Report of the Standing Scientific Committee of the National Salmon Commission

The Status of Irish Salmon Stocks in 2005 and Precautionary Catch Advice for 2006

Report of the Standing Scientific Committee of the National Salmon Commission - The Status of Irish Salmon Stocks in 2005 and Precautionary Catch Advice for 2006

Executive Summary

A **National Salmon Commission** was established in 1999 under the 1999 Fisheries (Amendment) Act along with a **Standing Scientific Committee** "***to advise and assist the Commission on all technical and scientific matters in relation to the performance of the Commission's functions."***

The purpose of this report, therefore, is to provide the technical and scientific information required by the National Salmon Commission in order to meet its terms of reference. This includes information on Irish salmon stocks, the current status of these stocks relative to the objective of meeting Conservation Limits (CLs), and the catch advice which will allow for a sustainable harvest of salmon into the future. The report also outlines the scientific advice process leading to the formulation and presentation of the catch advice for the 2006 season and whether or not national and international obligations are being met.

Prior to 2005, precautionary catch advice was provided on a district basis. With the establishment of the new terms of reference for the National Salmon Commission, (in particular Terms of Reference 1 and 5(g) and (h)), relating to Government policy, national objectives, national obligations and international obligations, it is necessary to examine all information available on a river by river basis and this now forms part of the advice process.

The reference point chosen by the Standing Scientific Committee to establish the status of individual or district stocks is the "maximum sustainable yield" or MSY.

The National Coded Wire Tag and Tag Recovery Programme currently provides information on the extent of mixed stock element of the commercial salmon fisheries. It has been estimated from coded wire tag returns that up to 50% of the catch of individual river tagged stock may be taken outside the fishery region where they originated and in most cases in several fishery regions.

There is also good evidence from this programme that exploitation rates averaging 10 to 12% (ICES 2005) may be possible on some southern UK stocks. Exploitation rates have not been calculated for other European stocks, but tagged salmon originating from France, Spain, Germany, Norway and Denmark have been captured in Irish drift net fisheries.

Analysis of the status of district stocks indicates that only 4 districts are meeting their Conservation Limits consistently (Cork, Kerry, Connemara, Ballinakill). Less than 50% of the Conservation Limit is being attained in 8 districts (Sligo, Shannon, Waterford, Dublin, Drogheda, Dundalk, Wexford, Galway). The remaining districts have consistently met over 50% of the Conservation Limit but less than 100% on average. Even in districts which met their Conservation Limits, some individual rivers within the district did not. Recent data suggests that four of seven rivers in Cork did

not meet their Conservation Limits. Similarly, four of nine rivers in Kerry, two rivers in Connemara, four of five rivers in Ballinakill, three of five rivers in Bangor, four of six rivers in Ballyshannon and five of 10 rivers in Letterkenny failed to meet Conservation Limits.

Marine survival is presently the lowest it has been since the present national assessment programme commenced in 1980. Data available from the Burrishoole index site indicates that the current marine survival is also lower than that recorded since the 1970's.

While the main focus of this report is on fisheries and fisheries effects, there are real concerns relating to factors causing mortality at sea such as predation by seals, diseases and parasites, marine pollution etc. However, there is insufficient empirical information to allow anything other than general advice to be given on these at this stage i.e. the more the effects of each individual factor can be reduced the more salmon will return to our coasts and rivers. Clearly, more directed investigations need to be carried out on these other factors.

Given the current poor marine survival conditions, the expectation of large catches is unrealistic at present and there should be a priority given to conservation rather than catch. Despite the recent reduced exploitation on stocks, many are falling well below their Conservation Limit. Due to their migratory nature, mixed stock fisheries pose particular threats to salmon stocks, especially those stocks which are below Conservation Limit.

Scientific advice is provided in the context of meeting both National and International obligations. In this regard the only situation where both can be met is where fisheries take place on stocks that are exceeding Conservation Limits, with the catch being limited to or less than the number of fish in excess of these Conservation Limits. Given the low level of stock generally, it is not currently possible to manage existing mixed stock fisheries (i.e. drift nets and some draft nets) such that only those stocks meeting their Conservation Limits will be caught and that only the number of fish in excess of the Conservation Limits for these stocks will be harvested.

The Standing Scientific Committee advises that :

- The overall exploitation in most districts should immediately decrease, so that Conservation Limits can be consistently met.
- Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to the status of individual stocks.
- Thus, the most precautionary way to meet national and international objectives is to operate fisheries on individual river stocks that are shown to be within precautionary limits i.e. those stocks which are exceeding their Conservation Limits.
- Fisheries operated in estuaries and rivers are more likely to fulfil these requirements.

It is recognised that it may not, for practical reasons, be possible to move to single stock fisheries immediately. In the event that a mixed stock fishery takes place in

2006, a precautionary catch table is provided based on the most recent district analyses.

The Status of Irish Salmon Stocks in 2005 and Precautionary Catch Advice for 2006

Introduction

Until recently, the Irish fishery for salmon (*Salmo salar*) was managed by a combination of effort limitation and the application of technical conservation measures relating to size and type of fishing gear. While these measures regulate the efficiency of the fishery, they are not sensitive to the stock available, and allow the same level of fishing even when stocks are low. In recognition of this and growing evidence both nationally and internationally of a widespread decline in salmon stocks, a **National Salmon Commission** was established in 1999 under the 1999 Fisheries (Amendment) Act. The Commission was reconstituted in 2005 with the following terms of reference:

1. To consider how best the wild salmon resource may be managed, conserved and exploited on a sustainable basis, having regard in particular to Government policy.

2. To consider what conservation management mechanisms might be required to achieve the alignment of national and district total allowable catches and quotas with scientific advice given to it by the Standing Scientific Committee not later than 31 March 2007.

3. To propose how an objective balance between competing interests in the salmon fishery may be obtained within the framework of the conservation management mechanism as necessary.

4. To engage, as appropriate, in a proactive dialogue with representatives of bodies and organisations prescribed for the purposes of section 55A(2)(b) of the Fisheries Act 1980 and other relevant persons and objectively evaluate any proposals they may have to achieve the alignment referred to in paragraph 2, having regard to the conservation, management, protection and development of the national salmon resource and to make practical recommendations to the Minister in this regard.

5. To consider in relation to the making of any practical recommendations under paragraph 4 the following points:

(a) best practice internationally,
(b) technical rules such as net size, lure type, etc.,
(c) enforcement measures,(d) catchment management,
(e) compensatory measures, including detailed costings of them, and details of how they are to be resourced,
(f) adjustments to fishing seasons,
(g) national obligations under relevant legislation of the European Communities,

(h) how the work of the Standing Scientific Committee may be better co-ordinated so that its scientific advice to the Commission reflects the needs of individual ecosystems
(i) how the private sector may best contribute to the promotion of effective management, development, sustainable exploitation and conservation of wild stocks of salmon, and
(j) a timeframe within which the Commission considers specific recommendations should be implemented.

6. To have regard, without prejudice to paragraphs 4 and 5, that any recommendations that may be made in relation to any compensatory measure must be predicated on the basis the Minister will not contribute to any funding that may be required for any measures that may be recommended, unless a public good is identified, justified and quantified.

Under the 1999 Fisheries (Amendment) Act, provision was made for the establishment of a **Standing Scientific Committee (SSC)**:

"***to advise and assist the Commission on all technical and scientific matters in relation to the performance of the Commission's functions."***

The SSC is selected by the National Salmon Commission and comprises scientific advisers drawn from the Marine Institute, Central Fisheries Board, the Environmental Protection Agency, National Parks and Wildlife Service, Bord Iascaigh Mhara, The Loughs Agency, and the Department of Agriculture and Rural Affairs for Northern Ireland (Appendix I). Although drawn from these agencies, the advice from the SSC is independent of the parent agencies.

Prior to 2005, precautionary catch advice was provided on a district basis. With the establishment of the new terms of reference for the National Salmon Commission, (in particular Terms of Reference 1 and 5(g and h), relating to Government policy, national objectives, national obligations and international obligations, it is necessary to examine all information available on a river by river basis and this now forms part of the advice process.

The purpose of this report, therefore, is to provide the technical and scientific information required by the National Salmon Commission in order to meet its terms of reference. This includes information on Irish salmon stocks, the current status of these stocks relative to the objective of meeting Conservation Limits (CLs), and the catch advice which will allow for a sustainable harvest of salmon into the future. The report also outlines the scientific advice process leading to the formulation and presentation of the catch advice for the 2006 season and whether or not national and international obligations can be met currently. A guide to these obligations is given below.

National Objectives

Government Policy

Government Policy (see http://www.dcmnr.gov.ie/Marine/Inland+Fisheries/)
for Irish salmon stocks is stated as :

To conserve the inland fisheries resource in its own right and its viability and economic and social contribution at national, local and community level.

The Governments strategic objectives are to **:**

- Ensure the effective conservation, primarily through the Fisheries Boards, of inland fish habitats and stocks.
- Deliver effective and value for money management of the inland fisheries service.
- Ensure effective legislative and regulatory framework for inland fisheries.
- Encourage sustainable development of the commercial and recreational fishing resource.

International Obligations

In the provision of advice the National Salmon Commission must also consider Irelands international obligations regarding catch advice and attainment of Conservation Limits. Some of these are outlined below.

