Department of Culture, Arts and Leisure

The development of Salmonid Catchment Management Plans for Northern Ireland: best practice, protocols and background information

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Executive Summary

This report sets out the rationale, process, content and format for preparing Salmonid Catchment Management Plans (SCMPs) in Northern Ireland, with supporting technical guidance. SCMPs are river specific documents prepared by DCAL staff. They are to be developed to a timetable as part of the over-arching National Salmon Plan for Northern Ireland and contain the management actions for salmon and sea trout fisheries as developed in consultation with stakeholders.

Fisheries and related environmental management responsibilities currently lie across several NI Executive departments (principally DCAL, DARD and the NIEA) and their agents, leading to potential disconnection and inefficiencies. SCMPs show the areas where cohesive, coordinated actions are needed to protect and enhance fisheries in order to maximise their socio-economic benefits to communities and the country.

Through the National Salmon Plan, the information and data on salmon stocks and their habitats will be reported to the North Atlantic Salmon Conservation Organisation as part of the obligations to the NASCO agreement, to which Northern Ireland is a signatory through the UK and EU delegation.

A feature of the plans lies in the use of Conservation Limits (annual egg deposition in each catchment) as reference points against which to assess stocks annually. This process is based upon many years continuous monitoring of stocks on the River Bush, supported since 2001 by a network of index rivers generating data essential for quantitative stock assessment and management decisions.

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

Contents

1 INTRODUCTION

This report sets out the rationale, process, content and format for preparing Salmonid Catchment Management Plans in Northern Ireland, with supporting technical guidance.

Salmon and trout fisheries in Northern Ireland are of high quality, have high tourist potential and form an important part of the country's natural resources. Across their North Atlantic distribution salmon stocks and fisheries are under threat from many directions, environmental pressures in fresh water and at sea, compounded by climate change and fishing pressures. The North Atlantic Salmon Conservation Organisation (NASCO) coordinates measures for salmon conservation including negotiation of high seas fishing controls as well as approaches to the problems of aquaculture and habitat in the national home waters from where salmon stocks arise. The practical actions to protect and enhance environments and the management of home water fisheries remain the responsibilities of individual states.

Northern Ireland has a national Salmon Management Plan (SMP), which forms the basis of its annual reporting to NASCO (through the EU delegation). The SMP is the umbrella for a proposed network of Salmonid Catchment Management Plans (SCMP) for all principal rivers; but the mechanism for SCMPs formulation and delivery has not yet been fully defined.

While salmon are the focus for SCMPs, because of the international drivers, other fish species (and indeed other taxa) are of importance to ecosystem function, biodiversity and socio-economic value and the SCMPs make appropriate reference to these. Practically, the information base for salmon is far better than for most other species; so a rational, target-based approach is feasible for salmon and an important first step towards integrating wider fisheries interests. Sea trout, the sea migrating form of brown trout, have fisheries and ecology very similar to salmon. In particular they display the migratory habit that makes their life cycle dependent upon connectivity and environmental quality across marine, transitional and fresh water habitats. This has allowed their practical incorporation into SCMPs at this stage (hence the term Salmonid in the SCMP).

The EU Water Framework Directive, to be implemented from 2009, has ecosystem health as its principle index of environmental quality. The River Basin Management Plans of the WFD will be the main national vehicles for resolving aquatic environmental problems, through their Programme of Measures (PoMs). SCMPs will form a crucial role in providing the technical rationale for the PoM actions necessary to protect migratory salmonids.

Fisheries and environmental management are intimately linked in theory and practice; but this coherence is not matched by the organisational structures of government departments and agencies. Significant interlinked roles in fisheries and related environmental management and regulation are found in DCAL, DARD, NIEA, AFBI and the FCB. This brings potential problems in coordination and efficiencies. SCMPs offer a framework for integrated management of fisheries and environmental resources.

The aims of this report are therefore:

1. To set out the rationale, process and structure for SCMPs, with advice on best practice.

2. To provide a mechanism, through SCMPs, for coordination of fisheries and environmental management in Northern Ireland that will allow fisheries interests to be managed coherently across departments and to be taken up efficiently into the WFD Programme of Measures.

Report layout: the structure and content of an SCMP are given in **Section 12**, the remainder of the report is the supporting information and guidance.

2. RATIONALE AND PROCESS FOR SALMONID CATCHMENT MANAGEMENT PLANS

2.1 Introduction

Atlantic salmon (*Salmo salar* L.) stocks form an important conservation and fisheries resource in Northern Ireland. Their effective management has implications for biodiversity and for the socio-economic benefits that fisheries deliver. Salmon use an exceptionally wide range of habitats in freshwater, estuaries, coastal waters and high seas throughout their life cycle and need high natural environmental quality in all of them. They are harvested in interceptory fisheries in rivers, estuaries and at sea, sometimes (much less so recently) in mixed stock fisheries. Thus the species is an important bio-indicator, exposed and responsive to environmental change in many environments. Conversely, to manage salmon stocks and fisheries successfully, requires coherent, long term, integrated activity across a wide range of government departments, organisations and user groups.

The purpose of Salmonid Catchment Management Plans (SCMP) is to provide the framework and best practice guidance that enables a coordinated, consistent and efficient approach to migratory salmonid management.

2.2 Other fish species

The salmon is only one of many fish species and sea trout, the migratory form of brown trout (*Salmo trutta L.)*, also supports valuable fisheries and has a life cycle very similar to salmon, but with a marine phase thought to be spent mainly in coastal waters. The migratory habit makes salmon and sea trout life cycles dependent upon connectivity and environmental quality across marine, transitional and fresh water habitats. Because of the similarity in their life cycles and fisheries it is practicable and advantageous to incorporate sea trout and salmon together in the SCMP guidance. Some Northern Ireland waters contain lake-stream migrating brown trout such as dollaghan (Lough Neagh) and sonaghan in Lough Melvin, amongst others, also with fishery importance that needs to be incorporated into the relevant SCMPs. Other species, such as cyprinids and eel have considerable fishery value and, with other species such as lampreys, give biodiversity value; but display a wide variety of life cycles and environmental requirements. It should be noted that cyprinids and pike, while having tourism fishing value, are not native species in NI. The potential for inter-specific competition with native species requires care in managing their distribution in line with strategic fishery development aims. However, while these species are not examined here in detail, the principle of SCMPs is that they should take into account the requirements of other species as constituent parts of ecosystem health (*cf* WFD) and no SCMP actions should be to the detriment of other fish species.

2.3 National strategic fishery objectives

The Programme for Government (PFG) sets out the strategic priorities and key plans of the Northern Ireland Executive for 2008-2011, to which DCAL and other departments will contribute. One of these priorities of which fisheries forms a part is to "**Protect and enhance our environment and natural resources**" (DCAL Corporate Plan and Business Plan, 2002-2011). Specific targets within this overall aim include:

- Increase sales in permits for public angling estates across minority groups and tourists by 2% each year to 2011.

- By 2011 to achieve the objectives as set out in the Salmon and Eel Management Plans

The National Atlantic Salmon Management Strategy (NSMS) for Northern Ireland (NI) sets an overarching objective to: ***conserve, enhance, restore and rationally manage salmon stocks in catchments throughout Northern Ireland through two Salmon Management Plans (SMP).*** The SMPs cover the two NI fishery districts, namely that for the cross border Foyle and Carlingford catchments, managed by the Loughs Agency, and that for the remaining rivers, administered by the Fisheries Conservancy Board (FCB) which is sponsored by DCAL. The Salmon Strategy is to be implemented in 2008 to 2012. Note that the roles and resources of the FCB are to be incorporated into DCAL by the end of 2008. In this text therefore reference to FCB conveys topics and activities which will be taken up shortly within DCAL.

This report and guidance on SCMPs is directed to the FCB rivers and thus SCMPs as described here will lie within the overall umbrella of the Salmon Management Plan of DCAL.

A major external driver for salmon management lies in the UK obligations to the North Atlantic Salmon Conservation Organisation (NASCO). NASCO was established in 1983 under the NASCO Convention to "contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks subject to the Convention taking into account the best scientific evidence available to it" (*www.nasco.int*). NASCO meets annually to examine scientific advice on fisheries status, to review management actions and to negotiate further agreements. It is divided into three Commission areas and The North East Atlantic Commission is the one relevant to Northern Ireland, which is a Party to NASCO through the UK and the EU delegation.

Northern Ireland's Atlantic Salmon Management Strategy is aligned to the agreement reached by NASCO and its Parties to adopt and apply a Precautionary Approach (**Appendix I**) to the conservation, management and exploitation of the salmon resource and the environments in which it lives. The NI strategy is based on the application of the Precautionary Approach, consistent with the three main NASCO agreements which address:

- fishery management;

- protection and restoration of habitat; and

- aquaculture, introductions, transfers and transgenics (including diseases and parasites).

The Precautionary Approach has important implications for the design and delivery of SCMPs, particularly: the use of Conservation Limits (CL), a risk-averse approach to stock assessment and management interventions and the recognition of socio-economic factors in reaching management decisions.

2.4 Conservation Limits

A basic tenet of modern salmon management in Northern Ireland is that spawning stocks will be managed to be at or above some predefined Biological Reference Point (BRP) considered to represent a safe stock level, having an acceptably low risk of stock decline. A BRP is thus a threshold value that management seeks to reach or exceed; it is not a "target" in the senses of being something just aimed at.

Stock assessment includes a) setting the reference point that matches management objectives and b) measuring fish abundance annually to compare against the BRP. Failure to be compliant with the BRP triggers management actions to address whatever factors are discovered to be causing decline.

NASCO guidance adopts a type of BRP called the Conservation Limit (CL), which is defined by ICES as the spawning stock level supporting maximum sustainable yield (MSY) (see Crozier *et al*., 2003 Potter *et al*., 2003 for full accounts of BRPs and CLs). In NI the interpretation of CL is the spawning stock giving maximum smolt output from each catchment, which represents a slightly more precautionary stock level than MSY (see section 7). Fortunately, the long-standing River Bush programme has been at the forefront of NASCO and UK salmon stock assessment method development and so NI is well placed to adopt this approach which is already part of its national strategy. The NI Salmon Strategy declares its central aim of management as being: ***to ensure that in most rivers in most years sufficient adult salmon are spawning to maximise output of smolts from freshwater and to monitor the river or catchment for salmon numbers and where levels are not attained to identify and address the problem.***

2.5 Non Fishery Objectives

While the CL compliance is central to fisheries assessment, the SCMP process is far wider and seeks to put in place prioritised actions to achieve outcomes for stocks and fisheries that will secure the objective of increased conservation, biodiversity, social and economic benefits for Northern Ireland. In addition to the NASCO imperatives there are other major influences on the direction and content of SCMPs deriving from EU legislation. Of special importance is the Water Framework Directive (Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003) which promotes integrated catchment management and assesses the ecological health of rivers and lakes by a comprehensive set of indicators including fish.

The overall objective of the WFD is that all surface waters should achieve either 'good ecological status' (GES) or 'good ecological potential'(GEP) by 2015. Formulation of the actual scientific definition of GES is part of detailed preparatory work currently under way throughout the EU. The rationale is an inherent shift from chemical to ecological indices for water quality classification. The WFD will repeal a number of existing Directives, such as the Dangerous Substances Directive (76/464/EEC), the Groundwater Directive (80/68/EEC), the Freshwater

Fish Directive (78/659/EEC) and the Shellfish Waters Directive (79/923/EEC), and absorb their requirements, while retaining others such as the Urban Waste Water Treatment Directive (91/271/EEC). The competent authority for the WFD in Northern Ireland is the Northern Ireland Environment Agency (NIEA) and good coordination between collaborating departments will be essential to maximise the benefits.

The European Union Habitats Directive (92/43/EEC) is another significant policy directive, which requires that actions should be undertaken to maintain and restore listed habitats and species to favourable conservation status. No FCB rivers are currently designated under the Habitats Directive, but this may change through the review of NI SAC designations, a responsibility of the NIEA.

2.6 The SCMP Structure

The components of the SCMP follow a logical sequence of setting objectives, defining standards that reflect the objectives, assessing stocks and fisheries against the standards, identifying factors that limit achievement of the objectives, designing and carrying out the plan to secure the desired outcomes. Finally, progress is reviewed at appropriate intervals and plans or objectives adjusted as appropriate. Details are given in Section 12.

This is a common model of the fisheries management cycle (**Figure 2.1**) and key actions within a typical SCMP with the suggested responsible bodies are shown in **Table 2.1**.

An important stage, sometimes omitted, is setting the initial management objectives and expressing them in ways that allow quantitative targets to be set, which in turn have relevance to the outcomes that the plan is seeking. The Conservation Limit is the SCMP common standard against which to compare stocks, and the default management objective (and target in this case) is to reach or exceed the standard (CL) each year. Other objectives-standards-targets might be set; e.g.

- Management Objective: to increase the proportion of good nursery habitat in the catchment.
- Standard: the Grade A habitat level in the LCUS system (see **Section 7**) and
- Management Target: to have a 10% increase in the quantity of Grade A habitat over a predetermined period.

Consultations with stakeholders are essential for the success of developing SCMPs, which therefore have two stages:

1. A consultation document, with proposed actions and priorities, prepared by DCAL,

2. A post-consultation document with agreed actions and priorities, following stakeholder input.

Both plans should be as concise as possible to support their proposals, but the second is a generally a shorter document, the background detail having been given with in the first, although matters of detail may be adjusted through consultation.

Figure 2.1 The SCMP and fisheries management cycle

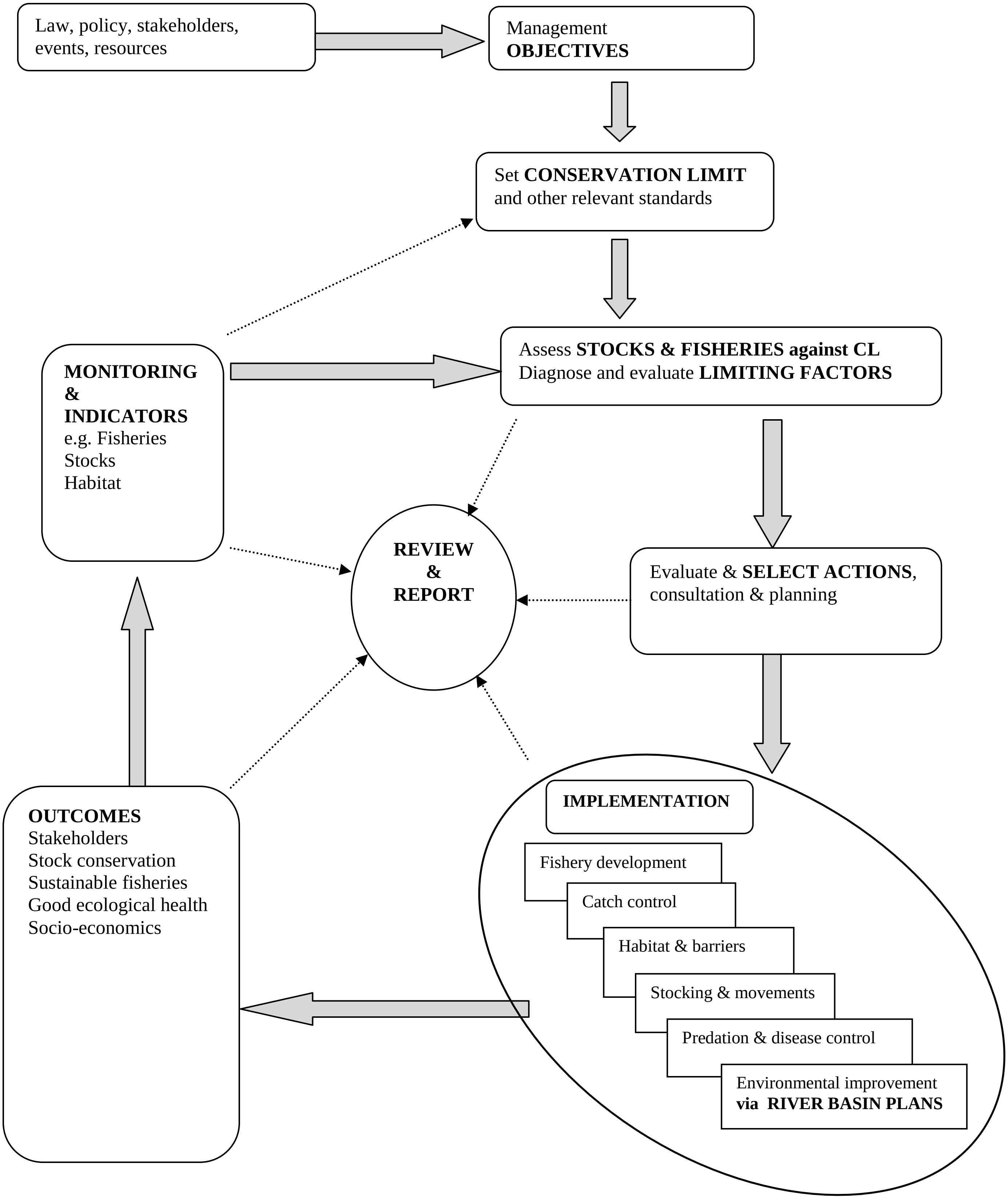


Table 2.1 Table of key SCMP actions (note the shared responsibilities)

ACTION	MEANS	PRIMARY RESPONSIBILITY
1. Set Objectives	Refer to NI Salmon Strategy and consult with local stakeholders	DCAL
2. Describe stocks, fisheries and habitat	Use all data to describe status and trends of stocks and fisheries; calculate egg deposition. and test against CL. Compare indicator against other targets	DCAL
3. Define Conservation Limit (or other standards and targets)	CL as egg deposition. Use transport methods outlined in S7. Set other targets as necessary.	AFBI
4. Assess stocks, fisheries and habitat	Test egg deposition against CL. Compare indicators against other targets as required	DCAL /AFBI
5. Identify limiting factors	Identify the environmental or other factors limiting achievement of CL, or other targets. Prioritise on basis of impact and feasibility to resolve	DCAL links to AFBI, NIEA, DARD (RA, Rivers Authority)
6. Evaluate, select, design and cost actions	Explore and test options; quantify benefits and costs	DCAL
7. Prepare the action plan	Complete standard table	DCAL
8. Consult on the plan	Using local consultation agreements and stakeholder groups (including interdepartmental)	DCAL, AFBI, NIEA, RA
9. Revise plan	Post consultation, revise the action plan table	DCAL
10. Authorisations and funding	Incorporate into Business Plans of DCAL and NIEA (NB in some cases as part of WFD River Basin Plans)	DCAL,AFBI, NIEA, RA
11. Implement, monitor and review, report	Transfer to operations and / or policy development	DCAL, AFBI, NIEA, RA

2.7 The SCMP development process

The SCMPs are to be prepared and managed by DCAL regional staff with technical input from AFBI, using data and information from the NIEA and DARD (Rivers Agency) as appropriate and with extensive consultation with external stakeholders.

The plans are to be prepared to the timetable set out in the Salmon Strategy (DCAL, 2008) shown in **Table 2.2**.

The recommended actions from the SCMP process will be considered as part the DCAL Annual Business Planning process and contribute to the Programme of Measures of the WFD River Basin Management Plans. The precise timetable for developing PoMs is not yet clear, but first plans are to be produced in 2009 and revised thereafter every six years. It should be noted that a draft PoMs consultation report will be prepared in January 2009, for a six months consultation period, and so notification of the intention to develop SCMPs needs to be included in that.

Table 2.2 Timetable for production of SCMPs (From DCAL, 2008)

2008	2009	2010	2011	2012	2013
Bush Main & tribs	Blackwater & tribs Glendun MoneyCarragh Garvary	Upper Bann Clady Shimna	Sixmilewater Agivey Glenarm Other Antrim rivers Ballinderry	Inver Moyola Quoile Enler Lagan Lower Bann	Crumlin/Glenavy Ballymoney/Ballycastle Ballinamallard Kesh

2.8 Quality Assurance

The assessments and agreed actions in SCMPs will form contributions to PoMs and will be collated by AFBI into the NI input to NASCO, via ICES. [**RECOMMENDATION: It is recommended that The NI Salmon Management Group provide the QA role to check the technical aspects of the plans and ensure that common best practice has been followed.**] The ICES North Atlantic Salmon Working Group meets in April each year and NI makes a contribution to that. Therefore, as SCMPs are prepared their information relevant to NASCO will need to be assembled before that time.

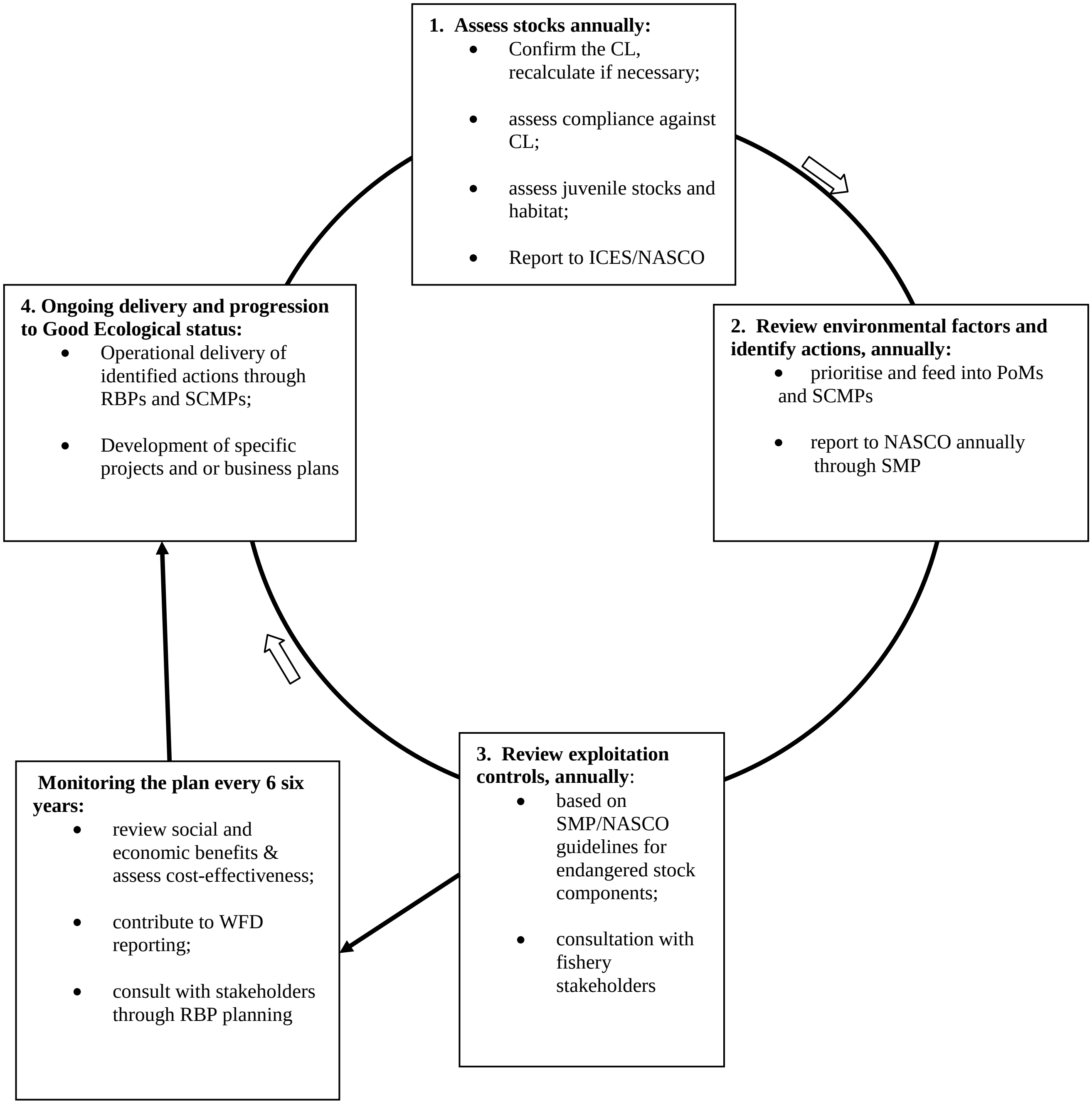
2.9 The SCMP process and the Water Framework Directive

One benefit of SCMPs is to be able to set out the fisheries rationale for environmental (ecological health) improvement through the PoMs. Thus SCMPs, while having their independent fisheries management role (e.g. actions to do with development, regulation, catch control, enhancement etc of fisheries), also need to be integrated into PoMs timetables for monitoring and reporting. A framework for this is shown in **Figure 2.2**.

WFD PoMs, to be put in place by 2009 to bring failing waters up to acceptable status, will assume some of the recommendations likely to come out of SCMPs, which are likely to assume the status of Supplementary Plans (see Section 16 of the regulations, http://www.opsi.gov.uk/sr/sr2003/20030544.htm).

The detail of reporting links between SCMPs and the River Basin Plan (RBP) is not specified at the time of writing. An issue to resolve is the communications and coordination between common fishery and environmental actions. These include for example: liaison with external stakeholders, the response to pollution (environmental and fishery assessment), review of consents for abstractions and discharges (e.g. agreeing critical habitats, setting protective environmental standards for fisheries), impact assessment for developments and integrated catchment habitat management.

Figure 2.2 Framework for salmonid management in the context of NASCO and the Water Framework Directive



3 LEGISLATION AND POLICY BACKGROUND

A wide range of mechanisms and activities have potential to impact upon salmon and sea trout and the wider fish community of Northern Ireland Rivers. These include direct exploitation of the species, via angling, commercial fisheries and illegal capture, direct impacts upon the river environment via in river works (e.g. flood defence), discharges (consented and unconsented) and abstraction. Impacts may also result from activities not directly associated with fish or the river environment most notably catchment land use in terms of extent of urban development, agricultural practice and forestry management.

