National Report for Ireland on Eel Stock Recovery Plan

Including River Basin District Eel Management Plans

The Department of Communications, Energy and Natural Resources

December 2008

National Report for Ireland on Eel Stock Recovery Plan

Including River Basin District Eel Management Plans

Submitted by: The Department of Communications, Energy and Natural Resources,
Inland Fisheries Division
Address: 29/31 Adelaide Road, Dublin 2.
Tel:+353 1 6782000
Web: www.dcenr.gov.ie

Executive Summary

Introduction

The latest scientific advice from the International Council for the Exploration of the Sea (ICES) concerning European eel is that the stock is outside safe biological limits and that current fisheries are not sustainable. ICES have recommended that a recovery plan be developed for the whole stock of European eel as a matter of urgency and that exploitation and other human activities affecting the stock be reduced to as close to zero as possible. Ireland established a National Working Group on eel management in 2006, in advance of the agreement of the Regulation (EC) No. 1100/2007, in order to begin the preparatory work required and Irish scientists participated in Working Groups and EU projects (i.e. EU SLIME) in developing methodologies and data collection and modelling for eel stock assessment.

Organisation of the Eel Management Units

The Eel Management Plans will be established and implemented for River Basin Districts as defined in Directive 2000/60/EC and in accordance with Article 2 of the Eel Regulation. Ireland will submit a National Report encompassing five River Basin EMPs and one transboundary EMP. These are the Eastern EMP, South Eastern RBD EMP, South Western RBD EMP, Shannon IRBD EMP, Western RBD EMP and the transboundary North Western RBD EMP.

Inland and estuarine eel fisheries in Ireland are managed by seven Regional Fisheries Boards, divided into Fisheries Districts, and the Loughs Agency. Fisheries District boundaries largely conform to the arrangement of river catchments. In general, eel fisheries managed on a Fisheries District basis fall naturally within the boundaries of the RBDs.

Description of the Eel Management Units

Current management of migratory species in Ireland, salmon and sea trout, has been at the catchment level and it is therefore logical to expand this to encompass the management of eel. A G1S based data model was established for the quantification of the freshwater salmon habitat asset and for the determination of the quantity of habitat available to migratory salmonids. 261 discrete migratory salmonid ‘Fishery Systems’ were identified. Four Northern Ireland catchments have now been included in this quantification in support of the NWIRBD transboundary management plan. It is likely that eels are present in the majority or all of these systems. Commercial fishing probably only takes place in 4.6% of the catchments, although this accounts for some 71% of the total wetted area.

The estimated total wetted area of the 265 lake, river and stream habitat accessible to migratory fish (including 1st order streams) in Ireland (including the Northern Ireland part of the Erne and the Loughs Agency Rivers in the Foyle and Carlingford areas) is 153,881ha. The 265 “migratory” systems were estimated to contain 132,275 ha of lake habitat and 21,606 ha of fluvial habitat, of which 2,826 ha is estimated to be 1st order stream. The ShIRBD, WRBD and NWIRBD are dominated by lacustrine habitat.

The catchments have been characterised on the basis of their underlying geology, specifically in terms of the proportion of the surface area comprising calcareous and non-calcareous types. This catchment characterisation led to a continuous summary variable for catchment freshwaters, i.e. the proportion of wetted area comprising non-calcareous geology. Lacustrine habitat dominates Ireland’s freshwaters, comprising more than 85% of the wetted area. Similarly, calcareous habitat heavily dominates overall.

Water quality in Ireland is generally good and compares favourably with other Member States. The main challenge for water quality is to deal with eutrophication arising from excess inputs of nutrients from all sources. The extent of eutrophication has been increasing persistently since the 1970s and is probably the most serious environmental pollution problem in Ireland. Poor water quality impacts on the potential of rivers to produce salmon. It is unknown whether similar poor water quality levels have an affect on eel. Nationally (RoI), the current water quality in 82.7% of the habitat available for salmon production is unpolluted, a further 12.8% is considered slightly polluted and the remaining 4.5% is considered to be moderately or seriously polluted. In general, persistent organic pollutants were relatively low in the Irish eels sampled to date.

Preliminary analysis of information available on the presence of *Anguillicola* in different catchments would indicate that approximately 50% of the wetted area is now potentially infected by the parasite and that it continues to spread.

Six catchments in Ireland have major hydropower installations in the lower catchments. 46% of the available wetted habitat is upstream of major barriers, although there is a greater proportion (53%) of the potential silver eel production when the differences in relative productivity are taken into account. An average mortality of 28.5% per turbine installation (ICES 2003) was used in assessing the impact of hydropower. It is intended that immediate measures will be put in place to mitigate against turbine mortality, including trap and transport on the Erne, Shannon and Lee. These are outlined in the management actions section. It is also recommended that all new hydropower turbines and potential barriers to upstream migration should be evaluated in Environmental Impact Assessments for potential impacts on eel.

Natural mortality of eels is a major, but relatively unknown, factor in the population dynamics of eels and mortality caused by predation is one of the factors contributing to natural mortality. There are few data on the level of predation on eel in Ireland or on the impact on the eel stock. The most recent census of cormorants in Ireland (Seabird 2000 breeding survey) reports that the Irish coastal population has remained stable since the previous census (1985-88). Other legislation must be complied with when considering possible actions against predators.

The Eel Fishery

Glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act). The commercial eel fishery involves harvesting both brown and silver eel in freshwater and in estuarine or tidal waters. Brown eel are fished using a variety of techniques, the most common of which are baited long-line, fyke nets and baited pots. When silver eel are migrating downstream are caught in fyke nets and stocking-shaped nets called "coghill nets" which are attached to fixed structures in the river flow, often at "eel weirs". The declared commercial eel catch in the Irish Republic, 2001-2007, ranged from 86t to 120t involving about 150-200 part-time fishermen, but inadequate reporting and illegal fishing makes this difficult to quantify accurately and it maybe a substantial under estimate. A total maximum of 278 licences were issued in 2006 and a maximum of 182 of these were actively fished in 2005. The value of the reported catch was therefore in the order of €0.5 million to €0.75 million.

Monitoring of elver migrating at Ardnacrusha (Shannon) and Cathleens Falls (Erne) is undertaken by the ESB. Indications are that recruitment is low.

In May 2008, a bye-law was introduced (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008) restricting the fishing season for both brown and silver eel. Analysis of the impact of implementing a Brown eel fishing season from 1st June to 31st August and a Silver eel season from the 1st of October to 31st December showed the impact of the reduced fishing season would have been different in each Region with the level of reduction ranging from 7 to 42% in brown eel catch and 0-40% in silver eel catch.

Recreational eel fishing is only carried out by a minority of rod anglers and there is no legal, or voluntary, declaration of catch which is probably relatively small. There is no legislation protecting eels from angling. All other fishing engines, including, fyke net and baited pots, are authorized under the commercial legislation.

There is no eel culture in Ireland at the present time and none is envisaged in the near future.

Escapement – Local Stock Modelling

The Irish Management Plans will include a time period for detailed data collection and a parallel programme of stock assessment, including silver eel escapement estimates, and model development. In the interim, the three options proposed in the Eel Regulation were used to make preliminary estimates of pristine production and current escapement. The approach outlined in Article 2 of the Eel Regulation (EC No. 1100/2007) was followed to calculate pristine and current escapement and a simple model was proposed to project the impact of management actions on escapement from freshwaters.

No estimates of truly pristine escapement exist for Irish eel catchments. Recruitment of juvenile eel to Irish catchments (2003-2007) has declined to between 4% (Shannon) and 23% (Erne) of historical (1979-1984) and has been particularly poor in 2008. Historical production of silver eels was calculated (for freshwaters only) using catch series for four catchments (where the fishery efficiency was estimated) for periods prior to 1980. These data were calibrated using eel growth rates for 17 catchments and a regression model was developed relating production to catchment geology, a proxy for productivity. This gave historic production rates of 0.9kg/ha (Burrishoole – unproductive) to 5.5kg/ha (Moy – productive) and total historic silver eel potential production (without anthropogenic mortality) of 595 t per annum.

Current silver eel production was estimated using a similar approach with rates of 1.3kg/ha (Burrishoole – unproductive) to 2.7kg/ha (Ennell – productive) and total current silver eel escapement of 140t. Irish escapement expressed as a percent of historic production (EU target = 40%) range from 8% in the ShIRBD to 64% in the SWRBD. The national percent escapement is 24%.

Due to the last 18+years of low and declining recruitment, regardless of which management actions are taken, achieving the 40% EU target in the long term will require a recovery of recruitment arising from concerted international action and cannot be achieved in Ireland alone. It was difficult to assess a timeframe for recovering the predicted downward trend in escapement in the absence of knowing what the European recruitment levels will be in the future and in the absence of a clear timeframe from the EU. To facilitate setting a timescale to recovery it was decided to adopt the approach used by Astrom and Dekker (2007) in predicting the recovery time for recruitment under different reduced levels of mortality. Two assumptions were made: the first that Europe responds in a similar fashion to reducing mortality and the second, that as recruitment recovers towards historical, the Spawning Stock Biomass is recovering towards the target. Therefore, recruitment recovery is used as an alternative target towards the escapement target. It is also possible that the EU biomass escapement target may be reached in a shorter timescale than full historical recruitment.

Stocking

Currently in Ireland there are two types of stocking carried out, both coming under the heading of "assisted migration" upstream. Purchase of glass eel for stocking from outside the state does not currently take place. During the monitoring programme, 2009-2011, an evaluation of recruitment levels will take place. This will facilitate an assessment of possible stocking strategies as a useful tool to aid stock recovery. This assessment will be guided by the Eel Scientific Committee. Any stocking taking place can, and will be, included in the assessment of the local stocks and the modelling of escapement and stock recovery. Assisted migration of upstream migrating pigmented elvers takes place in the Shannon (Ardnacrusha) and Erne (Cathaleens Falls) and of pigmented young eel (bootlace) on the Shannon (Parteen). It is proposed to **continue** this operation. Currently, small amounts of glass eel and elver are taken in the Shannon estuary and in neighbouring catchments and these are stocked into the Shannon above Ardnacrusha and Parteen. Given the widespread presence of *Anguillicola* and the move towards risk averse management strategies at low recruitment levels, this practice will be **discontinued**. It is proposed that in the event of recovering recruitment, a stocking strategy will be developed by stocking "surplus" recruits into good quality (e.g. low contaminants, no *Anguillicola*) catchments where stocks are identified to be low. Stocking will be for conservation and will be undertaken in a risk averse manner.

Monitoring & Post-evaluation

The national plan describes a comprehensive programme of monitoring and evaluation of management actions and their implementation, and also a programme of eel stock assessment to establish a stock baseline, estimate silver eel escapement and monitor the impact of the management actions on the local stocks.

Ireland is committed to compliance with the Data Collection Regulation (DCR) and submitted a provisional plan for 2009 and 2010 to the EU. Given the cessation of the eel fishery there will be no obligation to undertake sampling under the DCR.

Management Actions

There are four main management actions aimed at reducing eel mortality and increasing silver eel escapement in Irish waters. These are a cessation of the commercial eel fishery and closure of the market, mitigation of the impact of hydropower, including a comprehensive silver eel trap and transport plan, ensure upstream migration of juvenile eel at barriers and improve water quality including fish health and bio-security issues.

Eel traceability and catch and sales reporting will not be required under the management option of a ceased fishery and a closed market. Compliance with CITES will only be relevant where a fishery expects to export outside the EU and this will require a scientific non-detriment finding declaration. Given the cessation of the fishery this will not be an issue in the immediate future.

The CFB and eel fishermen will be engaged in investigating possible diversification schemes for the former commercial fishermen.

Summary

Irish silver eel escapement from freshwaters expressed as a percent of historic production (EU target = 40%) ranges from 8% in the ShIRBD to 64% in the SWRBD. The national percent escapement is 24%.

Management actions described will contribute to achieving a recovery in recruitment in 90 years (assuming an equivalent EU wide action), thereby aiming to achieve the EU escapement target in less than that timeframe. It is imperative that equivalent EU-wide action is taken at this level so as not to diminish the impact of Ireland's contribution

National Report for Ireland on Eel Stock Recovery Plan
Including River Basin District Eel Management Plans

Submitted by: The Department of Communications, Energy and Natural Resources

Version 1

Report Date: **19 December 2008**

Revision History:

Revisions by:

Table of Contents

1 Introduction

1.1 Background

The latest scientific advice from the International Council for the Exploration of the Sea (ICES) concerning European eel is that the stock is outside safe biological limits and that current fisheries are not sustainable. ICES have recommended that a recovery plan be developed for the whole stock of European eel as a matter of urgency and that exploitation and other human activities affecting the stock be reduced to as close to zero as possible.

In order to ensure that eel recovery measures are effective and equitable, it is necessary that Member States identify the measures they intend to take and the areas to be covered, that this information be communicated widely, and that the effectiveness of the measures be evaluated.

Ireland has fully engaged with the process of developing an EU Regulation for the Recovery of the Eel Stock, with representation at the national and international levels, ICES, EIFAC, WGEEL, STECF, Fisheries Working Group in Brussels and Council and Parliament.

Ireland established a National Working Group on eel management in 2006, in advance of the agreement of the Regulation (EC) No. 1100/2007 in order to begin the preparatory work required and Irish scientists participated in Working Groups and EU projects (i.e. EU SLIME) in developing methodologies and data collection and modelling for eel stock assessment.

It is noted that the timescale for implementation of the EMPs is short (Dec 2008) and therefore various projects and initiatives have been incorporated into the first phase of the eel plan, particularly in relation to collation and analysis of archived eel data, habitat and catchment data and eel surveys and estimation of production and escapement. There is a paucity of good quality comprehensive data required for assessment of the status of the eel stock and potential or actual silver eel escapement.

Ireland, through the National Development Plan Sea Change programme has funded a 15 month project to address the collation of archival data on eel surveys, catch statistics and productive habitat and this project will report finally in May 2009, with interim reports providing information in support of the development of the EMPs. See text box below for the project objectives:

NDP 2007-2013:

Science, Technology and Innovation (STI) Programme

Compilation of habitat based catchment information and historical eel data in support of Eel Management Plans

1) Collate, digitise and analyse the available published and unpublished historical and more recent eel data as a basis for the National Eel Management Plan and River Basin Management Plans.
2) Amalgamate catchment habitat data from the CFB & MI, EPA and River Basin Districts Geographical Information Systems (GIS) into a single database to support the modelling of eel stocks on a sub-catchment basis.
3) Compile a comprehensive eel habitat GIS, building on the existing salmon wetted areas habitat quantification model – linked with objectives (1 & 2).

1.2 Life cycle and glossary

The European eel *Anguilla anguilla* (L.) is found and exploited in fresh, brackish and coastal waters in almost all of Europe and along the Mediterranean coasts of Africa and Asia. The life cycle has still not been fully elucidated (Fig. 1.1), but current evidence supports the view that recruiting eel to European continental waters originate from a single spawning stock in the Atlantic Ocean, presumably in the Sargasso Sea area, where the smallest larvae have been found. Larvae (*Leptocephali*) of progressively larger size are found between the Sargasso Sea and European continental shelf waters. At the shelf edge, the laterally flattened *Leptocephalus* transforms into a rounded glass eel, which has the same shape as an adult eel, but is unpigmented. In Ireland, glass eel migrate into coastal waters and estuaries between October and March/April, before migrating, as pigmented elvers, on into rivers and eventually into lakes and streams between May and September. Following immigration into continental waters, the prolonged yellow eel stage (known as brown eel in Ireland) begins, which lasts for up to 20 or more years. During this stage, the eels may occupy fresh water or inshore marine and estuarine areas, where they grow, feeding on a wide range of insects, worms, molluscs, crustaceans and fish. Sexual differentiation occurs when the eels are partly grown, though the mechanism is not fully understood and probably depends on local stock density. At the end of the continental growing period, the eels mature and return from the coast to the Atlantic Ocean; this stage is known as the silver eel. Female silver eels grow larger and may be twice as old as males. The biology of the returning silver eel in ocean waters is almost completely unknown.

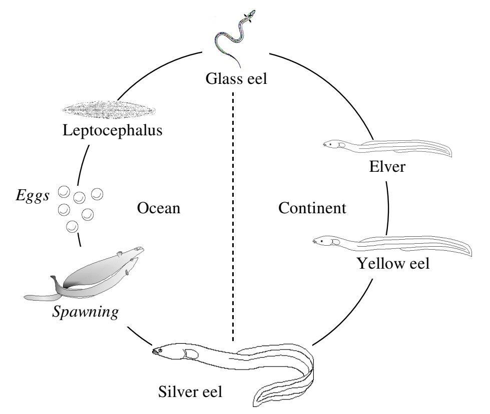


Figure 1.1. The life cycle of the European eel. The names of the major life stages are indicated; spawning and eggs have never been observed in the wild and are therefore only tentatively included. **(Diagram: Willem Dekker).**

Glossary

Leptocephalus larva.	Ocean pelagic. Deep-bodied, strongly compressed, transparent 'willow-leaf' shape
Glass eel	Small eel, less than one year post metamorphosis. Continental shelf waters to lower reaches of rivers. Body form as in adult, largely transparent but with localised pigment.
Elver	Migrating eel to 2 years post metamorphosis. Coastal and freshwater. This term is not strictly defined and is frequently used to include glass eel. Fully pigmented eel, blackish colour: to length 10cm.
Bootlace eel, snig	Small growing, sedentary or upstream migrating eel. Coastal and freshwater. Fully pigmented eel, yellow or brown colour: length 9 to 25 cm.
Brown (yellow) eel	Large growing, sedentary eel. Coastal and freshwater. Fully pigmented eel, yellow or brown colour: length greater than 20cm. Eyes small, body soft.

Silver (bronze) eel	Migrating, non-feeding eel. Freshwater to oceanic. Silver or bronze colour: length rarely less than 25 cm. Eyes large, body firm, lateral line prominent.

Acronyms in the Report

ACFM (ICES)	Advisory Committee on Fishery Management
AFBINI	Agri-food and Biosciences Institute
BIM	Bord Iascaigh Mhara
CFB	Central Fisheries Board
DARD	Dept. of Agriculture and Rural Development
DCAL	Dept. of Culture, Arts and Leisure
DCENR	Dept. of Communications, Energy and Natural Resources
EEEP	Erne Eel Enhancement Programme
EIFAC	European Inland Fisheries Advisory Commission
FAO	Food and Agriculture Organisation
FCB (NI)	Fisheries Conservancy Board
ICES	International Council for Exploration of the Seas
LNFCS	Lough Neagh Fishermen's Co-operative Society Ltd
MI	Marine Institute
RFBs	Regional Fisheries Boards
SSB	Spawning Stock Biomass
TACs	Total Allowable Catches

Definition

40% Target: *"The objective of each Eel Management Plan shall be to reduce anthropogenic mortalities so as to permit with high probability the escapement to the sea of at least 40 % of the silver eel biomass relative to the best estimate of escapement that **would have existed if no** anthropogenic influences had impacted the stock".*

2 Organisation of the Eel Regulation/EMPs

2.1 National Approach

The Eel Management Plans will be established and implemented for River Basin Districts as defined in Directive 2000/60/EC and in accordance with Article 2 of the Eel Regulation.

Ireland will submit a National Report encompassing five River Basin EMPs and one transboundary EMP. These are the Eastern Eel Management Plan (see Sec 2.2), South Eastern RBD Eel Management Plan, South Western RBD Eel Management Plan, Shannon IRBD Eel Management Plan, Western RBD Eel Management Plan and the transboundary North Western RBD Eel Management Plan (see Sec 2.2).

2.2 Transboundary Agreements

There are three transboundary River Basin Districts in Ireland. The Shannon IRBD is predominantly in the Republic and will not be treated as a transboundary EMP. The Neagh-Bann IRBD on the north east coast and the North West IRBD on the northwest coast are the two main River Basin Districts crossing the boundary between Ireland and Northern Ireland.

The Department of Communications Energy and Natural Resources and the Department of Culture, Arts and Leisure Northern Ireland met on the 11th March 2008 in Dublin and subsequently exchanged written agreements (13th March and 20th March 2008 (ref:C17/9/161)) on the transboundary EMPs and agreed full co-operation in this regard. Scientists from the Marine Institute, Central Fisheries Board, the Loughs Agency and AFBINI have also agreed co-operation. The agreement was as follows:

NEAGH-Bann IRBD
Pursuant to Articles 2(1), 2(2) and 6(1)of Council Regulation (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel, it was agreed to treat the Neagh Bann IRBD as comprising only the Lower River Bann and its tributaries, and Lough Neagh and all its influent rivers. Note: rivers flowing into Carlingford Lough from Northern Ireland are to be reported in an eel management plan for the North Eastern RBD prepared and submitted by DCAL, whilst rivers flowing into Carlingford Lough from the Republic of Ireland and into Dundalk Bay are to be reported in a plan for the Eastern RBD (the Eastern Eel Management Unit) prepared and submitted by DCENR and the Eastern Regional Fisheries Board (see Figure 2.1)

Shannon IRBD
An eel management plan for the Shannon IRBD will be prepared and submitted by DCENR and the Shannon Regional Fisheries Board.

North Western IRBD
One transboundary eel management plan will be submitted in respect of the North Western IRBD and this will be prepared by the Northern Regional Fisheries Board, the Loughs Agency and DCAL.

Figure 2.1. Map identifying the Neagh Bann IRBD area to be incorporated into the Eastern Eel Management Unit plan.

3 Description of Eel Management Units

3.1 Management Units & Authorities

As described in Sec. 2.1 there are five EMPs and one transboundary EMP:

Eastern EMP	Eastern Regional Fisheries Board (with the Loughs Agency)
South Eastern RBD	Southern Regional Fisheries Board (with the ERFB)
South Western RBD	South Western Regional Fisheries Board (with SRFB)
Shannon IRDB	Shannon Regional Fisheries Board
Western RBD	Western Regional Fisheries Board (with NWRFB)
North West IRBD	Northern Regional Fisheries Board (with DCAL & Loughs Agency)

3.1.1 Authorities

Department of Communications, Energy and Natural Resources (DCENR)
DCENR is the main governmental department with responsibility for fisheries policy, management, control and enforcement.

Department of Environment, Heritage and Local Government (DEHLG)
DEHLG is the main governmental department with responsibility for core functional areas of environment, water and natural heritage, built heritage and planning, housing, local government and meteorological services and implementation of the Habitats and Water Framework Directives.

The Marine Institute (MI)
The MI is a semi state marine research organisation which provides fisheries stock advice on migratory species (e.g. salmon, eels) to DCENR. The MI is charged by DAFF with the collection of scientific data on the marine fisheries sector and the implementation of the module on evaluation of inputs: fishing capacities and fishing effort and the module of evaluation of catches and landings as defined in the Application regulation of EU Council Regulation 1543/2000.

The Central (CFB) and Regional Fisheries Boards (RFBs)
The CFB is a statutory body, established under the Fisheries Act 1980, operating under the aegis of the DCENR. The principal functions of the CFB are to advise on policy relating to the conservation, protection, management, development and improvement of inland fisheries and sea angling, and to support, coordinate and provide specialist support services to the RFBs. The seven statutory RFBs are responsible for maintaining and improving environmental quality and developing and protecting the fisheries resource in their regions. Eel fishing licences and authorizations are issued on a Regional basis.

