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Protection, Restoration and Enhancement of Salmon Habitat Focus Area Report

EU-Ireland

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Focus Area Report on Protection, Restoration and Enhancement of Salmon Habitat in the Republic of Ireland

INTRODUCTION

Under the 'Next Steps' process, Focus Area Reports (FARs) are intended to provide an in-depth assessment of measures, as reflected in Implementation Plans, to implement NASCO Agreements, Resolutions, and Guidelines. The FARs provide the basis for review of the current management approach and proposed actions and to assess their efficacy in addressing the overall objectives of NASCO and, in particular, to conserve, restore and enhance salmon stocks.

A summary of Ireland's Implementation Plans for Habitat Protection and Restoration is set out in Appendix 1. The Summary Plan outlines the actions in response to the main threats affecting habitat in Irish rivers and outlines the management approach for the protection and restoration of habitat over the coming years including monitoring and actions required under the EU WFD and Habitats Directives. These actions also address these threats in the context of the NASCO agreements including expected outputs and delivery dates. This Focus Area report will set out in-depth the measures to implement the NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat. This Plan of Action identifies that NASCO's overall objective is to maintain and, where possible, increase the current productive capacity of Atlantic salmon habitat. Furthermore, Contracting Parties have agreed that they and their relevant jurisdictions should seek to:

- Protect the current productive capacity of the existing physical habitat of Atlantic salmon; and
- Restore, in designated areas; the productive capacity of Atlantic salmon habitat which has been adversely impacted.

This focus area report on protection, restoration and enhancement of salmon habitat will also address these objectives.

The report follows the layout suggested in NASCO CNL (08)33.

1. Overview of Salmon Rivers within the Jurisdiction

In Ireland, 148 rivers have been designated as salmon catchments (NASCO 2005, CNL (05) 45). These rivers were selected from an original list of 261 Fishery Systems (McGinnity *et al*, 2003). These rivers range from large catchments with salmon conservation limits over 10,000 fish (Moy, Suir, Nore, Blackwater) to small rivers with a CL of around 100 salmon. The rivers are distributed throughout the 17 Fishery Districts around the Irish coast (fig 1). There is only one designated salmon river in the Drogheda District (River Boyne) while there are 26 designated salmon rivers in the Kerry District (table 1). The conservation status of each river is shown (fig 2).

Table 1. Number of Designated salmon Rivers by District

Fishery District	Number of Salmon Rivers
Dundalk	5
Drogheda	1
Dublin	3
Wexford	3
Waterford	11
Lismore	7
Cork	10
Kerry	26
Shannon	14
Galway	6
Connemara	4
Ballinakill	8
Bangor	7
Ballina	6
Sligo	4
Ballyshannon	12
Letterkenny	21
Total	**148**

Map of Ireland Showing the 17 Fishery Districts and the 7 Regional Fisheries Boards

Fig 1. Location of 17 Fishery Districts

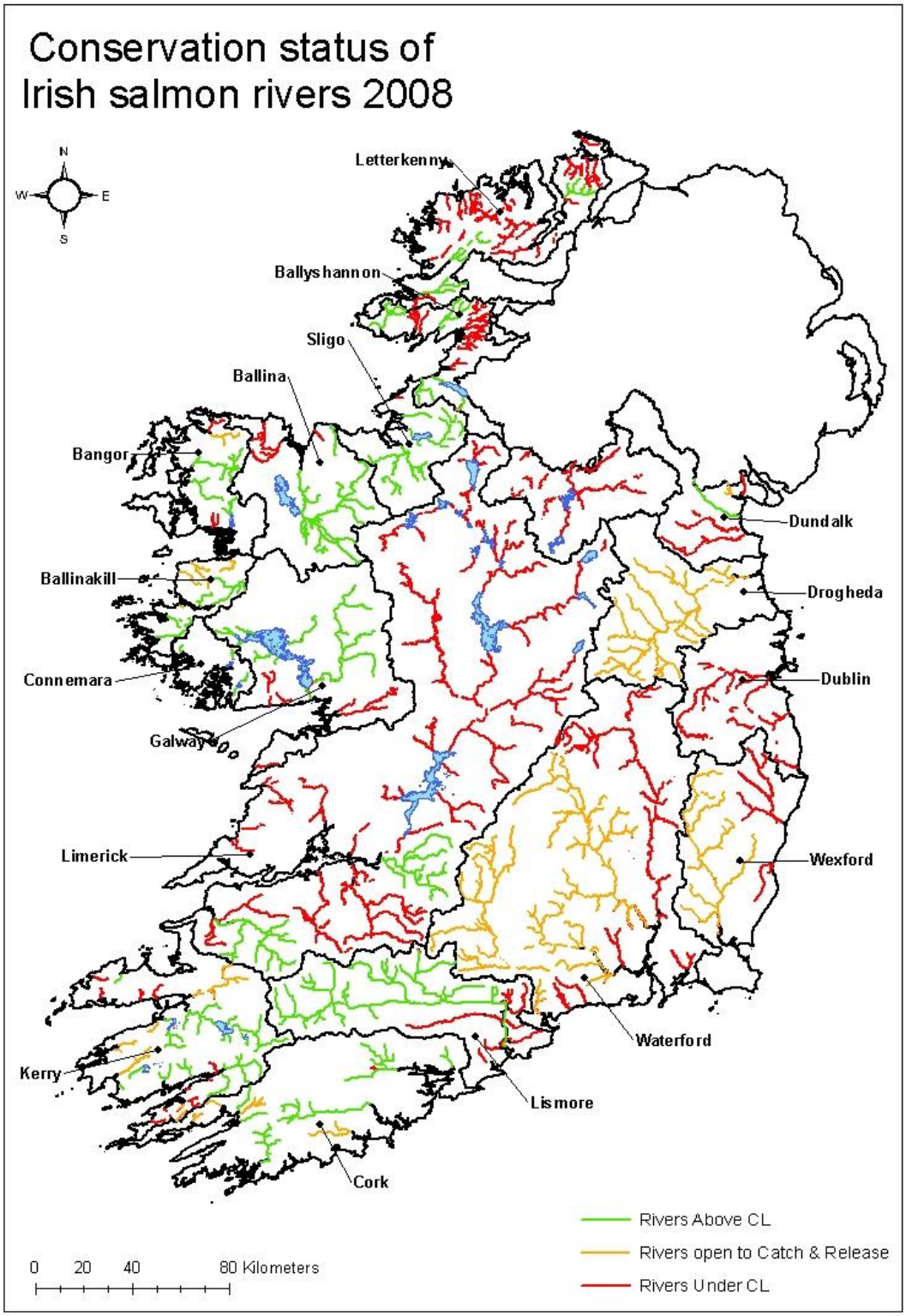


Fig 2. Location and conservation status of Ireland's 148 Designated Salmon Rivers - Rivers shown in green have salmon stocks meeting river specific conservation limits in 2008. Rivers shown in orange are meeting 65%-99% of conservation limit and rivers shown in red are meeting ≤ 65% of conservation limit.

2. Current status of salmon habitat and the quantity and quality of salmon habitat (historic and current)

The status of salmon habitat in Ireland was classified as poor in the "Status of EU Protected Habitats and Species in Ireland Report", (NPWS), 2008. This classification was as a result of reporting on the national overview rather than on an individual river basis. The poor status of salmon habitat reported resulted from the broad range of environmental factors affecting salmon rivers nationally. Agricultural enrichment, forestry related pressures and poor water quality resulting from inadequate sewage treatment were the major habitat impacts identified. Individual salmon rivers may be impacted to varying degrees by habitat impacts but not all salmon rivers can be classified as poor. The current status of salmon habitat in individual salmon rivers is set out in Section 5a of this report, where impacts and potential risks to productive capacity are addressed.

Quantity and Quality of Salmon Habitat

The quantification of salmon habitat was undertaken in a 2003 study, "*Quantification of the Freshwater Salmon Habitat Asset in Ireland using data interpreted in a GIS platform"* (McGinnity et al, 2003)

A quantitative estimate of the area (m^2) of salmon river and lake habitat resource in Ireland is presented for each of Ireland's 17 Fisheries District (Table 2).

Table 2. A quantitative estimate (m^2) of the national salmon river and lake habitat resource in Ireland presented on a Fisheries District basis.

FISHERIES DISTRICT	Total fluvial habitat in salmon rivers (m^2)	Accessible fluvial habitat in salmon rivers (m^2)	% of National total accessible fluvial	Total lacustrine habitat (m^2)	Accessible lacustrine habitat (m^2)
Dundalk	2,436,340	2,372,751	2.1	1,591,368	1,591,368
Drogheda	6,695,412	6,695,412	5.9	13,221,896	13,221,896
Dublin	3,967,758	2,741,828	2.4	23,031,955	667,656
Wexford	7,161,341	7,032,752	6.2	1,973,710	444,985
Waterford	24,569,103	24,345,915	21.5	350,587	350,587
Lismore	9,340,439	9,314,020	8.2	34,401	34,401
Cork	7,241,815	4,715,328	4.2	14,022,420	1,314,679
Kerry	8,797,110	8,522,449	7.5	58,520,473	56,607,695
Limerick	46,450,964	14,394,975	12.7	392,185,102	10,502,205
Galway	8,253,242	5,307,431	4.7	283,202,813	177,472,441
Connemara	867,759	811,701	0.7	18,023,298	17,323,803
Ballinakill	2,076,178	1,934,183	1.7	13,021,122	10,996,195
Bangor	3,336,934	3,239,957	2.9	18,348,851	18,348,851
Ballina	9,301,174	8,881,629	7.8	74,122,826	69,847,999
Sligo	4,200,104	3,990,574	3.5	32,002,961	19,502,146
Ballyshannon	10,178,849	3,361,359	3.0	92,513,368	28,714,469
Letterkenny	5,631,468	5,337,762	4.7	20,450,397	19,392,136
National TOTAL	**159,299,803**	**111,863,902**	**100**	**1,052,364,769**	**442,789,056**

A total fluvial habitat of 159 million m^2 was estimated nationally. Within salmon rivers, the analysis has estimated that 70% or approx 111 million m^2 is accessible to

salmon. Of the 17 Fisheries Districts, the Waterford District has the greatest quantity of accessible fluvial habitat (24.3 million m^2) available for juvenile salmon production or 21.5% of the national total. A total of 1,052 million m^2 of lake habitat was identified in the 17 Fisheries Districts (Table 2). Of this lake habitat, 442 million m^2 is available for salmon production. The Galway District accounts for 40% of the accessible lake habitat available. Data is provided on total and accessible fluvial and lake habitat on an individual river system basis (Appendix 2).

The River Suir in the Waterford District has the largest quantity of accessible fluvial habitat of any salmon river nationally (8.8 million m^2) or 7.8% of the national total, (Table 3). The largest twenty rivers in terms of accessible wetted area contain 67.5% of the total accessible fluvial salmon habitat in Ireland (Table 3, Figure 3).

Table 3. Quantity of Salmon Habitat in Ireland's Largest 20 Salmon Rivers

Rank	Fishery District	OS Catchment Name	Total fluvial habitat total (m2)	Fluvial habitat accessible (m2)	Fluvial habitat accessible by river as a % of national fluvial accessible	Cumulative fluvial habitat accessible to salmon as a % of total national fluvial accessible to salmon
1	Waterford	Suir	8911096	8795447	7.8	7.8
2	Lismore	Blackwater	7728122	7701703	6.8	14.6
3	Ballina	Moy	7495504	7075959	6.3	20.9
4	Waterford	Nore	6796230	6796230	6.0	26.9
5	Drogheda	Boyne	6695412	6695412	5.9	32.8
6	Waterford	Barrow	6548527	6495633	5.7	38.5
7	Wexford	Slaney	4945255	4945255	4.4	42.9
8	Galway	Corrib	6719329	4038058	3.6	46.5
9	Limerick	Shannon	35757947	3702750	3.3	49.8
10	Limerick	Maigue	2437307	2437307	2.2	51.9
11	Dublin	Liffey	3444930	2308361	2.0	54.0
12	Kerry	Laune	2482704	2265312	2.0	56.0
13	Sligo	Ballysadare	2301152	2190538	1.9	57.9
14	Limerick	Feale	2020036	2019244	1.8	59.7
15	Cork	Bandon	1663070	1652104	1.5	61.2
16	Wexford	Avoca	1766724	1638135	1.4	62.6
17	Limerick	Deel	1502689	1502689	1.3	63.9
18	Bangor	Owenmore	1386308	1386308	1.2	65.2
19	Sligo	Garvogue	1376884	1376884	1.2	66.4
20	Limerick	Fergus	1270553	1270553	1.1	67.5

A total of 40.1 million m^2 of potential fluvial salmon habitat is located upstream of the large-scale hydro dams (Figure 3) on four rivers (Liffey, Lee, Shannon and Erne). The Standing Scientific Committee of the National Salmon Commission have classified these rivers as non-self sustaining and these rivers are significantly below their salmon conservation limits. Plans have being drawn up to address both upstream and downstream fish passage issues on these rivers and salmon stock restoration plans have recently been prepared and published for the Shannon, Erne and Lee, (See Section 6 below).

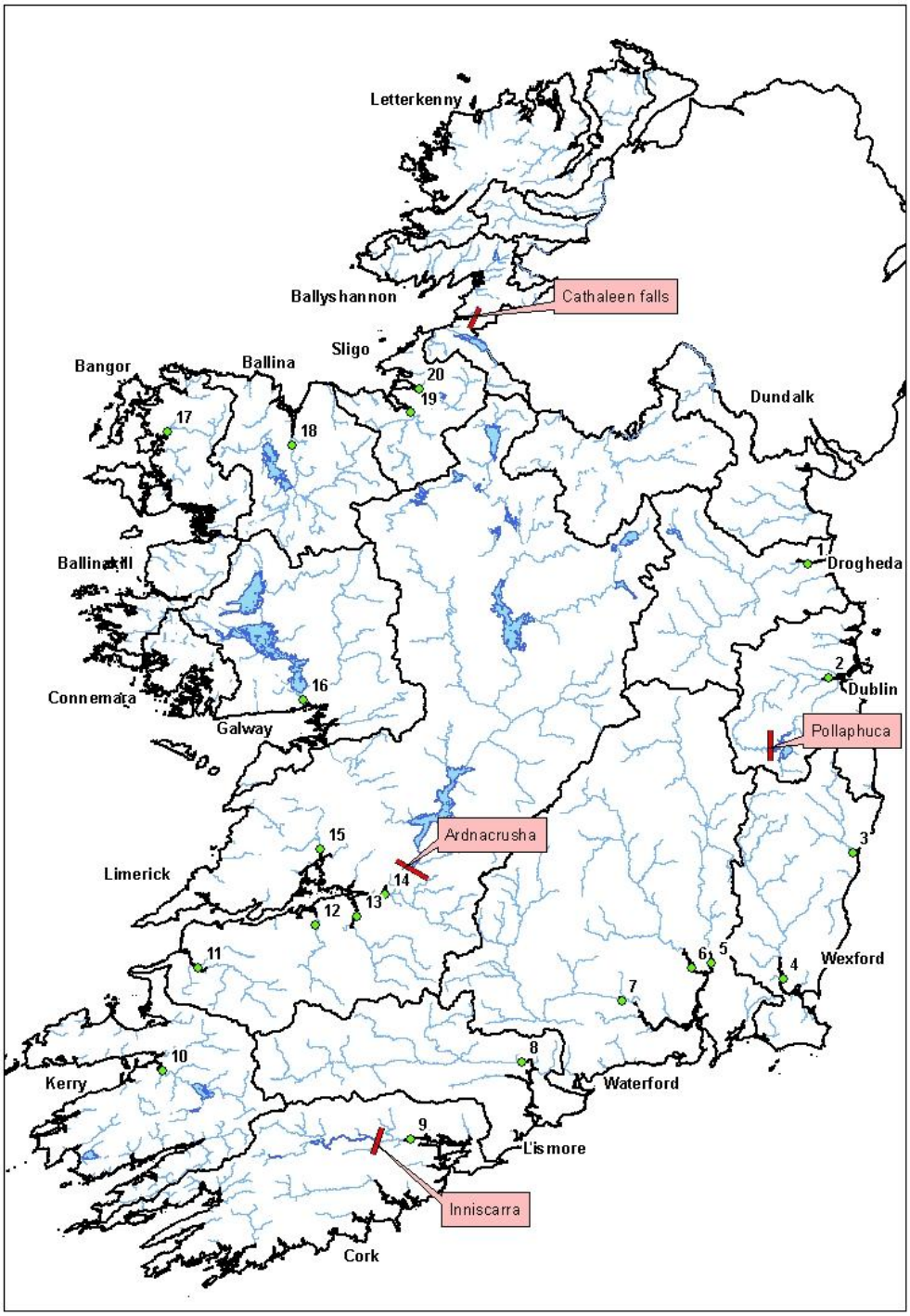


Figure 3. Map of the 17 Irish Fisheries Districts showing the location of the principal salmon rivers (only 5th order or higher tributaries shown) within each District.

Key: Red lines on four rivers (Liffey, Lee, Shannon & Erne) refer to hydroelectric dams above which salmon populations are considered not self-sustaining. Rivers marked 1 to 20 are the 20 rivers with the greatest quantity of habitat accessible to salmon. These rivers are: (1) Boyne, (2) Liffey, (3) Avoca, (4) Slaney, (5) Barrow, (6) Nore, (7) Suir (8) Blackwater, (9) Bandon, (10) Laune, (11) Feale, (12) Deel, (13) Maigue, (14) Shannon, (15) Fergus, (16) Corrib, (17) Owenmore, (18) Moy, (19) Ballysadare & (20) Garvogue.

Quality of Salmon Habitat

Habitat Quality

The quality of salmon habitat in terms of its capacity to produce juvenile salmon has been studied by Amiro (1993). Habitat is divided into eleven gradient classes, with Amiro class 1 being very low gradient (≤0.5%) and Amiro class 11 being very high gradient (>5%). Medium gradient (classes 4, 5, 6) has been shown to be potentially the habitat with the best capacity for the production of juvenile salmon.

Accessible fluvial habitat (wetted area) was categorised using the eleven-class Amiro classification system. Habitat in each Fisheries District was divided into three categories, low gradient (Amiro classes 1, 2 & 3), medium gradient (Amiro classes 4, 5 & 6) and high gradient (Amiro classes 7, 8, 9, 10 & 11) and expressed as a percentage of total available habitat nationally. 81.9% of accessible fluvial habitat was classified as low gradient, 8.35% as medium gradient and 9.74% as high gradient (Figure 4). The Waterford, Limerick and Kerry Districts have the largest quantity of accessible medium gradient habitat nationally indicating a higher potential for the production of juvenile salmon compared to other Districts, (fig 4). The Waterford District also has the greatest quantity of accessible fluvial habitat.

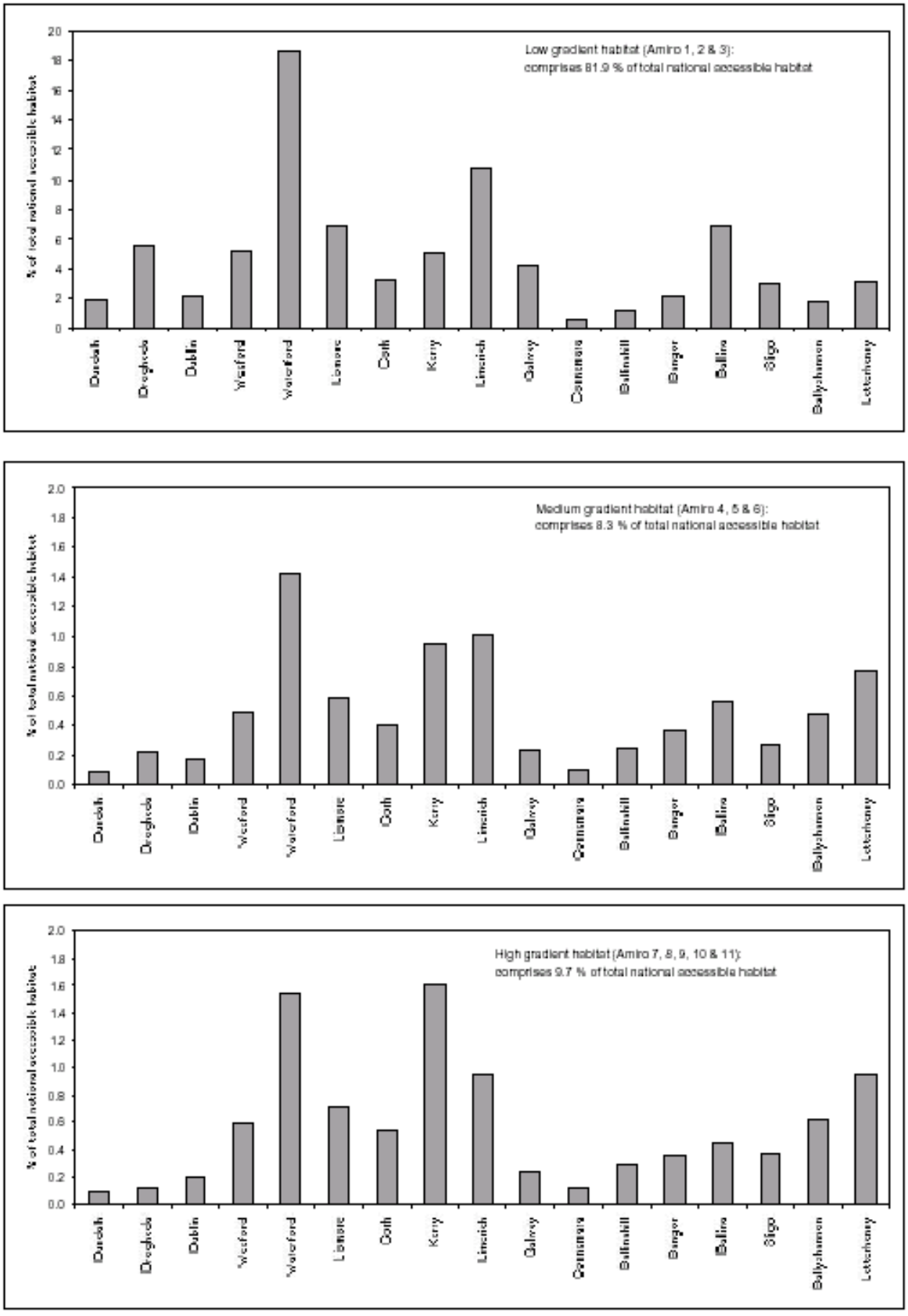


Figure 4. The percentages of low (upper figure), medium (middle figure), and high gradient habitat (lower figure), expressed as a percentage of total national accessible fluvial habitat.