The North Atlantic Salmon Conservation Organisation (NASCO)

Ireland, as part of the EU, is also a signatory to the NASCO Convention. The primary management objective of NASCO is :

'to contribute through consultation and co-operation to the conservation, restoration, enhancement and rational management of salmon stocks taking into account the best scientific advice available'.

In 1998, the North Atlantic Salmon Conservation Organisation (NASCO, 1998) to which the EU is a Contracting Party on behalf of member States, adopted the "precautionary approach" to fisheries management (as outlined in FAO, 1995, 1996). The NASCO Agreement on the Adoption of the Precautionary approach states, that

'*an objective for the management of salmon fisheries is to provide the diversity and abundance of salmon stocks'*

or in other words to maintain both the productive capacity and diversity of salmon stocks. NASCO provides interpretation of how this is to be achieved. Management measures should be aimed at maintaining all stocks above their Conservation Limits by the use of management targets. Socio-economic factors could be taken into account in applying the Precautionary Approach to fisheries management issues. The precautionary approach is an integrated approach that requires, *inter alia*, that stock rebuilding programmes (including as appropriate, fishery management actions, habitat improvements and stock enhancement) be developed for stocks that are below Conservation Limits.

The International Council for the Exploration of the Sea (ICES)

ICES provide advice to NASCO for the management of fisheries in the North Atlantic (Report of the Advisory Committee on Fisheries Management 2005) particularly the mixed stock fisheries of West Greenland and Faroes. General advice is also provided for homewater fisheries as follows:

- Stocks should be maintained above Conservation Limits
- The only fisheries for salmon should be on river stocks that are shown to be above Conservation Limits
- For stocks below Conservation Limits catches should be reduced to increase the probability of meeting the CL.
- Due to the different status of individual stocks within regions, mixed stock fisheries present particular threats to stock status.

The EU Habitats Directive

Council Directive 92/43/EEC (on the conservation of natural habitats and of wild flora and fauna) states that :

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

The North Atlantic salmon (*Salmo salar* L.) has been included as one of the species covered by the Directive. From an Irish perspective, there are currently 26 Irish salmon rivers listed which fall specifically under the directive (Appendix II). However, in applying the Directive consideration must be given to all of the populations and not just specifically to these 26 rivers.

The conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the its territory (also defined) and this *conservation status* will be taken as 'favourable' when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis…"

The directive specifically allows for provision to be made for management measures for salmon, if their conservation status so warrants, including the prohibition of certain means of capture or killing, whilst providing for the possibility of derogations on certain conditions.

Under the terms of the Directive, every 6 years member states are obliged to submit a report detailing the conservation status of their salmon stocks. The first such report is due to be submitted in 2007. Member States will be obliged to take measures to ensure that the exploitation of salmon stocks is compatible with their being maintained at a favourable conservation status. Such measures may include:

- temporary or local prohibition of the taking of salmon in the wild and exploitation of certain populations,
- regulation of the periods and/or methods of taking salmon,
- application, when salmon are taken, of hunting and fishing rules which take account of the conservation of such populations,
- establishment of a system of licences for taking salmon or of quotas,
- regulation of the purchase, sale, offering for sale, keeping for sale or transport for sale of salmon.

Conservation Limits and Scientific Advice

It is clear from a reading of the Governments strategy, National objectives and International obligations that ***conservation*** of salmon stocks is a central requirement. However, in order to provide advice on conservation, it is necessary for the Standing Scientific Committee to establish a conservation "reference point" which can be measured and used to assess the status of stocks.

The Salmon Management Task Force (Anon., 1996) provided the following advice regarding conservation of stocks:

- *Salmon Management will be based on the premise that there is a definable number of spawners for a given river*

- *Sustainable exploitation can take place if there is a surplus of fish over spawning requirements*

The Task Force proposed the application of a Total Allowable Catch (TAC) to allow sufficient fish to spawn to meet these "spawning requirements".

In 1998, the **North Atlantic Salmon Conservation Organisation** (NASCO, 1998) adopted the precautionary approach to fisheries management (as outlined in FAO, 1995, 1996). Central to this was agreement that management measures should be aimed at maintaining all salmon stocks in the NASCO Convention Area above pre-agreed Conservation Limits. The CL for Atlantic salmon is defined by NASCO as

"the spawning stock level that produces long term average maximum sustainable yield as derived from the adult to adult stock and recruitment relationship".

Both the Salmon Management Task Force and NASCO describe a biological reference point, which can be used to assess if salmon stocks are reproducing in sufficient quantities to generate the next generation of salmon. Salmon stocks home to their natal river to spawn and as the number of spawning fish increases, then the number of juveniles increases and also the number of migrating smolts increases.

This generally means that the number of adults returning in the following year as 1 sea-winter salmon (or grilse) or in subsequent years 2 sea-winter or multi-sea winter salmon also increases. These older fish usually return in the springtime and are often referred to as spring salmon.

However, there is a limit to the number of juvenile salmon any river can support due to competition for food and space. The addition of more spawning salmon can reach a point where they are not contributing to additional production of juveniles. In this regard, these fish are not contributing to spawning and can be harvested in a sustainable manner. As each river holds a unique spawning population, which has evolved to survive best in that rivers environment, and there is little straying of salmon from one river to another, a Conservation Limit can be associated with each individual river stock.

As both the Salmon Management Task Force advice and the NASCO definition are compatible, the reference point chosen by the SSC to establish the status of individual or district stocks is the maximum sustainable yield or MSY.

This point can be clearly identified from Stock/Recruitment curves, which are used extensively in fisheries science and fisheries management. ICES in particular has stressed that this is a **Limit Reference Point** i.e. it sets a boundary that defines safe biological limits within which the stocks can produce a long term maximum sustainable yield. It therefore sets the constraints within which the management strategy must operate to maintain a sustainable resource. Individual salmon stocks may well exceed this limit but should not be allowed to fall below the Conservation Limit.

Ideally river specific stock and recruitment analysis would be the most accurate way to determine river specific Conservation Limits (Crozier *et al.,* 2004). However, the acquisition of these relationships are resource intensive as they require a long time scale to cover several generations and a wide range of stock levels. It will, for the foreseeable future, be necessary to transport CLs from data-rich rivers to data-poor rivers (Prévost *et al*., 2004). To this end a Bayesian hierarchical modelling framework has been developed to transport stock and recruitment information between rivers and to set Conservation Limits accordingly (Crozier *et al.,* 2004, Ó Maoiléidigh *et al.,* 2004).

The Bayesian analysis of this hierarchical model has been developed from a set of 13 stock and recruitment data series from monitored salmon rivers located in the Northeast Atlantic. The model yields a set of predicted stock and recruitment parameters for new rivers, provided information is available on the size of the river (in this case usable habitat or wetted area is used) and on the rivers latitude. Details of the model specification and its Bayesian treatment are given in Prevost et al, (2003) and their application to Irish rivers in Ó Maoileidigh *et al*., 2004. The wetted area is computed from statistically combined parameters: the length of upstream river, upstream catchment area, stream order, and local gradient interpolated from aerial photography within a GIS platform (McGinnity *et al.,* 2003). The latitude value used is the river catchment area mid-point.

Irish Mixed Stock Fisheries

The migratory behaviour of the Atlantic salmon presents many opportunities for their interception, and a wide range of fisheries have developed, operating in rivers, estuaries, coastal waters and the open ocean. There is no agreed definition of mixed stock fisheries for salmon. Any definition should be related to the primary fishery management objective, which is to maintain river stocks within precautionary limits. Mixed stock fisheries might therefore be defined as any fisheries for salmon operating outside estuary limits. By this definition, tThe Irish mixed stock fisheries (predominantly drift nets as few if any draft nets operate outside of an estuary) accounted for approximately 68% of the salmon catch nationally in 2005 with 13.5% going to draft net fisheries and 16.6% going to the angling fisheries. The remainder (1.9%) are taken in snap nets, loop nets and other fixed engines. In each district salmon are captured that are destined for the rivers belonging to that district but fish are also taken that are returning to rivers in other districts. There is some geographical adherence as fishing boats belonging to each district are confined to an area within 6 miles of the statutorily defined boundary of that district and report their catch accordingly.

The National Coded Wire Tag and Tag Recovery Programme currently provides information on the extent of mixed stock element of the commercial salmon fisheries. It has been estimated from coded wire tag returns that more than 50% of the returning stock may be caught outside the fishery region where they originated and in most cases in several fishery regions (Figure 1).