Electricity Supply Board (ESB)
ESB has a statutory role in preserving and developing the Shannon fishery, since the establishment of a hydroelectric scheme on the river when the government handed over all fishing rights to the company in 1935.

An Bord Iascaigh Mhara (BIM – The Irish Sea Fisheries Board)
BIM is the Irish State agency with responsibility for developing the Irish Sea Fishing and Aquaculture industries and is charged by DAFF with the collection of economic data on the marine fisheries sector.

The Loughs Agency
The Loughs Agency aims to provide sustainable social, economic and environmental benefits through the effective conservation, protection, management, promotion and development of the fisheries and marine resources of the Foyle and Carlingford Areas.

Eel Scientific Committee

A scientific committee will be established for eel, comprised of representatives from the relevant State Agencies, to define and oversee a programme of monitoring, stock assessment and post-evaluation of management measures and to provide advice on eel.

3.1.2 Management Units

The coast of Ireland is covered by ICES Areas VI & VII (Fig. 3.1), which is in the single NE Atlantic category.

The EU has proposed (COM (2005) 472) that Eel Management Plans be established and implemented on a Water Framework Directive River Basin District level. The WFD subdivides the Republic of Ireland into four River Basin Districts and three International River Basin Districts (Fig. 3.2). Full descriptions of each RBD are given in the individual RBD Eel Management Plans

Inland and estuarine eel fisheries in Ireland are managed by seven Regional Fisheries Boards which are divided into Fisheries Districts (Fig. 3.2) and the Loughs Agency. Fisheries District boundaries largely conform with the arrangement of river catchments, although coastal boundaries may also relate to prominent coastal features such as headlands.

In general, eel fisheries managed on a Fisheries District basis fall naturally within the boundaries of the RBDs. In some cases individual catchments may differ on the boundaries as to which District and RBD they are in but in all cases, none of these contain active fisheries. (Fig. 3.3).

There is relatively little information on eel stocks in transitional and tidal waters in Ireland. Eels are know to inhabit extensive areas of estuaries and tidal lagoons (Arai *et al*. 2006; Harrod *et al*. 2005; Moriarty 1988; Poole and Reynolds 1996; Poole 1990). The amount of habitat utilised by eel in tidal and transitional waters is unknown and the escapement of silvers is also unknown. The eel fisheries in tidal and transitional waters are managed under the Inland Fisheries legislation and management structures.

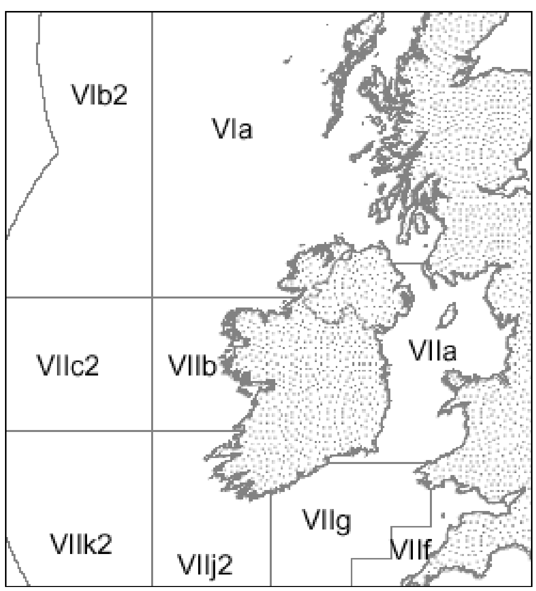


Figure 3.1. Map indicating ICES areas around Irish shorelines (Source: ICES).

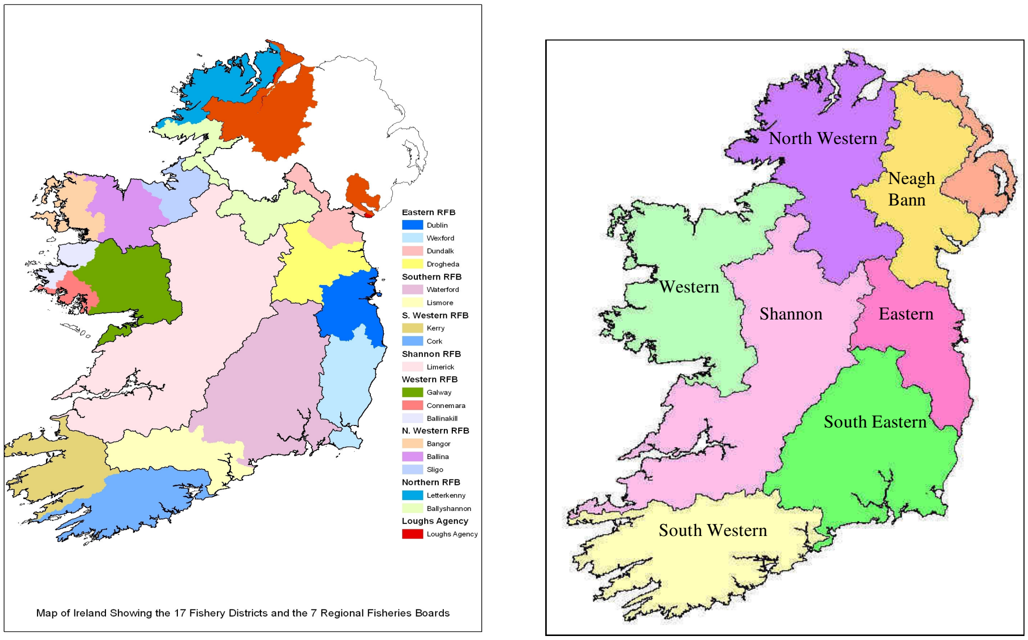


Figure 3.2. Map of Ireland on the left showing the seven Regional Fisheries Boards and the 17 Fishery Districts and on the right, showing the Water Framework River Basin District.

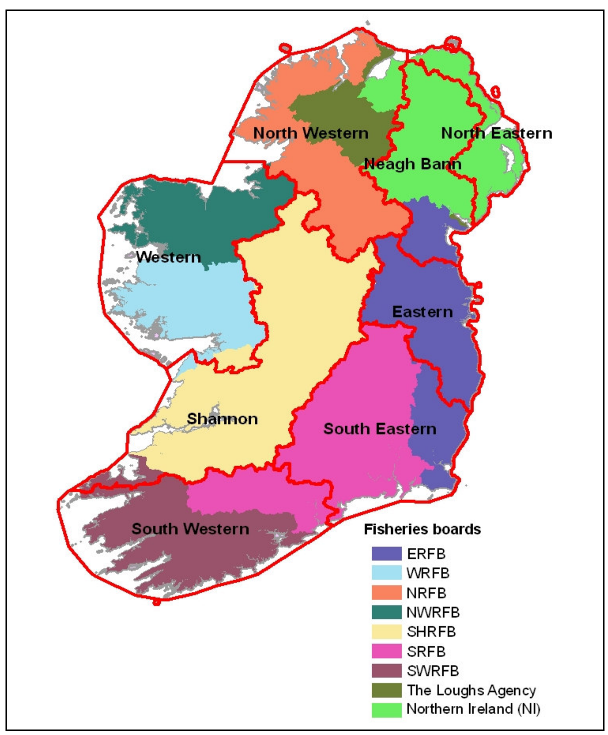


Figure 3.3. Map showing the Water Framework River Basin Districts and Regional Fishery Board areas.

3.2 River Inventory

For the past number of years management of migratory species, salmon and sea trout, has been at the catchment level and it is therefore logical to expand this to encompass the management of eel.

A G1S based data model was established for the quantification of the freshwater salmon habitat asset and for the determination of the quantity of habitat available to migratory salmonids. 261 discrete migratory salmonid 'Fishery Systems' were identified nationally of which 173 are recorded as being 'salmon and seatrout' and 88 as being 'seatrout only' (McGinnity *et al*. 2003). An additional four Northern Ireland catchments have been included in the quantification in support of the NWIRBD transboundary management plan. It is likely that eels are present in the majority or all of these systems although commercial fishing probably only takes place in 4.6% of them accounting for 71% of the total wetted area. It is also possible that this number of 265 catchments may change in the future as more information becomes available.

3.2.1 River / Lake network

The river and lake network held in the EPA and CFB GIS and used for Water Framework Directive and other applications is derived from original 1:50,000 scale Ordnance Survey of Ireland mapping.

The original OSI data has been subject to a thorough examination, removal of errors and addition of extra descriptor values so that the GIS version now contains:

- All component lines are 'with flow' in direction
- Spurious breaks in the linework has been removed
- Each "reach" or section between an upstream confluence and downstream confluence comprises a single line
- Lines have been inserted through lakes to connect inflowing tributaries with the lake outflow point to enable linear network analysis in the GIS.
- Each reach is provided with a unique code identification number.
- Additional variables (including reach length, reach gradient, Strahler stream order number (Strahler,1952), Shreve link magnitude number (Shreve, 1967), EPA river code have been added.

The number of lakes in the 1:50,000 scale GIS dataset comprises > 12,000 units. Many are small and many are not connected to the river network by mapped channels. Each contains a unique identification number and measurement of surface area.

The national river network and lakes have been assigned to River and Lake Waterbodies for implementation of the Water Framework Directive. Rivers with a catchment area >= $10km^2$ are included. In most instances the derived river waterbodies comprise a series of original 'reach' segments merged into longer waterbodies using Stahler stream order values to group connected reaches. Some 4500 waterbodies are identified

The logic for the derivation of Lake Waterbodies from the national lake dataset requires that >= 1 of the following 3 criteria are applicable:

- Lake surface area > 50ha
- Lake is used for water abstraction
- Lake occurs within a Protected Area designation

Some 805 lake waterbodies are identified on this basis.

3.2.2 Wetted Area

The wetted area model (2007) has its origin in a CFB methodology (Quantification of the Freshwater Salmon Habitat Asset in Ireland, 2003). It attempts to predict the likely river width along rivers based on a statistical model built from information derived in a GIS.

The core GIS data sets used in the development of the model include the river and lake network at 1:50,000 scale (EPA WFD GIS); estimates of the catchment area u/s of each reach; the total length of river channel u/s of each reach, the gradient of each reach and the stream order value (Strahler, 1952).These factors were related to field survey measurement of the river width at some 277 sites to allow derivation of a statistical formula that predicts the width at any reach where these GIS variables are known.

* *a 'reach' is defined in the GIS as the river line between an upstream confluence and a downstream confluence - typically of the order of ½ - 1 km in length*.

An exercise to derive an improved model for river width prediction was undertaken in 2006/2007. A new series of field measurements of width were obtained with a more complete distribution across the national river network (in the 2003 study the surveyed rivers were concentrated in the North West and excluded the larger rivers from the sample). Arising from exploratory statistical analysis it was determined that the most appropriate model to estimate river width would be based on 2 predictive variables - the catchment area u/s of each reach and the stream link magnitude (Shreve, 1967) which is a less conservative form of hierarchical numbering of streams in a network than the Strahler stream order.

3.2.3 Calcareous classification of bedrock

The geological bedrock mapping in Ireland undertaken by the Geological Survey of Ireland identifies some 1100 lithologies and formations. From this, GSI has derived a functional dataset of the principal or major rock types that comprises 27 types. Through analysis of water chemistry data GSI has assigned a threefold classification of the expected degree of expected nature of associated groundwaters (Table 3.1).

Table 3.1. Expected nature (degree of calcareousness) of ground-waters associated with geological classification.

ROCKUNIT	geochemistry
Basalts & other Volcanic rocks	Mod-Calcareous
Cambrian Metasediments	Non-Calcareous
Devonian Kiltorcan-type Sandstones	Non-Calcareous
Devonian Old Red Sandstones	Non-Calcareous
Dinantian (early) Sandstones, Shales and Limestones	Very-Calcareous
Dinantian Dolomitised Limestones	Very-Calcareous
Dinantian Lower Impure Limestones	Very-Calcareous
Dinantian Mixed Sandstones, Shales and Limestones	Very-Calcareous
Dinantian Mudstones and Sandstones (Cork Group)	Non-Calcareous
Dinantian Pure Bedded Limestones	Very-Calcareous
Dinantian Pure Unbedded Limestones	Very-Calcareous
Dinantian Sandstones	Mod-Calcareous
Dinantian Shales and Limestones	Very-Calcareous
Dinantian Upper Impure Limestones	Very-Calcareous
Granites & other Igneous Intrusive rocks	Non-Calcareous
Namurian Sandstones	Mod-Calcareous
Namurian Shales	Mod-Calcareous
Namurian Undifferentiated	Mod-Calcareous
Ordovician Metasediments	Non-Calcareous
Ordovician Volcanics	Non-Calcareous
Permo-Triassic Mudstones and Gypsum	Mod-Calcareous
Permo-Triassic Sandstones	Mod-Calcareous
Precambrian Marbles	Very-Calcareous
Precambrian Quartzites, Gneisses & Schists	Non-Calcareous
Silurian Metasediments and Volcanics	Non-Calcareous
Westphalian Sandstones	Mod-Calcareous
Westphalian Shales	Mod-Calcareous

3.2.4 Summary statistics for the rivers and lakes network

The estimated total wetted area* of the 265 lake, river and stream habitat accessible to migratory fish (including 1st order streams) in Ireland (including the Northern Ireland part of the Erne and the Loughs Agency Rivers in the Foyle and Carlingford areas) is 153,881ha (Table 3.2). The 265 "migratory" systems were estimated to contain 132,275 ha of lake habitat, 21,606 ha of fluvial habitat, of which 2,826 ha is estimated to be 1st order stream (calculated at a nominal width of 0.8m). The ShRBD, WRBD and NWIRBD are clearly dominated by lacustrine habitat (Fig. 3.4). A catchment by catchment summary of the wetted areas and geological classification is included in Appendix 1.

It is intend to refine this database in the future, adding in additional information such as obstacles to migration and natural barriers and ground truthing the potentially productive area with the presence/absence of eels.

Habitat quality data using the Amiro (Amiro 1993) and Rosgen (Rosgen 1994) gradient classification systems are available. For example, in the Kerry Fisheries District 48% of the potential salmon producing habitat has a gradient of < 0.5% (Amiro Class 1) (McGinnity *et al.* 2003).

* Data supplied by Central Fisheries Board, Compass Informatics, the Loughs Agency and EHS Water Management Unit, Northern Ireland

Table 3.2. Total wetted areas (ha) for lake, first order fluvial and greater than first order fluvial habitat for each River Basin District, including Northern Ireland (Erne, Drowes, Foyle, Roe & Faughan).

	Lake	>1st order fluvial	1st order fluvial	Total Wetted Area
EEMU	4,861	1,920	262	7,043
SERBD	178	3,626	412	4,216
ShRBD	40,241	4,487	590	45,317
SWRBD	7,534	2,714	419	10,666
WRBD	46,602	2,869	473	49,944
NWIRBD	32,859	3,165	670	36,694
Total	132,275	18,780	2,826	153,881

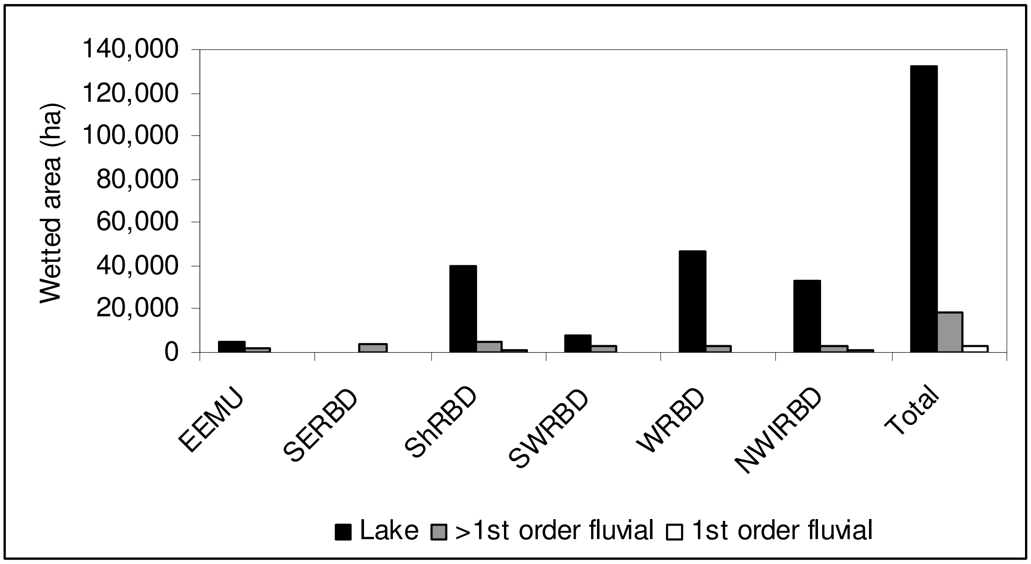


Fig. 3.4. Total wetted areas (ha) for lake, first order fluvial and greater than first order fluvial habitat for each River Basin District, including Northern Ireland (Erne, Drowes, Foyle, Roe & Faughan).

3.3 Habitat Types – National Overview

3.3.1 Potential productivity

In Article 2, of the Regulation, it states:

4. *The target level of escapement shall be determined, taking into account the data available for each eel river basin, in one or more of the following three ways:*

    (a) *use of data collected in the most appropriate period prior to 1980, provided these are available in sufficient quantity and quality;*
    (b) ***habitat-based assessment of potential eel production**, in the absence of anthropogenic mortality factors;*
    (c) *with **reference to** the ecology and **hydrography of similar river systems**.*

In support of this approach, the catchments have been characterised on the basis of their underlying geology, specifically in terms of the proportion of the surface area comprising calcareous and non-calcareous types. This catchment characterisation led to a continuous summary variable for catchments' freshwaters, i.e. the proportion of catchment comprising non-calcareous geology. If insufficient habitat specific information were available to use this continuous habitat variable for estimating habitat productivity, a coarse discrete classification of waters as calcareous or non-calcareous might be more appropriate. Therefore, the wetted areas of calcareous or siliceous waters were also estimated based on the ratio of calcareous to non-calcareous geology within the catchment (Table 3.2; Fig. 3.5). More detailed information on catchment productivity using water chemistry (pH, Conductivity, alkalinity) might improve this system in the future and this will be done during the final phase of the NDP Eel project.

It should be noted that lacustrine habitat dominates Ireland's freshwaters, comprising more than 85% of the wetted area. Similarly, calcareous habitat dominates overall (Table 3.3).

Table 3.3. Total wetted areas (ha) for lake, first order fluvial and greater than first order fluvial habitat for each River Basin District, separated by catchment geology.

	Wetted area		%
	Calcareous	Siliceous	Non calcareous
EEMU	5,578	1,465	21
SERBD	2,492	1,724	41
ShRBD	41,601	3,716	8
SWRBD	2,596	8,070	76
WRBD	35,110	14,834	30
NWIRBD	28,972	7,722	21
Total	116,349	37,531	32

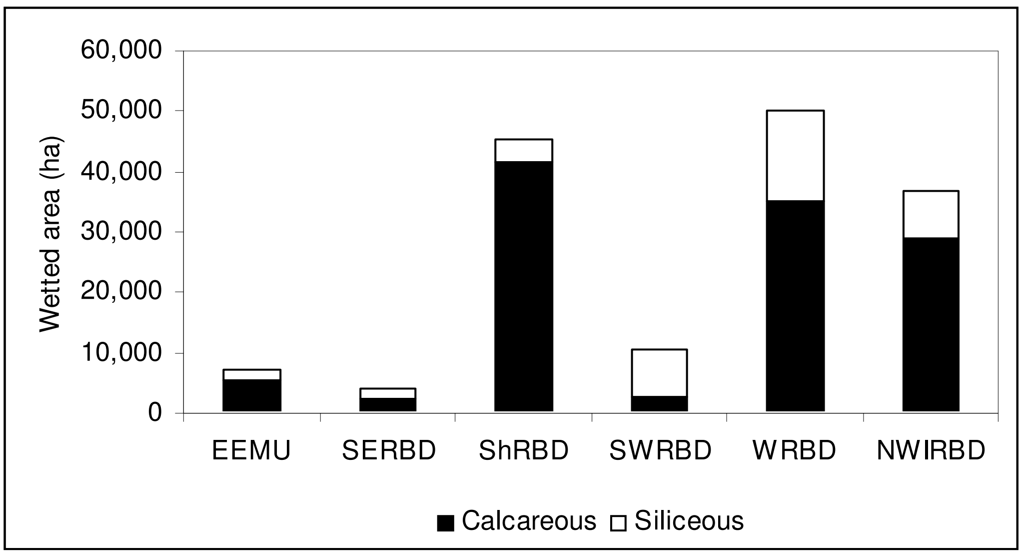


Fig. 3.5. Total wetted areas (ha) for lake, first order fluvial and greater than first order fluvial habitat for each River Basin District, separated by catchment geology.

3.4 Water Quality & Contaminants

3.4.1 Water Quality

Ireland is generally in a good position to implement the Water Framework Directive. Irish legislation provides (since 1977) for water quality planning on an integrated basis (i.e. to include surface and ground waters, including estuarine and tidal waters) and for inter-authority planning.

Since 1997 Ireland has promoted a catchment-based, national strategy to combat eutrophication in rivers and lakes. Major catchment-based initiatives have been carried out in respect of Loughs Derg, Ree and Leane and the Rivers Suir, Boyne and Liffey, linked to a major programme of investment in sewage infrastructure in these catchments. The work done in the context of these projects will be carried forward and developed in the context of River Basin Management Projects.

Water quality in Ireland is generally good and compares very favourably with other Member States. The main challenge for water quality is to deal with eutrophication arising from excess inputs of phosphorous from all sources. The extent of eutrophication in the river system has been increasing persistently since the 1970s and has been identified by the EPA as probably the most serious environmental pollution problem in Ireland.

Poor water quality impacts on the potential of rivers to produce salmon. It is unknown at this point whether similar water quality levels that impact on salmon have an affect on eel. The Environmental Protection Agency monitor water quality at over three thousand sites nationally from which a preliminary estimation of the area of channels with inadequate water quality which has been made.

Nationally (RoI), the water quality in 82.7% of the habitat available for salmon production is unpolluted, a further 12.8% is considered slightly polluted, the remaining 4.5% is considered to be moderately or seriously polluted. Recent studies carried out by the Central Fisheries Board (Kelly *et al.,* 2007) suggest that salmon distribution and productively are significantly impaired in both of the latter categories. The EPA has recently updated the 2002 data to cover the period up to 2006.

River by river water quality data are available from the EPA and these will be integrated into the eel habitat GIS database by May 2009. Ground truthing of the impact of water quality on eel stocks will be required in the future.

3.4.2 Eel Contaminants

3.4.2.1 Persistent organic pollutants

In 2005, eel samples were obtained from 5 locations and in 2007 two additional samples were taken from Burrishoole to investigate replicates from the one population (Marine Institute, unpublished data; McHugh, Poole & McGovern, in prep). Muscle tissue samples were analysed for a range of contaminant suites incl. Dioxins/Furans, PCBs, OCPs and flame retardants (PBDEs, PBBs, TBBPA and total HBCD (sum of α-, β-, γ- diastereomers)) by either Eurofins/ERGO, ERGO Forschungsgesellschaft mbH, Hamburg Germany or by the Central Science Laboratory in York England. Eurofins/ERGO analytical methodology complies with the requirements for the HRGC/HRMS confirmatory analysis of food for PCDD/Fs and PCBs as laid down by the EU directive 2002/69 as amended. Marker-PCBs and OCPs were determined by HRGC/HRMS on a DB-5 capillary column following solvent extraction and clean-up on an alumina/silica column. For each substance two isotope masses were measured. Quantification was carried out with the use of internal/external standard mixtures. For the analysis of brominated flame retardant compounds, a GfA-established GC/MS method was used.