Water Quality

Water quality from > 3,000 riverine locations, many of which are salmon bearing waters, are monitored, once every three years on a rotational basis, by the Environmental Protection Agency (EPA) using a macro-invertebrate index system. The EPA Q values are a biological water quality rating system developed for assessment of water quality in Irish rivers (Mc Garrigle *et al*., 2002).

A Q value of between 1 and 5 is assigned to each site on each sampling occasion. A score of 5 represents pristine conditions with a score of 1 illustrating grossly polluted conditions. A recent Irish study (Kelly *et al*, 2007) has shown that unless Q values are ≥ 3/4, then the river reach cannot support significant juvenile salmon numbers (Fig 5). 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 > Q3-4. The value of these data in identifying salmon riverine zones with water quality issues is self evident.

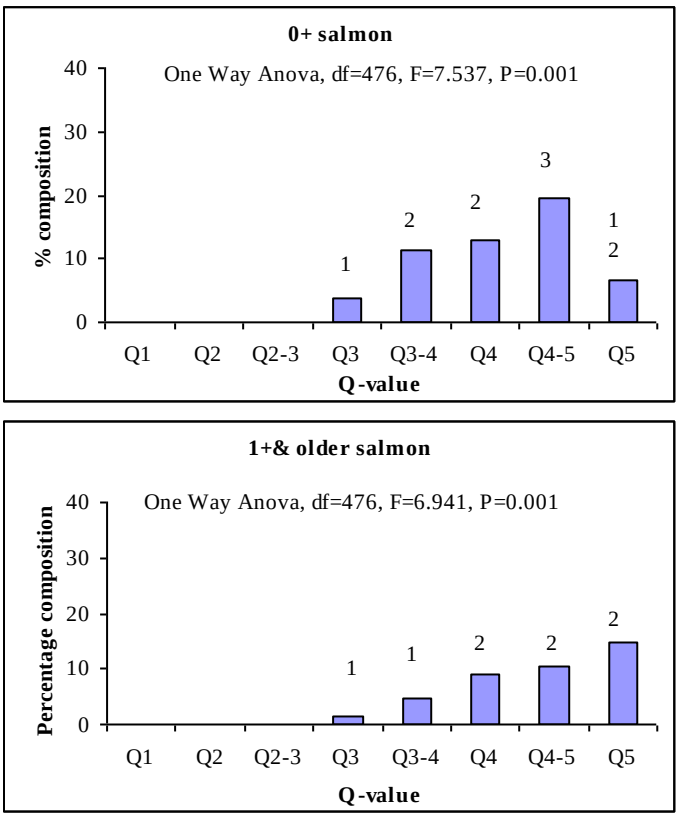


Fig. 5. Percentage composition of juvenile salmon in relation to water quality as indicated by Q-values. (From Kelly *et al*, 2007).

EPA Q value data are summarised in a national review of water quality in Ireland which is presented tri-annually by the Environmental Protection Agency (EPA). In the period 2004–2006, some 13,240 km of river channel was surveyed and this provides an overview of the status of the larger rivers and streams, (EPA, 2008).

Long-term trends demonstrated that the percentage of unpolluted channel fell steadily from 77% to 67% during the period 1987 to 1997 (Figure 6), and this decline was accompanied by an increase in instances of slight and moderate pollution. Subsequently, for the 1998 – 2000 period, an increase in unpolluted channel water quality (70%) was evident. This fell slightly again in the 2001–2003 period (69.2%). The most recent survey period (2004-2006) highlighted a 2% increase in unpolluted channel (71.4%).

Municipal and agricultural sources have been identified as the principal attributable causes of water pollution, by EPA, over this period, (Fig 7).

Figure 6. Long-Term River Water Quality Trends (13,240 km baseline) (Source: Clabby *et al*., 2008) Class A (unpolluted), Class B (slightly polluted), Class C (moderately polluted) and Class D (seriously polluted)

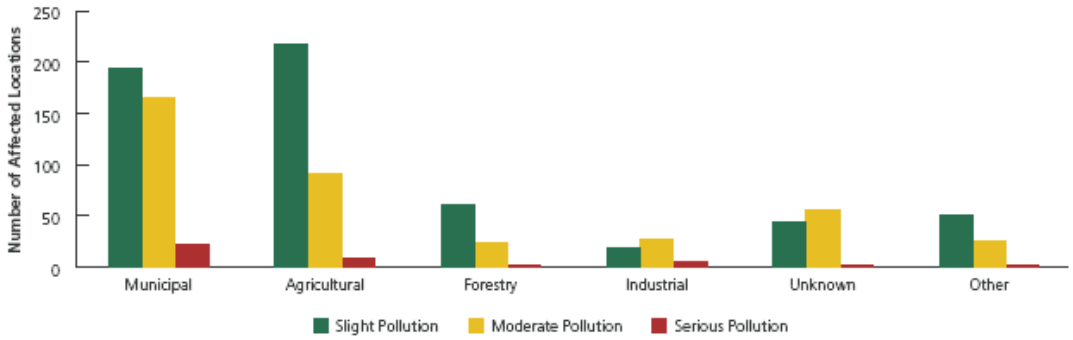


Figure 7. Suspected Sources of River Pollution Recorded in 2004–2006 (Source: Clabby *et al*., 2008)

Data on the proportion of impaired habitat from a water quality perspective in each Fishery District (McGinnity *et al*, 2003) is presented (Fig 8). Nationally, 4.5% of accessible habitat in salmon systems was moderately to severely polluted (≤ Q3) and thus not considered available for juvenile salmon production while 12.8% of accessible habitat was slightly polluted (Q3/4) but still considered to be capable of maintaining juvenile salmon. Rivers in Districts along the East and Southeast coast had the highest proportion of moderately to severely polluted waters and also of slightly polluted waters. Similar quantitative data on water quality on a Fishery District basis has not been compiled since the publication of the Wetted Area Report in 2003.

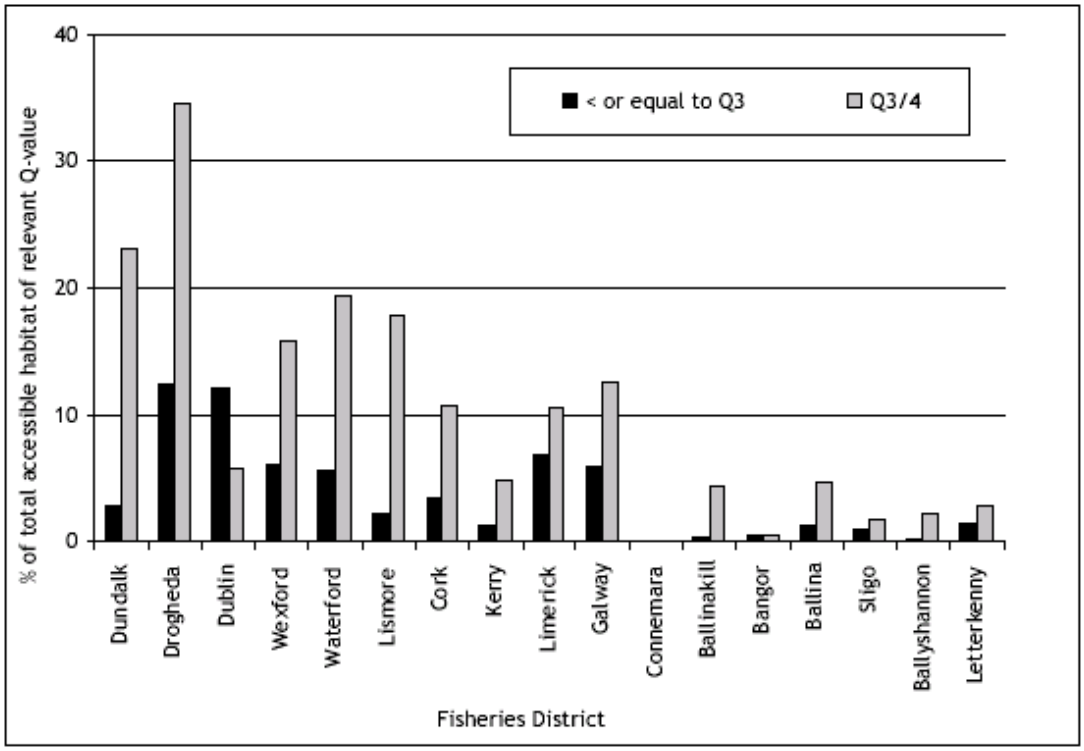
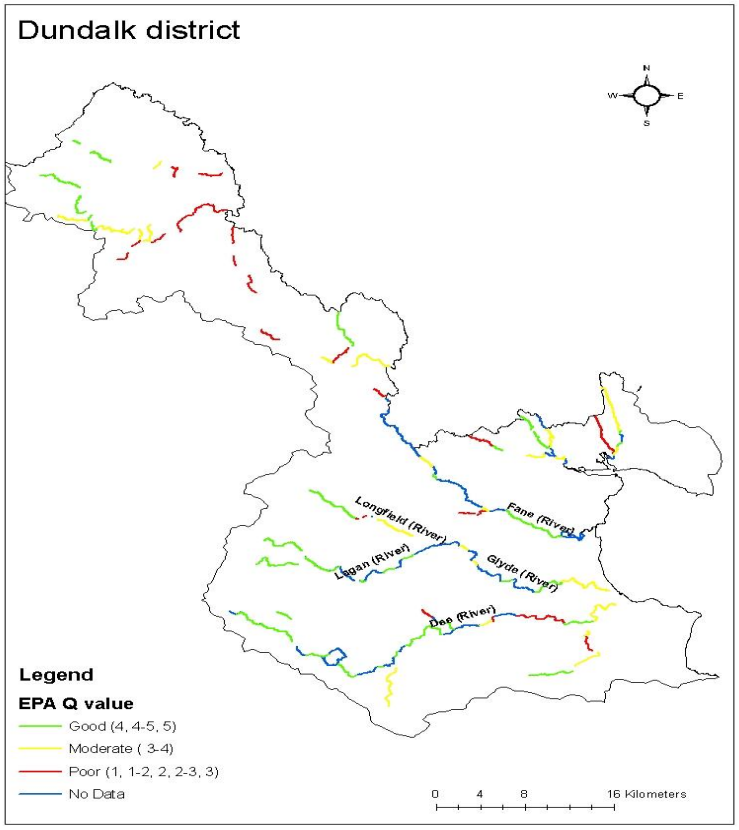


Figure 8. The proportions (%) of accessible riverine habitat with biological quality ratings of: (a) ≤ Q3 (moderately to severely polluted) shown as open bars; and (b) Q3/4 (slightly polluted) shown as solid bars; on a District basis.



Water quality data based on the EPA Q Value assessment is available for each of Irelands 148 salmon rivers. An example of the water quality data available for three salmon rivers in the Dundalk District is presented in graphical representation (fig 9).

Fig 9. Q Value data for Salmon Rivers in the Dundalk District.

3. Process for identifying and designating priority/key habitat areas and issues to be addressed

There are a number of means by which habitat issues are identified and habitat rehabilitation plans are drawn up for salmon rivers in Ireland.

1. Salmonid River Surveys

Extensive, detailed morphological and ecological surveys of many of Ireland's salmonid rivers have been carried out, for different purposes, by the Central and Regional Fisheries Boards, over the past decade. Many have resulted in river rehabilitation plans being prepared. Some of these surveys take place in conjunction with County Councils and other State bodies.

2. Salmon Conservation Stamp Funding

While this funding source is known colloquially as a conservation stamp, legally it is a component of the salmon licence fee, the proceeds of which are dedicated, on foot of a ministerial direction to the fisheries boards, to investment in salmon stock and habitat rehabilitation.

A salmon conservation stamp has been applied to all salmon rod licences and commercial salmon fishing licences since 2007. The salmon conservation stamp applied is equivalent to and additional to the licence fee in each category.

The revenue generated from the salmon conservation stamp is being reinvested in salmon stock rehabilitation and habitat improvement and will be ring-fenced and designated for the purpose of prioritised investment in salmon conservation initiatives. Funding is allocated to rehabilitate salmon rivers which are below their conservation limit and have the greatest prospect of recovery. Remedial works are proposed by the Regional Fisheries Boards for rivers where maximum benefit can be expected to accrue. The type of works funded to date include rehabilitation of degraded habitat, input of spawning gravels, shrub clearance, and provision of fish passes. For further detail see Section 6.

3. Catchment Wide Electro-fishing

Catchment-wide electro-fishing surveys are undertaken in approximately fifty salmon catchments annually by CFB/RFB teams. Data are generated on the abundance and distribution of juvenile salmon in catchments and the results are being compiled to help determine if salmon rivers are meeting salmon conservation limits. Catchment-wide electro-fishing is also important in providing managers with information on the distribution and abundance of salmon fry. The absence or low density of salmon fry may be related to water quality issues, obstructions, or habitat damage and areas of low abundance can be investigated. This has lead to habitat plans being drawn up for locations where low densities of juvenile salmon have indicated habitat problems exist.

4. Rehabilitation of Salmon Rivers above Hydro-Electric Dams

The Electricity Supply Board (ESB) manage the fisheries on Ireland's five hydro-electric rivers. As part of their responsibility to rehabilitate the salmon stock in these rivers, the ESB have embarked on a habitat rehabilitation programme. (See Section 6 for more detail).

5. Programme for Rehabilitation of Drained Rivers

Many of Irelands salmon rivers have been subjected to arterial drainage since the 1840s. Research has shown that drainage has reduced the capacity of many of these channels to produce salmon, (O'Grady, 2002). The Office of Public Works (OPW), who has responsibility for drained rivers, has embarked on a programme to restore these catchments. As part of their responsibility in such channels, and for the implementation of the WFD requirements, the OPW have contracted the CFB to carry out a programme of works that will address the negative impacts that drainage works have had on many Irish rivers. This programme will also continue to develop and implement an environmental approach to regular channel maintenance work, which the OPW undertake annually. The key areas within these catchments, requiring enhancement designed to increase salmon production have been identified and prioritized for works. (See Section 6 for more detail).

6. Aerial Photography Database

A high quality aerial photographic series of the majority of salmon rivers in Ireland, collected in the course of low level flights, is being compiled by CFB. These are, and will continue to be used to identify the location and extent of habitat imbalances in Ireland's salmon rivers. Overgrazing by sheep, in a discrete geographical area in the north-west of Ireland, has caused serious morphological damage to salmon rivers. The range and extent of the damage has been quantified by aerial photography. The Programme of Measures (POMS) National Committee have been informed of the extent of the damage and the necessity, under the terms of the Water Framework Directive, to repair same.

7. Water Framework Directive River Monitoring

Monitoring of fish stocks, invertebrates, water chemistry, macrophytes and morphology takes place at 179 WFD surveillance monitoring river sites every three years. The WFD monitoring programme will assign ecological status to each water body. This will be based on water quality, the presence and abundance of fish species, river morphology etc. Any water body classified as less than good status has to have remedial measures drawn up through the Programme of Measures (POMS). These were published through the River Basin District management plans in December 2008.

8. Programme of Measures under Water Framework Directive

The aim of the Water Framework Directive is to prevent any deterioration in the existing status of our waters, including the protection of good and high status where it exists, and to ensure that all waters are restored to at least good status by 2015.

These aims will be achieved through the implementation of River Basin Management Plans (RBMP). A key element of the RBMPs is a programme of measures (POMs) for each river basin district. POMs outlines the most cost effective management measures and their application within the basin to meet the multiple objectives set to obtain good ecological status. The measures aim to remedy conflicts between economic benefits from water use and associated contamination. Programmes of measures must be implemented by 2012. All of the environmental problems affecting rivers will be considered to formulate proactive Government policy to address the requirements of

the Water Framework Directive in relation to riverine morphological imbalances. This policy, when implemented, will be of major benefit to Irish salmon stocks.

9. Monitoring for Habitats Directive Fish Species

Funding has been allocated to meet the monitoring requirements of Annex II fish species (salmon, lamprey, shad, pollan) under Habitats Directive requirements. This monitoring programme will assist in the identification of impacted salmon habitat.

10. Fishery Owners / Angling Clubs

Fishery owners and angling clubs, who own or lease fisheries, undertake rehabilitation work on salmon rivers nationally. The work normally involves raking of spawning gravels, input of new gravels, tree pruning, bank clearance, fencing etc and is undertaken in consultation with Regional Fisheries Board staff.

11. NRFB Salmon Rivers Programme

The Northern Regional Fisheries Board (NRFB) has embarked on a salmon river rehabilitation programme over the past three years on 10 major salmon rivers within its remit. Electro-fishing was undertaken to establish current juvenile salmon production and habitat surveys and aerial photography surveys were conducted. The objective was to increase production of juvenile salmon, where feasible, by implementation of habitat rehabilitation programmes.

12. Mitigation for Infrastructural Programmes

As the Irish economy has been developing over the past twenty years, infrastructure has improved with increases in the extent and quality of the road network and other utilities including water supplies, and gas pipelines. Infrastructural change has led to different scales of disruption to salmon rivers and through the consultative and planning process mitigatory or ‘like for like replacement’ measures have been agreed and implemented. In isolated cases, where serious pollution or fish kills have occurred through attributable discharges, some channel rehabilitation works have been carried out to enhance the existing habitat and attempt to accelerate natural recolonisation rather than restocking.

13. Preparation of River Management Plans

Since the change in salmon management introduced in 2007 to comply with scientific advice, salmon stocks are being managed on an individual river basis with the objective of achieving river specific conservation limits. As part of this initiative, River Management Plans are being prepared for each salmon river (as required in the NASCO Implementation Plan) and the threats to individual river habitat will be identified.

Each of the programmes outlined above contribute to the development of habitat rehabilitation plans for Irish salmon rivers.

4. Activities and approaches used to share and exchange information on habitat issues, and best management practices, between relevant bodies within the jurisdiction.

Section 3 above sets out the many routes by which river habitat rehabilitation plans are formulated. Since the 1970s, Fisheries agencies have been working with other authorities, Dept of Environment Heritage and Local Government (DOEHLG), Dept of Agriculture, Fisheries and Food (DAFF), Environmental Protection Agency, Office of Public Works, National Parks & Wildlife Service, Marine Institute, etc) to advise and reduce the impacts of the various land use practices on waters and river habitat. Following the implementation of the Water Framework Directive and the formation of River Basin District management structures, a collective approach to reducing all adverse impacts on aquatic resources is now in place. Having characterised the risks posed to water-bodies nationally, Programmes of Measures are being developed to address habitat impacts / land use practices and to restore impaired water bodies to good status. Monitoring of water bodies for all biological and hydro-morphological elements has commenced.

A Strategic Environmental Assessment (SEA) is underway for all river basin districts. The Fisheries Boards participates in this process and represents inland fisheries interests on the SEA committee to evaluate any potential environmental impact of plans forwarded by river basin districts. An inter-agency SEA steering group is also in place with inland fisheries representation.

A variety of national committees and working groups have been set up to oversee and advance a wide range of tasks essential to the successful delivery of the administrative and operational aspects of the WFD (Appendix 3). The administration of the day to day operations is the responsibility of River Basin Districts (RBDs). Ireland has four RBDs and three International RBDs (IRBDs). Six RBD Projects financed by the DEHLG (each under a lead local authority, to which consultants have been appointed) are delivering the major requirements of the WFD. Each RBD has a River Basin Management Group and this is overseen by a separate RBD Steering Committee (the SCs will end with the termination of the RBD Projects in 2008). Advisory Councils have recently been set up in accordance with S.I. 722/2003 and these also have Technical sub-committees. Staff of the Central Fisheries Board, and each RBD, participate on some or all of these National and Regional committees and working groups (Appendix 4) to assist with the integrated and timely advancement of the programme and specifically to provide the necessary advice and assistance on fisheries and related matters.

The four RBDs referred to above are located entirely within Ireland and the three IRBDs are shared with Northern Ireland. The WFD is being advanced in the North South Shared Aquatic Resources Area through the N/S SHARE project.