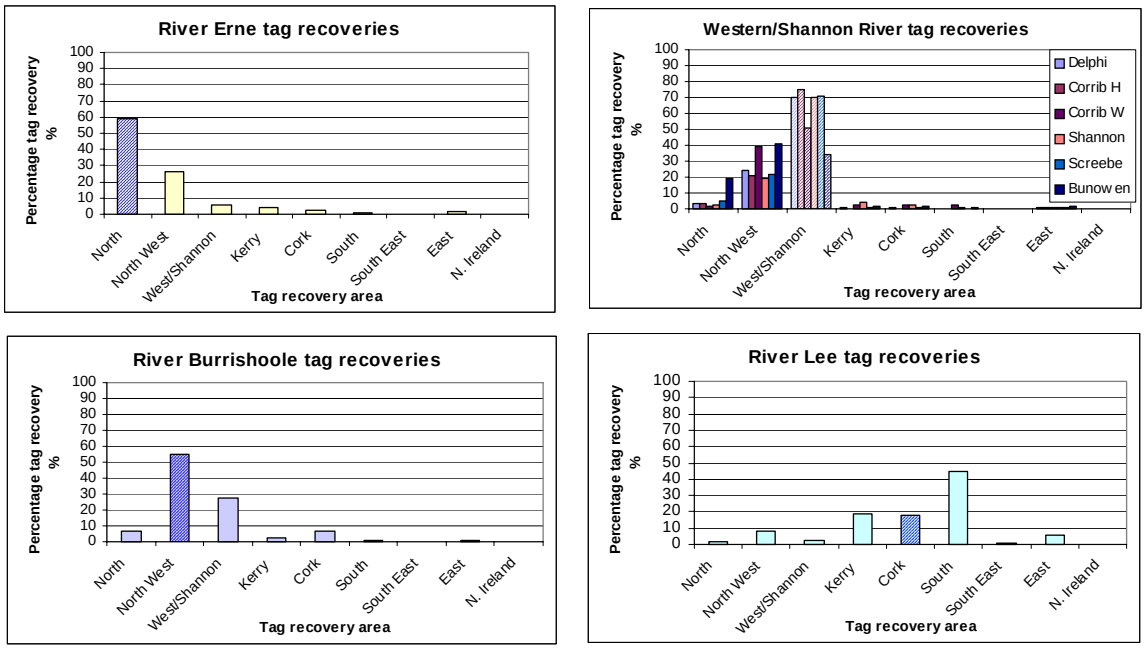

Figure 1 The average distribution of coded wire tag recoveries by tag recovery area (after 1997 when the fishery was restricted from 12 to 6 miles) including those recovered in freshwater (i.e. percentage of total tag recovery). Striped bars indicate the area from which the tagged fish were released e.g. River Erne fish released in the Northern area.

There is also good evidence from this programme that exploitation rates averaging 10 to 12% (ICES 2005) may be possible on some southern UK stocks. Exploitation rates have not been calculated for other European stocks, but tagged salmon originating from France, Spain, Germany, Norway and Denmark have been captured in Irish drift net fisheries.

	Countries of Origin								
Fishing year	**Ireland**	**N. Ireland**	**England/Wales**	**Scotland**	**France**	**Spain**	**Norway**	**Denmark**	**Germany**
1985	-	-	35	647	-	-	-	-	-
1986	**5,052**	-	155	802	-	-	-	-	-
1987	**2,450**	572	264	260	-	-	-	-	-
1988	**4,442**	627	658	401	-	-	-	-	-
1989	**2,833**	466	313	78	28	-	-	-	-
1990	**14,261**	153	514	375	9	-	-	-	-
1991	**15,945**	677	175	175	-	-	-	-	-
1992	**8,690**	820	204	10	10	-	-	-	-
1993	**9,352**	490	288	6	3	23	3	-	-
1994	**10,209**	247	229	9	-	11	3	-	-
1995	**5,793**	153	442	12	186	9	-	69	-
1996	**2,691**	302	237	31	3	9	-	3	-
1997	**17,994**	418	109	-	-	5	-	-	-
1998	**8,573**	133	88	18	-	42	-	36	-
1999	**12,322**	137	351	-	6	21	-	104	3
2000	**14,204**	379	280	5	2	42	-	-	2
2001	**7,956**	871	237	-	-	35	-	-	0
2002	**9,555**	260	122	6	-	18	-	-	3
2003	**18,136**	198	92	0		58			0
TOTAL	**152,321**	**6,703**	**4,703**	**2,834**	**247**	**216**	**6**	**213**	**9**

Table 1 The estimated number of tagged salmon originating from each country which are caught in Irish mixed stock fisheries.

While the recaptures of some countries salmon may be small, the potential for interception of non-Irish salmon in Irish mixed stock fisheries is shown. However, the scale of this interception and whether these represent a significant source of mortality cannot be assessed without more precise information on the levels of returns to the rivers of release and any other interceptory fisheries (legal and illegal, homewaters and international) which may also be operating. Similarly, some countries such as Scotland have not tagged in many years so information is lacking. Similarly, some countries do not tag consistently and this also must be taken into account when interpreting the relative contribution of tag recoveries from various countries. However, these recovers provide the only evidence of interception of non-Irish origin salmon in the Irish fishery.

Assessment Methodology

Information and data

Every effort is made to monitor the performance of stocks (attainment of Conservation Limits) at both the river and district level and consequently to assess the status of individual and aggregated district stocks. Several sources of information are used in this process.

Commercial catch data -The commercial catch statistics are an important source of quantitative information, particularly in determining the size of the returning stock and the attainment of district Conservation Limits. Catch records are obtained from commercial salmon dealers' registers and are available for the period 1971-2000. Following implementation of the wild salmon and sea trout tagging scheme which commenced in 2001 (Ó Maoileidigh *et al.,* 2001; Anon 2004), the catch data are derived from the logbook returns of commercial and recreational fishers.

Rod catch data - The reported rod catch from the wild salmon and sea trout tagging scheme is adjusted to take into account the numbers of fish that have been caught by anglers who have not returned their logbook. The adjustment follows Small (1991). Exploitation by angling is generally between 10% and 20% of the total river stock available (Shelton *et al.,* 2001). Therefore this range of values is used to provide an estimate of the total standing stock in the river prior to angling taking place and the number of spawners remaining after the fishery. It is recognised that some rod exploitation rates will fall outside this range e.g. they are possibly higher than 20% in very well fished rivers such as Ballysadare, Corrib, Moy etc. Account will be taken of these exceptions in the formulation of advice. In the main, however, the fish counter data suggests that there is good coherence between the adjusted rod catch and spawning escapement levels. As an example, the estimated spawning escapement into Irish rivers in 2004 was 184,382 1SW salmon (ICES 2005). The estimated rod catch in 2004 was 26,202 (Wild Salmon & Sea Trout Tagging Scheme) suggesting a national rod exploitation rate of approximately 14%, well within the range suggested. This assessment approach is best applied where there is a consistent level of fishing activity in the river system. For many small rivers this will not be the case. Consequently, for rivers with an estimated Conservation Limit of 200 or less or where the average reported rod catch, between 2001 and 2004, is 10 or less, this assessment approach is not applied.

Total traps and counters - Data from the Burrishoole river, which is a national and international salmon index river system, provides a direct measure of performance of an Irish salmon stock.

Count data are available for up to 17 fish counters nationally, since 2001. In interpreting the count data and utilising them as measures of the attainment of Conservation Limit, the following approach has been adopted. It is assumed that all of the downstream counts up to the end of May represent out-migrating kelts i.e. fish ascending the river in the previous year. The downstream count from June to December is then subtracted from the upstream count in the same period to provide the "net" run of fish. This corrects for fish counted upstream but which may then come back downstream. The ratio of salmon to sea trout, obtained during video analysis (resistivity counters) or image analysis (infra-red counters), and is applied to

fish observed over the entire run in order to determine the number of salmon in the run. The Slaney and Cork Blackwater counts are raised by a factor of two to allow for the partial nature of these counts. It is acknowledged that this may be an underestimate but until other verification is obtained provides at least a minimum count. For those counters where the possibility of fish moving over the weir has been reported (e.g. Bandon), the recorded count is raised by a further 10%. In those situations where the majority of the rod catch is made above the counter, the rod catch is subtracted from the fish counter record.

National Coded Wire Tagging and Tag Recovery - The programme was initiated in 1980 to estimate marine survival of Irish salmon stocks and exploitation rates by high seas fisheries, and home water commercial and recreational fisheries (Browne, 1982). A 1 mm long magnetised tag, etched with a specific batch code is injected into the nose cartilage of juvenile fish, usually pre-smolts. The code identifies the origin and release conditions of any fish subsequently recaptured. The adipose fin is removed to facilitate the identification of these fish in the recovery programmes. Tagging has taken place using over 10 hatchery stocks and between 1 and 3 wild salmon stocks. Since 1980, up to 200,000 salmon have been individually examined each year to identify coded wire tagged salmon and recover these tags. Over 50% of the declared catch has been examined in some years. In 2005, over 44,000 salmon were examined representing approximately 30% of the declared catch. Information is also collected from in-river traps and broodstock returns to allow a complete return of fish to be estimated and providing invaluable information on marine survival and exploitations rates for these tagged stocks.

Other data - Information on juvenile abundance indices derived from electro fishing surveys carried out annually may also be a useful surrogate of stock performance and will be developed in the future.

Water Quality Assessment - The Environmental Protection Agency (EPA) carries out a triennial survey of the biological elements of water quality at over 3,300 monitoring stations on main river channels. These surveys derive a biological quality rating or 'Q value' of waters at each monitoring station. Recent studies carried out by the Central Fisheries Board (T. Champ, *pers. comm.*) correlating the presence or absence of individual fish species to water quality (Q values) indicate that there is a relationship between juvenile salmon distribution and water quality. A GIS database was developed to link river habitat with water quality data provided in the Environmental Protection Agency's (EPA) 'Biological River Monitoring Programme'. A custom GIS automated function determines the Q value for each river by a geographical cross-reference to the corresponding element in the water quality database. Water quality statistics are taken directly from McGinnity *et al.* (2003) and are included in Appendix III (Supporting Information).