Data are summarised in Appendix 2. In general, persistent organic pollutants were relatively low in the Irish eels sampled to date, with the possible exception of dioxin levels in the Burrishoole eels. Current legislation is designed to protect the consumer from dioxin/furan and dioxin-like-PCBs in foodstuffs and using the additive TEQs approach (61), total PCDD/PCDF-TEQs in the range 0.18 to 0.26 pg total-TEQ (wet weight) were calculated for four of the samples in this study, while in the samples from the Burrishoole catchment a much more elevated Total-TEQ wet weight was recorded.

In the Burrishoole samples, PCDDs and OCDDs were elevated above EU legislative limits for dioxins in eel muscle strongly suggesting point source or local scale influences at this location. These sources have not been identified to date, Total furan levels in all samples were low. Concentrations and consequentially PCDF-TEQs in the Burrishoole being much less elevated than those observed for dioxins.

Further sampling may be required and investigation into potential point source influences is also merited. These low levels relative to many other countries was corroborated by recent data for Ireland (Lake Furnace and River Owengarve) which also showed low PCB levels for eels (Santillo *et al*., 2005).

3.4.2.2 Dangerous Substances Monitoring - WFD

In Ireland a National Dangerous Substances Expert group was established in 2003 to assist with developing lists of priority action, candidate relevant pollutants and candidate general components for surface waters in Ireland and to design a substances screening monitoring programme as part of the implementation of the WFD.

The overall programme ran from May 2005-May 2006. The initial 23 sites were monitored from May 2005-May 2006 (analysis was not done in December 2005). There were monthly water samples taken at each site over 12 months. One sediment and one biota sample was taken at each of the 17 surface water sites. At the freshwater sites, the biota analysed was the European eel *Anguilla anguilla* and at the Estuarine sites the biota analysed was Mussels *Mytilus sp.* A list of the sample sites is shown below (Table from: www.serbd.com/downloads).

Priority Action Substances (PAS)

The PAS's form a group of 41 parameters, a list of these 41 compounds can be viewed in the dangerous substances screening monitoring programme TNO report initial sites table 4 pages 10-11 (Reference: Priority action substances in the Dangerous Substances Screening Monitoring Programme: www.serbd.com/downloads).

In the biota samples that were analysed 20 of the PAS's were not found at all while 18 of the 51 compounds were found in more than 50% of the samples. The latter parameters mainly included polycyclic aromatic hydrocarbons, pesticides and metals with the highest concentrations found for the pesticides. Most metals were found in every biota sample.

The concentrations of the PAS found in water, sediment and biota were, in general, not different from concentrations that may be found in other non-suspect locations or countries. Exceptions were the pesticides, the number of pesticides that were found, but also the concentrations appeared to be lower than in countries with more intensive agriculture.

Relevant pollutants

An overview of the relevant pollutants can be viewed in the dangerous substances screening monitoring programme TNO report initial sites table 5 pages 12-15.

In the 21 biota samples that were analysed, 92 of the relevant pollutants were not found in all samples, while 37 of the 156 compounds were found in more than 50% of the samples. The latter parameters mainly included PCB's metals, polychlorinated dibenzodioxins and dibenzofuranes with the highest concentrations found for the metals.

In general, no extraordinary concentrations were found for the relevant pollutants in water, sediment or biota. As before, most of these concentrations can be found at other non suspect locations.

Monitoring Sites for dangerous substances in the Water Framework Directive

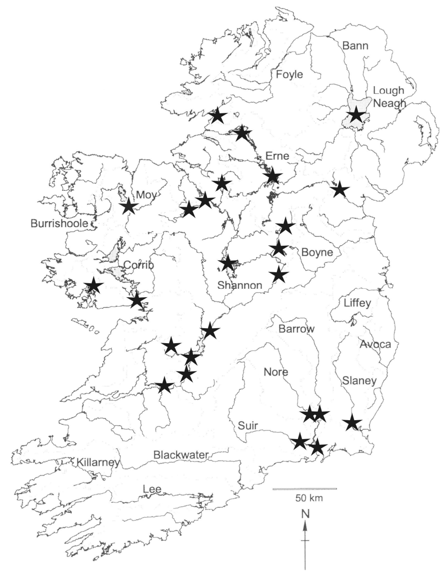
RBD	No.	Monitoring Sites	Location
South-Eastern	1	River Barrow	U/S of St. Mullins
	2	River Nore	U/S of tidal limits
	3	River Barrow	D/S Athy
	4	River Suir	U/S of tidal limits
	5	River Suir	D/S of Waterford City
	6	Waterford Estuary	D/S of Waterford City
	7	Athy UDWS- Townparks	Bagenalstown GWB
	8	Balinamuck- Dungarvan PWS	Dungarvan GWB
	9	Gorey WS (Barnadown)	Gorey GWB
Eastern	10	River Boyne	D/S of Drogheda
	11	River Liffey	U/S of Dublin City
	12	River Liffey	D/S of Dublin City
	13	Dublin Bay	D/S of Dublin City
	14	WWTP	Ringsend, Dublin
	15	Landfill	Ballyealy, Co.Dublin
Shannon	16	River Shannon	D/S of Athlone
	17	River Brosna	D/S of Mullingar
	18	River Suck	D/Sof Ballinasloe
	19	River Shannon	D/S of Limerick City
	20	Spring at Boyle	Spring at Boyle (Rockingham)
South Western	21	River Lee	U/S of Cork City
	22	Cork Harbour	Downstream of Cork City at the harbour mouth
Western	23	River Corrib	D/S of Galway City

3.4.2.3 Parasites and Diseases

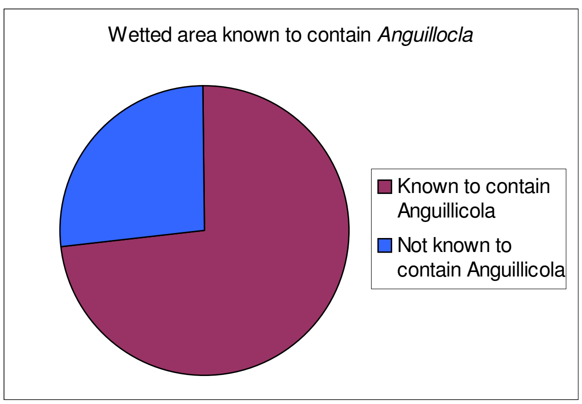
Preliminary analysis of information available on the presence of *Anguillicola* in different catchments would indicate that approximately 73% of the wetted area is now potentially infected by the parasite (Fig. 3.6) which is the equivalent to 75% of the potential eel production.

Catchments known to be infected by *Anguillicola* and included are:

Fane
Slaney
Barrow
Nore
Suir
Shannon
Corrib
Screebe
Moy
Ballysadare
Durnish L., Donegal
Erne



Map supplied by NUIG & MI



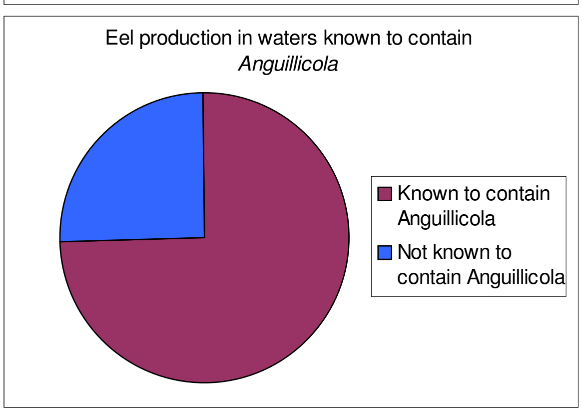


Figure 3.6. Proportions of wetted area and eel production potentially infected by the *Anguillicola* parasite.

3.5 Barriers to Migration

Obstacles to migration in river systems are one of several factors causing the dramatic decline in the eel population. Barriers impede eels from colonizing large parts of catchments, thus reducing upstream density and the additional production of larger more fecund spawners. Power plants also represent clear obstructions for downstream movement and cause a risk for the survival of silver eel (ICES, 2003, 2008).

3.5.1 Large Scale Hydropower and major barriers

3.5.1.1 Description

Six catchments in Ireland have major hydropower installations in the lower catchments (Fig. 3.7). The Shannon also has flow regulation throughout the catchment. These will be dealt with in detail in the respective RBD EMPs and are as follows:

The Shannon	(ShRBD)
The Erne	(NWIRBD)
The Liffey	(EEMP)
The Lee	(SWRBD)
The Clady/Crolly	(NWIRBD)
The Ballysadare	(WRBD)

Table 3.4 gives the wetted areas in each catchment with major hydropower. Almost 50% of the available wetted habitat is above major barriers (Fig. 3.8), although there will be a greater proportion of the potential silver eel production when the differences in relative productivity are taken into account. This is included in the Regional EMPs and in the estimates of pristine and current escapement.

Table 3.4. Wetted areas (ha) for lakes and fluvial area above major hydropower installations.

	Lake area (ha)	Fluvial area (ha)		Total wetted area	Pristine escapement
		>1st order	1st order	ha	kg/ha
Total wetted area	132,275	18,780	2,826	153,881	594,408
Total impacted	66,844	5,203	959	73,006	265,427
Shannon	38,771	3,304	391	42,466	200,839
Erne	24,848	1,098	251	26,197	116,633
Ballisadare	1556	29	227	1,812	8,239
Liffey	-	424	39	464	2,012
Clady/Crolly	391	20	5	416	505
Lee	1,278	327	46	1,651	753

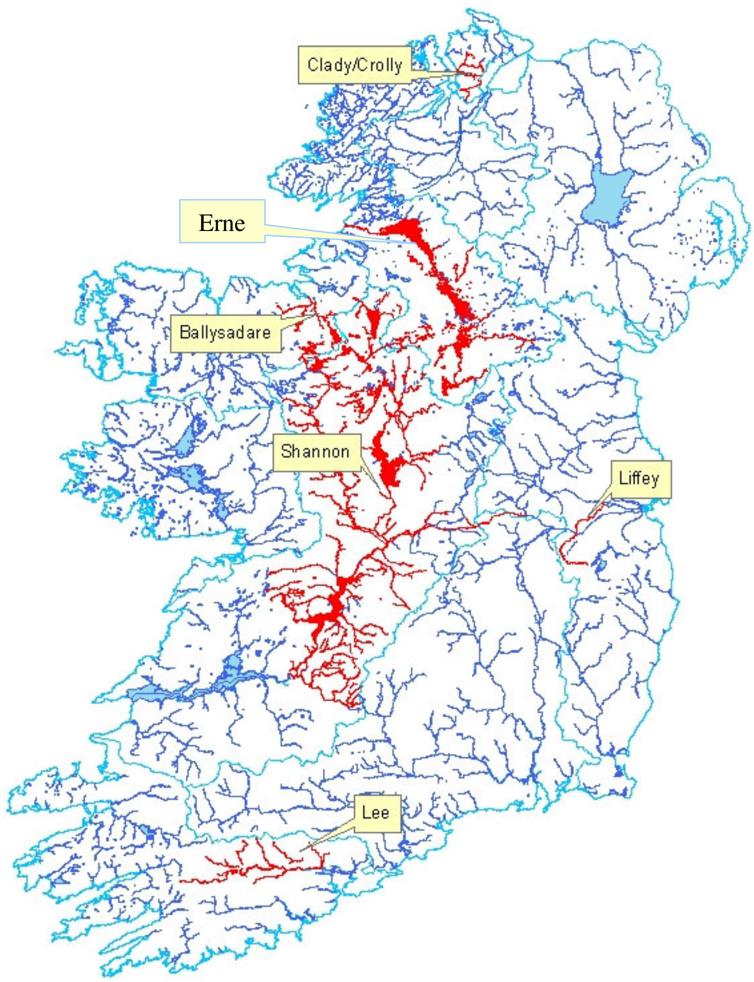
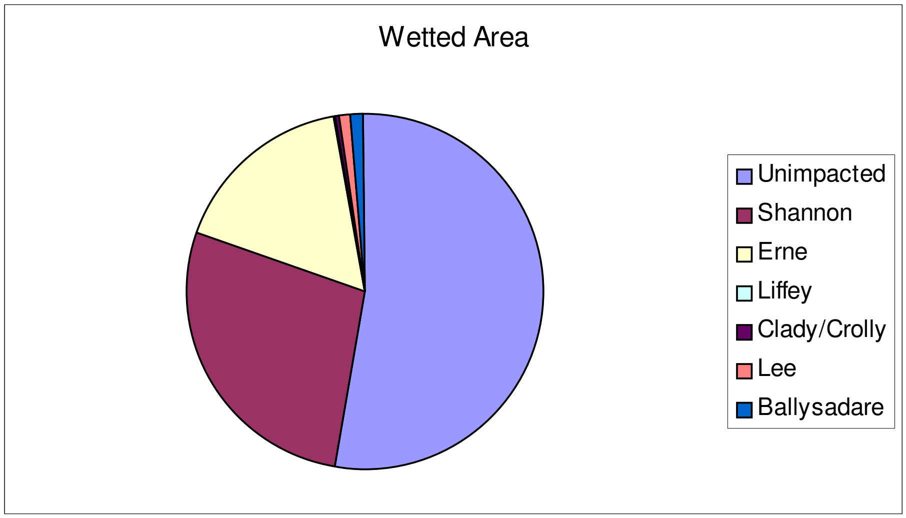


Figure. 3.7. Map showing location of catchments where major hydropower installations occur. Water-bodies upstream of hydropower stations are shown in red.



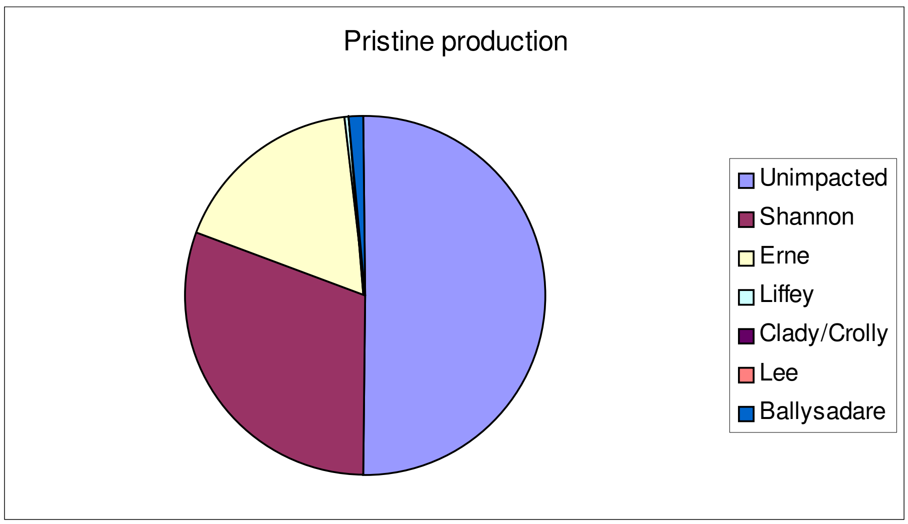


Figure 3.8. Proportions of wetted area and estimated pristine production for the catchments above major hydropower installations.

3.5.1.2 Mitigation measures

The Electricity Supply Board will develop a plan for mitigation of hydropower induced mortality in conjunction with the Eel Scientific Committee. Some measures to be included are as follows:

Trap and Transport
Migrating silver eel will be captured at various points about the Shannon, Erne and Lee catchments. This 'trap and transport' system will operated under an ESB tendered arrangement.

Bypasses
At present, there appear to be few (if any) facilities which could be used for an eel bypass channel at any of the ESB owned hydroelectric facilities (with the exception of Parteen Regulating Weir on the River Shannon). However, despite these infrastructural problems ESB Fisheries Conservation will strive towards the objective of reducing silver eel mortality as far as reasonably practicable using best practice engineering solutions and/or scientifically evaluated monitoring technologies.

Other Options
On-going research on predictive modelling, and on the potential of the Migromat ™ system may facilitate more effective management of migrating silver eels at hydropower plants. Such co-operative and collaborative research, currently being undertaken by ESB with NUIG and Electricité de France (EDF), will be developed and used to support management decisions concerning mitigation of adverse effects of hydropower generation on silver eels.

3.5.1.3 Silver eel trap and transport

The plan to trap and transport silver eels around barriers will be undertaken following an ESB plan and best practice protocol approved by the Eel Scientific Committee (in association with AFBINI and DCAL in the case of the Erne catchment). The pre-agreed targeted level of silver eel will be captured at various locations within relevant RBD's (see Chapter 8). These locations will be within the Shannon, Erne and Lee catchments and will be managed under the Electricity Supply Board (ESB), tendering system.

Part of the tender document (yet to be finalised), will be a work specification which will cover the detail of the location, the number of man-nights, gear types, health and safety considerations etc. An additional section of the tender document will detail the inspection and monitoring protocols that will be adopted in respect of the activities of the contracted party. Monitoring and assessment of this activity will be carried out by ESB Fisheries Conservation staff in conjunction with the relevant Fisheries Board management. The transport of the "trap and transport" catch will most likely be carried out under a separate tendered contract. The activity and the quantity and quality of the catch will also be monitored and assessed. Only eels captured by the contracted party will form part of the ESB's trap and transport system.

3.5.2 Small Scale Hydropower Schemes

3.5.2.1 Background

National and European Union policy support the generation of electricity through hydropower as a means of reducing CO_2 emissions from fossil fuel sources. The introduction of these schemes and recent advances in turbine and pipeline technology has lead to an increased interest in the development of small scale hydro-electric schemes in Ireland. Hydro-power developments have the potential for significant impact on eel resources.

Every dam in, or across, any salmon river must permit and allow, in one or more parts thereof, the free and uninterrupted migration of all fish at all periods of the year (Section 115 subsection 2 and 3 of the Fisheries – Consolidation – Act 1959). Good practice requires that the fish passes be capable of being negotiated by fish without undue effort, should not expose the fish to risk or injury, and be easily located by the fish. It is an offence to fail to preserve a fish pass free of an obstruction or to destroy or kill fish in a fish pass.

To prevent upstream and downstream migrating fish from entering a tailrace or headrace, Section 123 of the 1959 Act requires that the channel shall have bar screens with gaps not greater than 2 inches fitted. However, 2 inch spacing is too wide to prevent entry of sea trout or small salmon. Silver eel migrate in the autumn and may be susceptible to entrainment during power generation in all flow conditions. Turbine related silver eel mortality can be caused by jamming on the protection screens, collision with parts of the turbine, rapid changes in the hydrostatic pressure and predation in the tailwater. ICES (2003) concluded that obstruction to downstream migration and mortality caused by turbines are likely to reduce silver eel escapement considerably. Silver eel migration occurs at high water and flow levels when there is considerable entrainment of rubbish which can block nets and screens. The mortality rate of adult eels is high because of their length and may be 4-5 times higher than in juvenile salmonids.

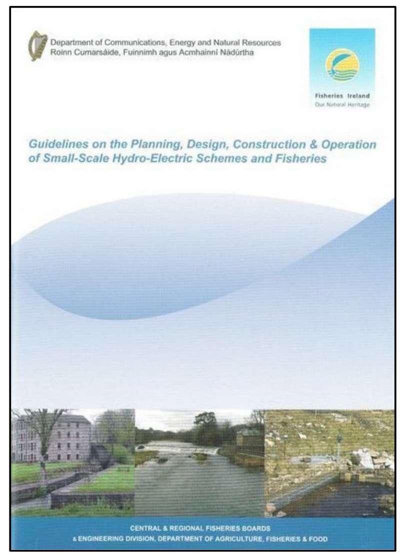
3.5.2.2 National Recommendation

Upstream passage of juvenile eel, migrating as elvers or juvenile “bootlace” brown eel, requires a fundamentally different approach to that for upstream migrating adult fish. Traditional upstream passes designed for salmon are largely ineffective for eel. Eels are incapable of jumping or swimming through strong laminar flows so vertical falls of more than 50% of their body length (approx 37 mm) represent a barrier to upstream migration (Knights & White 1998) However they are adept at exploiting boundary layers and rough substrates.

In response to these issues guidelines for the location, planning, design, construction, operation and impact evaluation of new small scale hydro-schemes have been prepared (Anon. 2007). These guidelines require a site specific approach to evaluating and minimising the impact of existing installations. The Environmental Impact assessment for any new barriers and/or turbines should include an evaluation of their potential impact on direct and indirect mortality of eels. Design criteria and best practice design for eel and elver passes have been published by the Environment Agency (UK) (Solomon & Beach 2004). Efficiency of screens should be monitored for at least the first three years after installation and where necessary modifications should be made.

3.5.3 Other obstructions to migration

Other obstructions to upstream eel passage include water level regulating weirs, road culverts, abstraction weirs for potable water supplies and weirs for supply of water to mills. A full inventory of these will be presented in the NDP Habitat database and a barriers evaluation tool will be inserted in the Eel GIS. The impact of such obstructions to upstream eel migration is currently unknown in Ireland. It is proposed to undertake an evaluation of Irish barriers and assess their passibility to eels (Briand – Indicang Project), including the barriers height, slope, roughness and bankside characteristics.



Information for French barriers indicated that the sum of barriers moving upstream had a significant impact on the eel density upstream with a 62% reduction in density since 1980, 30% of which could be attributed to obstacles to migration (Briand – Indicang Project).

A system of installing simple elver passes on significant obstacles is a relatively cost effective alternative to stocking and would lead to significant upstream migration of juvenile eel. Many opportunities exist for taking this approach. All new potential obstacles to migration should be assessed at the design stage and suitable mitigation or eel passes be incorporated into the structures at the construction stage.

3.6 Predation

Natural mortality of eels is a major, but relatively unknown, factor in the population dynamics of eels and mortality caused by predation is one of the factors contributing to natural mortality. The EU Regulation lists reducing predation as a possible management option that could be employed when attempting to reach escapement targets. As a result, predation on eel and potential mitigation measures to reduce it are considered here. No systematic review of eel predators is available and so, rather than merely list the predatory birds, mammals and fishes of eels, this section summarises information for some species likely to be ‘representative’ of the diversity of eel predators in non-marine habitats, covering both birds and mammals, and both common and less abundant species.

Predation on eel is not well represented in the published literature (see Tesch, 2003). In Ireland a number of piscivorous predators are known to consume eels, in particular birds such as the Great Cormorant (*Phalacrocorax carbo* hereafter ‘cormorant’) and the grey heron (*Ardea* *cinerea)* and mammals such as the Otter (*Lutra lutra*) and the mink (*Mustela* spp). This list is not exhaustive as many other possible predators occur such as eels and other fish, gulls, the dipper and kingfisher. There are relatively little data on the level of predation on eel in Ireland nor on the impact on the eel stock and what was available was limited to cormorants and otters.

3.6.1 Cormorants.

The endemic subspecies of the Great Cormorant breeding in Ireland is *Phalacrocorax carbo carbo* (Rogan, 2003). They breed primarily in coastal regions with some breeding also occurring inland. During the 1900s some fishery managers offered rewards for the killing of cormorants in their fisheries. This was later followed by a National bounty system introduced by the Department of Fisheries and between 1973 and 1976, 3,527 cormorants were reported killed under the scheme. With the implementation of the Wildlife Act (1976), Cormorants were given full protection and can now only be disturbed or shot by license in exceptional circumstances under Section 42 of the Act. The National Parks and Wildlife Division of the Department of Environment, Heritage and Local Government is responsible for the issuing of culling licences.