Fisheries Boards undertake collaborative projects with other agencies with regard to habitat and fisheries. Some examples are;

- Quantification of the Freshwater Salmon Habitat Asset in Ireland with Environmental Protection Agency

- Hydromorphology Study of Irish Rivers with EPA, Shannon International River Basin District
- Study of Barriers to Fish Migration with Shannon RBD, Southern Regional Fisheries Board
- Assessment of the Status of Annex II listed fish species in Ireland with Department of Environment Heritage and Local Government
- Assessment of the EPA Q Value system and its relationship with the presence of freshwater fish, with EPA
- Establishment of the Genetic Baseline of Irish Salmon Populations with Marine Institute
- Experimental Drainage Maintenance Programme to improve fisheries habitat on rivers with the Office of Public Works
- Training of staff from a range of State Agencies in habitat enhancement techniques

Fisheries Board staff have ongoing discussion and interaction with a range of State Agencies with regard to habitat issues and best management practice. Staff have contributed to the preparation of guidelines relating to forestry development and protection of fisheries and habitat, the Rural Environmental Protection Scheme and fisheries, best practice guidelines for establishment of riparian zones along river, etc.

The Central Fisheries Board (Dr Martin O'Grady) has published a training manual on habitat enhancement and numerous conferences have been held on protection and rehabilitation of freshwater habitat.

5. Description of Plans: Describe Work being undertaken and/or planned to establish comprehensive salmon habitat protection, restoration, and enhancement plans,

Table 4 sets out work undertaken in the recent past or planned to be undertaken in 58 Irish salmon rivers nationally. The body undertaking the habitat work is listed and the type of habitat work undertaken is set out. The work being undertaken includes improvement in fish passage, addition and upkeep of spawning beds, rehabilitation of drained channels, addition of instream structures to increase stream diversity, bank stabilisation. A full description of the major work programmes is given in Section 6.

Table 4. Ongoing Programme of Habitat rehabilitation on Irish salmon Rivers

River	Fisheries District	Nature of Habitat rehabilitation Works: Fish Passage Improvement	Bank Protection / Stabilisation	Restoration of Degraded Habitat	Tree Pruning	Fencing	Bankside Willow Planting	Creation of Additional Spawning	Raking Spawning Gravels	Input of Spawning Gravels	Smolt passage Diversion	Addition of Structures to Create Habitat	Rehabilitation of Drained Channels	Flood Rehabilitation Works	Body Undertaking Works
Flurry	Dundalk			√		√			√						Fisheries Board
Castletown	Dundalk								√						Angling Club, Fisheries Board
Fane	Dundalk		√						√						Fishery Board, FCB
Glyde	Dundalk								√		√	√			OPW Re-Hab, Fisheries Board
Dee	Dundalk	√										√			CS 2008, OPW Re-Hab
Boyne	Drogheda			√								√			CS 2007, OPW Re-Hab
Liffey	Dublin						√	√		√					CS 2007, ERFB, DCC, KCC, ESB
Dargle	Dublin	√					√				√				CS 2007
Vartry	Dublin								√						CS 2007
Avoca	Wexford									√					CS 2007
Owenavorragh	Wexford			√								√			OPW Re-Hab
Slaney	Wexford	√	√												CS 2007 & 2008, SRT, WCC
Owenduff	Waterford				√										Angling Club
Pollmounty	Waterford	√													2007 fish farm owner
Barrow	Waterford		√		√			√							CS 2008
Nore	Waterford	√	√		√										CS 2008, SRFB, angling clubs
Suir	Waterford	√		√	√									√	CS 2007, SRFB,
Clodiagh	Waterford	√	√												Fisheries Board
Glenshelane	Lismore	√													SRFB 2008
Blackwater	Lismore		√				√					√			CS 2007,OPW Re-Hab 2008
Blackwater	Kerry		√												CS 2007
Laune	Kerry		√												Fisheries Board
Deel	Limerick											√			OPW Re-Hab
Maigue	Limerick			√								√			CS 2007, OPW Re-Hab
Annageeragh	Limerick	√													CS 2007
Kilcolgan	Galway						√				√				CS 2007 & CS 2008
Corrib	Galway											√			OPW Re-Hab
Cashla	Connemara						√								CS 2007
Screeb	Connemara						√								CS 2007
Owenmore	Connemara		√			√			√						CS 2007
Dawros	Ballinakill										√				Fishery Owner
Culfin	Ballinakill						√								Fisheries Board
Erriff	Ballinakill		√												CS 2007
Carrownisky	Ballinakill		√												CS 2007
Bunowen	Ballinakill		√				√								CS 2008
Owenwee	Ballinakill				√										CS 2007
Newport	Bangor				√										CS 2007, Fisheries Board
Owenmore	Bangor		√												Fishery Board, Angling Club
Glenamoy	Bangor		√	√				√							CS 2008
Ballinglen	Ballina						√		√						Fisheries Board
Cloonaghmore	Ballina				√		√		√						Fisheries Board
Moy	Ballina											√			OPW Re-Hab
Easky	Ballina				√										Fisheries Board
Ballysadare	Sligo		√		√	√			√						Fishery owner
Garvogue	Sligo		√		√	√			√			√			OPW Re-Hab, CS 2007
Drumcliff	Sligo		√		√	√			√						Fisheries Board
Grange	Sligo		√												Fisheries Board
Duff	Ballyshannon											√			OPW Re-Hab
Drowes	Ballyshannon	√			√				√						Fisheries Board
Erne	Ballyshannon	√													Electricity Supply Board
Eske	Ballyshannon		√		√	√					√				CS 2007, NRFB
Glen	Ballyshannon		√			√									CS 2007
Owentocker	Letterkenny		√												Donegal County Council
Gweebarra	Letterkenny		√			√	√								CS 2007
Owennamarve	Letterkenny								√						Angling Club
Clady	Letterkenny		√												CS 2007
Lackagh	Letterkenny		√		√						√				CS 2007 & 2008
Glennagannon	Letterkenny				√										CS 2008

CS 2007	**Project funded under the Conservation Stamp programme 2007**
CS 2008	**Project funded under the Conservation Stamp programme 2008**
OPW RE-HAB	**Office of Public Works Re-habilitation of Drained Rivers programme**

5 A. Describe the extent to which these plans - identify Impacts and Potential Risks to Productive Capacity:

Table 5 sets out the impacts and potential risks for each of Irelands 148 salmon rivers in twenty principal categories.

Table 5. Impacts and Potential Risks to Productive Capacity of Salmon Rivers

Fisheries District	River	Agricultural enrichment	Afforestation	Artificial barriers / fish passage problems	Bank erosion / braiding	Drainage / channel modification	Fish farming - freshwater	Fish farming - marine	Flash flooding / excessive substrate displacement	Gravel removal	Hydropower	Inadequate sewage treatment	Industrial discharges	Overgrazing/bank trampling/riparian damage	Peat harvesting/other siltation	Quarrying/Suspended solids run-off	Urbanisation/road development /Siltation	Water abstraction	Tunneling	Invasive species	Wind Farm development impact / landslides
Dundalk	Flurry	*			*							*					*				
Dundalk	Castletown	*														*					
Dundalk	Fane	*																*			
Dundalk	Glyde	*				*						*					*	*			
Dundalk	Dee	*				*												*			
Drogheda	Boyne	*				*						*	*			*	*	*			
Dublin	Liffey	*		*							*	*	*				*	*			
Dublin	Dargle		*		*				*												
Dublin	Vartry			*								*						*			
Wexford	Avoca		*				*						*								
Wexford	Owenavorragh	*				*											*				
Wexford	Slaney	*	*								*		*			*		*			
Waterford	Corock	*												*			*				
Waterford	Owenduff	*																			
Waterford	Pollmounty	*	*	*			*											*			
Waterford	Barrow	*	*			*			*			*	*	*			*	*			
Waterford	Nore	*	*	*	*	*	*			*		*		*				*			
Waterford	Black Water	*		*								*									
Waterford	Lingaun		*	*	*									*				*			
Waterford	Suir	*	*	*	*				*			*	*	*			*				
Waterford	Clodiagh	*	*															*			
Waterford	Mahon		*															*			
Waterford	Tay		*																		
Waterford	Colligan		*																		
Lismore	Licky		*																*		
Lismore	Finisk	*	*																*		
Lismore	Glenshelane		*									*							*		
Lismore	Blackwater	*	*	*	*	*			*					*		*					
Lismore	Bride	*										*							*	*	
Lismore	Tourig	*																	*		
Lismore	Womanagh	*	*										*					*	*		

Table 5 (cont). Impacts and Potential Risks to Productive Capacity of Salmon Rivers

Fisheries District	River	Agricultural enrichment	Afforestation	Artificial barriers / fish passage problems	Bank erosion / braiding	Drainage / channel modification	Fish farming - freshwater	Fish farming - marine	Flash flooding / excessive substrate displacement	Gravel removal	Hydropower	Inadequate sewage treatment	Industrial discharges	Overgrazing/bank trampling/riparian damage	Peat harvesting/other siltation	Quarrying/Suspended solids run-off	Urbanisation/road development	Water abstraction	Tunneling	Invasive species	Wind Farm development impact / landslides
Cork	Owenacurra	*	*																		
Cork	Lee	*		*							*							*			
Cork	Bandon	*	*		*	*			*	*		*	*	*		*					
Cork	Ardigeen	*			*	*															
Cork	Ilen				*	*			*	*				*		*					
Cork	Mealagh												*								
Cork	Owvane				*	*		*	*					*							
Cork	Coomhola							*													
Cork	Glengarriff		*					*	*												
Cork	Ardrigole		*			*					*										
Kerry	Kealincha		*	*		*		*		*											
Kerry	Lough Fadda							*													
Kerry	Croanshagh	*					*	*													
Kerry	Owenshagh							*											*		
Kerry	Cloonee		*			*		*													
Kerry	Sheen		*		*			*		*	*										
Kerry	Roughty	*	*		*						*										*
Kerry	Finnihy															*			*		
Kerry	Blackwater				*																
Kerry	Sneem		*					*		*											
Kerry	Owreagh		*																		
Kerry	Currane		*																		
Kerry	Inny		*																		
Kerry	Emlaghmore																				
Kerry	Carhan									*								*			
Kerry	Ferta						*														
Kerry	Behy																				
Kerry	Caragh																				
Kerry	Cottoners				*					*											
Kerry	Laune	*	*	*	*	*				*		*		*		*	*	*			
Kerry	Maine			*	*	*				*			*			*	*				
Kerry	Emlagh				*	*								*							
Kerry	Owenascaul	*	*		*																

Table 5 (cont). Impacts and Potential Risks to Productive Capacity of Salmon Rivers

Fisheries District	River	Agricultural enrichment	Afforestation	Artificial barriers / fish passage problems	Bank erosion / braiding	Drainage / channel modification	Fish farming - freshwater	Fish farming - marine	Flash flooding / excessive substrate displacement	Gravel removal	Hydropower	Inadequate sewage treatment	Industrial discharges	Overgrazing/bank trampling/riparian damage	Peat harvesting/other siltation	Quarrying/Suspended solids run-off	Urbanisation/road development	Water abstraction	Tunneling	Invasive species	Wind Farm development impact / landslides
Kerry	Milltown				*																
Kerry	Feohanagh									*											
Kerry	Owenmore		*		*										*						
Kerry	Lee	*	*	*	*	*				*		*		*			*		*		*
Limerick	Brick	*										*									
Limerick	Feale	*	*		*				*	*		*	*	*		*		*			*
Limerick	Galey	*	*		*				*	*		*									
Limerick	Deel	*	*			*						*	*					*			
Limerick	Maigue	*	*		*	*						*									
Limerick	Shannon	*	*	*		*	*		*	*	*	*	*	*	*	*	*	*			*
Limerick	Owenagarney		*		*							*		*		*					
Limerick	Fergus			*								*				*	*				
Limerick	Doonbeg											*									
Limerick	Skivileen											*									
Limerick	Annageeragh			*					*			*									
Limerick	Inagh		*			*					*										
Limerick	Aughyvackeen																				
Galway	Aille											*									
Galway	Kilcolgan	*	*			*						*					*				
Galway	Clarinbridge	*				*						*					*				
Galway	Corrib	*	*			*						*					*				
Galway	Knock																				
Galway	Owenboliska		*															*			*
Connemara	Cashla		*													*		*			
Connemara	L. Nafurnac							*													
Connemara	Screeb		*					*							*						
Connemara	Owenmore		*					*						*							
Ballinakill	Owenglin		*					*									*				
Ballinakill	Dawros							*													
Ballinakill	Culfin		*				*	*						*							
Ballinakill	Erriff		*					*						*		*					
Ballinakill	Bundorragha		*					*				*		*							
Ballinakill	Carrownisky	*			*									*							

Table 5 (cont). Impacts and Potential Risks to Productive Capacity of Salmon Rivers

Fisheries District	River	Agricultural enrichment	Afforestation	Artificial barriers / fish passage problems	Bank erosion / braiding	Drainage / channel modification	Fish farming - freshwater	Fish farming - marine	Flash flooding / excessive substrate displacement	Gravel removal	Hydropower	Inadequate sewage treatment	Industrial discharges	Overgrazing/bank trampling/riparian damage	Peat harvesting/other siltation	Quarrying/Suspended solids run-off	Urbanisation/road development	Water abstraction	Tunneling	Invasive species	Wind Farm development impact / landslides
Ballinakill	Bunowen	*	*		*			*				*		*							
Ballinakill	Owenwee		*					*							*						
Bangor	Newport	*	*					*										*	*		
Bangor	Srahmore		*					*													
Bangor	Owengarve		*					*													
Bangor	Owenduff																				
Bangor	Owenmore	*	*														*				
Bangor	Glenamoy	*	*															*			
Bangor	Muingnabo		*																		
Ballina	Ballinglen	*	*												*		*				
Ballina	Cloonaghmore	*																			
Ballina	Moy	*	*			*						*	*								
Ballina	Brusna	*	*																		
Ballina	Leaffony	*																			
Ballina	Easky		*												*						
Sligo	Ballysadare		*		*						*	*									*
Sligo	Garvogue	*				*											*				*
Sligo	Drumcliff		*											*			*				
Sligo	Grange											*	*	*			*	*			
Ballyshannon	Duff			*		*				*											
Ballyshannon	Drowes		*									*									
Ballyshannon	Erne	*									*	*	*				*				
Ballyshannon	Abbey	*														*					
Ballyshannon	Ballintra		*									*								*	
Ballyshannon	Laghy	*																			
Ballyshannon	Eske	*	*								*	*					*				
Ballyshannon	Eany		*					*									*				
Ballyshannon	Oily							*		*							*				
Ballyshannon	Bungosteen																		*		
Ballyshannon	Glen					*							*					*			
Ballyshannon	Owenwee		*											*	*						
Letterkenny	Bracky									*											
Letterkenny	Owentocker	*	*							*											

Table 5 (cont). Impacts and Potential Risks to Productive Capacity of Salmon Rivers

Fisheries District	River	Agricultural enrichment	Afforestation	Artificial barriers / fish passage problems	Bank erosion / braiding	Drainage / channel modification	Fish farming - freshwater	Fish farming - marine	Flash flooding / excessive substrate displacement	Gravel removal	Hydropower	Inadequate sewage treatment	Industrial discharges	Overgrazing/bank trampling/riparian damage	Peat harvesting/other siltation	Quarrying/Suspended solids run-off	Urbanisation/road development	Water abstraction	Tunneling	Invasive species	Wind Farm development impact / landslides
Letterkenny	Owenea		*									*									
Letterkenny	Gweebarra				*																
Letterkenny	Owennamarve																				
Letterkenny	Gweedore																				
Letterkenny	Clady										*										
Letterkenny	Glenna											*					*				
Letterkenny	Tullaghobegly						*										*				
Letterkenny	Ray															*					
Letterkenny	Lackagh											*									
Letterkenny	Leannan	*	*					*				*									
Letterkenny	Swilly	*	*									*									
Letterkenny	Isle (Burn)	*				*															
Letterkenny	Mill																				
Letterkenny	Crana		*	*				*									*				
Letterkenny	Clonmany	*	*			*															
Letterkenny	Straid	*																			
Letterkenny	Donagh																				
Letterkenny	Glennagannon	*				*				*											
Letterkenny	Culoort	*			*																

Table 5 was first prepared in 2004 in consultation with Regional Fisheries Board throughout Ireland's 17 Fishery Districts and has been updated since it was initially presented, (NASCO 2005, CNL (05) 45). Several habitat impacts may prevail in any single salmon river. Habitat impacts prevailing in 2004 are compared with current impacts and presented in Table 6 & Fig 10 for comparison. The habitat impact information from 2004 indicated that agricultural enrichment, forestry related pressures and poor water quality resulting from inadequate sewage treatment were the major pressures affecting Irish salmon rivers. The 2008 assessment reveals that these three impacts remain the most significant affecting salmon habitat on a national basis. Municipal (including inadequate sewage treatment) and agricultural sources were also identified as the principal attributable causes of water pollution, by the EPA, (see Fig 7 earlier). Significantly, the number of rivers where these three impacts are recorded

as habitat impacts has increased over the four year period. It is felt that the level of reporting of habitat impacts has increased on an individual river basis since the first report in 2004 suggesting that the full range of impacts may have been under-reported in the first assessment.

Table 6. Comparison of Habitat Impact on Salmon Catchments 2004 & 2008

Habitat Impact	2004	2008	% change
Water Abstraction	10	26	160
Urbanisation / Road Development	24	29	21
Quarrying / Suspended Solids Runoff	8	17	113
Peat Harvesting / other Siltation	8	7	-13
Overgrazing / Bank Trampling / Riparian damage	24	24	0
Industrial Discharges	16	17	6
Inadequate Sewage Treatment	**30**	**43**	**43**
Hydropower	10	12	20
Gravel removal	12	20	67
Flash Flooding / Excessive Substrate Displacement	5	12	140
Fish Farming / Marine	24	27	13
Fish Farming / Freshwater	5	8	60
Drainage/ Channel Modification	23	32	39
Bank Erosion / Braiding	13	30	131
Artificial Barriers / Fish passage problems	10	18	80
Afforestation	**49**	**75**	**53**
Agricultural Enrichment	**56**	**63**	**13**
Tunnelling (loss of primary production)		11	
Invasive Species		2	
Development of Wind Farms / Landslides		7	

The incidence of water abstraction, quarrying / suspended solids runoff, gravel removal, and bank erosion increased on rivers nationally since 2004. A number of habitat impacts were recorded at a similar level to that in the first assessment in 2004, including peat harvesting impacts, overgrazing, industrial discharges and fish farming.

New habitat impacts which have been identified since the first review in 2004 were loss of production through the shading effects of tree cover (tunnelling), invasive species and wind farm development / landslides.

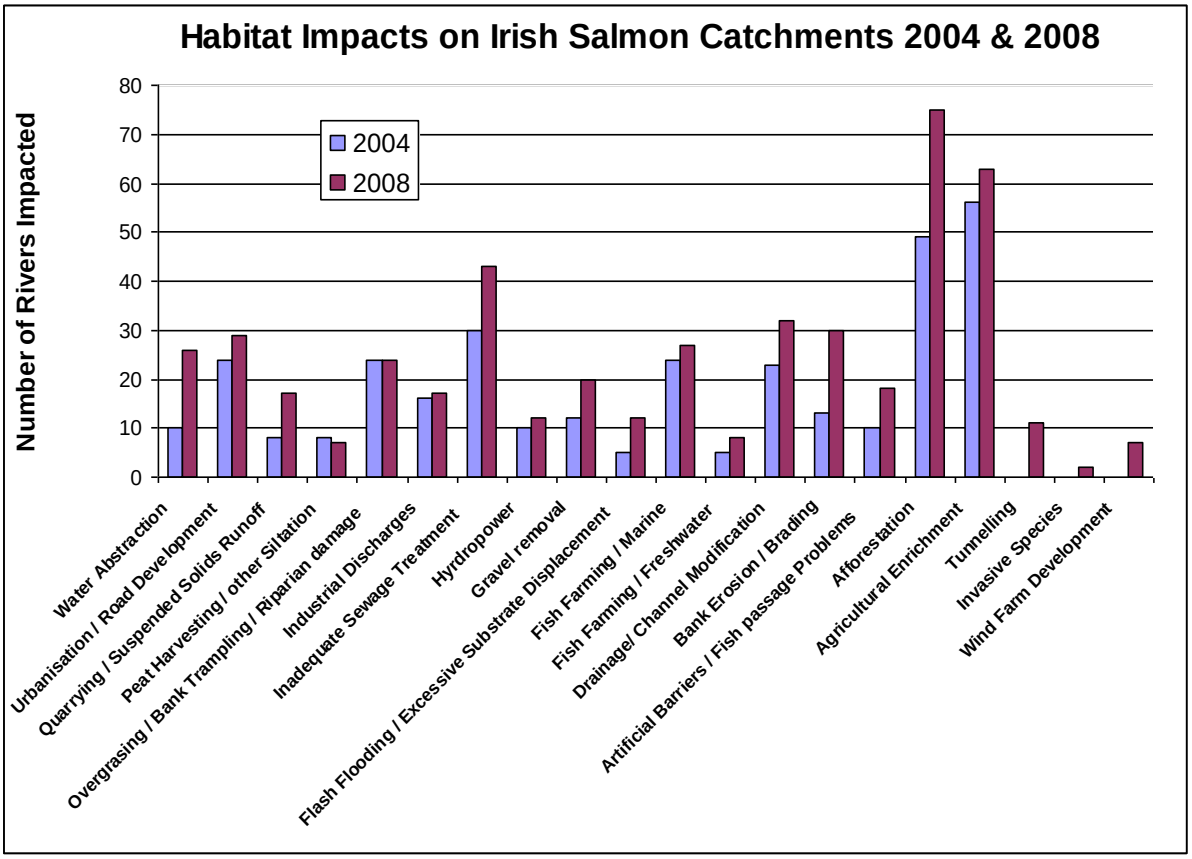


Fig.10. Comparison of Habitat Impacts in Salmon Catchments, 2004 & 2008.