Estimating the total returns of salmon and spawning stocks

Estimates are made of the total ***returns*** prior to the fisheries taking place and the ***spawners*** remaining after the fisheries using a run reconstruction approach similar to that described by Potter and Dunkley (1993) and Rago *et al.* (1993). Following Potter *et al.* (1998) the model takes the catch in numbers of 1SW salmon in each district, then raises it to account for exploitation rates and estimates of non-reported catches.

The two last parameters are generated from the National Coded Wire Tagging and Tag Recovery Programme (Browne, 1982; Ó Maoileidigh *et al*., 1996) described above.

In those districts where there are no specific exploitation rate data, the maximum and minimum exploitation rates either nationally or based on regional indices are used. Exploitation rate data for individual districts are based on the estimated range of values for the rivers monitored in the Coded Wire tagging programme in those districts or the next nearest districts.

Unreported rates prior to 2000 are based on best information available to Departmental Fisheries Inspectors in that period. After 2000 and with the introduction of carcass tagging and logbooks, these unreported rates have been reduced to account for the increase in the proportion of the legal catch now being declared. As unreported catch cannot be estimated precisely, minimum and maximum values likely to encompass true values are provided, based on local information or inspection. The spawning population is estimated by subtracting the catch from the returns.

Provision of Harvest Guidelines

Once estimates of average spawners, average catch, and district Conservation Limit (CL) are produced, harvest options are provided along with the associated probability of meeting the District Conservation Limit (Figures 2 to 4). It should be noted that as the harvest increases, the chances of meeting the Conservation Limit decreases. Following the procedure used by ICES for the provision of catch advice for West Greenland, the harvest option that provides a 0.75 probability level (or 75% chance) of meeting the Conservation Limit in a given district is highlighted. The average catch (2002 to 2005 by all methods) is also shown for comparative purposes. In following a precautionary approach, increases over the average catch for the period 2002 to 2005 should not be permitted even if the harvest option at the 75% probability of meeting the Conservation Limit is higher. This is because each district fishery catches salmon destined for other districts and there is clearly a need to protect vulnerable stocks in these other districts. This advice will be reviewed annually to assess any improvement in the status of these vulnerable stocks. Where there is no harvest option which will provide a 75% chance of meeting the district Conservation Limit, then there is no surplus of fish to support a harvest (commercial or rod). Based on the current mixed stock fisheries, examples of the risk outputs and application of the harvest guidelines are shown in Figures 2 to 4. These risk plots show the probability of meeting or exceeding the district Conservation Limit and the harvest options by all methods (commercial and rods) of one sea winter (1SW) salmon

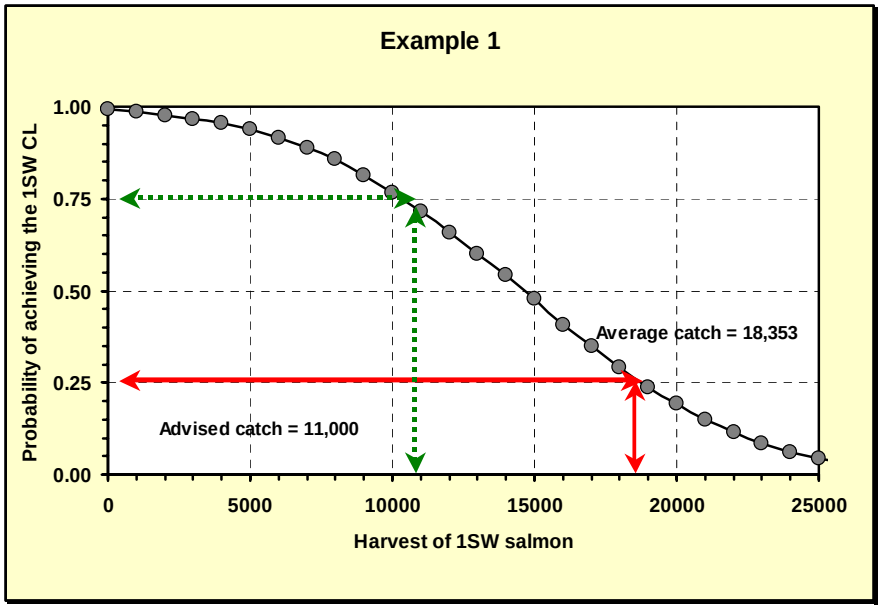

Figure 2 Example 1 district risk plot. The average catch for this district (2001 to 2005, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 18,358 1SW salmon. At this level of harvest there is only a 25% chance that the Conservation Limit will be met. The harvest option which provides a 75% chance of meeting the Conservation Limit is approximately 11,000 1SW salmon.

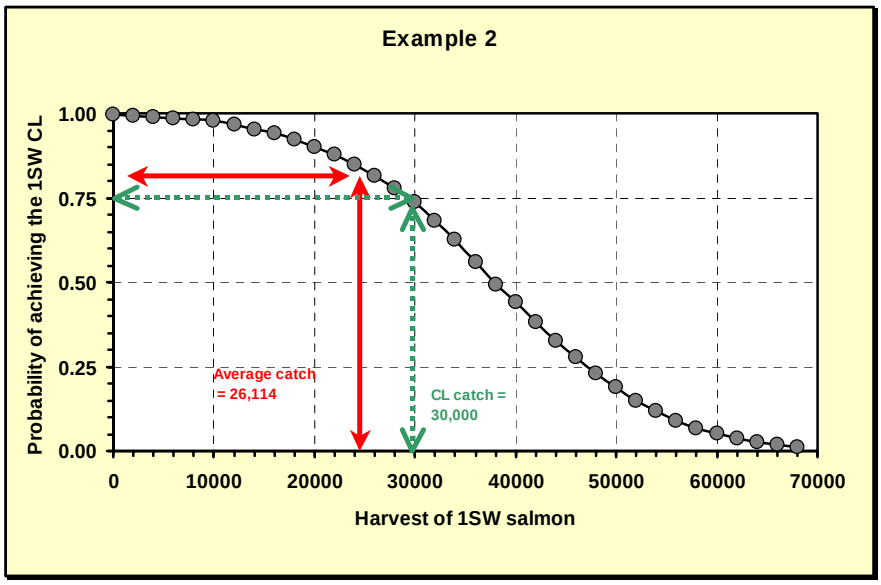

Figure 3 Example 2 district risk plot: The average catch for this district (2001 to 2005, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 26,114 1SW salmon. At this level of harvest there is a greater than 75% chance that the CL will be met. The harvest option, which provides a 75% chance of meeting the CL, is approximately 30,000 1SW salmon. As the average catch is lower than the harvest option at 75%, the lower catch is selected as the precautionary catch. This is because this district fishery catches salmon destined for other districts and there is clearly a need to protect vulnerable stocks in these other districts. Until significant improvements in these stocks occur the average catch when lower should be considered.

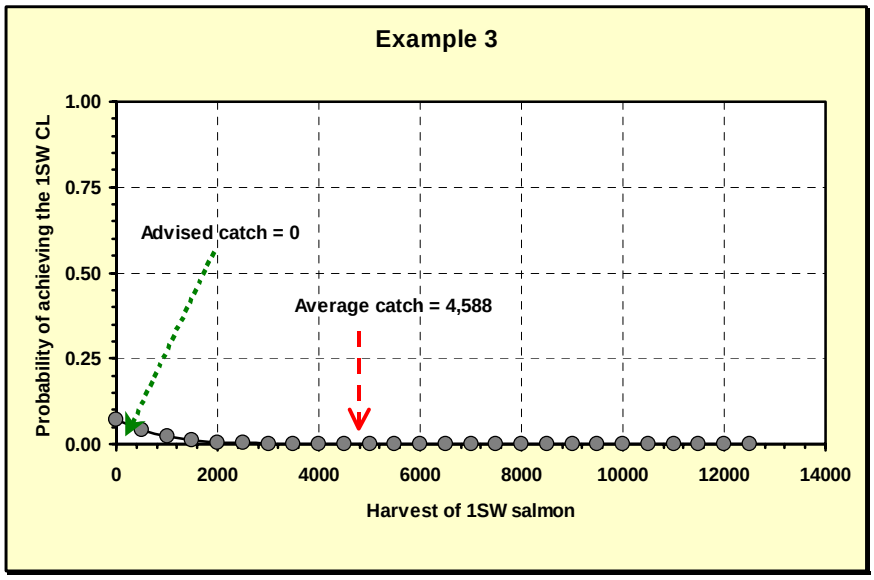

Figure 4 Example 3 district risk plot: The average catch for this district (2001 to 2005, all methods, excluding sea trout and hatchery fish, but including an unreported catch) was 4,588 one-sea winter salmon. At this level of harvest there is no chance that the CL will be met. Similarly, there is no harvest option, which provides 75% chance of meeting the CL. In this instance there is no surplus fish over spawning requirements to support a harvest (commercial or rod). This also suggests that mixed stock fisheries in other districts impacting on this district should also be curtailed.