During the mid-1980s the Forest and Wildlife Service carried out a cormorant breeding census to monitor changes in population size since the previous census in 1969/70. The results of this census showed the population had increased from 1865 pairs in 1969-70 (Operation Seafarer) to 4455 pairs in 1986-87. The reasons given for the increase in population size were: (1) reduction in human persecution; (2) The increased availability of winter food in inland waters as a result of pike predation control; (3) a stocking programme run by the Central Fisheries Board.

The most recent census of cormorants in Ireland was carried during the Seabird 2000 breeding survey. It reports that the Irish coastal population has remained stable since the SCR census (1985-88). However, regional changes were reported (Fig. 3.9). On the east coast the colony on Lambay Island, which had been the largest colony in Britain and Ireland, has decreased as a result of birds forming new colonies on nearby islands. Elsewhere declines in breeding numbers were reported for both the west and south of the country.

Figure 3.9 Location of main Irish cormorant breeding sites (Rogan, 2003)

Studies of Cormorant diet reviewed by Rogan (2003) have been carried out both in the breeding and non-breeding season. Examination of cormorant diet during the non-breeding season showed a high incidence of coarse fish, particularly roach and perch, with roach providing over 80% of the diet in late winter. Systems with high populations of roach coincided with the highest concentrations of wintering cormorants. Cormorants in the lower reaches of the Shannon fed predominantly on perch in winter and eels in summer and the 'greatest potential for impact on economically important fish stocks seems to involve eels'.

A study carried out at two breeding colonies on the west coast identified wrasse and eel as the dominant prey species and cormorants exploited locally available fish species within the local range of their breeding colony. In 1959 in Burrishoole/Clew Bay a study of 22 stomachs collected between May and October found the main freshwater prey was brown trout and eel.

3.6.2 Predator Management

Studies suggest that a number of birds, mammals and fishes prey on eels, although this has seldom been quantified and potential impacts on stocks are unknown (review by ICES, 2007). All bird and many mammalian predators of eels are the subject of national and international protective legislation across Europe. In the case of the cormorant, perhaps the commonest eel predator at the time of writing, attempts to mitigate against the species would involve formal requests to the relevant authorities (DoEHLG – National Parks & Wildlife) and require compliance with the Birds Directive. Other predators, such as the otter, have very high conservation status and it is likely to be extremely difficult to obtain permission for controlling these.

4 The Eel Fishery

This chapter describes the commercial and recreational fisheries for eels in Ireland. Recreational eel fishing is only carried out by a minority of rod anglers and there is no legal, or voluntary, declaration of catch which is probably small. Some "recreational" fishing using fyke and baited pots takes place and this is authorized under the commercial legislation.

4.1 The Irish Commercial Eel Fishery

Glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Sec. 173) and it is current government policy that this may only be carried out under Section 18 authorisation from the Regional Fisheries Boards for the purposes of developing the fishery. Capture of juvenile eel for supply to eel farms or export requires a Section 14 Authorisation from the Dept. of Communications, Marine and Natural Resources. Capture of glass eel did not take place in Ireland until the 1990s. This is a tidal activity using a variety of techniques such as anchored nets (tela), fyke net, trawl and dip-net. Elvers, migrating upstream, have been captured since 1959 under statute, for transfer upstream around barriers; first on the Shannon and more latterly on other rivers under the control of the Electricity Supply Board (ESB). This is usually carried out using fixed elver traps incorporating elevated ladders and collecting boxes. All juvenile eel captured are released upstream for enhancement. There is no national sampling programme for glass eel/elver.

The commercial eel fishery involves harvesting both brown and silver eel in freshwater and in estuarine or tidal waters. Brown eel are fished using a variety of techniques, the most common of which are baited long-line, fyke nets and baited pots. When silver eel are migrating downstream in the autumn they are caught in fyke nets and stocking-shaped nets called "coghill nets" which are attached to fixed structures in the river flow, often at "eel weirs".

The declared commercial eel catch (not including mortalities) in the Irish Republic, 2001-2007, ranged from 86t to 120t involving about 150-200 part-time fishermen, but inadequate reporting and illegal fishing makes this difficult to quantify accurately and maybe a substantial under estimate. The value of the reported catch was therefore in the order of €0.5 million to 0.75 million. A total maximum of 278 licences were issued in 2006 and a maximum of 182 of these were actively fished in 2005 (see Sections 4.1.3 & 4.1.4).

Currently, there are no statutory instruments for the co-ordinated management of the European eel stock, its exploitation or other impacts. Management of the Irish eel fishery is currently hampered by a number of factors, such as no national closed season, size limit, policy on estuarine and coastal fishing and a lack of sound scientific information on stock, catch returns or sales. There is no register of fishing effort, landings or sales and illegal fishing and unreported catches are believed to be considerable. The level of undeclared catch has not been recently quantified, but in some Regions this may have been as much as three to four times the declared catch (McCarthy, O'Farrell, McGovern & Duke 1994). A modelling study of the Shannon suggested that, annually, 20 tonnes were taken illegally pre-1992 (Bevacqua & de Leo in Dekker *et al*. 2006). More recent emphasis on catch reporting and conservation may have influenced the level of reporting and its accuracy.

4.1.1 Gear Types

4.1.1.1 Fyke Nets

Fyke nets come in many shapes, sizes and configurations, but all operate on the principle of a leader net which guides fish into a hoop net trap with a tapering cod end. Many fyke nets have double leaders which funnel the catch towards the trap and are staked out. The fyke net type authorised for use in Ireland is known as a small Dutch fyke, or summer fyke net (Moriarty, 1975; Poole, 1990). These consist of two funnel shaped traps facing each other, joined by a leader net, which usually has a mesh size of 16mm. Each trap consists of two chambers and a cod-end with knot to knot mesh sizes of 16, 12 and 10mm and the entrance is usually 50-60cm in diameter. The standard fyke has a leader length of about 8.2m and each trap end is 3.4m long, giving an overall length of about 15m when set. There may be variations in mesh size and length dimensions and these are not stipulated in the legislation. These fyke nets are usually joined end to end and fished in trains of multiple nets, often 5 or 10 in a train. Other fyke net designs with one metre diameter hoops and leader net height require special authorisation.

4.1.1.2 Coghill Nets

Coghill nets are used to capture downstream migrating silver eels in rivers and at the outlets from lakes. They come in a variety of shapes and sizes, but essentially all operate on the same principle, similar to a stationary trawl net either stakes instream or mounted on a frame, often at a bridge, which can be lifted by a winch to allow for passage of boats, migration of other fish species and servicing of the nets. The cod ends are either lifted and emptied into a shute or are emptied by boat. Major coghill fisheries occur at Killaloe (Shannon) and Corrib (Galway). The Galway Fishery coghill nets have dimensions overall Length 11.8 m. Mouth – 4.5m Length with 5cm knotted mesh. Middle Section- 6m length with 3cm Knotless Mesh. Codend – 1.3m length from Ring with 1cm fine mesh.

Silver eel are fished in the upper and middle Shannon catchment using instream coghill nets, similar to single chamber fyke nets with "v" configuration wing leader nets. These vary in shape and size depending on local conditions, ranging from 20m wings (3m high) and 15m chamber to 5-10m wings (1-2m high) and 5m chamber.

4.1.1.3 Longlines

Baited (earthworm, mealworm, fish, shrimp) longlines are used to catch brown eel in lakes. In most Regions the maximum licenced number of hooks is 1000. Longline fishing is highly skilled and labour intensive. Matthews *et al*. (2001) describe the preparation of a typical long line of 300 hooks which includes arranging of hooks and droppers in sequence on trays, replacing droppers which have been cut off following capture of an eel, can take 1 to 1.5 hours depending on the amount of eel (and therefore removed droppers) caught on that line the previous day). Lifting of a longline of 360 hooks takes between 1 hour and 1 hour and 15 minutes depending on catches. Baiting and setting of one longline of 360 hooks takes on average 1 hour to 1 hour and 15 minutes. Fishing of a series of longlines requires 3-5 hours for lifting, removal and storage of eel. Lines are normally set again that afternoon or evening. The later that longlines are set the smaller the bycatch of coarse fish will be as they are mostly visual predators, whilst eel are most active just after dusk and before dawn. Daily lifting of longlines is essential to minimise mortalities of captured eel.

4.1.1.4 Baited Pots

Until the 1960s the pot used in Waterford was a wicker basket about 1 m long and 50 cm in diameter. These were made in Carrick on Suir. In the late 1960s a visiting Dutch fisherman introduced gear known locally as the ‘beck’, a trap made from nylon mesh supported on plastic hoops. These must be baited with freshly-caught small estuarine fish such as herring.

4.1.1.5 Fixed Traps

Fixed traps are rigid structures in rivers for capture of downstream migrating silver eel. There are a variety of structures fished including modified smolt wolf type traps. Smolt traps are also used for sampling silver eels and in the case of the Burrishoole the entire run is trapped and monitored (see Section 5.2.1.1).

4.1.1.6 Glass Eel Gear

Commercial glass eel fishing is not allowed in Ireland and any glass eel capture has been used for stocking for fishery enhancement. Upstream migrating elvers are captured at a number of barriers for transport into the catchment and this is done using fixed elver ramps and box traps.

Some glass eel have been captured in the Shannon and Erne estuaries using a variety of techniques including active trawling, push and drag nets, maine fyke net, tela net and stationary nets suspended from the arches of bridges on rising tides.

Trawl Active trawling was chosen as the initial method of exploratory glass eel fishing on the Erne in March 1998 and has also been used with some success on the Shannon. Paired trawl nets (1 m high x 1.5 m wide x 7.2 m long), comprising of 2.5 mm mesh at the front end, and 0.5m mesh at the cod-end were mounted either side of a 4 m rigid inflatable boat and trawled at 1-2 knots into the incoming tide during nocturnal spring tides. Nets were fished in the top 1m of the water and lifted every hour.

Hand net The hand nets had a diameter of 0.5 m and mesh size of 1.0 mm. Fishing was confined to sites immediately around the mouth of the tailrace where the highest concentrations of glass eel were observed. Preliminary trials during 1998 indicated the majority of glass eel to accumulate along the Mall Quay shore outside the main flow of the R. Erne. Consequently, hand netting was based around this area in subsequent seasons (1999 and 2000).

Drag net Conical 'drag' nets were employed along steep banks or vertical walls where access or water depth prohibited fishing with hand nets. Each net, of 0.5 mm cotton mesh, was approximately 1m in diameter at the mouth and 1.5 m in length tapering back to a cod-end closed by tying. The mouth of the net was mounted on a circular frame constructed of Hydradare™ PVC piping and pulled by rope against the incoming tidal flow by a single fisherman walking along the shore.

Tela net *The dimensions of the nets used were:*
Float line (each wing) 9.8 m; net height 5.3 m; width of net end 0.8 m; lead line 11 m; mesh size 2mm. 12x10 l floats per wing. Plough anchors (15kg) were used to anchor each end of the net.

Fyke net Each net comprises a pair of floated wings, opening to a cod-end at the centre where the catch is collected. The wings are 8 m long by 2 m or 3 m high and made of 1 mm knitted polyester mesh. The entrance to the cod end is covered by 5 mm mesh to exclude debris and minimise by-catch.

4.1.2 Seasons

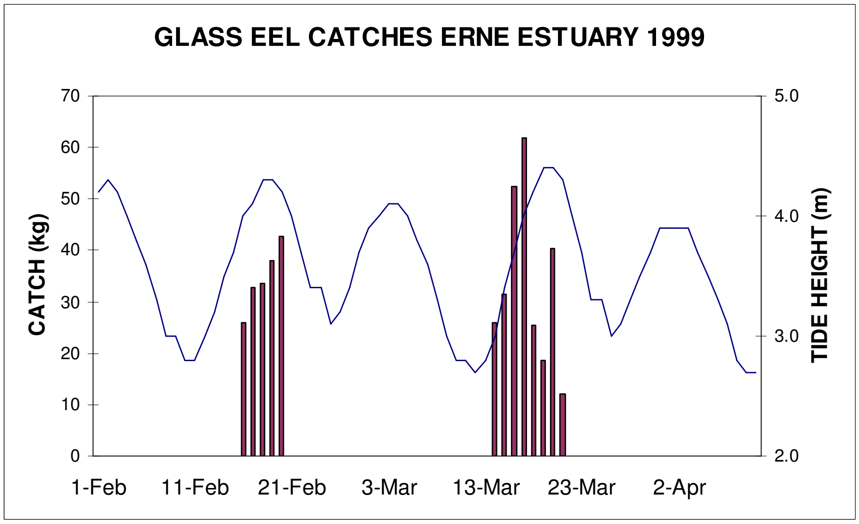
4.1.2.1 Glass Eel / Elver

Glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Sec. 173). It is current government policy that fishing for the purposes of developing the fishery may only be carried out under Section 18 authorisation from the Regional Fisheries Boards. Capture of juvenile eel for supply to eel farms or export requires a Section 14 Authorisation from the Dept. of Communications, Marine and Natural Resources. Capture of glass eel did not take place in Ireland until the 1990s. This is a tidal activity using a variety of techniques such as anchored nets (tela), fyke net, trawl and dip-net. Elvers, migrating upstream, have been captured since 1959, under statute, for transfer upstream around barriers; first on the Shannon and more latterly on other rivers under the control of the ESB and in the Corrib catchment. This is usually carried out using fixed elver traps incorporating elevated ladders and collecting boxes and the elvers are used for stock enhancement.

Season

Glass arrive of west coast	60km offshore	from early October
Estuarine tidal waters	west coast	late November to February/April
Move into freshwater	as elvers	late April to August
Peak Fishing Periods	Estuaries	February to April
	Fixed traps	May to July

Glass eel fishing carried out on the Erne and Shannon estuaries indicate the peak movements of glass eel were between February and April (Fig. 4.1). The shape and length of the estuary may determine the time period over which glass eel are available to the fishery, with larger estuaries yielding glass eel over a longer time period.



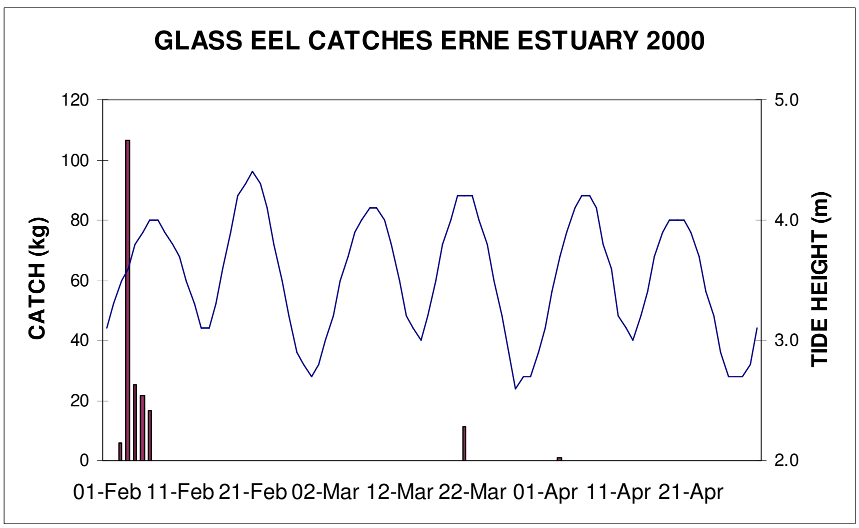


Fig. 4.1. Total glass eel catches (kg) (bars) from the Erne estuary in 1999 and 2000 in relation to tidal height (m) (line).

4.1.2.2 Brown Eel

Up to 2007, there was no national close season for brown eel although close seasons were already in place for a number of individual catchments. See below:

District	River System	Closed Season
Limerick	River Shannon (except with lines and hooks)	1 February to 30 June
	River Shannon, lakes and tributaries, with lines and hooks (other than single rod and line)	1 February to 30 April
	Rest of District	1 January to 30 June
Kerry	Between Dunmore Head and Kerry Head	1 January to 30 June
Galway	Corrib or Galway River	11 February to 30 June
Connemara	Whole District, with lines and hooks (other than single rod and line)	11 January to 9 April
Drogheda	Any river in the District	1 December to 30 June

Season

Peak brown eel fishing takes place between early May and the end September although recent mild winters extended the effective length of the brown eel season. Additional fishing may also take place later in the year in tidal waters.

4.1.2.3 Silver Eel

Silver eel capture takes place during the downstream migration in autumn and winter, mostly at fixed stations or 'weirs' using coghill nets. Fyke netting also takes place near lake outflows and in the larger rivers.

Season

The "normal" season for silver eel migration in Ireland is between August and January, with the main run in September to early November, depending on lunar phase, water temperature and water level.

4.1.2.4 Burrishoole Silver Eel

The Burrishoole catchment, on the west coast, an unexploited and hydrologically unregulated system, would reflect usual patterns of silver eel migration in Ireland. In this system, which is trapped at a research station, half the migration typically takes place in October (Table 4.1). Periods of low water, particularly in September (i.e. 1986) can delay the run leading to a larger proportion in latter months.

Table 4.1. Monthly catches (counts of individuals) of silver eels for 1985 – 1992 in the total traps in Burrishoole.

	1985	1986	1987	1988	1990	1991	1992	Total	%
August	259	135	138	201	77	44	521	1375	**7.1**
September	889	32	617	811	943	210	720	4222	**21.7**
October	212	1574	1596	1651	1148	1839	2168	10421	**53.4**
November	518	100	315	430	689	761	253	3066	**15.7**
December	80	15	47	190	31	48	8	419	**2.2**
Total	1958	1856	2713	3283	3121	2902	3670	19503	

4.1.2.5 Shannon Silver Eel

The Shannon is a regulated river to allow for the generation of hydro-electric power. Water level can have a major influence over the timing of the silver eel migrations.

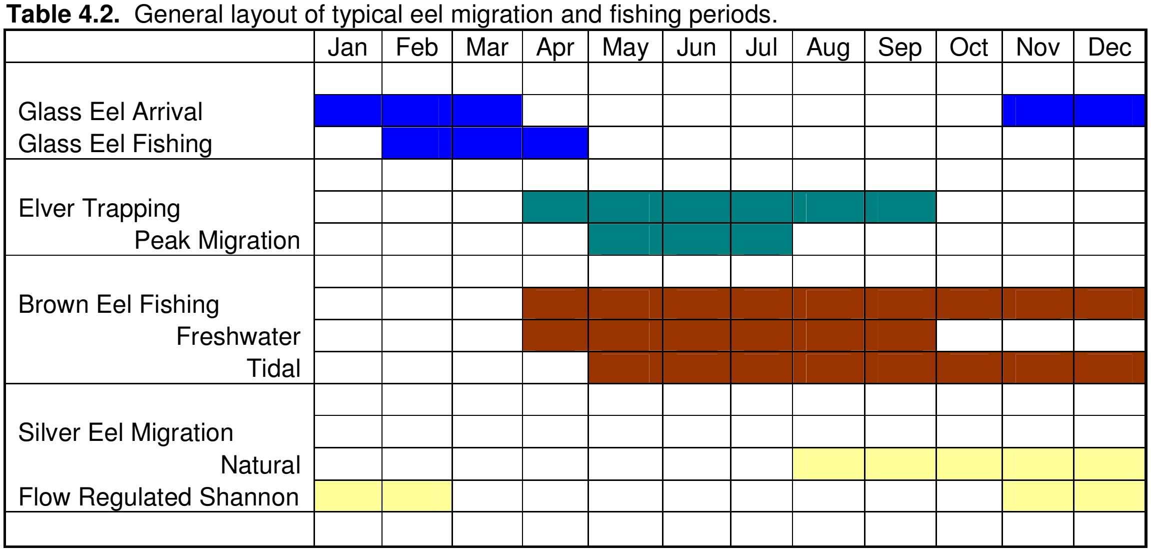
Silver eel fishing in the upper Shannon commences in August/September and catch is strongly regulated by water level and lunar phase. The main run would extend from August to December with peaks in September and October.

Fishing at Killaloe, the most downstream location below L. Derg on the Shannon, normally commences in early September with the main run of eels commencing in late October or November. Approximately 85% of the eel catch is taken in the first month of the run. Regulation of river flow often means the bulk of the Killaloe catch is delayed to a single peak in November or December. In extreme cases the delay may extend in January or even later.

4.1.2.6 Overall Summary

The following table 4.2 summarises the generalities of eel migration and fishing periods in the Republic of Ireland. Local factors may introduce variations to these periods but these would be unusual.

Table 4.2. General layout of typical eel migration and fishing periods.



4.1.3 National Commercial Capacity & Effort

Little data is available as reporting of effort is not a national requirement.

Fishing effort was not monitored in the Irish eel fishery. There was no log-book or compulsory recording system for fishermen and there is no eel dealer register or regular monitoring of eel dealers. There is also no registration of fishing boats in the eel fishery. Efforts have been made to improve on the data collection by circulating an agreed catch reporting form (Fig. 4.2) which may lead to data discontinuity.

The Management of Eel Fishing Bye-Law No.752, 1998 capped the number of long-line licenses that a Regional Fisheries Board may issue for long-line fishing for eels in any district. In addition, the Fisheries (Amendment) Act 1999 delegated authority to the Regional Fisheries Boards to issue authorisations for the use any fishing engine for the capture of eels including any long-line, as it sees fit.

Each Regional Fisheries Board has a policy on the number of fyke nets permitted for each licence and in some cases the locations where they are permitted to fish. It is difficult to convert the number of licensed nets in Tables 4.3-4.4 into an actual fishing effort, as many licensed fisherman either don't fish at all or only fish for a limited period of the year. In some areas for example, such as in the south east, fyke nets are used during the weaker tides and baited pots are used when the tides are too strong for fyke nets.

A preliminary analysis of the number of licences issued the number of end of year catch reports submitted and from that, the number of licences that fished and submitted a catch record was undertaken. The number of “actively fished” licences, grouped by gear type and by RBD, was examined as a proxy for “effort”. This has been presented for the national catch in Section 4.1.5 but the data was not suitable for analysis at a smaller scale.

Figure 4.2. Catch declaration form issued with each licence from 2005 onwards.

Eel Catch Return Year: 2006

Fishery Region: ____________ Licence Number: ____________

Name of Fisherman ____________ Signature ____________ Date ____________

Month Fished	River/Lake Fished	Indicate Method Longline, Fyke Net Pot, Coghill Net	No. Days Fished	Indicate Brown or Silver eel	Catch Sold kg / lbs or St*	Undersize Catch Mortalities kg / lbs or St*	Undersize Catch Released kg / lbs or St*	Dealer

Optional: Please provide an indication of price euro/kg or euro/lb offered throughout the season: ____________

* Please delete as appropriate: give weights in kg, lbs or stone and indicate on the form which.

4.1.3.1 Brown Eel Effort

Brown eels are fished for using either standard or deeper ("other") fyke nets, usually 20 per licence, longlines, usually limited to 1000 hooks per licence or baited pots (17 per licence?) (Table 4.3). The total numbers of licences, for Ireland, issued and fished are shown in Figure 4.3. No data is available for the effort of each licence in terms of nights fished or comparisons between gear types or amounts.

Since 2001 there has been an increase in the number of licences issued and in the number being actively fished for brown eel (Fig. 4.3).

