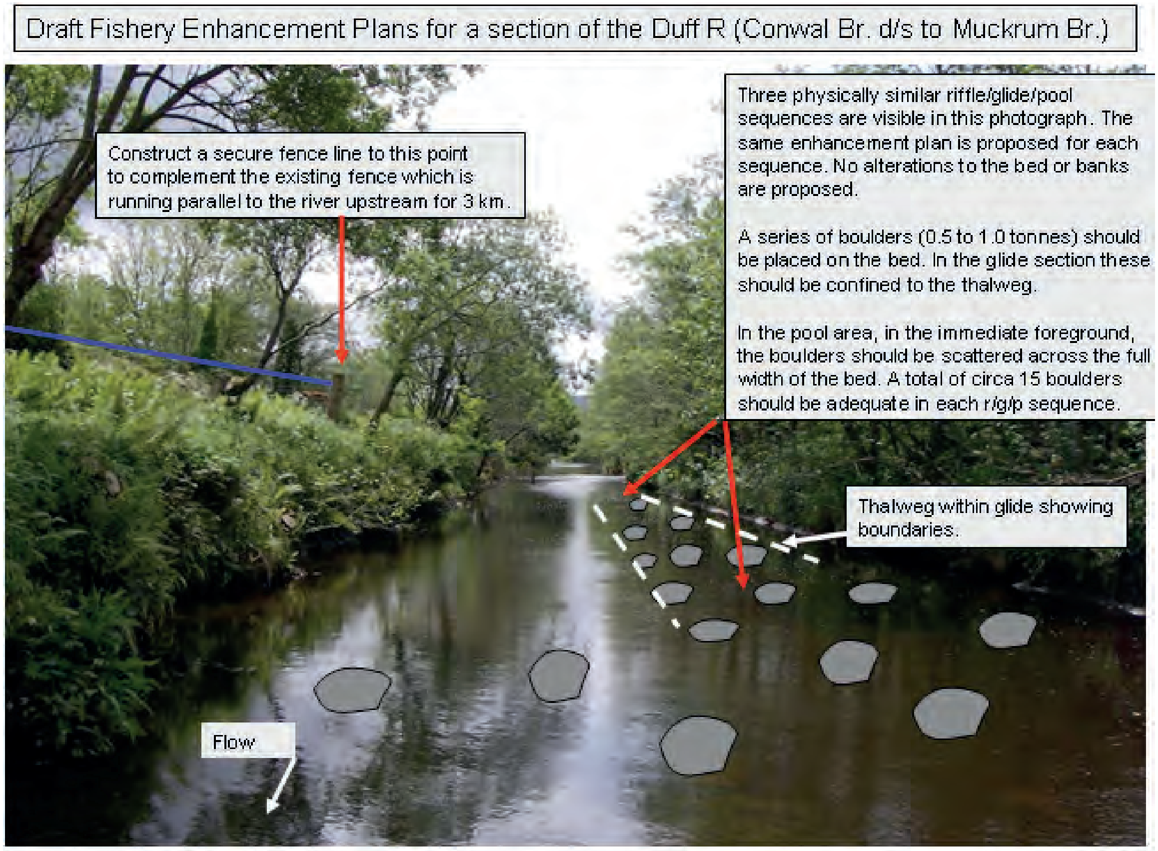


Plate 5.11.10. Example of site works programme for Duff system

The enhancement priority in the programme on the Duff relates to the easement of salmon passage over the waterfall in the lower reaches. This natural bottleneck did not arise from the arterial drainage programme and is beyond OPW responsibility. The solution to the problem will have to be addressed within the strict terms of the EU Water Framework Directive which prohibits physical modification to natural structures.

- **Likely Benefits of an Enhancement Programme**

Substantial benefits should accrue to the Duff, following the completion of the proposed enhancement programme. Following the easement of fish passage and the proposed shrub pruning and in-stream physical works programme a 200% (and possibly up to a 400%) increase in salmon smolt production is possible.

5.11.4. Conclusions

The Standing Scientific Committee of the National Salmon Commission (NSC) concluded that a catchment-wide average of 25 salmon fry/5-min fishing was high and indicative of good catchment-wide spawning (SSC, 2007). This figure has been applied by the NSC and the NFME as a threshold value to allow catch & release in previously closed salmon rivers. A revised average of 17 salmon fry/5-min fishing has been calculated for catchments exceeding their CL (SSC, 2010). The Duff has been in surplus since the individual rivers assessment has been in operation. However, the mean catch of 11 sal fry/5-min for the Duff was substantially below the 25 salmon/5-min threshold value. In a national context, the Duff catchment average was in the bottom 25% of values recorded for 31 catchments sampled in 2007. These data suggest that spawning escapement were unsatisfactory in the 2006 season.

Scientific assessment based on rod catch for the Duff catchment indicates the river is exceeding CL (SSC 2008). However, the low mean abundance of salmon fry recorded in 2007 suggests that the Duff is meeting a much lower proportion of its CL. The high levels of rod fishing mortality at the Bunduff pool on the main channel may bias this rod catch based assessment. These electrofishing data contradict the estimation of salmon stock status for 2007 from rod catch returns which suggest a surplus of 478 spawning salmon. Determination of a river specific rod exploitation rate for the Duff River is desirable to derive a more reliable estimate of salmon stock status.

The works programme recommended for the catchment will mainly be delivered through the OPW who have maintenance responsibility for this catchment. The Bunduff easement of passage is a priority for the NRFB to ensure that the overexploitation of salmon at this bottleneck is addressed and escapement increases.

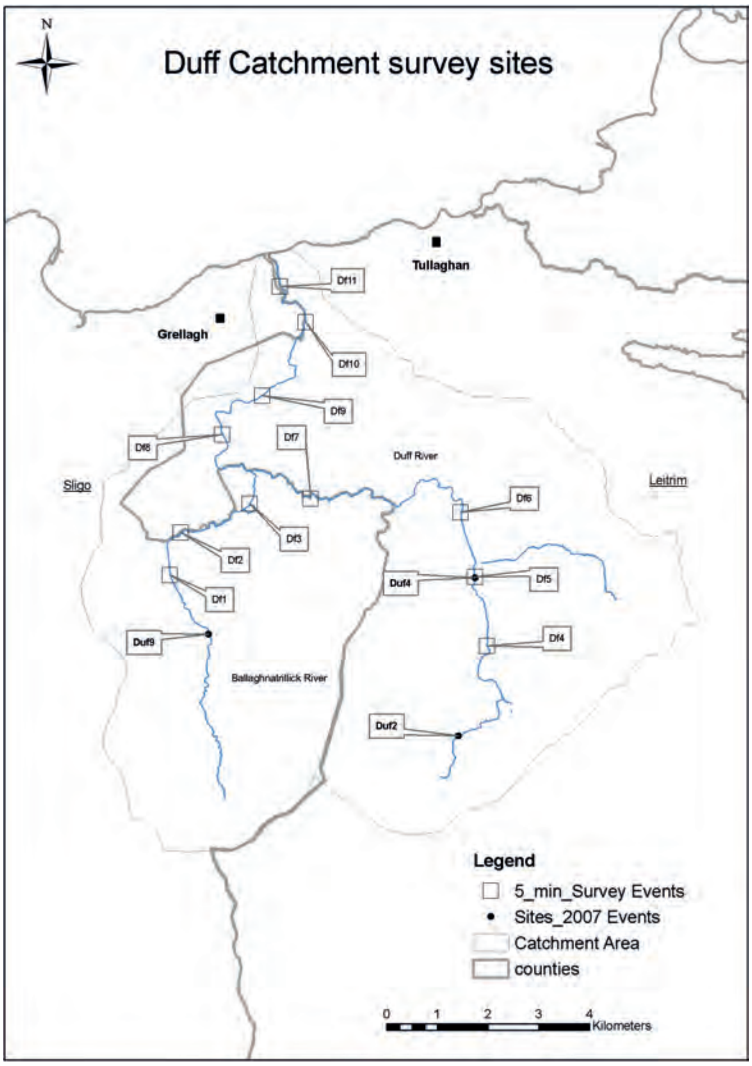


Fig. 5.11.4: Position of survey sites in the Duff catchment. Squares represent survey sites from the semi-quantitative survey and black circles represent sites from the quantitative survey.

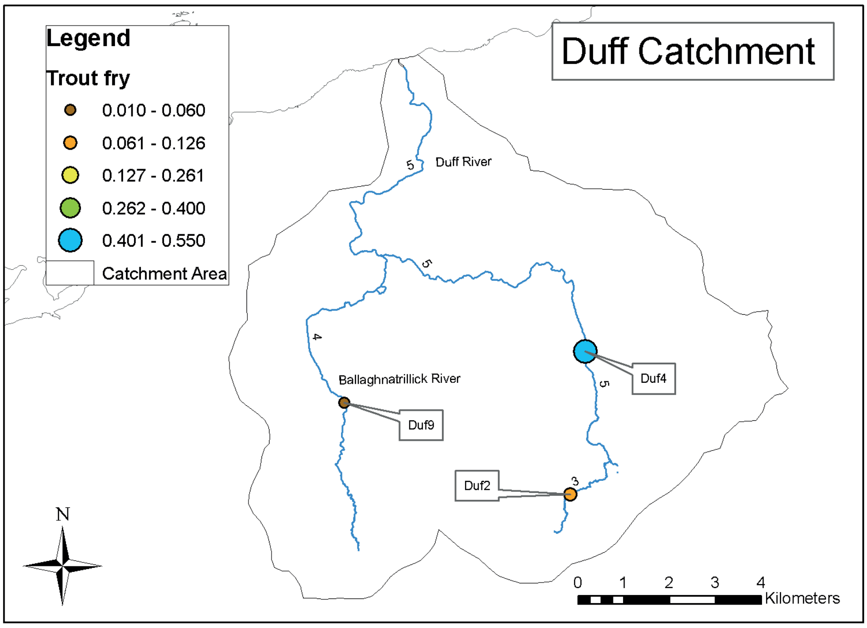


Fig. 5.11.5.: **Trout fry distribution and quantitative density estimates (no./m2) in the Duff catchment. Numbers on map represent stream order.**

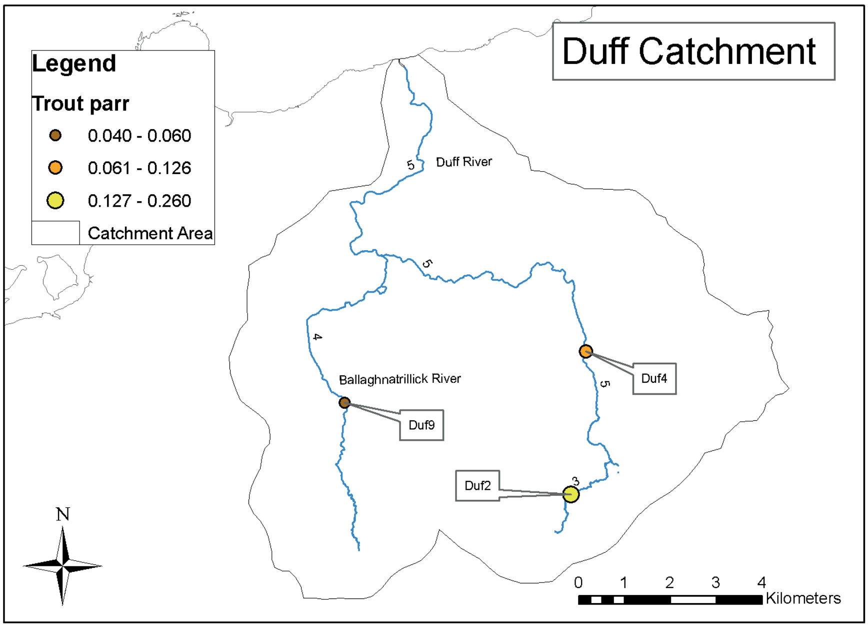


Fig. 5.11.6: **Trout parr distribution and quantitative density estimates (no./m2) in the Duff catchment. Numbers on map represent stream order.**

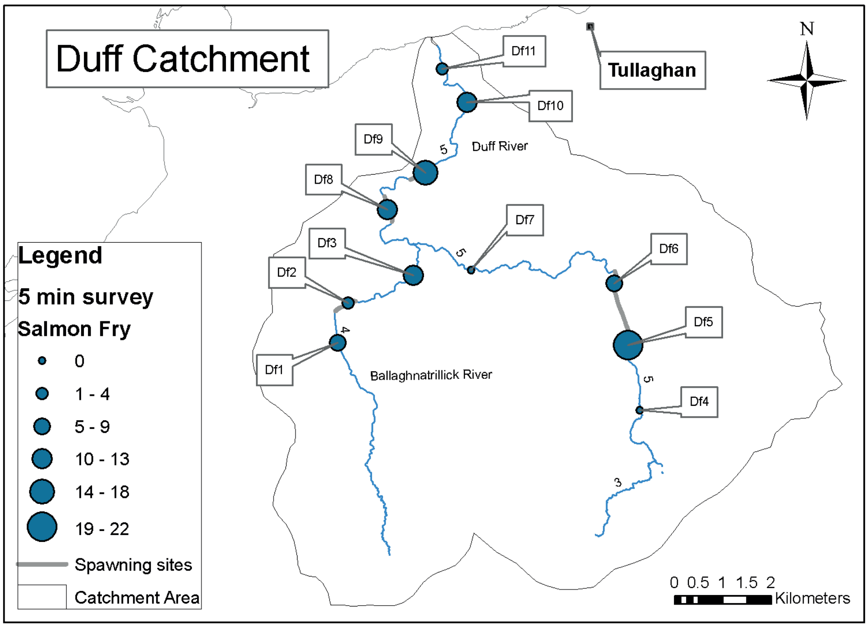


Fig. 5.11.7: Salmon fry abundance in the Duff catchment using catchment-wide electrofishing method.

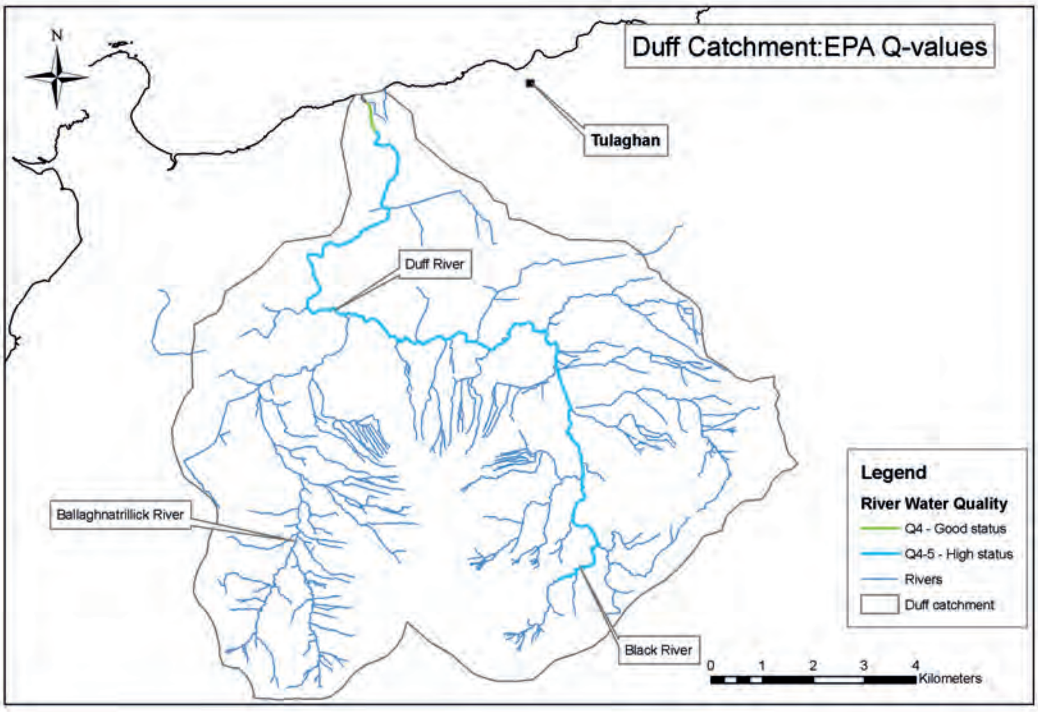


Fig. 5.11.8. Plot of EPA Q-values for the Duff catchment.

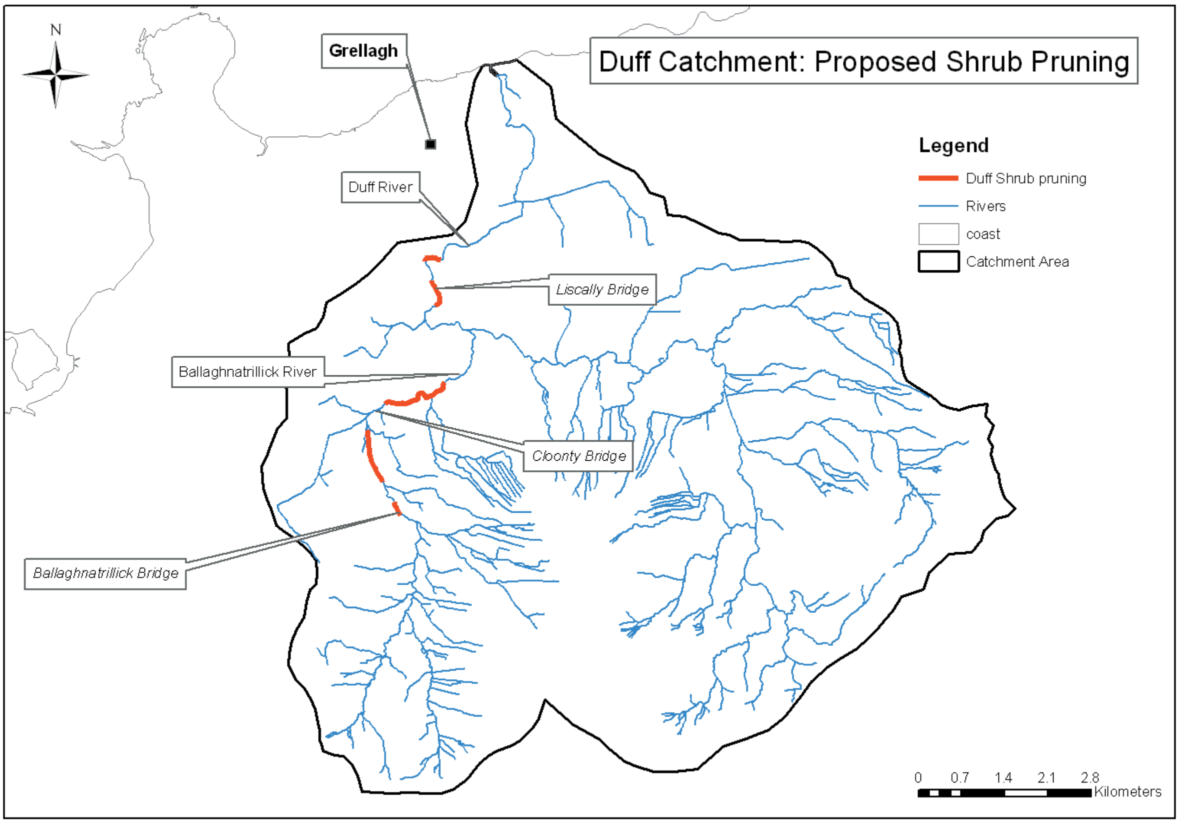


Fig. 5.11.9: Plot of proposed shrub pruning in the Duff catchment with 3kms of channel requiring work.

6. Inter-catchment comparisons & recommendations for improving assessment metrics

The Atlantic salmon (Salmo salar L) is one of the species covered by the Habitats Directive (92/43/EEC). The Directive states that:

> "If a species is included under this Directive, it requires measures to be taken by individual member states to maintain or restore them to favourable conservation status in their natural range".

The conservation status of a species refers to the sum of influences acting on the species concerned that may affect the long-term distribution of its populations within its territory. 32 of the 148 salmon rivers in Ireland are designated as Special Areas of Conservation (SACs) for the species. In applying the Directive, consideration must be given to all of the populations and not just the designated SAC rivers. Conservation Limits have been set for all 148 Irish salmon rivers and recreational and commercial inshore fisheries are now regulated relative to these conservation limits being met on a river by river basis. The EU Commission has accepted that the conservation limits set for Irish rivers constitute an acceptable conservation reference point for Irish salmon stocks which equates to favourable conservation status.

The assessment of salmon stock status in key fisheries in the NRFB area will contribute to salmon management in Ireland and support the rational management and longterm sustainability of the species. This programme will also contribute substantially to providing the necessary status report as required under the Habitats Directive.

The attainment of CL can be gauged by direct measures (e.g. counter data or the use of rod catch based estimates to calculate total numbers returning to the river) or by indirect measures such as redd counts or juvenile indices (Gargan *et al.*, 2008). Cowx and Fraser (2003) identified the adult run and juvenile densities as the key life stages where salmon can be monitored. For the purposes of this project, salmon rod catch, redd count and juvenile data were compiled to present individual catchment overviews together with all available habitat and water quality data relevant to the period prior to the juvenile assessment. This chapter compares each of the catchments under various headings.

6.1. Counters

Gargan et al (2008) have identified fish counters as the preferred direct counting method for salmon for a number of reasons: a counter provides a total count, it can be operated on an all year round basis and it can be used to monitor fish abundance from the tributary to catchment level. Analysis of counter and rod catch data in Scottish waters demonstrated that the two sources of information are mutually supportive (Eatherley et al, 2005). They also showed that validated resistivity counters in Scottish waters broadly reflected the local abundance of Atlantic salmon at the relevant scale. On the negative side, they noted that counters are expensive to buy and install, are vulnerable to vandalism and theft, and must be associated with a suitable in-river structure. Regular monitoring, maintenance and servicing are essential to ensure the data generated are reliable.

The capacity to accurately assess salmon stock status provides a manager with an essential management tool and the capacity to respond with appropriate management measures based on knowledge. Combined with quality rod catch data these strategically located systems can be developed as model systems for the region providing reliable data which can be validated. The Eany and Eske systems, both managed systems, fall into this category. The Crolly counter, operated by the ESB, also provides good quality data for manangment. To deliver data for management and the conservation objectives (e.g. EU Habitats Directive) for 1SW and MSW populations the NRFB should continue to pursue counter installation in the following systems:

- Leannan
- Lackagh
- Gweebarra
- Owenea
- Drowes

Counter data will provide quality data and is particularly valuable from MSW systems like the Leannan, Lackagh and Drowes where stock status is highly variable and requires accurate annual assessments. Counter data from 1SW fisheries like the Owenea and the Gweebarra will inform local and national management of salmon stocks and will be highly valuable.

6.2. Rod catches

6.2.1. Comparison of mean rod catches

Because of the availability of historical data for all systems being reviewed rod catch was used to provide an estimate of run size based on various assumptions regarding the relationship between catch, angling effort and stock. Shelton (2002) identifies weaknesses in rod catch data (inaccurate reporting, the lack of a means to assess angling effort and exploitation, and actual fish catchability). A highly variable rod catch versus stock size relationship is a feature of fisheries with low stock levels (Peterman and Steer, 1981). Despite these weaknesses and desirable modifications in improving the quality and applicability of such data, Youngson et al, (2007) recommend using their continued use for assessments. Specific proposals for refining these data are presented below.

Apart from providing data to estimate spawning escapement analysis, rod catch data assessment provides a measure of recent performance and contributes to identifying underperforming catchments. Plotting the 5-year average rod catch against accessible fluvial wetted area (Figs. 6.2.1 and 6.2.2) it is evident that the Leannan catchment, which has the greatest quantity of accessible fluvial habitat within the NRFB, could, in statistical terms, be considered an outlier (Fig. 6.2.1). However, this data point accurately reflects its poor rod catch and general status in recent years up to the fishery closure, corroborates the scientific analyses carried out by the SSC and justifies the closure. Like most major multi-sea-winter salmon fisheries in Ireland salmon in the Leannan were severely impacted by UDN (Ulcerative Dermal Necrosis) in the 1960s and 70s. Although stocks fluctuated (Roche et al 1994) it is reasonable to suggest that stocks in the Leannan have not recovered from the impact of UDN.

Removing the Leannan outlier (Fig. 6.2.2) a strong positive linear relationship is evident for the remaining catchments which emphasises that as fluvial habitat increases rod catches increase. The most productive angling fisheries are the larger systems, the Drowes, Eany, Owenea and Duff, and all differ with regard to abundance of spawning habitat. The Drowes and Owenea have abundant spawning areas while the Eany and Duff are less well endowed. Enhancement of existing spawning areas and development of new areas should be investigated as part of any programme for the Eany and Duff. The high Duff 1 SW catch emphasises the overexploitation at the Bun duff Pool downstream of a frequently impassable waterfall, except under ideal conditions.

Fig. 6.2.1. Relationship between 5-year average salmon rod catch (incl. catch & release) for all systems between 2002 & 2008 versus accessible fluvial habitat (km^2) – Clady, Glen, Eany and Eske are 4 year averages

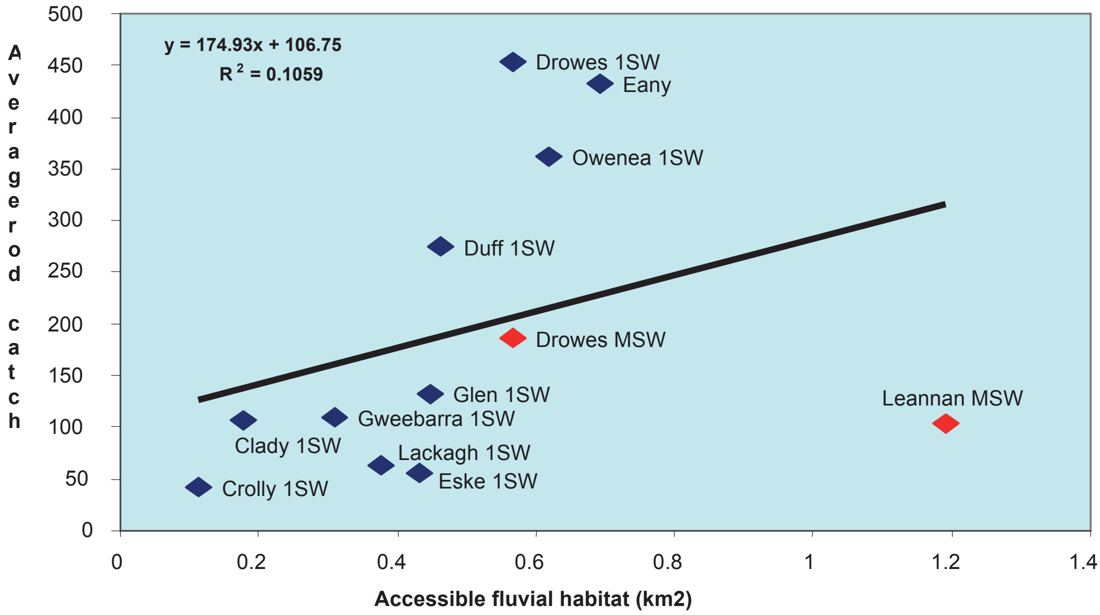
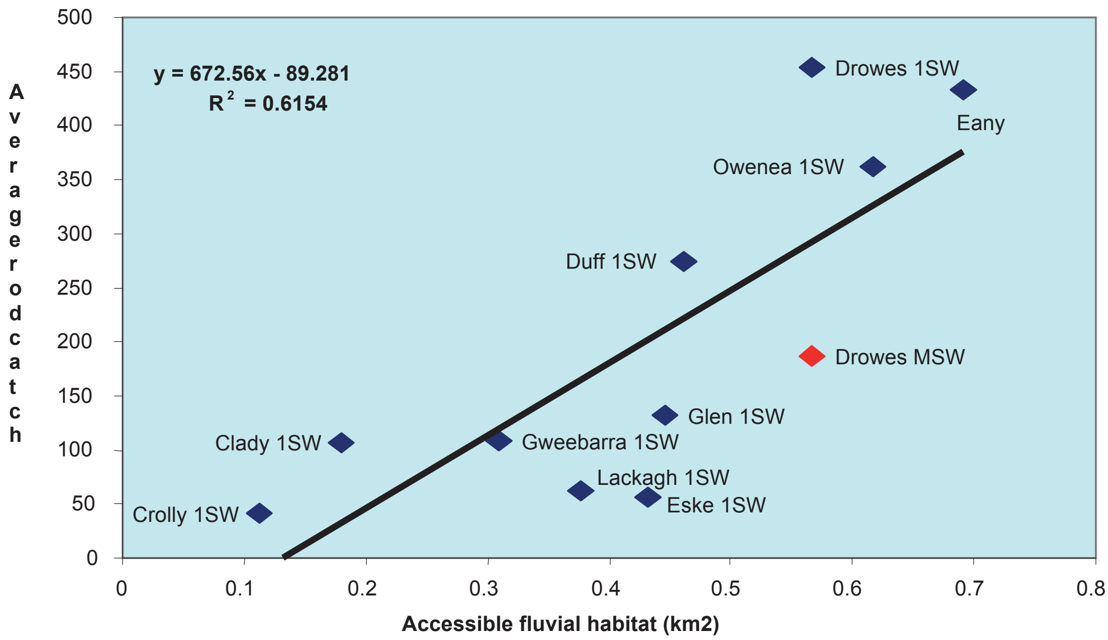


Fig. 6.2.2. Relationship between 5-year average salmon rod catch (incl. catch & release) for all systems EXCEPT the Leannan between 2002 & 2008 versus accessible fluvial habitat (km^2) – Clady, Glen, Eany and Eske are 4 year averages



The medium sized systems including the Gweebarra, Glen, Lackagh and Eske appear to be underperforming with rod catches equivalent to substantially smaller systems like the Clady and Crolly. The latter systems could be considered low priority in terms of angling potential and touristic value because of their low average rod catch – however, where funding may be limited, targeting of a smaller catchment for any required remedial works would represent good value as the benefits would be manifested quickly.