A schematic of the scientific procedure leading to the Precautionary Catch Advice is shown below in Figure 5

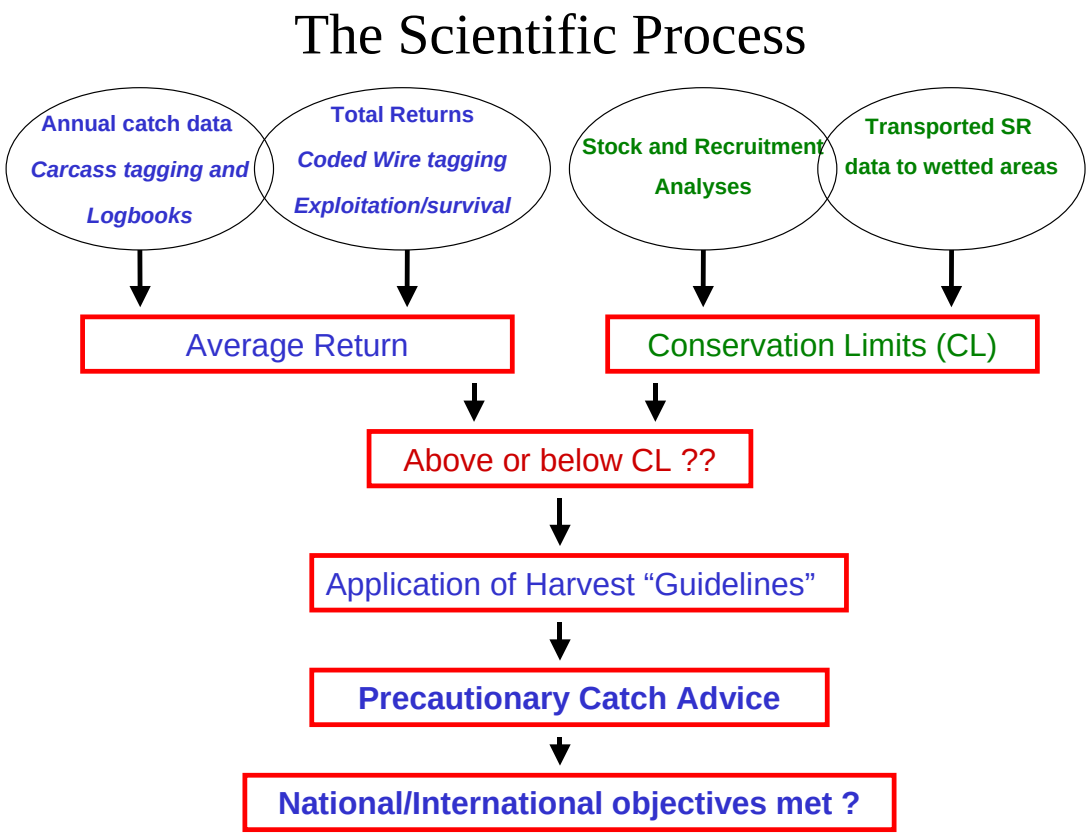

Figure 5 The Scientific process for the provision of catch advice for Irish salmon stocks

The National Overview

District Conservation Limits

Conservation Limits for each district are derived by aggregating the individual river Conservation Limits for each rivers in that district (Figure 6). The requirement varies considerable from district to district with the Waterford District requiring over 45,000 spawners to meet its requirement compared to less than 2,000 salmon required for spawning in Connemara.

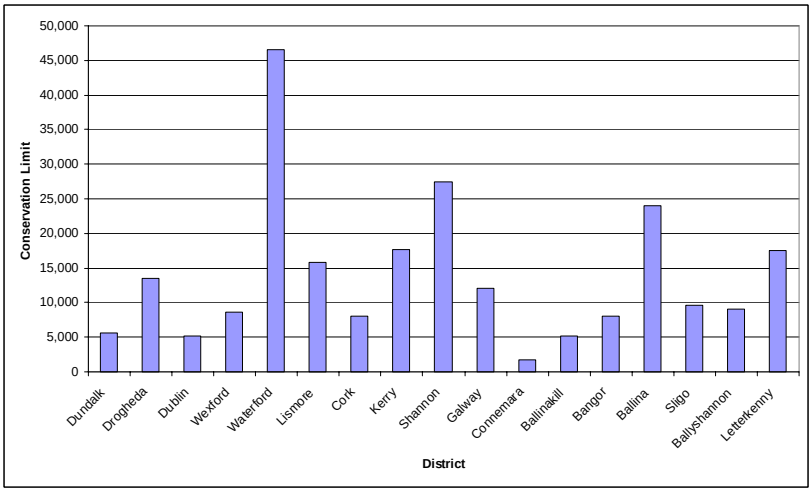

Figure 6 Number of salmon required for spawning (aggregated rivers in the districts) for each salmon fishing district in Ireland

Status of Aggregated National Stocks

Wild salmon production nationally (i.e. returns to the coast) was highest from 1970 and 1975, peaking at approximately 1.8 million 1SW salmon in 1975 (Figure 7)..

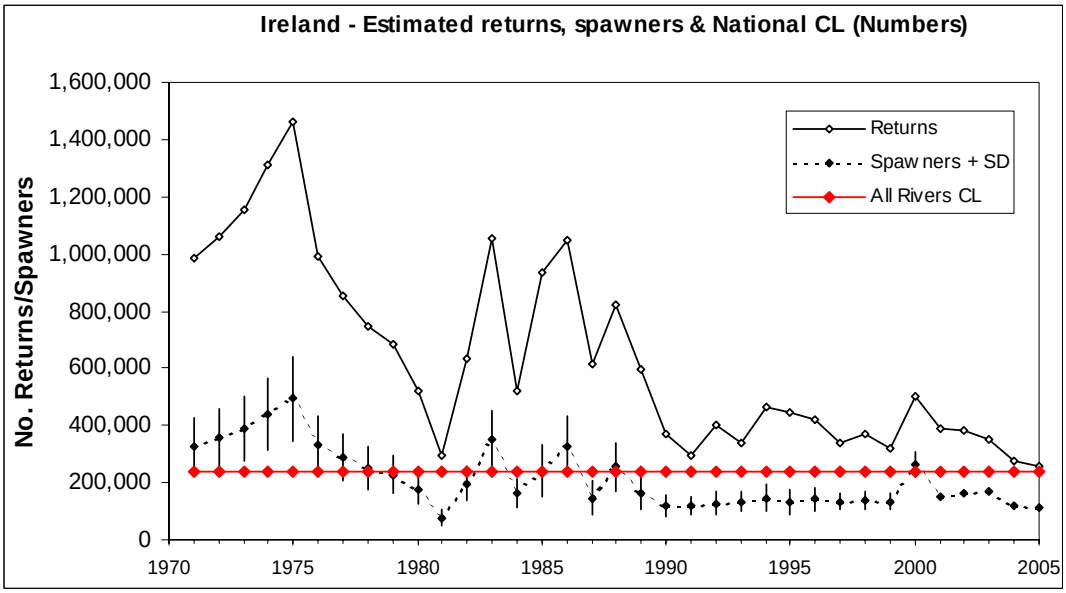

Figure 7 Estimated returns of salmon to the coast, spawning stock after fisheries and Conservation Limit for all individual rivers stocks combined.

From 1975, salmon production decreased significantly, with some recovery during the 1980's. However, since 1990, the national production has been much lower with on average just over 400,000 salmon being produced. There is now less than a third of the fish returning to the coast compared to the 1970's. The spawning stock has fluctuated in the same way as the overall returns with the highest spawning stock recorded for the 1970's. Despite meeting the national Conservation Limit in 25 of the previous 35 years, since 1981, the aggregated spawning stocks have fluctuated around the Conservation Limit, with periods during the 1990's where it consistently failed to achieve the spawning requirement. It is currently estimated that on average, between (2001 and 2005) only 70% of the aggregated one–sea winter (1SW) Conservation Limits was being attained. The estimated Irish 1SW spawning stock in all rivers in 2005, based on district catch statistics, was 157,870 fish.

As the aggregated salmon stock is made up of a large number of discrete river specific populations it is more important to examine the patterns and information at least on a district and preferably on a river by river basis. This information is presented in Appendix III. Only 4 districts are meeting their Conservation Limits consistently (Cork, Kerry, Connemara, Ballinakill). Less than 50% of the Conservation Limit is being attained in 5 districts (Sligo, Shannon, Waterford, Dublin, Drogheda). The remaining districts have consistently met over 50% of the Conservation Limit but less than 100% on average. Even in districts which did meet their Conservation Limits, some individual rivers did not. Recent data suggests that four of seven rivers in Cork did not meet their Conservation Limits, four of nine rivers in Kerry, two rivers in Connemara, four of five rivers in Ballinakill, three of five rivers in Bangor, four of six rivers in Ballyshannon and five of 10 rivers in Letterkenny.

Catch Rates

Indices of catch rate (or exploitation i.e. the catch of salmon relative to the total number of fish available to be caught) have been estimated for wild and hatchery reared salmon from the National Coded Wire tagging and Tag Recovery Programme since 1981 (Figure 8).