4.1.3.2 Silver Eel Effort

Silver eels are fished using fyke nets, fixed v-wing nets and coghill nets (Table 4.4), although standard fyke licences are only listed in the table for brown eel (Table 4.3). Effort is often targeted at short time windows in the autumn and winter during optimum conditions, such as dark moon and high water. The total numbers of licences (not including fyke nets), for Ireland, issued and fished are shown in Figure 4.4. No data is available for the effort of each licence in terms of nights fished or comparisons between gear types or amounts. (Note: coghill nets above Killaloe in the Shannon have been grouped under "v-wing fykes").

Since 2001 there has been an increase there has been an increase in the number of licences issued and in the number being actively fished for silver eel (Fig. 4.4) with a steadying in 2007.

Table 4.3. Details of brown eel licences for each Eel Management Unit, 2001 to 2007.
I = number issued, R = number reporting catch & A = the number that actively fished.

Management Unit	Year	Longline			Standard Fyke			Baited pot			Total		
		I	R	A	I	R	A	I	R	A	I	R	A
NWIRBD	2001	32	10	10	15	4	4				47	14	14
(ROI)	2002	30	11	11	18	8	8				48	19	19
	2003	30	0		16	0					46	0	0
	2004	24	8	8	13	2	2				37	10	10
	2005	25	14	14	18	18	8				43	32	22
	2006	24	20	19	21	15	13				45	35	32
	2007	27	25	16	19	17	11				46	42	27
SERBD	2001				8	0		27	0		35	0	0
	2002				32	13	13	27	0		59	13	13
	2003				16	14	14	20	19	14	36	33	28
	2004				16	16	16	20	10	9	36	26	25
	2005				15	7	5	20	13	10	35	20	15
	2006				13	9	7	20	10	9	33	19	16
	2007				16	12	10	20	13	6	36	25	16
EEMU	2002		7	7		4	4				0	11	11
	2003	4	4	4	3	3	3				7	7	7
	2004	5	5	5	5	5	5				10	10	10
	2005	3	2	2	3	2	1				6	4	3
	2006	4	2	2	3	2	1				7	4	3
	2007	3	3	2	3	2	2				6	5	4
SHIRBD	2001		14	11		13	13				0	27	24
	2002		19	16		18	15				0	37	31
	2003		13	12		15	13				0	28	25
	2004	24	16	16	23	15	15				47	31	31
	2005	22	18	16	21	19	19				43	37	35
	2006	22	17	2	21	10	1				43	27	3
	2007	22	21	17	21	13	10				43	34	27
SWRBD	2001	4	4	0	5	3	3	1	1	1	10	8	4
	2002	4	4	0	7	3	3	1	1	1	12	8	4
	2003	5	0		7	1	1	2	0		14	1	1
	2004				4	1	1	1	0		5	0	0
	2005				10	3	1	1	1	1	11	4	2
	2006				5	2	2	1	0		6	2	2
	2007				4	0		1	0		5	0	0
WRBD*	2001	15	0		24	19	14				39	19	14
	2002	8	5	5	25	23	20				33	28	25
	2003	16	15	15	25	20	13				41	35	28
	2004	14	15	11	28	24	20				42	39	31
	2005	15	13	13	28	28	25				43	41	38
	2006	32	13	12	29	22	21				61	35	33
	2007	32	26	19	28	21	18				60	49	39

* WRFB Standard Fykes includes 3 “other fykes” issued, reported and fished in each year.

Table 4.4. Details of gear, not including fyke nets, licensed for silver eel fishing in each Management Unit, 2001-2007.

Management Unit	Year	Coghill			Fixed trap			V-wing fyke*			Total		
		I	R	A	I	R	A	I	R	A	I	R	A
NWIRBD	2001	0									0	0	0
(ROI)	2002	0									0	0	0
	2003	0									0	0	0
	2004	4	0		1						5	0	0
	2005	1	0		1	0					2	0	0
	2006	3	1	0	1	0					4	1	0
	2007	1	1	0							1	1	0
SERBD	2001										0	0	0
	2002	2	0								2	0	0
	2003	2	2	2							2	2	2
	2004	2	2	2							2	2	2
	2005	2	2	0							2	2	0
	2006	2	2	2							2	2	2
	2007	2	2	0							2	2	0
EEMU	2002		7	7		2	2				0	9	9
	2003	8	6	6	2	2	2				10	8	8
	2004	7	8	7	3	2	2				10	10	9
	2005	7	5	5	0	0	0				7	5	5
	2006	7	7	7	2	2	2				9	9	9
	2007	6	2	2	0						6	2	2
SHIRBD	2001		0						19	13	0	19	13
	2002		20	20					19	17	0	39	37
	2003		0						19	16	0	19	16
	2004	26	20	20				21	21	20	47	41	40
	2005	22	21	21				23	23	19	45	44	40
	2006	22	20	20				23	21	19	45	41	39
	2007	2	0					23	21	19	25	21	19
SWRBD	2001										0	0	0
	2002										0	0	0
	2003										0	0	0
	2004										0	0	0
	2005										0	0	0
	2006										0	0	0
	2007										0	0	0
WRBD	2001	28	19	18	1	0					29	19	18
	2002	27	21	21	1	0					28	21	21
	2003	27	23	19	1	0					28	23	19
	2004	27	27	24							27	27	24
	2005	24	24	17	1	1	1				25	25	18
	2006	26	22	22	1	0					27	22	22
	2007	26	18	18	1	0					27	18	18

* V-wing fykes includes instream coghill nets

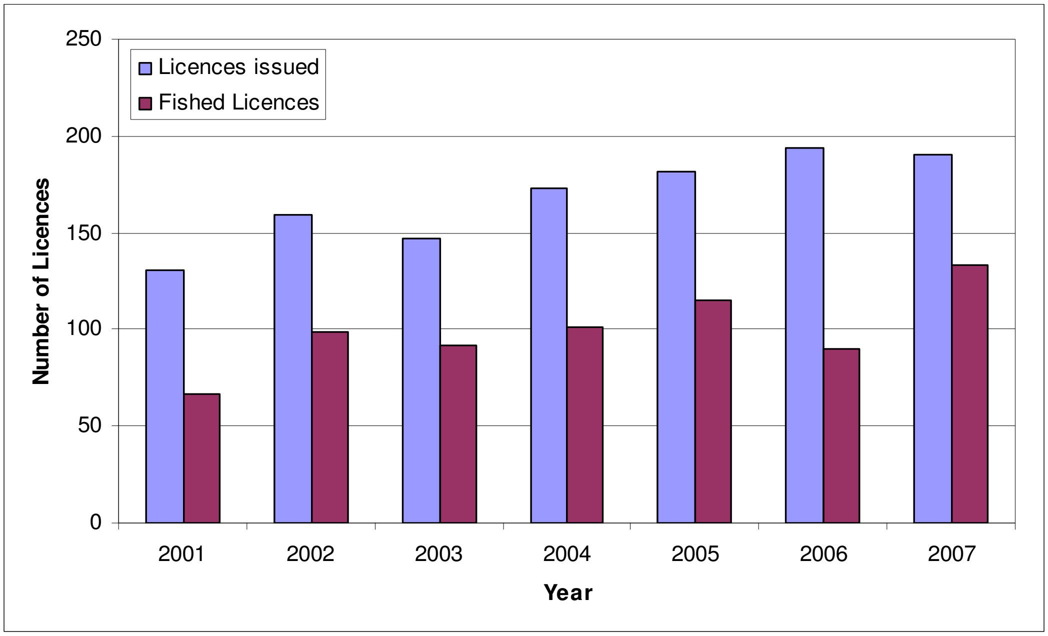


Figure 4.3. The total number of brown eel licences issued in Ireland and the number actively fished, 2001 to 2007.

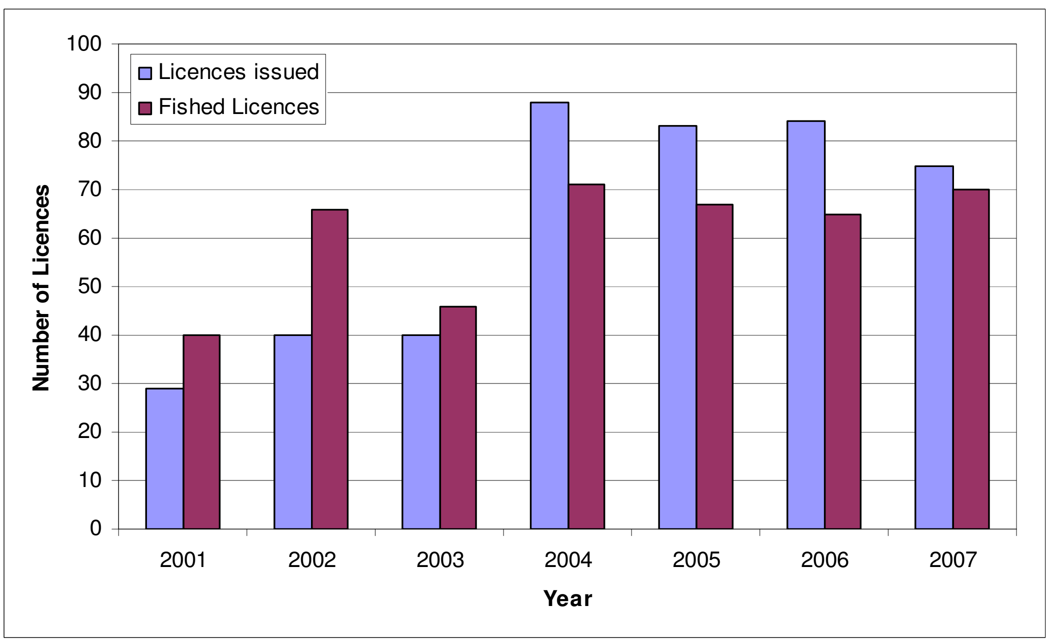


Figure 4.4. The total number of silver eel licences (coghill, v-wing fyke & fixed trap) issued in Ireland and the number actively fished, 2001 to 2007.

4.1.4 National Commercial Catch

4.1.4.1 Catch of Glass Eel/Elver

There is no authorised commercial catch of juvenile eel in Ireland and some fishing has been authorised in the past under Sec. 18 of the Fisheries Act for enhancement of the fisheries. Catches are made at impassable barriers and this is reported in the relevant Regional Management Plans (Fig. 4.5). Monitoring of elver migrating at Ardnacrusha (Shannon) and Cathleens Falls (Erne) is undertaken by the ESB (Fig 4.5). Indications are that recruitment remains low. Catches in 2004 for both Erne and Shannon were the second lowest recorded. Numbers in 2005 were more unpredictable, with good catches of elvers recorded in the Erne (45% of the 1979-84 mean) and a poor catch in Ardnacrusha (1.4% of the 1979-'84 mean). Recruitment remained low up to 2008.

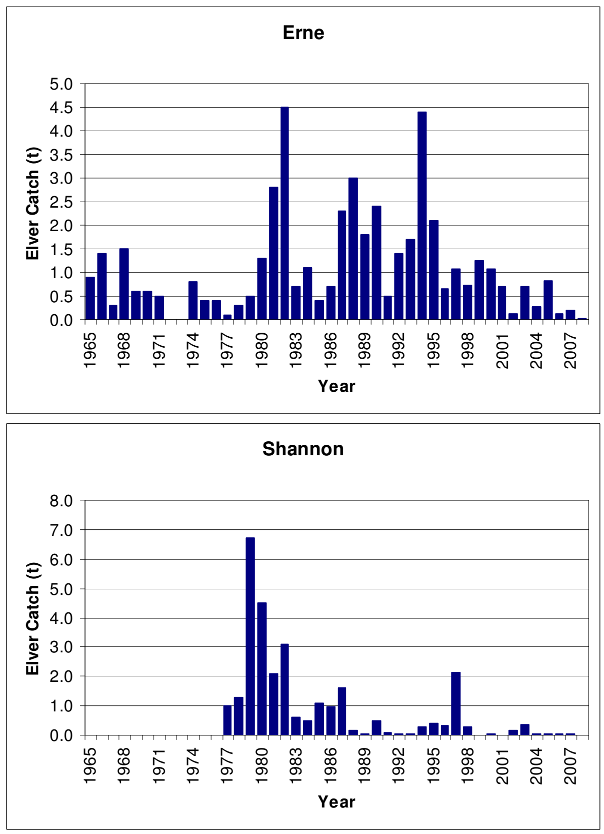


Figure 4.5. Annual elver catches (kg) in the traps at Ardnacrusha (Shannon) and Cathleens Falls (Erne) – data from ESB.

4.1.4.2 Catch of brown and silver eel

There is no compulsory declaration of eel catch in Ireland and in many Regions, declarations of catches are not complete and under-reporting is probably widespread. Currently, reported catches are available on an annual basis at the Fisheries Regional Level, with most RFBs reporting on a District basis. The introduction of the new catch reporting form has led to considerable improvement in the system since 2005.

For the Eel Management Plans, catches (RoI) of brown and silver eel have been collated from the District returns and are presented in Table 4.5 for 2001 to 2007 for each Eel Management

Unit (RBD). Also included in Table 4.5 are the catches for N. Ireland on the Erne supplied by DCAL and AFBINI.

Mortalities in the catch have not been consistently reported and the data have only been requested since 2005. Therefore, the landings reported here are for the declared up to 2005 and for the catch, not including mortalities, after 2005. Mortalities in 2006 and 2007 were 0.3% and 1.3% respectively.

Since 2001 the ESB has embarked on a programme of transporting a proportion of the silver eels captured in the Shannon silver eel fishery around the dams and releasing them for onward migration to the sea. These released eels are included in the data presented in Table 4.5 and this has ranged from 5% to 22% of the total silver eel catch on the Shannon.

There has been no discernable trend in the reported catch of either brown or silver eel (Figs. 4.6 & 4.7)

Reporting of silver eel in the NWIRBD ceased after 1997 although it is understood that fishing has continued though the following years.

Table 4.5. Declared catches of brown, silver and total catch for each management unit, 2001-2007. [1]The catch released below the dam on the Shannon is also listed separately with the (%). *RoI part of RBD only, **N. Ireland part of RBD only, *** total RBD. NR = no report.

Brown Eel

	2001	2002	2003	2004	2005	2006	2007
EEMU	305	7,806	6,060	5,420	841	703	1,487
SERBD	8,555	13,027	9,786	7,753	5,569	3,327	4,413
SWRBD	552	960	70	35	22	250	NR
SHIRBD	15,983	18,116	22,196	21,535	18,736	17,591	24,635
WRBD	22,126	15,043	23,415	21,142	17,851	18,276	17,922
NWIRBD*	4,743	8,911	NR	6,793	7,311	16,865	9,929
NWIRBD**	12,300	15,300	16,160	15,700	13,600	15,700	19,600
NWIRBD***	17,043	24,211	16,160	22,493	20,911	32,564	29,529
Total RoI	52,264	63,863	61,527	62,678	50,330	57,012	58,503
Total	64,564	79,163	77,687	78,378	63,930	72,712	77,986

Silver Eel

	2001	2002	2003	2004	2005	2006	2007
EEMU	127	2,360	2,460	1,810	396	364	90
SERBD	0	2,004	1,218	800	260	840	0
SWRBD	0	0	0	35	22	250	0
SHIRBD	24,107	25,248	17,075	37,116	21,535	34,478	18,122
[1]Catch rel.	1,300 (5)	3,900 (15)	1,600 (9)	2,900 (8)	1,500 (7)	7,700 (22)	3,665 (20)
WRBD	9,581	14,386	12,596	17,849	14,624	23,971	16,541
NWIRBD*	28	31	NR	NR	NR	564	947
NWIRBD**	NR	NR	NR	NR	NR	NR	NR
NWIRBD***	28	31	NR	NR	NR	564	947
Total RoI	33,843	44,029	33,349	57,610	36,837	60,467	35,700
Total	33,843	44,029	33,349	57,610	36,837	60,467	35,700

Total Catch

Total RoI	86,107	107,893	94,876	120,288	87,167	117,479	94,203
Total	98,407	123,192	111,036	135,988	100,767	133,179	113,686

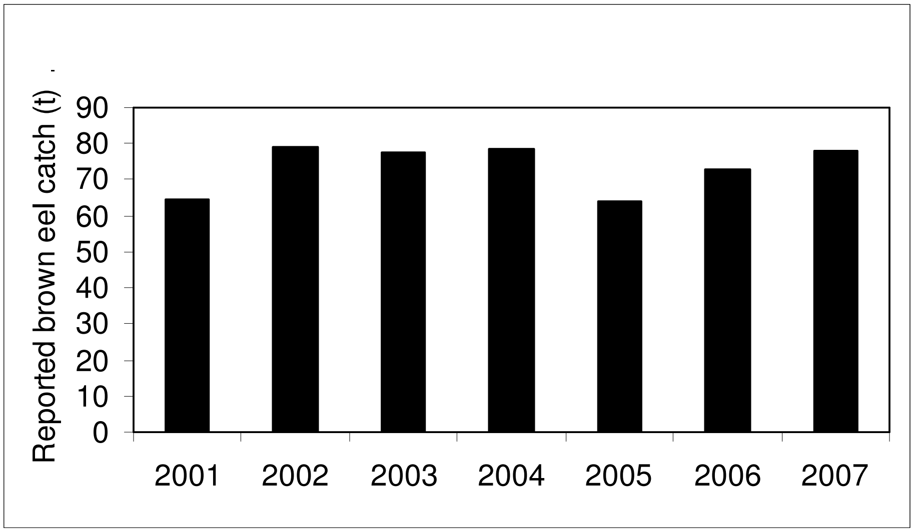


Figure 4.6. Total (RoI) brown eel declared catch for the period 2001 to 2007. Trend not significant.

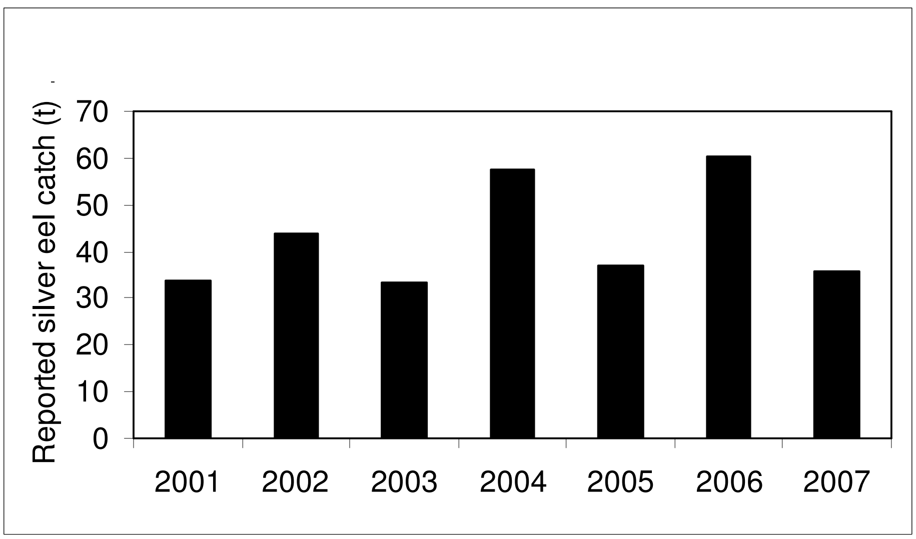


Figure 4.7. Total (RoI) silver eel declared catch for the period 2001 to 2007. Trend not significant.

4.1.5 Trends in Catch, Effort and CPUE

Trends in catch for a given fishing effort may be used to indicate changes to the stock. If fishing effort is precisely monitored, as in a scientific survey, the catch returns are a good proxy for stock. Such precise information is not available for the commercial eel fishery in Ireland. The best available information allows effort to be quantified as the number of licences actively fished and reported. This is a coarse proxy for effort, as catch returns for each licence ranged from a few kg to several tonnes (depending in large part on the number of nights and nets fished). This information is too coarse for examining trends in stock at the regional level. However, it is useful for examining national trends in stock because of the large number of licences involved. Catch per active licence is indicative of a declining stock of brown eels over the last 7 years at least (figure 4.8). Previous data was not available to allow this analysis prior to 2001 when CPUEs were likely to be higher.

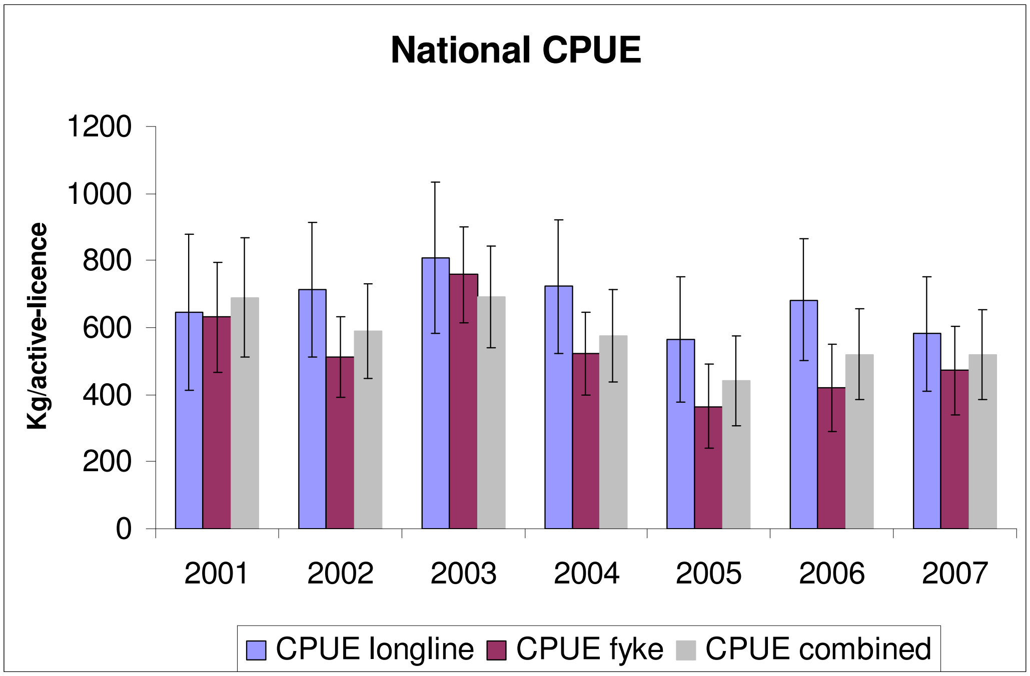


Figure 4.8. Brown eel catch per unit effort for longline, fyke net and combined gear types for the using the national reported catch based on reported actively fished licences.

4.2 National Legislations

The predominant fishing effort for eel in Ireland is commercial while angling for eel is less popular and is largely restricted to unintentional bycatch and a minority of rod anglers targeting specimen (>1.361 kg) sized eel. All commercial and non-angling recreational fishermen must be licensed.

4.2.1 Legislation up to 2008

The 1959 Consolidation Act

Section 14 in effect allows the Minister to issue an Authorisation to catch, attempt to catch and have in possession any specified fish, caught by any specified method. It has been used extensively not only for strictly scientific purposes but also to allow commercial fishermen to use methods which have not been covered by the existing legislation. It is also used to permit fishing in particular places, such as narrow estuaries, where fixed engines are normally prohibited. Ultimately, as happened with the fyke net, amending legislation may be been enacted to regularise the fishery.