This rod catch data takes no account of the influence of lakes on these fisheries and is mainly concentrated on analysis of 1SW catches which dominate the majority of fisheries. Separate analyses of river only and river/lake fisheries combined is warranted in addition to collecting an extensive set of statistics for multi-sea-winter salmon fisheries.

6.2.2. Recommendations:

(a) **Consistent collection of rod catch data:** under the National Carcass Tagging Scheme anglers are obliged to return their salmon rod license for compilation for statistical data which has improved the management of salmon fisheries since early 2002. These data reflect catch only and take no account of effort. Several fisheries within the current reporting area have dedicated angling centres where accurate effort data could be collected.

(b) **Develop river-specific exploitation rates:** the best available assessment of rod exploitation rates is applied by the SSC to estimate escapement under the current model. It is likely that there is considerable variation in catchments due to various factors including run timing, fishery access, angling methods and local conditions. Few of these factors can be legislated for in each fishery and it appropriate to develop river-specific exploitation rates. Tagging of catch and release fish or fish captured by trapping/netting in the estuary and then released, will provide the basis for developing robust exploitation rates for different fishery types – private fisheries, public fisheries, spate fisheries, lake fisheries, lake/river fisheries. In the short-term managed fisheries like the Owenea and Eany should be targeted for this type of programme. Data from the Eany will be particularly valuable because of the availability of counter data and the Eany could be developed as a model system for Donegal. The Owenea fishery will become very important in fishery management terms when the counter is installed. Both systems should provide high quality data for 1SW exploitation rates while providing some data for MSW assessments.

(c) Salmon scale collection: determination of rod exploitation rates by stock component also requires length, weight and scale samples from fresh-run fish over the entire season. Scales will also indicate run-timing of particular stock components. This material has been collected in some fisheries as part of a modest roll-out of a national salmon management plan by the CFB. Scales have been collected from several targeted fisheries, particularly those with a substantive MSW component. This has yielded some material but a co-ordinated programme with specific monthly data target needs to be established. A successful data collection programme should generate thousands of samples nationally and with some training and basic scale reading facilities it should be feasible to have the scales read locally and the data held centrally for management purposes.

(d) Collection and incorporation of environmental data: flow and temperature influence fish movement and activity. These basic data are being collected in different gauging stations nationally and should be incorporated into the river-specific data collection process. Such data will contribute to improved management by assisting in interpretation of catch data and temperature related effects.

With a substantially reduced commercial fishery one of the major sources of salmon data in Ireland is the angling fishery. Proper management requires these data and anglers are in an influential position to contribute to the conservation of the species by collecting the relevant data.

6.3. Redd counting

6.3.1. Between catchment comparisons

Redd counting is carried out annually by staff in many of the Regional Fisheries Boards. This enumeration process, which counts streambed disturbances in graveled areas created by spawning fish is often very subjective, is usually confined to the important salmon rivers, and provides an index of spawning effort at a given location. It provides data on the quantity and location of spawning but it is not a complete count as there are too many variable factors which influence the overall count including difficulties in distinguishing salmon redds from trout redds, high water levels, water colour, survey timing, personal interpretation of what constitutes a redd and time constraints which may limit counting activity. In several RFB Districts counting salmon redds is an irregular activity and many medium and smaller salmon rivers have little or no redd count data.

The CFB, in the course of contributing to the data collection process for the national salmon assessment process, has identified redd counts as an important potential method of indirect assessment of CL attainment (Gargan et al, 2008). While the exact relationship has to be developed it has been recommended to concentrate on systems with counters so that robust statistics can be developed. A national database of salmon redd counts, based on RFB data, has been compiled to provide an indirect measure of annual abundance.

Where available, redd count data for each of the catchments assessed over the course of this study was presented. Many of these datasets extended over a twenty year period but were contrary indices when other indices such as rod catch and high juvenile densities were taken into consideration. A simplistic analysis of the recent salmon redd count data (Fig. 6.3.1) shows no relationship between redd numbers and accessible fluvial habitat. Also redd counts and rod catch were not correlated (r^2 = 0.01).

The absence of a relationship was not unexpected and the analysis served to highlight some of the issues around redd counting as currently practiced. Some of the disparities arise from between catchment differences in stocks due to:

- different escapement levels by adult fish
- greater quantities and availability of spawning areas by catchment
- information from fish behavioural and genetic studies. Assumptions have been made that one redd equated with the presence of one female salmon but studies have shown that eggs numbers in redds are highly variable and some redds may have very few eggs and eggs may be absent in others. Genetic studies have shown that redds usually contain the eggs of several females inferring that individual fish contribute to several redds over a length of spawning area.

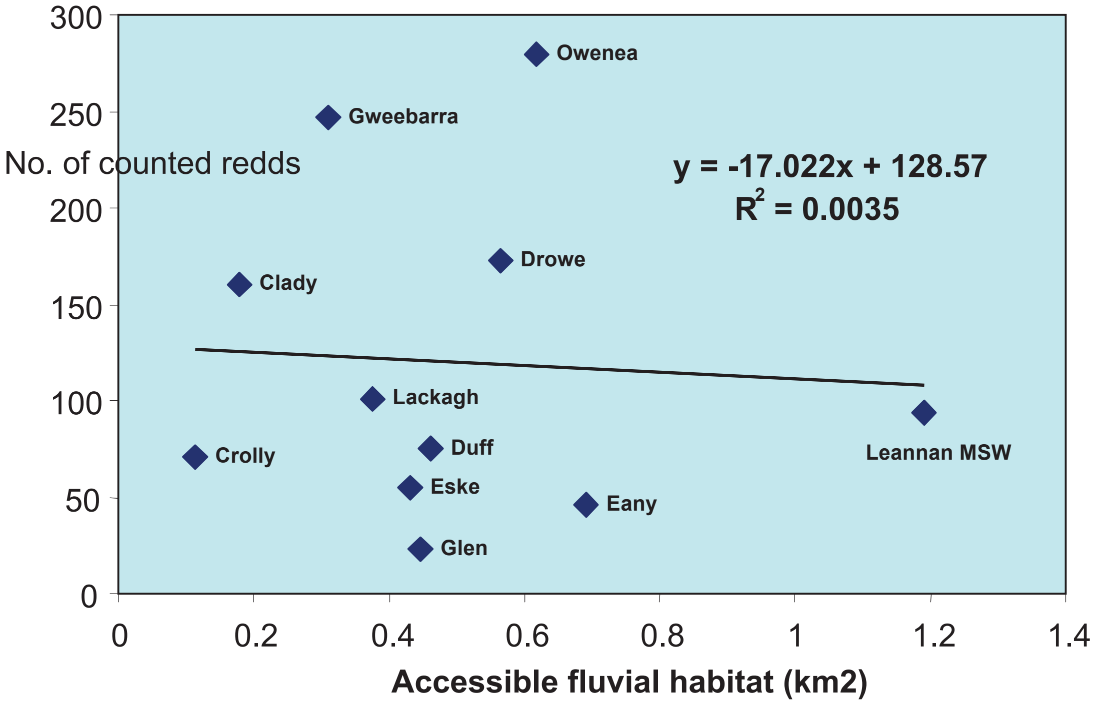
Assuming these differences were consistent and complete redd counts and/or good quality catch data were available stronger relationships would be anticipated. However, one of the fundamental issues in relation to "unevenness" in redd count data is likely to be the current approach to redd counting which may include:

- inconsistent approach (up to three counts are carried out in some reaches whereas many counts are single counts)

- year to year variation in sections counted (due to water levels, staff shortages etc); variation not included with counts so no effort data to qualify counts

Within these constraints the analysis identifies some extremes. High redd counts are a feature of the Owenea and Gweebarra systems suggesting that both are high status fisheries. Alternatively it could be concluded that redd counting data are of a higher quality in both (more intensive, widespread activity which is adequately resourced with staff) or that counting is easier to achieve in these catchments. Interestingly the rod catch is high on the Owenea while the Gweebarra catch has been relatively low in recent years. In contrast, the Leannan catchment, which has the largest quantity of accessible habitat, has a very poor count reflecting its poor overall status as a salmon fishery for at least the past decade. The challenge of accurate counting in a large catchment like the Leannan could be argued but spawning is confined to a relatively small number of key spawning areas. A grouping of three catchments, each with similar wetted areas, the Duff, the Eske and the Glen have low mean redd counts. The Eske and the Glen are below their CL based on rod catch analysis and a poor redd count seems to reflect their status (Fig. 6.3.2). However, the Duff is a very prolific system with high spawner escapement based on rod catch analysis. Another system with a low redd count is the Eany which has an exceptionally high rod catch. The available redd count data for the Duff and the Eany may indicate that neither system is particularly suited to redd counting. The known redd counting areas are very discrete and easily counted but it is likely that spawning occurs in multiple isolated pockets of substrate throughout both systems which are difficult to identify and time consuming to count.

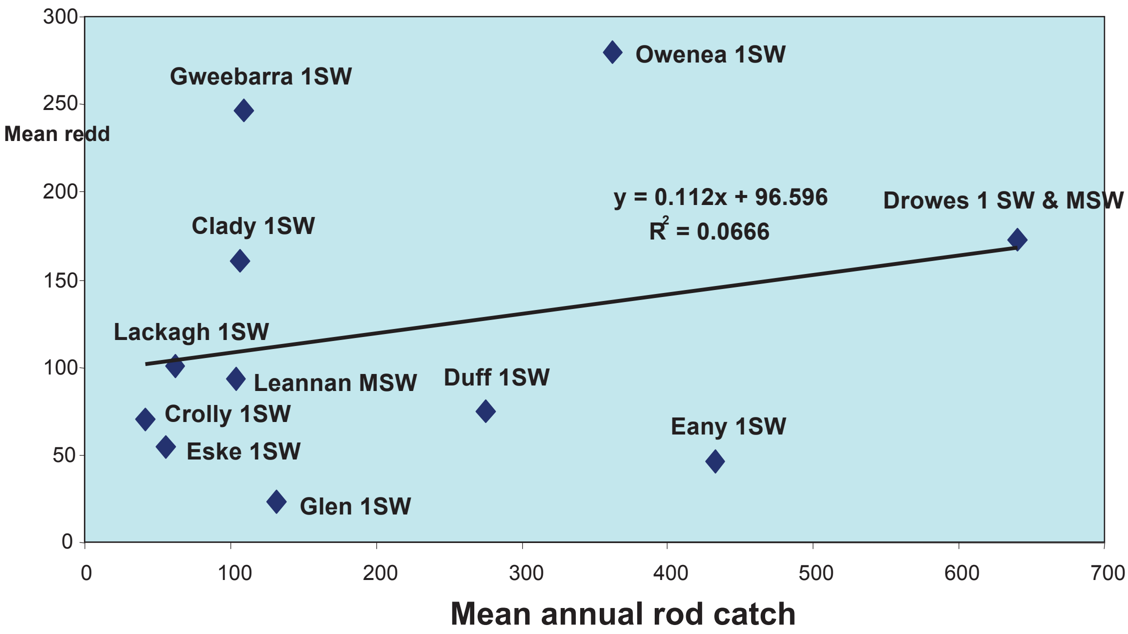
Fig. 6.3.1. Relationship between 5-year average salmon redd (2002/03 to 2006/2007) and accessible fluvial habitat (km2)



Significant progress has been achieved in recent years regarding redd count techniques in that spawning locations have been captured and mapped using GPS/GIS technology. This provides an accessible platform for enhancing the data capture process which is hampered by the variability in the habitat and the counting process. Examples of the impact of spawning habitat variability have been discussed above but it is clear that data collection quality needs to be improved to maximize the potential of this technique. All official redd count data are presented without any count effort data which makes between year comparisons prone to error. Critical factors include:

- Spawning area data: section walked, staff member, training received
- Counting conditions
- Quality rating: supporting information not provided with redd counting data to assess quality

Fig. 6.3.2. Mean annual rod catch 2002 - 2007 plotted against mean annual redd counts 2002-2007



Nationally, Regional Fisheries Board staff has expertise in the areas of salmon and trout redd counting but to ensure consistency in this potentially important monitoring tool specific training is required. A series of key index rivers and sites on which annual redd counting would be undertaken on a structured basis should be established. Some rivers are systematically counted by RFB staff but there is a requirement to enhance this activity and to provide standardized reporting formats. As Irish rivers are being managed on an individual basis with regard to meeting river specific salmon conservation limits, the requirement to obtain good redd counts to assess attainment of river specific conservation limits will be critical into the future.

6.3.2. Recommendations for improved redd counting

Recommendations include:

- Training for consistency
- Devising and implementing a national redd counting protocol to include standard survey form and GIS reporting
- Economy of scale: more advantageous to count several areas properly to provide good relative indices rather than many areas poorly
- Consider remote counting where aerial imagery might assist

It would not be feasible to count all redds in a medium or large system for the reasons outlined. The starting basis for this programme is that all the spawning areas can be identified. Redd counts from selected delineated spawning zones can be used to provide an index (rather than a total count) of spawning effort. This has the potential to produce a consistent and comparable inter-annual assessment at the site that reflects recruitment trends. The selection of index sites will be based on desktop spatial analysis and a stratified random sampling approach. These sites will be monitored at a high intensity over the entire spawning season, receiving frequent visits from fisheries personnel. This programme aims to determine the best approach to selecting the sites and determining the appropriate sampling frequency, timing of sampling and the size of the area to be surveyed.

An extension of this approach would be the provision of spawning population estimates made on whole tributaries with these estimates being compared with conservation limits determined on a tributary basis. For example, in the Girnock Burn, a tributary of the Aberdeenshire Dee, a ratio of 1 female salmon to every 1.4 (composite) salmon redds has been recorded over a lengthy trap monitoring programme (Youngson et al, 2007). Developing these ratios over a broad range of spawning areas will be required in order to scale the number of redds up to adult census estimates. Gallagher et al (2008) recommend using a 1:1 ratio by assuming a one redd per female or applying a constant of 1.2 for multiple redds as per Duffy (2005). Similar monitoring programmes are required for additional sites in Irish tributaries before this ratio could be used to scale up to adult escapement numbers. These assessments should be integrated with catchment wide surveys of all spawning areas. Catchment wide surveys will by their nature be conducted on a less intensive basis.

Despite reservations about the relationship between the number of spawners and redd counts at local population scales Cowx and Frazer (2003) state that redd counting has value to gauge spawning area contraction or expansion or as a means to measure river recovery by the presence or absence of spawning. Timing of redd construction may also be an indicator of the success of different stock components given that it is likely to be linked to run timing. However, they would not view redd counting as a core assessment technique. In contrast, Gallagher et al, (2008) cite several studies which have shown positive correlations between redd counts for Atlantic salmon and the numbers of adult spawners.

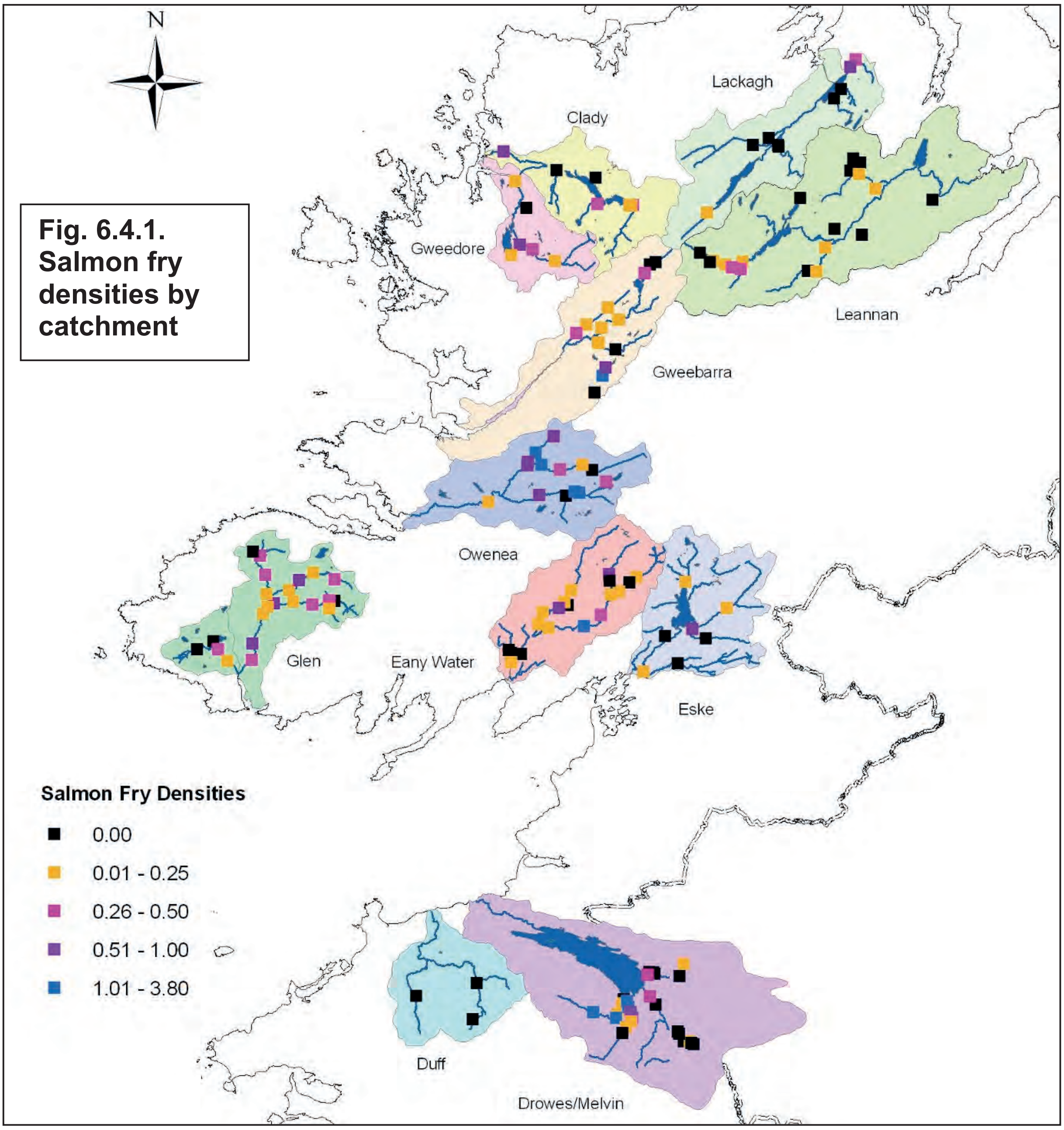
A detailed protocol for redd counting is not within the scope of this report. Gallagher et al (2008) present a very detailed appraisal of redd counting and its effectiveness stating that it is relatively inexpensive compared to tagging, trapping or other forms of monitoring and considerably less intrusive. A detailed protocol is presented in their review and many elements of this protocol should be adopted for this revised redd counting regime.

6.4. Juvenile salmon indices

6.4.1. Juvenile salmon density comparisons

One of the main activities conducted during this study was to assess salmon status through juvenile assessments derived from quantitative electrofishing. These data provides a measure of spawning and nursery habitat utilisation and an index of performance by highlighting areas with varying juvenile densities. These may range from absences to high densities which may be due to adverse environmental impacts, or different quality habitat conditions. Together with accurate rod catch data the electrofishing results provide a valuable assessment of salmon status in the catchment.

Comparisons of quantitative juvenile salmon densities are presented by way of an overview (Fig. 6.4.1) and catchment site density distributions for fry and parr (Figs 6.4.2 & 3). Salmon fry (0+) were absent from over 35% of sites in several catchments: Leannan, Lackagh, Eske and Melvin. Some of these absences were related to sites being situated above barriers but for the Leannan, Lackagh and Eske systems the juvenile densities reflect the low spawning escapement and generally low redd counts in each. Both of these indices indicate that the Melvin system is performing well; the high rate of salmon fry absence can be attributed to poor results from the County and Roogagh Rivers.



To establish the relative status of fish populations in rivers in England and Wales the National Rivers Authority (NRA, now Environment Agency) developed the National Fisheries Classification Scheme (NFCS, NRA, 1994). For salmon the scheme is based on an assessment of 600 sites and a series of bands ranging from good to poor has been developed (Table 6.4.1).

Table 6.4.1. Atlantic salmon abundance (per m^2) associated with absolute classifications in the NFCS (NRA, 1994). Grades run from A to F. (e.g. Grade A > 0.86/m2; Grade B 0.45 – 0.86/m2)

Lifestage	CLASS					
	A	**B**	**C**	**D**	**E**	**F**
0+ salmon	0.86	0.45	0.23	0.09	0	
>0+ salmon	0.19	0.1	0.05	0.03	0	

Abundance categories developed by Crozier & Kennedy 1994 to relate semi-quantitative abundance estimates with quantitative estimates derived from numerous electrofishing data from rivers in Northern Ireland are presented for national comparison (Table 6.4.1).

Excellent fry densities (> 1.15/m2) were recorded in sites in a few systems, the Owenea, Eske and Melvin and often in only a limited number of sites. A small proportion of systems have fry density profiles dominated by fair to good abundance ratings (red line in Fig 6.4.2 denotes the “fair” cut-off point). The Owenea has the highest density profile indicating its high status as a salmon production unit and the Glen/Owenwee was also satisfactory. The remaining systems are in the poor range in terms of overall 0+ density profiles particularly the Leannan and the Lackagh systems.

Table 6.4.2. 0+ Atlantic salmon abundance (per m2) derived from electrofishing in Northern Ireland rivers (Crozier and Kennedy, 1994)

	A (excellent)	**B (good)**	**C (fair)**	**D (poor)**	**E (absent)**
0+ density range	**> 1.15**	**0.69 – 1.15**	**0.41 – 0.69**	**0.1 – 0.41**	**0**

No comparable data are available for salmon parr (fish > 0+) from Crozier and Kennedy's 1994 study. Applying a value of > 0.14/m2, which is good in terms of results recorded by the survey team in other Irish catchments over the past 20 years, it is evident that several catchments are performing well. The Owenea is consistent for both fry and parr and is the most productive juvenile salmon producer of all catchments surveyed. Other good producers of salmon parr are the Clady, Eany, Gweebarra and Melvin systems while the Leannan is a consistent underperformer.

The catchment-wide semi-quantitative electrofishing technique, originally developed by Crozier and Kennedy (1994) for the River Bush salmon monitoring programme, began to be used nationally for monitoring the status of salmon fry population in Irish salmon rivers in 2007. It is less labour-intensive than quantitative electrofishing and provides a reliable, widespread and rapid assessment of the status of salmon fry which is suitable for catchment review. In the medium term, with suitable calibration, it is intended to use this approach to determine if populations are above a threshold which relates directly to CL attainment. For the purposes of this study and to overcome logistical issues which arose from elevated water levels in the Leannan main channel and the Duff catchment the semi-quantitative approach was used. Apart from providing a relative assessment of fry which showed that the Leannan and the Duff were supporting low abundances relative to their carrying capacity, and, in the case of the Duff, identifying overexploitation by the rod fishery which presented an exaggerated appraisal of the fishery performance, this technique provides the fishery manager with excellent spatial abundance data to enable identification of localized environmental issues impacting on stocks.