Given the wide spectrum of impacts, in order to effectively manage salmonid populations and implement SCMPs, Plan authors and managers need to understand the full range of mechanisms and legislation which apply to these activities. This legislation determines the regulatory framework in which they operate, provides many of the tools to regulate and remedy impacts and represent the policy levers to influence other bodies. **Appendix II** provides a list of the key legislation, and the areas of primary relevance for salmon and sea trout management.

4 REVIEW OF THE PRINCIPAL IMPACTS ACTING ON SALMONID FISHERIES IN NORTHERN IRELAND

4.1 Introduction

Most rivers in Northern Ireland have been impacted upon by man to some extent to the detriment of migratory salmonids (salmon and trout), other migratory species (e.g. eel and lampreys) and resident fish. The Rivers Habitat Survey showed that only 21 % of channels in NI were unmodified, compared with 28% in England and Wales and 44% in Scotland (Environment Agency, 1998). The environmental problems are widespread and diverse, but can be summarised as:

- loss or degradation of habitat through agriculture, forestry, water supply and in-river engineering;
- obstruction caused by dams, weirs or small structures like culverts; and
- pollution by industry, urban development, land use etc.

In the SCMP context it is important to note that the individual proximate environmental factors acting on fish can arise from many different causes. This is seen in **Table 4.1** which shows that, for example, sedimentation can arise from agriculture, forestry or river flow regimes shifts. Similarly, disrupted seasonal flow patterns can arise from abstraction to support agriculture, potable or industrial supply, forestry drainage, or might be the effect of climate change. In the SCMP context it is necessary to identify both the impact and the cause.

SCMP environmental actions (see **Section 5**) are usually a combination of *operational activities* (e.g. gravel cleaning or habitat restoration) to deal directly with the immediate effects of environmental impacts on fish and the *strategic activities* such as policy revision, or planning and consenting to manage the originating causes.

The impacts are summarised below, mainly under the column headings in **Table 4.1**. Additional impacts which might arise in SCMPs but do not fall easily into the classification of Table 4.1, are predation (birds, seals, fish), competition between fish species and conflicts arising from other legitimate water uses such as canoeing. Impacts from fishing are intrinsic to the fisheries management activities of DCAL and are mostly self explanatory, but are briefly covered below.

4.2 Physical Habitat

4.2.1 Barriers and intakes

Barriers introduce problems for migrant fish of passage, entrainment, flow change, sedimentation /substrate composition and resultant in stream habitat changes. Existing barriers may have problems enshrined in historical operating agreements and present a different situation to new proposals, which can take advantage of current knowledge and consenting legislation.

Protecting fish passage usually requires fish-passes to be installed, or weirs, sluices and culverts to be profiled to ease passage. There are many aspects of design, but failures arise when the physiological performance limits of fish are exceeded by the structures. Some common issues are:

- Pass water velocities too high (or too turbulent) for swimming speed
- Location of the pass entrance not placed to be attractive to fish
- Attraction velocities at entrance to low
- Heights of structure (or notch and gap dimensions) and water depths inappropriate to fish jumping capacity.

There are several guidance documents on choice, design and deployment of passes, weirs or sluices (e.g. Clay, 1961; Beach, 1984; Environment Agency, 2004 Wales; Scottish Office 1995). The Beach and EA documents overlap, but between them offer a full up to date account and further sources.

Barriers are built for many purposes, but most involve water abstraction or bypasses which can entrain migrants especially small fish with limited avoidance capacity because of lower swimming speeds, Screening of intakes is essential to avoid entrainment (see EA, 2004, Scottish Executive, 1995; Solomon, 1992; Turnpenny & O'Keeffe, 2005).

Many coarse fish, shad, eel and lampreys have comparatively low swimming speeds and their passage would not be enabled by a scheme designed for salmonids alone; indeed smaller trout have limited capacity compared to larger salmonids (Clough and Turnpenny, 2001). SCMPs should consider other species when designing fish passage facilities. See the references above for guidance.

The WFD may identify that barriers are constraining Good Ecological Status in terms of fish passage and river connectivity, i.e. geomorphological and hydrological features which form part of the WFD characterisation and impact assessment methodology. This is an opportunity for promoting fish passage development.

An initial task for an SCMP is to identify and map the barriers in the catchment, assess the significance of each in terms of difficulty of passage and the benefits of easing or opening passage in terms of increased fish production. This allows a priority listing of schemes which should then be taken to the design and costing stage and full cost-benefit analysis.

ACTIVITIES	PHYSICAL HABITAT						FLOW			WATER QUALITY										BIOHAZARDS				
	barriers: dams,weirs & sluices	barriers: culverts	channelisation & regrading	instream habitat loss	riparian habitat loss	sediment delivery	Flow volume	Flow regime	temperature	nutrients (NPK)	Sanitary dets	pesticides	herbicides	metals	acidification	eostrogen mimics	thermal regimes	sediment loads	organics	invasive spp	genetics of wild fish	competition	predation	disease &parasites
RURAL LANDUSE																								
Farming-crops	1	2	3	2	1	**3**	3	0	0	3		3	3			2	0	3						
Farming -stock		2	3		3	**3**	0	0	0	2	3	3	3			2	0	3						
Farming-biofuels						2	2			2														
Forestry-preparation & growth	0	3	3			3	3	3	3	3		3	3		3	2	3	3	1					
Forestry-harvest & rotation	0	0	0	1	0	3	2	1	3	3					1	0	2	3	2					
URBANISATION &DEVELOPMENT																								
Water supply, dams	3	0	2	2	0	3	3	3	3									2						
Water supply, abstraction			2			3	3	3	3									2						
Water supply, compensation flow						3	3	3	3									2						
Water supply, water transfer	3	0	0	1	0	0	2	0	0															
Building infrastructure	see water supply						3		2	3	3				3	3			3					
Industry (general)	see water supply									3	3			3	3	3	3	3	3					
Extractive industries			3	3		3								3				3	3					
Gravel extraction (rivers)			3	3		3												3						
Flood defence	3	3	**3**	3	3	1	1	3	0															
Sewerage	0		0	2						3	3	3	3	3	3	3	3	3	3					
FISHERY (EXC. Exploitation)																								
Aquaculture	2								1	3	3					3	1	1	1	3	3	3	2	2
stocking																				3	3	3	2	2
invasive species																				3		3		3
RENEWABLES																								
Hydroelectric barrage	3			3	3		3	3	3															
Low head hydro (RoR)	3			3	3		3	3	3															
Tidal range schemes	3			3				3																
Tidal stream schemes																								
CLIMATE CHANGE	Can affect all the above, mainly: farming-crops, invasives, temperture and flow																							

Table 4.1 Matrix of impacts on salmonid populations and their sources. 3 = strong association or high risk, 2= moderate, 1= small, 0= none known, blank = no information.

a major limiting factor on fisheries unless provided with efficient fish passes. Natural barriers, such as waterfalls and chutes have the same effects and historically were disapproved of in the same way as manmade barriers and some were removed. However, nowadays the genetic isolation above some natural barriers is recognised as a biodiversity asset, and there may be other reasons why new fisheries upstream of natural barriers are not desirable. This needs to be considered during in SCMP planning and consultation.

Extensive historical use of rivers for navigation, power generation and water supply has left a legacy of weirs and small dams, many of which have lost their original purpose, but some continue to be significant barriers. The modern equivalent is the new low head hydro-electric power schemes which are emerging as part of the Northern Ireland Renewables obligation (Department of Enterprise, Trade and Investment) and related moves to develop renewable energy supply.

Major dams for hydro-electric power generation, water supply and river regulation can be significant barriers, often having compensation agreements for loss of rearing or spawning area or to ensure minimum “compensation” flow. Changes to river flow regimes caused by impoundments have potentially major impacts on fisheries and river ecology. While a huge literature exists on these and there is a good understanding of the generic impacts (e.g. Brooker, 1987; Crisp, 1995, 2000; Baglinićre and Maisse, 1991), there is still a poorly developed protocol for setting environmental protective standards. Consequently, many current schemes have basic or non-existent regulations in force to moderate their environmental effects. Re-negotiation of consenting agreements is a difficult but necessary task.

Further barriers to passage are often presented by gauging weirs in rivers and sluices for flood control.

Culverts under roads and tracks are common structures as part of rural land use (especially forestry) and urbanisation. They are can be serious obstructions to fish passage in small streams, which form important spawning and nursery areas for trout (e.g. Beach, 1984, Crisp, 1991).

Depending on their precise structure, barriers may prevent upstream migration completely, or may allow passage at intermediate or higher flows only. Their location will also influence the magnitude of their impact: the lower down the catchment, the more of the upstream habitat will, obviously, be rendered inaccessible.

A by-product of impoundment is the risk of entrainment of downstream migrating smolts and kelts. These risks are highest where a large proportion of the riverine flow is abstracted e.g. in the case of run-of-river hydro electric schemes. In this case, the risk is also associated with passage through turbines, which have high potential to injure or kill fish (Turnpenny *et al*., 2000). Entrainment and the consequent need for screens is a significant fisheries issue with most impoundments and intakes (Solomon, 1992).

In summary, barriers affect fish by causing loss of habitat connectivity when passage is impeded and physical, sometimes fatal, damage through the physical and physiological trauma of entrainment or attempted passage under impossible conditions.

4.2.2 Physical habitat in channels

The physical habitat of river channels including the riparian zones is a key factor controlling fish abundance. Habitat requirements vary between fish species and life stages and an extensive literature describes this (e.g. Bjorn & Reiser, 1991, Armstrong *et al*., 2003; Bagliniére and Maisse, 1991; Crisp, 2000; Gibson, 1993; Hynes, 1979; Shearer, 1992).

Channelisation, re-grading dredging and in-stream habitat loss (loss of cover, coarse substrates, riffle-pool sequences and other features of channel complexity) have accompanied the extensive historical land drainage schemes in most parts of Ireland and related flood defence schemes (O'Grady, 2006). These were carried out mainly for the improvement of agricultural land and have dramatically altered the nature of many rivers shifting some from ecosystems that supported salmonids to lower gradient, deeper waters that support coarse fish. Channelization also arises in urban environments where rivers are contained in narrow, featureless, built channels, presenting difficult challenges in restoring natural features.

Flood defence often entails the creation of flood banks to prevent the river migrating outwith its direct channel during high flows. On a catchment scale, this can lead to increased conveyance rates, higher peak flows, and reduced capacity for the catchment to retain water to runoff during periods of low flows-in effect a more extreme hydrographical regime compared to a naturalised scenario.

Intensive farming is a major pressure leading to a wide range of impacts on physical habitat. A widespread and common problem is intensive stock rearing. This causes trampling and erosion by cattle and sheep of earth banks, destruction of riparian vegetation, siltation, channel widening and shallowing, barriers to migration through cross stream fencing and direct nutrient inputs (Hendry *et al*. 2003).

4.2.3 Riparian habitat loss

Arterial drainage, intensive agriculture and loss of bankside cover are regarded as principal causes of lost salmon production in Ireland (WWF, 2001).The type and extent of riparian vegetation can have a strong bearing on fish populations of the adjacent channel. Dense tree canopy can prevent light penetration and temperature, thereby reducing primary productivity, macr0phytes and fish density (O'Grady, 2006).

Conversely, too few trees may lead to locally lethally high water temperatures in summer months when high air temperature and low flows can arise, a problem that is likely to increase with global warming. Thus, an ideal scenario is one in which sporadic trees occur, allowing a cover of ground vegetation and providing both a mosaic of shade and sun, and a source of coarse woody debris, which further creates in-channel habitat and trophic diversity (Linstead and Gurnell, 1999; House & Boehne, 1985; O'Grady, 2006).

4.2.4 Sedimentation

Sedimentation is the increase above natural levels of fine particles on river beds. High levels of fine sediments within the river channel can reduce egg survival by blocking the interstitial spaces, reducing intra-gravel flows oxygen supply and removal of metabolites of developing embryos (MacCrimmon & Gotts, 1986; Scott and Beaumont, 1993; Theurer *et al*., 1998;). Excessive sedimentation can also eliminate habitat for small fish which shelter in gravel spaces and for invertebrates (Wood and Armitage, 1997). Sedimentation impacts on salmon have been studied on the River Bush (O'Connor and Andrew, 1998).

Sedimentation arises from many different causes, often from activities long distances from the site of impact (Ward, 1981). Farming has been referred to above under physical habitat. While mostly a problem of intensive cattle farming in lowlands, sheep grazing in the uplands at high stock density can also lead to significant bank erosion (Samson, 1999), sediment transport and siltation of spawning gravels. Intensification in agricultural practices such as winter wheat growing and outside stock over wintering have lead to increased sediment loss during high rainfall winter months. Similarly new crops such as maize have lead to changes in soil properties, water run-off and sediment dynamics damaging to fish habitat through sediment delivery and siltation (Theurer *et al*., 1998).

In Ireland the extensive land drainage has led to increased sediment loads and Evans *et al* (2006) give a good account of this problem and remedial management. Soil erosion from agricultural land is also closely associated with elevated levels of phosphorous entering the freshwater environment, as phosphorous is primarily transported adsorbed to soil particles, rather than in a soluble form. Fine sediments, by virtue of their high surface area, are also relevant to the transport and dynamics of toxic substances such as pesticides and heavy metals. Details of sediment levels in Northern Ireland are available (Riley and Ives, 2001) and should be consulted in assessing sediment impacts in relation to SCMPs.

4.3 River flow

River flow is the major physical force in rivers and thus flow regimes are intimately linked with almost all the processes governing habitat structure and function in rivers (e.g. Lewin, 1981; Vaughan *et al*., 2007). This is why SCMP solutions to site habitat shortcomings will often involve attention to the factors governing flow regimes in the catchment as a whole. Migratory salmonids are also directly affected by river flow (Arnold, 1974) and are adapted to natural flows through their behaviour and life histories. There is a huge literature on this subject (e.g. Armstrong *et al*. 2003; Banks, 1969; Baxter, 1961; Brayshaw, 1966; Milner 1991; Solomon *et al*., 1999; Hendry and Cragg-Hine, 1997; Hendry *et al*., 2003).

Abstractions are undertaken for purposes including potable and industrial water supply, hydroelectric power generation, aquaculture and agriculture. These result in reduced flow, and can impact upon fisheries by reducing wetted perimeter (habitat availability), velocity (food supply) and ability of salmonids and other species to undertake upstream and downstream migration. Impacts are more likely to be experienced during seasons where flows are naturally low, and during droughts, where a fixed volume of abstraction will constitute a higher proportion of overall flow. Abstractions are consented (by NIEA) and so can be regulated.

Increased flows or changes in seasonal flow regimes are associated with land drainage in the uplands for agricultural and forestry purposes and with compensation releases from reservoirs.

4.4 Water Quality

4.4.1 General

Water quality affects almost every aspect of fishes' lives (e.g. Hynes, 1979; Crisp, 2000) and is controlled by hydrological processes modified by human activities through point source pollution, diffuse pollution and changes to flow regimes which affect dilution of contaminants. In the UK issues of point source gross pollution have been mostly resolved through increasingly better pollution legislation and control since the 1960s; but significant new challenges lie in the effects of diffuse pollution resulting from land use, urbanisation and new industries (Hendry *et al* 2003; Mawle and Milner, 2003). A review of WQ issues and impacts is not feasible here, but Hendry *et al* (2003) give a good summary, see also Crisp (2000) and Hynes (1978). However, it is important to note that water quality impacts are usually compounded by interactions amongst the chemicals themselves, or with water temperature which can strongly influence concentrations and toxicity. Estuaries in particular present complex, rapidly changing physico-chemical conditions which make them risky environments for migratory salmonids.

The Freshwater Fisheries Directive gives the following values for water quality parameters in designated salmonid waters. Alabaster and Lloyd (1980) describe water quality standards and impacts in more detail:

- Temperature <21.5 °C
- Oxygen 50% of occasions >9 mg/l, 100% of occasions >7 mg/l
- pH 6 to 9[1]
- Suspended Solids <25 mg/l[2]
- Biochemical Oxygen Demand <3.0mg/l2
- Nitrites <0.01 mg/l NO22
- Non–ionised Ammonia <0.025 mg/l NH3 (preferably <0.005 mg/l NH3)[2]
- Total ammonium <1 mg/l NH4+ (preferably <0.04 mg/l NH4+)[2]

[1] 95% compliance
[2] Average value

4.4.2 Eutrophication

Eutrophication, the excessive enrichment of water with nutrients, occurs both as a result of point source discharges, (e.g. industrial and sewage treatment work discharges) and diffuse sources (most significantly as the result of application of organic and inorganic fertiliser to agricultural land, or waste products of stock). This has been identified as a major impact on freshwaters in Northern Ireland (see EHS document "Eutrophication in Northern Ireland's Waters) and in terms of the water Framework Directive assessment of Pressures and Impacts, diffuse pressures from agricultural and urban impacts were the most common reason for water bodies being "at risk" of failing their environmental objectives (EHS, 2005).

Coniferous forestry also involves fertiliser use on land which is often naturally nutrient poor, leading to similar effects. The effects are a combination of algal growth, low dissolved oxygen, low light penetration, changing invertebrate fauna, leading in some cases to major ecosystem shifts.

4.4.3 Sanitary determinands

These are typically the suite of compounds that arise through domestic sewage disposal, such as ammonia, dissolved oxygen, suspended solids and biological oxygen demand.

The major problems of this form of pollution, which occurs largely but not always in urban locations, can be been solved through sewage treatment. However, untreated discharges still occur and problems arise through storm water over flows at times of high rainfall Hendry *et al*., 2003).

4.4.4 Pesticides and herbicides

These chemicals are used to control pests and unwanted plants in agricultural and forestry contexts. They are highly toxic to targeted and other forms of fauna and flora and some of the chemicals tested have been shown to have significant effects on salmon reproductive success through deleterious impacts on reproductive priming, kin recognition behaviour and migration (e.g. Jaensson *et al.* 2009; Moore *et al*., 2007; 2009). They represent a serious threat to fisheries if not tightly managed.

Insecticide dips have been used for a number of years to control ectoparasite infestations in sheep. Until 1999, two groups of chemicals were licensed for sheep dipping: organophosphates (OPs) which have the active ingredients diazinon or propetamphos, and the synthetic pyrethroids (SPs) flumethrin and cypermethrin. The latter was introduced in the early 1990s, partly because of concern over the potential effects of organophosphates on the health of farmers undertaking the dipping process. Between December 1999 and October 2000, sale and use of OP dip compounds was prohibited and any unopened products should have been returned to the manufacturers. Since then, certain products containing diazinon have been relicensed for use with packaging designed to minimise risks of spillages.

Although SPs were deemed to be less damaging to human health than OP dips, they are at least 100 times more toxic to some aquatic species such that a few drops released into a small stream can wipe out invertebrate life for hundreds of metres downstream. Pollution events associated with these chemicals are not normally directly lethal to fish although there is great concern about the indirect effect of eliminating the invertebrate food supply. The sub-lethal effects of these substances are also less well understood. Juvenile salmon and trout are particularly at risk because of their abundance in upland areas where sheep farming is concentrated.

4.4.5 Acidification

Acidification became recognised as serious threat to salmonid fisheries in Scandinavia in the 1970s (Leivestad *et al*. 1976) and in UK upland waters by the early 1980s (Stoner *et al*., 1984) and in Wales effects on salmonid fisheries were found to be extensive and significant (Milner and Varallo, 1990). Following the pattern seen in Scandinavia, acidification was found to be the result of atmospheric deposition, strongly exacerbated in some cases by the accumulating effect of coniferous forestry planted on base poor soils (Stoner and Gee, 1985). Acidification implies an increase in hydrogen ion (reduced ph) but it is accompanied by an increase in metals, particularly toxic forms of aluminium, which at higher pH (5.2-5.5) are particularly toxic to salmonids. The patterns of impact are characteristically sharply episodic, associated with short-term high flows.

One area within Northern Ireland is known to suffer from acid deposition: the Mourne Mountains in County Down. A number of watercourses draining these mountains occur in the FCB region and are potentially affected by acidification.

4.4.6 Oestrogen mimics

Endocrine Disrupting Chemicals (EDCs) are substances which interfere with the endocrine systems and hormonal activities (See Trout and Salmon Association paper: www.salm-trout.org/files/issues/briefing_papers/Endocrine_Disruptors_Chemicals_Briefing_Paper.pdf).
There are currently over 200 species known or suspected to be affected by EDCs. Aquatic organisms are at enormous risk from EDCs, which enter watercourses through both diffuse and point source pollution. There are a wide range of known EDCs, these include natural (e.g. oestrogen) and synthetic hormones (such as ethynylestradiol; found in contraceptive pills), industrial chemicals (such as alkylphenols, bisphenol A, ethoxylates and TBT) and pesticides, fungicides and herbicides (including atrazine, diazinon, permethrin and DDE). A range of compounds have been demonstrated to mimic the effects of oestrogen and, when present in the aquatic environment, result in feminisation of fish (Jobling *et al*., 1998, Jaensson *et al*., 2007). Natural oestrogens also occur through sewage discharges and may be more important than the mimics e.g. on the River Lagan (Pottinger *et al*., 2000).

4.4.7 Thermal pollution

Sources of thermal pollution include power station cooling water discharges, reservoir discharges, or activities such as pond aquaculture or water-meadow style irrigation (Solomon and Lightfoot, 2007). Increases in temperatures can increase growth rates of juvenile salmonids and other fish during the winter, but have the potential to increase physiological stress in the summer, where ambient temperatures may be naturally high. Trout have a lower preferred temperature range and are thus more susceptible to temperature increase than salmon (Davidson *et al*., 2006). Conversely, discharges of cold reservoir water may reduce ambient temperatures, reducing growth rates of juvenile salmonids throughout much of the year, but potentially alleviating physiological stress from high temperatures during the summer (Crisp, 1991). Temperature of river water has been demonstrated as being critical for salmon migration and entry to freshwater (Alabaster *et al*., 1991; Smith *et al*., 2004; Solomon and Sambrook, 2004).

4.5 Bio-hazards

4.5.1 Non-native plants

The introduction of non-native plants can have adverse effects both on riparian zones and within freshwaters. Himalayan Balsam (*impatiens glandulifera)* which is extensively established in Northern Ireland (Invasive ref below) can establish dense stands along river corridors which excludes other native ground level plants. This species dies back in the winter leaving bare soil exposed, and vulnerable to erosion and ingress to rivers. Similar impacts are observed with respect to Japanese knotweed (*falopia japonica),* and giant hogweed (*Heracleum mantegazzianum)* which is also established throughout NI (http://www.habitats.org.uk/invasive/species.asp?item=3762). See also: www.invasivespeciesirleand.com . Himalayan Balsam will be listed on the revised Schedule 9 of the Wildlife (Northern Ireland) Order 1985 and therefore it will be an offence to plant or cause it to grow in the wild, upon its inclusion.

The non-native plant with arguably the greatest potential to impact upon freshwaters is the invasive *Crassula helmsii*. This species forms dense mats in the shallow margins of lakes. Given that a number of Irish river systems incorporate lakes, and that the shallow littoral zones are the most important areas for salmonids, colonisation by the species could have an adverse effect on productivity. Crassula is currently known to be present in a number of locations in Northern Ireland (Habitats Online – see above link).

4.5.2 Parasites and disease

The presence or introduction of parasites and disease can have acute impacts upon salmonid and other fish populations.

A particularly high risk to salmon stocks exists in the form of the parasite *Gyrodactylis salaris*. This species naturally occurs, and co-exists on Baltic Salmon. However, other populations suffer acute mortalities, such that entire catchment salmon populations have been lost, most notably in Norway. No outbreaks have occurred in the British Isles. However, the frequent movement of persons (not least anglers) and materials between infected and uninfected areas represents a risk of transfer to The British Isles. Concern has recently been raised regarding the increased prevalence of the nematode parasite *Anasakis simplex* in salmon, with several cases being recorded at the Bush Trap (Anon, 2008; DCAL *et al.*, 2008-2012). However, it does not appear that this results in mortality, or inhibition of spawning, in salmon (FRS, anon).

Sea lice *Lepoptherius salmonis* is a naturally occurring parasite on salmon and sea trout, but which at high infestation rates, potentially resulting from contact of wild salmonids with marine salmon cage farms, can reduce survival. This has been a major problem, particularly for sea trout in Western Ireland (Gargan *et al*., 2003) and Western Scotland (Butler and Walker, 2006) where fish farms in enclosed sea lochs increase infection rates. Only one salmon farm operates in NI coastal waters, so this is not considered a significant pressure at the moment

4.5.3 Invertebrates

The introduction of novel species and their ultimate establishment can impact on aquatic systems significantly. Problems and impacts of non-native species have been reviewed by DEFRA (2003). A prime example of the impacts of an introduced species relevant to Northern Ireland is the zebra mussel (*Dreissena polymorpha)* which is well established in the Lough Erne catchment (DoE & EHS, http://www.ni-environment.gov.uk/zmleaflet2005.pdf).

4.5.4 Stocking for fishery purposes

Stocking of Atlantic salmon for stock enhancement purposes can adversely affect populations, stocks and fisheries. Although it is sometimes seen as a panacea it needs to be undertaken with a clear rationale, and according to best practice guidance to minimise genetic and ecological risks (e.g. Aprahamian *et al*, 2003; Verspoor *et al*. 2007). Adverse impacts include reduced fitness through loss of locally adapted characteristics (Mcginnity *et al*., 2003). Stocking with hatchery reared brown trout can have similar potential genetic implications for wild brown trout (Ferguson, 2004; Ferguson, 2006; Ferguson, 2007).