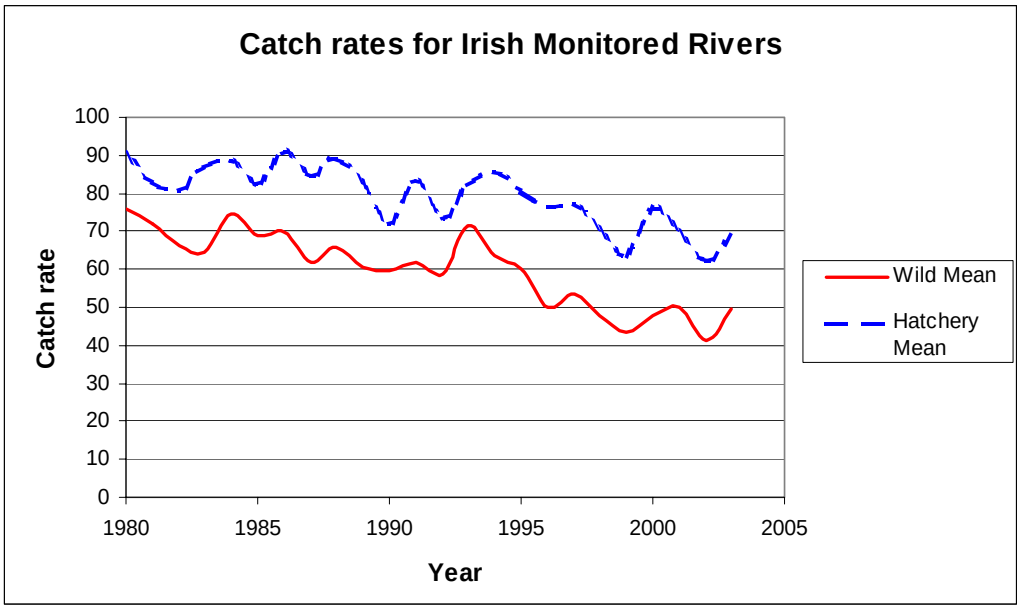

Figure 8 Average catch rates on wild and hatchery salmon stocks

Generally these rates are higher on hatchery-reared fish, but for both indices exploitation rates have decreased since the 1980's. This is probably due to a combination of technical conservation methods such as a reduction of the fishing area to six miles and of a reduction in fishing effort, and as a consequence of reduced stock sizes retuning to the coast. Currently, about 50% of the wild fish and between 60% and 70% of hatchery-reared fish, which return to the coast, are caught.

Marine Survival

Although there has been considerable fluctuation, estimates of marine survival prior to 1996 for wild stocks were generally higher compared to more recent years with survival rates in excess of 20% (i.e. 20 adult returns to the coast for every 100 smolts migrating, Figure 9).

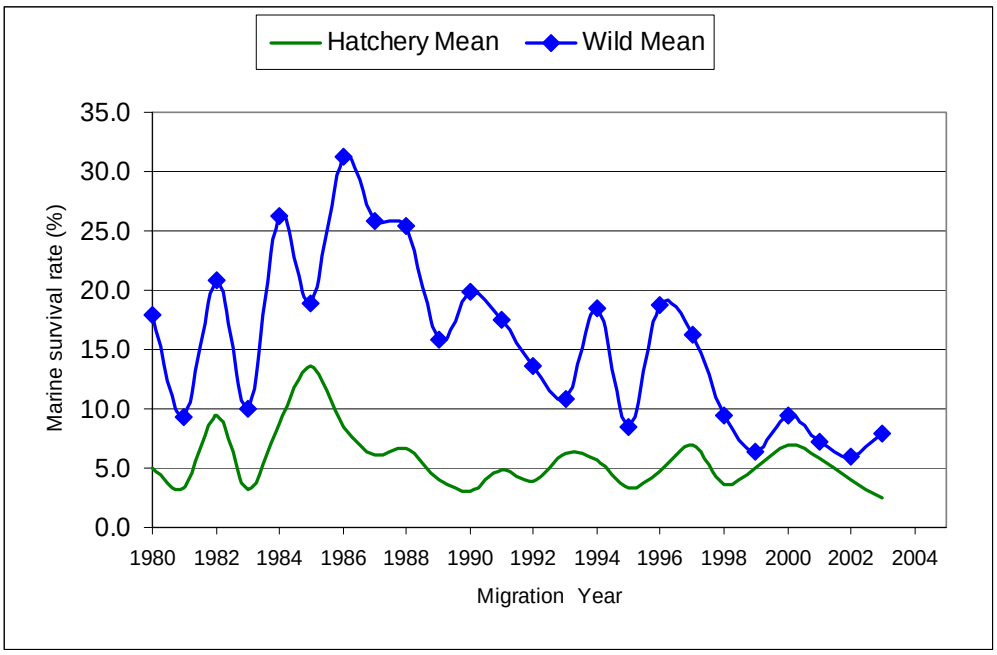

Figure 9 Marine survival (from smolt release to return to the coast) for wild and hatchery salmon.

The current estimates suggest that less than 10% of the wild smolts that go to sea from Irish rivers are surviving (i.e. less than 10 adults returning for every 100 smolts migrating). Survival rates from hatchery fish are usually lower than for wild fish. The decline is not as apparent for hatchery reared fish, although the highest survival values were also recorded in the 1980's.

Marine survival is influenced by many factors (Figure 10). While the main focus of this report is on fisheries and fisheries effects, there are real concerns relating to factors causing mortality at sea such as predation by seals, diseases and parasites, marine pollution etc. However, there is insufficient empirical information to allow anything other than general advice to be given on these at this stage i.e. the more the effects each individual factor can be reduced the more salmon will return to our coasts and rivers. Clearly more directed investigations need to be carried out on these other factors.

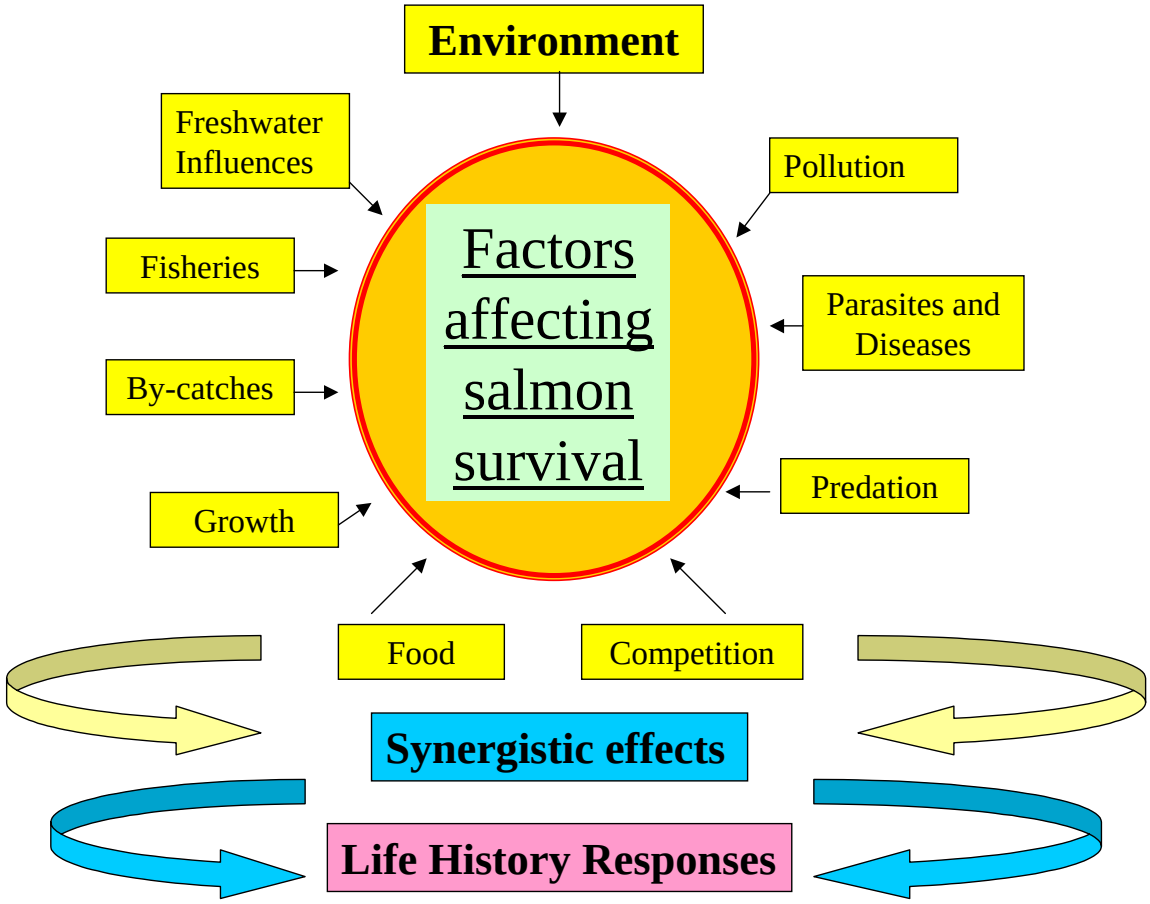

Figure 10 The factors which individually and synergistically affect the marine survival of salmon and which cause significant changes to life history responses such as population structure, fitness and size.

Conclusions

As the terms of reference of the National Salmon Commission now require assessments for each ecosystem (i.e. each river), other sources of information for individual rivers (e.g. fish counts, in-river catch, habitat quality) are examined in the supporting information (Appendix III) in this report and also form part of the assessment process.

Marine survival is presently the lowest it has been since the present assessment programme commenced in 1980 and probably since the 1970's also considering the information available for the Burrishoole index site. There are also indications from data sets going back further than 1970, that the 1970s and 1980's were a period of unusually high abundance with high marine survivals (Boylan and Adams, *in press*). Given the current levels of poor survival, the expectation of large catches is unrealistic at present and priority should be given to conservation rather than catch.