5.A Impacts and Potential Risks on a Regional Fisheries Board Basis.

Data is presented in fig 11 A – G on habitat impacts on a Regional Fisheries Board basis. In the Eastern Region, (Dundalk District to Wexford District), the primary impact are agricultural enrichment and water abstraction, (Fig 11A). Other impact factors remained similar in intensity with the exception of urbanisation / road development which decreased over the time period.

In the Southern Board area (Waterford & Lismore Districts), agricultural enrichment and afforestation were the principal habitat impact factors identified with an increase in the incidence of afforestation seen since 2004, (Fig 11B). An increase in water abstraction and artificial barriers was noted. Tunnelling was described as a habitat impact for the first time.

In the South Western Region (Cork & Kerry Districts) afforestation and bank erosion were the primary habitat impact factors identified, with a significant increase since 2004, (Fig 11C). Drainage / channel modification and gravel removal were also seen to increase over the time period. The potential impact of wind farm development / landslides were identified for the first time.

In the Shannon Region, inadequate sewage treatment, afforestation and agricultural enrichment were the principal habitat impact factors identified (fig 11D). Bank erosion, drainage, flash flooding and wind farm development were new impacts and potential risks identified.

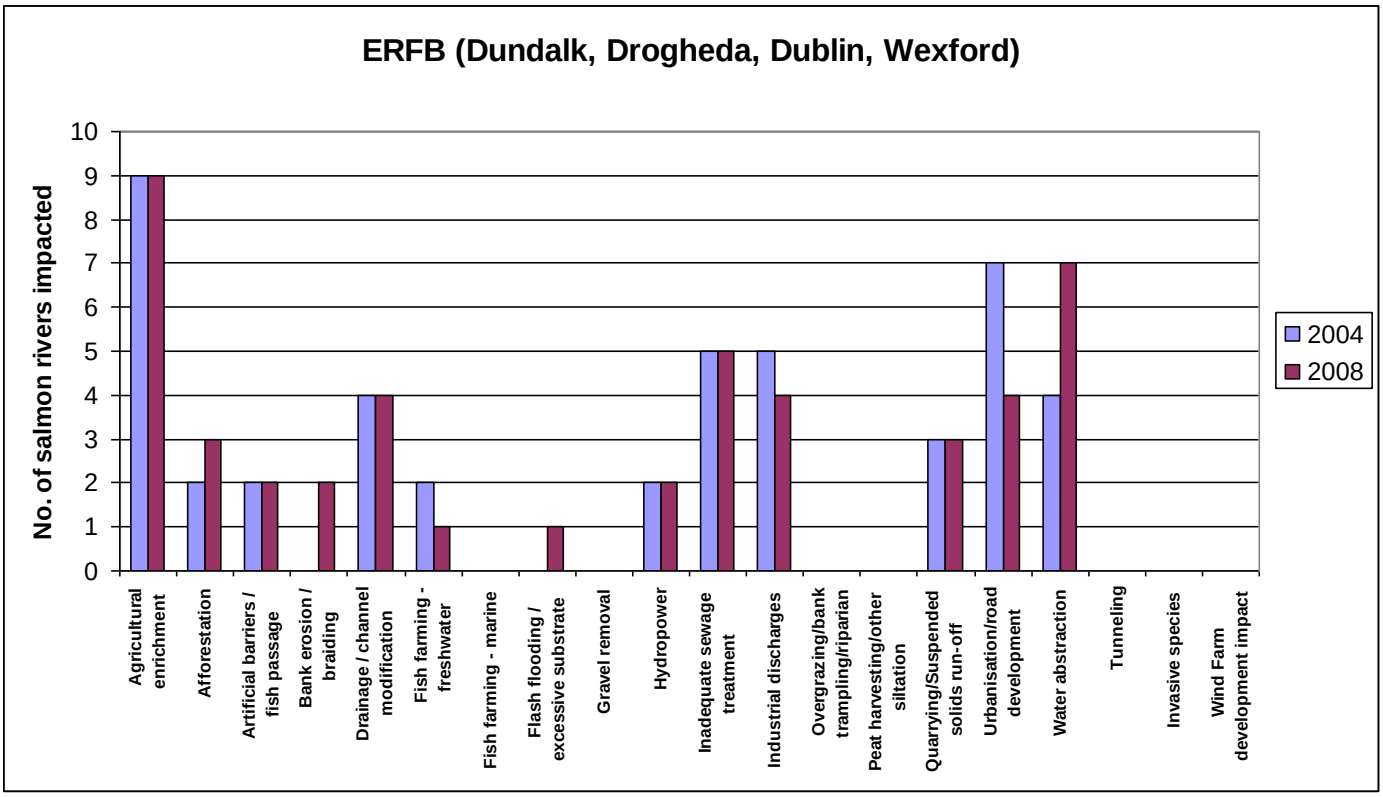


Figure 11A. Habitat Impacts in Salmon Catchments in the Eastern Region

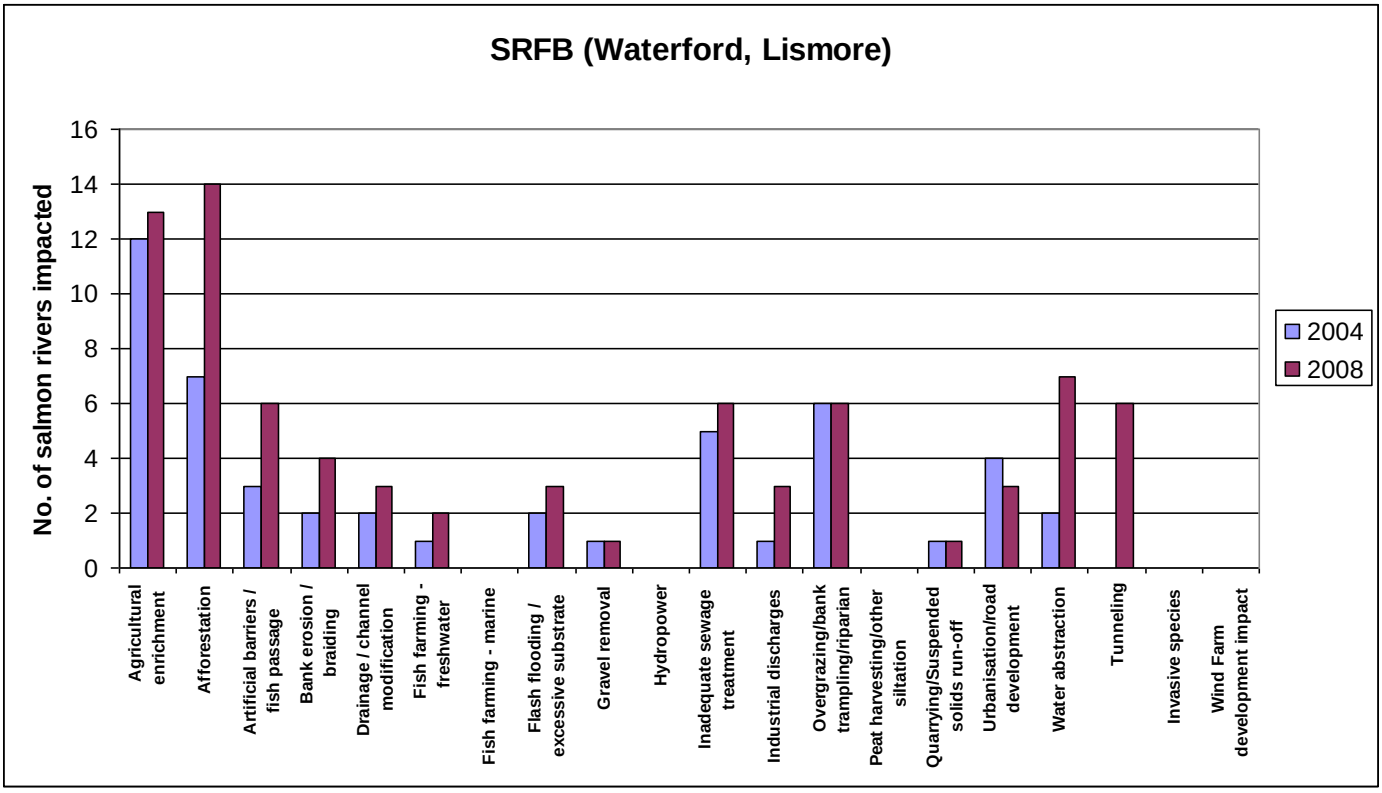


Figure 11B. Habitat Impacts in Salmon Catchments in the Southern Region

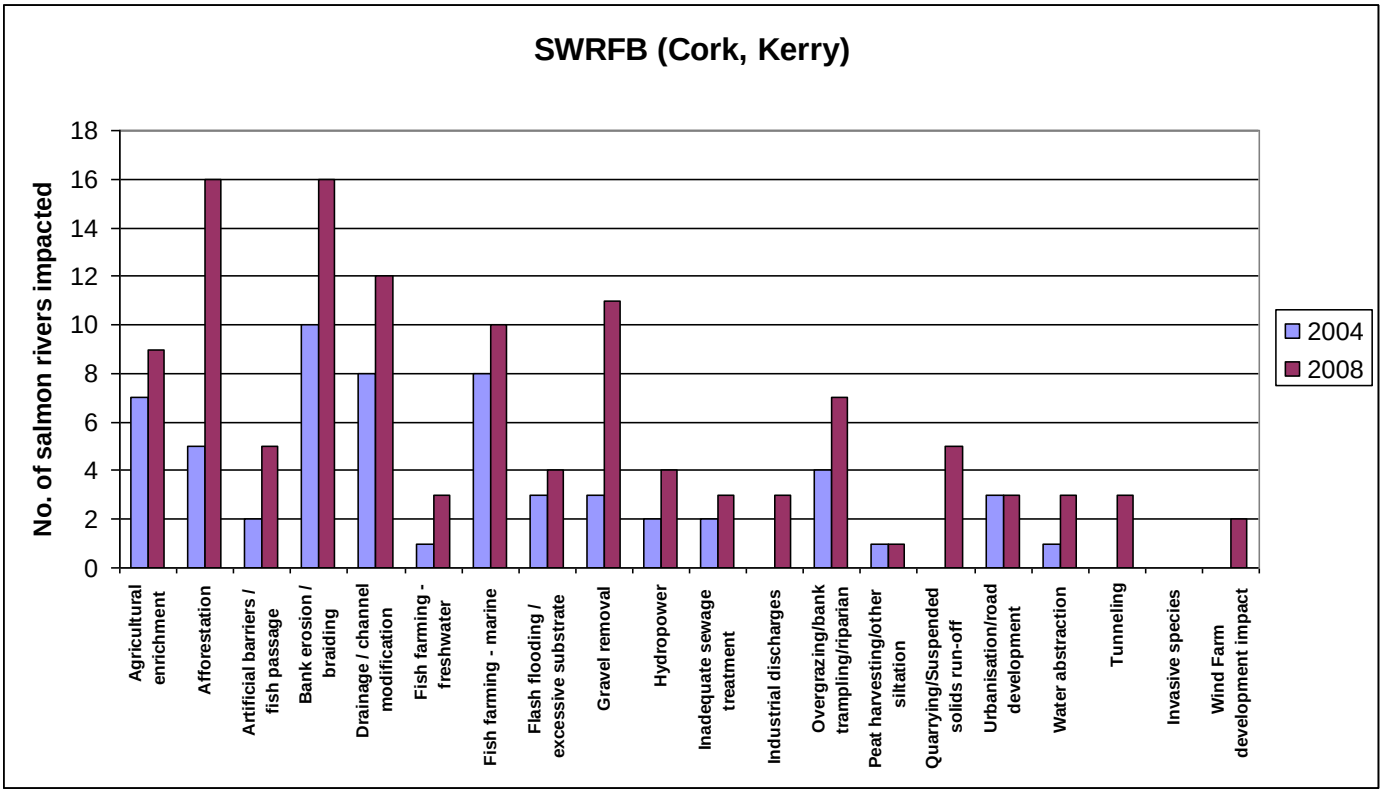


Figure 11C. Habitat Impacts in Salmon Catchments in the South Western Region

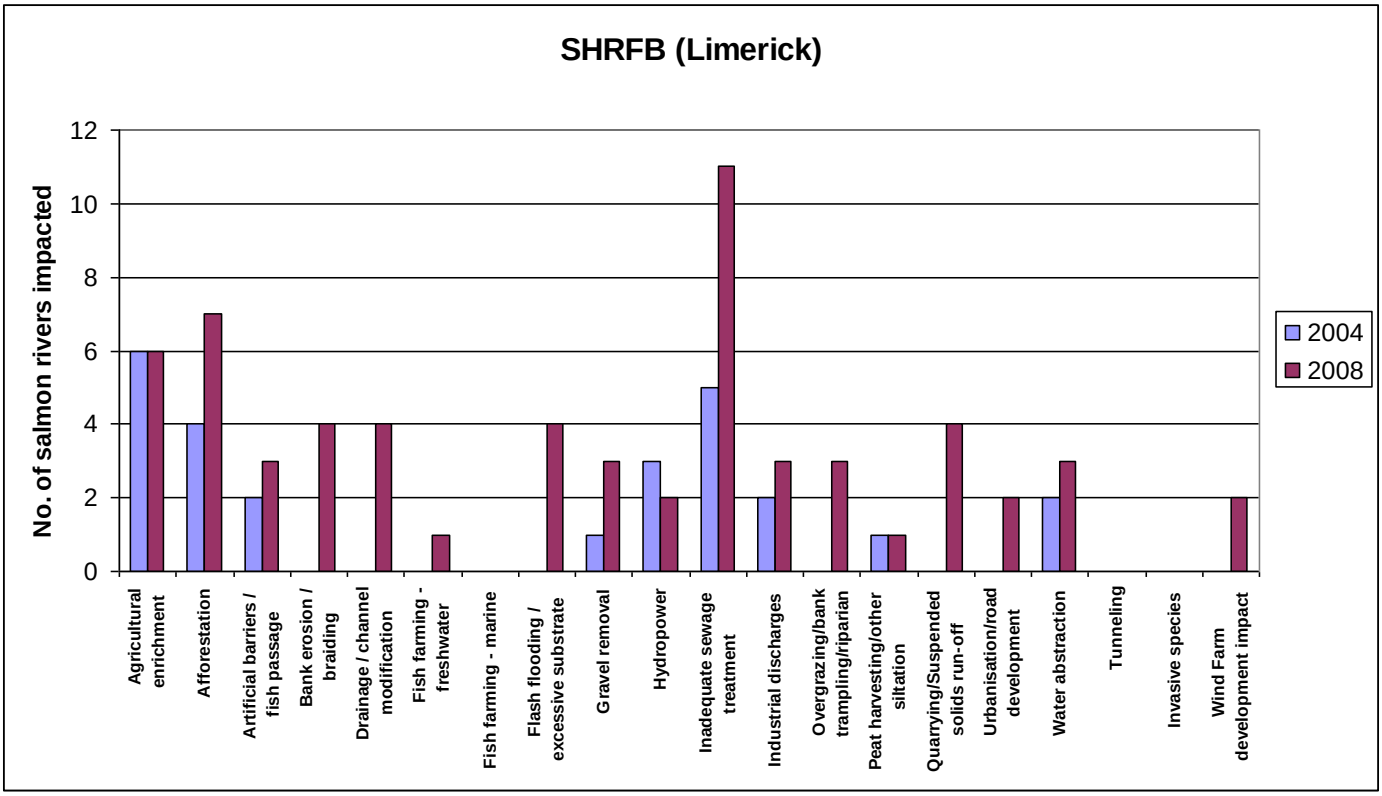


Figure 11D. Habitat Impacts in Salmon Catchments in the Shannon Region

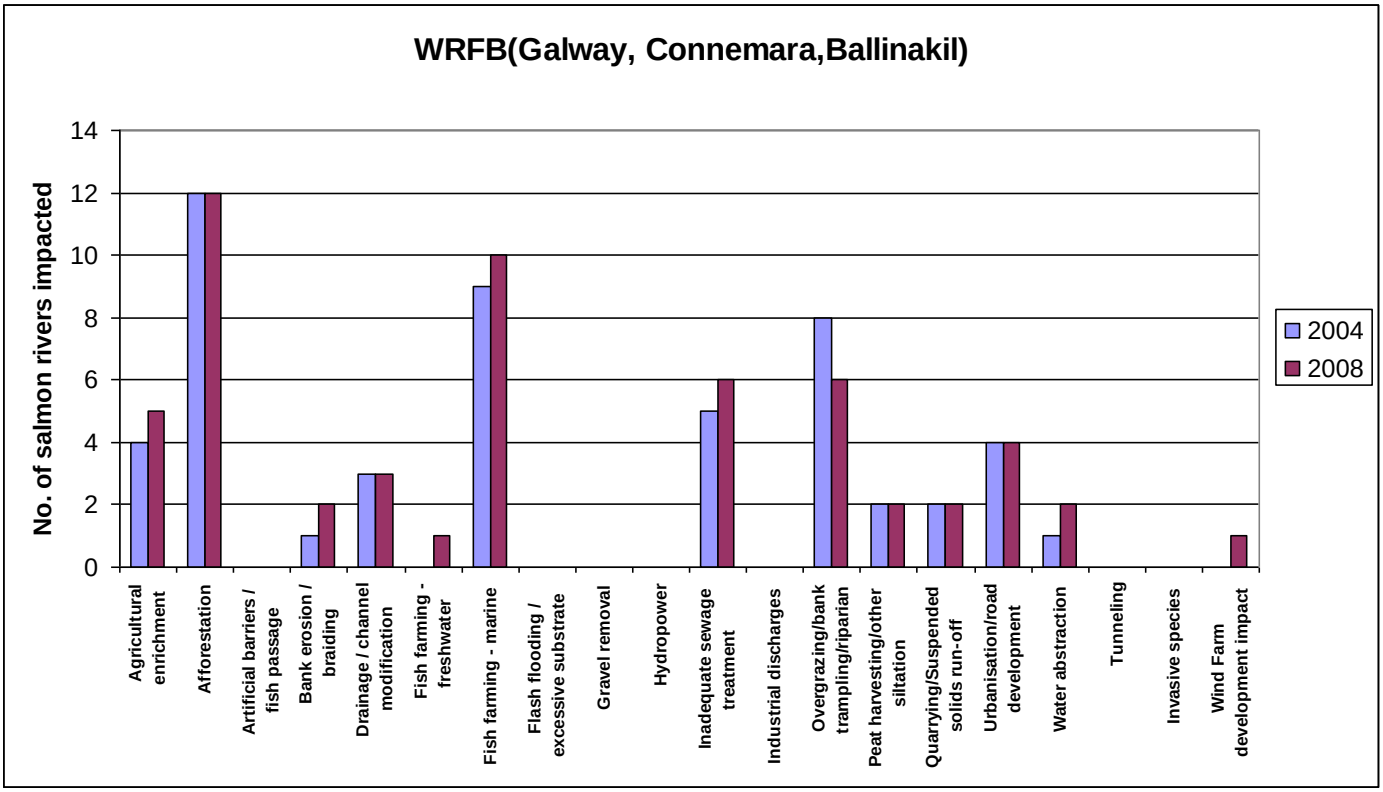


Figure 11E. Habitat Impacts in Salmon Catchments in the Western Region

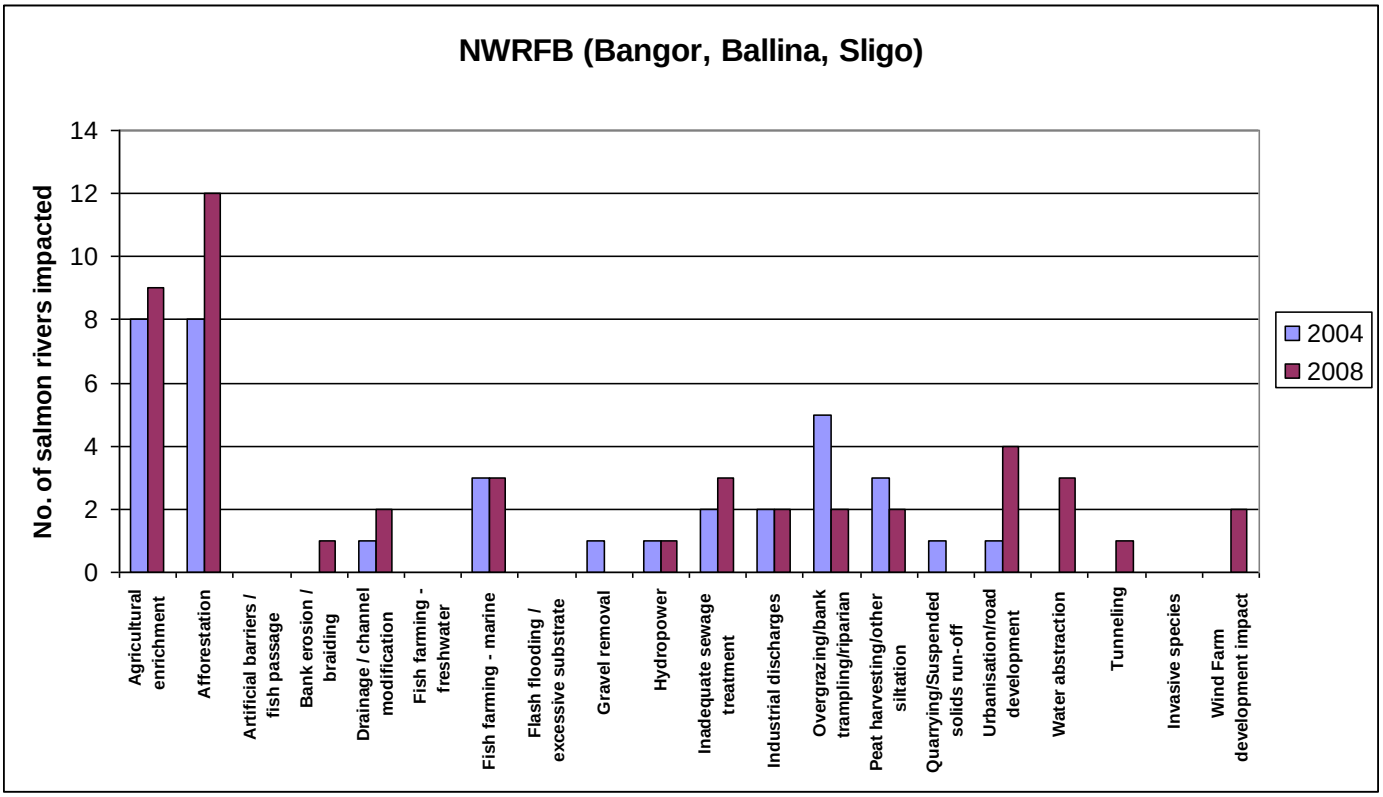


Figure 11F. Habitat Impacts in Salmon Catchments in the North Western Region

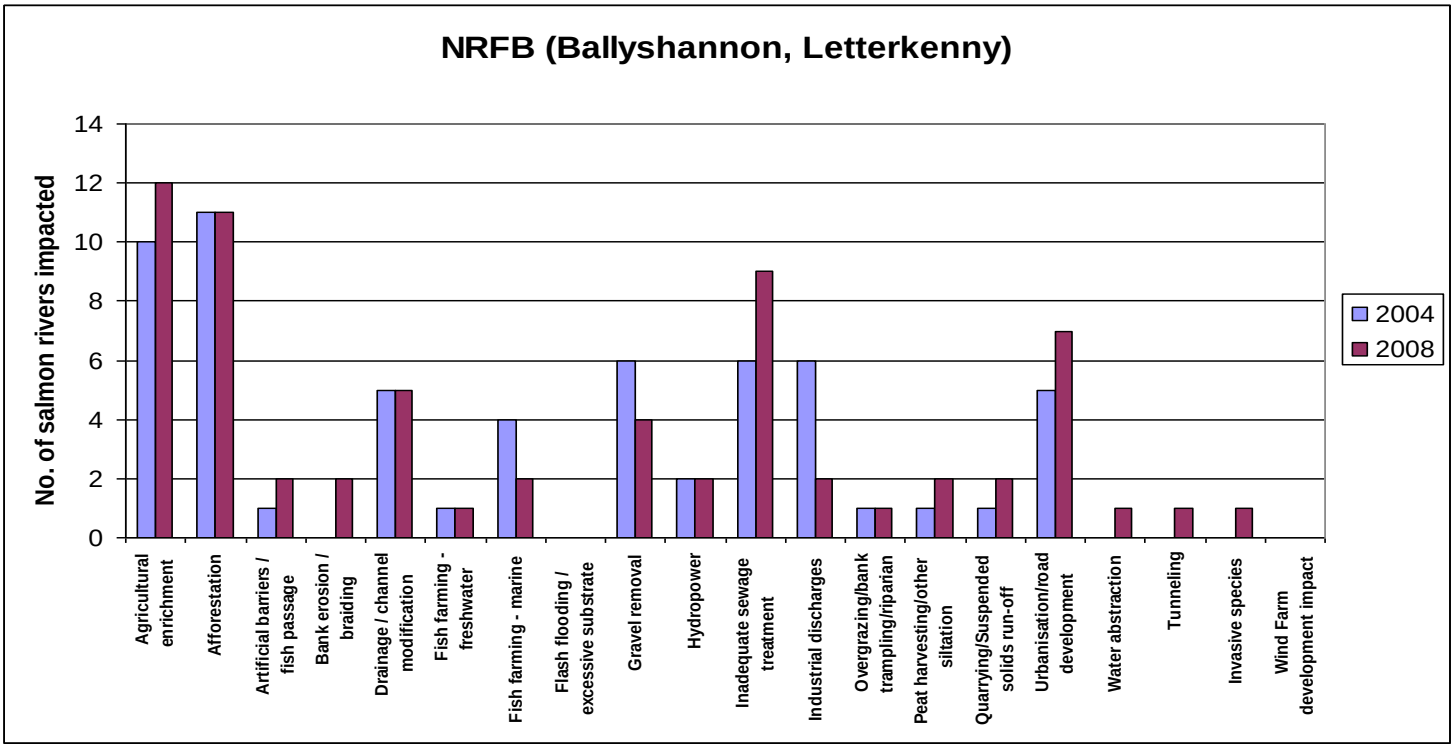


Figure 11G. Habitat Impacts in Salmon Catchments in the North Western Region

In the Western Region, afforestation and marine fish farming were identified as the primary impacts and potential risks to productive capacity of salmon rivers, (fig 11E). There was a reduction in the incidence of overgrazing identified as a habitat impact factor, due largely to the abolition of headage payments to sheep farmers and a reduction in flock sizes. The range of habitat impacts identified were lower than for other Regions.

In the North-Western Region, agricultural enrichment and afforestation were the principal habitat impact factors identified, (Fig 11F). Habitat impact were recorded on a lower scale that in the East and South. There was also a reduction seen in the incidence of overgrazing.

Agricultural enrichment and afforestation were identified as the main threats to salmon habitat in the Northern Region, (Fig 11G). Inadequate sewage treatment and urbanisation increased as habitat impact factors over the period.

5. A Descriptions of Habitat Impact Factors and Potential Risks to the productive Capacity of salmon Rivers

Water Abstraction

In Ireland, where the economy has been very strong over the past decade, there is competition for water for utilities, agriculture and industry. Any changes in natural water flow regimes (water quantity) will impact on ecological functioning with respect to spawning requirements and availability and quality of nursery habitats particularly during periods of reduced flow. Demand for water for tillage and crop production along the Eastern seaboard and for human consumption is putting increased pressure on salmon rivers.

The availability of adequate water of suitable quality is fundamental to salmon ecology. Increased demand from different sectors continues to threaten the species and potential impacts are likely to be magnified as a consequence of climate change and surface water flow predictions (Sweeney 2002). Currently various legislation (Water Supply Act, Water Pollution Act, Nitrates Directive and the Groundwater Directive) contribute to the control of water abstraction.

A POMS Abstractions Working Group for the River Basin Districts examined the issue of water abstraction from rivers, lakes and groundwater. Their approach was strongly influenced by ecological considerations and the potential adverse impacts of abstraction with regard to habitat loss in lakes and rivers. Some of the modelling approaches used salmon life history stages to examine the feasibility of abstraction and its impacts in specific channels. One of the recommendations from the Working Group was the requirement to establish a national register of abstraction with a regulator. Another recommendation was the need to have a licensing system in place above a certain volume. The findings from the group will contribute to a consistent national approach being adopted to management of the water resource in order to properly control abstractions and safeguard fish, including salmon, in watercourses. Of particular relevance here is the value of the PHABSIN and WUA modelling in assessing the feasibility of abstraction in salmonid channels.

For future water requirements, off channel storage in high and peak flow for use in drought conditions represents an ecologically acceptable alternative to the ecologically unsustainable practice of withdrawal/abstraction during extended periods of reduced flows.

Urbanisation / Road Development

Infrastructural development including road construction has increased over the past decade. Channel diversions, culverting of rivers and problems associated with road construction have resulted in habitat impacts. Increased levels of run-off and the requirement for additional assimilative capacity in rivers are problems associated with urbanisation and road development.

In recent decades urbanisation and associated hard infrastructural development has increased in Ireland due to increased population and economic growth. Increased development has lead to increases in effluent discharges and associated water quality problems. This contributes to eutrophication of rivers and has impacts on juvenile salmon production. Mc Ginnity et al. (2003) identified that rivers in the east,

southeast and south are impacted by poor water quality. This is not unexpected given the concentration of urban development on the east coast and that of intensive agricultural activity in the south of the country.

Significant upgrading of wastewater treatment plants has occurred in Ireland between 2000 and 2006 to assist Local Authorities in complying with the Urban Wastewater Treatment Directive. The EPA regulates major industrial activities through the Integrated Pollution Prevention and Control (IIPC) regulations while the Local Authorities license small-scale industrial discharges to waters under the Water Pollution Acts. The implementation of the EU Water Framework Directive and changes to the EU Common Agriculture Policy provide some likelihood of improving water quality conditions in the future. However, it is likely that demographic trends will continue on their current upward trajectory and thus it will be increasingly difficult to allocate scarce water resources between freshwater fisheries and the utilities required to sustain industrial and population development. However, this should not be a reason to allow any further deterioration in the freshwater fisheries resource and appropriate safeguards must be put in place.

Specific codes of practice have been drawn up covering the construction of roadways (NRA, 2004; Murphy et. al, 2005). However, it is likely that the aquatic environment and the biota will be at risk for the foreseeable future with the continuation of major infrastructural road-building projects.

Quarrying / Suspended Solids Run-off

Quarrying is carried out in several salmon river systems and can lead to the input of fine suspended material to the watercourse. This material can have a deleterious effect on the juvenile stages (eggs and fry) and render spawning areas unsuitable. Pollutants including dangerous substances such as metals and fuel, can travel through the ground water into surface waters affecting water quality and damaging the aquatic flora and fauna. At some quarries the water table is lowered to permit quarrying which can affect nearby wet areas. The transfer of groundwater to surface water can change water quality.

A range of legislation exists to deal with the establishment and operation of waste management, quarry and mine sites and contaminated lands. The Waste Management Act is the primary control for regulated waste management and the EPA administers the licensing of waste facilities. Under the Planning and Development Act quarries four years or older must register with Local Authorities and planning applications over five hectares usually require an EIA. Proposed new mines require three types of permits and in general require an EIA. The EPA, Department of Communications, Energy and Natural resources (DCENR) and Geological Survey of Ireland (GSI) have completed characterising historic mine sites in Ireland gaining better information about the sites and their environmental impact (Anon 2007d).

Mining activities can lead to serious contamination if leachate containing toxic metals is allowed access to watercourses. Old mining or abandoned mine sites which were not reclaimed after operations have ceased, can present significant threats to the aquatic environment. For example, the ongoing presence of high levels of copper and zinc in the Avoca River which has severely impacted on salmon populations in the river, is a long-standing problem due to the discharges of drainage waters from the

defunct copper mines into the main channel. Most mining related fish kills in Ireland in recent years were attributable to acid mine drainage in the Avoca which ceased production in 1982. Mining is identified as a significant pressure for WFD risk assessment purposes particularly in the south east of the country. The potential risk posed by any contamination is site specific and is determined by connectivity between the sources of contamination and any potential receptor (e.g. the aquatic environment).

Elevated values of different metals may render previously uneconomical ore deposits attractive for mining thus posing a potential threat to adjacent watercourses. Additional safeguards have been put in place and all new mining developments must secure an Integrated Pollution Prevention and Control (IIPC) licence from the EPA. This single integrated license covers all aspects of air and water pollution, and noise and waste issues. The main objective of IIPC licensing is to prevent or resolve potential pollution problems rather than transferring them from one part of the environment to another. Risk minimization to the whole environment by preventing the emission of potentially polluting substances is a key aim.

Peat Harvesting/other Siltation

Many peat bogs in Ireland are harvested on a large scale to provide fuel for electricity generation, fuel for the domestic market or to produce horticultural products. Problems associated with commercial peat harvesting include drainage of peatland resulting in increased run-off and increased siltation leading to increased sedimentation instream. Gravel compaction from sedimentation will reduce the salmon spawning capacity of the channel and losses in instream floral and faunal production will also impact on the capacity of the channel to produce juvenile salmon.