A potential impact associated with stocking brown trout in salmon rivers is hybridisation (Matthews *et al*., 2003; English Nature, 2006). Such effects have not been considered extensively, but are most likely to occur when stocking levels are high in relation to low adult salmon stocks, particularly when wild and introduced populations have not previously encountered each other (English Nature, 2006).

Intra-specific competition is a natural feature of fish ecology and a necessary component of internal population regulation (Crisp, 1991; Milner *et al*., 2003); but stocking can lead to unusually high levels of competition which can deleteriously affect indigenous populations. This is most likely in enhancement or mitigation stocking programmes where over-enthusiastic stocking is on top of reasonably healthy wild populations. Inter-specific competition is a further problem, where accidental or deliberate introductions can cause significant harm to indigenous species.

4.5.5 Invasive fish species

Northern Ireland has a naturally sparse native fish fauna, based on species with euryhaline ancestors. Introductions of cyprinids, perch and pike have led to significant fisheries in many places, but there are still no grayling or barbel. There should be a presumption in SCMPs to keep further expansion of non-natives contained and out of key salmonid habitats.

The introduction of more exotic (not native to the British Isles) non-native fish species is increasing through combinations of accidental transfer, increase in general commercial traffic, increase in the pet trade and is exacerbated by climate change where this makes survival of the invaders more likely (Copp *et al*., 2007a,b; Fox *et al*., 2007). Invasive species bring with them increasing risk of disease, e.g. topmouth gudgeon and sun bleak.

4.5.6 Predation

Predation of salmonids and other fish species by native species (e.g. pike, trout, piscivorous birds and mammals) is a natural phenomenon of ecosystems. However, when localised high levels occur it can be a significant issue. High levels of bird predation has become a well recognised issue possibly related to changing opportunity and bird behaviour (Russell *et al*., 1996) and has been recorded on the River Bush (Kennedy & Greer, 1988).

Seals can also be a localised problem when individuals of small groups specialise on feeding on salmonids entering estuaries (Carter *et al*., 2001; Butler *et al*., 2006).

4.6 Fishing Exploitation

Fishing can have deleterious effects on fish stocks if it reduces spawning escapement numbers or, through selective pressures, the composition of runs.

4.6.1 Angling

Anglers typically harvest a proportion of their salmonid catch (the remainder being released i.e. catch and release). Most (80%) of the FCB salmon rod catch is taken in The Northern Area and across the FCB most fish are taken in the later months of the season (July to October). In Northern Ireland annual rod exploitation rates on index rivers ranged between 10% and 30% (Kennedy, 2007), much of this variation being due to environmental factors affecting fishing efficiency. Under some conditions rod exploitation on salmon can be high, selective and detrimental to stock status (Gee and Milner, 1978). Catch and release is clearly beneficial and fish usually survive capture well (Webb, 1998). However, some mortality can still occur, and is likely to be determined by water temperature and the care in handling of fish during release.

4.6.2 Coastal and high seas fisheries

Based on the River Bush micro-tagging programme, marine exploitation rates by home water fisheries decreased from an average of 63.3% in 1988-97 to around 44% in 1998-2005 (Kennedy 2007). Given the voluntary buy-out of coastal fisheries in the FCB area starting in 2001/02, the cessation of the coastal netting in the LA area in 2007 and the closure of the Irish drift net fishery in 2007 future net exploitation is likely to reduce further considerably. The FCB buyout reduced net exploitation by 73% between 2002 and 2007. Mean exploitation rates of 1SW salmon decreased from around 43% to <17% over the same period (NASCO Report CNL(08)7). Most index rivers showed run increases in 2007, probably attributable to the buyouts.

4.7 Climate change

Climate change is demonstrated to affect ecosystems and fisheries in freshwater (Davidson *et al*., 2006) and at sea (Boylan and Adams, 2006; Edwards *et al*., 2007). The effects are complex and bound up with many of the interrelated factors governing ecological processes and pressures in the two environments. The prediction of future scenarios are uncertain and depend upon their assumptions, but the direction of change is clear (see UKCIP website). In freshwater, temperatures and river flows will change and at sea temperature is likely to directly affect growth dynamics and oceanographic conditions, currents and upwelling, which in turn may affect food chains and migration efficiencies of salmon and sea trout. Eventually, depending upon the future scenarios, conditions for the salmonid biogeographical distribution might change.

4.8 Planning and Development

Although planning policy *per se* does not impact upon aquatic environments, it is the framework within which all development is undertaken, and by earmarking areas for development and determining the type and extent of development which may take place therein, it is key in determining catchment scale, and more localised impacts. Large scale housing and industrial developments for example can have implications for water resources and discharges (affecting river flow and quality respectively) as well as run-off and catchment hydrology.

5 REVIEW OF REMEDIAL MEASURES

5.1 Introduction

Fisheries management over the last 50+ years has accumulated a wide range of practices to deal with the variety of pressures on fisheries. Many years ago most of these measures could be assembled in one book (Fort and Brayshaw, 1961). Increasing knowledge and technical capacity, coupled with new issues and more complex regulatory systems has massively increased the ranges of skills and techniques required and available. The aim of this section is to guide those preparing SCMPs towards the sources of information rather than present an unwieldy and rapidly out of date manual.

The matrix of causes and impacts (**Table 4.1**) shows that some of the measures will deal operationally with symptoms at local scale (e.g. habitat restoration at site to reach scale), while others deal with the causes through strategic measures such as policy change, regulation, advisory services or best practice campaigns for agriculture or forestry, for example.

Environmental policy in NI falls across several government departments, DCAL, DARD and NIEA or their agents. However, many of the operational measures dealing with physical aspect of river environment are most likely to fall to DCAL or DARD (the Rivers Agency).

5.2 Physical habitat

5.2.1 Barriers and intakes

Barriers introduce problems for migrant fish of passage, entrainment, flow change, sediment dynamics, substrate composition and resultant in stream habitat changes. Existing barriers may have problems enshrined in historical operating agreements and present a different situation to new proposals, which can take advantage of current knowledge and consenting legislation.

Protecting fish passage usually requires fish-passes to be installed, or weirs, sluices and culverts to be profiled to ease passage. There are many aspects of design, but failures arise when the physiological performance limits of fish are exceeded by the structures. Some common issues are:

- Pass water velocities too high (or too turbulent) for swimming speed
- Location of the pass entrance not placed to be attractive to fish
- Attraction velocities at entrance too low
- Heights of structure (or notch and gap dimensions) and water depths inappropriate to fish jumping capacity.

There are several guidance documents on choice, design and deployment of passes, weirs or sluices (e.g. Clay, 1961; Beach, 1984; Environment Agency, 2004 Wales; Scottish Office 1995). The Beach and EA documents overlap, but between them offer a full up to date account and further sources.

Barriers are built for many purposes, but most involve water abstraction or bypasses which can entrain migrants especially small fish with limited avoidance capacity because of lower swimming speeds, Screening of intakes is essential to avoid entrainment (see EA, 2004, Scottish Executive, 1995; Solomon, 1992; Turnpenny & O'Keeffe, 2005).

Many coarse fish, shad, eel and lampreys have comparatively low swimming speeds and their passage would not be enabled by a scheme designed for salmonids alone; indeed smaller trout have limited capacity compared to larger salmonids (Clough and Turnpenny, 2001). SCMPs should consider other species when designing fish passage facilities. See the references above for guidance.

The WFD may identify that barriers are constraining Good Ecological Status in terms of fish passage and river connectivity, i.e. geomorphological and hydrological features which form part of the WFD characterisation and impact assessment methodology. This is an opportunity for promoting fish passage development.

An initial task for an SCMP is to identify and map the barriers in the catchment, assess the significance of each in terms of difficulty of passage and the benefits of easing or opening passage in terms of increased fish production. This allows a priority listing of schemes which should then be taken to the design and costing stage and full cost-benefit analysis.

5.2.2 In-channel fish habitat restoration

Habitat restoration involves a wide variety of techniques ranging from hard engineering to modify channels, through to soft solutions that work more with the natural channel forming processes of the rivers (Hendry *et al*., 2003). There is also a broad distinction between activities at the site or reach level (the classic habitat structural techniques) and those which modify land use practice and thereby restore natural fluvial geomorphological processes. All have their applications and the choice depends on the nature of the problems and the resources available. It should be noted however that hard engineering (e.g. gabions or poorly designed stone deflectors/weirs) techniques in high energy channels are often high maintenance and ultimately fail, expensively.

The effectiveness of the measures depends upon the starting conditions. The prospects for making noticeable improvements are obviously better in a severely degraded channel compared with one that is more natural (O'Grady, 2006). Recent concerns over the effectiveness of habitat schemes may be partly because some have been inappropriately applied to locations where the habitat is already acceptable or where the limiting factor is more to do with recruitment failure for other reasons.

The aim of habitat restoration is to recreate the habitats for each life stage: the key ones being:

- spawning (gravel bed replacement or cleaning)

- nursery (structures to create cover, to establish and maintain depth and flow variation and food availability for different sized fish)
- holding areas (structures to create deep water, pools and cover for larger resident or migrating adult fish)
- angling: not strictly a life stage; but creation of glide/pool system and fishing platforms is a legitimate and effective activity to enhance fisheries, where conditions permit.

For in-channel habitat restoration in Irish rivers the first guide to turn to is O'Grady (2006), which is based on considerable experience in the Irish context, e.g. extensively drained and modified catchments. Other useful manuals are Hendry and Cragg-Hine (1997), which deals with salmon habitat, Giles *et al.* (2004) which covers trout, grayling and char and Ward *et al* (1994) which is more general. Hendry *et al* (2003) give a wide ranging general account of habitat management.

5.2.3 Riparian habitat loss

A common problem with riparian habitat for salmonid and other fish species in Northern Ireland rivers is lack of tree cover (WWF, 2001). Trees and shrubs are important as direct sources of invertebrate food, sources of carbon input through leaf fall and cover from predators and from excessive sunlight and heating. Coarse woody debris (CWD), comprising logs and branches, is an important by-product of riparian trees, which also provide nutrients, cover and wider ecological diversity (Linstead and Gurnell, 1999; Hendry *et al*. 2003).

The root systems of bankside vegetation also provide in-stream cover and reducing erosion by stabilising banks. Loss of bankside cover can arise through tree clearance in for example land drainage maintenance operations of through grazing and bank trampling (poaching) by stock, cattle in particular. This is a significant and common impact on streams leading to loss of cover, channel widening and depth reduction and reduced fish carrying capacity. These issues mean that bankside fencing is an effective and common habitat restoration method, which quickly allows the reestablishment of cover, banks stability and natural channel form.

A related measure is the establishment of buffer strips (often maintained by fencing) of natural vegetation along river and stream banks (Hendry *et al*., 2003; Ward *et al*., 1994). Buffer strips are thought to enhance water quality by reducing fine sediment delivery to water courses. Because cattle trample in stream to drink as well as browse on vegetation, a further solution is to relocating drinking points away from the river. The Countryside management Scheme (operated through DARD) provides options to enable the installation of water troughs to alleviate such impact. Active planting of native trees species is also practiced to enhance riparian vegetation.

When managing riparian tree cover the objective should be to ensure a mosaic of tree cover, such that shaded and open areas occur (O'Grady, 2006). Limiting removal only to where tangible risks exist will ensure benefits of CWD are retained. A further approach which ensures benefits are retained whilst reducing risk is securing CWD to the river bank or bed on a semi permanent basis in the form of engineered log jams (ELJ). SEPA (2006) provides guidance on the use and design of ELJs.

5.2.4 Sedimentation

Measures to deal with sedimentation include

- in-channel structures to speed up flow, increase scour and reduce deposition,
- *in situ* gravel cleaning,
- replacement and reconstruction of natural spawning beds, and
- reduction of the sediment source by managing agricultural and forestry practices.

Methods for in-channel structures, gravel bed construction and *in-situ* cleaning are described by Finnigan *et al.*, (1980), Lewis and Williams, 1984; Hendry *et al.*, 2003, Solomon (2006) and O'Grady (2006). It should be noted that depending on circumstances these methods may need repeating if sedimentation continues. The exception might be gravel bed replacement where this has been removed by gravel extraction or arterial drainage.

Land based approaches through the adoption of best practice for agriculture and forestry represent more sustainable approaches because there is a strong association between land use and sediments in rivers (e.g. Theurer *et al*, 1998; Boardman *et al*, 1990; D'Aucourt, 2004). In addition to tackling the problem at source, these measures have other benefits such as prevention of nutrient runoff. Hilton *et al.* (2003) and Hilton (2003) provide guidance for catchment managers in managing, and preventing run-off of silt and nutrients.

Although identification of sedimentation as a problem is relatively straightforward, in order to effectively target management measures at source, correct identification of the source is essential. Potential diagnostic techniques include: wet weather surveys involve surveying the catchment during heavy rainfall to visually identify and map where soil runoff is occurring; fluvial audit is focussed on the river channels, and identifies sources of erosion and deposition (Orr and Walsh, 2007); sediment fingerprinting (Walling *et al*., 2001) and aerial survey of the catchment and channel (Carbonneau *et al.*, 2004).

Further advice on habitat restoration can be found from The Rivers Restoration Centre, a national information and advisory centre offering technical advice and information on all aspects of river restoration and enhancement and sustainable river management (website is www.therrc.co.uk.). The Wild Trout Trust also offers an advisory service (website www.wildtrout.org).

5.3 River flow

Protective flow standards need to be set to meet the varying needs of different life stages of salmonid, recognising also the needs of other species. Key life stages are: spawning, egg incubation, emergence, fry-parr stages, smolt migration and adult migration. Flow requirements for salmonids have been well described (e.g. Armstrong *et al*. 2003; Banks, 1969; Baxter, 1961; Brayshaw, 1966; Milner 1991; Solomon *et al*., 1999; Hendry and Cragg-Hine, 1997). However the focus until recently has been on adult migration and there are still difficulties in establishing protective flow standards for all life stages. See Hendry *et al* (2003) for a recent account of managing flows. Note that water velocity is an important component in qualifying habitat quality (Symons and Helland, 1978) and should therefore be considered in tandem with the availability of physical habitat.

Water abstraction is a consented activity, and therefore efforts to target over-abstraction need to be pursued via the consenting body (NIEA).

Generally, consents will have been issued with regard to environmental requirements. However, SCMPs, with their more detailed fisheries surveys and assessment may more accurately identify if and where problems with existing abstractions occur (either in terms of volumes abstracted, or volumes licensed to be abstracted), thus providing further evidence to stimulate a review of abstraction consents. Given that consents may need to be modified to attain good ecological status in terms of the WFD, the fisheries needs must be conveyed to WFD managers in NIEA so that they can be incorporated into PoMs. Conversely the WFD imperative can be utilised by SCMP managers as a policy driver to effect change.

Where rivers have been impounded for reservoir storage, strategically timed release of compensation flows can be an effective tool in benefitting fisheries. Compensation flows can also be utilised to dilute the effects of poor water quality in estuaries and may stimulate the upstream migration of adults (Hayes, 1953; Thorstad & Heggberget, 1998).

In addition to migratory salmonids, the ecological management of flows must consider a range of species and key seasons. An example of these temporal considerations are provided in **Table 5.1** below.

Table 5.1 Fish species/life stage migration periods

	Jan		Feb		Mar		Apr		May		Jun		July		Aug		Sep		Oct		Nov		Dec	
MSW (spring)	■	■	■	■	■	■	■	■	■	■												■	■	■
2-SW (summer)											■	■	■	■										
1-SW salmon								■	■	■	■	■	■	■	■	■	■	■	■					
Salmon	■	■	■																■	■	■	■	■	■
Salmon eggs	■	■	■	■	■	■	■	■												■	■	■	■	■
Salmon smolt					■	■	■	■	■	■	■													
Autumn 'smolt'																		■	■	■	■			
Sea trout						■	■	■	■	■	■	■	■	■	■	■	■	■						
Sea trout	■																		■	■	■	■	■	■
Sea trout eggs	■	■	■	■	■	■													■	■	■	■	■	■
Sea trout smolt				■	■	■	■	■	■															
Brown trout	■																		■	■	■	■	■	■
Brown trout	■	■	■	■	■	■													■	■	■	■	■	■
Elver							■	■	■	■														
Silver eel																			■	■	■	■		
Brook lamprey					■	■	■	■																
Sea lamprey					■	■	■	■	■	■														
Sea lamprey									■	■	■	■												
Sea lamprey	■	■	■	■	■	■	■	■	■	■									■	■	■	■	■	■
River lamprey			■	■	■	■	■	■	■	■					■	■	■	■	■	■	■	■		
River lamprey					■	■	■	■																
River lamprey	■	■	■	■	■	■	■	■	■	■									■	■	■	■	■	■
Minnow							■	■	■	■	■	■												
Stickleback							■	■	■	■														
Pike spawning			■	■	■	■	■	■																
Perch spawning							■	■	■	■														
Flounder	■	■	■	■	■	■														■	■	■	■	■

5.4 Water Quality

Water quality control is the legal responsibility of the NIEA. Nevertheless, it remains an important topic for SCMPs, because as noted elsewhere it can be a major limiting factor on fisheries and may negate the benefits of other works such as habitat improvements. This applies especially in the context of cumulative effects of small point source or diffuse pollution, often on small water course such as might result from agricultural activities and which might go undetected or unmanaged through national large scale monitoring programmes. Thus it is important to make the fisheries-related WQ problems, along with the environmental standards required, known to the PoMs programme through SCMPs consultation, or included as a supplementary measure.

Further, following the new arrangements for water services and water utility funding established for Northern Ireland, water quality and resource impacts related to water company sewage discharges will be identified and addressed via the water company periodic pricing review, the first of which is due to take place in 2009. Thus, where it can be demonstrated that consented discharges or abstractions are risking failure of statutory water quality standards in rivers and lakes, a case for inclusion of measures to rectify these in the business plan can be made by NIEA, who are responsible for advising the Northern Ireland Authority for Utility Regulation on funding requirements under the periodic review process.

SCMP managers should liaise with NIEA staff responsible for inputting to the periodic review to help build the evidence base for where action is required under NI Water Company's investment programme.

5.4 Biohazards

5.4.1 General

Stokes *et al* (2006) have reviewed in detail the effects and control options for invasive species in Ireland. In the case of biological introductions the priority must be prevention of introductions of fish species or pathogens, because of the difficulty, or in most cases impossibility, of eradicating invasive species once introduced. The Defra (2003) review of non-native species provides an overview of the issues and strategies involved, and SCMP managers should seek to actively contribute to the various non-native and invasive initiatives underway. Specific management interventions recommended for each invasive species encountered in Northern Ireland are provided in the Invasive species in Northern Ireland website (www.invasivespeciesireland.com). Given the significant challenges in the control and eradication of invasive species, co-ordinated, catchment wide initiatives offer the best opportunity of success.

5.4.2 Non-native plants

Invasive plant control falls under the responsibility of the NIEA. Various guidance documents are available on the management of invasive plants in or adjacent to watercourses. Although legislation exists to prevent deliberated release of plant species listed under [wildlife order], public education is a key element in avoiding inadvertent and deliberate releases to the environment, and this should be considered as an element within SCMPs

5.4.3 Parasites and disease

The parasite with greatest potential to impact upon salmonid populations is *Gyrodactylus salaris*. A potential vector for introduction of the disease is anglers returning from infected countries and subsequently fishing NI waters with infected clothing or equipment. Advice has been issued regarding the parasite (Scottish Executive / Defra, 2003) and other river specific biosecurity measures have been adopted unilaterally (e.g. tweed). Development of cross border protocols to control *Gyrodactylus* are in hand between DARD (which has the regulatory responsibilities for fish health), LA and DAFF in Eire.

Although *Anisakis,* and its symptom red vent syndrome, has been recorded in Northern Ireland and elsewhere, it has not yet been identified as causing mortality or other impact on stocks. However, surveillance regarding this parasite should continue. Anglers, provide an ideal means of identifying problems associated with fish health, and consideration should be given to including prompts on permits and catch returns to comment on any abnormalities, and the telephone contact for the [DARD fish health inspector] in the event of significant concerns.

The virtual absence of Marine salmon farming means that the potential problems associated with high levels of salmon louse *Lepeoptheirus salmonis* reported elsewhere, are not currently relevant to FCB rivers. However, given the serious impacts that high level are shown to cause (e.g. Gargan *et al*., 2003), surveillance monitoring is still required to detect and manage problems at an early stage.

5.4.4 Invertebrates

The main concern regarding non-native invertebrate colonisation relates to zebra mussel, although this is not thought to be a major issue for salmonids. Boat movement represents a likely mechanism of transfer of the species between water bodies, and guidance exists on steam cleaning of boats when being relocated (http://www.ni-environment.gov.uk/zmleaflet2005.pdf). Signal crayfish, present in England Wales and Scotland have not yet become established in Northern Ireland or the Republic of Ireland and prevention of introduction should be a high priority.

5.4.5 Stocking for fishery purposes

Salmon stocking for fisheries restoration, mitigation or enhancement is regulated under current fisheries legislation managed by DCAL. Stocking can be a useful management tool or it can fail because:

- it may simply not be cost-effective, or
- causes harm through genetic or ecological risks.

Best practice for salmonid stocking is outlined in Egglishaw *et al*.(1984), Cowx (1994), Harris (1994) and Aprahamian *et al* (2003). In particular the costs and benefits of stocking should be set against the alternative methods of re-establishing stocks, such as habitat restoration. Stocking should not be carried out if environmental conditions are not suitable for fish. It is not an alternative to environmental improvement. Nevertheless, recovery of environmentally degraded fisheries can be accelerated by well-structured stocking programmes, e.g. the River Lagan. Like all management interventions stocking programme should have clear objectives, be costed and in the case of recovery programmes should be time limited to avoid compromising re-establishment of natural production.

Risks of adverse impacts of genetic modification and loss of locally adapted traits associated with stocking programmes are real (McGinnity *et al*., 2003), but can be reduced by using best practice. Advice is given in the guidelines for stocking and stock enhancement outlined in Appendix 4 of Williamsburg Resolution (NASCO, 2003), Cross *et al*.(2003), Youngson *et al*. (2003), Aprahamian *et al* (2003) and Verspoor *et al* (2007).

Trout stocking often involves adult fish of takeable size to provide increased fishing opportunities in lakes and rivers. The cost effectiveness of this has been questioned (Cresswell (1981) and it brings genetic risks (Ferguson, 2006), but it remains a popular management measure. Ferguson (2006) gives a thorough and detailed review of the issues surrounding trout stocking. Approaches to minimising the risks to wild brown (and sea) trout associated with stocking have been addressed in the Environment Agency's (England and Wales) National Trout and Grayling Fisheries Strategy (Environment Agency, 2003). Approaches include designating areas of known high value wild or genetically pristine trout as "wild trout fisheries" which will not be subject to stocking, and the use of triploid (infertile) brown trout to stock.

5.4.6 Invasive fish species

A proportion of the risk derives from the general public, via disposal of unwanted pet species. However, experience from the rest of the UK and Ireland (Caffrey *et al*., 2007) indicates that the release or escape of live bait used by pike anglers has had the most significant impact – particularly on stillwaters (Winfield 1991; Winfield *et al*., 1996) Thus, in addition to targeted education and enforcement, bans on the use of live bait are in place. Defra have produced a comprehensive risk assessment tool to help management the problem of invasive species (Copp and Fox, 2007).

5.5 Predation

Various guidance exists relating to the impacts of avian predators on fish and the management of such impact (Russell *et al*., 1996).

Habitat complexity, in terms of affording adequate variation in depth and in-stream structure (interstitial spaces, coarse woody debris and vegetation) is an important factor in minimising predation impacts. Furthermore, given that predation can be most significant at time of smolt migration, where circumstances permit (e.g. on regulated rivers) freshets timed to expedite smolt migration provide a potential means of reducing predation impacts.

Piscivorous birds are protected under the wildlife legislation. However, licences may be issued by NIEA to shoot cormorants as an aid to scaring. Isolated *ad hoc* attempts to scare cormorants are likely only to displace them, potentially elsewhere in the same catchment, thus obviating any benefits. Thus, co-ordinated approaches, where measures are needed should be promoted through SCMPs.

Predation of fish by fish is a natural phenomenon. However, artificially elevated levels resulting from stocking of fish, e.g. adult trout, can be avoided by restricting this practice, particularly in reaches known to have high capacity to produce juvenile salmonids.

5.6 Fishing Exploitation

5.6.1 Angling

Managing exploitation by angling follows the principles of basic fisheries management, with the overall aim of permitting sufficient spawning to naturally sustain healthy natural stocks. Numerous methods of effort and catch control exist, including bag limits, close seasons, restricted zones, method restrictions, size (minimum, maximum and slot) limits, and mandatory or voluntary catch and release. The existing fisheries legislation provides the means to apply most of the mechanisms outlined, notably the carcass tagging scheme. Consultation is important to achieve success because co-operation of the angling community is required to maximise effectiveness.

5.6.2 Coastal and High Seas Fisheries

Coastal fisheries within the 6 mile limit fall within the jurisdiction of the UK, and are therefore amenable to regulation by the Government, illustrated by the voluntary buy-out scheme undertake by DCAL in 2003-04. Although the current level of the commercial fishery is low, these mechanisms remain should the need arise. The other sea fishery known to exploit a significant proportion of stock in FCB region is the Irish drift net fishery. However, this is now closed. High seas distant water fisheries could recommence if future stock status permits and negotiations through NASCO will continue to monitor and control this.

5.6.3 Illegal fishing

Enforcement of fishery regulations by FCB/DCAL staff to minimise illegal fishing is a vital continuous fishery management practice. SCMPs may draw attention to the need for targeted campaigns, but it is likely that these would be already be part of enforcement programmes.