Plate 6.4.1. Upper reaches of the Eany

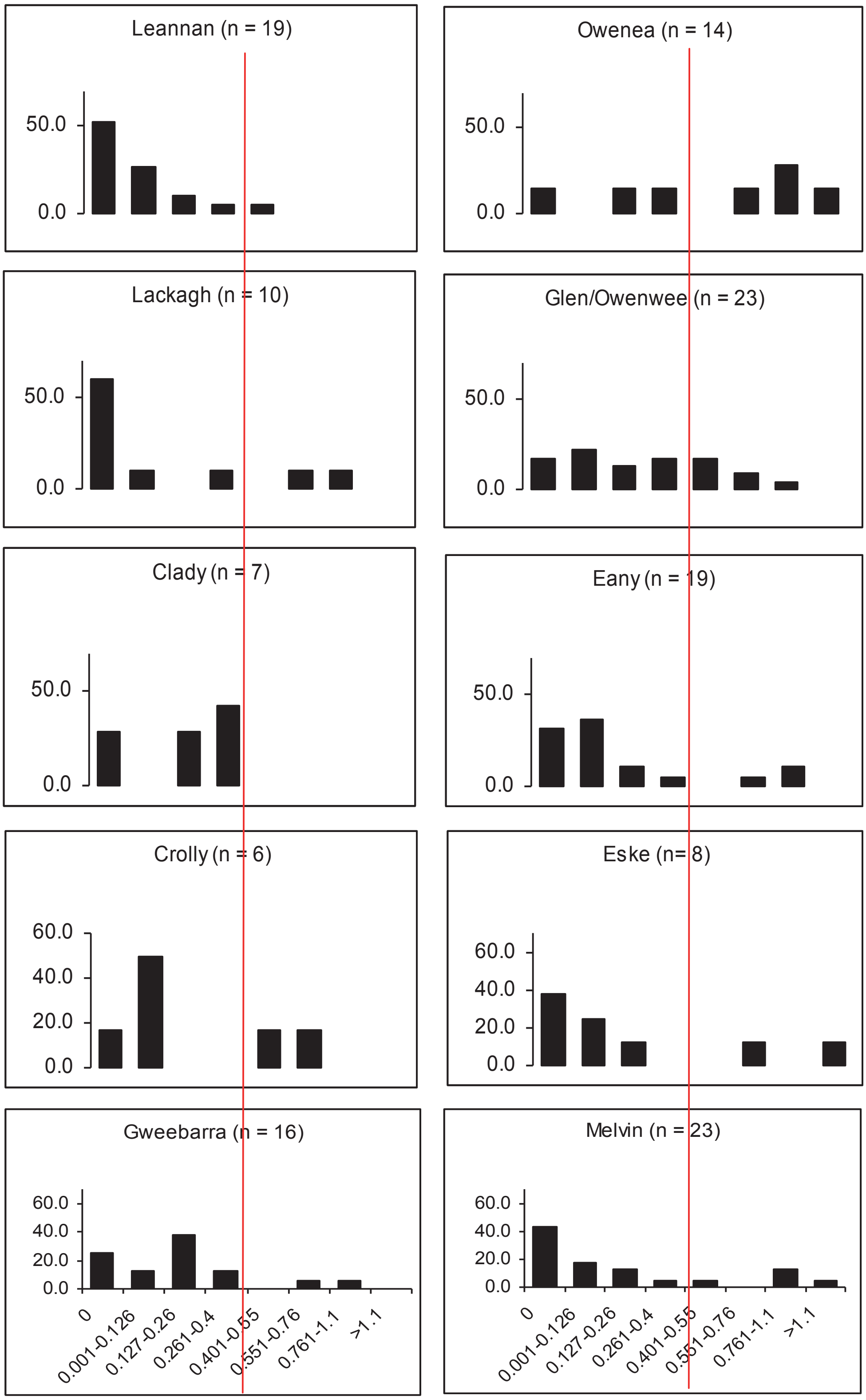


Fig. 6.4.2. Salmon fry density frequency distribution from catchments electrofished (n = no. sites sampled) – Duff excluded as n = 3. Red line denotes "fair" abundance/m^2 per Crozier & Kennedy 1994

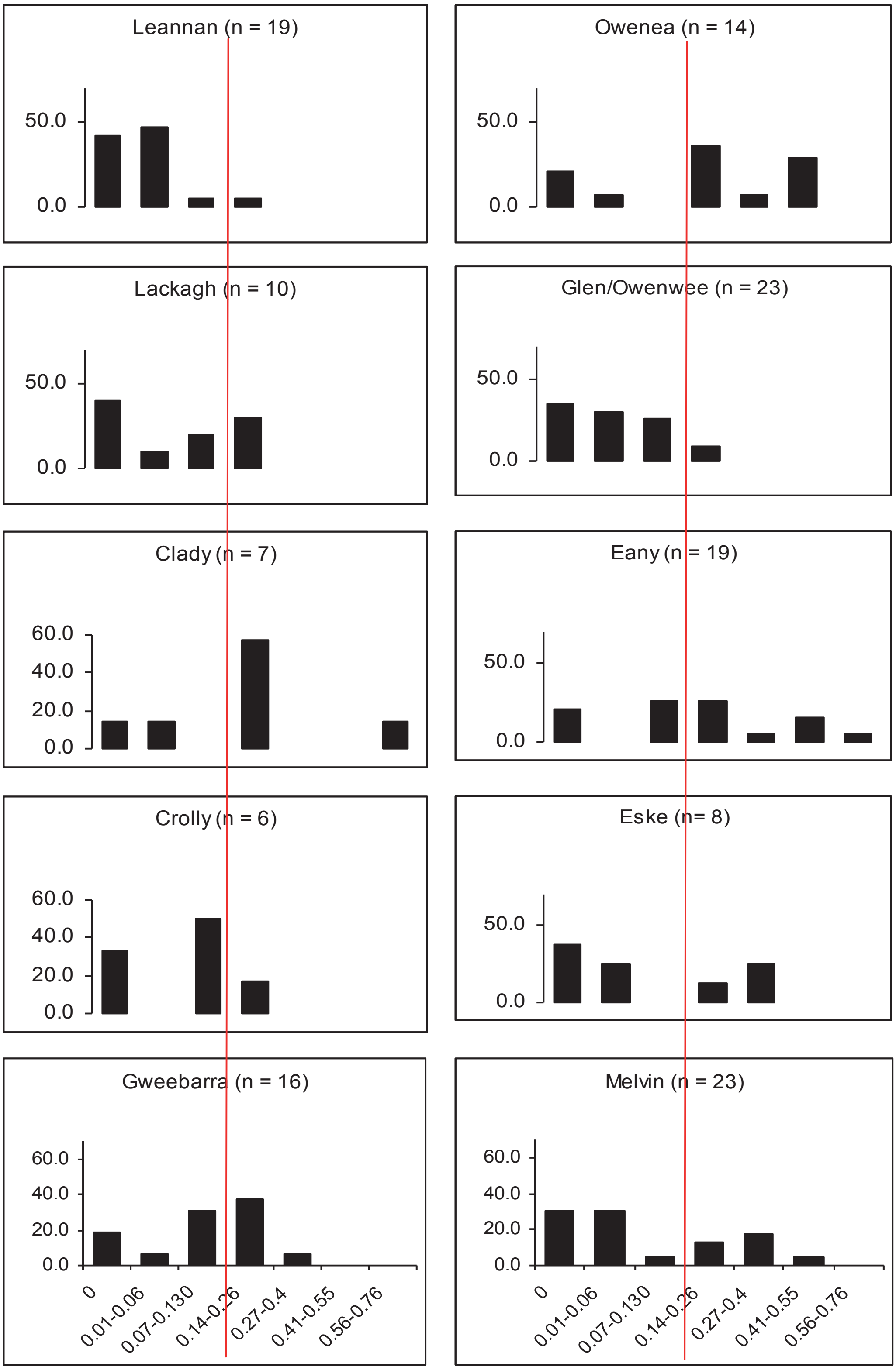


Fig. 6.4.3. Salmon parr density frequency distribution from catchments electrofished (n=no. sites sampled) – Duff excluded as n=3. Red line denotes good parr abundance/m^2 (authors, unpublished)

6.4.2. Recommendations for continued juvenile assessments

The effectiveness of the catchment-wide approach has been recognized nationally and regionally by the Central and Regional Fisheries Boards. Since

2007 the national sampling programme has been carried out and the technique has become a fixture in regular monitoring activities conducted by all of the Boards. The value of this work has also been acknowledged by the SSC and the results of the sampling programme are important determinants in the decision-making process regarding the opening of rivers to catch-and-release in the absence of any other data about a system. Detailed analyses of these combined datasets were carried out in 2009 (SSC, unpublished) to examine the linkages between fry abundance and CL attainment. Statistically significant differences in mean catchment-wide fry abundances were observed for rivers above and below their CL suggesting that the technique is potentially very powerful. Additional data are required to develop the robustness of the technique and this will be achieved over the next two years of the programme.

In 2007 and 2008, a catchment-wide fry index of 25/5-min was used as a conservative cut off point to facilitate catch-and-release angling, based on data presented in Crozier and Kennedy (1994). It should be noted that the Crozier and Kennedy 25 fry/5-min index was a site based index. The national data collected in 2008 and 2009 allowed a more meaningful determination of this cut off point and The results of this analysis showed that where there are more than one year's fry indices, the average should be ≥17 fry/5-min. For the NRFB systems surveyed catchment-wide electrofishing should be carried out annually in several catchments to deliver for the SSC, provide the required management information and also to satisfy the requirements of the Habitats Directive to report the conservation status of Ireland's salmon resource on a river-specific basis by 2013. A programme of surveys is set out in Table 6.4.3. The combination of the semi-quantitative rapid catchment-wide survey, which primarily targets salmon fry, and selective quantitative assessments is recommended for any future salmon orientated survey programmes. It has significant advantages in delivering a whole catchment appraisal rather than a fully quantitative assessment which may be limited by time, staff and financial resources. The CFB has begun to deliver surveys based on this approach to catchment assessment for salmon and Cowx and Fraser (2003) recommend it for monitoring SAC rivers. Following a review of electrofishing to assess juvenile salmonid stocks in Scotland Bacon and Youngson (2007) determined that significant additional research is required. The use of standard reference sites, sampling of pristine sites in both upland **and** lowland areas, collection of length and scale data to examine size-at-age, and temperature data to examine possible effects of climate change are included as part of an appropriate research programme, particularly in the context of the WFD and the Habitats Directive.

Table 6.4.3. Proposed rolling programme for NRFB catchment-wide electrofishing 2010 – 2013 for the systems reported in this report

System	2010	2011	2012	2013	Rationale for assessment regime
Leannan	yes	yes	yes	yes	Consistently underperforming MSW system; will complement annual counter data
Lackagh		yes		yes	Consistently underperforming MSW system; full counter to be installed;
Clady			yes		To monitor fishery status
Crolly			yes		To monitor fishery status
Gweebarra		yes			To monitor fishery status
Owenea		yes		yes	Potential model system acting as a control to monitor prime regional performance as ISW fishery but only if full counter installed
Glen/Owenwee	yes	yes	yes	yes	To monitor extensive restoration programme and bogslide aftermath
Eany	yes	yes	yes	yes	Full counter and discrete spawning areas; declining adult runs in recent years
Eske	yes	yes	yes	yes	Full counter and discrete spawning areas
Melvin/Drowes	yes	yes		yes	Basic survey required to provide up-to-date assessment
Duff	yes	yes	yes	yes	To maintain time-series from 2007; to monitor ongoing restoration and Bunduff falls passage easement

6.5. Identification of barriers to anadromy

6.5.1. Barrier identification

The conservation status of a fishery is determined from various factors including the capacity of the adult populations of salmon migrating to freshwater to adequately populate the available habitat. Knowledge of the extent of anadromy was a key determinant in calculating available habitat when the wetted area report (Mc Ginnitty et al, 2003) was being compiled originally. The wetted area report also identified all known barriers to salmon anadromy following consultation with RFB staff countrywide. This was essential to defining accessible habitat and subsequently to underpin the calculation of river-specific Conservation Limits.

One output from this NRFB salmon rivers study has been the identification of additional barriers from the electrofishing programme and from NRFB staff inputs. Juvenile salmon distribution data defines the extent of the productive area and identify reaches where salmon are absent. Assuming that the environment is suitable it is reasonable to conclude that absences are due to the presence of barriers downstream. Results from the current project identified putative barriers to migration which will alter the quantity of available habitat in several systems (Fig. 6.5.1). Some of these alterations are based on observations of barriers and relating juvenile distribution data or eels to barrier presence. In other cases salmon do not enter certain channels to spawn (RFB observation) and these are deemed as “not utilised by salmon” in the current wetted area report. All catchments, with the exception of the Crolly and the Gweebarra, require downward adjustment of wetted area on the basis of these new data. All of the known current barriers in the Crolly and Gweebarra were identified in the original analysis. The extent of the correction in each catchment varies from minor to important because the barriers are generally situated on lesser channels (low stream order), but to improve salmon fisheries management in these systems all updates should be notified to the SSC. This revised barrier information has been an important output from the project.

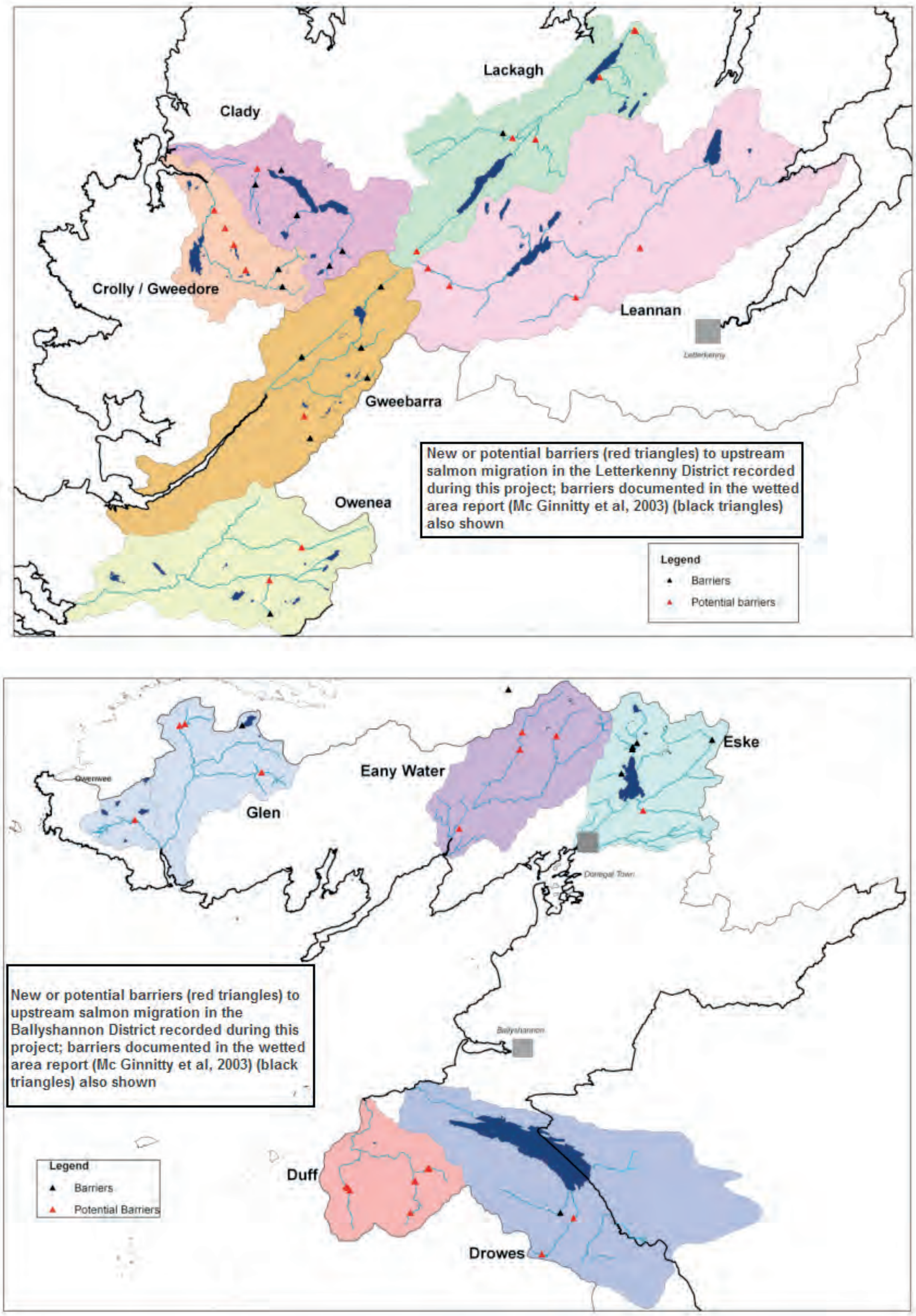


Fig. 6.5.1. New or potential barriers (red triangles) to salmon migration in catchments in the Letterkenny (top) and Ballyshannon Districts.

Table 6.5.1. Putative additional barriers/natural limits of upstream salmon migration for incorporation into any proposed revision of the original salmon wetted area report (Mc Ginnitty *et al*, 2003)

System	Tributary	Location	Rationale	Barrier type	Outcome
Leannan	Glashagh	Middle reaches at Drumbolloge Bridge	Barrier present; no juv. salmon at Site Ln3	Natural	New revised limit of anadromy on this tributary
Leannan	Bullaba	Upper reaches	No juv. salmon at Site Ln9	None; not utilised by salmon	New revised limit of anadromy on this tributary
Leannan	L. Akibbon inflow	Lower reaches	No. juv. salmon at Site Ln13	Unknown	Further investigation required
Lackagh	Glen	Middle reaches	No juvenile at Site 5 (Boylan &Sheridan , 1994)	Natural	New revised limit of anadromy on this tributary
Lackagh	Owenwee	Full extent of channel	No juvenile salmon in two separate surveys (current and Boylan & Sheridan, 1994)	None; high gradient; not utilised by salmon	New revised limit of anadromy on this tributary
Lackagh	Glasnaseeragh	Middle reaches	No juvenile salmon in two separate surveys (current and Boylan & Sheridan, 1994)	Natural; 1 km upstream of confluence with Owenacarrow	New revised limit of anadromy on this tributary
Lackagh	Owenacarrow/River Barra	Upper reaches	No juv. Salmon at Site 35 & 36 (Boylan & Sheridan, 1994)	None; not utilised by salmon	New revised limit of anadromy on this tributary
Clady	Altmore River	Full extent of channel	No juvenile salmon in two separate surveys	Existing barrier known but channel not utilised by salmon	New revised limit of anadromy on this tributary

			(current and Gargan, 1994)		
Crolly	No adjustment				
Gweebarra	No adjustment				
Owenea	Stracashel	Upper reaches at Graffy's Bridge	No juvenile salmon recorded	Natural rock sills	New revised limit of anadromy on main channel
Glen	Lougherah erk Lake	Falls d/s outflow	No juvenile salmon u/s falls in two surveys (current and Boylan & Sheridan, 1994)	Natural	New revised limit of anadromy on this tributary
Glen	Owenwee	Upper reaches – Lough Unna outflow	No juvenile salmon in two surveys (current and Boylan & Sheridan, 1994)	Mixed natural/ artificial barrier	New revised limit of anadromy on this tributary
Eany	Stranahen d stream	Lower reaches	No juvenile salmon recorded	None; not utilised by salmon	New revised limit of anadromy on this tributary
Eany	Eany Beg	Middle reaches	Spot electrofishi ng; barriers identified	Natural	New revised limit of anadromy
Eany	Sruell	Middle reaches @ Meenawilder g	Spot electrofishi ng; barriers identified	Natural	New revised limit of anadromy
Eany	Frosses Stream	Lower reaches	No juvenile salmon recorded	Natural barrier in lower reaches; suspect water quality?	New revised limit of anadromy on this tributary

Eske	Clogher River	Middle reaches	No juvenile salmon recorded in current & previous surveys	Natural	New revised limit of anadromy on this tributary
Eske	Limestone Brook	Lower reaches	No juvenile salmon recorded	Natural	New revised limit of anadromy on this tributary
Melvin/Drowes	Ballagh River	Upper reaches	No juvenile salmon recorded	Natural	New revised limit of anadromy on this tributary
Duff River	Main channel	Upper reaches u/s main road bridge	No juvenile salmon recorded	Natural	New revised limit of anadromy on main channel
Duff River	Ballaghnatrillick River	u/s Ballaghnatrillick Bridge	No juvenile salmon recorded	Natural	New revised limit of anadromy on tributary

6.6. Trout in the systems surveyed

Trout were widespread throughout the catchments surveyed. At least one life stage was present at all sites quantitatively sampled. Trout fry were recorded at 100% of sites in the Leannan, Lackagh, Eany and Duff catchments and a high percentage occurrence was recorded in the remainder (Table 6.6.1). The lowest occurrence was observed in the Crolly catchment.

Higher overall occurrence percentages were observed consistently for trout parr (1+ fish) and the lowest value recorded was 84% from the Eany. Older trout occurrences at sites were highly variable. High values (>70%) were recorded for the Clady, Glen, Eany and Melvin catchments. Individual site data are presented in Appendix 4. The presence of trout in all sites reflects the adequate water quality capacity at all sites to support salmonids.

Table 6.6.1. Frequency occurrence of different trout life stages at sites sampled. ** Melvin data are for 1+ and older combined.*

System	No. sites	0+ trout fry	1+ trout	> 1 + trout
Leannan	19	100%	95%	58%
Lackagh	10	100%	90%	60%
Clady	7	86%	100%	86%
Crolly	6	67%	100%	67%
Gweebarra	16	75%	94%	44%
Owenea	14	93%	100%	21%
Glen/Owenwee	23	91%	96%	74%
Eany	19	79%	84%	95%
Eske	8	100%	88%	38%
Melvin	23	78%		100% *
Duff	3	100%	100%	33%

Density values were highly variable for all trout life stages (Table 6.6.2) & (Appendix 4). Trout fry densities were generally low. This has been observed previously in other salmon catchments such as the Erriff (Gargan and Roche, pers. obs.) which are dominated by riverine habitat and where trout fry densities were minimal in the main channel, being confined largely to the smaller tributaries where exceptionally high densities were recorded.

Table 6.6.2. Density ranges (no. fish/m2) expressed as min-max from catchments sampled. **** Melvin data are for 1+ and older combined.***

System	No. sites	0+	1+ parr	> 1+
Leannan	19	0.07 - 0.82	0 - 0.19	0 - 0.04
Lackagh	10	0.04 - 0.38	0 - 0.38	0 - 0.03
Clady	7	0 - 0.14	0.01 - 0.17	0 - 0.02
Crolly	6	0 - 0.14	0.02 - 0.04	0 - 0.03
Gweebarra	16	0 - 0.26	0 - 0.14	0 - 0.04
Owenea	14	0 - 0.91	0.01 - 0.4	0 - 0.02
Glen/Owenwee	23	0 - 0.69	0 - 0.11	0 - 0.03
Eany	19	0 - 0.11	0 - 0.16	0 - 0.08
Eske	8	0.007 - 0.53	0 - 0.62	0 - 0.06
Melvin	23	0 - 1.6	-	0.02 - 0.68*
Duff	3	0.1 - 0.55	0.09 - 0.13	0 - 0.02

6.7. Other fish species

An abundance rating system was applied to all non-salmonid species based on in situ counts. The rating intervals were as follows: Abundance rating 1 = 1-10 individuals, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200. This system is particularly useful where shoals of fish are encountered. Detailed site abundance data for these species is presented in Appendix 6.

6.7.1. Eels

Eels were recorded in all catchments sampled (Fig. 6.7.1). Distribution varied within catchments – the highest percentage distribution was observed in the Gweebarra, Eany and Eske catchments where eels were recorded in over 80% of sites sampled (Table 6.7.1). The lowest percentages were recorded in the Clady, Glen and Melvin catchments. The regulating weir on the Clady and the natural weirs on the Melvin tributaries (Roogagh and County Rivers) may impede upstream migration.

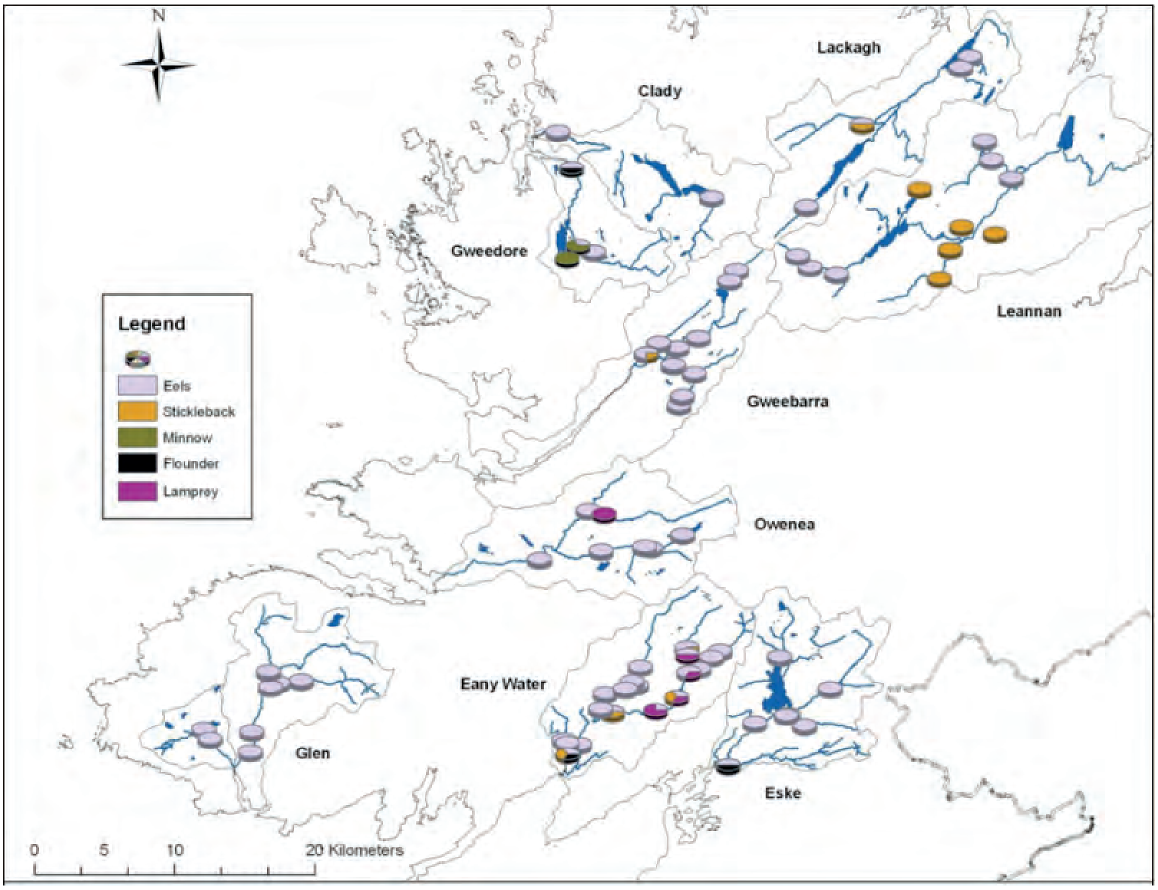


Fig. 6.7.1. Distribution of non-salmonid fish species recorded during electrofishing surveys

Distribution was disparate in all catchments apart from the Gweebarra and the Eany where eel distribution was widespread and virtually continuous. Eel abundance was low in all catchments and a high percentage (86%) of sites where eels were observed had an abundance rating of 1 (< 10 eels). 12% had an abundance rating of 2 while a single site was documented where eel achieved a rating of 3. The majority of the higher ratings were recorded in the Gweebarra and the Eany catchments. Barriers to eel migration may be one factor influencing their distribution in these catchments and these data should be forwarded to the Scientific Eel Group to be included in the national analysis of eel barriers.

The efficiency of multi-species electrofishing studies in enumerating eels is limited and eel specific sampling is required to accurately assess population strength. Nonetheless the low abundance of eels in these systems agrees with scientific advice that the European eel stock is outside safe biological limits (ICES, 2007).

Table 6.7.1. Percentage distribution of species within sites sampled

		Percentage of sites where species recorded				
Catchment	**No. sites sampled**	**Eel**	**3 spined stickleback**	**Minnow**	**Flounder**	**Lamprey**
Leannan	19	39%	21%	0	0	0
Lackagh	10	50%	10%	0	0	0
Clady	7	29%	0	0	0	0
Crolly	6	50%	0	40%	17%	0
Gweebarra	16	81%	6%	0	0	0
Owenea	14	43%	0	0	0	7%
Glen/O'wee	23	35%	0	0	0	0
Eany	19	95%	11%	0	5%	26%
Eske	8	88%	0	0	13%	0
Melvin	13	34%	0	69%	0	0

6.7.2. Three-spined stickleback

This species was recorded in four catchments, in low abundance (Table 6.7.1). Apart from the Leannan, where it was recorded at 21% of sites sampled, its presence was incidental. On the Leannan catchment this species was recorded at three sites on the Glashagh catchment, which suffers from periodic water quality problems. Kelly *at al,* 2007 found that three-spined stickleback are indicative of enriched sites.