Compacted gravels can no longer function as salmonid spawning areas and it has been shown that eggs laid in clean gravels which have subsequently been silted over by peat have failed to hatch (Crisp 1993). Settlement of peat particles/silt on the river bed can seriously reduce both the diversity and abundance of the aquatic flora and invertebrate fauna. Such discharges can lead to an accelerated rate of secondary bank (or berm) formation thereby creating long uniform glides where previously riffle/glide/pool sequences had predominated. These berms can quickly vegetate, stabilise and change the hydrology of a channel.

In state owned peat harvesting operations, more attention is now been paid to the entrapment of loose peat particles with the provision of an adequate number, and regular maintenance, of effective silt traps. Planting of deciduous hedgerows along bog drains help to minimise this problem. The Environmental Protection Agency's (EPA) national monitoring programme has demonstrated that Irish waters are becoming increasingly eutrophic over time. Catchments dominated by peat soils are viewed as sensitive to eutrophication because the peat has a low capacity to bind or fix phosphorous and because the buffering capacity of the water in the system is poor.

Overgrazing / Bank trampling / Riparian damage

Overgrazing by unsustainable populations of sheep in the more remote upland areas of the west has caused serious habitat damage to salmon rivers. EU subsidies led to a significant increase in the sheep numbers grazing poor mountain heathlands in the west of Ireland. This has resulted in serious overgrazing on both hillside and river

valley areas. O' Grady & Gargan (1993) suggested that the destruction of heathland has lead to increased run-off rates in watercourses resulting in higher peak flows during flood periods. Silt run-off has also increased because of the lack of vegetation. These factors, in combination with overgrazing along river banks, have resulted in significant increase in bank destabilsation leading to siltation and channel braiding.

The impacts of overgrazing on riverine channels have been documented in O'Grady *et al* (2002a, b). In summary, overgrazing on both hillsides and the valley floors has lead to increased run off rates causing unnaturally high bank erosion levels and a complete physical destabilisation of some river channels. The problem has had serious negative impacts on all ecological strata of river corridors and the aquatic flora and fauna, fish stocks and bird species associated with river corridors have been affected (O'Grady *et al* 2002, a & b). Localised excessive bank erosion, caused by bank trampling by livestock, can also be extensive and destructive even in catchments where the natural hydrology of the watershed has not been altered markedly by land management.

A change in EU policy linking subsidies to the area of land farmed rather than the number of livestock held has resulted in a significant reduction in sheep numbers in upland areas and a reduction in overgrazing. Field surveys have indicated a recovery of instream stability, increased macrophyte and invertebrate abundance and improved densities of juvenile salmonids in several areas previously affected by overgrazing.

The number of catchments where overgrazing is cited as a habitat problem has remained at 24 catchments over both time periods. However, the extent of overgrazing as an ecological problem is believed to be less now than in 2004 and recovery of many catchments is underway.

Industrial Discharges

Inadequate waste treatment from factory units, creameries and other industrial production can impact on salmon rivers either by increasing nutrient input/enrichment or input of toxic substances. The number of rivers citing industrial discharges as a habitat impact or potential threat has remained at a similar level over the time period. Significant upgrading of wastewater treatment plants has occurred in recent years to assist Local Authorities in complying with the Urban Wastewater Treatment Directive. The EPA regulates major industrial activities through the Integrated Pollution Prevention and Control (IIPC) regulations while the Local Authorities license small-scale industrial discharges to waters under the Water Pollution Acts. The Work of the EPA in enforcing the regulations and the implementation of the EU Water Framework Directive are likely to ensure that industrial discharges are adequately regulated to prevent impact on rivers nationally.

Inadequate Sewage Treatment

Many towns and villages have only primary or secondary treatment facilities resulting in large inputs of organic nutrients to watercourses. The increase in building groups of houses near villages with inadequate treatment has impacted salmon rivers over the past decade. This contributes to eutrophication of rivers and has impacts on juvenile salmon production.

The number of salmon rivers where inadequate sewage treatment is recorded as an impact increased from 30 to 43 over the time period. There has been considerable

recent investment in upgrading of treatment facilities, primarily in larger towns, and this process will continue with the Programme of Measures under the Water Framework Directive. The Department of the Environment, Heritage & Local Government plan to invest many hundreds of millions nationally over the coming decade in new treatment facilities, and many of the smaller town and village schemes will be upgraded in this process. It is therefore anticipated that the impact on productive capacity of salmon rivers from inadequate sewage treatment will decrease considerably over the coming decade with the requirements of the WFD being achieved.

Hydropower

A number of large-scale hydro-power schemes (Shannon, Lee, Erne, Liffey) can cause smolt passage problems and impede the upstream passage of adult salmon resulting in reduced salmon production. These rivers have been described as being non-self sustaining as a result (McGinnity *et al*., 2003). Many smaller hydropower schemes are also operational in Ireland and can impact on salmon populations in different ways including fish passage (upstream and downstream) and impacts on the natural channel.

Large-scale, high-head hydropower generating stations are unlikely to be constructed on Irish salmon rivers in the future. Salmon restoration plans have recently been prepared for three of the catchments with large high head hydropower, the Shannon, Erne and Lee catchments. These restoration plans include a review of current management practice for upstream and downstream fish passage on a site specific basis, a review of hatchery operations to maximise natural smolt production and water quality and habitat quality issues. The overall objective is to restore wild salmon runs on these rivers over the next two decades.

Guidelines on the planning, design, construction & operation of small-scale hydro-electric schemes and fisheries have been published recently (Anon, 2007b). It is envisaged that these guidelines will be included in the planning regulations governing any future small scales schemes.

Gravel Removal

Natural stream bed structure is changed where gravel is removed directly from watercourses. Riffle/glide/pool sequences are often disturbed leading to reduced juvenile production. Substrate mobility in the affected area can be increased leading to erosion and subsequent loss of habitat and invertebrate and fish productivity.

With increased availability of heavy machinery and developments in road building, housing and agriculture, extraction of gravel from rivers has become a significant problem in many salmon catchments and the incidence of gravel removal increased over the 2004-2008 period. During the 1980's, regular incidents where hydraulic machines entered rivers and excavated many tonnes of gravel directly from the stream bed took place. This caused loss of riffle / glide / pool sequence in rivers, lead to erosion and siltation and resulted in large areas being too broad and shallow to support juvenile salmonids, particularly during low flow conditions. While the incidence of gravel removal has increased over the period 2004 to 2008 (from being recorded in 12 to 20 rivers) the nature of gravel extraction is now largely confined to taking gravel off the gravel crown on depositing bends and not extracting gravel from

the stream bed. With improved communication between operators and Fisheries Boards' staff the incidences of gravel extraction directly from the river bed have declined. Isolated incidences of damage to habitat continue to occur and therefore vigilance is required to ensure that this level of cooperation is continued.

Flash Flooding / Excessive Substrate Displacement

A number of land use practices can lead to flash flooding and excessive substrate displacement including new forestry development, land drainage and overgrazing. These practices can results in a change in the hydraulic characteristics of the surface water drainage network. This leads to increased and rapid run-off of water and thus to shorter but more intense flood events. Consequently, bank erosion and substrate loading will increase. The geomorphological response of the river will be to widen, become shallower and increase substrate fines. The land use practices contributing to this habitat impact are discussed separately.

Marine Fish Farming

Marine salmon farming is associated with transfer of parasites or disease to natural populations e.g. mortality associated with sea lice infestations (*Lepeophtheirus salmonis*). Where escape farmed salmon interbreed with wild populations loss of genetic change and loss of production can occur.

Marine salmon farming can lead to increased marine mortality of migrating salmon smolts if sea lice are not adequately controlled (Skilbrei & Wennevik, 2005). Studies in Ireland (Tully and Whelan, 1993), Scotland (Butler 2002 & Watt, 2002) and Norway (Heuch and Mo, 2001) have indicated that in spring, the majority of sea lice nauplii arise from ovigerous lice infesting farmed salmon. Tully *et al.* (1999) have demonstrated that the presence of salmon farms significantly increased the level of sea lice infestation on sea trout post smolts in Ireland. Similar findings have been reported from Norway (Grimnes *et al.*., 2000) and Scotland (Mackenzie *et al*., 1998, Butler & Watt, 2002). In areas with lice epizootics, lice have been implicated in the mortality of 48-86% of wild salmon smolts in Norway (Holst and Jakobsen, 1998). Recent studies in Ireland undertaken as part of a wider EU funded study (SUMBAWS Q5RS-2002-00730) also demonstrate that salmon smolts entering bays with salmon aquaculture suffer increased marine mortality.

Unless ovigerous sea lice levels on marine salmon farms are maintained at near zero levels in spring, there is continued potential for impact on migrating salmon stocks. Implementation of the requirements of the EU Habitats Directive may have implications for the effective management of sea lice on marine salmon farms.

The number of salmon catchments listing marine salmon farming as an impact has remained constant since 2004 (24 in 2004 & 27 in 2007) and no new salmon farms have been established. The current regulation of sea lice on marine salmon farms is not adequate to ensure sufficient control of sea lice abundance on all farms in spring and continues to pose a threat to migrating salmon smolt in aquaculture bays.