5.11 Planning and development

The planning policy process has public consultation as an integral component, and this provides the basis for SCMP managers and the statutory bodies involved to advise the planning service of DOE on sustainable development and pursuit of policies which avoid adverse impacts upon fisheries and their environments.

6 STOCK, FISHERIES AND HABITAT ASSESSMENT

6.1 Introduction

This section sets out the aims of stock assessment relevant to SCMPs and outlines its main techniques. It gives sources of data and reference to best practice and background understanding. The subject is very large, but some good introductory or overview texts are: Bagenal, 1978; Crisp, 1999; Elliott,1994; Ricker,1975 Hilborn and Walters, 2001; King, 2007.

A programme of salmon assessment exists for all NI rivers under the auspices of the NI Salmon Management Plan, with different levels in rivers according to the facilities available. This hierarchy of assessment is led by the River Bush on which AFBI maintains the longest running programme and most comprehensive facilities, focused on the Bush trap site. This site is of international importance and is the only ICES index catchment in Northern Ireland. The next tier down is the Index Rivers, for which Conservation Limits have been set and four of which have electronic fish counters (see below). Index rivers are geographically dispersed (**Figure 6.1**) and cover the range of salmon producing rivers in NI (**Figure 6.2, 6.3)**.

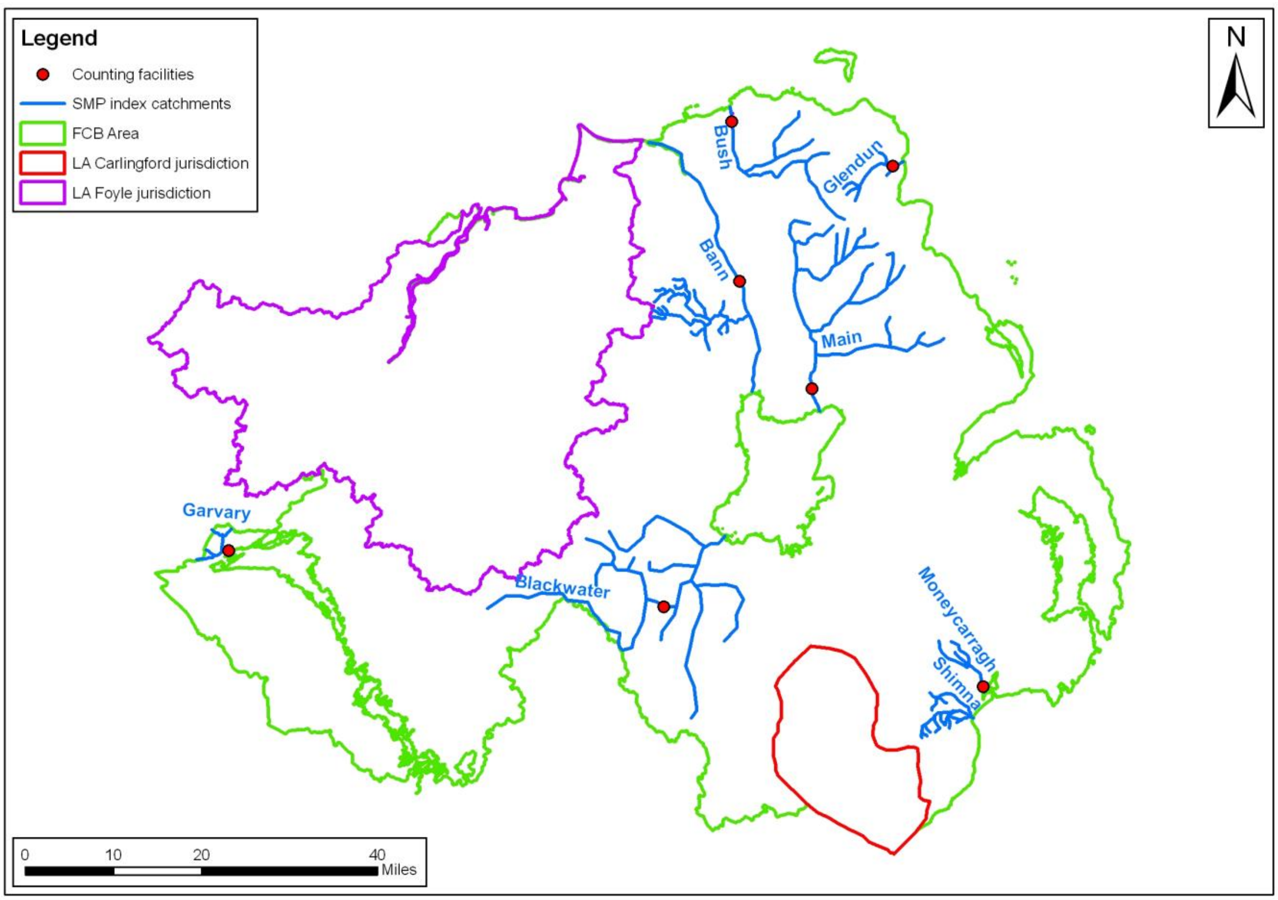


Figure 6.1 Index rivers and counter facilities in the FCB area

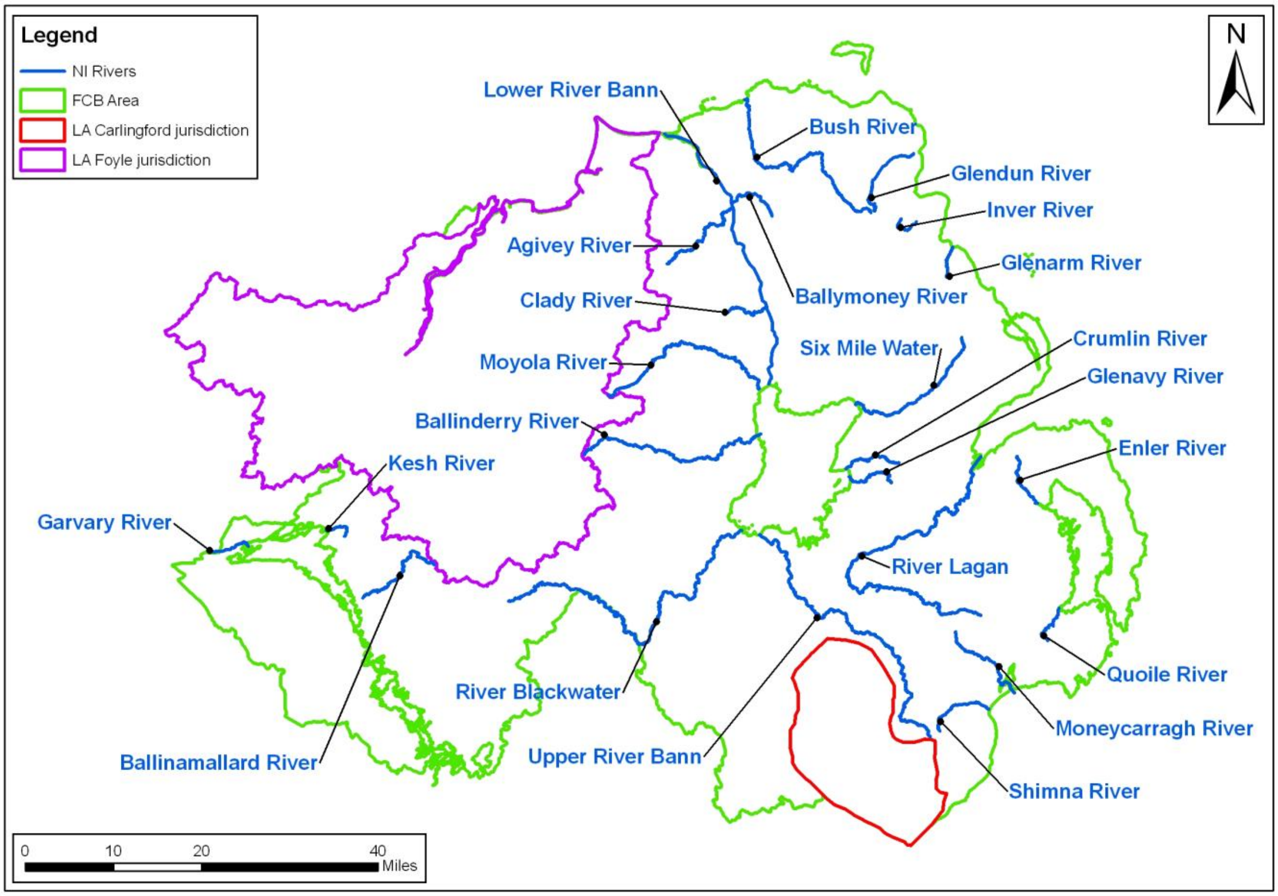


Figure 6.2 Main Salmon Producing (SCMP) rivers in the FCB area

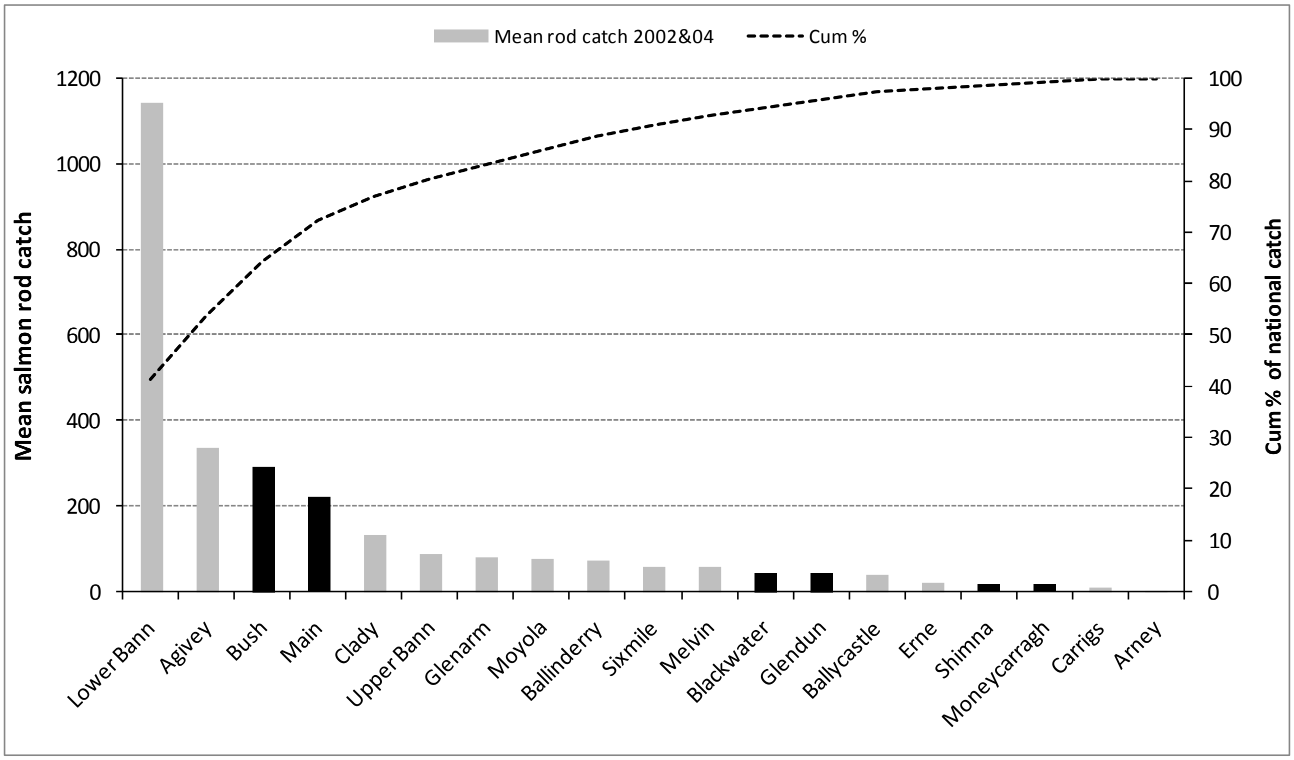


Figure 6.3 Comparison of the principal salmon rod catch producing rivers in Northern Ireland, ranked by their mean catch (2002 and 2004), showing the index rivers (black bars) and the cumulative percentage of national rod catch.

6.2 The aims of stock assessment

Stock assessment refers to the appraisal of fish stocks, their biodiversity and the fisheries that they support (Hilborn and Walters, 2001). In the SCMP context the aims extend to an evaluation of the impact of limiting factors.

- To determine if the selected indicators of stocks (or populations), fisheries and their habitat are at or above predetermined standards.
- If they are significantly below the standards, to assess what is/are the limiting factor/s and what effect they are having on the fisheries resource.

6.3 Indicators

Stock assessment involves measuring indicators that describe the levels and features of the following key stages. Note that, assuming adequate recruitment, the stream/river habitat is the key feature determining juvenile production and is thus the starting point for most river fisheries assessment. Habitat is as important a feature to measure during stock assessment as juvenile abundance indices or standing stocks of resident fish.

- **Stocks (naturally recruited adults**): annual abundance and composition (run timing and composition, age/size/sex), spatial and temporal (annual and seasonal) variation, redd count;
- **Egg deposition**: egg numbers per unit area;
- **Stocks (naturally produced juveniles)**: annual abundance and composition (mostly 0+ fry for salmon; may be standing stock and age class structure for trout), spatial and temporal (annual and seasonal) variation;
- **Fisheries**: rod and commercial catches, fishing effort, demand, values;
- **Stocking**: are there any stocking programmes that might confound electro-fishing survey data; and
- **Habitat**: channel and bank-side features variously at site, reach and catchment scale, depending upon application.

There is potentially a very wide variety of features to measure, and it is helpful to restrict assessment to key diagnostic variables and to add to these flexibly as SCMP circumstances indicate and resources permit.

6.4 Assessment scale

Some indicators, depending on how they are collected, refer to whole catchments, to sub-catchments or to short stream sections. The appropriate scale needs to be selected. Rod catches are variously reported for regions, whole catchments or major sub-catchments. In some cases where local fishery records are available the data may refer to single fisheries. Coastal net catches are interceptory fisheries and may relate to fish stocks returning to several adjacent rivers.

Counter data (run size and composition) are fixed by the position of the counter and provide and index of fish passing upstream of that point. Occasionally there may be significant upstream straying, but this is unusual and would be evident from the down count patterns.

Electro-fishing and redd count data may relate to a single site of a few metres dimensions or some composite mean, including up to the whole catchment.

6.5 Genetic identity of stocks

Salmon and trout show pronounced genetic variation between populations and between stocks (trout more so that salmon) and is recorded for NI (Crozier and Moffett, 1989, Ferguson, 2007). This variation arises for several reasons (Youngson *et al*., 2003; Verspoor *et al*., 2007), but there is strong evidence that salmonid populations are adapted to their local environments and that this fitness selection and related genetic variation are maintained by their tight homing to natal streams and rivers. This structuring of populations has been shown to occur even at sub-catchment level (Youngson *et al*., 2003). This is important to SCMP stock assessment because it may be necessary to assess stocks on finer scale than whole rivers. Moreover, any practices which compromise the genetic makeup of stocks such as selective exploitation, badly planned stocking or the accidental introduction of farmed salmon may compromise the long term fitness of the populations (Aprahamian *et al*., 2003; Laikre *et al*., 1999; Youngson *et al*., 2003; Verspoor *et al*., 2007). An objective in the NI National Salmon Strategy (DCAL, 2008) is to "Complete a DNA based study in 2009 to determine the genetic structure of salmon populations in the FCB area at catchment / sub catchment level. This will aim to complement other studies of Irish populations and so complete a "genetic baseline" of the island's populations.

Advice should be sought from AFBI on the genetics aspects of stock assessment and if this should be a factor in designing assessment or the investigation of limiting factors.

6.6 Conservation Limit

For salmon in NI the default standard is the Conservation Limit (CL) for the particular catchment. CL can be expressed as eggs per unit area, total eggs per river, or as adults needed to produce the ova. CLs are taken from a stock-recruitment curve (**Figure 6.4**) which describes the long term relationship between annual spawners (or egg deposition) in a catchment and the recruits which result from the egg deposition. In this case recruits are taken to be smolts leaving the catchment.

The NASCO definition of CL is the stock level supporting maximum surplus production, Sg in **Figure 6.4** (also known as maximum gain, or maximum sustainable yield). However, in the NISMP the CL is defined as the spawning level which produces maximum smolts, Sm in **Figure 6.4** and is thus a more risk-averse, precautionary level than Sg.

The only stock-recruitment curve for NI is that for the River Bush, where long term monitoring since 1973 has enabled derivation of the relationship. Thus, for the River Bush, CL (Sm) can be found directly from the curve's parameters (see e.g. Ricker 1975; Hilborn and Walters, 2001; Crozier *et al*., 2003). The eggs per catchment can be expressed also as density of eggs per habitat type, if the habitat features of the rivers have been mapped, which allows transport of that metric to other locations. If other rivers are mapped also then, assuming the Bush is broadly typical of recipient rivers, the egg deposition density can be simply applied to other rivers to allow calculation of a total egg deposition for each one. This has been done at the time of writing (November 2008) for 6 other "index" rivers (Dun, Moneycarragh, Shimna, Main, Blackwater and Garvary). The intention is to set CLs for other SCMP rivers in Northern Ireland through the SCMP programme, as habitat surveys are carried out (see **Example Conservation Limit Calculation** below).

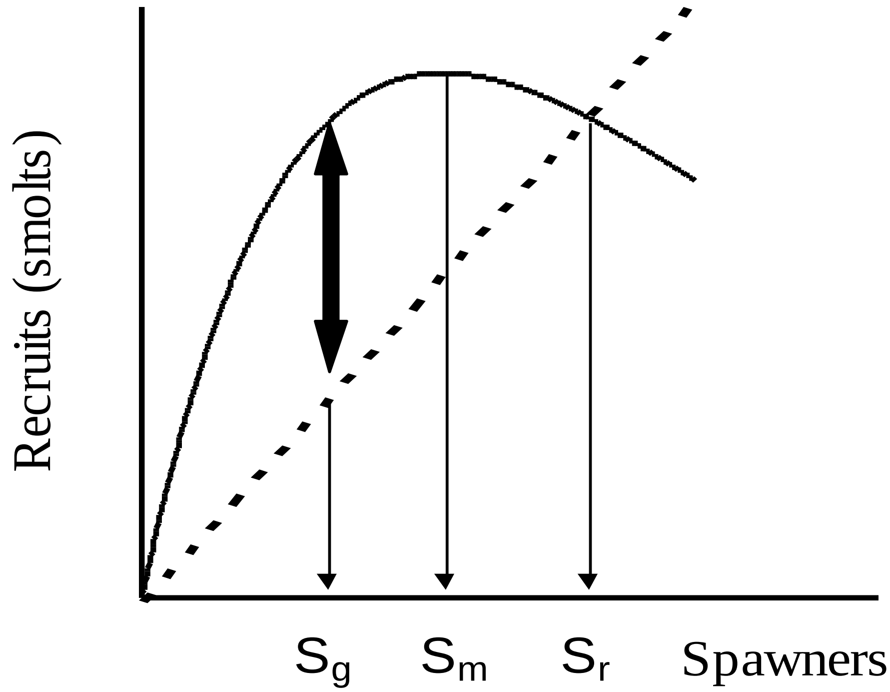


Figure 6.4 Diagrammatic stock-recruitment (S-R) curve showing three common options for biological reference points: S_r = equilibrium stock level for replacement in unexploited population, S_m = stock level providing maximum recruits, S_g = stock level providing maximum surplus production. The solid line is the S-R relationship, the dashed line is the relationship between the numbers of spawners that result from the smolts.

Example Conservation Limit Calculation

The following example, taken from the NI SMP, illustrates the process for transporting the CL from the Bush to the Glendun River.

Grade A habitat normally used on the Glendun[1]	3,807 m^2
Transport metric (egg density) from Bush S-R curve	9.5 – 14.2 eggs m^{-2}
Target egg deposition	361703 – 540651
Mean hen weight[2]	3.36 Kg
Relative fecundity	1,666 eggs Kg^{-1}
Sex ratio F:M	60:40
CL (in fish)	109 – 162

[1] Grade A habitat measured using Life Cycle Unit System method (see below), utilised proportion estimated from electro-fishing 5min fry survey.
[2] from local angler-caught fish

Caution: errors in the CL estimation. S-R curves and the reference points that can be derived from them have considerable statistical error. These arise mainly through a combination of process errors (not having a realistic enough model of the true relationship), measurement errors (bias and inaccuracies in measuring the variables) and random errors (arising through natural variation). In addition, stock-recruitment relationships of this type have particular problems due to long term changes in river productivity, resulting for example through systematic changes in agriculture and land affecting environmental quality. It takes 15-20 years to generate sufficient data for the S-R curve and changes in land use or predator abundance over time are to be expected, such that production of smolts for a given stock level can vary systematically with time. This is one example of a general phenomenon of "non-stationarity" (Hilborn and Walters, 2001; Crozier *et al*., 2003). The effect is minimised on the Bush by taking the earlier period of data (1973-1988), before significant land use changes are thought to have affected production. The errors and biases in estimation of CL can be expressed statistically, but a pragmatic approach on the Bush was to judge by eye the egg deposition range that likely encompassed the peak (Sm) of the S-R curve (Kennedy and Crozier, 1993). This is the range quoted in the example above.

6.7 Compliance

The NI SMP (Kennedy, 2007) outlines the methods for deriving annual egg deposition to compare with the CL. The process is not repeated in detail here (see also Kennedy and Crozier, 1995), but in principle takes an annual run estimation derived from total rod catch (inc. fish released) for each river if counter data are not available, subtracts the rod catch (fish killed) to estimate escapement, then applies default values for in-river survival, sex ratio and fecundity. This has been done for the six Index Rivers retrospectively to 2001, when the tagging scheme first enabled rod catch estimation. The rod catch reporting rates used to estimate rod catch are based on average values for each FCB region (Kennedy, 2007). A key variable is the rod exploitation rate which is highly variable between years (affected by river flows and effort for example). This is derived directly for the rivers with counters, but on others the nearest appropriate estimate will need to be used, as advised by AFBI.

Caution: application of the CL-compliance process

The use of standards and compliance to manage natural resources, such as fish stocks, is essentially a reductive process that simplifies very complex natural systems. It would normally be inappropriate and lead to errors to make management decisions on the basis of CL compliance on its own. Many other factors and sources of information need to be taken into account and numerous factors could lead to misinterpretation of a single CL set for a whole river (Hendry *et al*., 2007). A particular problem is the possibility of stock structuring on larger rivers, which might require CLs to be set for different stocks components originating from sub-catchments and having particular age, run or exploitation characteristics. On smaller NI rivers such spatially specific assessment may not be appropriate, although it is on the Foyle for example and may be appropriate to the Neagh and Bann systems.

Moreover, the compliance data are also subject to errors, introducing uncertainty and risks to the management decisions, but this is the case even without standards. Management decisions require trade-offs between competing interests and evaluation of the associated risks, perhaps expressed in terms of non-biological measures such as economic and social consequences. While these decisions are becoming increasingly complicated, CL methodology is continually improving and the systematic approach to fishery problems aided by CLs does facilitate the process.

6.8 Other standards

CLs are the default standards for salmon, they reflect the wording of the Salmon Strategy Management objective (**Section 2**) and serve a valuable role in formalising assessment, directing monitoring programmes and providing consistency in approach. However, other standards may be appropriate. One might want to set interim targets as milestones towards the achievement of the CL, or stock levels for sea trout for which CLs are not available, or use other measures than spawning escapement such as angling participation, catches or exploitation rates, for example.

Other standards might be relevant to specific aspects of a SCMP, for example fish abundance per unit habitat (comparing observed with the target expected value, e.g. Barnard *et al*., 1995; Milner *et al*., 1995, 1998) are useful for environmental impact assessment and can be developed as appropriate to the management objectives for a catchment, to complement, but not replace the default CL. Alternative reference points from S-R curves (**Figure 6.4**) might also have application; but it is likely that, if ever required, these would be promoted by AFBI centrally as part of a strategic change to the National Salmon Plan.

It might be necessary to adjust the CL expressed for the whole catchment by omitting areas where access is prevented through a manmade barrier for which no fish pass is practicable, or where there are environment problems that are intractable during the lifetime of the SCMP. This approach, which is effectively derogation, should not be used to escape the obligations to resolve environmental issues; but is acceptable where the intention is to report against the feasible production capacity of the catchment.

6.9 Sources of data

Data will be some mixture of contemporary survey data, collected specifically for a SCMP, and historical data typically collected by centralised means and retrieved from central databases. Both are necessary because the temporal variability afforded by historical data establishes the statistical uncertainty in the data and because trends in abundance are as important as contemporary levels. Similarly, spatial variation and the notions of spatial controls are inescapably important when trying to investigate the role of a supposed limiting factor. Statistical rigour in the assessment will give authority and credibility to the SCMP diagnosis and recommendations. This can be a daunting prospect because the statistical problems presented by fisheries data can be severe, especially when trying to use them retrospectively for ecological diagnosis. But it is recommended that a strong statistical base is established for SCMPs from the start, perhaps taking advantage of external statistical services if none are available in-house. This does not in any way devalue or preclude the simple collation, exploration and presentation of data, which are essential first steps in assessment, and often give enough information for reporting purposes.

6.10 National databases for stock assessment

The importance of maintaining coherent, co-ordinated databases cannot be over-emphasised. This ensures consistency in data provision, quality and provides the basis for future monitoring and survey design.