Section 14 has been used since 1959 to permit the capture of glass eel or elver for overland transportation or for intensive culture. It is required in this case because Section 173 prohibits the capture or possession of the ‘fry’ of eel. A particular advantage of Authorisations under Section 14 is that strict conditions as to date, place and time of capture may be applied together with a requirement for reporting on the catch. This has been of great importance in providing scientific information.

Section 67 requires a Board to issue an 'ordinary fishing licence'. The majority of such licences are for salmon, but the long-line for eel is included. This gave the Boards no discretion in issuing licences. The 1994 Amendment sought to rectify this by deleting a part of Subsection 4 of Section 100 in accordance with the assumption that the long-line was a 'fixed engine'. This was successfully challenged in the Circuit Court in March 1997 by long-line fishermen, the court holding that the long-line was not a fixed engine. Further amending legislation will be required to put the long-line for eel on the same footing as fixed engines.

Section 68 provides the regulations for duties on ordinary licences.

Section 69 makes provision for fixing a duty for an unscheduled engine.

Sections 70 and 71 deal with the appointment of agents to issue licences. There is no record of their use in the case of eel.

Section 90 provides for the forfeiture of licences as an optional penalty for offences.

Section 95 generally forbids the use of nets in fresh water. Subsection 1(d), however, permits the use of a net 'constructed for the capture of eel'.

Section 99 prohibits the erection in fresh water of fixed engines. Subsection 4, however, excludes the long-line for eel from this prohibition. This is of historical interest in that it seems to infer that the long-line was considered to be a fixed engine. Subsection 5 allows the Minister 'by order' to authorise the erection of a fixed engine in accordance with plans approved by the Minister. Subsection 6 allows the ESB to erect fishing weirs in accordance with Section 101.

Section 100 permits the use of a fixed engine which was in operation in one or more of the years 1936, 1937 or 1938. These were the years immediately preceding the 1939 Act which prohibited the erection of fixed engines in fresh water. Subsection 4 excluded the long-line from this prohibition and was repealed in the 1994 Amendment – with the intention of equating the long-line with fixed engines and therefore requiring that long-lines be operated only when duly authorised.

Subsection 5 allows the Minister to authorise the use of a fixed engine for eel. An Authorisation under this Subsection is the usual instrument to allow fishing for silver eel.

Section 101 allows the ESB, with the consent of the Minister, to construct a fishing weir on their own property.

Section 102 forbids the erection of a fixed engine in an estuary where the breadth of the channel at low water of spring tide is less than three quarters of a mile. This provision was primarily part of salmon conservation legislation and Section 14 has been used frequently to allow the operation of small fyke nets in such estuaries.

Section 103 similarly forbids the erection of a fixed engine within one mile seaward or coastward of the mouth of a river where the breadth of the channel at low water of spring tide is less than half a mile.

Section 107 requires a free gap in the deepest part of any fishing weir. The gap must be one tenth of the width of the river and not less than 3 feet, but need not be more than 50 feet. The provision for 'deepest part' is to ensure that the gap is not made at a point, such as the margin of a river, where the water is usually much shallower and the effect of the gap would be less.

Section 109 permits the Minister by order to allow an eel weir to be used without a free gap. It had been considered, at the time of the legislation, that it would be sensible to close the free gap at the most downstream weir on any river to maximise the catch. This has never been invoked. Current thinking would generally be strongly opposed to closing off a free gap on the grounds that every fishery throughout Europe should make an effort to ensure some escapement of breeding stock.

Section 110 allows the Minister to require the construction of a free gap in a fishing weir.

Section 111 prohibits the alteration of the bed of a river in a way that would affect the flow through the free gap.

Section 112 prohibits the use of any sort of fishing gear within the free gap or within 50 yards upstream or downstream of it.

Section 114 limits to 20 feet the length of any guiding wall to a fishing weir and forbids the use of a guiding wall to alter the flow of water through the free gap.

Section 151 provides for close-season bye-laws and Subsection 1(b) imposed a general close season from 11 January to 30 June. This subsection was repealed in the 1962 Amendment.

Section 152 sets out the penalties for infringements of the close season, but excludes fishing by rod and line.

Section 153 requires the opening of the gaps of an eel weir in the day-time.

Section 173 prohibits capture, possession of or injury to the 'fry' of eel.

The 1962 Amendment
Section 11 allows the Minister to authorise by bye-law the erection and use of fixed engines.

Section 12 allows the Minister to grant exemption from the guiding wall restrictions of Section 114 of the 1959 Act.

The 1980 Amendment
Section 18 allows the Central Board or a regional board to 'take fish from a fishery by any means whatsoever'. This would allow a board's employees to capture glass eel or elver.

The 1994 Amendment
Section 18 amended Section 95(1) of the 1959 Act to bring eel nets under the authorisation regulations of its Section 100.

Section 19 increased penalties for existing offences and introduced penalties for failure to comply with the conditions of a Section 100 authorisation. By removing Subsection 1 of Section 100 it simplified the issuing of authorisations for new fixed engines. The Section was intended to bring the long-line under the same regulations as fyke nets and other gear but was found defective by a Circuit Court judgement in March 1997 which held that the long-line was not a 'fixed engine'.

This led to the re-instatement of the unsatisfactory situation whereby Regional Fisheries Boards were required to issue a long-line licence to any person applying. The intended effect of Section 19 of the Fisheries (Amendment) Act of 1994 was to allow Regional Fisheries Boards to control all forms of eel fishing, including the use of the long-line which was deemed to be a fixed engine. Until a further amendment is made, full control of eel fishing in the interests of stock conservation will not be possible. As a temporary measure a bye-law, capping the number of long-line licenses to equal the numbers issued in 1997, was introduced in 1998 and re-issued in 1999. The legality of the 1999 bye-law was challenged by a fisher, who claimed that it interfered with his livelihood.

Section 20 amended Part X of the 1959 Act by adding eel to the provisions for control of dealing in and possession of salmon. This greatly increases the powers of officers to inspect vehicles suspected of containing eel and places on a person in possession of eel the need to prove that they were lawfully captured. Previously, it was almost impossible to secure a conviction for an eel fishing offence unless the capture of the eel was actually witnessed.

Section 21 introduces penalties for unlawful sale or possession of eel.

Section 22 requires marking of packages containing eel.

Bye-laws

Close seasons existed pre-2008 under Bye-law in the following Districts:

Limerick	River Shannon (except with lines and hooks)	1 February to 30 June
	River Shannon, lakes and tributaries, with lines and hooks (other than single rod and line)	1 February to 30 April
	Rest of District	1 January to 30 June
Kerry	Between Dunmore Head and Kerry Head	1 January to 30 June
Galway	Corrib or Galway River	11 February to 30 June
Connemara	Whole District, with lines and hooks (other than single rod and line)	11 January to 9 April
Drogheda	Any river in the District	1 December to 30 June

The following Bye-laws deal with other aspects of the fishery. Enforcement of the half-pound (454 g) minimum size limit for the Limerick District and the Corrib system would cause considerable problems and there are no good scientific grounds for its application to the silver eel fishery.

Bye-law 253 Drogheda District, dated 23rd August 1906
Prohibits the use of any 'night line' except in Loughs Ramor and Mullagh.

Bye-law 368 Lamb's Head to Dunmore Head, dated 30th August 1919

Bye-law 399 River Corrib, its lakes and tributaries, dated 4th February 1930
Prohibits the use of a long line with more than 1,000 hooks and imposes a minimum size of half a pound (454 g). Prohibits also the use of a hook with gape less than three-eighths of an inch (9.5 mm)

Bye-law 220 Lough Derg, dated 9th January 1896
Prohibiting to use for the capture of fish of any kind, in the said Lough Derg, lines commonly called and known as "Tram Lines" or "Long Lines", baited with the fry or young of fish.

Bye-law 130 Westmeath and Cavan Lakes, dated 4th January 1890
Prohibiting to use for the capture of fish of any kind in any of the Lakes situated in the Counties of Westmeath and Cavan, lines commonly called and known as "Tram Lines" baited with fry or the young of fish.

Bye-law 386 Limerick Whole District, dated 14th January, 1929
Prohibiting to kill, take, or have in possession, in or near the banks of the rivers, lakes and tributaries in the Limerick District, any freshwater eel of less than one half of a pound weight.

Any such eel, if taken, must be forthwith returned to the water.

Prohibiting to use for the capture of eel, or for any method of fishing by which eel are commonly captured in the Limerick District, any hook of less than three-eighths of an inch (9.5 mm) gape, measured from the point to the shank thereof.

Bye-laws 745 and 752 Management of eel fishing, dated 26th March and 15th December 1998.
Cap the number of long-line licenses that may be issued in any Fishery District, on the basis of the numbers issued in 1997.

4.2.2 Byelaws 2008

Bye-law No. C.S. 297

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a byelaw (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008). This Bye-law prohibits the taking or fishing for brown eel under 30cm in length. The Bye-law also provides for a close season for brown eel, from 1 September to 31 May of the following year. The Bye-law also provides for a close season for silver eel from 1 January to 30 September in any year.

Bye-Law No. 838, 2008

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a byelaw (Conservation of Eel Fishing (Restriction on Issue of Licences) Bye-Law No. 838, 2008). This Bye-law caps the number of eel fishing licences which may be issued in each Fishery District in 2008 or any year thereafter.

4.2.3 Reporting 2008

In the past, there has been no legal requirement for reporting catch and effort.

The Conservation of Eel Fishing (Restriction on Issue of Licences) Bye-Law No. 838, 2008, now makes this a compulsory requirement before a new licence will be issued. "Where an application is made by a person for a fishing licence referred to in Article 3, the licence shall not be issued to the person unless the person submits information to the regional board concerned in respect of fishing effort and catch for eels taken by the person under a fishing licence in the preceding year to which the application relates."

4.2.4 Closed Season 2008

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a byelaw (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008) restricting the fishing season for both brown and silver eel as follows:

(a) to take or to attempt to take, or to fish for or to attempt to fish for, or to aid or assist in the taking or fishing for or the attempting to take or fish for, or to be in possession of brown eel during the period-

- (i) from 16 May 2008 to 31 May 2008, and
- (ii) in any year from 1 September to 31 May in the next following year.

(b) to take or to attempt to take, or to fish for or to attempt to fish for, or to aid or assist in the taking or fishing for or the attempting to take or fish for, or to be in possession of silver eel during the period

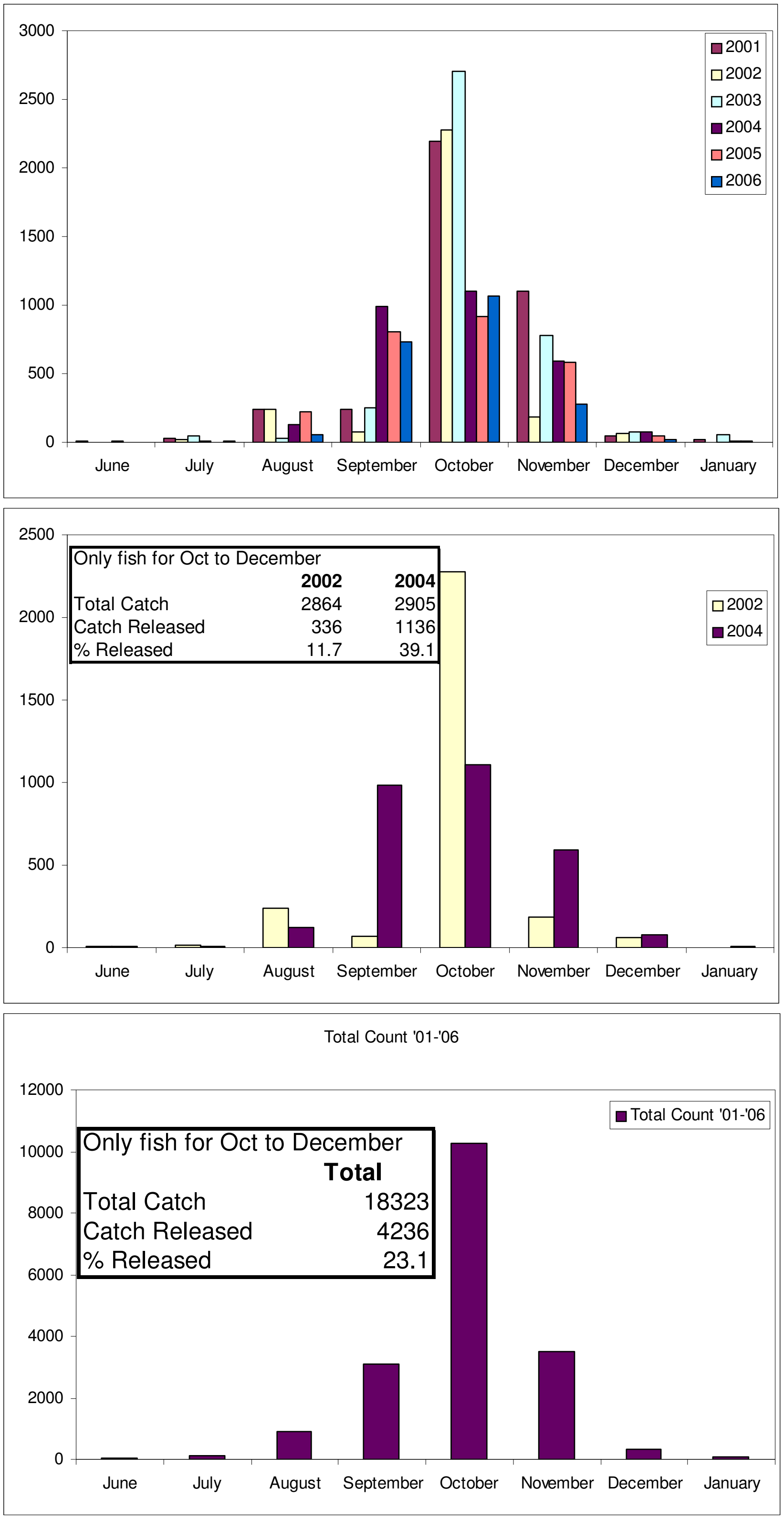
- (i) from 16 May 2008 to 30 September 2008, and
- (ii) in any year from 1 January to 30 September.

Analysis of the impact of implementing a Brown eel fishing season from 1st June to 31st August and a Silver eel season from the 1st of October to 31st December was carried out using data where catch returns were reported by month. The impact of the reduced fishing season would have been different in each Region with the level of reduction ranging from 7 to 42% in brown eel catch and 0-40% in silver eel catch (Table 4.6).

Data (2001-2006) from the Burrishoole traps in the west of Ireland (Fig. 4.9) indicates that the 2008 close season byelaw would probably ensure between 12% and 40% (average 23%) escapement of silver eels from the catch – supporting the analysis of the commercial catch figures.

Table 4.6. The proportion of the eel catch reported by month occurring in each month for brown and silver eels. Also shown is the expected proportional reduction in the catch as a consequence of the shortened season outlined in Bye-law No. C.S. 297, 2008

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Bylaw reduction
EEMU	Brown					0.36	0.40	0.14	0.10				0.24
	Silver						0.00	0.11	0.34	0.48	0.06		0.11
NWIRBD	Brown		0.02	0.14	0.17	0.22	0.20	0.14	0.10	0.01			0.42
	Silver								0.92	0.08			0.00
SERBD	Brown					0.44	0.49	0.07					0.07
	Silver								0.27	0.73			0.00
SHIRBD	Brown				0.21	0.35	0.37	0.07					0.07
	Silver								0.02	0.12	0.82	0.04	0.40
WRBD	Brown	0.01	0.02	0.10	0.25	0.24	0.20	0.14	0.04	0.01			0.31
	Silver					0.00	0.01	0.11	0.26	0.36	0.26		0.12



C

Figure 4.9. Silver eel counts for the Burrishoole system permanent traps from 2001 to 2006 (top graph), showing two extreme years in run timing (middle graph) and a combined total for the six years (bottom graph).

4.2.5 Minimum Size

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a byelaw (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008) setting a minimum length. Notwithstanding anything contained in any Bye-law it is prohibited in any fishery district to which this Bye-law applies to take or to attempt to take, or to fish for or to attempt to fish for, or to aid or assist in the taking or fishing for, or to be in possession of a brown eel less than 30 cm in length, measured from the tip of the snout to the tip of the tail.

4.2.6 Recreational Fishing

4.2.6.1 Angling for eel

Recreational eel fishing is only carried out by a minority of rod anglers and there is no legal, or voluntary, declaration of catch which is probably relatively small. There is no legislation protecting eels from angling.

All other fishing engines, including, fyke net and baited pots, are authorized under the commercial legislation.

Data on the recreational fishery in Ireland are scant. This is probably related to the low level of interest in the species and information from the Regional Fisheries Boards indicates that angling interest is very limited. Occasional individuals or groups of anglers target the species but there is no regular fishery. Eel are taken as by-catch during competition, or pleasure coarse angling, and also by salmon or trout anglers using worms. Some tourists (mainly German anglers) have been identified as eel anglers, but usually as an adjunct to pike angling, but the perception from these anglers and any relevant tourist operator is that eel numbers have declined and the fishery is currently not as productive as previously.

A summary of known recreational angling is given in each Regional Eel Management Plan.

4.2.6.2 Specimen eel angling

Specimen eel angling

Specimen eels are targeted by specimen fish hunters and are also taken as by-catch by anglers targeting other species. The Irish Specimen Fish Committee (ISFC) is an independent voluntary body, representative of angling interests in Ireland, whose principal function is to verify, record and publicize the capture of large (i.e. specimen) fish caught on rod and line by anglers in Ireland, both in freshwater and marine waters. The Committee also ratifies Irish record rod caught fish. Analysis of Irish Specimen Fish Committee records for eel show no discernable trends in the numbers of specimen eels taken by anglers since the species was included in the listings since 1966 (Fig. 4.10). The current specimen weight is 1.361 kg. (3lbs)

Since records have been logged by the ISFC specimen eels have been recorded from rivers, lakes, and transitional waters throughout the country. Lakes are the principal source of large eels accounting for over 56% of specimens taken (Table 4.7). September is the most productive month for specimen eels but there is a relatively consistent return of specimens each month from May to September (Fig. 4.11).

Captors of specimen fish tend to fall into two categories - the occasional angler who catches a specimen as by-catch and those that target the species through specific research. If a potential specimen venue is identified by an angler and yields a specimen, it will usually be angled heavily by the successful angler and by other anglers in subsequent years leading to good returns from particular venues. Where annual specimen numbers are low, as for eels (average number specimens per annum = 4.45 fish), returns from some waters may be exaggerated because of this ‘specimen effect’ (Table 4.8).

Table 4.7. Origin of specimen eels by water type 1966 – 2007

Water type	No. of specimens	%
Lake	105	56.2%
River	48	25.7%
Estuary	20	10.7%
Reservoir	11	5.9%
Canal	3	1.6%
Total	187	

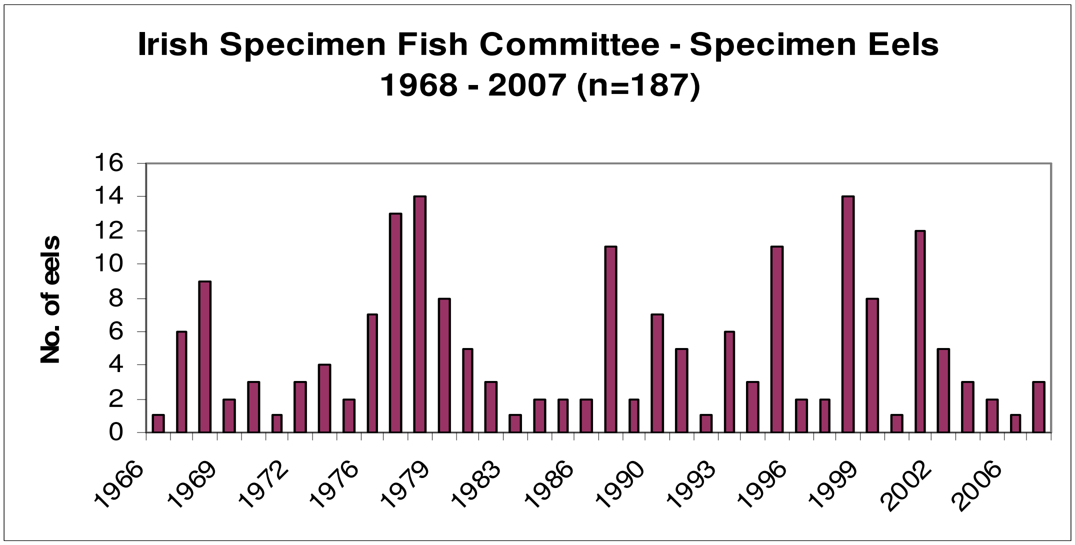


Figure 4.10. Number of specimen weight eels declared to the Irish Specimen Fish Committee, 1968-2007.

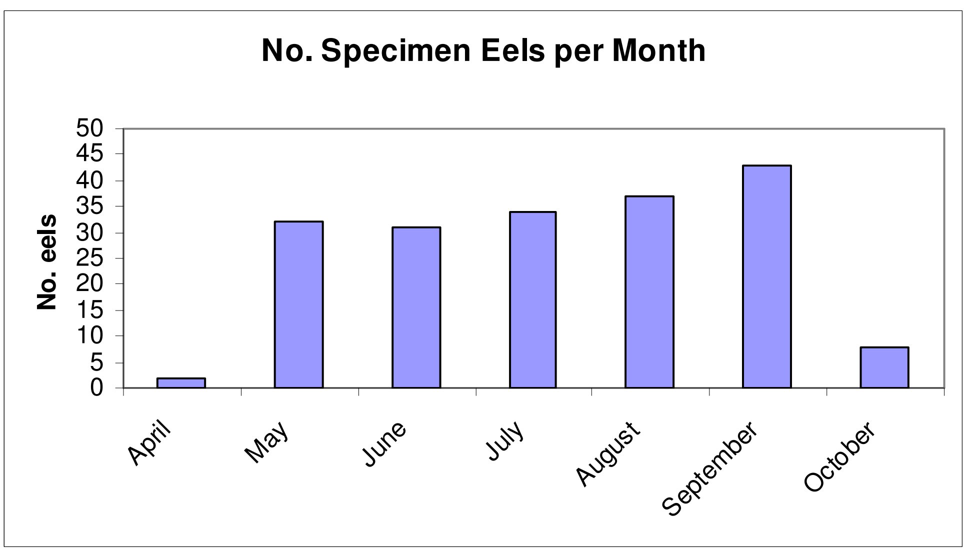


Figure 4.11. Number of specimen weight eels for each month declared to the Irish Specimen Fish Committee, 1968-2007.

Table 4.8. The top 10 locations for specimen eels from Irish Specimen Fish Committee records 1967 to 2007

	Waterbody type	Place of capture	RFB	Easting	Northing	Total no. of specimen eels caught	Years
1	Lake	The Lough, Cork	SWRFB	166586	70696	27	1976 - 2007
2	Lake	Aughrusbeg Lake	WRFB	55934	258086	16	1977 - 1991
3	Reservoir	Iniscarra Res.	SWRFB	153554	72269	16	1990 - 2005
4	River	River Lee	SWRFB	131137	70900	12	1990 - 2005
5	River	River Barrow	SRFB	271270	127170	10	1977 - 1995
6	Lake	L Derravaragh	SHRFB	239861	267403	8	1988 - 1997
7	Lake	Ballinafid Lake	SHRFB	241129	260520	5	1972 - 2002
8	Lake	Maumeen Lake, Clifden	WRFB	65513	241126	5	1977
9	River	R. Blackwater, Cappoquin	SRFB	209854	99383	5	1967 - 1970
10	Lake	Calloughs Lake	NRFB	222621	304888	4	1999 - 2001

4.2.7 Aquaculture

Due to the high commercial value of eel, eel farms have been set up throughout Europe and the Far East in recent decades. As it is not possible to breed eel in captivity, elvers have to be captured for on-rearing in these farms. The improved survival of the early life stages of the eel in culture is highly significant and allows optimum use of this very scarce and valuable resource. A large proportion of glass eels collected in Europe are for direct human consumption which is enormously wasteful of the resource.