Despite the recent reduced exploitation on stocks, many are falling well below their Conservation Limit. Mixed stock fisheries pose threats, particularly to those stocks which are below Conservation Limits. The current district assessment, although necessary to provide estimates of returns and spawners, assumes that the catch in the district originates from rivers within that district alone. Given the evidence from the Coded Wire Tagging returns (Figure 1), this is not the case in reality but there is insufficient information available to identify every stock contributing to each district mixed stock fishery. Therefore extra caution is required when interpreting the output from the district analyses.

Where districts are shown to be meeting Conservation Limits, this uncertainty in the actual catch composition, particularly in districts with highly mixed fisheries and large catches may suggest a higher surplus of fish than actually available for capture within that district. For example, the Kerry district represents 7.5% of the available habitat nationally, yet captures, on average (2001-2005), approximately 15.5% of the national catch. The discrepancy between the potential of rivers in the Kerry district to produce fish based on available freshwater habitat and the number of fish being caught in the fishery illustrates that caution is required when interpreting the output from the district analyses particularly in relation to the potential harvest available. (Appendix III).

Similarly, analysis of information available for individual rivers in Connemara and Ballinakill suggest that the majority of rivers in these districts are not meeting Conservation Limits. However, the district analysis suggests that the Conservation Limit is being met at the district level (Appendix III) in both districts. In this instance, it is likely that many of the fish caught in these district mixed stock fisheries do not originate from these districts.

The difficulty in separating out the individual stocks contributing to the mixed stock fisheries means that the management of these fisheries should be highly precautionary. A research programme to examine more specifically the extent of mixed stock fisheries in Ireland has been funded under the National Development Plan and it is envisaged that outputs from this will be beneficial in increasing the resolution of the current mixed stock fisheries information provided in the National Coded Wire Tagging and Tag Recovery programme. In this way it will be possible to show the extent of the mixed stock fisheries and in particular those stocks particularly vulnerable to exploitation.

It is also likely that in a number of districts, interceptory fisheries have been sustained by the artificial releases of large numbers of hatchery smolts. For example, commercial fisheries in the Ballinakill district, contrary to the national trend, have significantly increased, coincident with the annual release of approximately 100,000 smolts in the region. Consistent large-scale releases of hatchery fish in rivers without terminal traps to remove the returning adults may ultimately lead to a reduction in the genetic “fitness” and subsequently the returns of wild populations in the same river (McGinnity et al, 2004).

Twenty-one Irish stocks were classified according to NASCO guidelines in a recent appraisal as being “threatened with loss” ((NASCO, CNL05/45). Based on updated

analysis (Appendix III) at least 49 Irish salmon population may be threatened with loss. It is also likely that this is an underestimate as no data are available for approximately 80 small rivers without counters or where the rod catch was insufficient to carry out an assessment. The salmon populations in at least nine rivers have been consistently achieving and exceeding Conservation Limits, including the Bandon, Kerry Blackwater, Feale, Erriff, Owenmore/Owenduff in Mayo, Laune, Moy, Easky, and Drowes. Characteristically, these are clean, large rivers with complex population structure i.e. early run fish, late run fish, early maturing fish, late maturing fish, wide smolt age distribution etc.

Scientific Advice

Scientific advice is provided in the context of meeting both National and International obligations. In this regard the only situation where both can be met is where fisheries take place on stocks that are exceeding Conservation Limits, with the catch being limited to or less than the number of fish in excess of these Conservation Limits. Given the low level of stock generally, it is not currently possible to manage existing mixed stock fisheries (i.e. drift nets and some draft nets) such that only those stocks meeting their Conservation Limits will be caught and that only the number of fish in excess of the Conservation Limits for these stocks will be harvested.

The Standing Scientific Committee advises:

- The overall exploitation in most districts should be immediately reduced, so that Conservation Limits can be consistently met.
- Furthermore, due to the different status of individual stocks within the stock complex, mixed stock fisheries present particular threats to the status of individual stocks.
- Thus, the most precautionary way to meet national and international objectives is to operate fisheries on river stocks that are shown to be within precautionary limits i.e. those stocks which are exceeding their Conservation Limits.
- Fisheries operated in estuaries and rivers are more likely to fulfil these requirements.

In order to manage single stock in-river fisheries, river specific stock information will be required from at least one of the following: counters, catch data, tagging studies, juvenile assessment, redd counts. These data exist for many rivers in the country and are probably sufficient to facilitate management of single stock fisheries in the short term (i.e. 1 to 2 years). However, there are a significant number of rivers, predominantly small rivers with small but important stocks, which would require some specific assessment in order to manage the stocks in the longer term.

Operation of Mixed Stock Fisheries in 2006

It is recognised that it may not, for practical reasons, be possible to move to single stock fisheries immediately. In the event that mixed stock fisheries take place in 2006, the precautionary catches in the district analysis in Table 2 can be used as a guidance to the **maximum** catch which should be considered. Given the uncertainty in the origin of the catch in each district and the need to adopt a

precautionary approach, further reductions should be considered in all districts where catches are indicated.

In adopting the numerical advice below the following should be noted. The district analysis suggests that there is little chance the Dundalk, Drogheda, Dublin, Wexford, Waterford, Shannon, Galway, Sligo districts will meet their Conservation Limit given the continued likelihood of poor returns. Therefore, there should be no harvest of salmon originating in these districts. Even with the closure of these fisheries, as salmon from these districts will be caught in mixed stock fisheries in other districts then National objectives and the International obligations outlined in this report will not be met.

The district analysis suggests that Lismore, Connemara, Ballinakill, Bangor, Ballina, Ballyshannon and Letterkenny would have a 75% chance of meeting the Conservation Limits in all rivers if the catch was reduced as indicated (Table 2). However, as the analysis is not sensitive to the mixed nature of the catch, this may result in rivers within these districts not meeting their Conservation Limits and may also fail to adequately protect stocks in other districts, which are below their Conservation Limits. In this instance, National objectives and the International obligations presented in this report will not be met.

REGION	DISTRICT	2001-2005 Average Spawners	2001-2005 Est. Avg. Catch excl. hatchery, STrt incl. Unrecorded & rods	District CL Simultaneous attainment of CL in all rivers	Precautionary catch of wild salmon with 75% probability of meeting CL
EAST	Dundalk	2,383	881	5,641	No surplus
EAST	Drogheda	5,904	2,166	13,468	No surplus
EAST	Dublin	403	68	5,214	No surplus
EAST	Wexford	4,147	1,362	8,688	No surplus
SOUTH	Waterford	13,541	15,969	46,605	No surplus
SOUTH	Lismore	9,630	11,723	15,835	1,500
S.WEST	Cork	19,826	26,114	8,096	26,114
S.WEST	Kerry	22,114	28,353	17,718	28,353
SHANNON	Shannon	11,149	16,181	27,397	No surplus
WEST	Galway	4,990	4,588	12,128	No surplus
WEST	Connemara	2,039	1,874	1,779	1,400
WEST	Ballinakill	6,643	6,135	5,150	5,000
N.WEST	Bangor	7,421	10,132	8,091	7,500
N.WEST	Ballina	19,761	26,794	24,030	18,000
N.WEST	Sligo	3,852	5,181	9,577	No surplus
NORTH	Ballyshannon	8,727	11,514	9,029	7,500
NORTH	Letterkenny	13,908	18,359	17,597	11,000

Table 2 In the event that mixed stock fisheries take place in 2006, then the precautionary catches in the district analysis above should be considered as a guidance to the **maximum** catch by all methods (including angling) as indicated. In providing numerical district catch advice for 2006, the most recent five year average was maintained for catches, returns and spawners.

As the rod catch data and the exploitation rate data for 2005 are not available until 2006, the average for the same period was used. Also, for the 2005 analysis, exploitation rate indices where standardised.

In the case of Cork and Kerry the district analysis suggests that if only the average catch is taken then there is a 75% chance that all rivers in these districts will meet

their Conservation Limits. Again as the analysis is not sensitive to the mixed nature of the catch, this may result in rivers within the district not meeting their Conservation Limit and may also fail to adequately protect stocks in other districts which are below their Conservation Limits. In this instance, National objectives and the International obligations presented in this report will not be met.

Given the specific nature of the National Salmon Commissions new terms of reference, the Standing Scientific Committee will need to consider the status of multi-sea winter stocks which to date have not been included in the precautionary catch advice. This may have implications for the catch advice in 2007. Similarly, as many rivers are far below their Conservation Limits and reducing or eliminating fisheries alone will be insufficient to allow them meet their Conservation limits in the short term, future advice will need to incorporate other stock rebuilding strategies for particular rivers.

Acknowledgements

Particular thanks are extended to Dr. Gerald Chaput (DFO, Canada) who provided considerable advice on risk analysis, E.C.E Potter (CEFAS, UK) for developing the district models and to Dr. Étienne Prévost (INRA, France) who provided the Bayesian Hierarchical Stock and Recruitment analysis.

We also wish to acknowledge the significant contribution of the Marine Institute, Aquaculture and Catchment Management Services Area, particularly Dr. Ken Whelan, Dr. Russell Poole, Dr. Deirdre Cotter, Anne Cullen, Tom McDermott, Ger Rogan, Nigel Bond and Denis McLaughlin who provide information from the National Coded Wire Tagging and Tag Recovery Programme and the Fish Counters programme.