The core fisheries databases upon which each SCMP should draw are maintained by FCB/DCAL and by AFBI, under service level agreement to DCAL. However, not all the data are routed through the same departments (NIEA for example also use AFBI to carry out fisheries survey work) and that requires some rationalisation to maximise the overall benefits of monitoring and survey expenditure. The main types of data, their principal features, their sources and method of collection are outlined below. Most environmental data are held by EHS and flow data by the River Agency.

6.10.1 Rod logbook and carcass tagging scheme

The angler logbook scheme introduced in 2001 (but first full year in 2002) is the main method for recording rod catches and related variables for Northern Ireland. It gives rod catch, effort, location, timing, and release rate. The scheme is administered and the database is maintained by FCB/DCAL. Logbooks are issued to all salmon and trout licence purchasers at the sites of authorised sales agents and are accompanied by the sale of salmon jaw tags as required by the angler. The sales outlet records license number and numbers of issued tags, returning this information to FCB/DCAL. Jaw tags, which are individually numbered, are required to be applied to all killed salmon (it is illegal to be in possession of an untagged dead salmon) and the numbers recorded in the logbook. At the end of the season anglers return their logbooks and unused tags to FCB/DCAL. Data in logbooks are recorded by each fishing trip (one per page), comprising: date, location, hours spent fishing, and for each fish: species (salmon or sea trout), weight, method, released/retained, sold/not sold, tag code and number.

The FCB/DCAL produces an annual fisheries report (latest available: 2006) in which summary statistics from the logbooks and tagging scheme are reported by region. For SCMP purposes river specific catches are necessary and should be use in the stock assessment section. Depending upon the purposes, catch data should be reported both as catches and as catch per unit effort (e.g. catch per hour, catch per day, catch per license sale.

Exploitation rate is the proportion of the annual run (including out of season run) taken by angling, expressed as either fish killed or as total fish caught (including those returned). Exploitation can be calculated for different seasonal run groups, e.g. spring run, to examine selective exploitation. Calculation of exploitation rate requires an independent assessment of run size, normally obtainable through trapping or an electronic counter, currently limited to 7 index rivers (see above). Exploitation rates can be extrapolated to other nearby rivers, with caution and the appropriateness of this will have to be judged by reference to local knowledge of catchment productivity fisheries, fishing effort and catch levels.

Caution: non-reporting adjustment. Not all fish catches are recorded and not all records are returned by anglers. This is a routine problem with catch statistics and can be a considerable source of error. In the FCB/annual reports adjustment is made by knowledge of the return rates of tags and licenses. These corrections should continue to be made centrally in the database to ensure consistency; but in SCMPs the use of both raw and adjusted data may be necessary (even if only to emphasise a low reporting rate that needs managing, for example). It is important to keep a record of this to ensure that confusion does not arise between the two types of data.

6.10.2 Net logbook and carcass tagging scheme

This follows the same principles as the rod scheme, but because the number of participants in the fishery are far smaller the recording rate is 100%. The fisheries are in coastal and estuarine waters and the fish caught are from different rivers. Allocation to rivers is not normally something that would be done in isolation, but as part of a national assessment, and would involve some form of tagging programme run across several catchments. However, net exploitation may be a relevant limiting factor on some rivers, in which case that information would be sourced from AFBI as part of the national salmon plan and annual ICES reporting. Note that the commercial salmon fishery is much reduced following the DCAL sponsored voluntary buyout scheme in 2003/04. This removed 90% of the licensed commercial fishing engines and left 2 commercial nets, 2 fixed bag nets and 1 tidal draft net in operation in 2006. Further regulatory measures are being explored in 2008.

6.10.3 Fish counters

This gives annual upstream and downstream run, seasonal run timing, and depending on facility, species split and size distribution, by river. Electronic counters are located on 4 index rivers (Glendun, Main, Blackwater and Moneycarragh) with a counter on the Garvary becoming operational in 2007. The SMP has proposed the development of further facilities on the Lower Bann and on either the Cady or Agivey. They are managed by AFBI who also retain the data.

6.10.4 Fish traps – the River Bush station

This research and monitoring facility gives all the adult data types from counters, but much better quality data on fish species and biological characteristics such as age, size and sex. Smolt traps give smolt run size, timing and, by sub-sampling, the size and age composition. Coded wire tagging gives marine return rates and exploitation in interceptory fisheries).

The Bush station runs all year round and provides the NI focus for salmon assessment and information and data that feed into international programmes and into NASCO via the ICES

Salmon Working Group and the EU NACO delegation. Access to the data for any SCMP purpose is via AFBI staff who run the science programme (DCAL manage the Bush site).

6.10.5 Electro-fishing surveys

Electro-fishing gives indices or absolute abundance estimates of fish abundance by site, by reach or for whole catchments, depending upon survey method and design.

Electro-fishing surveys are carried out by AFBI for DCAL for fishery-specific purposes, by AFBI for Water Framework purposes and by FCB/DCAL for fishery management purposes. Data is held on a central database maintained by AFBI; nevertheless cross-referencing and checking between the organisations may be necessary to capture all data relevant to a SCMP. The data are of two main types: quantitative, being population estimates based on run depletion methods, and semi quantitative (SQ), being based on timed single run fishings. SQ data are normally focussed on 0+ fry abundance sampled in typical fry habitat surveyed for 5 minutes. Intensive annual fry surveys have proved to be a very useful way of giving an index of spawning activity the previous year and show correlations with subsequent smolt production. The latter relationships are possible because most density dependent mortality seem to have taken place by the mid to late summer when such surveys are conducted.

NB shortfall in electro-fishing data (too few sites/occasions and not enough information on all age classes) will often be a constraint on SCMP diagnosis and additional surveys (along with habitat) are likely to be an early task for the SCMP.

6.10.6 Redd counts

Gives annual redd counts per sub-catchment. Redds are the spawning sites dug by salmon and sea trout in October/November and can be identified visually by patches of clear gravel and mounds and pits in the gravel surface. Bankside walkover surveys can be used to counts redds and they provide evidence of spawning, but lack of visible redds does not means that spawning has not occurred. Kennedy and Crozier (1991) concluded that redd counts data in NI were generally not suitable for assessing the benefits of management interventions. However, in rivers where conditions are good for surveying redd counts can provide useful data on spawning location and intensity. The problems with redds counts are the time needed to do the surveys, as spawning may not be completed for some weeks and early redds can be obscured by floods and gravel movements. Over-cutting may confuse counts. Salmon, sea trout and lake brown trout of similar size dig redds that cannot be distinguished, although the species often show some spatial separation, which may be part of local knowledge. Water visibility is obviously critical and counting can be tricky in some coarser unstable substrates where the contrast between dug and not dug areas may be indistinct. Redd counts are made by FCB field staff and are reported annually in FCB Fishery Reports.

6.10.7 Data storage

As part of the NI SMP, all historical fisheries data noted above (except redds?) are maintained on a database supported on a Geographical Information System (GIS) which is maintained by the AFBI. For SCMP purposes it is effective and ultimately time-efficient to use the GIS as much as possible to ensure that maps and data extraction are systematic and repeatable.

6.11 Field survey methods

The principal survey methods of electro-fishing and habitat are outlined below. Fortunately in NI salmon assessment has well-established protocols developed through the pioneering work on the Bush catchment. Note that while these are the default practices to ensure consistency across NI SCMPs, always keep an open mind about new methods and critically reappraise the old ones as appropriate. Resources are normally the main constraint on practice, but methods do evolve. This is particularly important when considering any operational investigation that it may be necessary to recommend in a SCMP action plan, for which novel methods may be the only solution. For example modern fish tracking or video methods may help to examine a fish-pass or other barrier problem, or passive microchemistry samplers may help in studies of diffuse pollution.

6.11.1 Electro-fishing surveys

Electro-fishing is the standard method for sampling fish in freshwater stream and rivers. Electricity and water form a potentially dangerous mix, so training, medicals and tight health and safety protocols must be absolutely paramount in every survey. Procedures are well established and survey teams are operated through service level agreements by AFBI (for DCAL and NIEA) and DCAL itself.

In addition to training and H&S, issues to consider are survey timing, survey design and fish welfare. Mid to late summer (July to September) is the preferred window because it is a time of low flows, enabling wading; 0+ fish are large enough to handle and have gone through most of their density-dependent mortality phase, so their number better represents subsequent recruitment and leaf fall does not obscure visibility or clog stop nets (if used). Field techniques and the population estimation methods are well described (Crozier and Kennedy, 1994) with protocols for the timed fry surveys developed specifically for NI rivers. There are two main type of method:

- Quantitative surveys in which repeated runs through a reach covering all available habitat types are used to derive abundance estimates form depletion statistics,
- Semi-quantitative, normally 5 minute single run, fry surveys confined to fry habitat.

Various permutations can be employed depending upon survey objective. Electro-fishing involves teams of 2 or more staff and full quantitative (multiple runs) surveys can be time consuming. Depending upon site size and location 1 to 4 per day sites are possible. In contrast, semi-quantitative 5 min fry surveys are faster and up to 15 sites per day are achievable (Crozier and Kennedy, 1994). The trade-off is in the data quality and information. Quantitative sites give much fuller information of absolute abundance, for all age classes and species. Timed surveys give relative abundance and for salmon and trout fry only. The distinction between the "index" nature of timed fry survey data and the absolute nature of quantitative surveys should be borne in mind. They are not directly comparable, although there are ways to relate the two by cross-calibration if required and if the sites and method of fishing are appropriate (Crozier and Kennedy, 1994; Strange *et al*., 1989; Winstone *et al*., 1993).

SQ (5 minute fry) surveys are useful for finding out where spawning occurs, assessing annual variation in recruitment and identifying areas where there are shortfalls in fish production (in relation to available habitat quality). SQ data are pooled as required to show fry abundance indices (as means, standard deviations, ranges etc) for reaches, sub-catchments or whole rivers. Quantitative surveys are useful for evaluating impacts of various pressures and for estimating stock abundance. Multiple fishing data need to be processed to estimate the absolute population sizes and errors using conventional statistical methods (e.g. de Lury, Bohlin, Carle and Strub, 1978; Zippin, 1956). AFBI acts as the advisor on these procedures. Subsequent treatment of the quantitative data varies according to the objective of the assessment in hand. Normally the statistics are presented to represent abundance in whole or part catchments, often stratified by habitat or other reach feature to explore the variations that the assessment is aimed at, in the same way as for SQ data.

6.11.2 Habitat surveys

Habitat is the physical environment occupied by fish and is conventionally taken to include structural features (e.g. substrate size, depth width, channel section, channel longitudinal form, gradient, cover, in stream and bankside vegetation etc), water quantity and quality. However, ecosystem and catchment processes are interrelated in a continuum of change along the length of natural rivers (Vannote *et al*., 1980). Site and reach physical features are related to the processes that govern catchment and channel structure, so the features in the fishes' immediate habitat are determined by the whole panoply of fluvial geomorphologic processes throughout a catchment (Mather *et al*., 1998). Thus, the definition of habitat broadens considerably (Harper and Everard, 1998); but in order to avoid the daunting prospect of having to measure and understand everything at once it is necessary to make the pragmatic distinctions between site/reach based features and those at wider scale. The important point to remember that to solve a local habitat problem in a SCMP one may have to evaluate habitat processes and address remedial actions elsewhere in the catchment.

In pristine environments with adequate recruitment to seed rivers fish habitat is the most important determinant of fish abundance and there is a vast literature on the fishes' habitat requirements and methods for habitat description and evaluation (e.g. Gibson, 1993; Crisp, 1999; Armstrong *et al*.,2003; Bardonnet and Bagliniere, 2000). During their lifetime salmonid fish need a wide range of habitat, key requirements being for spawning (egg deposition in suitable gravels), rearing (fry and parr production), adult holding areas (for resident salmonid production) and passage (for migration of spawners, smolts and kelts). Coarse fish, eel, other fish species and lamprey also have specific habitat requirements, particularly for spawning and migration. However, because they are mostly less territorial in behaviour and have larger home ranges than juvenile salmonids, they may be less tied to local habitat features and require more generally suitable habitat over wider extents (kms). The type of habitat survey to use is determined by its purpose, four principal aims are:

- To estimate (predict) expected standing stock (fish abundance in a section or whole river);
- To set an expected target for fish abundance against which to compare observed abundance;
- To evaluate habitat quality and level to assess deviation from some reference condition (*cf* Water Framework Directive – ecological condition); and
- To identify and map sections requiring habitat intervention (restoration or enhancement).

All require some form of model which range from informed, subjective opinion of what a habitat "type" should support, through to complex multivariate empirical models and dynamic conceptual models calibrated on observed abundance data.

In Northern Ireland there is a basic habitat description and mapping method, the Life Cycle Unit System (LCUS) that has been developed on the River Bush (Kennedy, 1984; Kennedy and Crozier, 1993; Crozier *et al*., 2003), and is being rolled out across the SMP index rivers, with the intention of extending throughout the wider group of SCMP rivers. <u>It is the default habitat mapping method to be used for SCMPs.</u> The method involves walkover surveys of rivers with classification of habitat into 3 categories:

- Spawning habitat,
- Nursery (juvenile rearing area) and
- Holding (pools)

Each category is further split into 3 grades, based on quality. A fourth category is used for habitat of limited value for salmonids. The principal function of the LCUS is to enable transport of the Conservation Limit metric (eggs deposited per unit area, see above) to all rivers, adjusting by their proportional area of common (e.g. grade A) habitat. The method also allows a preliminary evaluation of each river section's potential to hold fish and thus can guide stocking programmes or habitat restoration schemes. While the method has the merits of being simple, relatively quick and intuitive, it has a low precision in terms of any predictive capability and a significant subjective element. Training and quality assurance are import to ensure consistency in habitat evaluation using LCUS.

AFBI are the keepers of this methodology and should be consulted for the detail of field protocols, recording sheets, data manipulation and storage.

The LCUS method is applicable to complete catchment coverage, but it takes time and the returned data are reduced descriptions of habitat. Moreover, in general there is an inverse relationship between method complexity (=detail, time and cost) on one hand and precision on the other (O'Connor and Kennedy, 2002). Selection depends upon the objective of the survey, but for preliminary NI SCMP purposes the LCUS method is standard and appropriate.

Other methods might be more applicable to specific applications where more precision is necessary (e.g. impacts assessment) required or when a full catchment survey may be needed quickly, when the detail of habitat improvement are required, or where the special impacts of flow on in-stream habitat are needed (e.g. to evaluate abstraction licenses, drought permits or changes to compensation flows).

There is no single source for the wide range of fish habitat assessment tools currently available; but some methods common in the British Isles, with their principal applications and constraints are summarised in Table 6.1. A key distinction to be aware of is that some (e.g. LCUS, aerial surveys) are habitat characterisation and mapping methods, providing habitat inventories for whole rivers or sub-catchments; others are essentially sub-sampling descriptive methods (e.g. RHS) and others are sub-sampling modelling approaches which predict fish from habitat features (e.g. HabScore and PHABSIM).

Table 6.1 Summary of habitat mapping and assessment methods

Method	Content and Approach	Application/advantages	Drawbacks	References
LCUS	Protocols and recording system for walkover surveys that identify and grades key habitat types , mapping their longitudinal distribution by visual observation polygons of habitat type	Site-reach-catchment habitat description and longitudinal mapping, informed, subjective quantification of key life stage habitats. Catchment scale inventories and mapping; location of habitat improvement schemes. Fairly quick. Designed on the Bush, used on NI index rivers so expertise established.	Subjectivity requires attention to training and QA. No prediction of fish abundance.	O'Connor and Kennedy, 2002
HENDRY-CRAGG-HINE	Protocols and recording system for walkover surveys that map from visual observation polygons of habitat type. Similar to LCUS, but without the grading within habitat categories.	Site-reach-catchment habitat description and areal mapping (unlike LCUS), informed, subjective quantification of key life stage habitats. Catchment scale inventories and site scale detail, locations of habitat improvement schemes. Fairly quick.	Subjectivity requires attention to training and QA. No prediction of fish abundance.	Hendry and Cragg-Hine, 1997
HABSCORE	Field methodology and software for empirical models relating fish abundance of 0+, parr and older to habitat features; transect surveys of short (<100m) reaches + map-derived variables.	Site-based habitat description and evaluation. Impact assessment .Trout and salmon of diff ages/size. Prediction of expected population size (N); statistical comparison with observed N (If available), impact assessment. Errors and uncertainties are comprehensively treated	Calibrated on English and Welsh rivers, transport to other rivers depends upon comparable river types. Site specific (NOT a mapping method). Assumes calibration sites are pristine. Field work is comparatively time consuming (20-40mins per site)	Milner *et al*. 1975, 1978; Wyatt *et al*. 199n; EA Tech reports
PHABSIM	Field methodology and software for eco-hydrological models linking habitat variable to flow changes, in turn linking habitat change (Weighted Useable Area) to N through Habitat Suitability curves.	Water Resource issues. Flow change impact assessment. Effects of flow changes on abundance. Gives detailed, reproducible and factually correct description of physically habitat changes	Very time consuming (channel section and flow gauging required. Several key assumptions about independence of variable and fish response to key feature changes that are contentious.	Moir *et al* 2005; Booker and Dunbar 2004; www.fort.usgs.gov/products/software/PHABSIM
AERIAL SURVEYS	Several methods in development. Most involve high resolution digital photography coupled with spectral, texture or image analysis.	Wide scale assessment of habitat quality based on physical attributes, catchment scale inventories, stock prediction and site scale detail. Design of habitat improvement schemes. Quick, repeatable, stores large quantities of precise image data that can be interrogated for different purposes later. Proven image analysis methods now available	Specialist. Costs (may be offset by quantity and quality). Software dependent. Some ground truthing may be required, Some practical constraint through visibility of features due to riparian vegetation, light conditions and water conditions.	Amiro, P.G. (1993). Hedger *et al* (2006) Carbonneau *et al*. (2005) Marcus and Fondstad (2008)
FLUVIAL AUDIT	A generic term covering diverse surveys of physical biotopes and catchment hydraulic features	Increasingly used to describe the geomorpholigical features of rivers linking catchment processes to site/reach features. Useful for catchment diagnostics e.g. sources of erosion or controls on sediment transport. Will form pat of WFD monitoring to assess river morphology	Time consuming and not specifically fisheries orientated, (but can be linked to spawning sites and sediment transport issues).	Newson *et al*., (1998) Orr and Walsh (2007)
RIVER HABITAT SURVEY	field based survey method for 500 m reach lengths using transects and sweep-up semi-subjective descriptions	Widely used, well-established protocols and accreditation schemes. General wildlife and conservation habitat description, impact identification, big UK-wide database. Routinely used by EHS for wildlife conservation purposes (with SERCON)	Comparisons need to be restricted to common river type. Features include some appropriate to fisheries, but correlations with fisheries abundance are comparatively weak.	Raven *et al*., (1998), Boon *et al*.,(1998)

6.12 A Comment on compliance testing

Compliance of stock status with the CL is the first test that SCMPs employ and is the main metric to be reported back to ICES and NASCO. Compliance assessment is essentially a statistical task and there are many ways to do it. A review of these is outside the remit of this report (see Crozier *et al*., 2003, for an introduction to the issues), but some principles can be illustrated.

A simple annual pass/fail, i.e. the annual stock (egg deposition) is above/within/ below the CL range is the current approach, but on its own loses information on stock variation and trends. **Figure 6.5** shows three scenarios of long term (10yrs) variation, set against a CL rage of 12 to 18. Based on the long term means, the upper, middle and lower panels show good pass, borderline pass and fail respectively.

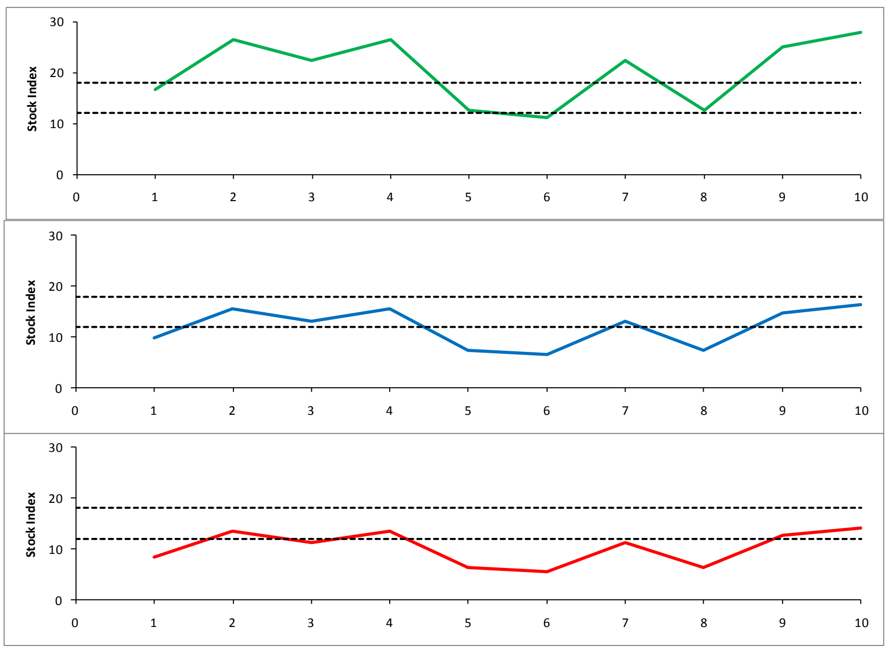


Figure 6.5 Illustration of compliance scenarios. CL range = 12-18. Top panel: good pass (mean = 20), middle: borderline pass (mean = 12), lower: fail (mean = 10).

However, the data are reported annually raising the question: is it appropriate to signal "failure" in year 6 in the top panel, or to report pass in years 2, 5, 9 and 10 in the lower panel. In practice, annual variation is usually high in fish stocks, and with these hypothetical (but realistic) data even a just compliant stock (mean =12) in the middle panel would have reported failure (<12) in four years out of ten. Trends in stock status also need to be taken into account; for example, a stock above CL but on a significant declining trend would require more urgent action that one in a stable state.

Currently in NI the issues of reporting are not critical because all the index rivers have stocks below the CL lower ranges, with the exception of the Shimna in 2004 (Kennedy, 2007) and so all need attention. However, the statistical process needs to be resolved because eventually there will be decisions to be justified on the basis of compliance, and experience in England and Wales indicates that, when management resources are limited, this can be a contentious topic. In England and Wales CL compliance is based on a comparatively robust statistical scheme (Cefas/EA 20008); but full stock diagnosis also takes into account other indicators such as juvenile abundance and catch changes. Issues which need consistency, such as the statistics and protocols for compliance reporting, should be centrally managed through AFBI. **[RECOMMENDATION: Develop a statistically based compliance scheme to suit the NI Salmon Strategy context.]**

7 ECONOMIC EVALUATION OF FISHERIES

7.1 Introduction

Cost benefit analysis of management actions requires an assessment of the current value of the assets and their value when restored. This section provides guidance on assessing the value of a fishery and how these data can be applied in the context of SCMP's.
Assessing fishery value is complex and while economic values may override other factors, it is also important to consider the non-monetary values, the social and environmental benefits from having fish in rivers and the fisheries they support.

7.2 Assessing participation

Level of participation by anglers can be assessed using license return statistics to extract data pertaining to the number of days fished on each river/catchment. Such estimates must however be treated as minimum participation, due to the failure of some anglers to submit returns. To account for this an adjustment factor may be applied and although acknowledged as being imprecise, the best estimates available in England and Wales suggest that a multiple of 1.2 provides a rough guide to the true level of angler participation. Based on angler's postcodes, these data can be further explored to determine the ratio of local to visiting anglers. Such data may be important in assessing the value of the fishery to local tourism – Section 6.4. Again, these figures should be multiplied by 1.2 to account for anglers not submitting license returns.

With regard to the net fishery, level of participation can be established from regional catch statistics where these are available.

7.3 Assessing value

The proposed methods given below for assessing value have been adopted from the Environment Agency (England and Wales) Salmon Action Plan Guidelines (Environment Agency, 2003) and can be summarised as follows.

Value to fishery owners + Value to anglers + Value to netsmen = Nett Economic value of fishery

To assess the value of a fishery, one must first identify the users and establish a baseline of the current value of the commodity. Invariably these data are most effectively gathered from catch statistic reports and possibly through the issue of strategically designed questionnaires.

Value to fishery owners (Market value of fishing rights)

This is a measure of the present value of the capitalised values (i.e. accumulated future annual benefits) and can be calculated by multiplying the local (i.e. river/catchment) mean value per salmon (ideally the 5 year annual catch should be used) by a correction figure to allow for the percentage of anglers who do not submit catch returns. In the absence of specific figures for Northern Ireland, Small (1988) estimated that this figure was between 30 and 40 percent for which a multiple of 1.10 should be applied.

For example:-
(5-year average declared catch) x 1.10 x (mean value per salmon from the area/catchment)

The mean value per salmon varies regionally in England and Wales with an overall average (Radford *et al*., 2001) of £9,000 per fish (this will also vary with inflation).

Value to anglers (Consumer's surplus)

The Nett value of a fishery to anglers is called their 'consumer surplus'. This can be defined as: the difference between the figure that anglers pay for their fishing and what they would be willing to pay. Therefore the value of each river to anglers (consumer's surplus) may be calculated from the sum of the different surpluses of the anglers who fish it. A previous study in England and Wales found these values to be highly variable between rivers and ranged between 1:1 and 20:1 (Radford, 1984). If however the lowest ratio is applied as a conservative measure, then Anglers' consumers' surplus (capitalised) is equivalent to market value of rod fisheries.

Value to netsmen (Profits from sale of catch).