6.7.3. Minnow

Minnow were recorded from two systems only, the Crolly and Melvin – both have substantial lakes. In Ireland, minnow are regarded as being widely distributed and abundant (Kelly et al. 2007) so their presence in these waters was not unexpected.

6.7.4. Lamprey

Lamprey spp. were recorded in two catchments, the Owenea and the Eany (Table 6.7.1). The specimens were not speciated but it is likely that all those encountered were brook lamprey (*Lampetra planeri*) which is tends to have a localized distribution but is quite common in Irish watercourses. All lamprey species have a high conservation value and are protected under the Habitats Directive.

6.7.5. Flounder

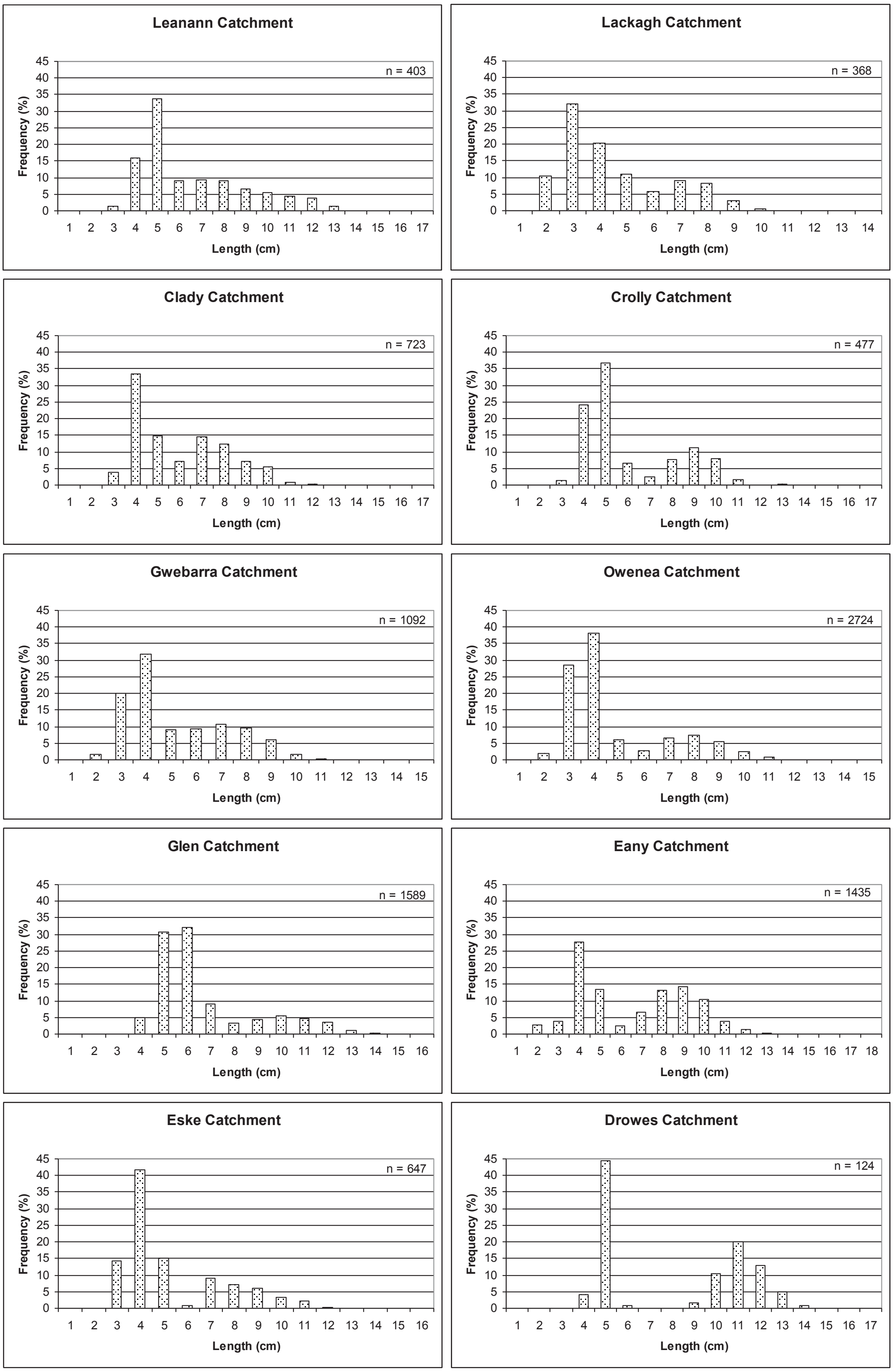
This species commonly inhabits the lower reaches of rivers as it spends part of its juvenile life cycle in freshwater. Specimens were recorded in low numbers in the lowermost sites in the Crolly, Eany and Eske systems.

6.8. Salmonid length frequencies by catchment

Large samples of juvenile salmon and trout were measured (forklength cm) at all sites. Data were combined to provide a catchment overview of length range and are presented for salmon (Fig. 6.8.1) and trout (Fig. 6.8.2).

In all catchments salmon length distribution was bimodal reflecting the dominance by 0+ and 1+ fish. Previous studies in Irish salmon catchments (compiled by Went 1970) found that the majority, circa 85%, of Irish adult salmon migrated as two-year smolts. The dominance by 1+ parr and the virtual absence of 2+ parr in these distributions suggests that salmon populations in these rivers are not deviating from this smolt migration pattern. This is also the case in many other Irish salmon systems where studies over the past decade (authors, unpublished) have observed similar juvenile length frequency distributions.

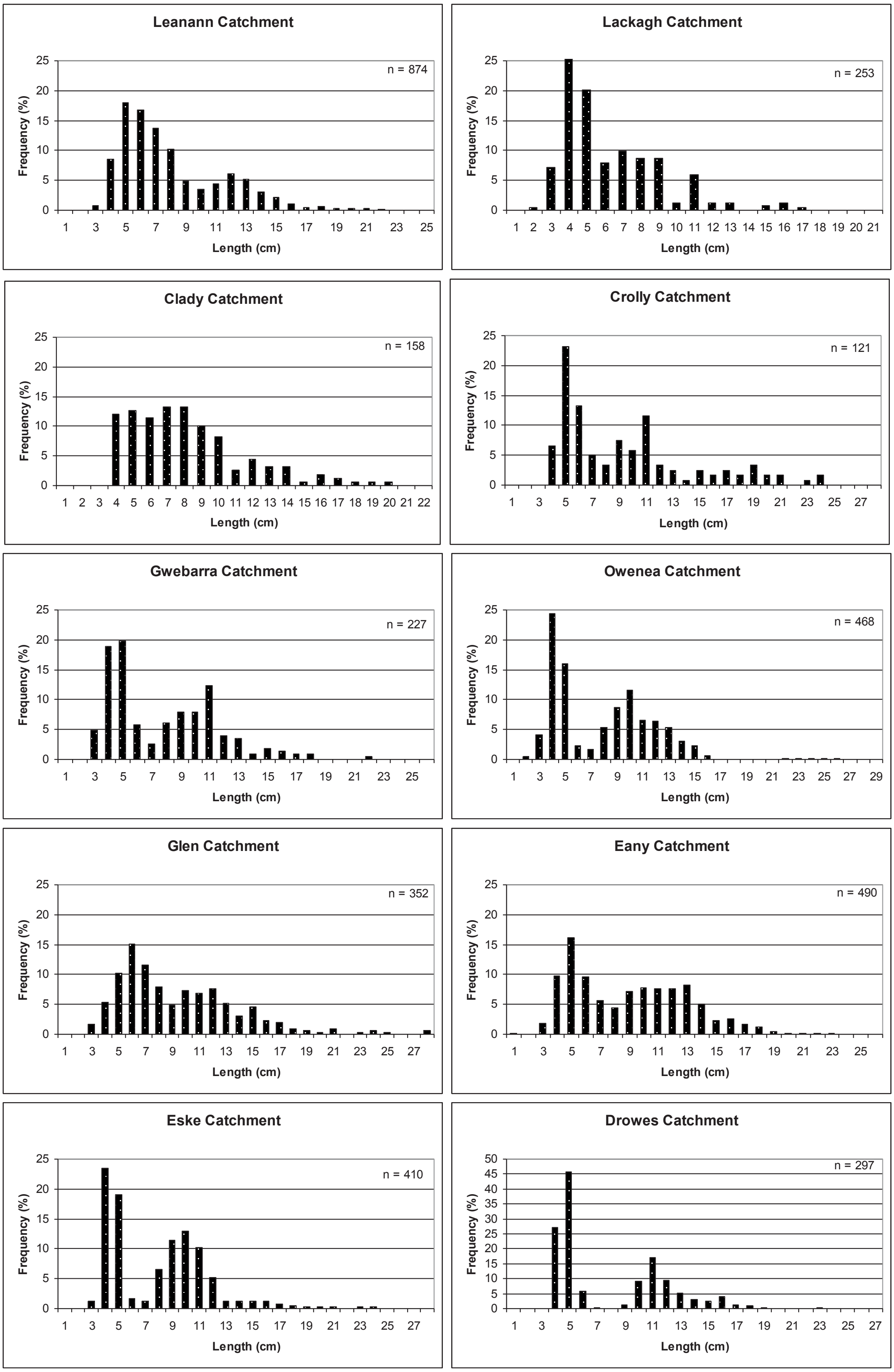
Fig.6.8.1. Length frequency distributions for juvenile salmon by catchment



The modal length of 0+ salmon fry ranged from 3 to 6 cm. The lowest value was observed in the Lackagh while the highest was in the Glen. 50% of 0+ salmon recorded modal lengths of 4 cm. Gibson and Cutting (1993) indicate that habitat zonation (quality) and growth influence fry modality in different river reaches but it would appear that underlying productivity is a factor in the systems examined in this study. The Leannan, Crolly, Glen and Drowes were producing larger fry, on average, than the other systems. Streams in the Melvin catchment drain off limestone but granite, schist and gneiss geologies, which are substantially less productive, underlie the other catchments. The size advantage is also evident in salmon parr in the Crolly, Glen and Drowes systems where the modal values are 2 to 3 cm higher than in the other catchments. Assuming that this size advantage continues into smolting a competitive advantage is conferred on salmon smolts produced (Saloneimi et al, 2004) in these catchments based on this dataset.

Trout length frequency distributions were variable from bimodal to tri-modal with some larger, older fish in the broader distributions (Fig. 6.8.2). The majority of brown trout in all catchments were < 20 cm forklength. The same modal value was recorded for 0+ trout fry and salmon in six of the catchments. Exceptions were the Lackagh, Clady, Gweebarra and Eany where trout fry were approximately 1 cm longer than the equivalent salmon. The primary difference is observed at 1+ parr level where trout are consistently larger than salmon. Juvenile trout are more aggressive than salmon of a similar size and this restricts salmon to shallower habitat to which they are better adapted than trout (Kennedy and Strange, 1986b). This has obvious implications for availability of habitat in any system. In this regard it is important to clearly identify production bottlenecks so as to ensure that any remedial or restorative measures are beneficial and do not constrain the quality of different habitat types within the catchment which both trout and salmon require over the duration of their life span (Armstrong et al. 2003).

Fig.6.8.2. Length frequency distributions for trout by catchment



7. Conclusions and Recommendations

The distribution and abundance of salmon (and trout) in any catchment is strongly influenced by its habitat. Abiotic and biotic factors influence the habitat and both factors are intrinsically linked through composite webs.

The primary aim of this project was to assess the salmon resource in eleven key catchments within the NRFB remit, with a view to maximising sustainable juvenile salmon output in freshwater. This was achieved by using available data on adult populations (including rod catch and redd counts), reviewing juvenile population status and assessing habitat quality. Post assessment, recommendations for habitat restoration or enhancement were compiled and various programmes for improved monitoring of salmon populations were recommended.

7.1. Quantity and quality of the salmon production resource

The 11 systems investigated accounted for almost 5% of the total national accessible fluvial wetted area (Mc Ginnitty et al., 2003) and 60% of the entire accessible wetted area salmon resource in the NRFB area. The Leannan accounts for 1% of the total national accessible resource.

Stream gradient is known to be one of the principal determinants of juvenile salmon production (Amiro, 1993). Gradient is a surrogate of biologically more meaningful hydromorphological entities such as riffles, glides and pools, and medium gradient (classes 4, 5, 6) habitat has been shown by Amiro (1993) to be potentially the habitat with the best capacity for juvenile salmon production. The combined total of the Letterkenny and Ballyshannon Districts medium gradient habitat (1.23%) is ranked second only to the Waterford District total of 1.42%, which has the highest overall productive potential, which emphasises the productive capacity potential of rivers in the NRFB Region for salmon, as a whole.

The project identified that the Leannan, by virtue of overall catchment size, has the highest percentage of the potentially more productive, medium gradient channel, but medium-sized catchments like the Owenea, Glen, Eske, Eany, Drowes and Duff are prominent indicating their natural potential.

Salmon fry and parr densities vary immensely in natural watercourses and one of the primary limiting factors is usually the availability of suitable habitat. For the duration of the life cycle, each lifestage utilizes different habitats and habitat availability will strongly influence final recruitment to the smolt stage. Having established that sufficient quantities of potentially productive habitat are available in the majority of catchments studied, water quality in the catchments in the period prior to this study, which would influence one primary index, juvenile densities, was assessed. Based on the 2003 quantitative analysis which was presented in the wetted area report (Mc Ginnitty et al, 2003), only the Leannan and Glen Rivers and, to a lesser extent, the Eske displayed any level of water quality impairment (Fig. 3.8). All of the remaining channels were classified as unimpaired.

7.2. How are salmon catchments in the NRFB region performing?

7.2.1 Assessment of the resource based on biotic factors

In a national context any review of salmon stocks has to concentrate on the period post-closure of the mixed stock fishery at sea (i.e. the drift net fishery) in 2007. Mc Ginnitty et al., (2007) demonstrated, through a comprehensive salmon genetic stock identification analysis, the extensive mixed stock nature of this fishery.

Data from the National Fish Counter Programme (Fig. 7.2.1) shows counts for the years after the closure to 2009. Assuming that exploitation rates on wild stocks in this fishery averaged approximately 50% in recent years (based on coded wire tag returns), an increase of 100% (i.e. a doubling of counts indicated in the figure below) might have been expected in 2007. This was achieved or exceeded for most rivers in 2007. While this increase was noted again in 2008, in only one case was the increase higher than in the previous year. In 2009, virtually all counts were down on the previous two years with some counts being even lower than the pre-closure period. Both the Eske and the Eany reflected the national trend.

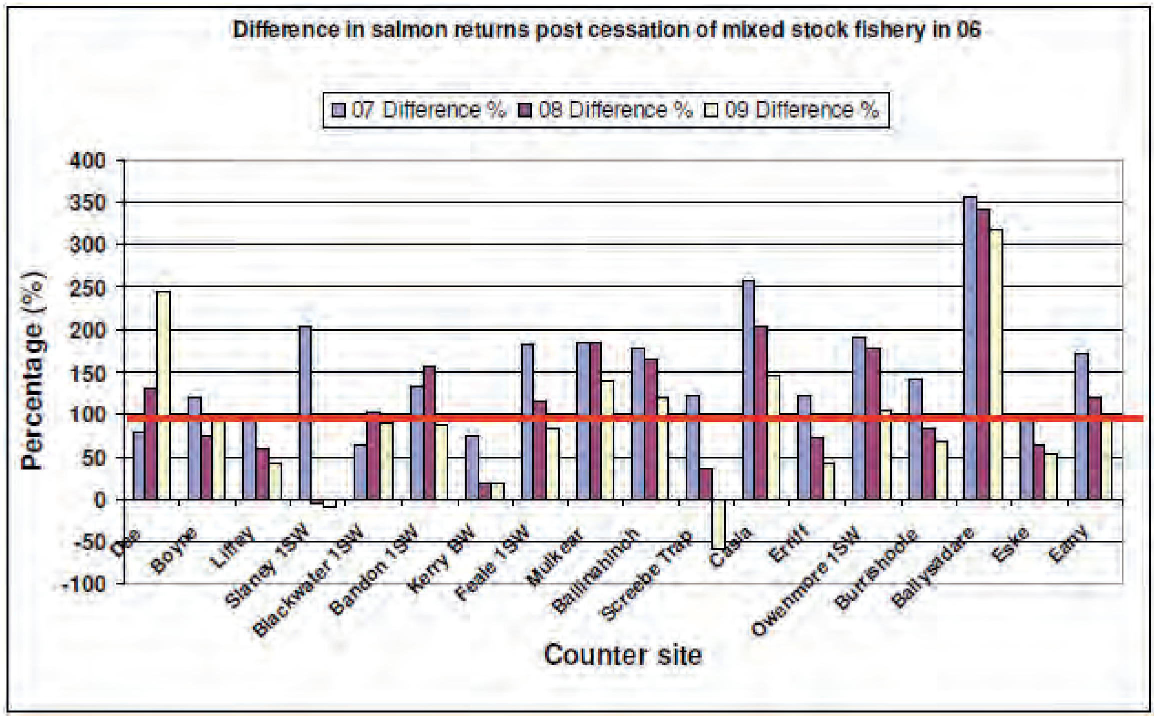


Fig. 7.2.1 Percentage change in salmon returns based on counter data 2007 - 2009 following closure of the salmon mixed stock drift net fishery in 2006 (from SSC report 2010)

An earlier review - the national assessment of the status of Atlantic salmon for the EU Habitats Directive - found that the overall conservation status of salmon in Ireland was "bad" (CFB, 2007). The assessment stated:

"The salmon population in Ireland has declined by 75% in recent years and although salmon still occur in 148 Irish rivers, only 43 of these have healthy populations". (Anon. 2008)

Note: The analysis carried out by the SSC in 2008 indicated that the number of rivers with "healthy populations" i.e. meeting Conservation Limits was now 57.

Factors leading to this decline are described and included reduced marine survival (from several factors including possibly climate change), poor river water quality (resulting from factors such as inadequate sewage treatment, agricultural enrichment, acidification, erosion and siltation), forestry related pressures and over-fishing. Concerns related to factors causing mortality at sea, such as diseases, parasites and marine pollution are noted. Although the range where salmon were to be found was classified as good, the population size was considered bad, habitat condition was considered “inadequate” with future prospects also considered poor. The overall classification for the Atlantic salmon in Ireland, based on a decision matrix, was therefore “Bad”.

Table 7.2.1. Catchments ranked by total scores of biotic assessments. Scores are rated from 1 to 5 (low to high).

	Spawning escapement levels	Redd counts	Juvenile assessments	Total score
Owenea	4	4	4	12
Melvin	5	3	3.5	11.5
Gweebarra	4	4	3	11
Clady	3	4	3	10
Duff	4	3	2	9
Eany	2.5*	1	3	6.5
Glen	2	1	3	6
Lackagh	1	2	2	5
Crolly	1	2	2	5
Eske	1	2	2	5
Leannan	1	2	1	4

* Recent counter data reflected in Eany score

The current project identified, through various indices, including spawning escapement levels, redd counts and juvenile assessments, extremes in salmon population health status in the NRFB area that concur with the general findings of the national assessment. The Owenea scored extremely positively for all indices while the Leannan fared very poorly and ranked lowest for most. The remaining catchments were positioned within these extreme boundaries (Table 7.2.1). Two divisions emerged from this assessment. An upper division comprising the Owenea, Melvin, Gweebarra, Clady, Eany and Duff and a lower division including the Glen, Lackagh, Crolly, Eske and Leannan.

7.2.2. Recommendations for habitat improvement

Comprehensive habitat restoration programmes have been developed and are presented for each catchment in the body of this report. The natural division of catchments will serve to focus management on improving the status of catchments in the lower division. Physical restoration or enhancement programmes have been developed for the high performance catchments (upper division) but best value for money would be achieved by prioritizing within the lower division. The extensive Glen and the Leannan catchments should be targeted for intensive programmes to restore their production capacities which have deteriorated over the past two decades for different reasons. The modification of the weir at Watts Pool has been identified as a priority measure. The "do-nothing" option is recommended for the Lackagh and Crolly catchments which are physically stable. Lough Eske modulates flows on the Eske and apart from the extreme erosion on the Lowerymore the Eske system has a good physical habitat regime. Where funding opportunities permit capital works should be undertaken on the Lowerymore but it is liable to be a significant drain on limited resources in the current economic climate and a "do-nothing" approach is advocated in this channel as sheep destocking may facilitate a natural recovery in this highly erosive channel. The recent decline in the Eany, if it continues, may require intervention to investigate likely causes and targeted remedial measures.

One exception to the strategic approach being recommended for prioritisation of habitat restoration is the installation of the large gravel trap in the upper reaches of the Shallogen River in the top ranked Owenea catchment. Severe degradation of this immensely valuable tributary will continue unless immediate steps are taken to prevent extreme gravel movements which occur regularly and are causing major erosion and instability problems with associated production losses.

Some costs for specific habitat programmes have been included in the relevant catchment assessments. Since these proposals were originally developed and subsequently modified in 2009 the economic downturn has resulted in major reductions in the costing structure for all construction work and materials. Reductions of up to 50% in material prices (stone etc) are not uncommon and on a local scale this may be even more variablie. In view of this no attempt has been made to compile a costing for implementation of the full restoration/enhancement programme as it would be grossly inaccurate. It is recommended that the NRFB Inspector would cost the plans as presented in this document on a prioritized basis to ensure delivery of best value for money for each system and for the NRFB.

7.3. Wetted area update

The physical driver for salmon Conservation Limits in Ireland is accessible riverine habitat which was initially quantified in the wetted area report (Mc Ginnitty et al., 2004). Over the course of the present study several systems revealed absences of juvenile salmon which were attributable to new or previously unknown barriers in 10 catchments. These barriers are listed in Table 6.5.1. A total of 15 barriers and 5 channels which adult salmon do not utilise are listed. As all of the barriers are natural they cannot be modified under the terms of the Water Framework Directive – none are effecting any reduction in juvenile production.

Recommendation: The presence of additional barriers in all systems except the Clady and the Gweebarra (Fig. 6.5.1) should be notified to the Standing Scientific Committee as these new barriers will reduce the nominal quantity of accessible habitat in each catchment and have the effect of lowering the CL. Some of these barriers are on high order streams and are likely to have a bearing on CLs and it is important to ensure that the wetted area model is refined and accurate where additional data are available.

7.4. Fisheries assessment techniques and CL attainment

7.4.1 Current inputs to the SSC process

Gargan et al., (2008) identified counter and rod catch as direct measures, and redd counts and juvenile salmon assessments as indirect measures of CL attainment. Data from fish counters monitored by the Regional Fisheries Boards, the Marine Institute, the Electricity Supply Board and private owners is provided for the annual scientific review of CL attainment undertaken by the Standing Scientific Committee. Rod catches from the CFB/RFB salmon carcass tagging scheme is central to the process and catch data from other CFB/RFB verified sources as also incorporated.

7.4.2. Recommendations for improving NRFB rod catch inputs to the SSC process

It is recognized that total fish counters are the preferred mechanism to determine CL attainment but it is not feasible to install counters in all rivers. A counter programme is in place for all RFBs and all potential counter installations are reviewed under the Conservation Stamp funding measure and funding is prioritised based on strict qualifying criteria. Rod catch data is expertly collated by CFB/RFB staff annually but additional data are required to fully understand the dynamics of salmon populations on a river-specific basis. Where fisheries are open salmon stock statistics should be collected to determine the composition of the stock particularly the percentage of MSW salmon in the population.

Salmon stock structure statistics to be collected by river
• Biological data: length, weight, sex, fresh-run or stale • Scale collection for age, sea age, run-timing and growth data

Because of their larger size MSW salmon bring more eggs (on average 2 – 2.5 times) into a catchment, and with higher female to male sex ratios than 1SW salmon, they are considerably more valuable.

The angling exploitation rate on salmon stocks by angling can vary depending on the size of the salmon stock, time of year fishery operates, level of angling pressure, angling method, nature of the fishery, (i.e. river only fishery or river and lake fishery, etc). Currently a range of exploitation rates is applied to all rod catch data to estimate total salmon stock size in rivers without counters to determine stock size and if conservation limits are being met. It would be preferable to determine river specific rod exploitation rates and rod exploitation rate on spring salmon and grilse fisheries. One method of achieving this goal is tagging and release of adult salmon in the lower reaches of a system and anglers reporting back on captures of tagged fish. This is a typical mark-recapture type study. The Bunduff falls fish passage easement proposal, designed by O'Grady in 2009, should be monitored using mark-recapture techniques to review its effectiveness.

7.4.3. Recommendations for improving NRFB redd counting

Section 6.3 of this report details the potential value of redd counting and identifies it as a very useful index if counting and reporting is properly structured. Consistent effort over a standard area to provide index counts is more valuable than attempting an all-inclusive catchment-wide approach. Gallagher at al. 2008 describe a detailed redd counting protocol and this report firmly endorses development of a protocol based on Gallagher's approach to maximize the quality and usefulness of this technique. A more comprehensive review is presented in Section 6.3.

7.4.4. Recommendations for catchment-wide electrofishing

This technique for juvenile assessment has demonstrated excellent potential as a tool for determination of CL attainment. Section 6.4.2 describes the technique and how additional data are required to build up solid time-series data to devise robust relationships between juvenile 0+ salmon timed abundance and CL attainment. Table 6.4.3 presents a 4 year programme for this activity within the catchments surveyed over the course of this study.

7.4.5. Detailed study of MSW stocks

To manage MSW salmon populations rationally it is essential to understand fully all the processes that influence MSW salmon production. Current knowledge of the life history of MSW salmon in Irish waters is limited and requires elucidation if effective management strategies are to be formulated. Identification of MSW salmon spawning areas is essential to begin the process of proper management in the freshwater environment.

With the MSW component in general decline in Irish fisheries, fishery managers are expressing concern about the future of the stock. Central to managing the stock is identification of spawning areas to:

- Allow relevant authorities to enable measures to adequately protect these extremely important MSW spawning habitats (e.g. impose special area of conservation status or similar)
- Provide the opportunity to study MSW spawning timing and the numbers and behavior of spawning MSW adults
- Provide index sites to monitor of MSW adult escapement and level of spawning activity
- Provide opportunity to study and model juvenile MSW progeny production
- Enable targeting of specific measures to protect and enhance these areas rather than wide non-targeted dispersal of such efforts – very important where funding may be limited
- Allow monitoring of environmental variables influencing the spring running trait
- Allow important input to the development of models of the life history and exploitation rates
- Permit investigation and measurement of the particular physical habitat characteristics and subsequent restoration of degraded habitat
- Permit examination of certain anthropogenic activities on these habitats

Water temperatures will require to be regularly monitored in watercourses to understand potential effect of increased temperatures on all biota, especially fish populations. The performance of salmon, particularly MSW salmon, may be criticially impacted by increased water temperature. Installation of a network of inexpensive temperature monitors (< €100) in various habitats throughout rivers in the NRFB area is highly recommended. Data derived from this type of inexpensive long-term programme will provide important information to allow monitoring of any possible impacts of climate change.

On a broader scale, to deliver on rational management for the valuable MSW stock component it will be necessary to fund a research proposal designed to assess the feasibility of using genetic material from juvenile and adult salmon to discriminate between MSW and one-sea-winter salmon (grilse) progeny so that the spawning areas of MSW salmon can be accurately identified and afforded targeted and possibly increased protection from any degradation.