Due to growing interest, BIM commissioned a manual in their *Aquaculture explained* series entitled “Eel farming in re-circulation systems” (Warrer-Hansen, 1997). The first commercial eel farm with a 60t per annum production capacity was set up in Ireland in 1996 although this level was never reached. The farm closed in 2000.

There is no eel culture in Ireland at the present time and none is envisaged in the near future.

4.3 Catch Sales/Dealers/Export

The decision to cease the fishery has been made (see Chapter 8) and the fishery will be closed under the 2008 bylaw from 1st Jan to 1st June 2009 while legislation is drafted for a full cessation. This legislation will be enforced by the Regional Fisheries Boards.

4.3.1 Eel Sales and traceability

Eel traceability and catch and sales reporting will not be required under the management option of a ceased fishery and a closed market for eel.

A traceability system will be put in place for eels captured for trap and transport around hydropower. Conditions of the Fish Health Directive will be fully complied with during trap and transport operations.

In the future event of a reopened fishery, a traceability scheme will be implemented in accordance with the Regulation.

4.3.2 CITES

The European eel is listed in Annex B of 338/97 (equivalent of appendix II of the CITES Convention). For Annex B specimens internal commercial trade is allowed where the authorities are satisfied with the legal acquirement in accordance with the legislation in force for the conservation of wild fauna and flora (or if they originate outside the Community that they were introduced in line with EU regulation 338/97).

For exports outside the EU, the CITES scientific authorities within the EU Member States have to make a "non detriment finding" in accordance with Art. 4.2.a.. This is a separate issue/responsibility and the CITES Scientific authorities in the EU (in the framework of the Scientific Review Group) are discussing at the moment how these non detriment findings can be implemented together will relevant eel specialists/colleagues from Member States and linked to the developments of the management plans.

In the future event of a reopened fishery, CITES requirements will be fully complied with.

4.3.3 Price Monitoring of <12cm eel catch

There is no commercial fishery and no commercial market for eel <12cm in Ireland. Therefore there is no requirement to monitor price of eel <12cm.

5 Escapement - local stock modelling

5.1 Introduction

The international assessment that the eel stock is depleted and its fishery is unsustainable is based largely on strongly declining trends in recruitment and in landings. Data at the local, or regional, level are, however, limited. Recruitment of juvenile eel to Irish catchments (2003-2007) has declined to between 4% (Shannon) and 23% (Erne) of historical (1979-1984) and has been particularly poor in 2008.

The EU SLIME project, in which Ireland was represented, brought together modellers and case study data providers to develop methods for assessment of local stock size and production (Dekker *et al.* 2006). It is still evident that sufficient quality data and development of models are not at the stage where accurate stock assessment or evaluation of silver eel escapement is possible.

There is a paucity of data across Europe on silver eel escapement and, in particular, on levels of "pristine" productivity in terms of silver eel biomass per unit area (Moriarty & Dekker, 1997). It is unknown to what extent catchments were populated by eel and whether the carrying capacity limits were ever reached. Furthermore, there is some evidence that local eel stocks (i.e. Shannon, Burrishoole) may be exhibiting a density dependent response (i.e. change in sex ratio and increase in eel size) to decreased recruitment and the mechanisms that influence this are not understood. This density dependent response may have implications for comparing current SSB with previous "pristine" SSB output. Without information relating to these, which will be difficult to achieve in the short-term, only "ball park" estimates will be possible in the short-term and these will be subject to regular review.

Considerable stocks of eels inhabit the lower tidal areas of catchments and may also remain in coastal areas for significant time or for all of their growth period. It is currently not possible to quantify the biomass of growing eels or the biomass of silver eels being produced and escaping from these areas which has hampered their inclusion in the development of models for quantifying the escapement target or the mortality rates. ICES (2008) has also recognised this deficiency and has established a Study Group in 2009 to address this issue of eels in tidal waters. As data and methodologies become available they will be incorporated into the Eel Plans.

Consequently, the Irish Management Plans will include a time period for detailed data collection and a parallel programme of stock assessment, including silver eel escapement estimates, and model development. In the interim, the three options proposed within the Eel Regulation will be used to make preliminary estimates of pristine production and current escapement. The approach outlined in Article 2 of the Eel Regulation (EC No. 1100/2007) will be followed to calculate pristine and current escapement and a simple model is proposed to project the impact of management actions on escapement from freshwaters.

5.2 Pristine silver eel production estimation

No estimates of truly pristine escapement exist for Irish eel catchments. Recruitment of juvenile eel to Irish catchments (2003-2007) has declined to between 4% (Shannon) and 23% (Erne) of historical (1979-1984) and has been particularly poor in 2008.

Unknown factors hindering estimation of pristine silver eel escapement are: absolute recruitment, rate of colonisation upstream, carrying capacity of different catchments and what stock levels the catchments were carrying in the past, use of different habitats and density dependence issues (i.e. sex ratio, growth rate, natural mortality). Without information relating to these, which will be difficult to achieve in the short-term, only "ball park" estimates will be possible in the short-term and these will be subject to regular review.

In the EU Regulation, in Article 2, Establishment of Eel Management Plans, it states:

4. The target level of escapement shall be determined, taking into account the data available for each eel river basin, in one or more of the following three ways:

(a) use of data collected in the most appropriate period prior to 1980, provided these are available in sufficient quantity and quality;
(b) habitat-based assessment of potential eel production, in the absence of anthropogenic mortality factors;
(c) with reference to the ecology and hydrography of similar river systems.

Pre-1980s data is limited to a single small coastal catchment, Burrishoole, with a direct count of the silver eel escapement and long-term records of silver eel yields from four eel-weirs, Galway, Erne, Moy and Garavogue. These data will be used in accordance with option "a". There is currently insufficient available data of sufficient quality and quantity to rely exclusively on this approach. The collation of eel survey data may extend the use of this approach in the future. Consequently, options "b" and "c" are required to extrapolate the available information to estimate escapement from the remaining catchments.

5.2.1 Available pre-1980s data - Option (a)

5.2.1.1 Historic escapement Data

The only total silver eel escapement data available in Ireland is for the Burrishoole catchment in the WRBD a relatively small catchment (0.3% of the national wetted area), in the west of Ireland. The Burrishoole consists of rivers and lakes with relatively acid, oligotrophic, waters (Fig. 5.1). The catchment has never been commercially fished and there are no barriers or turbines. The eels have been intensively studied since the mid-1950s; total silver eel escapement from freshwater was counted since 1970 (Poole *et al.*, 1990; Poole, data unpublished); and an intensive baseline survey was undertaken in 1987-88 (Poole, 1994). The detailed nature of the Burrishoole data makes it suitable for model calibration and validation (Dekker *et al.* 2006).

The Burrishoole silver eel data, summarised in Table 5.1, has indicated a average pre 1980 production rate of silvers of 0.9 $kg.ha^{-1}$ (post-1980 - 1.3 $kg.ha^{-1}$) with possible density dependent changes to female number (sex ratio) and size.

Table 5.1. Summary statistics for the Burrishoole silver eel census showing pre 1980 and post 1996 silver eel numbers, biomass and production figures. Also included are the average number of females and average biomass of females for the same periods.

Silver Eel	1971-1980	1996-2006
Average count	4409	2882
Biomass (kg)	436	617
Production (kg/ha)	0.9	1.3
Number of females	1626	1970
Biomass of Females	329	538
Potential No. Ova (1.5m/kg)	494,127,893	807,562,987

5.2.1.2 Historical catch based estimates

The calculation of pristine productivity for exploited catchments requires estimates of silver eel escapement along with historic silver and brown eel catches (Figure 5.2). Historical catch records for silver eel fisheries were available for the four catchments of the Corrib, Moy, Garavogue and Erne. The efficiencies of the fisheries had been previously estimated for the Corrib and Erne silver eel fisheries. Where the efficiency of the weir was not measured an approximately average value of 33% was used to calculate escapement. In addition to the catch at the recording station and escapement past the recording station the brown eel and silver eel catches made upstream were included to estimate pristine productivity. In the absence of historic data for these latter parameters (brown and silver eel catches upstream of the recording station) it was assumed that the yields were equal to those currently observed (2001-2007).

Brown eel yield was assumed to be equivalent to the same weight of potential silver eel. This assumption was based on the logic that in a system subject only to natural mortality, migration would only be delayed such that fecundity (related to weight) would be maximised. Consequently, it was considered unlikely that there would be a net loss of weight in subsequent years from a cohort.

Finally, the productivity estimates were corrected by the level of unreported and illegal fishing. Unreported yield was derived as the ratio of unreported licences to licences issued within the relevant River Basin District between the years 2001-2007. The proportion of the fishery yield taken illegally was assumed to be equal to that estimated for the Shannon (40% of the declared catch) by the DEMCAM (SLIME) model (Bevacqua & de Leo in Dekker *et al.* 2006). For those catchments with hydropower, an estimate of the impact was derived from imposing a 28.5% mortality per turbine passage, an estimated European average (ICES, 2003). Therefore, the probability of surviving passage through 'n' number of hydropower installations is $(0.715)^n$.

The estimated pristine spawner escapement ranged from 0.9 to 5.5 kg/ha (Table 5.2).

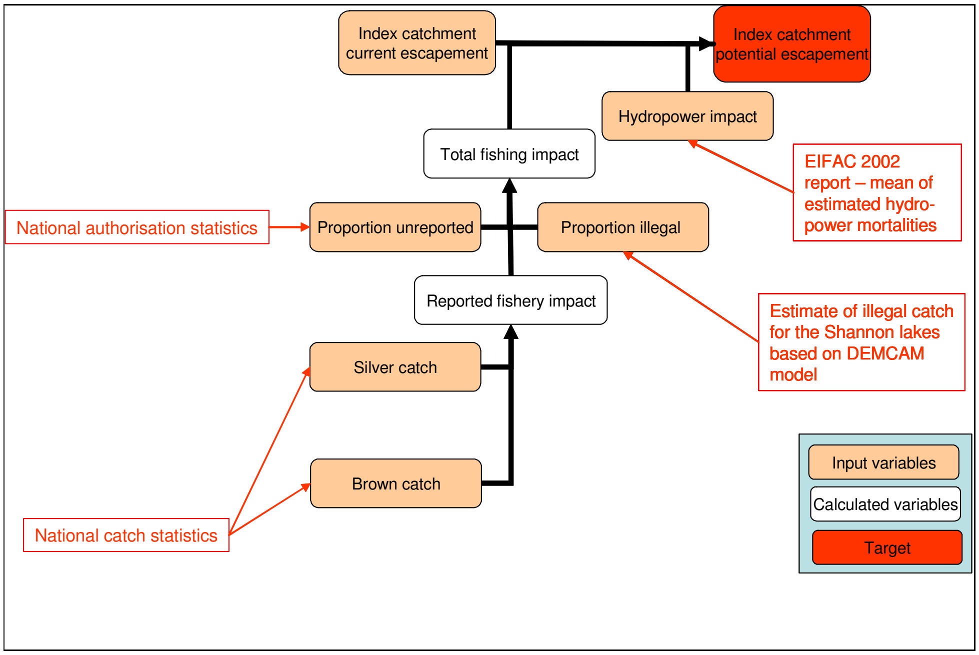


Figure 5.2. Description of how potential production (escapement) was derived from the current escapement of catchments where estimates of silver eel escapement, fishery yield and the impact of hydropower are available.

Table 5.2 Estimated pristine spawner productivity from five Irish catchments based on either direct measurement and/or catch data. See Appendix 1 for full description of calculations.

	Moy	Garavogue	Erne	Corrib	Burrishoole
Years	'42-52	'62-75	'55-82	'76-82	'71-80
Silver catch at weir	3.4	0.9	9.2	19.4	0.0
Escapement past weir	6.8	4.4	51.3**	38.8	427.5
Reported brown catch upstream	4.0	1.7	13.4	9.0	0.0
Non-reported brown catch upstream	3.0	1.2	23.4	6.5	0.0
Reported silver catch upstream		0.0		18.6	0.0
Non-reported silver catch upstream	29.1*	1.2	9.2	13.4	0.0
Potential production	46.4	9.6	116.6	97.5	0.4
Wetted area (ha)	8418.0	1783.0	25959.6	28869.0	475.0
Productivity (kg/ha)	***5.5***	***5.4***	***4.5***	***3.4***	***0.9***
% non-calcareous	25.7	19.5	0.0	18.5	96.2

*upstream Verscoyle weir efficiency estimated at 7 times that of the recording station (North Western Regional Fisheries Board)
**occurs following recording station (therefore, ignored in calculation of productivity).

5.2.2 Potential production based on habitat of similar characteristics, options (b) & (c)

Note: transitional and tidal waters were not included in the modelling exercises. Potential production was not determined for these waters as currently a methodology is not available to support this.

To estimate potential spawner escapement for non-index catchments, the geological characteristics of the catchments comprising available habitat for eels and their wetted areas were calculated in a GIS (See Sec 3.2). The approach involved determining the relationship between productivity and the geological characteristics of the catchment. Growth rates of eel were available for 17 catchments (Moriarty 1988, Central Fisheries Board). The wetted area within each catchment was quantified using a geographical information system and classified according to the proportion of the catchment area comprising non-calcareous geology. For 17 catchments growth rate was found to be closely related negatively to the proportion of the catchments comprising non-calcareous geology (Figure 5.3) (r^2=0.67; p<0.0001).

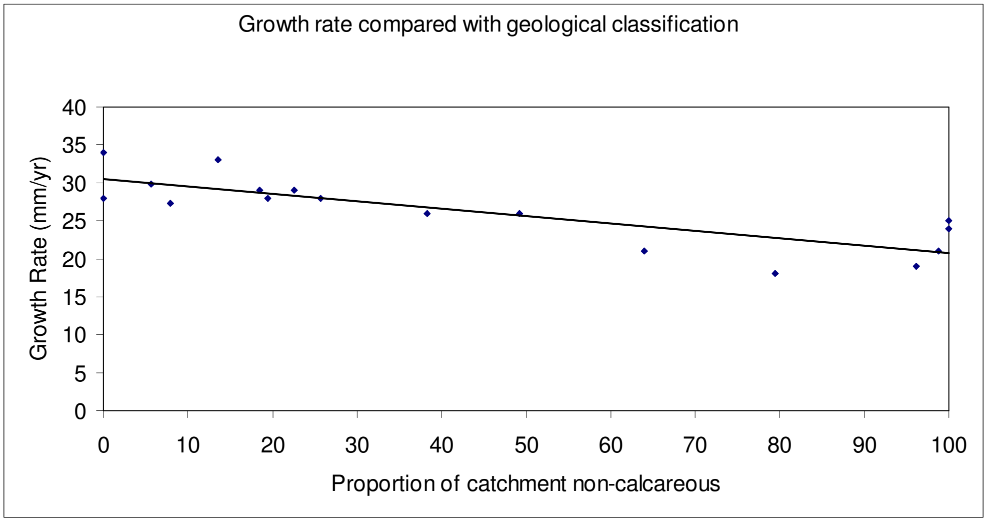


Figure 5.3. The relationship between growth rate and the proportion of the catchment comprising non-calcareous geology.

The four catch-based production estimates and the single direct estimate (Table 5.2) were plotted against the proportion of non-calcareous geology within the catchment (Figure 5.4). These historic estimates suggest that in exclusively non-calcareous catchments silver eel productivity was approximately 0.9kg/ha while in predominantly calcareous catchments silver eel productivity averaged about 4.5kg/ha.

An obvious weakness in the relationship presented in Figure 5.4 is the distribution of the data, with little data for intermediate or non-calcareous catchments. To increase the robustness of the model the 5 available productivity catch based estimates were used to convert the growth rate estimates for 17 catchments into pristine production estimates.

We assumed that silver eel productivity is a product of recruitment, natural survival and average silver eel weight. Natural mortality was imposed at a constant rate of 14% per annum. This rate was chosen because the average age of Irish silver eels is approximately 18 years and the cumulative natural mortality over the continental life stages is approximately 2.5 (Dekker 2004). The residence time was the time required for glass eels (70mm) to grow to the Irish average silver eel length of 480mm (sexes combined).

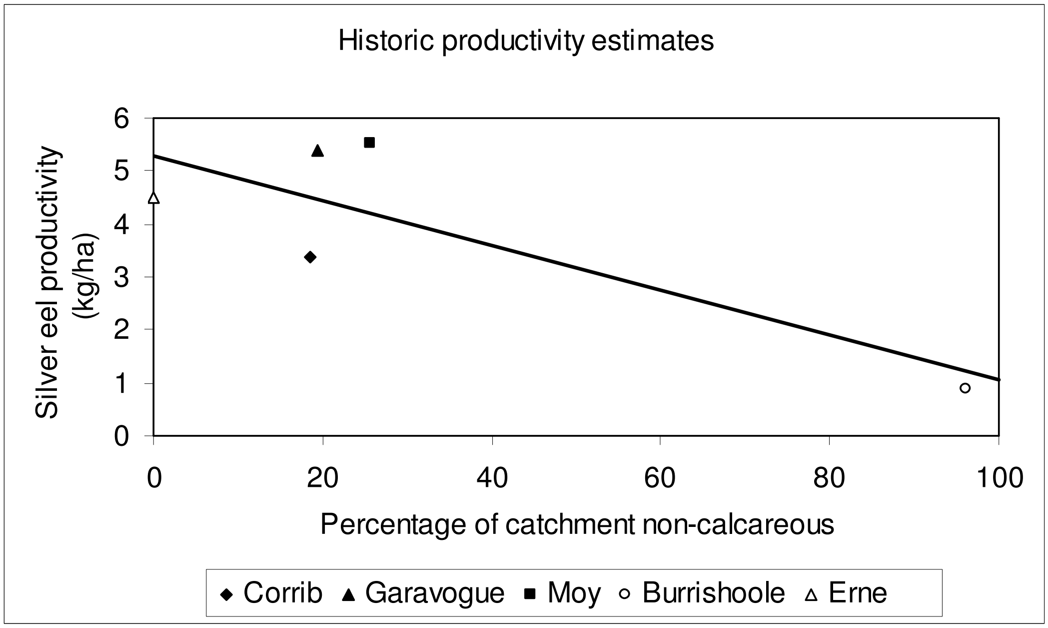


Figure 5.4. Catch based productivity estimates plotted against the percent of catchment with siliceous (non-calcareous) geology.

For each of the 17 catchments the proportion of fish surviving (S) was thus estimated as follows:

$S = (natural\ annual\ survival)^{(residence\ time)}$ or $S = (1\text{-}0.14)^{((480\text{-}70)/G)}$

Where G = *growth rate (mm/yr)*

Data on silver eel production was also available for five catchments (Table 5.2) and these where used as index catchments to estimate potential silver eel escapement as follows:

$Silver\ eel\ production_x = (Survival_x / Survival_i) * Silver\ eel\ productivity_i$

Where *I = “index” river* ; *x = river where no estimate of silver eel production is available.*

This calculation was repeated using the survival and silver eel productivity for each of the five “index” catchments and the mean computed. The relationship between the estimated productivity and geology for the 17 catchments is shown in Figure 5.5 together with the estimate for those five catchments where productivity had been measured (directly or indirectly).

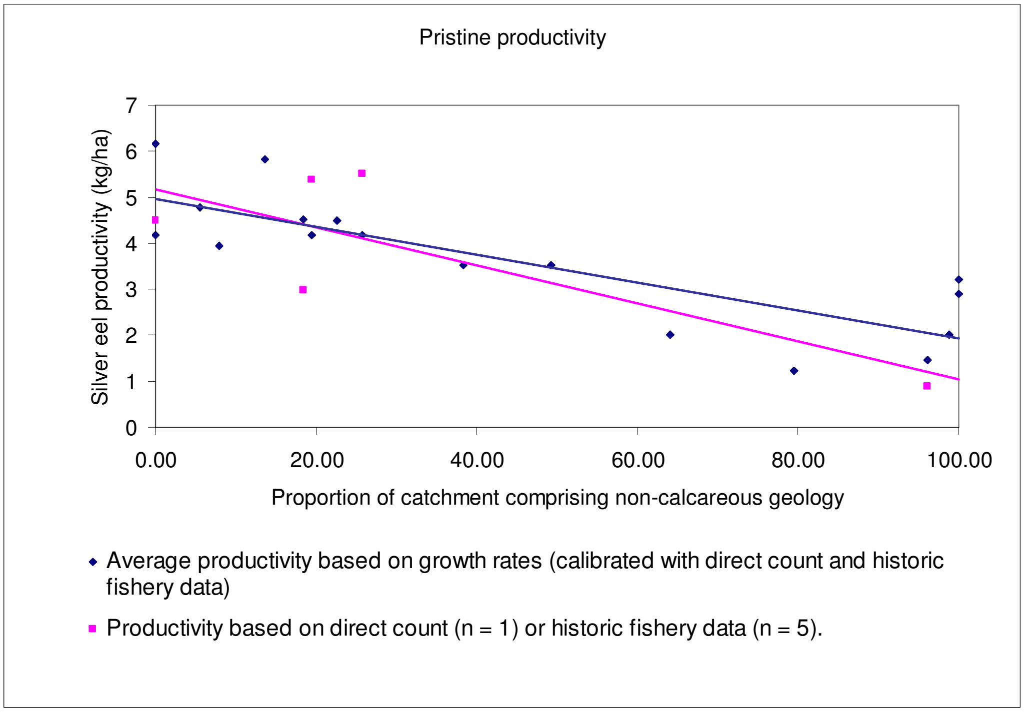


Figure 5.5. Relationship between silver eel productivity (kg/ha) and percentage of catchment with siliceous (non-calcareous) geology. The pink points are based on catch based or direct estimates of productivity. The blue points are based on the relative productivity of the catch based estimates but these are not included in the regression.

These data now allow for calculation of pristine productivity (kg/ha) based on either:

Option A The relationship between silver eel productivity (based on 4 historic catch records and 1 historic total count) and the proportion of non-calcareous geology in the catchment using the regression equation:

Productivity (kg/ha) = -0.041*(percentage of catchment non-calcareous) + 5.18

Option B The relationship between silver eel productivity (based on 17 growth rates calibrated with 4 historic catch records and 1 historic total count) and the proportion of non-calcareous geology in the catchment using the regression equation:

Productivity (kg/ha) = -0.030*(percentage of catchment non-calcareous) + 4.97

Option C Using catchment specific measured data where available and applying the national model, Option B, elsewhere.

The productivity estimates using options A, B and C are given in Table 5.3. The data supported the use of the linear regression in the calculation of pristine production. Using the linear relationship based on 17 catchment growth rates calibrated with the 6 catchments with historic stock information, option B, includes all available data and provides a more robust habitat based approach to determining silver eel production. This approach avoids relying on two data points (calcareous average and non-calcareous point - option A) situated at each end of the productivity range with no clear threshold for whether a catchment is calcareous or siliceous.