Profits to the net fishery can be calculated by subtracting the operating costs of the fishery (i.e. fuel, mooring charges, net maintenance, license duties etc.) from the gross revenue derived from the sale of fish (i.e. the weight of fish (kg) caught and the price (£) per unit weight). The example data presented here are extracted from the EA (England and Wales) SAP Guidelines and enable a rough estimation of the annual nett profits to netsmen within each fishery.

5-year average catch of salmon: 932 kg
Gross revenue (salmon) £4.1 (price per kg) x 932 = £3821
Nett profit = £3821 – operating costs

Following the most recent assessment of operating costs in England and Wales, it has been estimated that following an increase in license duties, these costs may be as high as 75%. Using this figure as an example the nett profit would be calculated by multiplying the gross revenue of £3821 by 0.25, thus giving a figure of £955.

Using these data, managers can derive a preliminary estimate of the economic value of fisheries the implications of a failing fishery and potential economic benefits of improvements. Note that economic assessment is contentious and uncertain and so specialist advice may need to be sought. Moreover the benefits of fisheries include non-monetary aspects which are even harder to estimate. Nevertheless, a priority within the SCMP should be to quantify the economic benefits of management actions so that these can be communicated to stakeholders and potential funding bodies.

7.4 Assessing angler expenditure

In England and Wales, angler participation (rod days) and willingness to pay have been demonstrated to be positively correlated with the catch performance of salmonid fisheries (Environment Agency, 2003). Interestingly, this was not observed to be the case with stillwater coarse fisheries, where riverside access, onsite facilities and general aesthetic appeal of the surroundings were found to be key drivers. Indeed, while fishery catch performance is likely to be the key driver in Northern Ireland fisheries, these other components should not be overlooked in assessing the value of a rod fishery.

The economic value of a rod fishery can be broken down to a number of components which will each be specific to individual beneficiaries:

- Angler license sales
- Permit sales
- Tackle dealer sales
- Hotel and B&B utilisation by visiting anglers (and families)
- Distance travelled by anglers (fuel, vehicle running costs etc.)
- Ghillie fees

In a recent and detailed report addressing the social and economic impact of recreational angling in Northern Ireland (PriceWaterhouseCoopers, 2007), the net benefit arising from the presence of recreational angling in 2005 was estimated at £20.5 million, with £13.4 million of this figure being directly derived from game fishing. The economic implications of a failing fishery may therefore impact on a range of businesses and while the level of expenditure by salmon anglers in England and Wales has been described as low significance to the national economy, the degradation of fisheries in Northern Ireland may have significant impacts on some local rural economies and associated employment. A framework for assessing the Nett economic impact of tourism angling is provided in the PriceWaterhouseCoopers (2007) report and can be summarised as follows:

Number of visitor/tourist anglers
*
Average number of trips per year
*
Average number of days/nights per trip
*
Average expenditure per angler per day/night
=
Total Gross Expenditure Contribution of Visitor/Tourism Angling
*
Multiplier Factor
*
Opportunity Cost of Resources/Displacement Impact Factor
=
Net Economic Impact of Visitor/Tourism Angling

[RECOMMENDATION: At present, no figure is available for the current average expenditure per angler per day. It is recommended that this is quantified so the best estimate can be fed into the above calculations. The PriceWaterhouseCoopers (2007) report includes estimates pre 2005 and describes effective methods of collecting these data.]

7.5 The social and environmental impact of angling

The availability of a naturally sustainable fishery provides additional social value to local communities although these benefits are less tangible and thus more difficult to quantify. Such benefits may include better health through increased exercise and stress management; a reduction in crime and antisocial behaviour due to the provision of alternative recreational opportunity and the enhanced interaction among a range of ages and social classes. Educational benefits have also been highlighted through raising awareness and appreciation of ecosystem functioning. In terms of environmental value, the presence of anglers on the river bank has been demonstrated to be effective in rapidly alerting organisations such as the FCB to pollution incidents. Furthermore, independent angling organisations and the revenue raised by angling license sales, has been effectively used to create and enhance habitats such as nursery refuges, and have thus provided direct ecologically positive feedback at the ecosystem level. A comprehensive overview of non-monetary (social and environmental) benefits is detailed in the previously referenced report (PriceWaterhouseCoopers, 2007). Indeed, one of the conclusions of this document was that by promoting angling participation, significant savings in other departments and agencies can be realised. This is particularly relevant in the cases of health and crime reduction.

7.6 Applying the data

Following the establishment of a baseline valuation, these data can be applied to the following:

- Damage assessments for pollution incidents
- Justifying enhanced expenditure on fisheries management
- Projecting and quantifying financial gains in relation to managed ecological enhancements
- Public relations – communicating the environmental value of environmental protection and future investment to prospective beneficiaries.

With respect to the last point, a study by Spurgeon (2001) identified that the status of the salmon as being symbolic of high environmental quality, was also considered as important by the non-angling component of the population within the catchments of the Rivers Thames and Wye. Indeed this study identified a willingness of households to contribute financially to the promotion of salmon stocks with the projected revenue from these contributions being £12 million and £40 million each year for the Thames and Wye regions respectively.

8 GATHERING EVIDENCE ON IMPACTS, MONITORING AND EVALUATION OF LIMITING FACTORS

8.1 Introduction

Gathering evidence on limiting factors requires data on pressures and receptors (in this case stock, fishery and habitat) to be assembled in ways that allows the statistical testing of hypotheses on impacts, correlations, associations etc.

The pressures on stocks and fisheries are listed in **Section 5** and these are the potential factors that limit the achievement of the standards predetermined for the catchment when the SCMP is prepared (primarily the CL, but see section 6 for others). The evidence of pressures can arise from various sources, e.g.:

- Anecdotal, *ad hoc* observation by users e.g. illegal fishing, predation by birds or seals, point source pollution and fish kills, development;
- Routine monitoring programmes by authorised bodies such as agencies, Trusts or quangos (**Table 8.1**); and
- Specific targeted investigations commissioned to examine known problems.

Table 8.1 Routine monitoring programmes contributing data to SCMPs

Programme	Data types	Indicators	Responsible body (Reporting)
Rod and net catches	catch, effort, CPU, daily -annual	adult stock fishery performance exploitation	FCB (Annual fishery reports)
Enforcement	incidents and prosecutions	illegal exploitation illegal transfers/introductions	FCB
Counters	Run size, timing, composition daily-annual	adult, smolt migrants	AFBI
Bush Trap	adult/smolt runs, composition	adult/smolt runs, composition	AFBI/DCAL
Electro-fishing	Q: juvenile N, age, Survival, growth, distribution SQ: fry index, spawning distribution	fry (& spawning activity), parr standing stocks	AFBI DCAL NIEA
Redd counts	redd counts, spawning distribution	spawning activity	FCB
River flows	flows, at gauging stations	fry to adults, fishery	River Agency
Water quality	water chemistry at fixed sites part of harmonised monitoring programmes; WFD monitoring	range of determinands, need to check specific programmes	NIEA
Invertebrates	sampling at fixed sites part of harmonised monitoring programmes; WFD monitoring.		NIEA

8.2 Water Framework Directive monitoring

Water Framework Directive monitoring potentially has major implications for salmonid management (Solbé, 2003) will be an important source of information on environmental pressures affecting all fish species. The Water Framework Directive (WFD) has a much broader view of aquatic management than has been taken previously and its implementation will involve management by means of river basin management plans, taking account of the aquatic environment from source to sea. Essentially, its requirements will shape future aquatic monitoring plans. It subdivides monitoring into three categories: surveillance, operational and investigative. Full details of WFD monitoring requirements are provided in the UKTAG Monitoring Guidance document. The WFD arose out of the recognised need for an integrated European Union (EU) policy on water. Its purpose is to 'establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater…' in order to:

- prevent further deterioration and protect and enhance the status of aquatic ecosystems;
- promote sustainable water use;
- protect and improve the aquatic environment;
- ensure the progressive reduction of pollution of groundwater and prevent further pollution; and
- contribute to mitigating the effects of floods and droughts.

The overall objective is that all surface waters should achieve either 'good ecological status' or 'good ecological potential' by 2015. Formulation of the actual scientific definition of good ecological status is part of detailed preparatory work currently under way throughout the EU. The rationale is an inherent shift from chemical to ecological indices for water quality classification. For groundwater, good quantitative and chemical status should be met. For Fisheries the classification tool is based on the Environment Agency (England and Wales) Fisheries Classification scheme, the new version being termed FCS-2 and will include all fish species. The Directive sets out a planning cycle for river basin management, which consists of four main parts:

1. characterisation of river basin districts;
2. environmental monitoring programmes informed by the river basin characterisation;
3. setting environmental objectives;
4. designing and carrying out an action plan or a 'programme of measures' to achieve the Directive's environmental objectives.

The NIEA is the NI body responsible for designing and implementing the WFD monitoring and its Monitoring Strategy report outlining its proposals for meeting the monitoring requirements of the Directive can be accessed as a pdf file at: Aquatic Monitoring Strategy 2006-2007 and Water Framework Directive Monitoring Plans. (PDF 1.3 MB) Further information about the WFD can be found on the website at:

http://www.ehsni.gov.uk/environment/waterManage/wfd/wfd.shtml

and detailed information about aquatic monitoring can be found at:

http://www.ehsni.gov.uk/environment/waterManage/quality/quality.shtml

8.3 Assessment of limiting factors

Assembling and evaluating the data on limiting factors has much in common with ecological impact assessment, for which there are published best practice guidelines in the planning context (IEEM, 2006). The process draws on the techniques and skills of the experimentalist combined with the knowledge and expertise of the ecologist. Frequently it requires a multidisciplinary approach, especially in light of the WFD (see above). An unavoidable difficulty is that this frequently takes place only after an environmental pressure is suspected. Consequently, much of the data is not structured to any statistically acceptable experimental design, is often incomplete and of varying quality. This can lead to erroneous conclusions if not managed carefully and fisheries management plans elsewhere are sometimes flawed by poor quality science which leads in turn to erroneous conclusions and problems of credibility. There is no substitute for insisting on the highest scientific standards that the data permit and developing SCMPs from the start with that as a guiding principle. Statistical analysis is often essential to maintain rigour and credibility in the assessment and a good account of methods for this, in the impact assessment context, is given by Sedgwick, (2004). While informed opinion and expert judgement remain essential parts of the process they should not be confused with the more formal analyses. However, note also the principle of thee Precautionary Approach (FAO, NASCO): that the absence of scientific information should not be used as a reason to avoid taking action.

The approach to data review and analysis will be different in each case, and reference should be made to the many textbooks on fishery-environmental assessment (e.g. Crisp, 1999; Hilborn and Walters, 2001; King, 2007) and the related literature; but the following is a useful sequence of tasks:

1. Assemble data on adult stock (fish counter/trap/catches/effort/C per effort) for the catchment. Describe and explore data to examine temporal variation and trends in abundance and composition and run timing.

2. Compare [1] data with adjacent rivers (or between sub-catchments if data permit) – statistically if possible, to test for spatial river effects and interactions.

3. Map and tabulate the river habitat, identifying the accessible and inaccessible areas. The most basic level is wetted area, (which requires width data) and embellish with habitat description as data allow. The LCUS would allow mapping and tabulation of spawning, rearing, and holding/pool areas by river reach or sub-catchment. For non-index rivers It will be necessary to commission additional habitat surveys to allow catchment scale evaluation.

4. Assemble fry survey data from electro-fishing surveys on the habitat maps/tables. Interpret to explore areas where the fry index is lower than expected. It may be necessary to commission additional fry surveys to allow catchment scale evaluation.

5. Repeat for the parr/adult standing stock data as available, to explore areas where older fish are lower than expected. It may be necessary to commission additional electrofishing surveys to allow catchment scale evaluation. Note the difficulties of sampling using electro-fishing in large deep channels and the need to explore alternative methods such as boat electro-fishing, hydroacoustics, snorkel surveys netting or trapping.

6. Prepare an inventory of barriers to migration. The major ones are usually well known to local fisheries staff, but there may be many others where access is difficult or partially flow dependent. It may be necessary to commission a barriers survey or assessment of individual sites (Beach, EA) to assess their degree of obstruction .

7. From comparison of 4,5 and 6, and taking into account spawning levels (1 and 2) the potential for environmental impacts can be derived qualitatively and compared with known or suspected environmental impacts (see **Section 4**) based on environmental data (see **Table 8.1**).

8. Note that the assessment to this point has been on fish numbers (of whole populations or age/life stage classes and based on a presumption that the impacts of putative pressures will translate into recruitment and fish numbers. There are other types of effect that can be used to detect impacts. For migratory fish the timing and age/size composition of runs can offer clues to the influence of pressures on life histories. For example smolt age changes (e.g. Davidson and Hazlewood, 2006) might be due to changing productivity or conditions for fresh water growth. Similarly, adult age and size might be the consequence of changing conditions at sea, to selective exploitation, or even of linked feedback to fresh water conditions.

9. Problems of contamination, accumulation or dysfunctional physiological or behavioural responses in the face of exposure to contaminants are only revealed by appropriate analyses and tests, which are situation specific and which require proper experimental or survey design (e.g. Sedgwick, 2004).

10. It is worth reiterating the need to distinguish between the effects of low recruitment *per se* due to low spawning abundance, from the impact of fresh water environmental factors. Clearly they may be related, but the time scale of population response (the generation time of salmon is 4-5 years) means that recruitment might still be low even when environmental conditions have been restored. Under these circumstances pump priming by stocking might be a useful tactic.

8.4 Simultaneous effects

Environmental pressures seldom act alone (**Table 4.1**). Some example associations are:

- Temperature/riparian vegetation/ flow
- Sedimentation/eutrophication/low DO/organic contaminants
- Acidification/metals
- Loss of in-stream cover/flow/temperature/food supply

The permutations are almost endless. The point to remember is that having identified one limiting factor, there may be others. They all need to be resolved to effect an improvement in stocks. Moreover, the order in which they are addressed can be critical. For example there is no point in addressing habitat restoration on its own if water quality or flow regimes are inadequate to support fish. Similarly, opening up barriers to areas where habitat is poor is unlikely to be cost-effective.

The reciprocal point is equally an issue and can be more contentious. The benefits claimed for improvements in stocks as a result of management interventions (i.e. elimination or reduction of limiting factors) such as habitat improvements and stocking, for example, sometimes do not stand up to scrutiny because of simultaneous confounding factors, or because they simply do not work as well as expected (e.g. (Kennedy and Crozier, 1991; Milner *et al*., 2004. More often, the interventions have not been monitored effectively, if at all, and so the benefits are not tested.

Notwithstanding these issues, it should be possible to derive a shortlist of limiting factors, in some cases traced back to the causal activities, for which remediation plans can be prepared.

9 PRIORITISING LIMITING FACTORS AND SELECTING MEASURES

9.1 Prioritising limiting factors

This stage in the SCMP prepares for making choices about what factors need to be addressed in the plan and in what order. The aim is to avoid ending up with just a wish list of the possible "issues" and little idea of what are the priority topics to address. There is no straightforward process for this, but several questions need to be answered:

- How confident are you that the problem is a real one? Some issues emerge through "tradition". For example predation (while it might genuinely be serious) is not always a problem. The quantitative evidence may be weak or missing, but experience and precautionary instincts (and the Precautionary Principle, FAO 1997) may suggest otherwise.

- If there is a problem, how significant is its effect on the fisheries; conversely would its solution offer significant benefits?

- Where does it lie in the matrix of limiting factors. Pressures often occur simultaneously, exerting joint effects, e.g. low flow/high temperature/low dissolved oxygen often arise together, all need to be resolved.

- Is the limiting factor to solve a pressure, or the cause of the pressure? e.g. siltation or loss of spawning gravel affects reproduction at a site, but arise through land use (forestry, agriculture, mining) or sediment control (dams) higher up the catchment (see **Figure 9.1**). It might often be necessary to solve both.

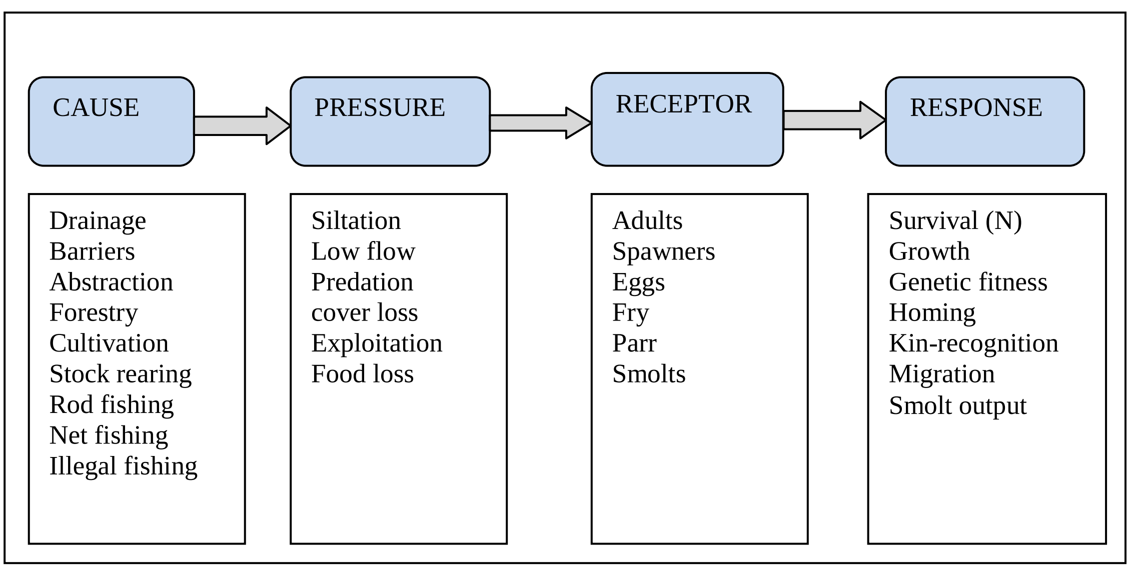


Figure 9.1 Examples of linkages between cause, pressures and response

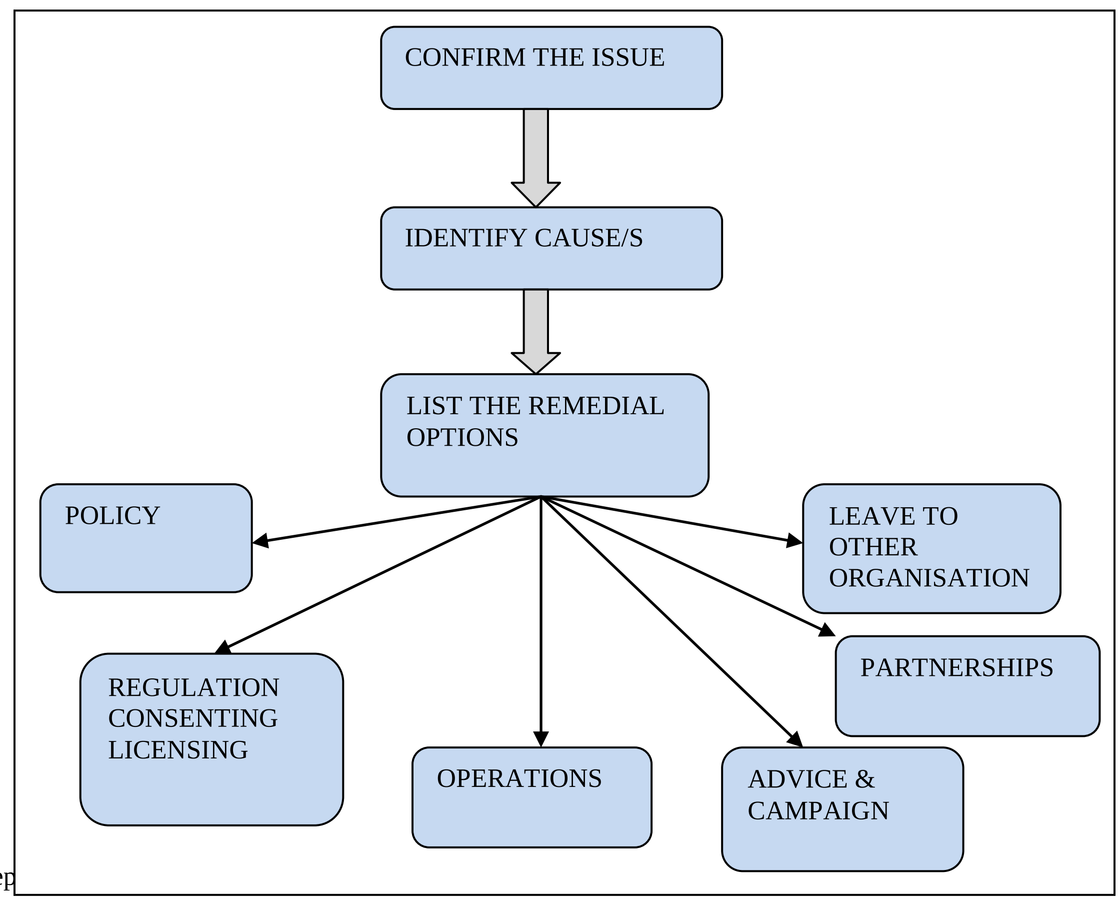
- Can it be solved in practice?
- What are the costs?
- Are there conflicts with other fishery or wider environmental responsibilities? e.g. opening up a barrier may compromise biotopes upstream such as non-migratory trout populations, or a fish pass for salmon may not be suitable for lampreyor eel; fish predators are also important types of wildlife; stocking can compromise genetic fitness.

Summarise the issues faced by the stocks and fisheries, which the SCMP will address, and the pressures and other limiting factors which are thought to limit achievement of the CL or other management targets (see **Section 5**).

9.2 Designing and selecting measures

The measures to be taken might include operational practices (see Fig 1, Ch 2), mitigation, compensation, policy adjustment recommendations They will be a mixture of actions specific to the fisheries functions of DCAL, DARD or their agents, to the environmental roles of NIEA, the operational works role of the RA, or might be better left to the responsibilities of other organisations (**Figure 9.2**).

Figure 9.2 Selecting measure to solve pressure or limiting factors



The principle of identifying the causes, listing the options and selecting the type of action required is common to addressing all limiting factors. More than one action may be required. For example reversing habitat degradation might require operational work on site, advisory work with farmers, possibly coupled with policy review and in partnership with fishery groups.

The technical design of works is too varied and complex to summarise here. But sources of technical information and advice on best practice are given in Section 6.

10 CONSULTATION AND WORKING WITH STAKEHOLDERS

10.1 Consultation

Stakeholders not only include groups and individuals potentially affected by SCMPs, but also those who are pivotal in implementing SCMP actions and therefore the success of SCMPs(e.g. owners of rivers and riparian land). Thus, stakeholders should not be regarded merely as consultees, but as partners in delivering SCMPs. The significance of various stakeholders includes:

Farmers – pursuing agri-environment options, and implementing river corridor and water quality measures therein;

Landowners – managing rivers to enhance salmonid populations to obtain a financial income from fisheries;

Local communities – realising the socio-economic benefits of viable fisheries, accessible greenspace (e.g. for recreational walking) in the locality;

Water companies or reservoir operators – who may be able to discharge flow to benefit fisheries with no detriment to their own interests;

Voluntary bodies - are often able to access funding sources unavailable to public bodies to undertake environmental measures and other actions relevant to the SCMP (*cf* Rivers Trusts elsewhere in the UK);

Anglers and their representative bodies – as well as being the "eyes and ears" on the riverbank, angler co-operation can be key in pursuing non mandatory conservation initiatives such as voluntary catch and release or catch constraint, catch reporting to assist stock assessment, and adhering to biosecurity measures as well as being vocal advocates for SCMPs and freshwater and environmental issues;

Commercial fisheries – Commercial fisheries are important advocates for maintaining adequate stocks, reporting catches accurately (to identify exploitation, and also contribute to an understanding of stock size); and

Other public bodies – SCMPs are likely to offer a vehicle for delivery of their operational objectives (e.g. DCAL, DARD, NIEA, Waterways Ireland).

A cross section of stakeholder bodies representing various sectors is provided in **Appendix III**. An important aspect of successful stakeholder engagement will be to ensure that as full a spectrum of interest groups and individuals as possible is represented.

10.2 Working with stakeholders

Stakeholder involvement should be incorporated into the SCMP process as an integral element. The role of stakeholders in the process is set out in **Figure 10.1** below.

The first opportunity for significant stakeholder input is at the consultation stage, where views of stakeholders in terms of identifying the main issues and opportunities can be collated. This can be done as a web-based exercise, whereby the consultation document and questionnaire are available for completion on line, followed up by workshops bringing key stakeholders together. An example of the internet based consultation approach (the River Tees Salmon Action Plan; Environment Agency & APEM (2008)) is provided in **Appendix IV**.

The opportunity for stakeholders to input to the process (using the internet consultation site, or where requested by stakeholders, via a hard copy) site should be publicised as widely as possible, making use of publicity outlets such as the press, membership group newsletters and existing stakeholder groups (e.g. WFD). This process has a twin purpose – raising awareness of the SCMP, and identifying priority issues and opportunities. The outcome of the consultation should then be incorporated within the second stage of the SCMP drafting and used to focus on the key issues of concern, and identify how, and by whom, these might be addressed.

It is also important that stakeholders have an ongoing input into the SCMP process, and this should be achieved by establishment of a Stakeholder Steering Group. **Figure 10.1** shows this as occurring after establishment of the SCMP, although this could equally occur at an earlier stage of the process.