7.5. Sea trout

Sea trout, the migratory form of trout (*Salmo trutta*), offer excellent sport often when angling conditions are less than ideal for salmon. Several systems and their estuaries within the NRFB administrative area offer quality sea trout angling which should be thoroughly investigated to understand the extent and quality of the resource. NRFB has made good progress in investigating the angling potential of several estuarine/coastal fisheries (e.g. the Erne estuary) but additional work is required in the riverine fisheries. A major international study, the Celtic Sea Trout Project, with CFB heading up the Irish interest, is currently underway. Extending from sea trout fisheries (riverine and estuarine) in Strangford Lough to Lough Currane in Kerry the main aims of the study are:

- To understand and describe sea trout stocks in the Irish Sea and thereby to enhance sea trout fisheries and strengthen their contributions to quality of life, to rural economies and to national biodiversity.
- To explore the use of sea trout life history variation as a tool to detect and understand the effects of climate change.

To close the circle and develop a thorough understanding of all sea trout in Irish waters, the new inland fisheries agency, Inland Fisheries Ireland, should consider developing a complementary sea trout research project extending from Lough Currane northwards to the exisiting NRFB area and over to Strangford Lough. Central to this project would be the valuable sea trout fisheries in the NRFB area including several of the eleven systems investigated over the course of this study.

7.6. Future prospects and the management objective

This study has identified several catchments which are underperforming, several which are in the middle ground and some which are extremely satisfactory in terms of performance. The physical resource is generally satisfactory in terms of quantity and quality, although some specific problems were identified, and water quality, with some notable exceptions (parts of the Leannan), is also satisfactory. The reasons for the underperformance in some catchments may be due to subtle intermittent factors which may include the possible impact of sea lice infestation from marine salmon farms on migrating salmon smolts (Gargan, pers. comm.), stocks which have been genetically compromised by stocking or introgression with farm escapees (McGinnitty et al., 2009), and the effects of acidification in poorly buffered catchments.

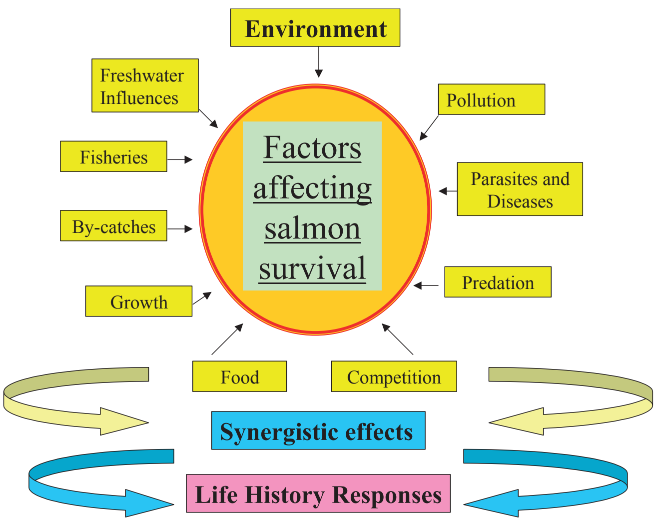


Fig. 7.5.1 Factors affecting salmon survival (from Anon, 2007)

One of the most influential factors is likely to be reduced marine survival. For the past 15 years ICES has been reporting that marine survival indices remain low and are considered to be a key factor limiting salmon production. Although there has been considerable fluctuation, estimates of marine survival prior to 1996 for wild stocks were generally higher compared to more recent years with survival rates in excess of 20% (*i.e.* 20 adult returns to the coast for every 100 smolts migrating, The current estimates suggest that substantially less than 10% of the wild smolts that go to sea from Irish rivers are surviving (*i.e.* less than 10 adults returning for every 100 smolts migrating). Marine survival is influenced by many factors and there are real concerns relating to factors causing mortality at sea including predation by seals, diseases and parasites and marine pollution. The multi-agency international SALSEA research programme, which is investigating marine mortality, will aid fishery managers to understand the likely factor and this will improve understanding of the scale of the problem when it reports in due course.

The NRFB will have to adopt a watching brief until the SALSEA project reports and understanding of this complex issue improves. For the foreseeable future the primary role of the NRFB, under its statutory function, is to continue to ensure that freshwater production units (i.e. salmon catchments) are fully functional in terms of habitat and water quality, and that juvenile and adult stocks are protected under the various national and international obligations which underpin salmon stock management in this country. This approach is fully aligned to the NASCO Plan of Action for the Protection and Restoration of Atlantic Salmon Habitat (Anon, 2001) which aimed to maintain and, where possible, to increase current productive capacity of Atlantic Salmon habitat. Key actions in the NASCO Plan have been delivered: inventory of rivers including an assessment of stock status, reporting baseline salmon production and identifying impacts responsible for reducing productive capacity and to facilitate development of restoration plans. Protection of the freshwater environment and maximising its potential if any improvement in adult escapement occurs must be the primary focus of the NRFB as it has been since its inception. Underpinning this primary role is the collection of baseline datasets and continued monitoring of stocks to detect any change in salmon status. The NRFB has been active in carrying out remediation works in many salmon catchments since acquiring the freshwater salmon brief in 1980 under the 1980 Fisheries Act.

The current report, commissioned by the NRFB, generated various outputs including:

- A fully geo-referenced high quality oblique aerial photography suite for all catchments surveyed
- A detailed fish stock assessment for all species
- An aerial and on-the-ground freshwater habitat quality assessment
- A detailed programme of restoration or enhancement measures for each catchment (if required)
- A set of comprehensive survey data sheets with site photographs
- Sets of scales from juvenile salmonids retained for any future analysis (genetics, microchemistry etc)
- Annotated historical data captured
- A comprehensive database of fish species and their abundance or density values
- A report detailing individual catchment performance based on biotic indices
- Recommendations for enhanced baseline data capture processes

The report provides baseline data to measure any change in performance or fishery status in addition to recommending priority actions for the restoration or improvement of any degraded or underperforming habitat within the study area.

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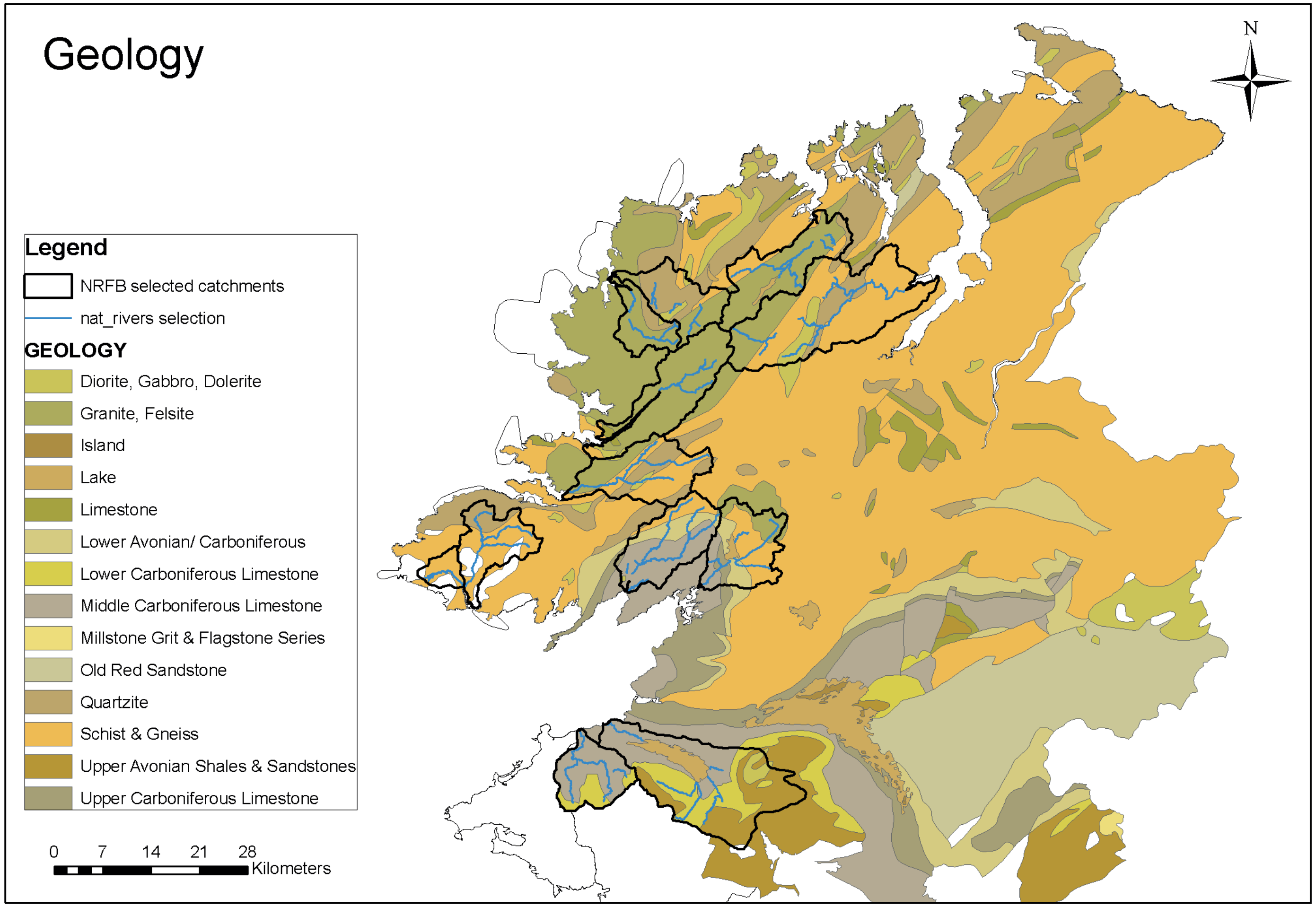
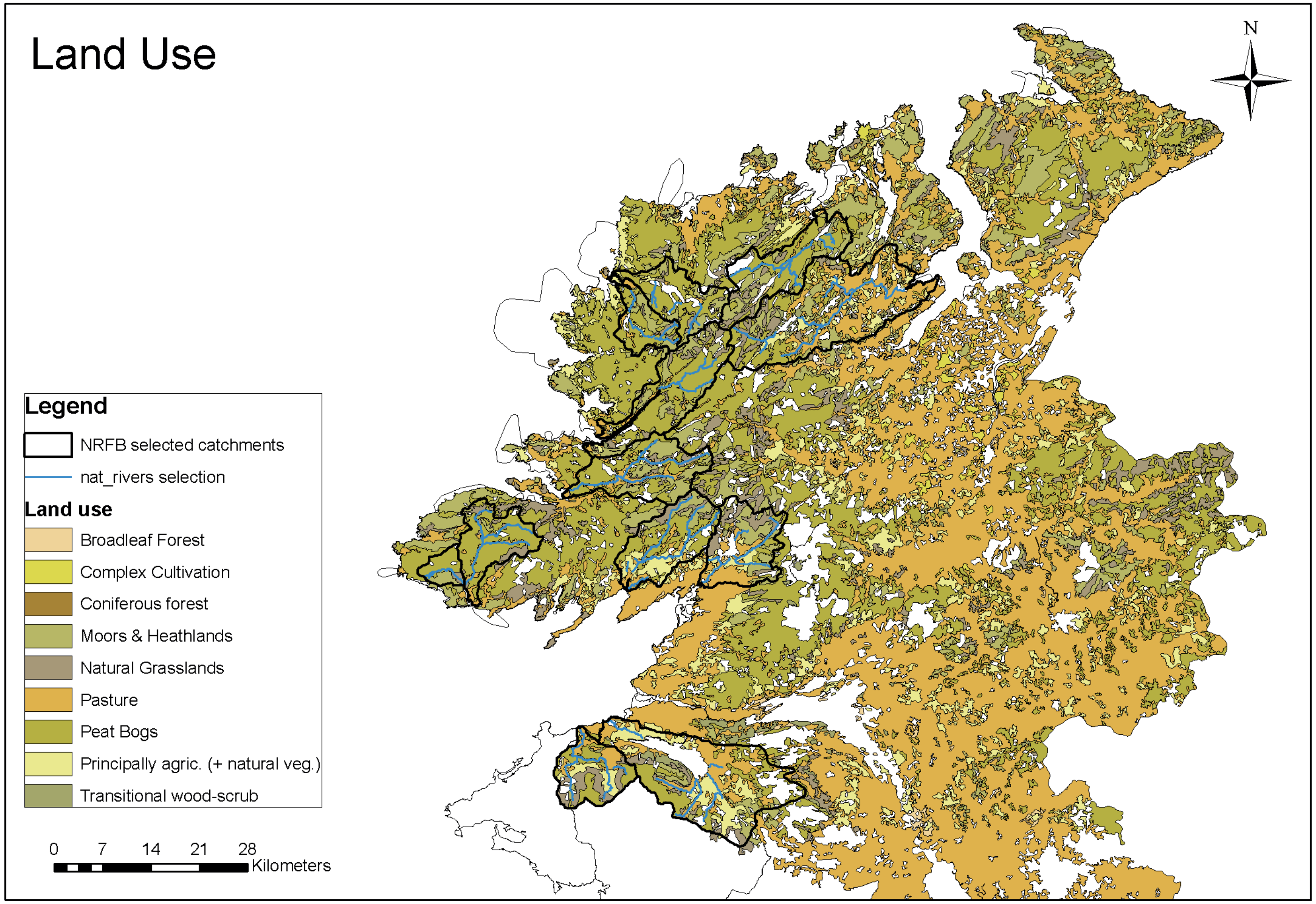
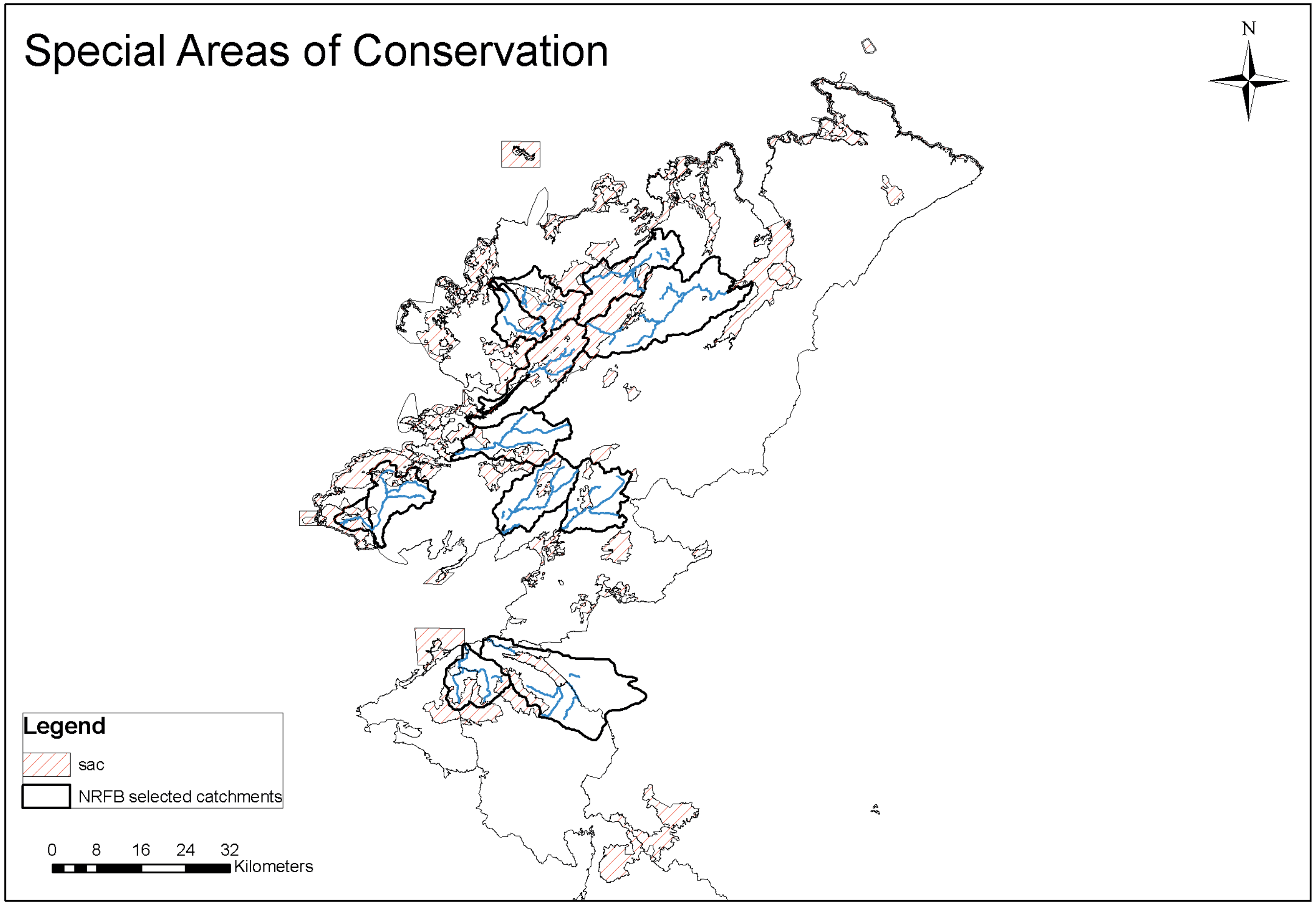
Appendix 1 – Geology, Land use and SACs in NRFB & Field survey sheets




Land Use
N
Legend
NRFB selected catchments
nat_rivers selection
Land use
Broadleaf Forest
Complex Cultivation
Coniferous forest
Moors & Heathlands
Natural Grasslands
Pasture
Peat Bogs
Principally agric. (+ natural veg.)
Transitional wood-scrub
0 7 14 21 28
Kilometers


Special Areas of Conservation
N
Legend
sac
NRFB selected catchments
0 8 16 24 32
Kilometers

Central & Regional Fishery Boards
Fish Stock & Habitat Assessment Survey Sheet

Catchment:……………………	**Stop nets used (Y or N):**…………	Plant sample taken:
River:……………………………	**Gear Type: B….. HS….BP………**	Other type of sample taken(specify) : ………………
Site No.:…………………………	**Time of Arrival:** …………………	**Water Temperature (oC)**………………………
Fishery Board: ………………	**Time of Departure:** ……………	**Conductivity:** …………**Time Recorded:** …………
CFB/RFB Personnel:…………	Photograph taken:	Velocity Status: ………………………………
Date: ………………………	Water sample taken:	Velocity Rating (t, f, m, s, vs) ………………………
Channel Code: ………………	Invertebrate sample taken:	Pollution Status: *Clean Suspect Polluted*
OPW Chainage: ………………	Sediment sample taken:	Thalweg: *none moderate well defined*
GPS: ………………………	Fish tissue sample taken:	Drainage Status: *undrained drained unknown*
Altitude *(from GPS unit)* ………		

LOCATION OF SITE:

BANK FEATURES *(tick or estimate)*	LHS	RHS
Bank height (m)		
Fencing		
Trampling		
Bank erosion		
Bank slippage		
overhang/undercut		

SUBSTRATE *(% of stream bed covered within site)*				
Surface Substrate Types	**Site**	Riffle	Glide	Pool
exposed bedrock sheet:				
boulder (26-200cm):				
cobble (6-26cm):				
gravel (0.4-6cm):				
sand (0.06-0.2cm):				
mud/silt (<0.06cm):				
other comments:				

MARGINAL VEGETATION *(list & estimate %)*	
LHS	**RHS**

INSTREAM VEGETATION *(list & estimate %)*		
Submerged	**Emergent**	**Floating**

LAND USE:	**LHS**	**RHS**
Pasture		
Tillage		
Woodland (specify)		
Urban		
Bog		
Other		

SHADE DUE TO TREE COVER *(tick) (E / M):*

LHS: none (0%) light (<25%) medium (<50%) heavy (<75%)

RHS: none (0%) light (<25%) medium (<50%) heavy (<75%)

TREE SPECIES *(list)*

LHS :

RHS :

CURRENT STATUS/POTENTIAL:

RECOMMENDATIONS:

Spawning:

Nursery:

Angling:

General comments:

Survey information compiled at each sampling location.

Detailed Physical Measurements

River:	**Date:**	**GPS:**
River Bed Diversity: *uniform/broken*	*eroding/depositing*	Gauge Reading:
Water level: *flood high moderate low*		
Bankfull Width (m):	**Mean width (m):**	**Length of site (m):**

WIDTH - DEPTH PROFILE *(minimum of 3 transects and 5 depth readings)*

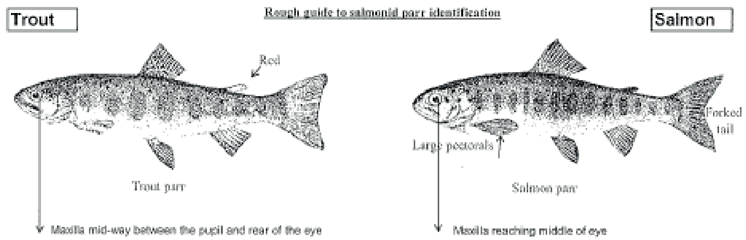
Dist u/s from zero (m) (bottom net)	Widths (m)	Depth LHS 1	(cm) 2	3	4	Depth RHS 5	max depth (cm)	mean depth (cm)	Habitat Type (riffle/glide/pool)

HABITAT TYPE % *(please indicate if measured or estimated)*

% Riffle:	% Glide:	% Pool:

Site Sketch *(optional)*

Rough guide to salmonid parr identification



ADDITIONAL SURVEY SHEET FOR MACROINVERTEBRATES

RIVER:....................................... CODE........................... **DATE**..........................

TIME....................................... STATION NO.:............... LOCATION:..................

EPA Q-VALUE*:................................ ALGAE: *Sewage fungus* .... *Other* ....

CLARITY RATING: *Clear* .... *Peaty* .... *Turbid* .... **CONDUCTIVITY (uS/cm)** ....

GPS: ....

OPERATOR/SAMPLER: ....

LIST OF MACROINVERTEBRATE TAXA

1-5 (Few)	6-20 (Common)	
21-50 (Numerous)	51-75 (Dominant)	>75% (Excessive)

MACROINVERTEBRATE DENSITY AND DIVERSITY

Diversity (tick):	Density (tick):	No. taxa:	Method:	
High Average Low	Plentiful Average Scarce		Pond Net	x 2.5mins Stones Dredge Weed sweep

Q-value:.......................... Previous:...................... Sample Retained:.....................

Remarks

ADDITIONAL INFORMATION

ANNEX II SPECIES

Species	Abundance Rating
Crayfish	
Lamprey	
Freshwater Pearl Mussel	

Abundance Ratings
1 = 1-10 2 = 11-50 3 = 51-100 4 = 101-200 5 = >200

NUISANCE PLANT SPECIES

Species	LHS	RHS	
Giant Hogweed			
Japanese Knot Weed			
Himalayan Balsam			
Other			

(please indicate if present, common or abundant)

E/F START TIME: .... Voltage (V) ....
E/F FINISH TIME: .... Current (A): ....
Fishing Run No.: .... Pulse Frequency (Hz)..................

Species:			
cm		cm	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23		**Other species**	
24		1	
25		2	
26		3	
27		4	
28		5	
29		6	
30		7	
31		8	
32		9	
33		10	
34		11	
35		12	
36		13	
37		14	
38		15	
39		16	
40		17	

OTHER SPECIES

Fishing	Stoneloach	Stickleback 3/10 sp.	Minnow	Pike	Perch	Roach	Lamprey	Eel	Other
1									
2									
3									
Abundance Rating									

Abundance Ratings
1 = 1-10 2 = 11-50 3 = 51-100 4 = 101-200 5 = >200

BATCH WEIGHTS

Species	Life stage	Batch weight	No. individuals in batch

COMMENTS

Appendix 2- EPA Q values

Appendix 2: Table 1: EPA Q values for the Leannan Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1977	1980	1985	1988	1991	1996	1998	2001	2004	2006
Bullaba	100 (Ln11)	201100	413760			5	5	5	5	5	5		
Owenwee	100	201536	413468			4-5	4-5	3-4	4-5	4	4		
Glashagh lwr	75	215741	416504							4	3-4		
Glashagh lwr	100	216946	417187	4-5	4*	4**	4	4	4	3-4			
Glashagh lwr	200	218987	419422	4	4	4	4	4	4	3-4	3-4		
Glashagh upr	200 (Ln4)	208159	413207			5	5	5	4-5	4-5	3		
Glashagh upr	400	209629	415234			5	4-5	5	4-5	4-5	3		
Leannan	100	206881	416990	5	4-5	4	4		4-5	4-5	4-5		
Leannan	200	209517	415967	4-5	5	4-5	4-5	5				4	
Leannan	250	211383	416406								3-4		
Leannan	300	212486	417658	4-5	5	5	4-5	4-5	4	5	4	3-4	
Leannan	450	215000	420800		5	4-5	4						
Leannan	500	216451	421904	4	3-4	3-4	4	4-5	4	4-5	3-4	4-5	
Leannan	600	219011	421891	4-5	4	4	4	5	4	4-5	4	4	
Leannan	800	221996	420893	5	4	5	4	4-5	4-5	4-5		4-5	
Lurgy	100 (Ln17)	212254	422915	4	4	4-5	4	5	4	4	3		
Lurgy	200 (Ln19)	213700	420900	4	4	4-5	4-5	5					
Lurgy	300	214924	421057	3	3	4	3	4-5	3	4	4		

**sampled in 1986

Appendix 2: Table 2: EPA Q values for the Lackagh Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB survey code)	Easting	Northing	1973	1985	1990	1994	1997	1999	2000	2003	2006
Owenwee	100	210361	428281	5	5	4-5		4-5	5	4-5		
Glen	400	213706	429668	5	4-5			4-5	4-5	4		
Glen	900 (Lk1)	211832	431043	5	4	4-5		4-5	4-5			
Owencarrow	100	204164	423018	4	4*							
Owencarrow	150	204314	423444	4	4-5	4	4		4-5	4-5		
Owencarrow	200 (Lk10)	206196	425780	5*	5	5						
Owencarrow	300	199865	423516	5	5	4	4-5		4-5	4-5	4-5	
Calabber	100	199865	423516	4-5	4	4-5	4-5	4-5	4-5	4-5		
Calabber	200	-	-			4-5						
Calabber	300 (Lk9)	203369	423980		4-5	4-5	4-5	4-5	4-5	4-5		
Lackagh	100	209569	430880	4	4	4		4				

* = sites surveyed in 1980

Appendix 2: Table 3: EPA Q values for the Clady Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality). Site codes in brackets related to CFB electrofishing site codes (check for corrections but looks ok)

River	Site code (CFB site code)	Easting	Northing	1973	1977	1980	1985	1990	1994	1997	2000	2003	2006
Clady	150	185255	422485				4	4-5	4	4-5	4-5	4	4-5
Clady	175	186300	422900			5	5	5	5	5			
Clady	300 (Cl7)	180893	423661	4-5	4-5	5	4-5	4-5	4	4	4	4	4
Cowenwee/ Dunlewy	200	193125	418757					5	4	5	4-5	4-5	
Cronaniv Burn	100 (Cl2)	193109	418649					4-5	4	5	5	4-5	4-5
Owenwee	200	193125	418757					5	4	5	4-5	4-5	4-5
Devlin	80 (Cl3)	192884	418619					4-5	4	5	5	5	5

Appendix 2: Table 4: EPA Q value for the Crolly Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	2006	2003	2000	1997	1994	1990
Owenator	100 (Cr4)	184263	415002	4-5	4-5	4-5	4-5	4	4

		Station Nos.	1973	1977	1980	1985	1990	1994	1997	2000	2003	2006
Keel Lough strm	0200		5	4	4	4	4	3-4	3	3	2/0	2-3