A new strategy for improved pest control on Irish salmon farms was published in 2008. There are a number of recommendations regarding management of farms with regard to single generation sites, all in all out bay by bay strategies and review of existing and new sites which may improve the current system of sea lice control. A

new role for Single Bay Management as a focus for management cells to manage sea lice control aims to create an integrated mandatory real time management regime. If the management cell approach fails to effectively prevent infestation and impact on wild salmonids, a broader range of options may need to be considered than envisaged in the strategy.

Freshwater Fish Farming

Freshwater fish farming is the production of trout and salmon in freshwater. Rearing fish in freshwater can result in enrichment, siltation and dewatering. Escapes can result in predation on wild juvenile salmonids, genetic introgression and transfer of disease. The production of salmon smolts in rivers has resulted in excessive water abstraction, escapes into the wild and enrichment from farm discharges. Enrichment has caused the greatest problem in salmon rivers with low Q values being recorded downstream of discharge points. The number of rivers listing freshwater fish farming as an impact are relatively low (5 in 2004 and 8 in 2008) and it is not regarded as a major risk to productive capacity in salmon rivers nationally.

Arterial Drainage / Channel Modification

Arterial drainage is the re-engineering of natural river channels to increase the rate and volume of water transfer from land to sea resulting in loss of natural stream and bankside structure. Maintenance programmes are conducted on an ongoing basis to maintain channel design. In recent years, habitat rehabilitation programmes have been undertaken to restore natural stream features.

Land drainage results in a change in the hydraulic characteristics of the surface water drainage network. This leads to increased and rapid run-off of water and thus to shorter, but more intense, flood events. Consequently, bank erosion and substrate loading can increase. The geomorphological response of the river is to widen, become shallower and increase substrate fines resulting in reduced habitat quality.

Some of Ireland's major salmonid catchments have been subjected to arterial drainage schemes at some time between 1840 and 1980. The more major mechanised schemes took place from 1950s onwards. While the short-term impact of these schemes was very detrimental to salmon stocks, recent studies have shown that the long term impact has been varied and complex ranging from positive, to neutral, to negative in relation to salmon stocks (O'Grady 1991(a), 1991(b);O'Grady & King 1992 and O'Grady & Curtin 1993).

The long term negative impacts of drainage on the fish carrying capacity of Irish salmonid rivers are, in most cases, very significant. Surveys have shown little physical recovery of the natural form of channels even 60 years after drainage (O'Grady 2006). Any land management practice or, combination of practices, which lead to a significant alteration in the natural morphology of a channel and/or its riparian zone, will have negative consequences for fish stocks. It is difficult to quantify the negative impact of drainage alone as a factor. In general terms drainage of smaller channels (<6m) will usually result in a significant loss in the standing crop of 1+ year-old salmonids. In larger (>6m) channels there will be a reduction in the number of resting pools for adult salmon (O'Grady 2007 *et al.*).

Large scale arterial drainage programmes such as those that were carried out in the latter part of the last century are unlikely to be undertaken in the future. Rehabilitation works have been carried out by the Fisheries Boards to restore salmon productive capacity at locations in drained rivers in conjunction with the Office of Public Works. The OPW have embarked on a programme to restore riverine habitat in drained channels over the coming years (Section 6.).

Drained channels are subject to regular maintenance which may have further consequences for salmonid stocks. An experimental drainage maintenance programme has been undertaken in recent years to design a drainage maintenance strategy which will have the greatest benefit to fish production including salmonids. The programme has clearly identified the feasibility of introducing environmentally sensitive strategies as a 'norm' so that such approaches become 'standard' (King 1996, King et al., 2000, 2002).

The number of salmon catchments where drainage/ channel modification is identified as a habitat impact increased from 23 to 32 over the 2004 to 2008 period. The onset of a major habitat rehabilitation programme on drained rivers will result in many kilometres of drained channel being rehabilitated in individual catchments.

Bank Erosion / Braiding

A combination of habitat impacts including land drainage, afforestation /reafforestation, gravel removal, over-grazing and other factors can result in bank erosion and braiding (excessive channel widening and loss of channel depth) resulting in loss of channel form and a natural riffle / glide / pool sequence and introduction of fines into streambed substrates. This reduces the quantity and quality of habitat for juvenile salmon production. The land use practices resulting in bank erosion are discussed separately.

Artificial Barriers / Fish Passage Problems

Artificial barriers may be small hydro-schemes, weirs for water abstraction, old mill weirs or other obstacles that prevent or impede upstream passage of adult salmon or downstream passage of smolts. Such artificial barriers may result in stress, onset of disease and mortality of fish and also present opportunities for predator aggregations and illegal fishing.

Many large stone weirs were built in Irish rivers in the 18th and 19th centuries principally to power mills. Over time, fish passes have been incorporated into these structures to varying degrees of success and efforts continue to improve fish passage at such weirs. Irish rivers are relatively low gradient channels and consequently weirs often impound a significant length of channel. Electro-fishing surveys have shown that the capacity of such individual ponded reaches to support both juvenile salmon and trout and adult trout are seriously impacted. In quantitative terms salmonid numbers in impounded reaches are usually $\leq$10% of that in adjacent free flowing zones (O'Grady, 2002).

The number of catchments where artificial barriers are listed as a habitat impact increased from 10 to 18 over the 2004 to 2008 period. The EU WFD requires that waters currently at high ecological status are maintained in that category. River continuity (the ability of sediment and migratory species to pass freely up/down

rivers) is an important quality supporting ecological status under the hydromorphological element of the WFD. In high status waters, "the continuity of the river is not disturbed by anthropogenic activities and allows undisturbed migration of aquatic organisms and sediment transport". If any structure impedes or prevents the passage of fish in waters of high status, to the extent that species composition and abundance are changed even slightly from the type-specific communities, then such a structure contravenes the terms of the WFD. Likewise, with regard to the biological quality elements of fish, fauna and river continuity, anthropogenic activities must not result in a downgrading of water bodies in any category, for example from good status to moderate status.

Accordingly, any in-river structure must not downgrade the status of a water body (WFD, 2003) as this will most likely impact on conservation status of salmon. In this regard, a pilot study has recently been completed to develop a methodology to assess the impact of weirs and other obstructions on fish passage on the river Nore (Anon, 2008). Current policy with the DCENR is to remove defunct/derelict weirs where they create unnecessary impediments to fish passage.

Afforestation / Reafforestation

Afforestation is the planting of commercial, non-native, coniferous trees in previously unafforested land. Reafforestation is the second and subsequent rotation of the forest crop. Although Ireland has the most favourable climate for tree growing in the EU, it has one of the lowest proportions of tree cover. However, coniferous afforestation is a widespread commercial activity in Ireland particularly in upland areas and on poor quality low lying agricultural lands, (O'Grady, 2002). Shading, tunnelling, acidification in acid sensitive catchments, hydrological regime change, erosion, sedimentation and enrichment are impacts that are often associated with commercial forest programmes. Coniferous plantations in areas of poor base geology which are acid sensitive can sometimes cause acidification problems (Bowman and Bracken, 1993, Allott *et al*., 1997 and Kelly-Quinn *et al*.., 1997). Many Irish salmon rivers have some coniferous plantation, particularly in their upper reaches.

There are concerns about the possible negative effects of conifer afforestation to fish stocks particularly where steep upland areas are planted. Potential problems include increased run-off rates through afforested drainage networks and the discharge of increased sediment loads and phosphorous to catchments, (O'Grady 2002). Phosphorous can cause cultural eutrophication problems in watercourses further downstream. Planting of coniferous trees too close to stream banks has resulted in excessive shade (tunnelling) and subsequent bank erosion and siltation, Smith (1980). Tunnelled areas ≥100m in length, rarely support more than 40% of the juvenile salmon numbers observed in adjacent open areas (O'Grady, 2006). Clear felling has been shown to result in elevated phosphorous export/loss to waters (Cummins & Farrell 2001). This has resulted in significant eutrophication in upland areas.

Environmental guidelines for forestry management and protection of the fisheries resource have been published by the Forest Service (2000) and are currently being reviewed. Effective implementation of these guidelines will reduce the impact of potentially adverse forestry practices on watercourses and fish stocks. Various reasons, including the discontinuance of State afforestation, high land prices, has

meant that the current rate of afforestation is not achieving the Government's target for the industry (EPA, 2006).

The number of salmon catchments where afforestation has been listed as an impact increased from 49 to 75 over the period 2004 to 2008. Afforestation is the single biggest habitat impact or potential risk listed for Irish salmon rivers nationally. As forests become mature over the coming years and are subject to harvesting it will be essential to ensure that there is minimal impact on the fisheries resource.

Agricultural Enrichment

Argicultural enrichment refers to organic enrichment of surface water bodies from agricultural sources, including intensive livestock rearing, run-off from fertiliser application, and farmyard point source enrichment. The extensive use of fertilisers in forestry and agriculture has increased the input of phosphate and nitrate to rivers. This occurs in forestry both directly by initial site fertilization and indirectly during clear-cutting operations when soils are disturbed and as a consequence of over application, leaching and surface run-off from fields and farmyards in agriculture. The risk is enhanced if operations coincide with heavy precipitation.

Agricultural activities regularly feature as the main causative agent contributing to fish kill statistics mostly through deoxygenation. Agriculture is identified as the greatest single cause of the fish kills reported during the 1990's, (Lucey *et al.,* 1999).

The number of salmon catchments where agricultural enrichment is listed as a habitat impact increased from 56 to 63 over the 2004 to 2008 period. Following the implementation of the Water Framework Directive and the formation of river basin district management structures, a collective approach to reducing all adverse impacts including agricultural enrichment and eutrophication on aquatic resources is now in place. Having characterised the risks posed to water-bodies nationally, Programmes of Measures are being developed to address habitat impacts / land use practices and to restore impaired water bodies to good status. The aim of the Water Framework Directive is to prevent any deterioration in the existing status of our waters, including the protection of good and high status where it exists, and to ensure that all waters are restored to at least good status by 2015. As a consequence of the implementation of the WFD and the Nitrates Directive, the impact of agricultural enrichment on salmon rivers is expected to reduce considerably over the coming decades.

New Habitat Impacts Identified since 2004

New habitat impacts identified since the first review in 2004 were loss of production through the shading effects of tree cover (tunnelling), invasive species and wind farm development / landslides.

Tunnelling

Tunnelling can be described as the encroachment of trees along rivers leading to excessive shading and elimination of sufficient light penetration. This can result in a reduction of epiphytic algal and macrophyte growth and a loss of productivity of invertebrates and juvenile fish. While this impact is often related to afforestation, it also occurs in the absence of afforestation, where the native tree canopy (willow, hazel, alder, ash, etc) growing along river banks and tributary streams forms a "tunnel" effect to eliminate light reaching the stream bed.

The number of Irish salmon catchments where tunnelling is described as a habitat impact is low (11 catchments). Where tunnelling is associated with conifer plantations, the forestry guidelines should be applied to remove trees back from river banks. Where tunnelling occurs along river banks in the absence of afforestation, tree pruning can be undertaken to increase light penetration.

Invasive Species

The Chinese mitten crab is native to China and South Korea and has been recorded in the lower reaches of the River Suir. This invasive has the potential to cause serious damage to watercourses as it burrows into river banks causing them to become unstable and collapse. This could have negative consequences for salmon spawning and nursery habitat. The spread of the mitten crab is being monitored in the lower reaches of the Barrow, Nore and Suir rivers.

Non-native fish species can impact on the productive capacity of salmon rivers through predation and competition. Chub were recorded for the first time in Ireland in 2006. Chub are known to be a serious competitor with juvenile salmonids and replace salmonids where present in significant numbers. Dace were confined to a very small number of rivers in the south until recent years. Dace are now being recorded in a greater number of salmon rivers and present competition for food and space with juvenile salmonids. Roach are also spreading to new waters and can be present in very large numbers also presenting significant competition.

Non-native plant species may also impact on the productive capacity of salmon habitat. The invasive plants, Himalayan balsam and Japanese knotweed, can grow profusely along river banks eliminating light and resulting in loss of native vegetation. This causes destabilization of banks and subsequent erosion and can have impacts on juvenile salmon production.

It is proposed to commence a national survey of all non-native aquatic and riparian plant and animal species in Ireland in 2009. Data from this and other related surveys will be fed into the National Biodiversity Data Centre in Waterford and will be available on their website. During this survey period close attention will be paid to species that are not yet present in Ireland but that could easily be brought in and that could significantly impact salmonid species and habitat. One typical example is the signal crayfish.

5B. The Extent To Which These Plans Include Procedures For Implementation, In A Timely Fashion, Of Corrective Measures;

The primary habitat impacts affecting salmon rivers nationally are set out in table 5. Table 4 sets out salmon habitat rehabilitation plans in place for individual rivers, describes under which programme the rehabilitation work are being undertaken and describes the nature of the rehabilitation works. These habitat rehabilitation plans will address some of the identified impacts such as bank stabilisation, rehabilitation of drained channels, provision of improved fish passage, rehabilitation of spawning beds, etc. However, not all habitat impacts, particularly those occurring at a wider catchment level (agricultural enrichment, afforestation, inadequate sewage treatment), can be addressed under the current plans in place.

River management plans will be prepared for each salmon river and will delineate the degree and extent of individual habitat problems and plan for their resolution. These plans will be integrated into River Basin District Programme of Measures and be in place by 2011 (NASCO Implementation Plan) and identified habitat impacts will be prioritised for work programmes, given availability of resources.

Following the implementation of the Water Framework Directive and the formation of River Basin District management structures, a collective approach to reducing all adverse impacts on aquatic resources is now in place. Having characterised the risks posed to water-bodies nationally, Programmes of Measures are being developed to address habitat impacts / land use practices and to restore impaired water bodies to good status. The Programme of Measures (POMS) will address many of the larger environmental problems such as agricultural enrichment and inadequate sewage treatment.

POMS is designed to ensure that the objectives of WFD will be achieved by 2015, i.e. salmon rivers which have been damaged morphologically will be restored to good condition. The implementation of POMS aims to ensure that land use practices, urbanisation, the Sustainable Urban Development Scheme (SUDS), municipal discharges, agricultural impacts and other pressures will be conducted in a sustainable manner.

5C. The Extent to Which the Plans Place the Burden of Proof on Proponents of an Activity Which May Have an Impact on Habitat;

There are a range of regulatory processes and guidelines in place to protect salmon habitat. For large scale developments above a certain threshold (e.g. size, scale, volume), the EIA legislation requires developers to deliver an Environmental Impact Assessment (EIA) to demonstrate the level of any impact of a development, and ensure mitigation measures are in place. The competent authority (EPA) will then assess the EIA and determine whether the development should proceed. The Central & Regional Fisheries Board are Statutory Consultees and require to be consulted with regard to planning applications and make comment regarding protection of the aquatic environment. For developments below the threshold which may have an adverse impact, Local Authorities may require an Environmental Impact Statement (EIS) for

the development. A similar process applies, Fisheries Boards are consulted and the local authority will assess if the development should proceed.

Other statutory instruments are also in place to protect salmon habitat, such as the Fisheries Acts and a range of EU Directives. For salmon rivers designated as Special Areas of Conservation in Ireland under the EU Habitats Directive (32 catchments) a series of notifiable actions are in place to protect these catchments. Any activity covered by the notifiable action (such as spreading of fertiliser, reclaiming of land, water extraction, altering the river bank of stream bed) must be notified to the Minister for the Environment Heritage and Local Government and must not proceed before consent is given.

There are also a range of other non-statutory Guidelines / Best Practice Guidelines in place aimed at protecting the fisheries resource.

- Fisheries & Irish Farmers Association Protocol,
- National Road Authority Guidelines
- Forestry and Fisheries Guidelines,
- ERFB Guidelines on Road Development,
- Fishery Board Guidelines for Small-Scale
- Hydro-Electric Developments and Fisheries,
- Code of Practice for Native Woodlands, etc.

The purpose of all these safeguards is to ensure that development is done in an environmentally sensitive way to minimise adverse impacts or to mitigate any negative impacts. When activities do result in habitat degradation, a range of environmental legislation (Fisheries Acts, Water Pollution Acts, EPA Environmental Legislation, Local Authority legislation, etc.) is enacted and legal action can be pursued. This also applies to breaches of EU legislation e.g. the Habitats Directive.

5D. The Extent to which these Plans address how the risks and the benefits to the Atlantic salmon stocks are weighed with the socio-economic implications of any given project;

No specific strategic assessment process is currently in place to assess the socio-economic implications of any particular development on salmon stocks or habitat. However, the regulatory process and guidelines outlined above are taken into consideration before any development can proceed.

While a clear process for socio-economic evaluation is not in place, all rivers are required to meet salmon Conservation Limits (CL) annually before exploitation of salmon can take place. Many rivers are below CL as a result of inadequate spawning salmon and varying degrees of impacted habitat causing reduced salmon production. The new salmon management regime in place together with river management plans for each river and the implementation of the Programme of Measures under WFD are expected to result in significant improvements to the status of salmon habitat and salmon runs.

Regardless of the socio-economic implications of any given project, there is a clear policy in place to protect salmon and its habitat in Ireland. The function of the Fisheries Boards are to conserve, protect, manage and develop the inland fisheries resource (including salmon) and general Government policy is to conserve the inland fisheries resource in its own right and to facilitate exploitation of the resource on an equitable and sustainable basis. These objectives mean that the salmon resource must be given adequate protection when the socio-economic implications of any project are being considered.

5E The extent to which these plans consider the effects of habitat activities on biodiversity in the area affected;

The 1999 Fisheries Amendment Act requires the Fisheries Boards to consider the implications of habitat rehabilitation on natural heritage, including biodiversity. There is also a requirement to comply with the National Biodiversity Plan and these requirements will be taken into account in the river management plans being prepared for all salmon rivers.

Previous studies (O' Grady et al 2002b) have demonstrated that river rehabilitation works, primarily designed to enhance salmonid stocks, also have major biodiversity benefits for other flora and fauna within the river corridor. For example, restoration of natural river morphological form has been shown to greatly increase aquatic plant and macro-invertebrate populations in addition to salmonid fish. Other benefits include a significant improvement to the biodiversity of riparian flora and bird populations.

As the objective of habitat rehabilitation works is to restore a natural ecological balance in the entire river corridor, it is highly unlikely that habitat enhancement plans will impact negatively on biodiversity. However, current and future river enhancement programmes for drained rivers are taking cognisance of all floral and faunal changes being generated by these programmes in the river and its riparian corridor. This will result in a more comprehensive audit of changes arising from habitat enhancement and any alterations required to rehabilitation plans will be incorporated into future plans.

Since 2007, discussion has taken place with agencies with responsibility for other aspects of biodiversity (National Parks and Wildlife Service) to ensure that salmon rehabilitation plans maximise biodiversity benefits. Where other Habitat Directive Annex II species exist in salmon rivers, such as the freshwater pearl mussel, due cognisance must be taken by all parties of the implications on instream rehabilitation work on such protected species. Fisheries Board inspectors consult with the NPWS prior to any habitat rehabilitation plans being implemented on salmon rivers.

The Rural Environmental Protection Scheme (REPS) is being implemented by the Dept of Agriculture, Fisheries and Food nationally and has potential to maintain or restore ecological diversity along river channels. In a fishery context, REPS is positive in that it obliges participants to fence river channels encouraging a riparian zone to establish between the fence and river channel. This eliminates bank trampling promoting bank stabilisation and prevents livestock access to river channels. This programme has benefits for biodiversity along the river corridor.

5F. The extent to which these plans take into account other biological factors affecting the productive capacity of Atlantic salmon populations.

Biological factors affecting the productive capacity of salmon populations in Ireland include poor water quality, disease, parasites (e.g. sea lice infestation of post smolt salmonids), competition/predation, fish farm escapees, invasive fish species and introductions of fish species. Due cognisance is taken of these factors and habitat rehabilitation programmes are prioritised on rivers where these factors will least impede the success of habitat rehab plans. Inadequate water quality tends to be the critical factor in this decision making process.

6. Overview of Ongoing Habitat Activities: Summarize ongoing or planned habitat work to demonstrate progress in implementing the salmon habitat protection, restoration and enhancement plans identified above in item 5.

Table 4 sets out the salmon habitat rehabilitation programmes being undertaken on a river specific basis. The type of rehabilitation work is also described. Many of these habitat rehabilitation plans fall into a number of categories set out below.

A. Conservation Stamp Funding

The 'Salmon Conservation Stamp Fund' is generated from the sale of angling and commercial salmon licences. It was established in December 2006 as a means of funding a programme for the rehabilitation of salmon rivers not meeting their conservation limit. €637,000 was collected in conservation stamp monies in 2007 and the revenue generated from the salmon conservation stamp is being reinvested to promote the recovery of our salmon stocks and habitats. There are 148 listed salmon rivers in Ireland many of which are below their conservation limit.

The 'Salmon Conservation Stamp Fund' is being managed by an implementation committee who receive project applications from the Central and Regional Fisheries Boards. Each project is assessed and scored based on the rivers conservation limit status, its SAC status, its water quality (Q-value) and the maximum benefit to the river. Those projects recommended for funding are then forwarded to the CEO's of the Regional Fisheries Boards for final approval.

In 2007, thirty four projects were approved and funded under this initiative resulting in the following conservation benefits: River banks were protected and restored in order to prevent widening of the river channel and deposition of silt to spawning gravels. Bank protection was carried out on the River Mattock (Eastern Region), River Blackwater (South Western Region), Rivers Gleninagh, Glencoaghan, Erriff, Lough Inagh, Owenmore and Costello (Western Region), the Rivers Glen, Claddy and Gweebarra (Northern Region).