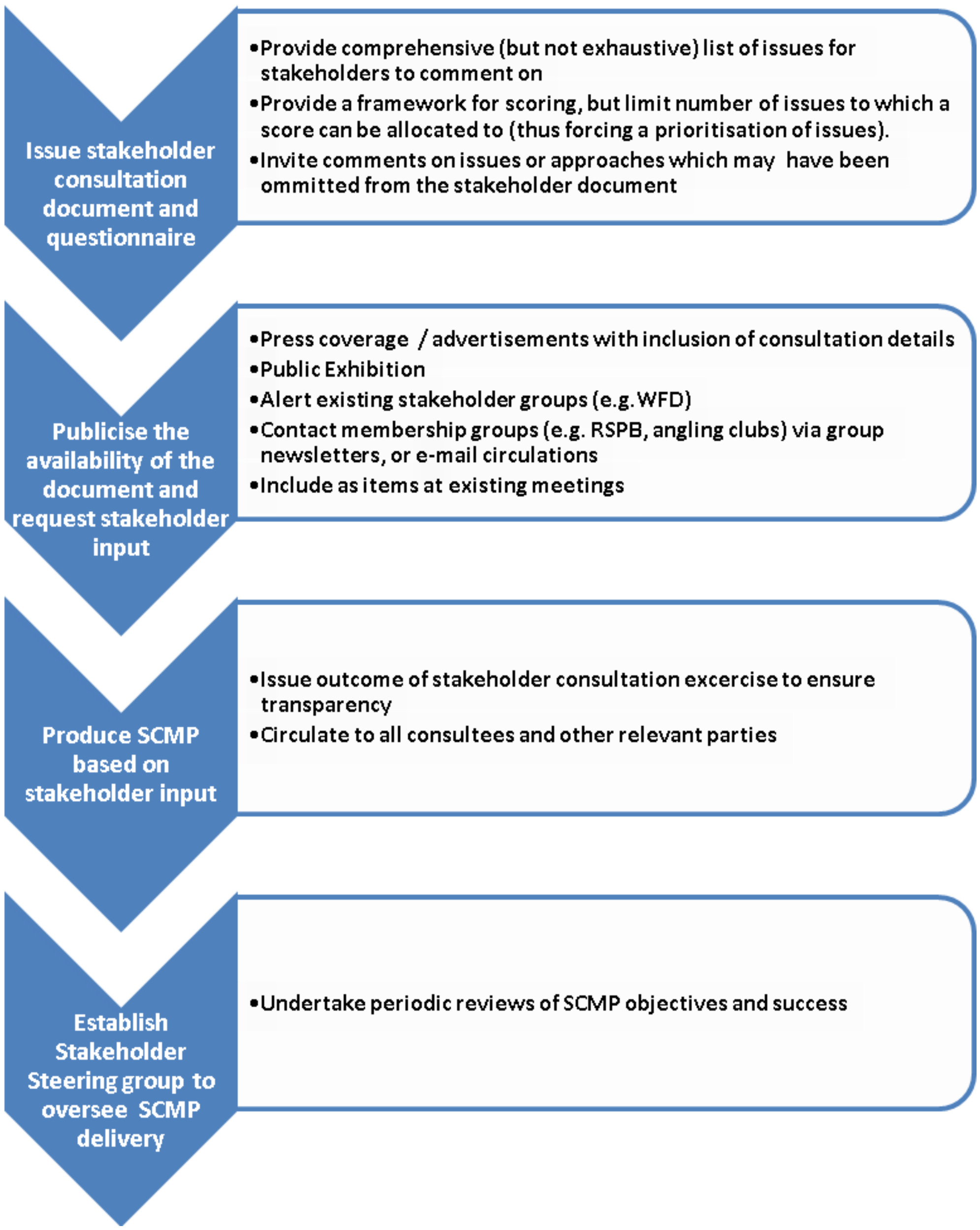


Figure 10.1 Process for SCMP consultation and Stakeholder engagement

11 MANAGING THE SCMP, DELIVERING THE BENEFITS

11.1 Project management requirements

Experience of catchment management plans in England, Wales and Scotland has revealed critical issues that must be addressed at an early stage if the SCMP process is to be successful. These issues are:

- Stakeholder Engagement;
- A Consistent Management Framework within which plans are constructed; and
- Cross Departmental Cooperation for plan implementation.

11.2 Stakeholder engagement

Stakeholders must buy-in to the SCMP at an early stage, feel engaged in the process of development of the plan and in its implementation. Early engagement in the process facilitates ownership of the outputs and actions, which are crucial to the success of the plan.

Ensuring wide and appropriate representation of those with an interest in fisheries and their catchments is an essential part of stakeholder engagement. Riparian interests, commercial netsmen and angling clubs are key starting points and should be encouraged to become involved. Other organisations with a wider interest in the river are often valuable contributors, including wildlife and conservation groups, tourist and leisure industry representatives and where they exist, rivers trusts.

A combination of a regular (annual) open forum type meetings with nominated working sub-groups meeting at intervals as required are suggested. This aids representation and ensures the flow of information in both directions.

11.3 SCMP management framework

Whereas stakeholder engagement is essential, it is also necessary that a SCMP Framework is established within which the necessary consultation processes involved in developing the plan can proceed. The framework should be able to accommodate views and information from disparate sources and in varying formats. Inputs might include historical catch data, monitoring data, stock performance indicators, stakeholder opinion and professional fishery science views where they exist. In essence this requires a consistent approach across SCMPs with a common methodologies, standards, presentation and reporting frameworks. The framework in S.12 provides this.

However, sufficient flexibility to meet local needs is essential to avoid bureaucracy and maintain relevance, an important feature to maintain stakeholder engagement. Thus the framework should not be over prescriptive to constrain the process, but should rather provide guidance for common approaches and outputs. The latter is particularly important given the international reporting requirements required for Atlantic salmon.

11.4 Cross-departmental cooperation

Whilst external stakeholder engagement has been identified as important to the success of the SCMP, the same can be said of institutional organizations, in particular other Government departments. This is particularly important in Northern Ireland, where significant reform of government departments has recently occurred and/or is underway. This provides an opportunity to establish new working relationships and partnership in catchment management.

In addition, the development of SCMPs is timely insofar that the Water Framework Directive also necessitates cross departmental working and stakeholder engagement. In particular by harnessing stakeholder input, a key component of the WFD is achieved. Hence feeding in to the WFD River Basin Plans would be a key output of SCMPs.

This leads onto another requirement for SCMPs in that to be successful, they cannot operate in isolation from other river catchment based initiatives. To attempt to do so would inevitably result in the plans being little more than paper exercises which do little to initiate change, rapidly lose credibility and alienate stakeholders. However, herein lies an opportunity in that incorporating or at least acknowledging the wider context in which fisheries operate within the catchment will help imbed SCMPs in cross departmental operational thinking. At the outset this should be the objective via inclusivity.

High level engagement at senior executive level within relevant Government Departments is suggested as the appropriate way forward. This can be achieved by emphasizing the wider socio-economic benefits that will accrue by ensuring optimum catchment management and healthy fisheries. Buy-in at the highest possible level within departments will ensure top-down prioritization of SCMPs and adherence to their management requirements.

11.5 Post-implementation, monitoring & reporting

Following implementation of SCMPs it is important that they are updated regularly to maintain relevance and that the progress of actions is followed and reported upon. If not, the all important stakeholder engagement and cross department cooperation will rapidly evaporate. Hence a framework for monitoring implementation of the plan and reporting progress is essential.

Although there may be some similarities between actions identified in SCMPs, such as coastal netting for example, it is likely that they will vary in terms of the management actions identified based local needs. Hence maintaining a mixture of consistency in approach, but flexibility in application will facilitate reporting of relevant data and help maintain the dynamic nature of the plan.

The consistency of approach in monitoring might best be achieved by ensuring that key performance indicators (KPI's) are identified in the plan for routine reporting. For example interim egg deposition targets on the road to meeting CLs, or targets for removing barriers and increasing accessible rearing area of the catchment might be agreed. Additional KPIs might be juvenile salmonid densities, smolt output, fish counter data or even redd counts. Other KPIs might include specific restoration targets identified for individual catchments or river reaches within them. Habitat improvement for example can be quantified in terms of miles of river in need of restoration and a KPI developed based on the length of river to be restored each year. Similar approaches could be developed for water quality improvements, abstraction related issues and exploitation.

There are several reporting obligations of a SCMP, which include:

- Informing the local catchment fisheries managers of the progress of their efforts;
- Conveying this information to stakeholders;
- Informing government departments of progress to distil information from each individual SCMP such that an overall view of management progress towards defined targets can be assessed; and
- Contributing to NASCO reporting through the NI National salmon Management Plan..

The WFD RBP and its programmes of measures will also have reporting schedules (to a 6year cycle) and arrangements should be put in place to minimise duplication of reporting effort. It is suggested that SCMPs will have a fishery-specific set of managers and stakeholders, as well as overlaps with the RBMPs. This requires central co-ordination from the sponsoring department to maintain continuity and consistency in report delivery.

12 SCMP – EXAMPLE STRUCTURE AND CONTENT

12.1 Introductory notes

The purpose of this Chapter is to give guidance on how SCMPs should be completed to ensure consistency between plans. Please note the following:

- The final document will go out to public consultation, it should be written appropriately;
- After consultation the plan may have matters of detail corrected, but the main change is in SCMP **Table 8**, which sets out the agreed actions;
- Use the headings shown here (summarised in **Section 12.2**);
- Where possible use bullet point format to present text, graphics and tables in order to summarise information and keep the document short and concise;
- The tables designated SCMP tables should appear in all SCMPs as they may be used to inform the NI national plan and report information to NASCO. Other tables are optional and are shown here to illustrate ways to summarise information or structure the planning exercise;
- An audit trail of calculations, assumptions annotated spreadsheets and data sources should be kept to enable later cross-reference or checking; and
- Use photos where possible (e.g. of the catchment or other features) to add interest to the document.

12.2 Salmonid Catchment Management Plan Content

The recommended sections for a SCMP is outlined in **Table 12.1** below.

Table 12.1 Proposed sections for a SCMP

1. INTRODUCTION
2. DESCRIPTION CATCHMENT
3. SALMONID FISHERIES DATA INVENTORY
4. FISH HABITAT AND BARRIERS
5. FISHERIES STATUS AND TRENDS
6. ECONOMIC EVALUATION OF FISHERIES

7. CONSERVATION LIMIT / MANAGEMENT OBJECTIVES AND TARGETS
8. STOCK STATUS
9. ISSUES, LIMITING FACTORS AND PROPOSED ACTIONS
10. FUNDING THE PLAN
11. MANAGING THE PLAN
12. CONSULTATION PLAN

12.3 Salmonid Catchment Management Plan Format

1. INTRODUCTION

Use standard text (**Appendix V**) modified as required for the **{NAME}** catchment.

2. DESCRIPTION OF CATCHMENT

Include a catchment map with brief summary text on the principal physical and biogeographical features of the catchment relevant to salmonid fisheries. Refer to the river's type and WFD characterisation given in the NIEA Report on River Reference conditions (Article 5 Characterisation Technical Report), see http://NIEAni.gov.uk/pubs/publications/article5report.pdf

SCMP TABLE 1 Physical & Geographical Characteristics of {NAME} catchment	
Name	River Main
Major Tributaries	Kellswater, Braid, Clogh, Cloghwater, Killagan.
Co-ordinates of River Mouth	54 43 0 06 17 8
River Type	Lough Neagh tributary
Catchment Area	25,678Km^2
Average daily flow (ADF) m^3s^{-1}	
Topography and principal land use,	
Habitat Units Available (LCUS, if available)	2055323
Biogeographical Region	Lough Neagh
WFD river characterisations	Tribs: NI Type 13
Conservation designations (SSSIs, SACs etc)	

3. SALMONID FISHERIES DATA INVENTORY

Show a table of the data available for the catchment (example for River Main shown below).

Table of fisheries data available for {NAME} catchment

SCMP TABLE 2 Fisheries data available for {NAME} catchment			
Parameter	***Type of Data***	***Availability***	***Notes***
Habitat Inventory	Life Cycle Unit habitat data	Catchment scale survey completed 2000	Data managed on Arcview 3.2 GIS
Stock Recruitment Study	N/A	N/A	N/A
Conservation Limit	Threshold biological reference point (MSY)	2007	Based on transport of productivity metrics from River Bush SR study against in river habitat measures
Juvenile survey (0+)	Semi Quantitative electric fishing (180 sites)	Annual survey 2002-	Qualitative data with extensive spatial coverage
Juvenile survey (1+)	Fully Quantitative electric fishing (3-10 sites)	Opportunistic surveys 2002-	Quantitative data
Juvenile survey(smolt count)	No	N/A	N/A
Adult escapement	Direct count from resistivity counter	Annual counts 2002-	Partial count with full river correction coefficient
Exploitation estimates	Catchment scale angling exploitation	Annual estimate 2002-	Based on data from FCB carcass tagging scheme
Hatchery Stocking History	Areas stocked and stocking densities available on GIS	GIS based data available from 2002-	Data based on records supplied by local clubs
Smolt tagging	No	N/A	N/A
Adult tag recovery programme	No	N/A	N/A
Redds Counts	Annual counts	Data available from 1970s	Annual surveys conducted by FCB staff

4. FISH HABITAT AND BARRIERS

On a catchment map show the main barriers to fish passage, distinguishing between natural and man-made and impassable and partial (e.g. flow dependent); show the stream lengths above and below barriers.

Using LCUS, if available, describe the availability and distribution of the principal habitat types. Tabulate the areas of spawning and rearing habitat above and below (1) natural and (2) manmade barriers. The aim of this is to show the potential for habitat development and the potential benefits of barrier removal of fish pass installation. The detail of geographic distribution of barrier types and habitat grade need to be available for later analysis, but no detail here.

SCMP TABLE 3 for {NAME} catchment																
Habitat Type	**Spawning**				**Nursery**				**Holding**				**Total**			
Grade	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Accessible																
Inaccessible																
Total																

5. FISHERIES STATUS AND TRENDS

Salmon and sea trout

Text description of the rod and, where relevant, net fisheries for salmon and sea trout, the centres of participation (e.g. clubs, associations, estimates of fishermen numbers). Include specifically graphs of:

- participation (license sales, combined for both species)
- effort (from logbook scheme, combined for both species) in days fished
- annual catches (of each species) since tagging scheme began (2001)
- catch per effort (of each species)
- catch and release proportion (of each species)
- exploitation rate (catch/ annual run), normally only available for index rivers.

Tabulate seasonal catch pattern for each species and note any trends since 2001

Year	% monthly catch (mean last 5 yrs)												Annual Total
	J	F	M	A	M	J	J	A	S	O	N	D	number
Salmon													
Sea trout													

Refer to FCB annual and/or AFBI statistics.

Other species

Give a brief description of the presence of other fish species and fisheries, including Habitats Directive listed species (**Appendix VI**) and notable coarse fish, pike or eel fishery activities.

6. ECONOMIC EVALUATION OF FISHERIES

PARTICIPATION AND FISHERY VALUE

Present data on level of participation and fishery value. Refer to **Section 7** for guidance on completing this section.

6.1 ASSESSING PARTICIPATION

Enter statistics into **SCMP Table 4** for the rod fishery and **SCMP Table 5** for the net fishery using figures from the Loughs Agency and DCAL catch return statistics. A split into resident and visiting anglers is possible using postcode information submitted with licence returns. Table B - Include data on all local net fisheries to which the stock contributes and provide explanatory text where appropriate. For guidance on sourcing these data and the application of appropriate adjustment factors see **Section 7.**

SCMP TABLE 4 Rod fishery participation

RESIDENT ANGLERS				VISITING ANGLERS				TOTAL			
No.		Days fished		No.		Days fished		No.		Days fished	
Current	5yr mean	Current	5yr mean	Current	5yr mean	Current	5yr mean	Current	5yr mean	Current	5yr mean

Note: Current year is last year with available data and 5yr mean is for latest period excluding current year

SCMP TABLE 5 Net fishery participation

LICENSEES		ENDORSEES		TOTAL NETSMEN		DAYS FISHED	
Current	5yr mean	Current	5yr mean	Current	5yr mean	Current	5yr mean

Note: current year is last year with available data and 5yr mean is for latest period excluding current year

6.2 ECONOMIC EVALUATION

See main report Section 7 for guidance on calculating Nett Economic value and the assessment of anglers' expenditure. Incorporate into tables similar to the examples shown below, and include brief explanations of the meaning of these values and the limitations of the estimates given.

6.2.1 Nett Economic Value

The Nett Economic value comprises the value to the fishery owners and the salmon anglers **(TABLE SCMP 6)** and to the netsmen (**SCMP TABLE 7**). Data presented in the following tables are examples taken from the Environment Agency (England and Wales) SAP guidelines. For explanatory text see **Section 7.**

SCMP TABLE 6 Value to fishery owners (Market value) and to salmon anglers (Anglers' consumers' surplus):

Mean declared rod catch 2003-2008	Mean total rod catch 2003-2008	Mean Regional value per salmon in 5 yr mean rod catch	Market (capital) value to rod fishery	Ratio Anglers' consumers surplus: Market value	Anglers' consumers surplus
538	592	£10,000	£6 million	1:1	£6 million

SCMP TABLE 7 Value to netsmen:

Species	Mean declared weight of catch 1997-2001	Price per kg	Gross revenue	Nett profit	Capitalised Nett profit
Salmon	932kg	£4.1	£3,821	~£1,000	£10,000
Sea trout	14 kg	£3	£42	Combined with salmon	Combined with salmon

Calculation of Nett Economic Value:

Enter amounts estimated above into **SCMP TABLE 8** to calculate Minimum Nett Economic Value.

SCMP TABLE 8 Fishery Nett Economic Value

VALUE	£
To fishery owners (from Table C)	6 million
To salmon anglers (from Table C)	6 million
To netsmen (from Table D)	10,000
Minimum Nett Economic Value	12 million.

Anglers' expenditure

Provide an explanation of this value and its significance for the local economy in **SCMP TABLE 9**, based on guidance in **Section 7**.

TABLE SCMP 9 Anglers' expenditure

Mean declared days fished 1999-2000	Mean total days fished 1999-2000	Expenditure per day	Total expenditure per year
2,700	3,200	£36	£115K

Based on data presented in a recent report published by DCAL (2007), a minimum national figure can be derived from considering local resident anglers only. This would suggest that the average anglers spends a total of £1253 a year on game angling and fishes on average a total of 35 days a year. This equates to expenditure per day of £35.80. Note: these figures are based on 2005 estimates and do not include visiting anglers, for which financial output is considerably higher due to the need for accommodation and travel. Therefore the true figure of expenditure a day/year is likely to be considerably higher, although until this is established, it is recommended that £36 is used as a minimum value.

Incorporate more general comments regarding tourism, local economy, rural areas, heritage fisheries, etc., into these sections. For example, if a particular rod fishery attracts a strong tourist element then this may be relevant to interpretation of Angler expenditure estimates, etc. See Section B5 for guidance on calculating Nett Economic value and Anglers' expenditure. Incorporate into tables similar to the examples shown below, and include brief explanations of the meaning of these values and the limitations of the estimates given.

7. CONSERVATION LIMIT AND OTHER MANAGEMENT OBJECTIVES AND TARGETS

Calculate and tabulate the Salmon Conservation Limit (as eggs and fish equivalents) including the parameters used in estimation, e.g.

SCMP TABLE 10 Parameters for Conservation Limit estimation and CL values {NAME}		
Parameter	**Value**	**Source**
Grade A habitat normally used on river (accessible)	m^2	from LCUS surveys
Transport metric from River Bush	range, min-max (egg dep/m^2)	from SMP, AFBI
Target ova deposition =**Conservation Limit (as eggs)**	range, min-max (N eggs)	by calculation
Mean female weight	kg	From local angling returns, check with AFBI
sex ratio	dimensionless, default value (e.g.60:40)	From River Bush, or nearest index river, check with AFBI
Conservation Limit (as fish)	Escapement fish numbers (male +female)	by calculation

Various management objectives, standards and targets can be set for the catchment. These may become more apparent through consultation, but examples are shown in the Table below, the first being the CL default.

Management objective	Standard	Management target
Ensure maximum smolt production from current capacity of catchments	CL (NI Salmon Plan version), a the range of escapement representing maximum smolt output from S/R curve	Achieve the minimum value of the CL each year.
Ensure that all naturally accessible spawning and rearing areas are used for salmon and sea trout production	100% of Grade A spawning and rearing areas are accessible to salmon and sea trout	all barriers removed by 2015
Ensure all rearing areas are producing to their pristine capacity (equivalent to good ecological health)	all degraded habitats are restored to grade A	50% of degraded habitats are restored to Grade A by 2020.

8. STOCK STATUS

(See **Section 6** for summary of approaches and sources of further information)

This section summarises information on adult and juvenile stocks, using counter and trap data (at time of writing only available for Index Rivers and the Bush). It follows the methodology in the National Salmon Plan (Kennedy, 2007). In absence of trap/counter data the rod catch data can serve as stock indices, noting the caveats on interpretation (S. 6). Compare with trends in adjacent rivers and test variation statistically, if appropriate (e.g. GLM methods (see S.6; and e.g. Sedgwick, 2007).

Tabulate the Parameters used for estimation of annual egg deposition e.g.

SCMP TABLE 11 Parameters for estimating egg deposition and escapement {NAME}

Parameter	Value	Comments
r, rod catch	Variable	Primary return from carcass tagging scheme
y, rod catch reporting rate	Variable; range 0.23-0.37	Determined annually for FCB region from carcass tagging scheme
U, annual extant exploitation rate	Range: 0.09 – 0.42 (River Bush 10 year average 17.2%)	Highly variable between years, need to refer to nearest index river (having catch and independent run estimate)
s, in river survival to spawning	0.91	Referenced from EA 1996
Pf, proportion females	0.6	Based on River Bush population studies.
F, fecundity	1,666 eggs/kg	Based on River Bush

Calculate annual egg deposition estimates. Graph the annual variation in egg deposition showing the upper and lower bands of the CL.

Juvenile stock data is derived for electro-fishing data. Note that the FCB Annual Report has tabulations of electro-fishing data, but more detail than this is usually required (e.g. survey type, time of year, error estimates for quantitative surveys etc). There may also be other sources, see Ch7). Tabulate and graph as appropriate to show the spatial and temporal variation around the catchment. The aim of these actions is to explore the possible impacts on freshwater production and will be compared with the data in next section.

Make reference to cautions over data quality as necessary and the uncertainties in the data, in order to inform external readers of the SCMP.

9. ISSUES, LIMITING FACTORS AND PROPOSED ACTIONS

Summarise in **Table SCMP 12** the issues faced by the stocks and fisheries, which the SCMP will address, and the pressures and other limiting factors which are thought to limit achievement of the CL or other management targets (see **Section 4**).

The actions might include operational practices, policy adjustment, developing partnerships etc (**Section 9**) and will be a mixture of tasks specific to the fisheries function of DCAL and others for the environmental roles of NIEA and the RA.

Note the benefits in terms of stock and fisheries values, including non-monetary valuations, sources of information and approaches. Do not include this information in the table, because of the uncertainties involved at this stage, but retain for the consultation and planning stages. Include broad indicative non-staff costs

Indicate the ranking (1 high – 5 lowest) i.e. relative importance of factors, noting in the audit trail the reasons for that assessment, or indicate if their ranking is not known. Consider scale of the benefits to fisheries, feasibility and risks, wider consequences (e.g. are they linked to factors outside catchment, are there opportunities for collaborative, more cost-effective solutions, or for leverage on external funding? Make any links to Programme of Measures or monitoring under WFD implementation

TABLE SCMP 12 Summary of issues and potential options to be incorporated into the SCMP

SCMP TABLE 12 ISSUES, LIMITING FACTORS AND PROPOSED ACTIONS FOR {NAME} CATCHMENT					
ISSUE	**LIMITING FACTORS**	**OPTIONS**	**RESPONSIBILITY**	**COST £K**	**PRIORITY**
Briefly describe Issue	***List limiting factors in relation to this issue***	***List options for removing or reducing limiting factors***	***E.g. FCB, NIEA, owners, anglers***	***Estimate Cost (excl. Staff)***	***1(high),2,3,4,5 (low)***
1. Escapement currently 25% below CL	1. low production throughout life cycle, to combination of factors (see below)	1. protect escapement by reducing exploitation through increased C&R, publicity campaignand monitoring benefits	FCB, anglers	1. £5k.	1
2. Illegal fishing	1. illegal fishing at known barrier, reducing escapement	1. Enforcement blitz in November. 2. Publicity campaign	FCB FCB	2. £5k	3 3
3. Low fry production in middle catchment tribs	1. Habitat loss in middle catchment tribs, through historical drainage 2. Hab loss through intensive stock rearing	1. Refine loss estimates; draft and cost plans; consult with RA on mitigation works to restore habitat. 2. Draw up bankside fencing scheme, apply to ??? grant scheme and /or DCAL project budget 3. Promote sensitive farming BP campaign	1. FCB/RA 2. FCB/ owners / anglers 3. NIEA **NB PoMs activity?**	1. £15k 2. £150k 3. £10k	1 2 2
4. 30% catchment above manmade barriers, catchment production capacity underutilised	1. spawning access prevented by 3 weirs, 2. one subject to low head hydro application	1. estimate production capacity and check environmental quality above weirs and benefits to fishery; consult on fishery and conservation issues; 2. cost fish-passes; seek funding 3. Negotiate fish pass on LHH site with developers in planning consultation	1 & 2.FCB/NIEA/RA/owners/anglers on all **3. PoMs activity?**	2.. £200k cap	1 2 1

SCMP 13 table of agreed action of the SCMP

SCMP TABLE 13 AGREED ACTIONS FOR {NAME} CATCHMENT			
ISSUE	**AGREED ACTIONS**	**RESPONSIBILITY**	**COST £K**
Briefly describe Issue	***List actions agreed through consultation with internal and external stakeholders***	***E.g. FCB, NIEA, owners, anglers***	***Estimate Cost (excl. Staff)***

10. FUNDING THE PLAN

10.1 Recent and current funding

A Salmon Habitat programme was drawn up in 2001, but not fully funded. DCAL the FCB and the LA secured European Economic Area (EEA) funding in 2005 of €519,000 towards a total of 688.00. Of this £160,000 was allocated to the River Main system for salmon habitat restoration works and £53,051 was spent in 2006 and the project was completed in 2007. £5m funding through the Peace 1 fund and the EU was allocated to a salmon Enhancement programme. DCAL provided advice to the recipients of £3m carrying out salmon habitat schemes. The Angling Development Programme completed in 2007 secured a further £2m.