The CEOs and staff of the Regional and Central Fisheries Boards are also gratefully acknowledged for the salmon catch data and provision of river-specific information used in this report.

Technical inputs from Paul Mills (Compass Informatics) and Andrew Long (River Monitoring technologies) are also acknowledged with gratitude.

Finally, thanks are also due to the staff of the Department of Communications, Marine and Natural Resources, Members of the National Salmon Commission and particularly the Chair of this Commission, Mr. Joey Murrin for their keen interest and patience as this process has evolved.

References

Anon. 1996. Making a new beginning in salmon management. Report of the Salmon Management Task Force. Government Publications, Molesworth Street, Dublin. 68 pp.

Anon. 2004. Wild salmon and sea trout tagging scheme: Fisheries statistics report 2001–2003. Central Fisheries Board, Ireland. 40 pp.

Boylan, P and Adams CA. The influence of broad scale climatic phenomena on long term trends in Atlantic salmon population size: an example from the River Foyle, Ireland. J.Fish.Biol. *in press*

Browne, J. 1982. First results from a new method of tagging salmon – the coded wire tag. Fishery Leaflet, Marine Institute, Dublin, 114. 10 pp.

Crozier, W. W., Potter, E. C. E., Prévost, E., Schon, P–J., and Ó Maoiléidigh, N. 2003. A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the north-east Atlantic (SALMODEL – Scientific Report Contract QLK5–1999–01546 to EU Concerted Action Quality of Life and Management of Living Resources). Queen's University of Belfast, Belfast. 431 pp.

FAO. 1995. Precautionary approach to fisheries. Fisheries Technical Paper, 350, Part 1. 52 pp.

FAO. 1996. Precautionary approach to fisheries. Fisheries Technical Paper, 350, Part 2. 210 pp.

McGinnity, P., Gargan, P., Roche W., Mills, P., and McGarrigle M. 2003. Quantification of the freshwater salmon habitat asset in Ireland using data interpreted in a GIS platform. Irish Freshwater Fisheries Ecology and Management Series, Central Fisheries Board, Dublin, 3. 131 pp.

McGinnity, P., Prodohl, P., Ferguson, A., Hynes, R.,Ó Maoiléidigh, N., Baker, N., Cotter, D., O'Hea, B., Cooke, D., Rogan, G., Taggart, J. and 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. *Proc. R. Soc. Lond.* B (2003) 270, 2443–2450

NASCO. 1998. North Atlantic Salmon Conservation Organisation. Agreement on the adoption of a precautionary approach. Report of the 15th annual meeting of the Council. CNL(98)46. 4 pp.

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

Ó Maoiléidigh, N., Browne, J., Cullen, A., McDermott, T., and Keatinge, M. 1994. Exploitation of reared salmon released into the Burrishoole river system. ICES Document, CM 1994/M: 9. 6 pp.

Ó Maoiléidigh, N., Browne, J., McDermott, T., Cullen, A., Bond, N., O'Farrell, M., and Rogan, G. 1996. Marine survival and exploitation of Irish salmon stock. *In* Irish Marine Science 1995, pp.16–22. Ed. by B. F. Keegan and R. O'Connor. Galway University Press. 124 pp.

Ó Maoiléidigh, N., McLaughlin, D., Cullen, A., McDermott, T., and Bond, N. 2001a. Carcass tags and logbooks for managing Irish salmon stocks. In Catchment Management – Proceedings of the 31st Annual Study Course of the Institute of Fisheries Management, pp 40–48. Ed. by C. Moriarty. Trinity College, Dublin. 129 pp.

Ó Maoiléidigh, N., Potter, E. C. E., McGinnity, P., Whelan, K. F., Cullen, A., McLaughlin, D., and McDermott, T. 2001b. Attainment of conservation limits in the Burrishoole River, Co. Mayo, Ireland since 1980 – implications for local management. ICES Theme Session on Setting Conservation Limits for Salmon. ICES Document, CM 2001/M: 08. 14 pp.

Ó Maoiléidigh N., Potter E. C. E., McGinnity P., Whelan K. F., Cullen A., McLaughlin D., and McDermott T. 2001c. The significance and interpretation of net catch data. *In* Proceedings of the Atlantic Salmon Trust Symposium on the Interpretation of Rod and Net Catch Data, Lowestoft, 2001, pp. 15–30. The Atlantic Salmon Trust, Pitlochry. 107 pp.

Potter, E. C. E., and Dunkley, D. A. 1993 Evaluation of marine exploitation of salmon in Europe. *In* Salmon in the Sea, and New Enhancement Strategies, pp. 203–219. Ed. by D. Mills. Fishing News Books, Oxford. 424 pp.

Potter, E. C. E., Hansen, L. P., Gudbergsson, G., Crozier, W. W., Erkinaro, J., Insulander, C., MacLean, J., O'Maoileidigh, N. S., and Prusov, S. 1998. A method for estimating preliminary conservation limits for salmon stocks in the NASCO–NEAC area. ICES Document, CM 1998/T: 17. 11 pp.

Potter, E. C. E., and Nicholson, M. 2001. A simple model for estimating biological reference points from noisy stock–recruitment data. Theme session on developing conservation limits – recent progress and reviews. ICES Document, CM 2001/M: 04. 6 pp.

Prévost, E., Chaput, G., and Chadwick, E. M. P. 2001. Transport of stock–recruitment reference points for Atlantic salmon. *In* Stock, Recruitment and Reference Points – Assessment and Management of Atlantic Salmon, pp. 95–135. Ed. by E. Prévost and G. Chaput. Hydrobiologie et Aquaculture, INRA, Paris. 223 pp.

Prévost, E., Parent, E., Crozier, W., Davidson, I., Dumas, J., Gudbergsson, G., Hindar, K., McGinnity, P., MacLean, J., and Sættem, L. M. 2003. Setting biological reference points for Atlantic salmon stocks: transfer of information from data-rich to sparse-data situations by Bayesian hierarchical modelling. ICES Journal of Marine Science, 60: 1177–1194.

Rago, P. J., Reddin, D. G., Porter, T. R., Meerburg, D. J., Friedland, K. D., and Potter, E. C. E. 1993. A continental run reconstruction model for the non-maturing component of North American Atlantic salmon: analysis of fisheries in Greenland and Newfoundland–Labrador, 1974–1991. ICES Document, CM 1993/M: 25. 11 pp.

Shelton R.G.J 2001. The significance and interpretation of net catch data. *In* Proceedings of the Atlantic Salmon Trust Symposium on the Interpretation of Rod and Net Catch Data, Lowestoft, 2001, The Atlantic Salmon Trust, Pitlochry. 107 pp.

Appendix I Members of the Standing Scientific Committeee of the National Salmon Commission 2000 to 2006

Dr. N. Ó Maoiléidigh (Chair) – Marine Instituite
Dr. P. Boylan – The Loughs Agency
Dr. N. Connolly (to 2001)– Coastal Research Centre, University College, Cork
Dr. W. Crozier – Department of Agriculture and Rural Development for Northern Ireland
Ms. Marie Dromey (to 2005) – National Parks and Wildlife Service
Dr. P. Gargan – Central Fisheries Board
Dr. M. McGarrigle – Environmental Protection Agency
Dr. P. McGinnity – Marine Institute
Dr. Ferdia Marnell (from 2005) – National Parks and Wildlife Service
Dr.Vera O'Donovan – Bord Iascaigh Mhara
Dr. C. O'Keeffe – National Parks and Wildlife Service

Invited contributors

Dr. F. Grant – Central Fisheries Board
Dr. E. de Eyto – Marine Institute
Dr. W. Roche – Central Fisheries Board

Appendix II Rivers designated as Special Areas of Conservation for Salmon in Ireland (EU Habitats Directive), wetted area and associated one - sea winter salmon (1SW) Conservation Limit in number of fish

District	River	Wetted area m^2	1SW CL
Drogheda	Boyne	6,695,412	13,204
Wexford	Slaney	4,945,255	2,343
Waterford	Barrow	6,495,633	11,124
Waterford	Nore	6,796,230	11,061
Waterford	Suir	8,795,447	13,646
Lismore	Blackwater	7,701,703	11,128
Kerry	Blackwater	353,999	498
Kerry	Currane	266,976	352
Kerry	Laune	2,265,312	3,168
Kerry	Caragh	586,454	807
Shannon	Feale	2,019,244	2,990
Shannon	Mulkear	3,702,750	6180
Galway	Corrib	4,038,058	7,800
Connemara	Cashla	178,862	322
Connemara	Owenmore	524,049	1007
Ballinakill	Owenglin	186204	344
Ballinakill	Erriff	606,758	1,202
Bangor	Newport	493,143	1,037
Bangor	Srahmore	196,105	615
Bangor	Owenduff	645,812	1,374
Bangor	Glenamoy	260,000	583
Ballina	Moy	7,075,959	14,810
Sligo	Ballysadare	2,190,538	4,715
Sligo	Garvogue	1,376,884	3,111
Ballyshannon	Eske	431,848	1,050
Ballyshannon	Drowes	562,314	1,283
Letterkenny	Owenea	616,966	1,584
Letterkenny	Gweebarra	248,480	629
Letterkenny	Lackagh	375,778	1,002
Letterkenny	Leannan	1,167,125	3,347

Appendix III Supporting District Information and Analyses