Spawning grounds were created, rehabilitated and enhanced by introducing gravels at appropriate river sections as well as freeing up compaction of existing gravels. These

works were carried out throughout the Dundalk district, as well as the Rivers Liffey, Vartry, Dargle and Urinn (Eastern Region), River Allow/Dalua (Southern Region), River Screebe, Owenmore and Costello (Western Region), Glenamoy River (North Western Region) Rivers Glen and Gweebarra (Northern Region).

In stream works and habitat restoration were carried out on the River Maigue (Shannon Region), Rivers Glen and Gweebarra (Northern Region).Weirs/pools were constructed and rehabilitation works carried out on the Glenamoy River (North Western Region) and the River Mattock (Eastern Region). On the Avoca River a smolt rescue programme involved the construction of a partial weir and the installation of a smolt trap upstream of Avoca Mines. This will assist many thousand additional smolts to survive their journey to sea.

Trees and obstacles were cleared from rivers and river banks where overgrowth and obstructions occurred. These works were undertaken on the Rivers Liffey and Urinn in the Eastern Region.

The above works have significantly enhanced the capacity of salmon rivers to reach their conservation limits. The 2008 conservation stamp fund will be managed in a similar way to the 2007 fund. The Regional Fisheries Boards have submitted applications under the 2008 conservation stamp programme to the implementation committee for consideration. These applications are currently being assessed for funding in 2009.

B. Programme for Rehabilitation of Drained Rivers

Major salmonid river rehabilitation programmes has been initiated on arterially drained rivers in Ireland in 2008 and will continue for at least 5 years. Six different salmon catchments have been targeted for work initially in different geographical areas – the Boyne and Dee Rivers in the east, the Moy and Corrib in the west and the Maigue and Maine systems in the south west. Once all possible works have been carried out in these systems this programme will systematically address problems in all other drained salmonid rivers under the remit of the Office of Public Works (O.P.W.) – the Irish Government Agency with responsibility for maintaining drained river systems. This work is being funded by O.PW. under a programme called the Environmental Rivers Rehabilitation Programme (E.R.E.P.). Annual expenditure of €1.1m. is incurred. The effectiveness of all programmes will be monitored closely. Monitoring of these programmes will be more comprehensive than the previous T.A.M. exercises – in this instance changes in the aquatic plant and macro invertebrate communities and all fish stocks will be monitored. In addition, post works alterations in the riparian corridor, in terms of plant communities, small mammal, bats and birds will also be checked.

Environmental River Enhancement Programme (EREP)

The Office of Public Works, having implemented a number of large and small scale arterial drainage schemes between 1940 and 1980, are responsible for the maintenance of these channels. Much of the drainage works lead to changes in the channel morphology, hydrology and ecology. As part of their responsibility to such channels and for the implementation of the WFD requirements the OPW have contracted the CFB to carry out a

programme of works that will try and address the negative impacts that drainage works have had on many Irish rivers. This programme will also continue to develop and implement an environmental approach to regular channel maintenance work, which the OPW undertake annually.

Channels selected for inclusion under this project are based on two different approaches. The programme has two strands, the first deals with channels that form part of the regular maintenance schedule. These channels/rivers fall under the Enhanced Maintenance Programme, which include many rivers which have good salmonid potential, in terms of habitat and productivity. However many will not. The second strand focuses more on channels that do not receive regular maintenance and have a gradient of $\geq$ 0.2% and relatively good water quality. Such rivers usually have greater salmonid potential than those of the Enhanced Maintenance programme. This side of the project is referred to as the River Enhancement Programme. Together both these programmes encompass the EREP project.

All programmes aim to improve the fishery potential of the river by addressing some of the issues caused by either the initial drainage scheme and/or those due to regular maintenance. Enhancement works carried out are dependent upon the channel's requirements and will involve the usual suite of enhancement possibilities, such as riffle/pool creation, thalweg development, bank protection, weir development, building of deflectors, shrub/tree pruning, etc. Enhancement plans drawn up for all channels will identify where and what works are required and then implemented by OPW, under Fishery Board supervision.

A secondary target of the project is to provide scientific monitoring, on a limited number of the rivers annually. This aspect of the project will monitor the impacts of the enhancement works on the river corridor biodiversity and hydromorphology. All aspects of the river and river corridor are to be considered, namely the fish, macroinvertebrates, flora, birds, mammals and also the hydromorphology. Monitoring will cover pre-works and a number of years post works sampling events. It will represent a range of the different channel types and reflect the types of enhancement works undertaken.

River Enhancement Work Programme

Catchment	**2008**	**2009**	**2010**	**2011**	**2012**
Boyne	Mongagh	Stoneyford	Stoneyford/	Trimblestown	
			Trimblestown		
Dee & Glyde		Dee MC	Dee MC	Dee MC	
Moy	Owenaher	Owengarve	Moy MC	Moy	Moy
	Owengarve	Mullaghanoe			
		Moy MC			
Corrib	Robe MC	Robe MC	Corrib	Corrib	Corrib
	Robe tributary				
Maigue		Morningstar	Morningstar	Maigue	Maigue
Maine		Maine MC	Maine MC	Maine	

Duff		Duff MC	Ballinatrillick		

Each river included under the River Enhancement annual programme will usually represent a section of channel that covers 1 – 1.5 km of that channel. In total it is envisaged that a minimum of 10-15km of channel will be enhanced annually, through this programme. Initially the programme will cover a 5 year period (2008-2012), but it is most likely to continue past this.

Enhanced Maintenance Programme

Channels included under this element of the project depend on what channels the OPW have scheduled for maintenance within any given year. These maintenance programmes are worked out annually and submitted to the CFB and RFB's (and other relevant bodies), at the beginning of each year, for consultation. Therefore it is not possible to provide a definitive list of channels that will be included under this programme at this stage. This side of the EREP project will target somewhere between 50 and 70km of enhanced maintenance per annum which will be well distributed throughout all three OPW districts.

Catchment	**2008**	**2009**
Boyne	Boycetown	Boycetown
Owenavorragh		Owenavorragh
Deel (Limerick)		Deel MC
Maigue	Gloshagh	Gloshagh
Moy	Owengarve	
	Killeen	
Lung	Lung tributary	

The combined effect of the Environmental River Enhancement programme and the Enhanced Maintenance programme will be to rehabilitate drained river at areas of suitable gradient and increase juvenile salmonid productive capacity.

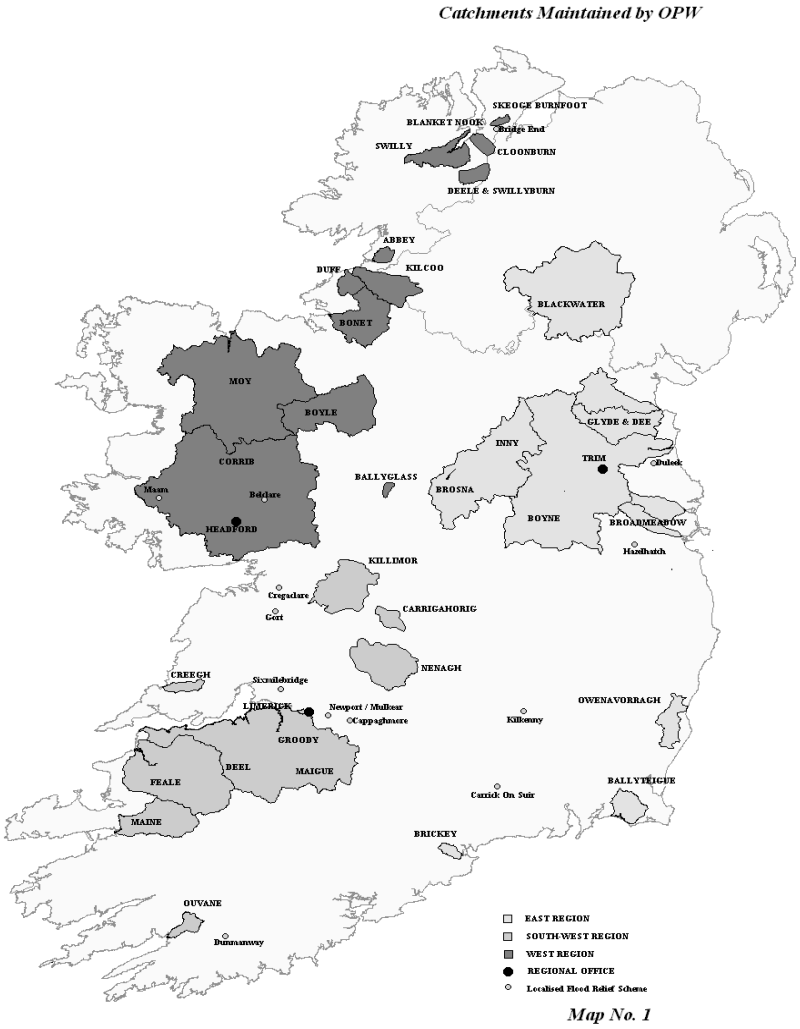


Fig 12. Office of Public Works Drained Channels in Ireland.

C. Rehabilitation of Salmon Rivers above Hydro-Electric Dams

The Electricity Supply Board regulates the fisheries on Ireland's five hydro-electric rivers. As part of their responsibility to rehabilitate the salmon stock in these rivers, the ESB have embarked on a habitat rehabilitation programme.

ESB Fisheries Conservation are currently engaged on habitat improvement works on the Shannon catchment. Most of the sites worked upon were previously drained rivers and work was undertaken in a partnership approach with the Shannon Regional Fisheries Board. The rivers being worked upon are as follows;

1. **The Big Brosna** (environs of Kilcormac village): Clearance of excess vegetation and the provision of fencing.
2. **The Little Brosna (**environs of Birr town). This area has been worked on for the past two years and is approx 5km in length. Works include construction of vortex weirs, placement of large boulders and the re-construction of river banks to prevent slippage, the provision of discrete cattle drinking areas and

the fencing of the riverbanks. Angling access was also improved with the provision of styles and footbridges and seating.

3. **The Tang River** (tributary of the Inny): Bankside clearance and fencing, instream works included construction of small stone weirs and the provision of discrete cattle drinking areas.
4. **The Dungolman River** (tributary of Lough Ree): Similar to the Tang river above.
5. **The Cross river** (enters the main Shannon below Athlone town): this was the 3rd year of a partnership between local industry (Elan), the Sh.RFBd., local angling clubs and the ESB. The entire system has been restored with the re-creation of instream sinuosity and the riffle, glide pool sequence. Both river banks were fenced and signage and angling access were also provided.
6. **The Nenagh River** (environs of Nenagh town). Improved angling access points and from 2009 onwards there will be a programme of instream works.
7. **The Mulkear:** Angling access points (styles and footbridges), and from 2009 onwards there will be a programme of instream works.

Habitat rehabilitation plans are also being considered for the other hydro-electric rivers being regulated by ESB, The Erne, Lee & Liffey.

D. Other Programmes

When river management plans are finalised for salmon rivers (2011), detailed habitat requirements will be available for all salmon rivers. A range of other bodies and organisations (Fishery owners, angling clubs, Regional Fisheries Boards, County Councils, Community Groups) also engage in riverine habitat protection in consultation with Fisheries Boards which benefit salmon in freshwater.

Where possible, quantify the extent to which habitat has been restored or enhanced, or describe other criteria used to evaluate progress.

Over the period 1996 to 2001, very extensive salmonid habitat enhancement programmes were carried out by the Fisheries Boards in Ireland on a range of river catchments as part of a National Development Plan (part of a Tourism Angling Measure Programme (TAM)) at a cost of 15M Irish pounds. About 800km of channel was surveyed and 300km of channel enhanced. The work included restoration of degraded channels and restoration of a riffle / glide / pool sequence, creation of additional instream diversity, bank stabilisation, improvement of spawning areas, etc and was designed largely to increase salmonid productive capacity and restore degraded habitat. These programmes were very successful in terms of increasing juvenile salmon and juvenile and adult brown trout stocks, (O'Grady & O'Leary, 2007).

Other smaller work programmes have taken place since the TAM programme nationally. The initiation of the Salmon Conservation Stamp programme and the OPW programme of rehabilitation of drained rivers are the major work programmes underway since TAM in the 1990's. .

References

Anon. (1996).Report of the Salmon Management Task Force. Government Publications, Molesworth Street, Dublin. 68 pp.

Anon. (2001) Plan of Action for Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat, Council Document CNL (01) 51. North Atlantic Salmon Conservation Organisation, Edinburgh, Scotland.

Anon (2003) The Water Framework Directive (2003) (2000/60/EC) transposed into Irish Law by National Regulation S.I. 722 of 2003.

Anon (2006) Central fisheries board (2006) Wild salmon and sea trout statistics. An unpublished report by the Central fisheries board (2006)

Anon, (2006a). Report of the Standing Scientific Committee of the National Salmon Commision- The Status of Irish Salmon Stocks in 2005 and Precautionary Catch Advice for 2006. Standing Scientific Committee.

Anon (2006b), Ireland- Reports of the National implementation plans meeting the objectives of NASCO resolutions and agreements. Document prepared for EU delegations, NASCO, Ivalo, Finland, 2006.

Anon (2007a), Report of the Standing Scientific Committee of the National Salmon Commission; The Status of Irish Salmon Stocks in 2006 and Precautionary Catch Advice for 2007

Anon (2007b) Guidelines on the planning, design construction and operation of small-scale Hydro electric schemes & fisheries, Central and Regional Fisheries Boards and Dept. of Communication, Marine & Natural Resources.

Anon (2007c) Western River Basin District Project. Further Characterisation of Small Streams and Development of a New Small Stream Risk Score (SSRS) Project Output report May 2007.

Anon (2007d) Water Matters. South Western River Basin District 2007.

Anon (2008) Assessment of the Risk of Barriers to Fish Migration in the Nore Catchment. A Report for the Shannon River Basin District.

Allott, N., Brennan, M., Cooke, D., Reynolds, J.D. and Simon, N. (1997). A study of the effects of stream hydrology and water quality in forested catchments on fish and invertebrates. In: Aquafor Report, Vol 4, Stream Chemistry, Hydrology and Biota, Ghalay-Mayo Region, 157pp. Dublin. COFORD

Bowman J.J. and Bracken, J.J. (1993). Effects of run-off from afforested and non-afforested catchments on the survival of brown trout, Salmo trutta L. in two acid-sensitive rivers in Wicklow, Ireland. Biology, and Environment: Proceedings of the Royal Irish Academy 93BG, 143-50.

Boylan.P, Adams C.E. (2006) The influence of broad scale climatic phenomena on long term trends in Atlantic salmon population size: an example from the River Foyle, Ireland Journal of Fish Biology 68 (1), 276–283.

Butler, J.R.A. & Watt, J. (2002) Assessing and managing the impacts of marine salmon farms on wild Atlantic salmon in western Scotland: identifying priority rivers for conservation. In: Salmon on the Edge (ed. D. Mills), pp. 93-118. Blackwell Science, Oxford, UK.

Caffrey J. (1990) Problems relating to the management of *Potamogeton pectinatus L*. in Irish rivers. Proc EWRS 8th Symp on Aquatic Weeds, 1990, 61-68.

Carey, M (2007) Fertiliser application to conifer plantations on oligotrophic peat sites. Silviculture/ Management No.14 Coford Connects.

Champ, W.S.T. (2003). The effects of pollution on freshwater fish stocks.19th Annual Environmental Conference. Central; Fisheries board

Crisp, D.T. (1993) The environmental requirements of salmon and trout in fresh water(1993) Freshwater Forum Vol. 3, no. 3, Freshwater Biological Association, Ambleside.

Cummins, T. & Farrell, E.P. (2003) Biogeochemical impacts of clearfelling and reforestation on blanket peatland streams I.phosphorous. Forest Ecology & Management 180 (2003) 545-555

de Eyto, E., McGinnity, P., Consuegra, S., Coughlan, J., Tufto, J., Farrell, K., Megens, H.-J., Jordan, W., Cross, T. & Stet, R.J.M. (2007). Natural selection acts on Atlantic salmon major histocompatibility (MH) variability in the wild. Proc. R. Soc. Lond. B, 274, 861–869

EPA (2006). Environment In Focus 2006 - Environmental Indicators For Ireland. Environmental Protection Agency, Wexford.

European Communities (Water Policy) Regulations (2003) The European Union Water Framework Directive (S.I.NO.722 of 2003)

Fitzsimons, M & Igoe, F. (2004) Freshwater fish conservation in The Irish republic: A review of pressures & Legislation impacting on conservation efforts. Biology & Environment: Proceedings of the Royal Irish academy, Vol. 104B, No.3, 17-32

Fleming, I.A., Hindar, K., Mjølnerød, I.B., Jonsson, B., Balstad, T. & Lamberg, A. (2000). Lifetime success and interactions of farm salmon invading a native population. Proc. R. Soc. Lond. B 267: 1517-1523.

Forest Service (2000) Forestry and Water Quality Guidelines. Forest Service, Dept. of Agriculture & Food.

Gargan, P.G., O'Grady, M.F., Delanty, K., Igoe, F. & Byrne,C. 2002. The effectiveness of habitat enhancement on salmon and trout stocks in streams in the Corrib Catchment. In: O'Grady, M. F. (ed.) Proceedings of the 13th International Salmonid Habitat Enhancement Workshop, Westport, Ireland, Sept., 2002, pp220-233.

Gargan, P.G., Tully, O. and Poole, W.R. (2002) The relationship between sea lice infestation, sea lice production and sea trout survival in Ireland, 1992-2001. In: Salmon on the Edge (ed. D. Mills), pp. 119-135. Blackwell Science, Oxford, UK.

Grimnes, A., Finstad, B., and Bjorn, P.A. (2000). Registrations of salmon lice on Atlantic salmon, sea trout and charr in 1999. NINA Oppdragsmelding 634, 1-34. (In Norwegian with English Abstract).

Heuch, P.A., and Mo, T.A. (2001). A model of salmon louse production in Norway: effects of increasing salmon production and public management measures. Diseases of Aquatic Organisms 45, 145-152.

Hindar, K., Ryman, N. and Utter, F. (1991). Genetic effects of cultured fish on natural fish populations. Can Jour of Fisheries and Aquatic Science, 48: 945-957.

Holst, J.C., and Jakobsen, P.J. (1998). Dodelighet hos utvandrende postsmolt av laks som folge av lakselusinfeksjon. Fiskets Gang 8, 13-15. (In Norwegian).

Kelly, F., Champ, T., McDonnell, N., Kelly- Quinn, M., Harrison,S., Arbuthnott,A., Giller,P., Joy,M., McCarthy, K., Cullen, P., Harrod,C., Jordon, P., Griffiths, D. & Rosell, R. (2007) Investigation of the Relationship between Fish Stocks, Ecological Quality Ratings (Q-Values), Environmental Factors and degree of Eutrophication. Environmantal Protection Agency 2007.

Kelly- Quinn, M., Tierney, D., Coyle, D. and Bracken, J.J. (1997) A study of the effects of stream hydrology and water quality in forested catchments on

fish and invertebrates. In: Aquafor Report, Volume 3, Stream Chemistry Hydrology and biota, Wicklow Region, 92. Dublin. COFORD

Kennedy, G.J.A. & Greer,J.E. (1988) Predation by cormorants *Phalacrocarax carbo (L.),* on the salmonid populations of an Irish river. Aquatic fish management 19, 159-70.

Lucey, J., Bowman,JJ., Clabby,K.J., Cunningham, P., Lehane,M., Macarthaigh, M., Mcgarrigle, M.L. & Toner, P.F. (1999) Water quality in Ireland 1995A 1997 Wexford Environmental; Protection agency.

King, J.J. (1996) Channel maintenance in drained Irish catchments: experimental strategies, ecological impacts and management implications. Ph.D. Thesis, National University of Ireland, 160pp.

King, J. J., O' G, M. F. and Curtin C, J. (2000) The Experimental Drainage Maintenance (EDM) programme: engineering and fisheries management interactions in drained Irish salmonid channels. Verh. Internat. Verein. Limnol. 27, 1532-1535.

King, J. J., Joyce T., Collins, M., O'Donaill , C. and, Rhatigan, V. (2002) Mitigating for fish and habitat: Fisheries-Engineering interactions in Flood Relief Schemes in Ireland, 1996-2002. In: O' Grady. M. F. (ed.) Proceedings of the 13th International Salmonid Habitat Enhancement Workshop, Westport, September, 2002. pp234-259. Dublin. Central Fisheries Board

Mackenzie, K., Longshaw, M., Begg, G.S., and McVicar, A.H. (1998). Sea lice (*Copepoda: Caligidae)* on wild sea trout (*Salmo trutta L.*) in Scotland. ICES Journal of Marine Science 55, 151-162.

McGinnity, P., Stone, C., Taggart, JB., Cooke, D., Cotter, D., Hynes, R., MaCamley, C., Cross, T. and Ferguson, A. (1997). Genetic impact of escaped farmed Atlantic salmon on native populations: use of DNA profiling to assess freshwater performance of wild, farmed and hybrid progeny an a natural river environment. ICES Journal of Marine Science, 54, No. 6.

McGinnity P., Prodöhl P., Ferguson A., Hynes R., Maoiléidigh N., Baker N., Cotter D.; O'Hea B., Cooke D., Rogan G., Taggart J., Cross T. (2003). Fitness reduction and potential extinction of wild populations of Atlantic salmon, Salmo salar, as a result of interactions with escaped farm salmon. Proceedings of the Royal Society: Biological Sciences, 270: 2443-2450.