Appendix 2: Table 5: EPA Q values for the Gweebarra Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1980	1985	1990	1994	1997	2000	2003	2006
Owenwee	100	190696	410020			5	4-5		4-5		
Owenwee	250 (Gw3)	187425	407336			5	4-5	4-5	5	4-5	4-5
Cloghernagore	100 (Gw11)	191423	406379			4			4-5	4	4
Glenleheen St.	300 (Gw9)	190293	403976			5	4-5	4-5	4-5	4	4
Gweebarra	100 (Gw5)	195017	414076	5	5	5	4-5	5	5	4-5	4-5
Gweebarra	200 (Gw2)	189731	407697	5			3	3-4	4-5	4	3-4
Gweebarra	300	186813	406457	5	5	4-5	4-5	5	4-5	5	

Appendix 2: Table 6: EPA Q values for the Owenea Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality)

River	Site code (CFB site code)	Easting	Northing	1980	1981	1984	1990	1994	1997	2000	2003	2006
Stracashel	50	188500	394100		5		5	4-5	5	5		
Stracashel	100	184774	393748		5							
Stracashel	200	181655	394017		4-5		3-4	4	4	4	3	3
Shallogan	300 (Ow3)	183748	396566				4-5	4-5	4-5	4-5	4	4
Owenea	40 (Ow9)	189049	393792					5	4-5	4-5	4-5	
Owenea	50 (Ow11)	188500	394100	5		5	5					
Owenea	100 (Ow12)	184774	393748	5		4-5	5	5	4-5	4-5	4	4
Owenea	200	181489	393601	5		3-4	4-5					
Owenea	300 (Ow14)	180635	393332	5		5	4	4	5	4	4	
Owenea	400	176607	392715	4		4	4-5					
Owenea	500	173693	392030	4		4	4	4	4-5	4	4	4

Appendix 2: Table 7: EPA Q values for the Glen Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	**Site code (CFB site code)**	**Easting**	**Northing**	**1977**	**1980**	**1986**	**1990**	**1994**	**1997**	**1999**	**2002**	**2005**
Crow	200 (Gl15)	166012	384286					3-4	3-4	3-4	3	4
Crow	700 (Gl17)	161179	384033				4-5	4-5	4-5	4	4	4-5
Owenteskiny	300 (Gl7)	166513	386721				4	4-5	4	4	3-4	4-5
Owenteskiny	400	164162	386517				4-5	4-5	4-5	4		
Owenteskiny	500 (Gl10)	162591	385504			4-5	4	4	4-5	5		
Owenwee	***400***	***156787***	***380248***					***4***	***5***	***5***		
Owenwee	***500 (Gl4)***	***158423***	***378270***					***5***	***4-5***	***4-5***	***4-5***	***4***
Glen	45 (Gl19)	161102	385157				4-5	4-5	4-5		3-4	
Glen	50					5	4-5	5	5			
Glen	70(Gl21)	160450	382389				4-5	3-4	4-5	3	3-4	
Glen	200	158944	378712	4	4	5	4	4-5	4-5	4	4	3

Appendix 2: Table 8: EPA Q values for the Eany Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1973	1980	1984	1986	1990	1994	1997	1999	2002	2005
Eanybeg	200	199106	386949					5	4	5	4-5		
Eanybeg	700 (En9)	184559	382183				4-5	4-5	4	4-5	4	4	
Eanymore	50 (En16)	191060	385200 4-5	5	5	5	5	4-5	4-5	4-5	4-5	4	
Eanymore	150	188289	382363					5	4-5	4-5	5		
Eanymore	250 (En9)	184486	381543				5	5	4-5	5	4	4	
Eglish	100 (En11)	192548	386018				5	4	5	4	4-5	4	
Eany	300	184040	381396	5	5	5	5			5		4	

Appendix 2: Table 9: EPA Q- values for the Eske Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1973	1982	1986	1990	1994	1997	1999	2002	2005
Drummenny	300	196819	378952				5	4-5	4-5	4-5		
Drummenny	400 (Ek8)	193768	378612				4	3-4	4	4-5	3-4	4
Corabber	100 (Ek2)	197506	386218				4-5	4-5	5	4-5	4-5	4
Lowerymore	100	203978	387023				4	4	4-5	4		
Lowerymore	400	198016	381985				4	5	5	5		
Clogher	400 (Ek6)	197803	381694				5	4-5	4-5	4	4-5	4-5
Eske	200	195573	380905	5	4-5	4	4	4-5	4-5	4-5	4-5	4
Eske	310				4-5		4-5					
Eske	400	193047	378532		4-5	4-5	4	4	4	3-4	3-4	

Appendix 2: Table 10: EPA Q- values for the Drowes Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1990	1994	1997	2000	2003	2006
Drowes	100	181843	357276	4	4	3-4	4-5	4	4
Drowes	200	179241	358300	4	4	4	4	4-5	
Glenaniff	200	192043	349681	5	4-5	4-5	4-5	4-5	4-5

Appendix 2: Table 10a : Q-values for the Drowes catchment surveyed in 2001. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

Site Code	River	Q- Value (2001)
CFB033	County	4-5
CFB034	County	4-5
CFB035	County	4-5
CFB036	County	4-5
CFB037	County	4-5
CFB038	County	No sample
CFB039	Trib of County	4-5
CFB040	Trib of County	4-5
CFB041	Roogagh	4
CFB070	Clancy's	4-5
CFB071	Glen R	No sample
CFB072	Roogagh	No sample
CFB073	Roogagh	4-5
CFB074	Roogagh	4-5

Appendix 2: Table 11: EPA Q values for the Duff Catchment. The Q-values range from 5 (excellent water quality) to 1 (poor water quality).

River	Site code (CFB site code)	Easting	Northing	1982	1986	1990	1994	1997	2000	2003	2006
Duff	20 (Duff2)	179056	348081						5	5	4-5
Duff	100 (Df5)	179289	351138	5	4-5	5	4-5	4	4-5	4-5	
Duff	200 (Df6)	179035	352525	5	4-5	4-5					
Duff	250 (Df7)	175221	353206							4-5	4
Duff	300 (Df8)	174310	353945	5	5	5	4-5				
Duff	400 (Df11)	175163	356848	5	4-5	5	5	4-5	4-5	4	4

Appendix 3 – Site location data

Table 39: List of sites and coordinates, conductivity (µS), temperature (°C), time and sampling date

Site Code	River	GPS Coordinate		Cond.	Temp	Time	Date
		Easting	Northing	µS	°C		M/Yr
LEANNAN							
Ln1	Glashagh	219007	419441	180*	28*	14.00	10/07
Ln2	Trib. Glashagh	212844	416387	152.6	11.0	14.20	09/07
Ln3	Glashagh	208137	413214	106.9	9.6	10.20	09/07
Ln4	Glashagh	208887	413194	114	10.3	13.35	09/07
Ln5	Glashagh	209635	415265	120	10.5	16.30	09/07
Ln6	Owenbeg	202308	413403	127.3	11.0	14.35	09/07
Ln7	Owenwee	201535	413519	-	-	-	09/07
Ln8	Bullaba	199624	414019	-	-	-	09/07
Ln9	Bullaba	198755	414827	-	-	-	09/07
Ln10	Bullaba MC	199886	414080	-	-	-	09/07
Ln11	Bullaba MC	200951	413809	40.2*	14.0*	17.30	09/07
Ln12	Bullaba MC	202422	414029	59.8	10.9	13.00	09/07
Ln13	Cammare St	207462	419603	-	-	-	09/07
Ln14	Trentagh Trib.	210458	416885	121	11.6	12.10	09/07
Ln15	Drumbrick St.	211810	421963	-	-	-	09/07
Ln16	Trib. Lurgy	212710	422680	-	-	-	09/07
Ln17	Lurgy MC	212097	423037	-	-	-	09/07
Ln18	Lurgy MC	212585	421681	153.4*	19.3*	16.50	10/07
Ln19	Lurgy MC	214034	420379	103*	20*	11.30	10/07
Leannan Semi-quantitative survey							
Ln20	Bullaba	202410	414011	-	-	-	-
Ln21	Lurgy	212584	421662	-	-	-	-
Ln22	Leannan MC	206819	416983	-	-	-	-
Ln23	Leannan MC	210471	415851	-	-	-	-
Ln24	Leannan MC	213337	419121	-	-	-	-
Ln25	Leannan MC	214717	420597	-	-	-	-
Ln26	Leannan MC	215110	420933	-	-	-	-
Ln27	Leannan MC	218111	421547	-	-	-	-
Ln28	Leannan MC	219035	421865	-	-	-	-

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Lk1	Glen	212281	431657	92	12.7	16.30	09/06
Lk2	Glen	211832	431018	135	12.6	12.03	09/06
Lk3	Glenreraragh	211034	429062	88	12.7	13.45	09/06
Lk4	Owenwee	210393	428272	85	12.3	10.00	09/06
Lk5	Glasnaseeragh	205611	424047	65	14.3	15.30	09/06
Lk6	Glasnaseeragh	205565	424202	64	14.2	-	09/06
Lk7	Owencarrow	199331	418296	53	-	-	09/06
Lk8	Owencarrow	199360	418319	54	13.5	15.00	09/06
Lk9	Calabber	203364	424197	65	13.6	11.05	09/06
Lk10	Owencarrow	204739	424813	54	13.5	11.00	09/06
CLADY							
Cl1	Trib. L. Nacung	189675	421355	91	14.8	16.3	08/07
Cl2	Cronaniv R.	192900	418956	62	16.2	17.3	08/07
Cl3	Delvin R.	192754	418920	35	15.2	15.3	08/07
Cl4	Delvin R.	192603	418998	36	14.0	12.3	08/07
Cl5	Trib. L. Nacung	189802	419082	55	14.3	16.15	08/07
Cl6	Forestry St.	186248	422035	58	14.8	10.0	08/07
Cl7	Clady MC	181628	423668	78	15.3	11.3	08/07
CROLLY							
Cr1	L. Keel outflow	183636	418707	75	15.4	16.2	08/07
Cr2	Owenator upper	186082	414111	52	15.5	15.25	08/07
Cr3	Owenator	184194	415102	60	14.9	12.0	08/07
Cr4	Owenator	183070	415510	61	15.9	16.3	08/07
Cr5	Trib. L. Anure	182283	414598	112	16.1	14.5	08/07
Cr6	Crolly MC	182623	421068	81	16.3	12.3	08/07
GWEEBARRA							
Gw1	Owenwee	190715	410041	63	16.3	17.30	08/06
Gw2	Owenwee	188838	408579	45	15.2	13.30	09/06
Gw3	Owenwee	187969	407820	60	14.8	12.00	08/06
Gw4	Gweebarra MC	194379	413781	45	19.2	14.50	08/06
Gw5	Gweebarra MC	194873	413996	50	16.7	16.25	08/06
Gw6	Gweebarra MC	193900	413021	47	17.0	13.30	08/06
Gw7	Glenleheen st.	189555	402608	65	16.0	13.20	09/06
Gw8	Glenleheen st.	190284	404097	85	17.0	15.30	08/06
Gw9	Glenleheen st.	190515	404791	88	14.8	1.30	08/06
Gw10	Abroe	191364	406387	39	14.9	11.30	09/06
Gw11	Abroe	189894	406944	79	16.6	13.00	09/06

Gw12	Abroe	189867	407009	78	16.5	15.30	09/06
Gw13	Gweebarra MC	191663	408985	41	16.7	14.00	09/06
Gw14	Gweebarra MC	191656	408956	40	17.1	15.00	09/06
Gw15	Gweebarra MC	190168	408263	40	18.4	16.30	09/06
Gw16	Gweebarra MC	190155	408247	40	18.4	14.00	09/06
OWENEA							
Ow1	Shallogan	186017	398834	98	13.6	11.05	09/06
Ow2	Shallogan	184408	397419	92	16.0	10.00	08/06
Ow3	Shallogan	183778	396611	107	22.1	15.15	07/06
Ow4	Stracashel	189350	395881	103	23.8	14.30	07/06
Ow5	Stracashel	188485	396348	11?	23.2	17.00	07/06
Ow6	Stracashel	186578	395911	106	20.3	12.20	07/06
Ow7	Stracashel	184936	396337	10?	15.1	12.00	08/06
Ow8	Stracashel	183738	396303	92	16.7	17.45	08/06
Ow9	L. Ea outflow	190552	394860	51	17.1	17.00	08/06
Ow10	Owenea MC	187074	393659	60	14.3	16.45	08/06
Ow11	Owenea MC	188253	393908	73	16.0	16.30	08/06
Ow12	Owenea MC	187814	393986	64	16.6	15.45	08/06
Ow13	Owenea MC	184721	393721	-	-	-	-
Ow14	Owenea MC	180317	393100	96	13.3	12.30	09/06
GLEN							
Gl1	Owenwee	154933	380267	103.1	15.0	14.00	08/07
Gl2	Trib. Owenwee	156339	380949	65	14.8	10.30	08/07
Gl3	Owenwee	156782	380267	83	14.8	12.00	08/07
Gl4	Owenwee	157580	379221	83	14.8	12.00	08/07
Gl5	Trib. Glen	160948	385061	58	17.8	15.10	07/07
Gl6	Trib. Lougheraherk	159792	388750	86	15.8	17.30	08/07
Gl7	Owenteskiny	166905	386324	44	16.4	14.00	07/07
Gl8	Owenteskiny	165025	386962	41	14.9	12.30	07/07
Gl9	Owenteskiny	163837	386275	58	15.7	11.10	08/07
Gl10	Owenteskiny	162948	385446	62	17.2	15.00	08/07
Gl11	Trib. Crow	166420	384496	70	16.3	17.10	08/07
Gl12	Crow upper	166890	384451	-	-	-	
Gl13	Crow upper	166469	384451	60	15.0	11.00	07/07
Gl14	Crow upper	166432	383795	54	13.6	12.50	08/07
Gl15	Crow	164991	384166	69	14.2	18.20	08/07
Gl16	Crow	163305	384407	70	17.4	16.00	08/07

Gl17	Crow	161652	384263	66	14.0	12.00	08/07
Gl18	Glen upper	160390	388394	65	15.2	13.00	07/06
Gl19	Glen upper	160857	386732	94	14.3	12.20	08/07
Gl20	Glen MC	161092	383964	67	14.2	16.00	08/07
Gl21	Glen MC	160664	383362	68	13.3	12.00	08/07
Gl22	Glen MC	159773	380767	119	17.7	15.00	08/07
Gl23	Glen MC	159684	379321	113	16.2	12.10	08/07
EANY							
En1	Stranahend	182082	380175	108	14.3	12.00	09/05
En2	Stranahend	182291	379957	-	-	-	
En3	Stranahend	182307	379149	105	14.5	14.00	09/05
En4	Lettermare	185011	383501	-	-	-	
En5	Oughtadooney	187235	384102	67	15.4	17.10	09/05
En6	Eanybeg	187505	385398	-	-	-	
En7	Eanybeg	186894	384357	-	-	-	
En8	Eanybeg	186450	383827	88	15.5	12.00	08/05
En9	Eanybeg	184680	382404	70	12.0	12.00	10/05
En10	Eglish	193203	386539	85	18.4	17.00	08/05
En11	Eglish	192601	386086	99	17.7	15.30	08/05
En12	Eglish	191707	385266	70	12.7	16.40	10/05
En13	Frosses	183179	379850	127	14.3	15.20	09/05
En14	Eanymore	190840	386793	98	12.9	16.00	10/05
En15	Sruell	190862	386251	78	18.1	12.35	08/05
En16	Sruell	190991	385020	99	19.2	15.30	08/05
En17	Sruell	190119	383229	104	19.1	17.00	08/05
En18	Eanymore	188619	382279	118	18.4	13.30	08/05
En19	Eany	185541	382145	-	-	-	
ESKE							
Ek1	Trib. Eske	195690	381408	288	16.8	13.3	07/06
Ek2	Carabber	197472	386116	39	13.9	11.2	08/06
Ek3	Lowerymore	201088	383859	55	14.1	12.2	08/06
Ek4	Lowerymore	198083	382004	69	15.0	16.3	08/06
Ek5	Clogher R.	199251	381198				
Ek6	Lowerymore	197938	381937	170	18.4	14.15	07/06
Ek7	Drummenny	196821	379028	185	20.5	17.2	07/06
Ek8	Drummenny	193807	378337				
LOUGH MELVIN							

Gf1	Glenaniff R.	192071	349747	-	-	-	
Gg2	Glenaniff R.	191989	349365	-	-	-	
Gf3	Glenaniff R.	191943	349084	-	-	-	
Gf4	Glenaniff R.	191925	348784	-	-	-	
Gf5	Glenaniff R.	191553	348466	-	-	-	
Gf6	Glenaniff R.	191417	348112	-	-	-	
Gf7	Glenaniff R.	189473	348639	-	-	-	
Bl8	Ballagh R.	192369	349579	-	-	-	
Bl9	Ballagh R.	192485	349061	-	-	-	
Bl10	Ballagh R.	192696	348632	-	-	-	
Bl11	Ballagh R.	192867	348134	-	-	-	
Bl12	Ballagh R.	192724	347787	-	-	-	
Bl13	Ballagh R.	192274	347289	-	-	-	
Bl14	Ballagh R.	191981	346799	-	-	-	
CFB033	County R.	194899	349295	-	-	-	
CFB034	County R.	196825	346933	-	-	-	
CFB035	County R.	197297	346060	-	-	-	
CFB036	County R.	197879	346060	-	-	-	
CFB037	County R.	194348	349998	-	-	-	
CFB038	County R.	196919	346752	-	-	-	
CFB041	County R.	197319	352816	-	-	-	
DUFF							
Duf2	Black upper	178961	348020	157	12.9	12.00	07/07
Duf4	Duff Trib	179290	351145	204	13.9	14.55	07/07
Duf9	Ballaghnatrillick R.	174016	350027	243	14.3	17.20	07/07
Duff Semi-quantitative survey							
Df1	Duff Trib	173255	351199	-	-	-	-
Df2	Duff Trib	173469	352032	-	-	-	-
Df3	Duff Trib	174833	352608	-	-	-	-
Df4	Duff Trib	179522	349795	-	-	-	-
Df5	Duff MC	179284	351157	-	-	-	-
Df6	Duff MC	179004	352439	-	-	-	-
Df7	Duff MC	176030	352706	-	-	-	-
Df8	Duff MC	174288	353973	-	-	-	-
Df9	Duff MC	175077	354739	-	-	-	-
Df10	Duff MC	175938	356193	-	-	-	-
Df11	Duff MC	175431	356893	-	-	-	-

Appendix 4 – Quantitative electrofishing results

Appendix 4 (Table 1): Estimated and minimum densities (no/m^2) of salmonids for the Leannan catchment. Density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing) ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Ln1	Glashagh lwr	0		0.02	(md)	0.07	(md)	0.02	(0)	0.02	(md)
Ln2*~	Trib Glashagh	0		0		0.08~		0.02	(md)	0.04	(md)
Ln3*~	Glashagh	0		0		0.07~		NR		0.01	(md)
Ln4	Glashagh	0.03	(md)	0.07	(md)	0.10	(0.02)	0.17	(0.02)	0.04	(md)
Ln5	Glashagh	0.09	(md)	0.01	(md)	0.15	(0.02)	0.10	(md)	0.04	(md)
Ln6	Owenbeg	0.34	(0.04)	0.03	(md)	0.29	(0.06)	0.022	(md)	0	
Ln7	Owenwee	0.41	(md)	0.20	(md)	0.10	(0.02)	0.045	(md)	0	
Ln8	Owenvehy Trib.	0		0		0.30	(md)	0.13	(md)	0	
Ln9	Bullaba	0		0		0.80	(md)	0.13	(md)	0.03	(0.01)
Ln10*~	Bullaba	0.02~		0.04~		0.05~		0.05~		0	
Ln11	Bullaba	0.08	(md)	0.04	(0.002)	0.50	(md)	0.04		0.01	(0)
Ln12	Bullaba	0.18	(md)	0.08	(md)	0.04	(md)	0.04	(md)	0.01	(md)
Ln13	Cammare St.	0		0		0.65	(0.02)	0.032	(md)	0	
Ln14*~	Trentagh Trib.	0		0		0.18~		0.04~		0	
Ln15	Drumbrick St.	0		0		0.65	(0.1)	0.05	(0.01)	0	
Ln16	Lurgy	0		0		0.82	(0.25)	0.02	(md)	0	
Ln17	Lurgy	0		0.02	(md)	0.54	(0.12)	0.19	(0.01)	0.01	(0)
Ln18	Lurgy	0.13	(md)	0.02	(md)	0.22	(md)	0.15	(md)	0.032	(0.004)
Ln19	Lurgy	0.04	(md)	0.01	(0)	0.13	(0.01)	0.07	(0.02)	0.01	(0)

Appendix 4: Table 2: Estimated and minimum densities (no/m^2) of salmonids from the Lackagh system, Summer 2006. Density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing).

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Lk1	Glen	0.26	(md)	0.15	(md)	0.20	(md)	0.10	(md)	0	
Lk2#	Glen	0.66	(0.16)	0.07	(md)	0.22	(0.06)	0.05	(md)	0.03	(0)
Lk3	Glenieraragh	0		0.09	(md)	0.38	(0.07)	0.24	(0.02)	0	
Lk4#	Owenwee	0		0		0.09	(0.03)	0.38	(md)	0.01	(0)
Lk5*	Glasnaseeragh	0		0		0.04	(md)	0.09	(md)	0	
Lk6	Glasnaseeragh	0		0.20	(md)	0.04	(0.01)	NR		0.01	(0)
Lk7#	Owencarrow	0.94	(0.32)	0.22	(0.01)	0.17	(0.08)	0.01	(0)	0.01	(0)
Lk8*	Owencarrow	0.04	(md)	0.03	(md)	0.03	(md)	0.01	(md)	0.003	(md)
Lk9*	Calabber	0		0		0.02	(md)	0.01	(md)	0	
Lk10	Owencarrow	0		0		0.26	(0.04)	0.11	(0)	0.01	(0)

Appendix 4: Table 3: Estimated and minimum densities (no/m^2) of salmonids in the Clady catchment in Summer 2007. Density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing).

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	≥1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Cl1	Trib L. Nacung	0		0.01	(0)	0.09	(md)	0.17	(md)	0.01	(0)
Cl2	Cronaniv R.	0.48	(md)	0.18	(0.06)	0.08	(md)	0.02	(md)	0.004	(0)
Cl3	Delvin R.	0.17	(md)	0.25	(md)	0.02	(md)	0.01	(md)	0.004	(0)
Cl4#	Delvin R.	0.23	(0.05)	0.26	(md)	0.04	(md)	0.03	(0)	0	
Cl5#	Trib L. Nacung	0.47	(md)	0.60	(0.10)	0.14	(md)	0.11	(md)	0.01	(0)
Cl6	Altmore R.	0		0		0		0.10	(md)	0.02	(0)
Cl7	Clady MC	0.53	(md)	0.20	(md)	0.02	(md)	0.03	(md)	0.013	(md)

Appendix 4: Table 4: Estimated and minimum densities (no/m^2) of salmonids for the Crolly system. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing), ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Cr1*	L. Keel outflow	0		0		0		0.02	(md)	0	
Cr2	Owenator upr	0.06	(md)	0.09	(md)	0.03	(md)	0.04	(md)	0.01	(md)
Cr3	Owenator	0.50	(0.11)	0.13	(md)	0.06	(md)	0.03	(0)	0.01	(md)
Cr4	Owenator	0.67	(md)	0.20	(md)	0.05	(0.01)	0.03	(md)	0.03	(md)
Cr5*	Trib L. Anure	0.04	(md)	0		0.14	(md)	0.025	(md)	0	
Cr6~	Gweedore MC	0.03~		0.07	(0.01)	0		0.03	(0.01)	0.015	(md)

Appendix 4: Table 5: Estimated and minimum densities (no/m^2) of salmonids from the Gweebarra catchment. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing) ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	(95%CI)	≥ 1+	(95%CI)	0+	(95%CI)	1+	(95%CI)	>1+	(95%CI)
Gw1	Owenwee	0.18	(0)	0.22	(0.05)	0.14	(md)	0.10	(md)	0.04	(0)
Gw2#	Owenwee	0.15	(md)	0.12	(md)	0.02	(md)	0.03	(0)	0	
Gw3#	Owenwee	0.30	(md)	0.26	(0.02)	0.09	(md)	0.1	(0.03)	0	
Gw4*	Barra MC	0		0		0		0.02	(md)	0	
Gw5*	Barra MC	0		0		0		0.14	(md)	0.01	(md)
Gw6#	Barra MC	0.28	(md)	0.19	(md)	0.05	(0.01)	0.04	(md)	0.01	(0)
Gw7#	Glenleheen St.	0		0		0		0		0.02	(md)
Gw8#	Glenleheen St.	1.08	(0.21)	0.17	(0.03)	0.26	(md)	0.07	(0)	0	
Gw9#	Glenleheen St.	0.60	(0.11)	0.28	(0.03)	0.07	(md)	0.05	(md)	0.01	(0)
Gw10~	Abroe	0		0.03~	(0.01)	0.09	(md)	0.03	(md)	0	
Gw11	Abroe	0.21	(0.03)	0.09	(0.01)	0.05	(md)	0.06	(md)	0	
Gw12#	Abroe	0.13	(md)	0.10	(0.02)	0.01	(md)	0.03	(md)	0.02	(md)
Gw13#	Gweebarra MC	0.24	(0.08)	0.24	(0.04)	0.01	(md)	0.01	(md)	0.01	(0)
Gw14#	Gweebarra MC	0.22	(md)	0.22	(md)	0.01	(0)	0.01	(0)	0	
Gw15~	Gweebarra MC	0.02	(md)	0.09~	(0.02)	0.003	(0)	0.02	(md)	0	
Gw16~	Gweebarra MC	0.04	(md)	0.13~	(0.03)	0		0.01	(0)	0	

Appendix 4: Table 6: Estimated and minimum densities (no/m^2) of salmonids from the Owenea catchment. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing) ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	**River**	**Salmon fry**		**Salmon parr**		**Trout fry**		**Trout parr**		**Trout adult**	
		0 +	(95%CI)	**≥ 1+**	**(95%CI)**	**0+**	**(95%CI)**	**1+**	**(95%CI)**	**>1+**	**95%CI**
Ow1	Shallogan	0.71	(0.06)	0.43	(0.07)	0.91	(md)	0.40	(0.06)	0	
Ow2#	Shallogan	1.10	(0.13)	0.17	(0.01)	0.07	(md)	0.06	(md)	0.02	(md)
Ow3	Shallogan	0.55	(0.05)	0.25	(0.04)	0.04	(md)	0.05	(md)	0	
Ow4	Stracashel	0		0		0.12	(0.03)	0.18	(0.02)	0	
Ow5	Stracashel	0.19	(0.02)	0.18	(0.02)	0.12	(0.04)	0.12	(0.01)	0	
Ow6	Stracashel	0.32	(0.06)	0.16	(md)	0.14	(md)	0.22	(md)	0	
Ow7	Stracashel	1.93	(0.19)	0.50	(0.07)	0.05	(md)	0.10	(0.02)	0	
Ow8#	Stracashel	0.76	(0.19)	0.53	(0.09)	0.02	(md)	0.08	(md)	0	
Ow9	L. Ea outflow	0.34	(md)	0		0.22	(md)	0.13	(0.03)	0.01	(0)
Ow10*~	Owengarve	0		0		0.05~		0.03	(md)	0	
Ow11~	Owenea MC	1.04	(0.17)	0.43~	(0.07)	0.05	(0)	0.06	(md)	0	
Ow12#	Owenea MC	2.18	(0.32)	0.28	(md)	0.04	(md)	0.04	(0.01)	0	
Ow13#	Owenea MC	0.71	(0.11)	0.04	(0.01)	0.04	(md)	0.01	(0)	0	
Ow14	Owenea MC	0.25	(md)	0.27	(0.08)	0		0.02	(md)	0.01	(md)

Appendix 4: Table 7: Estimated and minimum densities (no/m^2) of salmonids from the Glen and Owenwee catchments. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing) ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Gl1	Owenwee	0		0		0.18	(0.03)	0.10	(md)	0.03	(md)
Gl2	Trib Owenwee	0		0		0.09	(md)	0.01	(0)	0.03	(0)
Gl3#	Owenwee	0.45	(0.10)	0.10	(0.02)	0.01	(0)	0.02	(0.01)	0.01	(0)
Gl4	Owenwee	0.05	(md)	0.12	(md)	0.04	(md)	0.02	(md)	0.02	(md)
Gl5	Meenaghavy	0.07	(md)	0.02	(0)	0.05	(0)	0.05	(md)	0.01	(0)
Gl6	Lougheraherk	0		0		0.69	(md)	0.05	(0)		
Gl7	Owenteskiny	0.43	(0.11)	0.01	(0)	0.02	(0)	0.04	(0)	0	
Gl8	Owenteskiny	0.10	(md)	0.05	(md)	0		0.02	(0)	0	
Gl9	Owenteskiny	0.55	(0.12)	0.11	(md)	0.01	(0)	0.01	(0)	0.01	(0)
Gl10	Owenteskiny	0.19	(0.05)	0.08	(md)	0		0.01	(0)	0	
Gl11	Trib Crow	0.35	(md)	0		0.09	(md)	0.05	(0)	0	
Gl12*	Crow upr	0		0		0.19	(md)	0.06	(md)	0.05	(md)
Gl13~	Crow upr	0.45~	(0.1)	0.01	(0)	0.08	(md)	0.11	(md)	0.01	(0)
Gl14	Trib Crow	0.20	(md)	0		0.08	(md)	0.05	(md)	0.01	(0)
Gl15#	Crow	0.32	(0.06)	0		0.05	(md)	0.05	(md)	0.02	(md)
Gl16	Crow	0.23	(md)	0.06	(md)	0.01	(md)	0.01	(0.004)	0.002	(0)
Gl17#	Crow	0.90	(0.22)	0.13	(md)	0.003	(md)	0.003	(md)	0.003	(md)
Gl18#	Glen upr	0.32	(md)	0.06	(md)	0.04	(0.01)	0.11	(md)	0.01	(0)
Gl19	Glen upr	0.44	(0.10)	0.10	(md)	0.01	(0)	0.05	(md)	0.01	(0)
Gl20~	Glen MC	0.1~	(0.03)	0.08	(md)	0.01	(0)	0.002	(0)	0	
Gl21	Glen MC	0.25	(0.07)	0.16	(md)	0.02	(0.01)	0.004	(0)	0.02	(md)
Gl22	Glen MC	0.62	(0.18)	0.05	(md)	0.02	(0.002)	0		0.03	(md)
Gl23	Glen MC	0.40	(0.05)	0.14	(0.03)	0.03	(0.004)	0.01	(md)	0.01	(0.003)

Appendix 4: Table 8: Estimated and minimum densities (no/m^2) of salmonids in the Eany catchment. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing), ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion. NR indicates that no life stage was collected/ recorded.