10.2 Potential future sources

Peace fund / Interreg options may be available. Developing the SCMP should include review of Area Development Plans to identify developments that might affect rivers or offer opportunities for collaborative funding. Advice and information should be available from the DCAL Planning Service. Note that the Rivers Agency Rivers Maintenance Programme includes measures for rehabilitation and protection of fisheries (and other interests) and is an important resource for the SCMP to influence and direct.

11. MANAGING THE PLAN

Outline briefly for stakeholders benefit the basic governance of the plan, who controls it and who is responsible for monitoring and delivering it (see **Section 11** of main report).

12. CONSULTATION PLAN

Outline briefly who will be consulted, how and to what timetable (see **Sections 10** and **11** of main report). After the consultation the final plan can be modified by the inclusion of TABLE SCMP 13 which summarises the finally agreed actions.

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APPENDIX I NASCO PRECAUTIONARY APPROACH

CNL(98)46 *Agreement on Adoption of a Precautionary Approach*

1. NASCO and its Contracting Parties agree to adopt and apply a Precautionary Approach to the conservation, management and exploitation of salmon in order to protect the resource and reserve the environments in which it lives. Accordingly, NASCO and its Contracting Parties should be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.

2. The Precautionary Approach requires, *inter alia*:

a) consideration of the needs of future generations and avoidance of changes that are not potentially reversible;

b) prior identification of undesirable outcomes and of measures that will avoid them or correct them;

c) initiation of corrective measures without delay, and these should achieve their purpose promptly;

d) priority to be given to conserving the productive capacity of the resource where the likely impact of resource use is uncertain;

e) appropriate placement of the burden of proof by adhering to the above requirements.

3. The application of a Precautionary Approach should involve all parties concerned with salmon conservation, management and exploitation.

4. The Precautionary Approach will be applied by NASCO and by its Contracting Parties to the entire range of their salmon conservation and management activities. Initially the application will be to the following three areas:

-Management of North Atlantic salmon fisheries

-The formulation of management advice and associated scientific research

-The area of introductions and transfers including aquaculture impacts and possible use of transgenic salmon.

5. Both NASCO and its Contracting Parties should as the next step address application of the Precautionary Approach to freshwater habitat issues and the by-catch of salmon in other fisheries.

Management of North Atlantic salmon fisheries

6. An objective for the management of salmon fisheries for NASCO and its Contracting Parties is to promote the diversity and abundance of salmon stocks. For this purpose, management measures, taking account of uncertainty, should be aimed at maintaining all salmon stocks in the NASCO Convention area above their conservation limit (currently defined by NASCO as the spawning stock level that produces maximum sustainable yield), taking into account the best available information, and socio-economic factors including the interests of communities which

are particularly dependent on salmon fisheries and the other factors identified in Article 9 of the Convention. In order to achieve this, a Precautionary Approach will be applied to the management both of fisheries regulated by NASCO and those in homewaters.

7. The application of the Precautionary Approach to salmon fishery management is an integrated process which requires at least the following:

a) that stocks be maintained above the conservation limits by the use of management targets;
b) that conservation limits and management targets be set for each river and combined as appropriate for the management of different stock groupings defined by managers;
c) the prior identification of undesirable outcomes including the failure to achieve conservation limits (biological factors) and instability in the catches (socio-economic factors);
d) that account be taken at each stage of the risks of not achieving the fisheries management objectives by considering uncertainty in the current state of the stocks, in biological reference points and fishery management capabilities;
e) the formulation of pre-agreed management actions in the form of procedures to be applied over a range of stock conditions;
f) assessment of the effectiveness of management actions in all salmon fisheries;
g) stock rebuilding programmes (including, as appropriate, habitat improvement, stock enhancement and fishery management actions) be developed for stocks that are below their conservation limits.

8. The management procedures for all salmon fisheries could include the following elements:

a) definition of target spawning stock levels in the relevant rivers;
b) definition of pre-fishery abundance of individual salmon stocks or groups of stocks occurring in the relevant fishery;
c) utilisation only of the surplus according to a) and b) above;
d) socio-economic factors.

9. New fisheries targeted on salmon or which could result in a by-catch of salmon should be subject to cautious conservation and management measures. In accordance with Article 2, paragraph 3 of the Convention, the Parties shall invite the attention of non-Contracting Parties to any significant by-catch of salmon by its vessels.

10. Efforts to minimise unreported catches, and to improve estimates of them, are consistent with the Precautionary Approach. NASCO and its Contracting Parties agree to evaluate and report on progress in this area.

The formulation of management advice and associated scientific research

11. ICES or other scientific advisors should be requested, *inter alia*, to:

a) provide stock conservation limits and management targets for all river stocks;

b) advise on the risks of not achieving the objectives of NASCO or its Contracting Parties by considering uncertainty in the current state of the stocks, in biological reference points related to specific management objectives and in fishery management capabilities;
c) provide catch options or alternative management advice with associated risk assessments for the fisheries regulated by NASCO and homewater fisheries for all salmon stocks;
d) advise, in the light of current conditions in the freshwater and marine environment, on stock rebuilding programmes including, where appropriate, habitat improvement, stock enhancement, disease prevention and fishery management actions;
e) identify the monitoring and data collection required to better achieve the objectives of NASCO and its Contracting Parties;
f) advise on the impacts on salmon stocks of existing and new fisheries for other species, and of salmon fisheries on non-target species.

The area of introductions and transfers including aquaculture impacts and possible use of transgenic salmon

12. Implementation of the measures contained in the following agreements is essential in the light of the Precautionary Approach:

- North American Commission Protocols on Introductions and Transfers, NAC(92)24
- Amendments to the North American Commission Protocols on Introductions and Transfers, NAC(94)14
- Resolution by the Parties to the Convention for the Conservation of Salmon in the North Atlantic Ocean to Minimise Impacts from Salmon Aquaculture on the Wild Salmon Stocks, CNL(94)53
- NASCO Guidelines for Action on Transgenic Salmon, CNL(97)48.

APPENDIX II TABLE OF PRINCIPAL LEGISLATION AND SIGNIFICANCE FOR SCMPS

Legislation	significance
Water Environment	
The Water Environment (Water Framework Directive (2000/60/EC)) Regulations (Northern Ireland) 2003	Transposes the EU Water Framework Directive. This requires member states to achieve, by 2015 Good Ecological Status (GES) for all water bodies (or Good Ecological Potential (GEP) for heavily modified waterbodies. GES for freshwaters is defined in terms of macroinvertebrates, macrophytes, diatoms and fish. Criteria for GEP with regard to salmon are based round compliance with river / catchment specific conservation limits. WFD also requires a programme of monitoring for the various biological elements listed above, and establishes a Programme of Measures to address issues identified as posing a risk to GES The competent authority for administering the WFD is NIEA. Details of WFD with links to other key WFD information sources are available on NIEA website at: http://www.ni-environment.gov.uk/water/wfd.htm
Nature Conservation	
Conservation (natural habitats) Regulations (Northern Ireland) 1995	The Regulations implement Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the "Habitats Directive"). Requires member states to Designate Special Areas of Conservation (SACs) for a range of species including salmon. SACs are subject to stringent protection measures, and competent authorities must ensure that activities undertaken or consented have no adverse effect on the integrity of SACs. The Regulations also apply to Special Protection Areas (SPAs) designated under Council Directive 79/409/EEC on the conservation of wild birds (the Birds Directive). No SACs are currently designated within the FCB area although this is under review. Importantly, any activities consented by the FCB e.g. coastal netting, which may impact upon salmon populations of SAC rivers elsewhere must be administered such that they do not adversely impact upon site integrity. Competent authorities for the Regulations in Northern Ireland are al public bodies who must adhere to the regulations in undertaking their own activities, and consenting others to undertake relevant activities.
The Conservation (Natural Habitats, etc.) (Amendment) Regulations (Northern Ireland) 2007	These amend the 1995 regulations above in a number of respects. Most significantly from a land management perspective is the clarification that land use plans e.g. Development plans and the Regional Development Strategy are subject to the provisions of the Habitats Regulations. This provides a mechanism for addressing potential land use policies and plans which have potential to impact upon SACs / SPAs.
Nature conservation and Amenity Lands (Northern Ireland) Order 1985 (as amended)	This makes provision for designation of NNRs LNRs MNRs

Northern Ireland Biodiversity Strategy	This implements the UK Biopdiversity Action Plan (BAP) at a NI level DoE and its agencies have primary responsibility for delivering NI BAP, although DARD and DCAL also share these responsibilities. A number of fish species and aquatic habitats are listed on the UK BAP list including: Salmon ,Sea / brown trout, Arctic charr, Eel, Sea lamprey, Gravel bed rivers , Lakes A list of Northern Ireland species requiring priority Action was produced in 2004 and included 5 fish. Following a revised list of UK BAP species in 2007, the NI priority species list ism also under review. To date two Northern Ireland Species Action Plans Have been produced for fish: Pollan and Arctic charr.
The Environment (Northern Ireland) Order 2002	The DOE designates Areas of Special Scientific Interest (ASSI) under this Order. The legislation makes it an offence to carry out operations likely to damage an ASSI without prior permission from DoE. Environment and Heritage Service, DOE. It is also an offence to damage or destroy a protected scientific interest. Public bodies are required to further the conservation and enhancement of ASSI land through the appropriate exercise of their functions. A number of aquatic ASSIs are present in the FCB area. The presence of an ASSI is significant from a FCMP perspective in that it both provides the mechanisms by which damaging activities within ASSI can be managed to benefit the FCMP, and that it may restrict thy type and extent of management activities which may be sought for FCMP purposes.
Fisheries / Angling / Fish health	
Fisheries Act (Northern Ireland) 1966 (as amended)	This is the primary piece of fisheries specific legislation, and contains a range of measures relating to fisheries. Measures include those relating to: • Methods of capture • Polution • Sale and possession of fish • Removal of gravel from rivers • Migratory passage • Limiting entrainment from abstraction Enforcement of the Act is undertaken by the FCB.
Public angling estate byelaws (Northern Ireland) 2005 (SR 2005 No. 267)	
Diseases of fish Act (Northern Ireland) 1967	Makes provision for DARD to inspect and monitor fish farms and control the outbreak of notifiable fish diseases.
EU fish health regime	This determines arrange of health fish matters, and determines whether a country, or area has a disease free status, and thus the conditions which apply to import and export of fish.
Commission Decision 2004/453/EC	Determines that Northern Ireland is free of the parasite G. Salaris, and therefore requires that specific provisions set out in the decision are adhered to in respect of introductions of species susceptible to the

	parasite.
Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations (Northern Ireland) 1999 (SR No 415)	Implements Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment in respect of marine fish farming.
Planning & Development Control	
Planning (Assessment of Environmental Effects) Regulations (Northern Ireland) 1999 (as amended)	These implement the Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. Developments which meet criteria specified in the Directive (size, extent or type of development) must be subject to an Environmental Impact Assessment. The process is aimed at establishing the scale and nature of any environmental impacts associated with the proposal, and provides the opportunity for these to be offset or reduced by mitigation measures. This Environmental Statement is a key consideration for the planning Authority in consenting the development , and applying planning conditions.
Water quality	
Water (Northern Ireland) Order 1999	Makes a number of provisions to prevent discharge of pollutants to surface or groundwater. DoE is responsible for consenting and regulation of discharges under the legislation
The Urban Waste Water Treatment Regulations (Northern Ireland) 1995 (as amended)	Implements Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (the Urban Wastewater Treatment Directive). Requires specific discharge standards for waste water treatment works (WWTW) effluent, according to the population size served by the WWTW for river reaches designated as “nutrient sensitive” under the Directive. Lough Erne & Lough Neagh catchments are both identified as Nutrient Sensitive Areas under the Directive. Three new sensitive areas at the Tidal River Lagan, Inner Belfast Lough and the River Quoile Pondage will also be formally identified under the terms of the Directive.
The Surface Waters (Fishlife) (Classification) Regulations (Northern Ireland) 1997 (as amended)	Implements DIRECTIVE 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life (the Freshwater Fisheries Directive) This establishes mandatory and advisory values for a range of water quality parameters necessary to sustain freshwater fish. River reaches are designated as salmonid, or coarse, which in turn establishes the values of the parameters which must be attained. Salmonid waters have more stringent requirements than coarse waters. Implementation of the Directive is the responsibility of DoE, who monitor water quality in terms of the parameters and standards set by the Directive. Avaialbility of compliance data is available from DoE.
Nitrates Action Programme (NAP) Regulations (Northern Ireland) 2006 (as amended)	Implements the requirements of the EU Nitrates Directive

	Limits the application rate of N in manure to 170kg/ha/yr farmland, to improve water quality Chemical nitrogen (N) fertiliser must not be applied between 15 September to 31 January. Organic manures, excluding farmyard manure and dirty water, must not be applied between 15 October to 31 January. All fertilisers, chemical and organic, must not be applied: • on waterlogged soils, flooded land or land liable to flood; • on frozen ground or snow covered ground; • if heavy rain is forecast; • on steep slopes where other significant risks of water pollution exist. Prevent entry of fertilisers to waters and ensure application is accurate, uniform and not in a location or manner likely to cause entry to waters. Chemical fertilisers must not be applied within 1.5m of any waterway. Crop and soil management to minimise soil erosion and nutrient run off. A DARD / EHS guidance document on the Regulations is available here.
Nitrates Action Programme (Amendment) Regulations (2008)	Amend the above regulations to allow a derogation from the above standard, to 250kg/ha/yr. Farmers must apply for individual derogations.
Phosphorus (Use in Agriculture) (P) Regulations (Northern Ireland) 2006	Can only apply chemical Phosphorus fertiliser if soil analysis shows a requirement as per RB209.
The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations (Northern Ireland) 2003 (SSAFO)	Establishes mandatory criteria for the siting design, operation and maintenance for facilities for storing Silage slurry and agricultural fuel oils to minimise risks of pollution. DOE EHS is competent authority
Food and Environment Protection Act 1985	(chapter 48, part III) – This controls the use, storage, sale, supply and advertisement of pesticides, and prohibits the use of pesticides such that they would pollute the environment or harm humans or animals.
Water Resources	
Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006	Makes provision for licensing of abstraction and impoundment by EHS.
Flood Defence	
Drainage (Northern Ireland) Order 1973	Gives Rivers Agency permissive powers to undertake drainage and flood defense activities on designated watercourses. Places a duty upon landowners to *scour and cleanse* undesignated watercourses such that the *efficiency of the watercourse* is not impeded, and enables the Rivers Agency to serve notices on landowners to this effect, or directly undertake such work. Requires EIA to be undertaken for flood defense / drainage schemes with a likely significant environmental effect.

	Makes provision for compensation to owners of fisheries for injury to the fishery.
Drainage (Environmental assessment) Regulations (Northern Ireland) 1991 (As amended in 1998)	Implements Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment in respect of drainage activities and projects.
Introduction of non-native plants and animals (including fish)	
Wildlife (Northern Ireland) Order 1985	This provides protection for wild birds (including fish eating birds) and makes provision for their shooting under license from DoE to protect serious damage to fisheries. Enforcement is by the police
Fisheries Act (Northern Ireland) 1966 (as amended)	Section 13 – Establishes provisions to make orders to name fish species which cannot be released to the wild without a license
Catchment Land Management	
Environmental Impact Assessment (Uncultivated Land and Semi-Natural Areas) Regulations (N.I.) Order 2001	Transpose Council Directive 85 / 337/ EEC . The regulations require EIA to be undertaken in respect of any proposals to alter the use or management of any uncultivated or semi-natural land. DARD is the competent authority.
Environmental Impact Assessment (Forestry) Regulations (Northern Ireland) 2000 (SR No 84) as amended by the Environmental Impact Assessment (Forestry) (Amendment) Regulations (Northern Ireland) 2002 (SR 2002 No 249)	Implements Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment in respect of Forestry activities and projects.
Countryside Management Regulations (Northern Ireland) 2005	Provides the basis for payments to be made to landowners for a range of environmentally beneficial land management practices. The Regulations are the basis of the Countryside Management Scheme

APPENDIX III EXAMPLES OF STAKEHOLDERS RELEVANT TO SCMPS IN NORTHERN IRELAND

Angling Groups Salmon and Trout Association Ulster Angling Federation Ulster Coarse Fishing Federation Irish Federation of Sea Anglers - Ulster Provincial Council NI Angling Advisory Council
Commercial Fishing Groups Toome Eel Company Ltd Lough Neagh Fishermans Co-operative Society Ltd Lough Erne Fishermen's Association North Coast Drift Net Association North Coast Salmon Fisheries Federation Bann Systems Ltd Lough Neagh Commercial Fishermen
Professional Fisheries Organisations Institute of Fisheries Management
Farming organisations Ulster Farmers Union North West Organic Producers Group
Conservation Bodies RSPB Farming and Wildlife Advisory Group World Wildlife Fund Water Service Council for Nature Conservation and the Countryside Ulster Wildlife Trust Northern Ireland Environment Link Tidy Northern Ireland Western Group Environmental Health Service The Woodland Trust River Action Group, Omagh Bat Conservation Group Save Our Lough Derg
Landowner Bodies Countryside Land and Business Association

Aquaculture The aquaculture initiative
Tourism NI Tourist Board
Professional bodies The Royal Town Planning Institute in Ireland Institute of Fisheries Management The Law Society of Northern Ireland Police Federation
Government Departments / Public Bodies Office of the First Minister and Deputy First Minister DoE DARD EHS DETI DCAL Rivers Agency DENI NI Local Government Association Local Authorities Food Standards Agency Northern Ireland
Others Geological Survey of Northern Ireland Electricity Supply Board NI Food and Drink Association

APPENDIX IV WEB-BASED CONSULATION MECHANISM

To ensure that the views of interested parties could be considered and incorporated where appropriate into the SAP review process for the River Tees, two forms of consultation were undertaken. The first centred around the production and hosting of a web based questionnaire and the second a workshop.

Web-based questionnaire

The web-based questionnaire was hosted for a period of approximately three and a half months on the North-East Region's fisheries pages of the Environment Agency's website. The questionnaire encompassed the main issues that have arisen in previous SAP discussion on the Tees summarised into a total of 23 issues. Participants were asked to indicate those issues they considered of greatest importance through a scoring process. To ensure some discrimination and prioritisation of the relative importance of the different issues, limits were set for the number of scores that could be assigned throughout the table. These limits were set as follows; a maximum of 7 rank 1 scores, 13 rank 2 scores, 18 rank 3 scores and 20 rank 4 scores, the number of rank 5 scores was unlimited. The opportunity was also given for participants to elaborate on any of the issues they felt were particularly important or any that were missing through the use of a comments box.

The issues included within the questionnaire were as follows:

- In-stream habitat quality e.g. cover, substrate
- Spawning habitat availability
- Bankside habitat e.g. trees, flood banks
- Physical obstructions e.g. dams, weirs, culverts
- Siltation
- Estuarine water quality
- Diffuse pollution e.g. pesticides, minewaters
- Food supply e.g. fly life decline
- Flow regimes e.g. low/high flows, timing
- Over fishing
- Illegal fishing
- Reliability of rod catch data, e.g. under reporting
- Mine discharges
- Sewage discharges
- Agriculture
- Hydro power development
- Reservoir releases
- Land drainage e.g. upland, urban
- Flood defence
- Abstraction
- Forestry
- Climate change

- Predation e.g. seals and/or birds

A total of 67 responses were received for the River Tees questionnaire up to the 31st October 2008. The Tees Barrage appears to consistently be seen as the most important issue with predation and physical obstructions ranking as the most important issues. Physical obstructions were ranked as score 1 by 85% of participants and predation by 79%. Issues ranked as the least important include hydropower, mine discharges and climate change. Figure 5.1 details the results of the questionnaire and highlight the relative rankling of each of these issue by participants.

Workshop

A workshop was held on the 12th November 2008 to discuss the River Tees SAP review consultation document. Workshop attendance invitation were sent to interested parties along with a draft copy of the report.

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River Tees Questionnaire

1. We have listed below the main issues that have arisen in previous SAP discussions. We seek here your views on which are most important. They are not all mutually exclusive. Some are *factors* acting directly on fish e.g. habitat, flow regimes, others are *activities* that may be regulated and which impact fish in many ways e.g. agriculture, fishing, land drainage.
2. **Please score each issue 1 (high importance) to 5 (low importance); one value per issue, all issues must be scored.**
3. If you give a high ranking to an issue, i.e. a score of 1 or 2, and you want to elaborate then please indicate briefly your view of the principal ways in which this arises, in the text box below the table. For example, habitat quality issues might be due to agriculture and /or land drainage and/ or flood defence; illegal fishing might be coastal and/or freshwater; reservoir releases might lead to temperature and /or flow changes.
4. In order to ensure some discrimination and prioritisation between issues there are controls on the number of scores that can be assigned throughout the table. Thus **you can award a maximum of 7 rank 1 scores, 13 rank 2 scores, 18 rank 3 scores and 20 rank 4 scores. The number of rank 5 scores is unlimited.** The numbers differ slightly between rivers and you will be advised automatically if you exceed those limits.
5. If you wish to raise other matters please use the text box below. There is a 500 character limit on the text box.

Issues	Most Important 1	2	3	4	Least Important 5
In-stream habitat quality, e.g. cover, substrate	○	○	○	○	○
Spawning habitat availability	○	○	○	○	○
Bankside habitat, e.g. trees, flood banks	○	○	○	○	○
Physical obstructions, e.g. dams, weirs, culverts	○	○	○	○	○
Siltation	○	○	○	○	○
Estuarine water quality	○	○	○	○	○
Diffuse pollution, e.g. pesticides, minewaters	○	○	○	○	○
Food supply, e.g. fly life decline	○	○	○	○	○
Flow regimes, e.g. low /high flows, timing	○	○	○	○	○
Over fishing	○	○	○	○	○
Illegal fishing	○	○	○	○	○
Reliability of rod catch data, e.g. under reporting	○	○	○	○	○
Mine discharges	○	○	○	○	○
Sewage discharges	○	○	○	○	○
Agriculture	○	○	○	○	○
Hydro power development	○	○	○	○	○
Reservoir releases	○	○	○	○	○
Land drainage, e.g. upland, urban	○	○	○	○	○
Flood defence	○	○	○	○	○
Abstraction	○	○	○	○	○
Forestry	○	○	○	○	○
Climate change	○	○	○	○	○
Predation, e.g. seals and/or birds	○	○	○	○	○

Please use this box to add your comments (max 500 characters):

Submit Questionnaire

record your salmon and trout catches

Angler logbook 2007

Logbook

Anglers at the Bankside

Regional information » Anglian | Midlands | North East | North West | South West | Southern | Thames | Wales

Privacy Policy

Questionnaire hosted by Arup on behalf of The Environment Agency

APPENDIX V STANDARDS TEXT FOR SCMP INTRODUCTION

The purpose of this SCMP is to provide the management plan for salmon and sea trout in the **{NAME}** catchment and thus to deliver the NI Assembly's strategic aims for these species. These are summed up as:

- To ensure that migratory salmon stocks and fisheries make their maximum contribution to the social and economic development of Northern Ireland

- To protect, promote and where necessary enhance the biodiversity and conservation status of stocks and to ensure that they contribute to the ecosystem health of Northern Irish waters.

The SCMP process is designed to provide a consistent approach to stock assessment, fisheries management and related environmental management in all Northern Irish rivers. This is achieved by adopting the common format, set out here, and common protocols for catchment diagnosis and design of appropriate management interventions.

A management plan should be judged on its final benefits. Delivery of plans is dependent upon commitment and resources, which in turn are aided by widespread ownership and shared responsibilities amongst the stakeholders. The plan is owned by the Fisheries Conservation Board (FCB), currently an arm's length body of DCAL; but it incorporates actions across a wide range of public sector departments, their agencies and non-governmental stakeholders – conservationists, fisheries owners and fisheries licence holders. The SCMP coherence and its successful delivery depend crucially upon input from all these bodies and groups. Thus the SCMP is the vehicle for consultation and agreement amongst these bodies and is prepared through collaboration.

Although the SCMP is specific to the **{NAME}** rivers it also contains reference to generic regional scale issues, such as climate change and interceptory mixed stock fisheries, and forms part of the over-arching national Northern Ireland Salmon Management Plan (SMP). It thus provides the detail of the NI input to the North Atlantic salmon Conservation Organisation.

Fisheries management is a multifaceted multidisciplinary activity. The actions in the SCMP are a mixture of fisheries and environmental management. Fisheries regulation, enforcement and monitoring are carried out by DCAL and its agencies; but environmental actions are largely the responsibility of the NIEA, Rivers Agency and water Agency. However, the two types of activity are closely linked in theory and in practice. This highlights the need for coherent strategic objectives and coordination between departments. A crucial role of the SCMP is to provide the rationale and plans for those environmental measures that enhance stocks, fisheries and biodiversity. Therefore the SCMPs should feed fisheries environmental requirements into the Programmes of Measures (PoMs) of the Water Framework Directive River Basin Management Plans.