McGinnity, P.Gargan, P.Roche, W. Mills, P. McGarrigle, M. (2003). Quantification of the freshwater salmon habitat asset in Ireland using data interpreted in a G. I. S. platform. Irish Freshwaterer Ecology & Management Series: No. 3, Central fisheries board.

Murphy, D. & ERFB (2004) The protection of fisheries habitat during construction and development works at river sites. Eastern Regional Fisheries Board fisheries protection guidelines.

NASCO,2003. Report of the North Atlantic Salmon Conservation Organisation 2002-2003. Report of the 20th meeting of the Council. 16pp

NASCO 2005 CNL (05) 45. Development of the NASCO Database of Irish Salmon Rivers. Report on Progress, May 2005. NASCO, Edinburgh

O' Grady, M. F. (1991a). Rehabilitation of salmonid habitats in a drained Irish river system, in Steer, M. W. Irish Rivers: Biology and Management, Royal Irish Academy, Dublin

O'Grady, M.F. (1991b). Ecological changes over 21 years caused by drainage of a salmonid stream, the Trimblestown. Irish Fisheries Investigation Series A, 33, 16pp.

O'Grady, M.F. (1981) A study of brown trout *(Salmo trutta L.)* population in selected Irish lakes. P.h.d. thesis NUI.

O' Grady & Curtin (1993). The Enhancement of Drained Salmonid Rivers in Ireland. The Enhancement of Drained Salmonid Rivers in Ireland-A bio-engineering perspective. Hydroecologie Applique, Tome 5, 2: 7-26

O'Grady.M.F.(2002).Salmonid Riverine Enhancement in Ireland Past, Present and Future. \Went Memorial lecture, 2002. Royal Dublin Society. Occasional Papers in Irish Science & Technology, No. 26, 24pp

O'Grady, M. (2006) Channels & Challenges. The Enhancement of salmonid rivers. Irish freahwater fisheries ecology & Management series No. 4, Central fisheries board, Ireland

O'Grady, M.F. and King, J.J. (1992). Ecological changes over 30 years caused by drainage of a salmonid stream, the Bunree River, Irish Fisheries Investigation Series A, 34, 16pp.

O'Grady, M.F. and Gargan, P G., (1993). Factors affecting salmon production in Irish catchments. ICES Statutory Meeting 1993.

O'Grady, M.F., Delanty, K. and Igoe, F. (2002a). Enhancement of brown trout spawning and nursery habitat, in the Lough Ennell \ catchment, \co. Westmeath, Ireland. In: O'Grady, M. F. (ed.) Proceedings of the 13th International Salmonid Habitat Enhancement Workshop, Westport, Ireland, Sept., 2002, pp78-92

O'Grady, M.F., P, Gargan, Delanty. K., Igoe, F, and Byrne, C. (2002b). Observations in relation to changes in some physical and biological features of the Glenglosh River Following bank Stabilisation. In: O'Grady, M. F. (ed.) Proceedings of the 13th International Salmonid Habitat Enhancement Workshop, Westport, Ireland, Sept., 2002, pp61-77

O' Maoiléidigh, N., Cullen, A., Mcdermott, T., Bond,. N. Mclaughlin, D. Grant,. F. Rogan, G. & Cotter, D.(2006) National Report for Ireland-The 2006 Salmon season.

Skilbrei, O.T and Wennevik, V. (2005) Survival and growth of sea-ranched Atlantic salmon treated against salmon lice prior to release. ICES Journal of Marine Science, Vol: 63, Issue: 7, pages 1317-1325.

Smith, B.D. (1980) The effects of afforestation on the trout of a small stream in Southern Scotland Fishery management 11, 39-58

Tully, O. and Whelan, K.F. (1993) Production of nauplii of *Lepeophtheirus salmonis* (Kroyer) (*Copepoda: Caligidae*) from farmed and wild salmon and its relation to the infestation of wild sea trout (*Salmo trutta L.)* off the west coast of Ireland in 1991. Fisheries Research 17, 187-200.

Tully, O., Gargan, P., Poole, W.R. & Whelan, K.F. (1999). Spatial and temporal variation in the infestation of sea trout (*Salmo trutta L.)* by the caligid copepod Lepeophtheirus salmonis (Kroyer) in relation to sources of infection in Ireland. Parasitology 119; 41-51.

Whelan, B.J., O'Connor,R. & McCashin, A.(1974).An economic evaluation of Irish Salmon fishing III. The commercial fishermen. The Economic & Social Research Institute Dublin

Appendix 1. Summary from Irelands Implementation Plan outlining the actions in response to the main threats affecting habitat in Irish rivers

Objectives, vision or goals		Protect the current productive capacity of the existing physical habitat of Atlantic salmon in Ireland	Restore the productive capacity of Atlantic salmon habitat which has been adversely impacted		
Obligations		Legal obligations under national legislation	EU Habitats Directive	EU Water Framework Directive	NASCO obligations

Delivery	**Action No.**	**Action**	**Outputs**	**Responsible agencies**	**Evaluated by**
Ongoing 2007 - 2015, completion by 2015	**HAB1**	National assessment of water quality impacts on fish stocks, including salmonids, and their habitat is currently carried being out under the WFD. Includes the designation of hundreds of operational sites (fish communities only) and surveillance sites (includes all parameters) which have been categorised by specific habitat type and quality.	Specific targets for water/habitat quality have been set under the WFD which must be met. Implementation of certain corrective programme of measures (POMS) arising from these evaluations.	Central and Regional Fisheries Boards(CFB/RFB), Environmental Protection Agency (EPA), National Parks and Wildlife Services (NPWS)	Dept. of Energy, Communications and Natural Resources (DECNR), Dept. of Environment (DOE), EU
Ongoing 2007 to 2011, completion by 2011	**HAB2**	River management plans being prepared for each river and the threats to individual river habitat will be identified	Threats will be identified and prioritised.	CFB/RFB, NPWS, EPA	Dept. of Energy, Communications and Natural Resources (DECNR), Dept. of Environment (DOE), EU
2007 - 2010	**HAB3**	Funding for remedial measures to be raised from the angling levy contributing to the Salmon Conservation Fund and Wild salmon fishery management initiatives - additional government funding	Remedial actions to be taken on specific prioritised rivers. 3 fish passage improvement and 32 river habitat rehabilitation projects funded to date.	CFB/RFBs.	DECNR
2007	**HAB4**	Update the NASCO rivers database	Update or improve the information on habitats	CFB/RFB, Marine Institute (MI)	NASCO
2008	**HAB5**	Improve the quantification of the	More precise estimate of habitat	CFB/MI, RFBs. Review by SSC	Standing Scientific

		National Freshwater Habitat Asset	sizes and types for estimation of CLs and river specific management and catch advice		Committee of the National Salmon Commission ((SSC(NSC))
Ongoing 2008 - 2010, completion by 2012	**HAB6**	OPW drainage plans Habitat rehabilitation on all drained rivers channels	Restoration of spawning and nursery areas on all drained rivers	Office of Public Works.	CFB/RFBs
Ongoing 2008 - 2010, completion by 2012	**HAB7**	Under the Water Framework Directive, the Shannon River Basin District is undertaking a review of the extent to which the morphology of Irish rivers has been damaged.	A report will be prepared for Government on recommendations for river enhancement with a view to implementing the requirements of the Water Framework Directive	Shannon River Basin District (ShRBD)	CFB/RFBs, EU

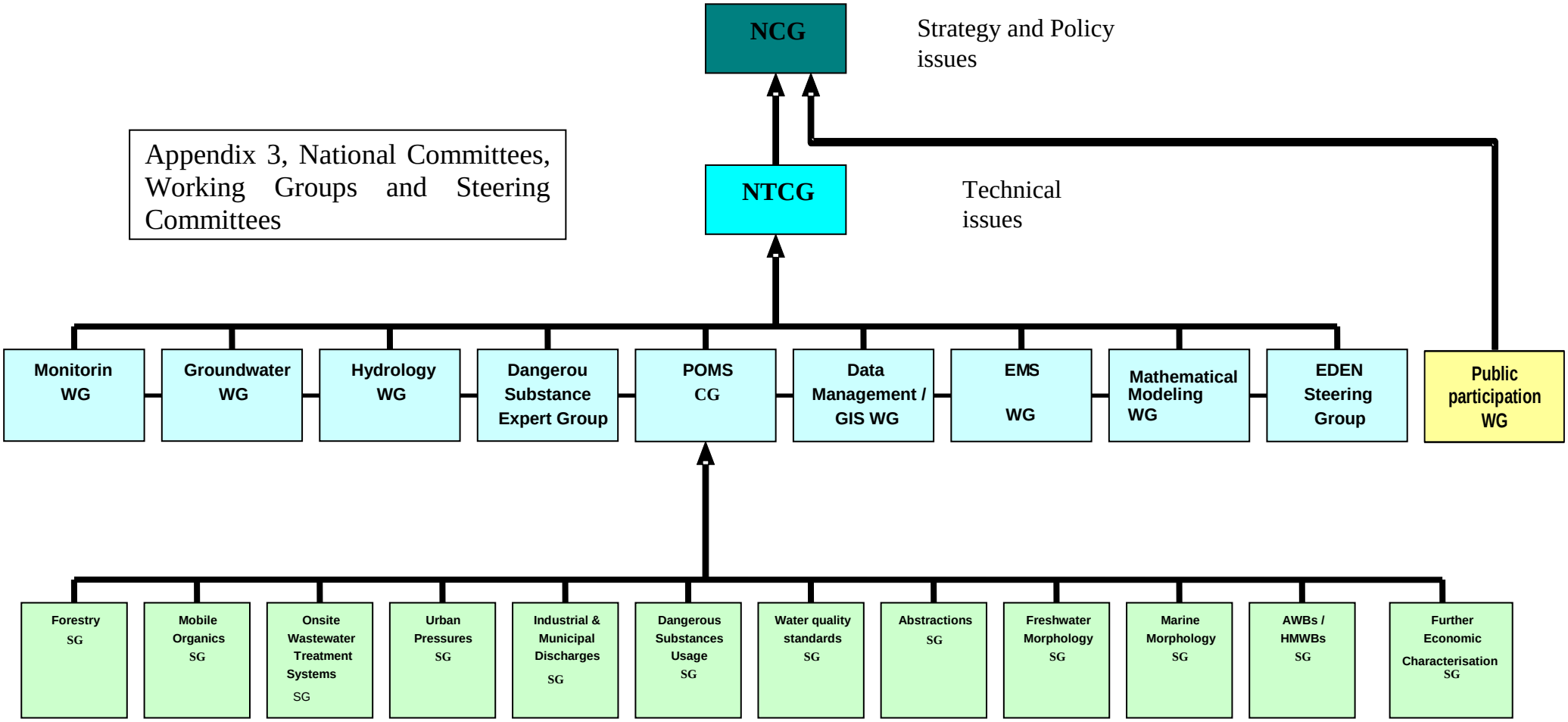
Appendix 2. Quantity of Salmon Habitat in Irelands 148 Salmon Rivers

River	Fisheries District	Total fluvial habitat (m^2)	Accessible fluvial habitat (m^2)	Total lacustrine habitat (m^2)	Accessible lacustrine habitat (m^2)
Flurry	Dundalk	53,530	53,530	0	0
Castletown	Dundalk	82,514	82,514	0	0
Fane	Dundalk	238,298	238,298	18,104	18,104
Glyde	Dundalk	933,025	933,025	1,142,900	1,142,900
Dee	Dundalk	1,128,973	1,065,384	430,364	430,364
Boyne	Drogheda	6,695,412	6,695,412	13,221,896	13,221,896
Liffey	Dublin	3,444,930	2,308,361	20,209,909	664,779
Dargle	Dublin	344,425	331,623	2,877	2,877
Vartry	Dublin	178,403	101,844	2,819,169	0
Avoca	Wexford	1,766,724	1,638,135	1,960,344	431,619
Owenavorragh	Wexford	449,362	449,362	0	0
Slaney	Wexford	4,945,255	4,945,255	13,366	13,366
Corock	Waterford	450,615	450,615	0	0
Owenduff	Waterford	128,171	128,171	0	0
Pollmounty	Waterford	55,719	55,719	0	0
Barrow	Waterford	6,548,527	6,495,633	12,473	12,473
Nore	Waterford	6,796,230	6,796,230	87,376	87,376
Black Water	Waterford	263,393	214,168	55,681	55,681
Lingaun	Waterford	221,793	221,793	0	0
Suir	Waterford	8,911,096	8,795,447	195,057	195,057
Clodiagh	Waterford	417,450	417,450	0	0
Mahon	Waterford	287,493	282,073	0	0
Tay	Waterford	179,556	179,556	0	0
Colligan	Waterford	217,306	217,306	0	0
Licky	Lismore	76,032	76,032	0	0
Finisk	Lismore	294,352	294,352	0	0
Glenshelane	Lismore	92,191	92,191	0	0
Blackwater	Lismore	7,728,122	7,701,703	34,401	34,401
Bride	Lismore	884,654	884,654	0	0
Tourig	Lismore	60,132	60,132	0	0
Womanagh	Lismore	204,956	204,956	0	0
Owenacurra	Cork	268,408	268,408	0	0
Lee	Cork	3,221,156	1,139,285	12,591,971	4,674
Bandon	Cork	1,663,070	1,652,104	556,405	556,405
Ardigeen	Cork	282,954	282,954	0	0
Ilen	Cork	848,826	698,138	0	0
Mealagh	Cork	213,617	61,384	20,148	0
Owvane	Cork	326,629	267,210	0	0
Coomhola	Cork	282,583	211,273	100,296	0
Glengarriff	Cork	162,540	162,540	534,956	534,956
Ardrigole	Cork	118,834	118,834	218,644	218,644
Kealincha	Kerry	88,633	88,633	0	0
Lough Fadda	Kerry	85,634	64,356	767,433	103,156
Croanshagh	Kerry	203,271	203,271	600,056	600,056
Owenshagh	Kerry	224,097	224,097	13,268	13,268
Cloonee	Kerry	65,639	51,564	2,377,093	2,146,267
Sheen	Kerry	428,784	417,944	0	0
Roughty	Kerry	869,984	869,984	183,061	183,061

Finnihy	Kerry	93,458	93,458	0	0
Blackwater	Kerry	353,999	353,999	398,044	398,044
Sneem	Kerry	247,232	247,232	296,178	296,178
Owreagh	Kerry	73,895	73,895	0	0
Currane	Kerry	270,377	266,976	15,547,809	15,274,805
Inny	Kerry	436,214	436,214	29,401	29,401
Emlaghmore	Kerry	50,539	50,539	0	0
Carhan	Kerry	59,917	59,917	0	0
Ferta	Kerry	132,368	132,368	0	0
Behy	Kerry	94,655	94,655	1,419,413	1,419,413
Caragh	Kerry	586,454	586,454	6,911,501	6,911,501
Cottoners	Kerry	116,938	109,263	322,055	26,290
Laune	Kerry	2,482,704	2,265,312	28,418,286	27,969,380
Maine	Kerry	961,799	961,799	0	0
Emlagh	Kerry	82,317	82,317	0	0
Owenascaul	Kerry	125,295	125,295	256,564	256,564
Milltown	Kerry	51,528	51,528	0	0
Feohanagh	Kerry	100,979	100,979	10,810	10,810
Owenmore	Kerry	65,361	65,361	543,775	543,775
Lee	Kerry	367,655	367,655	0	0
Brick	Limerick	490,616	490,616	0	0
Feale	Limerick	2,020,036	2,019,244	0	0
Galey	Limerick	629,442	629,442	0	0
Deel	Limerick	1,502,689	1,502,689	91,016	91,016
Maigue	Limerick	2,437,307	2,437,307	42,761	42,761
Shannon	Limerick	35,757,947	3,702,750	381,689,656	6,759
Owenagarney [Ratty] (River)	Limerick	459,282	459,282	3,080,973	3,080,973
Fergus	Limerick	1,270,553	1,270,553	5,216,536	5,216,536
Doonbeg	Limerick	244,268	244,268	67,632	67,632
Skivileen	Limerick	210,312	210,312	139,532	139,532
Annageeragh	Limerick	171,443	171,443	1,458,709	1,458,709
Inagh	Limerick	574,980	574,980	398,287	398,287
Aughyvackeen	Limerick	117,864	117,864	0	0
Aille	Galway	149,746	45,389	4,360	0
Kilcolgan	Galway	857,525	857,525	3,010,720	3,010,720
Clarinbridge	Galway	191,132	30,949	4,363	0
Corrib	Galway	6,719,329	4,038,058	276,932,006	171,210,357
Knock	Galway	62,281	62,281	569,502	569,502
Owenboliska	Galway	273,229	273,229	2,681,862	2,681,862
Cashla	Connemara	179,316	178,862	3,328,750	3,056,329
L. Nafurnac	Connemara	33,108	33,108	777,817	777,817
Screeb	Connemara	75,682	75,682	2,978,435	2,978,435
Owenmore	Connemara	579,653	524,049	10,938,296	10,511,222
Owenglin	Ballinakill	186,204	186,204	466,039	466,039
Dawros	Ballinakill	271,612	271,612	1,660,519	1,660,519
Culfin	Ballinakill	75,147	69,199	2,146,539	2,034,746
Erriff	Ballinakill	665,301	606,758	1,712,382	985,075
Bundorragha	Ballinakill	110,674	95,883	2,135,673	2,135,673
Carrownisky	Ballinakill	184,686	170,599	602,285	602,285
Bunowen	Ballinakill	329,659	291,177	132,740	31,929
Owenwee	Ballinakill	177,468	169,326	394,477	17,784
Newport	Bangor	512,934	493,143	4,108,524	4,108,524
Srahmore	Bangor	259,032	196,105	4,405,450	4,405,450

Owengarve	Bangor	86,608	86,608	0	0
Owenduff	Bangor	645,812	645,812	77,875	77,875
Owenmore	Bangor	1,386,308	1,386,308	9,716,482	9,716,482
Glenamoy	Bangor	274,259	260,000	0	0
Muingnabo	Bangor	142,564	142,564	0	0
Ballinglen	Ballina	162,656	162,656	0	0
Cloonaghmore	Ballina	545,722	545,722	18,653	18,653
Moy	Ballina	7,495,504	7,075,959	72,868,341	68,593,514
Brusna	Ballina	466,431	466,431	0	0
Leaffony	Ballina	90,486	90,486	0	0
Easky	Ballina	540,375	540,375	1,235,832	1,235,832
Ballysadare	Sligo	2,301,152	2,190,538	15,156,100	2,655,285
Garvogue	Sligo	1,376,884	1,376,884	15,700,844	15,700,844
Drumcliff	Sligo	226,737	195,882	1,146,017	1,146,017
Grange	Sligo	141,987	141,987	0	0
Duff	Ballyshannon	461,575	461,575	2,446	2,446
Drowes	Ballyshannon	611,703	562,314	22,242,496	22,242,496
Erne	Ballyshannon	6,457,264	10436	60558212	0
Abbey	Ballyshannon	107,691	107,691	1,196,249	1,196,249
Ballintra	Ballyshannon	392,356	158,131	2,301,371	158,660
Laghy	Ballyshannon	181,228	181,228	147,627	147,627
Eske	Ballyshannon	496,658	431,848	4,263,573	3,964,506
Eany	Ballyshannon	656,530	656,530	102,600	102,600
Oily	Ballyshannon	210,618	210,618	376,826	376,826
Bungosteen	Ballyshannon	175,143	154,911	239,144	3,187
Glen	Ballyshannon	359,004	356,998	629,681	66,729
Owenwee	Ballyshannon	69,079	69,079	453,143	453,143
Bracky	Letterkenny	109,650	109,650	0	0
Owentocker	Letterkenny	204,263	182,949	154,005	63,893
Owenea	Letterkenny	630,856	616,966	1,661,413	1,267,137
Gweebarra	Letterkenny	287,952	248,480	758,254	650,429
Owennamarve	Letterkenny	56,359	56,359	1,257,850	1,257,850
Gweedore	Letterkenny	118,319	111,149	1,500,716	1,500,716
Clady	Letterkenny	195,006	179,023	3,665,464	3,352,520
Glen	Letterkenny	41,307	37,455	0	0
Glenna	Letterkenny	72,633	72,633	36,282	36,282
Tullaghobegly	Letterkenny	78,626	78,626	1,331,457	1,331,457
Ray	Letterkenny	168,605	146,332	208,298	208,298
Lackagh	Letterkenny	436,109	375,778	4,454,288	4,301,184
Leannan	Letterkenny	1,167,125	1,167,125	4,826,205	4,826,205
Swilly	Letterkenny	394,241	380,213	237,707	237,707
Isle (Burn)	Letterkenny	183,078	183,078	0	0
Mill	Letterkenny	123,296	95,019	0	0
Crana	Letterkenny	433,536	383,036	161,244	161,244
Clonmany	Letterkenny	151,703	151,703	0	0
Straid	Letterkenny	78,092	67,152	0	0
Donagh	Letterkenny	141,449	141,449	0	0
Glennagannon	Letterkenny	126,111	120,435	181,149	181,149
Culoort	Letterkenny	71,714	71,714	0	0
Total		**159,299,803**	**111,863,902**	**1,052,364,769**	**442,789,056**

Appendix 3, National Committees, Working Groups and Steering Committees



Appendix 4, National Committees, River Basin District Steering Committees and RBD Management Groups.