Site no	**River**	**Salmon fry**		**Salmon parr**		**Trout fry**		**Trout parr**		**Trout adult**	
		0 +	**95%CI**	**≥1+**	**95%CI**	**0+**	**95%CI**	**1+**	**95%CI**	**≥1+**	**95%CI**
En1*~	Stranahend	0		0		0.06~		0.02	(md)		
En2*~	Stranahend	0		0.07	(md)	0.08~		0.08~		0.02	(md)
En3	Stranahend	0.06	(md)	0.24	(0.03)	0.11	(0.02)	0.11	(0.02)	0.01	(md)
En4#	Lettermare	0.18	(md)	0.43	(0.05)	0.09	(md)	0.14	(0.03)	0.08	(0)
En5	Oughtadooney	0		0.07	(0.01)	0.15	(0.02)	0.05	(0.01)	0.04	(0.01)
En6*~	Eanybeg	0.06	(md)	0.14~		0.02~		0		0.01	(md)
En7*	Eanybeg	0.03	(md)	0.08	(md)	0		0.009	(md)	0.03	(md)
En8	Eanybeg	1.0	(md)	0.51	(0.09)	0.05	(md)	0.03	(0)	0.07	(0.01)
En9#	Eanybeg	0.22	(md)	0.50	(0.12)	0.03	(md)	0.02	(0)	0.01	(md)
En10	Eglish	0.01	(md)	0.07	(0.01)	0		0.04	(md)	0.01	(md)
En11*~	Eglish	0		0		0.14~		0.07~		0.07	(md)
En12*	Eglish	0.04	(md)	0.22	(md)	0.14	(md)	0.05	(md)	0.03	(md)
En13	Frosses	0				0		0		0.01	(md)
En14	Eanymore	0.72	(0.2)	0.13	(md)	0		0.01	(0)	0.01	(0)
En15	Sruell upr	0		0		0.13	(0.04)	0.16	(0.04)	0.003	(0)
En16~	Sruell	0.16	(0.02)	0.37~	(0.05)	0.08	(md)	0.08	(0.01)	0.04	(md)
En17	Sruell	0.36	(0.03)	0.22	(0.03)	0.03	(md)	0.02	(md)	0.01	(0)
En18	Eanymore	1.09	(0.05)	0.67	(0.1)	0.05	(md)	0.01	(0)	0.003	(0)
En19	Eany	0.06	(md)	0.13	(0.01)	0.002	(0)	0		0.02	(md)

Appendix 4: Table 9: Estimated and minimum densities (no/m^2) of salmonids from the Eske catchment. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing) ~ p-value – derived probability of capture value applied where only one fishing was carried out or when a two fishing survey had a poor depletion.

Site no	**River**	**Salmon fry**		**Salmon parr**		**Trout fry**		**Trout parr**		**Trout adult**	
		0 +	**95%CI**	**1+**	**95%CI**	**0+**	**95%CI**	**1+**	**95%CI**	**>1+**	**95%CI**
Ek1	Trib Eske	0		0		0.16	(0.01)	0.09	(md)	0	
Ek2*~	Carrabber	0.08~		0.04~		0.007	(md)	0		0	
Ek3*	Lowerymore	0.009	(md)	0		0.04	(md)	0.06	(md)	0	
Ek4	Lowerymore	0.62	(0.19)	0.38	(0.08)	0.01	(0)	0.02	(md)	0.003	(0)
Ek5*	Clogher R.	0		0		0.09	(md)	0.03	(md)	0	
Ek6#	Clogher R.	2.55	(0.42)	0.23	(0.01)	0.18	(md)	0.03	(0)	0	
Ek7	Drummenny	0		0.01	(0)	0.53	(0.16)	0.62	(0.18)	0.03	(0.01)
Ek8	Drummenny	0.21	(0.07)	0.29	(0.09)	0.109	(md)	0.35	(0.07)	0.06	(md)

Appendix 4: Table 10: Population estimates from the Drowes catchment surveyed in 1992 and 2000. Density estimates were calculated using Seber & Le Cren unless otherwise stated, # = Zippin's method (3 fishing), (md) = Minimum Density (Gargan *et al*, 2000)

Site no	Year	River	Salmon fry		Salmon parr		Trout fry		Trout parr & older	
			0 +	(95%CI)	**1+**	**95%CI**	**0+**	**95%CI**	**>1+**	**95%CI**
Gf1	1992	Glenaniff	0		0		0.12	(md)	0.23	(md)
	2000	(not sampled)	-		-		-		-	
Gf2	1992#	Glenaniff	0.03	(md)	0	(md)	0.09	(md)	0.25	(0.02)
	2000		0.05	(0.01)	0.04	(md)	0.01	(md)	0.13	(0.01)
Gf3	1992	Glenaniff	0.34	(0.05)	0.04	(0.01)	0.11	(md)	0.13	(0.1)
	2000		0.15	(md)	0.11	(0.03)	0.06	(md)	0.13	(0.02)
Gf4	1992#	Glenaniff	0.34	(md)	0.42	(0.07)	0.18	(0.07)	0.19	(md)
	2000		0.08	(0.02)	0.18	(0.04)	0.12	(0.01)	0.18	(0.09)
Gf5	1992	Glenaniff	0.18	(md)	0.28	(0.04)	0.11	(0.02)	0.14	(0.05)
	2000	(not sampled)		-		-	-		-	
Gf6	1992	Glenaniff	0.42	(0.15)	0.46	(0.21)	0.2	(0.02)	0.26	(0.06)
	2000		1.02	(0.46)	0.31	(0.09)	0.26	(0.06)	0.21	(0.01)
Gf7	1992	Glenaniff	0.55	(md)	0.34	(md)	0.83	(0.02)	0.54	(0.03)
	2000		1.04	(md)	0.37	(md)	0.39	(md)	0.18	(md)
Bl8	1992	Ballagh	0		0		0.29	(0.14)	0.51	(0.15)
	2000	(not sampled)	-		-		-		-	
Bl9	1992	Ballagh	0.19	(md)	0.03	(md)	0.33	(md)	1.27	(0.24)
	2000		0.22	(0.03)	0.05	(0.03)	1.6	(0.29)	0.68	(0.07)
Bl10	1992	Ballagh	1.88	(0.39)	0.48	(0.1)	0.71	(0.13)	1.1	(0.11)
	2000		0.24	(0.14)	0.42	(0.12)	0.26	(0.08)	0.62	(0.04)
Bl11	1992	Ballagh	0.76	(0.1)	0.25	(md)	0.16	(md)	0.18	(0.03)
	2000	(not sampled)	-		-		-		-	
Bl12	1992#	Ballagh	1.1	(md)	0.52	(0.08)	0.7	(0.21)	0.68	(0.04)
	2000		0.97	(md)	0.37	(0.07)	0.26	(0.12)	0.30	(0.04)
Bl13	1992	Ballagh	1.73	(md)	0.56	(0.05)	0.89	(0.14)	0.39	(0.03)
	2000	(not sampled)	-		-		-		-	
Bl14	1992	Ballagh	1.56	(0.18)	0.15	(0.02)	0.53	(0.06)	0.1	(0.004)
	2000		3.8	(0.84)	0.22	(md)	0.55	(0.32)	0.20	(0.06)

Appendix 4: Table 10a: Population estimates from the Drowes catchment surveyed in 2001. Density estimates were calculated using Seber & Le Cren unless otherwise stated, (md) = Minimum Density (Gargan *et al*, 2002)

Site code	River	Salmon fry		Salmon parr		Trout fry		Trout parr & older	
		0 +	95%CI	1+	95%CI	0+	95%CI	>1+	95%CI
CFB033	County	0		0.02	(0)	0		0.15	(0)
CFB034	County	0		0.04	(0)	0.03	(0)	0.21	(0.04)
CFB035	County	0		0		0.42	(md)	0.28	(0.07)
CFB036	County	0.01	(0)	0.01	(0)	0.05	(0)	0.06	(0)
CFB037	County	0.30	(0.05)	0.28	(0.07)	0		0.08	(0.02)
CFB038	County	0		0.02	(0)	0.04	(0)	0.27	(0.06)
CFB039	Trib County	0		0		0.21	(0)	0.05	(0)
CFB040	Trib County	0		0		0.13	(0.01)	0.06	(0)
CFB041	Roogagh	0.09	(0.02)	0.02	(0)	0		0.2	(0)
CFB070	Clancy's	0.41	(md)	0.24	(0.01)	0.42	(md)	0.23	(0.05)
CFB071	Glen R.	0		0		0.03	(0)	0.36	(0)
CFB072	Roogagh	0		0		0		0.02	(0)
CFB073	Roogagh	0		0		0		0.06	(0)
CFB074	Roogagh	0		0		0.28	(0.1)	0.08	(0.03)

Appendix 4: Table 11: Estimated and minimum densities (no/m^2) of salmonids from the Duff catchment. The density estimates were calculated using Seber & Le Cren method (2 fishing) with the following exceptions, # = Zippin's method (3 fishing), * = Minimum density (1 fishing), P = present.

Site no	River	Salmon fry		Salmon parr		Trout fry		Trout parr		Trout adult	
		0 +	95%CI	1+	95%CI	0+	95%CI	1+	95%CI	>1+	95%CI
Duf9	Ballaghnatrillick	0		0		P		P			
Duf2	Duff (Black upper)	0		0		0.10	(0.01)	0.132	(0.01)	0	
Duf4#	Duff	0		0		0.55	(0.09)	0.09	(md)	0.02	(0)

Appendix 5: Catchment-wide electrofishing results for the relevant NRFB catchments

Appendix 5: Table 1. Results for catchment-wide survey on the Leannan catchment 2007

Catchment	MC/trib	Site No.	Date	GPS easting	GPS northing	Elevation (m)	Habitat/riffle quality rating (1 good-3 poor)	No. sal fry captured	No. fry missed (T&S)	Salmon Fry (captured & missed)	Mean no. sal fry (all sites)	Mean no. sal fry (main channel sites only)
Leannan											**9**	**9**
Leannan	mc	1	19/10/2007	219035	421865	21	3	2	1	2		
Leannan	mc	2	19/10/2007	218111	421547	21	3	4	1	5		
Leannan	mc	3	19/10/2007	215110	420933	9	2	8	4	12		
Leannan	mc	4	19/10/2007	214717	420597	28	2	5	2	7		
Leannan	mc	5	19/10/2007	213337	419121	43	3	7	2	9		
Leannan	mc	6	19/10/2007	210471	415851	42	2	5	2	6		
Leannan	mc	7	19/10/2007	206819	416983	70	1	14	7	20		
Leannan	lurgy	8	19/10/2007	212584	421662	57	2	3	1	3		
Leannan	bulluba	9	19/10/2007	202410	414011	77	1	18	4	22		

Appendix 5: Table 2. Results for catchment-wide survey on the Duff catchment 2007

Catchment	MC/trib	Site No.	Date	GPS easting	GPS northing	Elevation (m)	Habitat/riffle quality rating (1 good-3 poor)	No. sal fry captured	No. fry missed (T&S)	Salmon Fry (captured & missed)	Mean no. sal fry (all sites)	Mean no. sal fry (main channel sites only)
Duff											**8**	**8**
Duff	mc	1	18/10/2007	175431	356893	22	3	2	1	3		
Duff	mc	2	18/10/2007	175938	356193	34	3	7	4	11		
Duff	mc	3	18/10/2007	175077	354739	22	1	11	3	14		
Duff	mc	4	18/10/2007	174288	353973	30	2	8	4	11		
Duff	mc	5	18/10/2007	176030	352706	43	3	0	0	0		
Duff	mc	6	18/10/2007	179004	352439	46	1	5	1	6		
Duff	mc	7	18/10/2007	179284	351157	46	2	14	6	20		
Duff	mc	8	18/10/2007	179522	349795	63	2	0	1	0		
Duff	Ballynatric	9	18/10/2007	174833	352608	40	2	8	3	10		
Duff	Ballynatric	10	18/10/2007	173469	352032	38	1	4	0	4		
Duff	Ballynatric	11	18/10/2007	173255	351199	33	2	7	1	8		

Appendix 6 – Abundance ratings for non-salmonid species recorded during quantitative electrofishing surveys

Appendix 6: Table 1 - Abundance rating for other species recorded in the Leanann catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	3 Spined Stickleback
Ln1	Glashagh Lwr		
Ln2	Trib Glashagh		1
Ln3	Glashagh		
Ln4	Glashagh		1
Ln5	Glashagh		1
Ln6	Owenbeg		
Ln7	Owenwee	1	
Ln8	Owenvehy trib		1
Ln9	Bullaba	1	
Ln10	Bullaba		
Ln11	Bullaba		
Ln12	Bullaba		
Ln13	Cammare St.	2	
Ln14	Treantagh Trib	1	
Ln15	Drumbrick St.		
Ln16	Lurgy		
Ln17	Lurgy	1	
Ln18	Lurgy	1	
Ln19	Lurgy	1	

Appendix 6: Table 2: Abundance rating of other species collected in the Lackagh catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	3 Spined Stickleback
Lk1	Glen	1	
Lk2	Glen		
Lk3	Glenreraragh	1	
Lk4	Owenwee	1	
Lk5	Glasnaseeragh		
Lk6	Glasnaseeragh		
Lk7	Owencarrow		
Lk8	Owencarrow	1	
Lk9	Calabber	1	1
Lk10	Owencarrow		

Appendix 3: Table 3: Abundance rating for other species collected in the Clady Catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200

Site no	River	Eel
Cl1	Trib L. Nacung	
Cl2	Cronaniv R.	
Cl3	Delvin R.	
Cl4	Delvin R.	1
Cl5	Trib L. Nacung	
Cl6	Altmore R.	
Cl7	Clady MC	1

Appendix 6: Table 4: Abundance rating for other species collected in the Crolly Catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	Minnow	Flounder
Cr1	L. Keel outflow			
Cr2	Owenator upr			
Cr3	Owenator	1		
Cr4	Owenator	1	2	
Cr5	Trib. L. Anure		4	
Cr6	Gweedore MC	1		1

Appendix 6: Table 5: Abundance rating for other species collected in the Gweebarra catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	Stickleback
Gw1	Owenwee		
Gw2	Owenwee	2	2
Gw3	Owenwee	3	
Gw4	Barra MC	1	
Gw5	Barrra MC		
Gw6	Barra MC	1	
Gw7	Glenleheen St.		
Gw8	Glenleheen St.	1	
Gw9	Glenleheen St.	1	
Gw10	Abroe	1	
Gw11	Abroe	1	
Gw12	Abroe	1	
Gw13	Gweebarra MC	2	
Gw14	Gweebarra MC	2	
Gw15	Gweebarra MC	1	
Gw16	Gweebarra MC	2	

Appendix 6: Table 6: Abundance rating for other species collected in the Owenea catchment.
Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	Lamprey
Ow1	Shallogan		
Ow2	Shallogan		
Ow3	Shallogan	2	
Ow4	Stracashel		
Ow5	Stracashel		
Ow6	Stracashel		
Ow7	Stracashel		1
Ow8	Stracashel		
Ow9	L. Ea outfall	1	
Ow10	Owengarve		
Ow11	Owenea MC	1	
Ow12	Owenea MC	1	
Ow13	Owenea MC	1	
Ow14	Owenea MC	1	

Appendix 6: Table 7: Abundance rating for other species collected in the Glen catchment. Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel
Gl1	Owenwee	
Gl2	Trib Owenwee	1
Gl3	Owenwee	1
Gl4	Owenwee	1
Gl5	Meenagharvy Trib	
Gl6	Lougheraherk Trib	
Gl7	Owentiskiny	
Gl8	Owentiskiny	
Gl9	Owentiskiny	
Gl10	Owentiskiny	
Gl11	Trib Crow	
Gl12	Crow upr	
Gl13	Crow upr	
Gl14	Trib Crow	
Gl15	Crow	
Gl16	Crow	1
Gl17	Crow	1
Gl18	Glen upr	
Gl19	Glen upr	
Gl20	Glen MC	1
Gl21	Glen MC	
Gl22	Glen MC	1
Gl23	Glen MC	1

Appendix 6: Table 8: Abundance rating of other species collected in Eany catchment. Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Site no	River	Eel	Lamprey	3 Spined Stickleback	Flounder
En1	Stranahend	1			
En2	Stranahend	1			
En3	Stranahend	1			1
En4	Lettermare	1			
En5	Oughtadooney		1		
En6	Eanybeg	1			
En7	Eanybeg	1			
En8	Eanybeg	2			
En9	Eanybeg	1			
En10	Eglish	1			
En11	Eglish	1			
En12	Eglish	1			
En13	Frosses	1			
En14	Eanymore	2			
En15	Sruell upr	1	1		
En16	Sruell	2	1		
En17	Sruell	1	1	1	
En18	Eanymore	1	3		
En19	Eany	1		1	

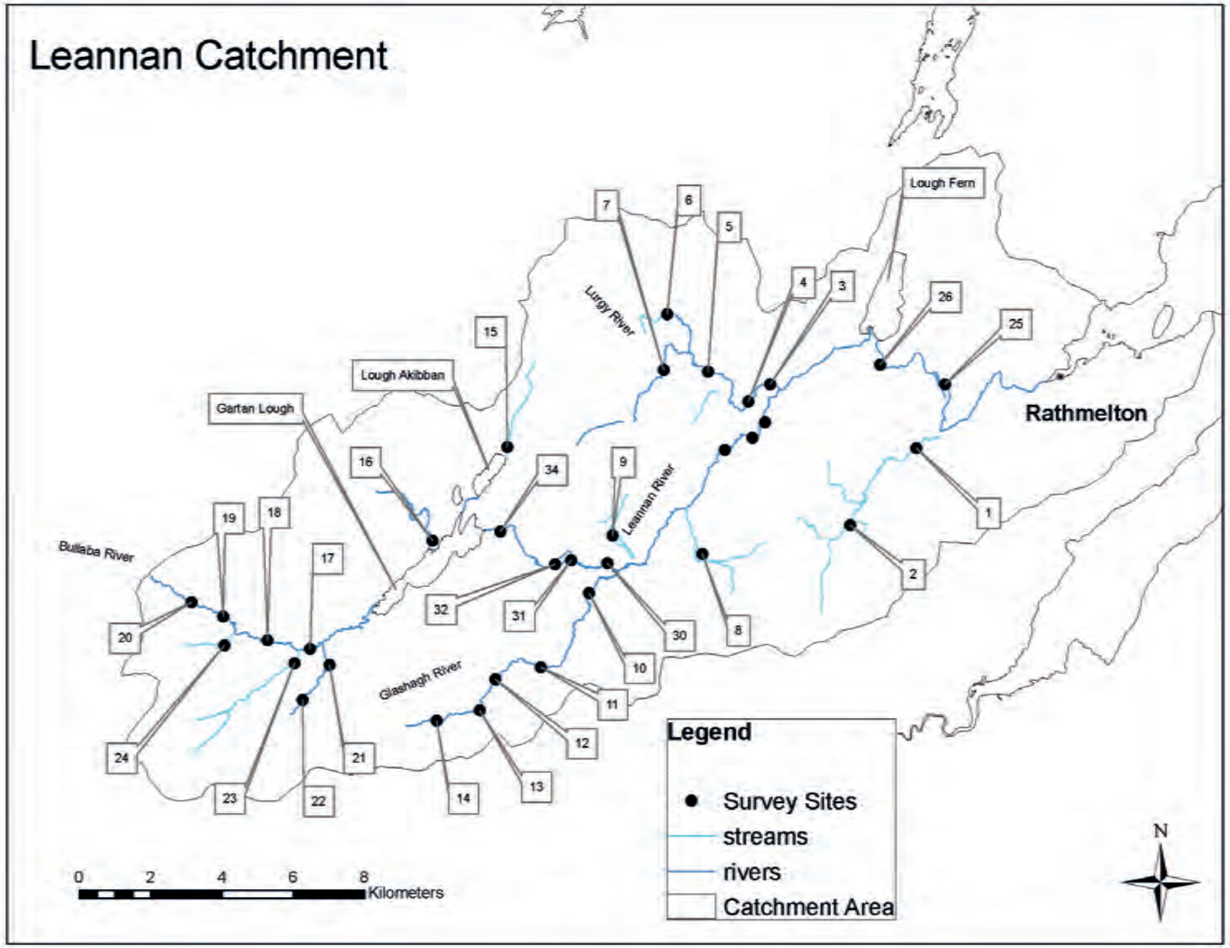
Appendix 6: Table 9: Abundance rating of other species collected in Eske Catchment. Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200. Number and forklenghts (cm) shown for sea trout.

Site no	River	Eel	Flounder	Sea trout
Ek1	Trib Eske	1		
Ek2	Carabber	1		
Ek3	Lowerymore	1		
Ek4	Lowerymore	1		1 (25cm)
Ek5	Clogher R.	1		
Ek6	Clogher R.	1		
Ek7	Drummenny			
Ek8	Drummenny	1	1	3 (20, 22 & 24 cm)

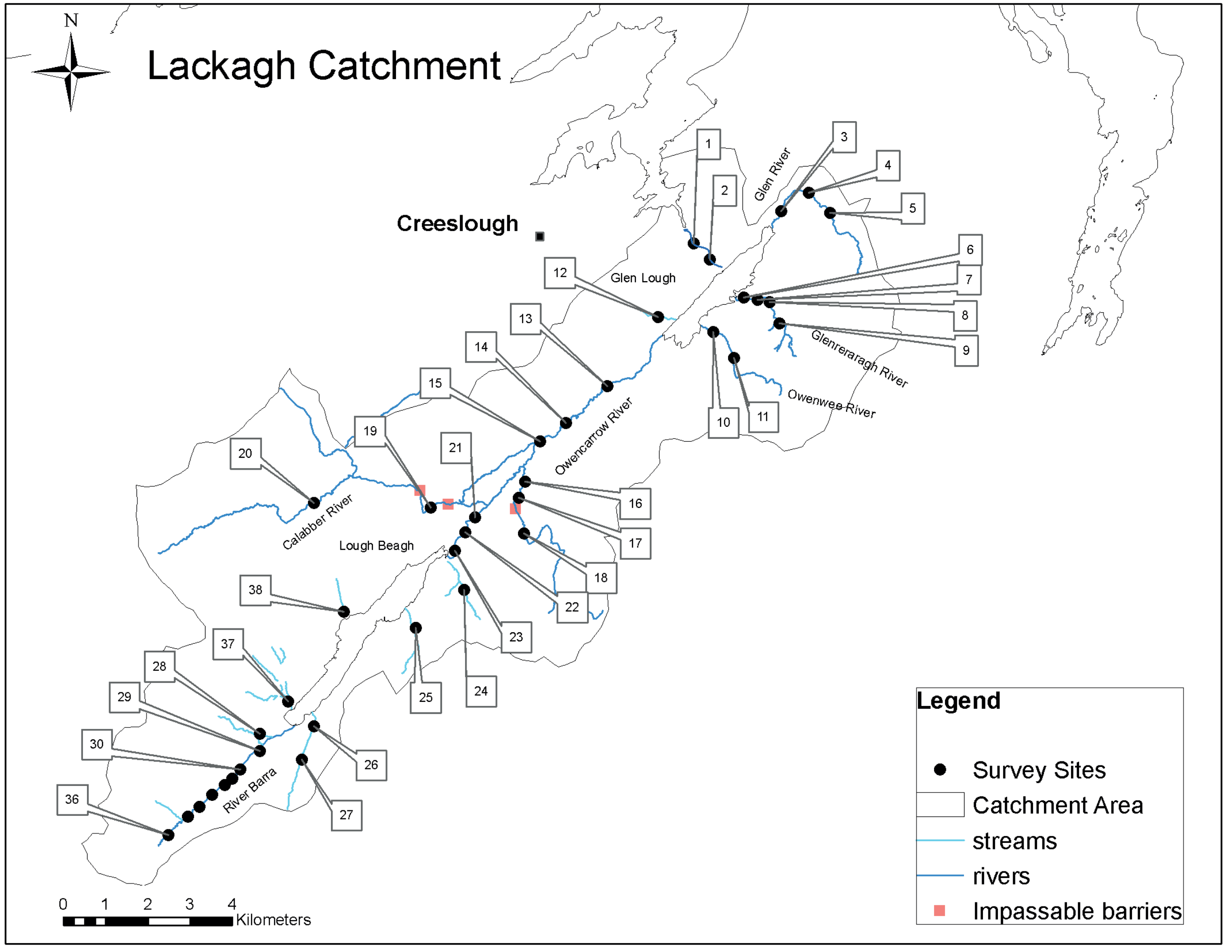
Appendix 6: Table 10: Abundance rating for other species collected in the Drowes catchment. Abundance rating 1 = 1-10, 2 = 11-50, 3 = 51-100, 4 = 101-200, 5 = >200.

Code	River	Eel	Minnow
CFB033	County		
CFB034	County	1	2
CFB035	County	1	2
CFB036	County		3
CFB037	County		1
CFB038	County	1	1
CFB039	Trib Country	1	2
CFB040	Trib Country		3
CFB041	Roogagh	1	
CFB071	Clancy's		
CFB072	Glen R.		
CFB073	Roogagh		1
CFB074	Roogagh		2

Appendix 7: Electrofishing data from previous surveys of NRFB catchments



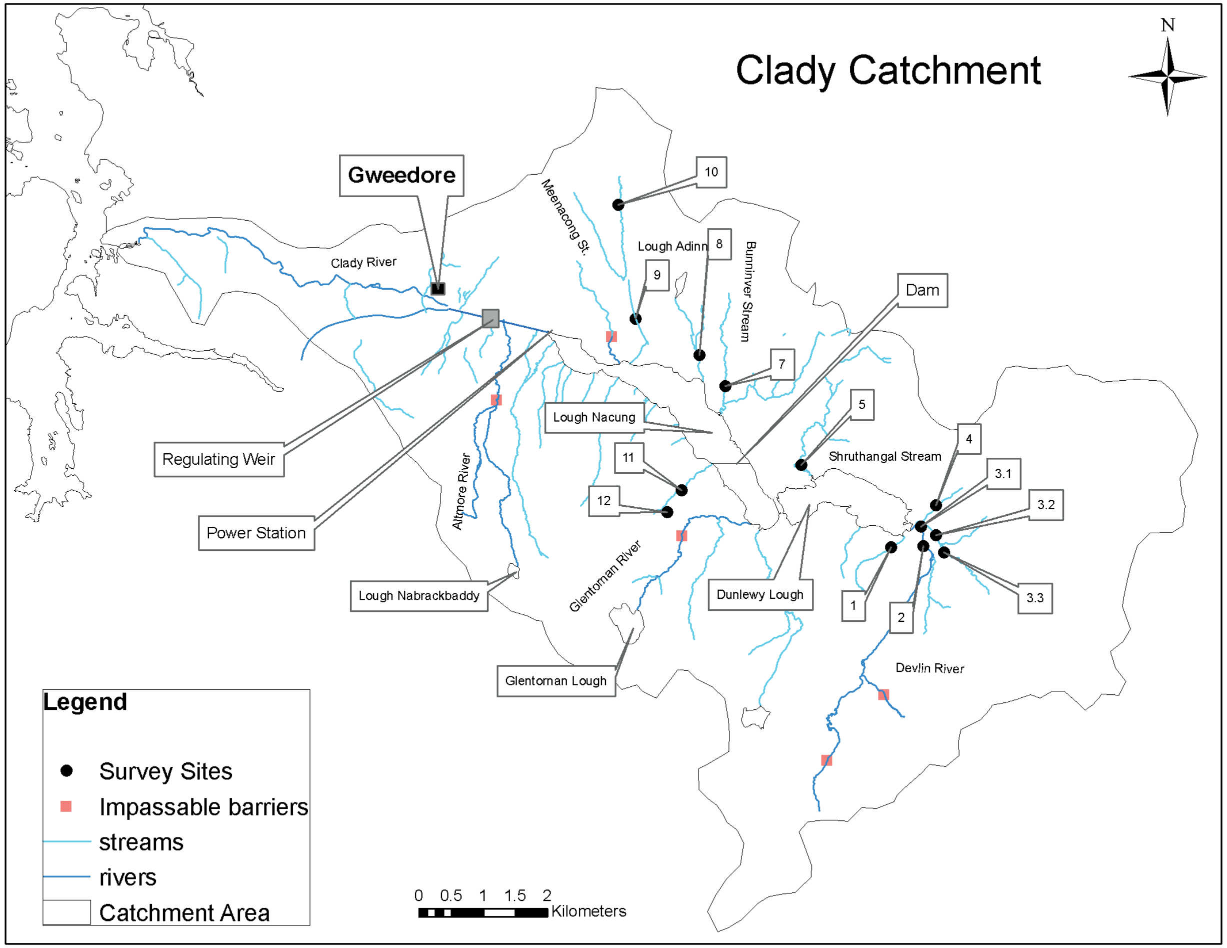
Appendix 7: Fig. 1. Electrofishing sampling sites from the 1992 Leannan catchment survey (Roche & Gargan, 1994).



Appendix 7: Fig. 2: Electrofishing sampling sites from the 1994 Lackagh catchment survey (Boylan & Sheridan, 1994).

Appendix 7: Table 2: Population estimates for the Lackagh catchment (Boylan & Sheridan 1994). # minimum density; * semi-quantitatively sampled

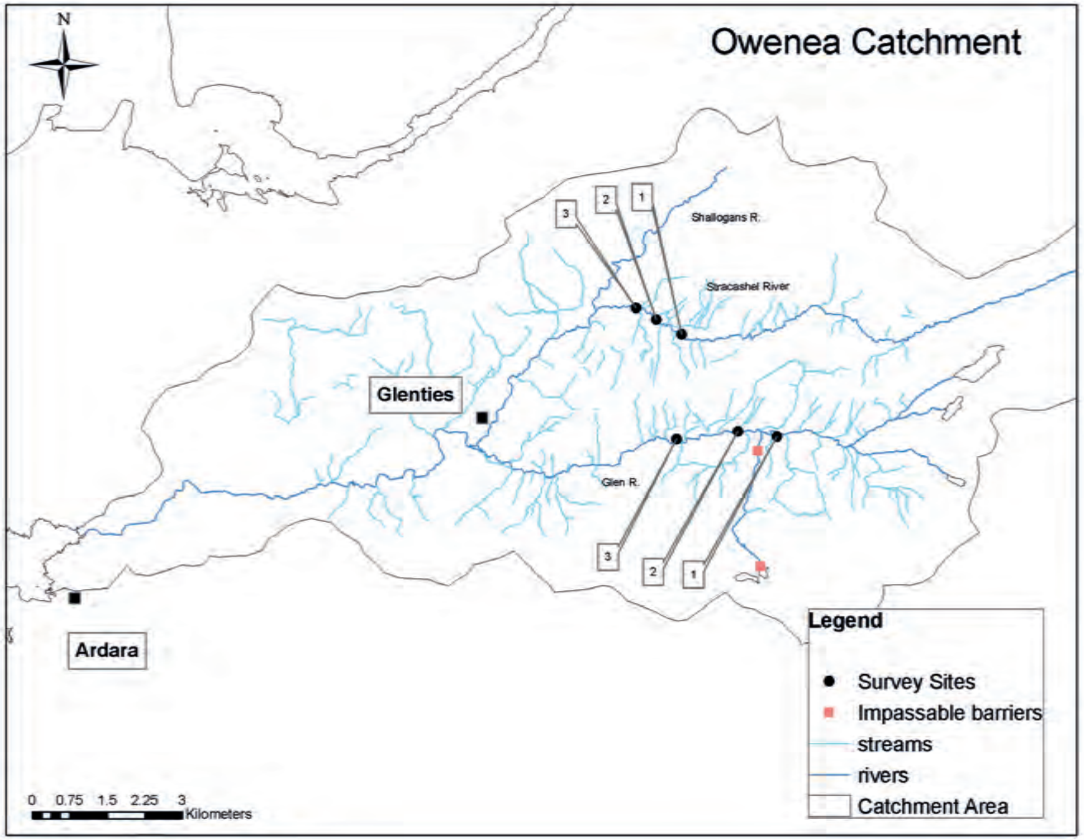
River	Site no	Nearest	Salmon fry		Salmon parr		Trout fry		≥Trout parr	
		'07 site	0+	95%CI	1+	95%CI	0+	95%CI	1+	95%CI
Lackagh 1			0		12		0		0	
	2		0		7		0		9	
Tribs Glen L.	3	Lk2	1.96	(0.01)	0.02	#	0.49	(0.01)	0.02	#
	4	Lk1	1.51	(0.01)	0.32	(0.02)	0.42	(0.01)	0.01	(0)
	5*	Lk1	0		0		Present		Present	
	6	Lk3	0.14	#	0		3.38	(0.14)	0	
	7	Lk3	0.06	#	0		1.69	(0.11)	0.51	(0.01)
	8	Lk3	0		0		0.46	(0.02)	0.15	(0.01)
	9	Lk3	0		0		0.32	(0.07)	0.04	#
	10	Lk4	0		0		1.05	(0.18)	0	
	11	Lk4	0		0		0.69	(0.03)	0.31	#
Owencarrow	13		0		0		0.01	#	0	
	14		0.01	#	0.01	#	0.01	#	0.01	#
	15		0.14	(0)	0.03	(0.01)	0.04	(0)	0.01	#
	21		0.37		0.11		0.04	#	0.01	#
	22		0.3	(0)	0.11	(0)	0.02	#	0	
	23		0.1	#	0.02	#	0.01	#	0	
Glasnaseeragh	16	Lk6	0.31	(0.02)	0		0.05	#	0.04	#
	17	Lk5	0		0		0.06	#	0.04	#
	18*	Lk5	0		0		Present		Present	
Calabber	19	Lk9	0		0		0.16	#	0.1	#
	20		0		0		0.06	(0.01)	0.06	(0)
Owennacally	24		1.28	(0.31)	0		0.61	(0)	0.03	#
	25		2.36	(0.39)	0		0.16	(0.08)	0	
	26		0.49	(0.01)	0.02	#	0.36	(0.02)	0.1	(0.04)
	27		0		0		1.29	(0.05)	0.04	#
Owenbeagh	28	Lk8/Lk7	0.16	#	0		0.03		0	
	29	Lk8/Lk7	0.12	#	0.02	#	0.08	#	0.03	#
	30	Lk8/Lk7	0.19	(0.02)	0.12	(0.05)	0.11	#	0.08	#
	31	Lk8/Lk7	0.98	(0.03)	0.02	#	0.05	#	0.03	#
	32	Lk8/Lk7	0.22	#	0.03	#	0.06	#	0.03	#
	33	Lk8/Lk7	0.26	(0.12)	0.07	#	0.1	#	0.04	#
	34	Lk8/Lk7	0.2	(0.13)	0		0.07	#	0.09	#
	35	Lk8/Lk7	0		0		0.04	#	0.01	#
	36	Lk8/Lk7	0		0		0.5	(0.19)	0.07	#
	37		0.43	(0.03)	0.18	(0.05)	0.23	(0.07)	0.09	#
	38*		0		0		Present		Present	



Appendix 7: Fig. 3: Electrofishing sampling sites from the 1989 Clady catchment survey (Gargan & Whelan, 1990).

Appendix 7: Table 3: Minimum density estimates for the Clady catchment as surveyed in 1989 (Gargan & Whelan 1990).

River	Site no	Nearest '07 site	Salmon fry 0+	95%CI	Salmon parr 1+	95%CI	Trout fry 0+	95%CI	Trout parr & Greater 1+	95%CI
Dunlewy Hse St	1		0.08	#	0.6	#	0.06	#	0.16	#
Devlin R.	2	Cl3	0		0.04	#	0		0.04	#
Poison Glen	3 (i)	Cl2	0.007	#	0.041	#	0.02	#	0	
Poison Glen	3 (ii)		0.011	#	0.006	#	0.006	#	0.023	#
Poison Glen	3 (iii)		0		0.038	#	0		0.03	#
Croloughan	4		0		0.015	#	0.059	#	0.119	#
Sruhangal	5		0		0.022	#	0.044	#	0.089	#
Meenacreeva	6		0.107	#	0.107	#	0.240	#	0.080	#
Bunninver	7	Cl1	0.063	#	0.175	#	0.100	#	0.025	#
Lough Adinn St	8		0		0		0.333	#	0.100	#
Meenacung	9		0		0.008	#	0.100	#	0.208	#
Meenacung (above falls)	10		0		0		0		0.043	#
Glenthoran	11		0		0.054	#	0.014	#	0.122	#
Glenthoran side st	12		0		0		0.300	#	0.200	#



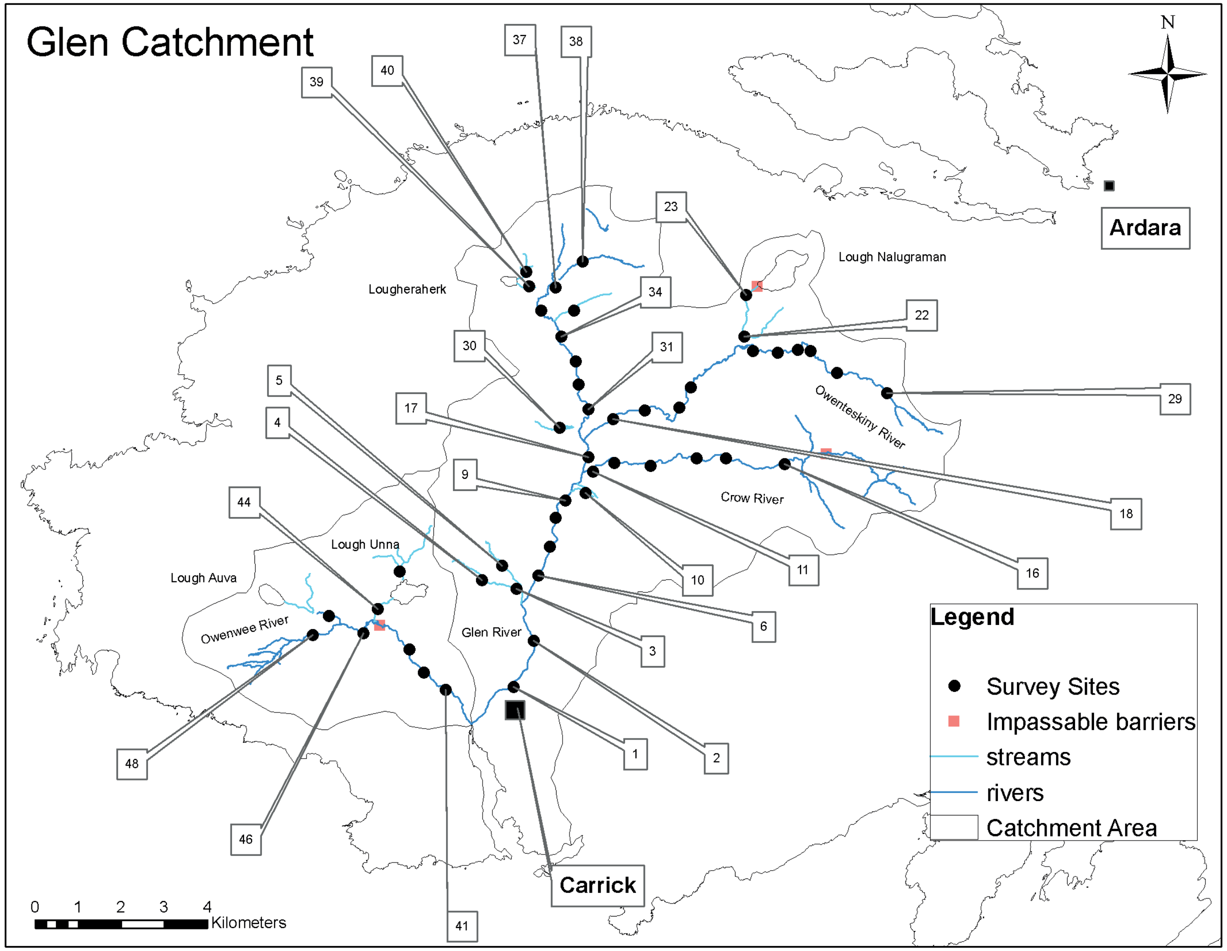
Appendix 7: Fig. 4. Sites sampled in Owenea by Mc Carthy (1972)

Appendix 7: Table 4: Species density (no/m^2) in the Owenea Catchment (McCarthy 1972).

River	Year	Salmon	Brown Trout	Eels
Stracashel	1968	0.30	0.09	0.05
	1969	0.35	0.13	0.09
	1970	0.14	0.02	0.01
Glen	1968	0.20	0.10	0.08
	1969	0.116	0.06	0.03
	1970	0.04	0.013	0.005

Appendix 7: Table 5: Density (no/m^2) of each year class of juvenile salmon per m^2 in the Owenea Catchment in 1969 & 1970 (McCarthy 1972).

River	Year	Salmon 0+	Salmon 1+	Salmon 2+
Stracashel	1969	0.1	0.2	0.02
	1970	0.03	0.086	0.02
Glen	1969	0.04	0.07	0.066
	1970	0.01	0.035	-



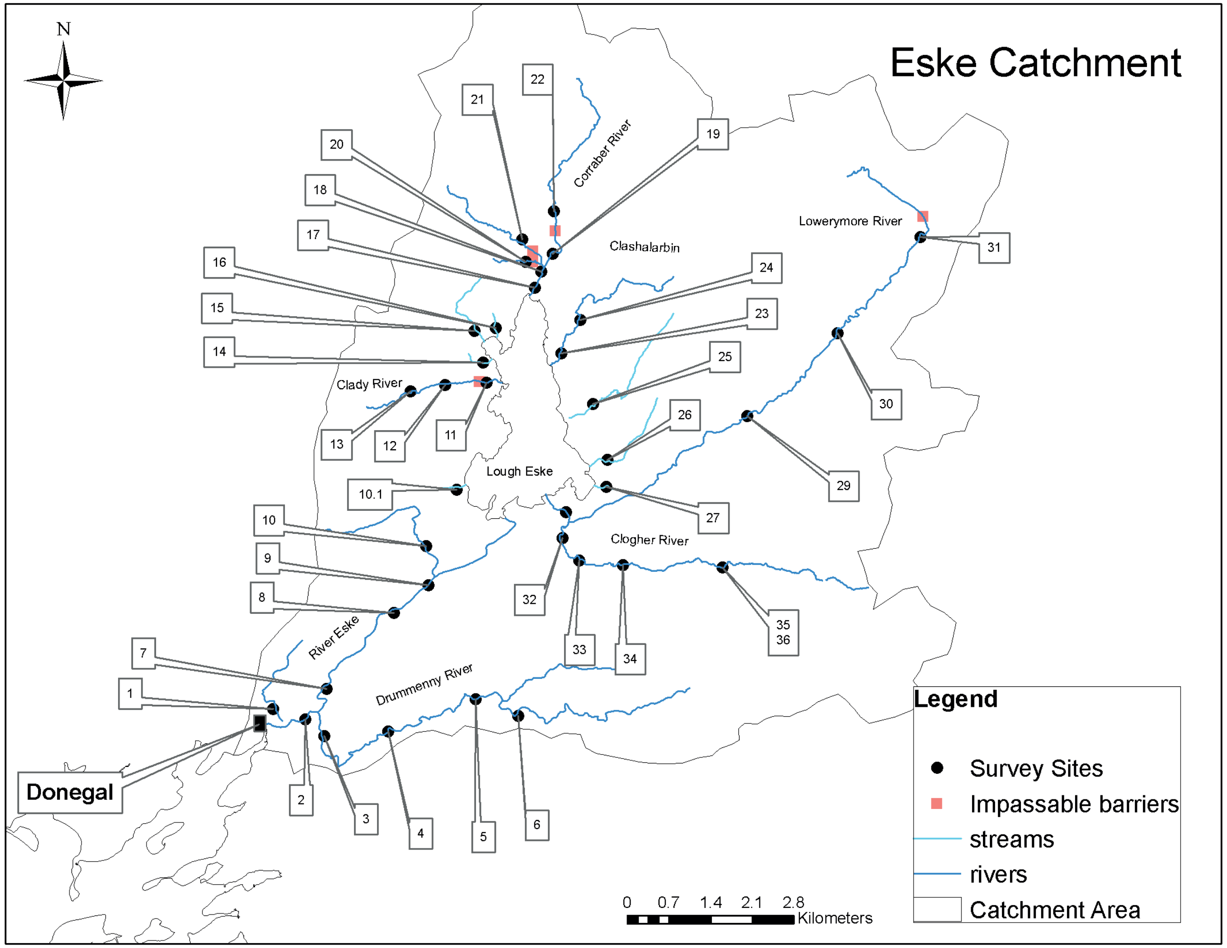
Appendix 7: Fig. 5. Sites sampled in the Glen catchment by Boylan & Sheridan (1989)

Appendix 7: Table 6: Population estimates (no/m^2) for the Glen catchment as surveyed in 1993 (Boylan & Sheridan 1994). # indicates minimum density; * indicates sites that were only semi-quantitatively sampled.

River	Site	Nearest	Salmon fry			Salmon parr			Trout fry			Trout 1+ and older	
	No.	2007 site	0+	95%CI	1+	95%CI	0+	95%CI	≥1+	95%CI			
Glen MC	1	Gl23	1.32	#		0.02	#		0.19	#		0	
	2	Gl22	0.13	(0.04)		0.3	(0.07)		0.17	(0.08)		0	
	6	Gl21	0.55	#		0			0.1	#		0	
	7	Gl21	0.14	(0.01)		0.11	(0.01)		0.02	#		0.02	#
	8	Gl21	0.1	#		0.04	#		0.06	#		0	
	9	Gl21	0.37	#		0.03	#		0.19	#		0.06	#
	17	Gl20	0.11	(0)		0.28	(0)		0			0.03	#
Trib 1	3		0.34	(0.01)		0.08	#		0.38	#		0	
	4		0.05	#		0			0.05	#		0.05	#
	5		Present			0			Present		Present		
Trib 2	10		0			0.1	#		0.05	#		0.05	#
Trib 3	11		0.01	#		0.17	(0.01)		0.01	#		0.08	#
	12	Gl17	0.2	(0.01)		0.17	(0.01)		0.08	#		0	
	13		0.22	(0.01)		0.17	#		0.08	(0)		0	
	14		0			Present			0			Present	
	15		0			0			0			Present	
	16	Gl15	0			0			0.02	#		0.11	#
Owenteskiny	18	Gl10	0.13	#		0.04	(0.01)		0.04	(0.01)		0.02	#
	19	Gl10	0.05	(0.01)		0.12	(0.01)		0.05	#		0.02	#
	20	Gl9	0.03	#		0.11	(0.04)		0.05	#		0.07	(0.02)
	21	Gl9	0.29	(0.01)		0.05	(0.01)		0.09	(0.01)		0.01	#
Nalugh. Trib	22		1.67	#		0.14	#		0.24	#		0.14	#
	23??		0			Present			Present			Present	
Owenteskiny (4)	24	Gl8	0.99	(0.01)		0.15	(0.02)		0.08	#		0.03	#
	25	Gl8	0			0.01	#		0.04	#		0.05	#
	26		0			Present			0			Present	
	28		0			Present							

Appendix 7:Table 6 contd: Population estimates (no/m^2) for the Glen catchment as surveyed in 1993 (Boylan & Sheridan 1994). # indicates minimum density; * indicates sites that were only semi-quantitatively sampled.

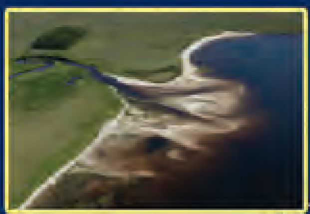
River	Site No.	Nearest 2007 site	Salmon fry 0+	95%CI	Salmon parr 1+	95%CI	Trout fry 0+	95%CI	Trout 1+ and older ≥1+	95%CI
	29	Gl7	0		0		0		0.17	(0.06)
Glen upper (5)	30	Gl5	0		0		0.32	(0.02)	0	
	31	Gl19	0.3	(0.01)	0.02	#	0.02	#	0	
	32	Gl19	0.01	#	0.12	#	0.02	#	0.05	#
	33	Gl19	0.08	#	0		0.24	(0.01)	0	
	34	Gl19	0.07	(0.01)	0.02	#	0.18	(0.01)	0.08	(0.01)
Glen upper (6)	35		0.08	#	0.08	#	0.17	#	0.25	#
	36	Gl18	0		0.03	#	0.13	(0.03)	0	
	37	Gl18	0		0.03	#	0.2	(0.02)	0.03	#
	38	Gl18	0.05	#	0.02	#	0.23	(0.02)	0.05	#
Lougheraherk	39		0		0		0.1	#	0.5	0.09
Lougheraherk tr	40	Gl6	0		0		1.14	(0.03)	0	
Owenwee	41	Gl4	0.03	#	0.07	(0.01)	0.07	(0)	0.11	(0)
	42	Gl4	0.04	#	0.2	(0.01)	0.08	(0.01)	0.03	#
	43	Gl4/Gl3	0.06	#	0.15	(0)	0.07	(0.01)	0.06	(0.02)
	44						Present		Presest	
	45		0		0		Present		Present	
	46	Gl1	0.32	(0.02)	0.11	#	0.05	#	0.03	#
	47		0		0		Present		Present	
	48		0		0		0.27	(0.04)	0.4	(0.04)
	49		0		0		Present		Present	

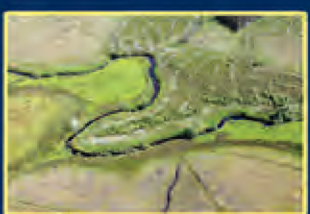


Appendix 7: Fig. 6. Sites sampled in the Eske catchment by Boylan & Sheridan (1989)

Appendix 7: Table 7: Population estimate for the Eske catchment as surveyed in 1993 (Boylan & Sheridan 1994). # indicates minimum density; * indicates sites that were only semi-quantitatively sampled

River	Site no	Nearest	Salmon fry		Salmon parr		Trout fry		Trout 1+ & older	
		'07 site	0+	95%CI	1+	95%CI	0+	95%CI	1+	95%CI
Eske	3	Ek8	0.24	#	0.2	#	0.19	#	0.09	#
	4	Ek8	0.25	#	0.29	#	0.2	#	0.12	#
	5	Ek7	0		0		0.21	#	0.05	#
	6	Ek7	0.31	#	0.18	#	0.19	#	0.11	#
	7*	Ek7	0		0		0		Present	
	10i*	Ek1	0		0		Present		0	
	18	Ek2	0.05	#	0.01	#	0.04	(0.01)	0.01	#
	19	Ek2	0.21	(0.01)	0		0.01	#	0	
	20	Ek2	0.38	(0.01)	0.04	#	0.02	#	0.01	#
	29	Ek4	0.46	(0)	0.01	#	0.03	#	0	
	30	Ek3	0		0		0.13	#	0.09	(0.01)
	33	Ek6	0.85	(0.02)	0.18	(0.01)	0.14	#	0.03	#
	34	Ek6	0.87	(0.01)	0.08	(0.02)	0.02	#	0	
	35*	Ek5	Present		0		Present?		Present?	
	36*	Ek5	0		0		Present?		Present?	





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