Option C has the advantages of Option B with the added benefit of including catchment specific data where available and the output from Option C is used in the following Sections.

This extrapolation approach is well established for salmon management in Ireland. The regression approach, as described, allows the transfer of data from index catchments with production estimates to catchments where little or no data exists on the basis of geological proxy for production.

Table 5.3. Historical silver eel production rates calculated for each RBD.

Option A

	Regression based on historical catch or total count data only
	Pristine silver eel production (kg)
EEMU	21,641
NWIRBD	140,334
SERBD	14,714
SHIRBD	219,346
SWRBD	19,329
WRBD	165,431
Grand Total	***580,794***

Option B

	Regression based on growth rates calibrated with historical catch or total count data, national model only
	Pristine silver eel production (kg)
EEMU	21,773
NWIRBD	146,536
SERBD	15,723
SHIRBD	214,048
SWRBD	25,925
WRBD	170,403
Grand Total	***594,408***

Option C

	Regression based on growth rates calibrated with historical catch or total count data, including catchment specific data where available
	Pristine silver eel production (kg)
EEMU	21,742
NWIRBD	146,538
SERBD	15,700
SHIRBD	170,397
SWRBD	25,924
WRBD	213,895
Grand Total	***594,196***

5.2.3 Current silver eel escapement

Direct estimates of current escapement can be made for four catchments: the Corrib, Ennell (sub-catchment of the Shannon), Shannon and Burrishoole. These catchments represent 47% of the wetted area covered by Irish Eel Management Plans. The three former catchments have silver eel fisheries at the lower end of the catchment whose efficiencies have been previously determined (table 5.4). The annual catch is therefore a proxy for annual escapement. The latter catchment is an unexploited research catchment where all migrating individuals are counted (see section 1.2.1.1). It is intended to monitor current escapement from additional catchments during the first three years of the EMP

The regulation requires an estimate of the current silver eel escapement for each RBD. Current escapement is a function of the current production, or potential production, of silver eels and the loss of silver eels (or potential silver eels through brown eel mortality) to exploitation or turbine mortality. These impacts are locally specific and therefore it is preferable to use index catchments as a proxy for current silver eel production rather than actual escapement. The estimated current productivities are then used to calibrate the relative productivities of 17 catchments, as derived from growth rates calculated in the same way as described above for pristine productivity. The directly derived current potential productivity estimates give an approximation of the average rate of elver recruitment per ha of wetted area to Ireland currently. The current silver eel production estimated from this national model is modified by the specific local impacts to give an estimate of local escapement. This approach has been outlined in general and in detail in figures 5.6 and 5.7. A weakness to this approach at present is the lack of catchment specific directly derived eel data and it is intended to increase the number of data points (current silver escapements) in the next few years.

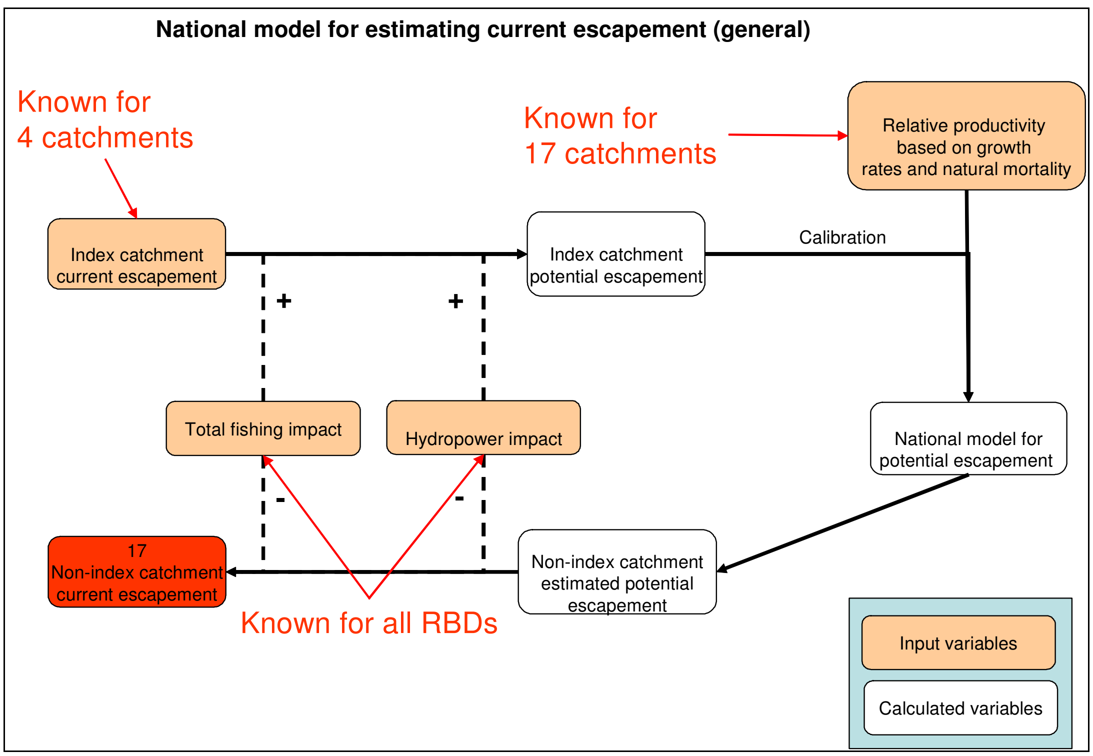


Figure 5.6. An overview of the generalised model for estimating current escapement.

Table 5.4. Current escapement (t) and current potential productivity (kg/ha) estimates for index catchments 2001-2007. Note: Units in tonnes except for productivity.

	Shannon	Corrib	Ennell*	Burrishoole
Silver catch at weir	4.6	7.2		0.0
Escapement past weir	***11.0*****	***13.4***		***616***
Reported brown catch upstream	19.5	9.0		0.0
Non-reported brown catch upstream	14.4	6.5		0.0
Reported silver catch upstream	20.6	7.2		0.0
Non-reported silver catch upstream	15.5	5.2		0.0
Hydropower impact	2.1	0.0		0.0
Potential production	85.7	48.5	3.8	0.6
Wetted area (ha)	42466	28869	1404	474
Productivity (kg/ha)	***2.0***	***1.7***	***2.7***	***1.3***
% non-calcareous	7.9	18.5	0	96.2

* Summarised data provided by McCarthy pers. comm..
** Hydropower impact occurs downstream of recording station (estimated 2.1 tonnes killed).

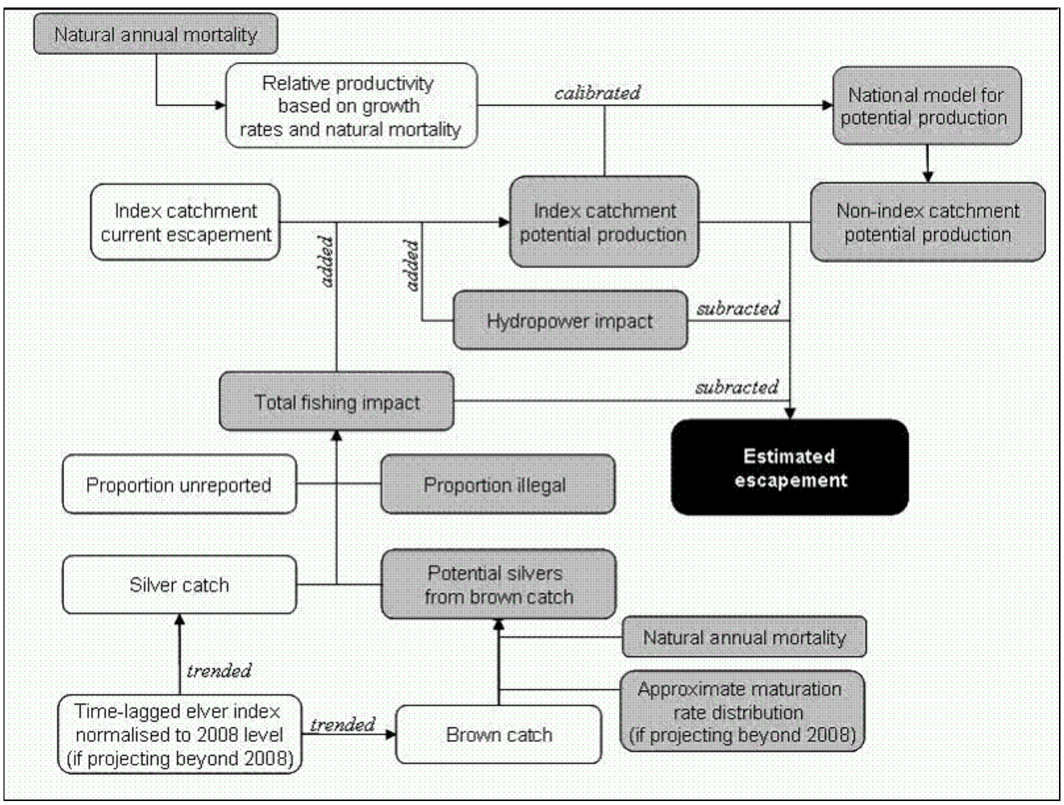


Figure 5.7. A detailed schematic of the generalised model for estimating contemporary escapement. White boxes represent input data while grey boxes represent input assumptions or derived parameters.

5.2.3.1 Step 1 - estimate current productivity

Figure 5.8 presents the national habitat-based model for current productivity as derived by using the index catchments (with directly derived current production) to calibrate the relative productivities of the 17 catchments with growth rate estimates as described previously in section 5.2.2.

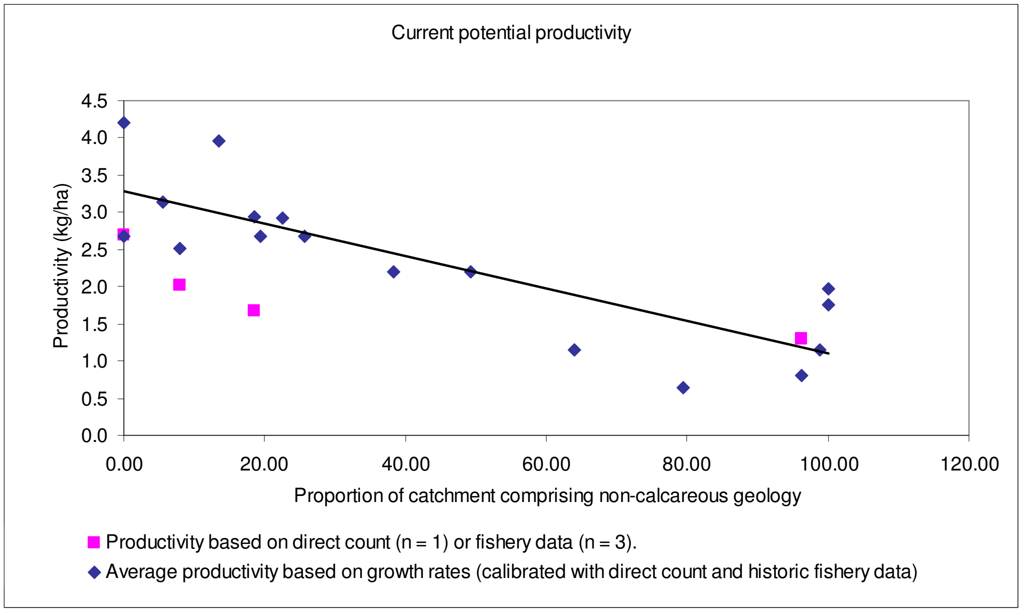


Figure 5.8. Current productivity of the index catchments and its relationship with the geology of the catchment.

5.2.3.2 Step 2 – quantify RBD specific fishery impacts

The current reported brown and silver eel catch was based on the average catch reported to the relevant Fisheries Boards from 2001-2007. The impact of the reported fishery was calculated as the sum of the silver eel reported catch and the production of silvers achieved through preventing mortality of the brown eel reported catch. As before the brown eel catch was assumed to produce at least an equal weight of silver eel if released. The unreported and illegal fishing yields were estimated in the same way as described for estimating pristine production above.

5.2.3.3 Step 3 – quantify catchment specific hydropower impacts

Hydropower impacts on approximately 46% of the wetted area accounted for in the six EMPs (Sec. 3.5.1). There has been no direct measurement of hydropower mortality or morbidity in Ireland. However, there have been a number of studies carried out elsewhere that suggested an average mortality rate of 28.5% across all length classes per hydropower installation (ICES 2003). Therefore, the probability of surviving passage through 'n' number of hydropower installations is $(0.715)^n$. Where bypass estimates exist (i.e. 30% on the Shannon) these have been incorporated.

Direct estimates of mortality rates and bypasses will be required for each of the Irish stations in order to more accurately inform the estimates in the first three years of the plan.

5.2.3.4 Step 4 - estimate current escapement

Pristine escapement and current potential production were calculated for the fresh (non-transitional) waters within each catchment based on the national models described above

(Appendix 1: see Table 5.5 for RBD totals). The potential production was summated by River Basin District and current escapement estimated by including the effects of anthropogenic impacts (i.e. fisheries and hydro-power installations). Current escapements are presented below as a percent of the pristine escapement to determine where Irish RBDs are currently in relation to the 40% target defined in the EU Regulation. Note: transitional and tidal waters were not included in the models.

Table 5.5. Estimates of pristine production and current escapement of silver eel and the % escapement for freshwater catchments. Note the EU target is 40%

	Pristine Production (t)	Current Escapement (t)	Current Escapement as % of Pristine Escapement
EEMU	22	7	33
SERBD	16	9	55
SWRBD	26	17	64
SHIRBD	214	18	8
WRBD	170	51	30
NWIRBD	147	38	26
National	595	140	24

5.2.4 Projecting the impact of management measures on future silver eel escapement

The escapement of Irish silver eels until at least 2020 will be a function of the levels of reduction of fishery mortality, hydropower mortality and the legacy of poor and steadily declining recruitment over the past 18+ years. A model that incorporates the impact of past declines in recruitment and reductions in anthropogenic mortality to estimate the effect of and need for management actions was developed. For illustrative purposes, the trend in silver eel escapement until 2020 is presented for four separate scenarios: no management action taken, closure of the fishery and market for eels, complete avoidance of hydropower mortality, and combined closure of the fishery and market for eels with complete avoidance of hydropower mortality. The model can of course be used to assess differing levels of management actions.

5.2.4.1 Incorporating the effect of declining recruitment

In Ireland the average age of migrating silver eel is approximately 18 years although this is catchment specific and related to the catchment productivity, sex ratio, density dependence and growth rate. The smoothed trend of elver indices (ICES, 2007) for the last 18 years (back to 1990) therefore approximated to the silver eel escapement of 2008 and so on. The 1990 elver run was approximately 12% of historical pre-1980 levels. It is assumed therefore, that density dependence is unlikely to be of much importance going forward as the elver index has fallen further since 1990 and density dependence is likely to have occurred already and is assumed not to taking place in the models, unless it can be demonstrated at the catchment level. Therefore declines from this 1990 level are assumed to be directly and linearly related to eel production. The Shannon elver index, which declined at a similar rate to the European trend (Astrom & Dekker, 2007), was used as the national trend and the Erne trend, which was at odds with other data, was applied to the Erne catchment only (Fig. 5.9).

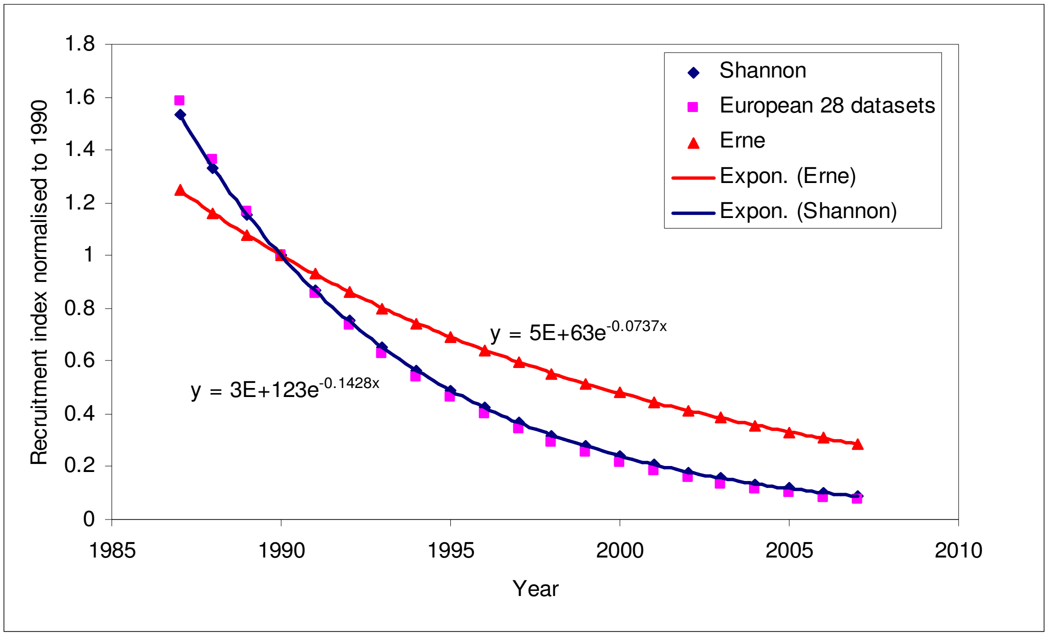


Figure 5.9. Trended recruitment for the Erne (red), the Shannon (blue) and a mean for 28 stations across Europe (pink – source: WGEEL 2008). The series have been scaled with reference to 1990.

Estimates of likely future silver eel catches, and escapements, are based on the current (2008) estimates modified to take account of the decline in recruitment, such that their trend directly reflects the 18 year time lagged trend in the elver index. Similarly, the average age of eels caught in the brown eel fishery is approximately 13 years (e.g. Matthews et al. 2001). Future brown eel catches are therefore assumed to be directly proportional to changes in the elver index of 15 years previous. The reference years for the smoothed elver indices are 1990 for silver eels and 1995 for brown eel (i.e. the years giving rise to the current eel stocks).

5.2.4.2 Projecting silver eel escapement from closure of eel market

The impact of a possible closure of the Irish market for brown and silver eel was simply modelled by adding the catch of silver eels and the estimated level of unreported/illegal catch to the current escapement. Both the expected contemporary escapement and silver eel catches were trended with regard to the elver index of 18 years previously (see section 5.2.4.1 above).

As before, the brown eel yield (reported and unreported/illegal) was assumed to be equivalent to the same weight of potential silver eels (see section 5.2.1.2). Box 1 shows the calculations required to estimate the increased silver eel production in a given year owing to brown eel fishery closure at time t.

Box 1. Calculating the silver eels produced in subsequent years by closing the brown eel fishery at time t (note that the elver index is normalised to 1995)

Silvers released at time t+10 by ending brown eel fishery at time t

$Silvers_{.\ t+10}$=

[(Elver $index_{t-8}$) * (Brown eel $catch_t$) * (Proportion of catch maturing in 1 year)]

+

[(Elver $index_{t-9}$) * (Brown eel $catch_t$) * (Proportion of catch maturing in 2 years)]

+

\- - - - - - - - -

+

\- - - - - - - - -

+

[(Elver $index_{t-18}$) * (Brown eel $catch_t$) * (Proportion of catch maturing in 10 years)]

The length frequency of the brown eel and silver eel catches is known for some catchments. However, there is much overlap between length classes and age classes. Complex models are under development that may be able to derive the maturation rate of eels based on length. However, it is not straightforward and is confounded by the need to include maturation rates in terms of age rather than length. We have therefore opted to use a simple, approximate distribution of maturation rates based on a triangular distribution peaking at five years. The majority of the brown eel are 8 years of age when they become exploitable by the fishery and remain in the fishery for up to 10 years on average. The brown eel catch, if it was released or not caught, would therefore mature as silver eels, on average, over the following 0-10 years range (see figure 5.10). This assumed maturation distribution of the brown eel commercial catch will need improvement based on local data collected through surveys.

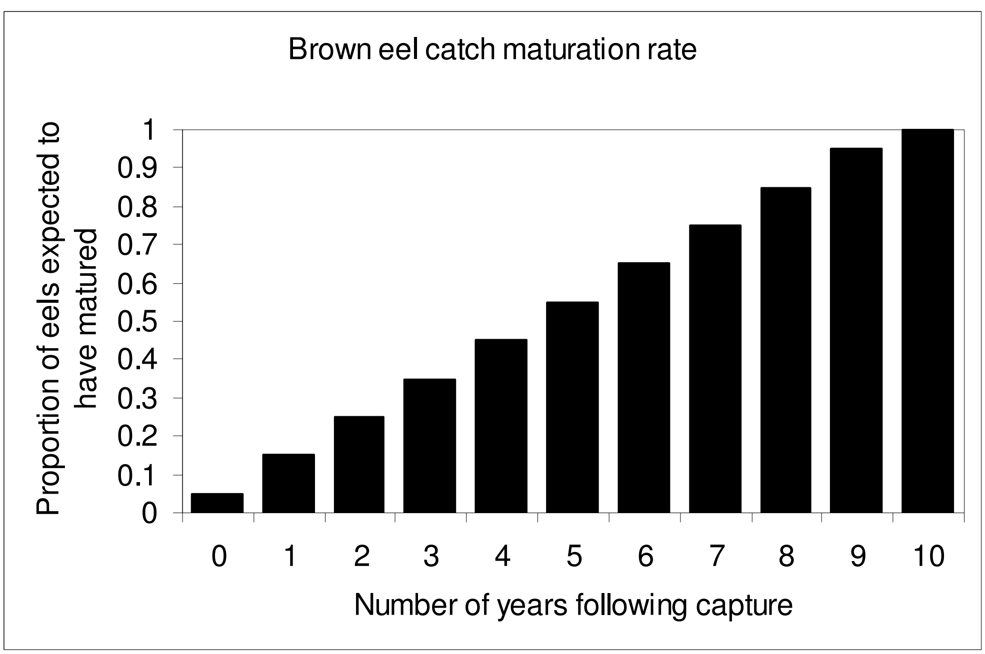


Figure 5.10. The approximated proportion of brown eels expected to have matured to silver eel if the catch had not been killed.

5.2.4.3 Projecting the impact of reducing hydropower mortality

As before, hydropower mortality of 28.5% was imposed across all size classes on the projected silver eel escapement passing through one set of hydropower turbines It is possible that the 28.5% of eels dying are larger then average and so that more than 28.5% of the silver eel biomass is killed. The model currently ignores size selectivity. It is important that the size selectivity and a catchment specific mortality rate are determined in the future.

5.2.4.4 Summary of individual RBD targets

Using the modelling described above, preliminary estimates of pristine silver eel production and current silver eel escapement were determined for the freshwater catchments and plotted for each RBD and for the total national situation (including the Loughs Agency and DCAL areas in the EEMU and NWIRBD) (see following figures). Also shown on these plots is the Eel Regulation's '40% of pristine escapement' target line marked in red. It should be noted that no estimate of uncertainty has been built into the model as yet.

The effect of complete fishery closure (brown, silver and illegal/unreported) and/or removal of all hydropower mortality is also shown along with the "do nothing scenario". The impact of these management options is trended to take account of the legacy of the previous 18 years of decreasing recruitment trends.

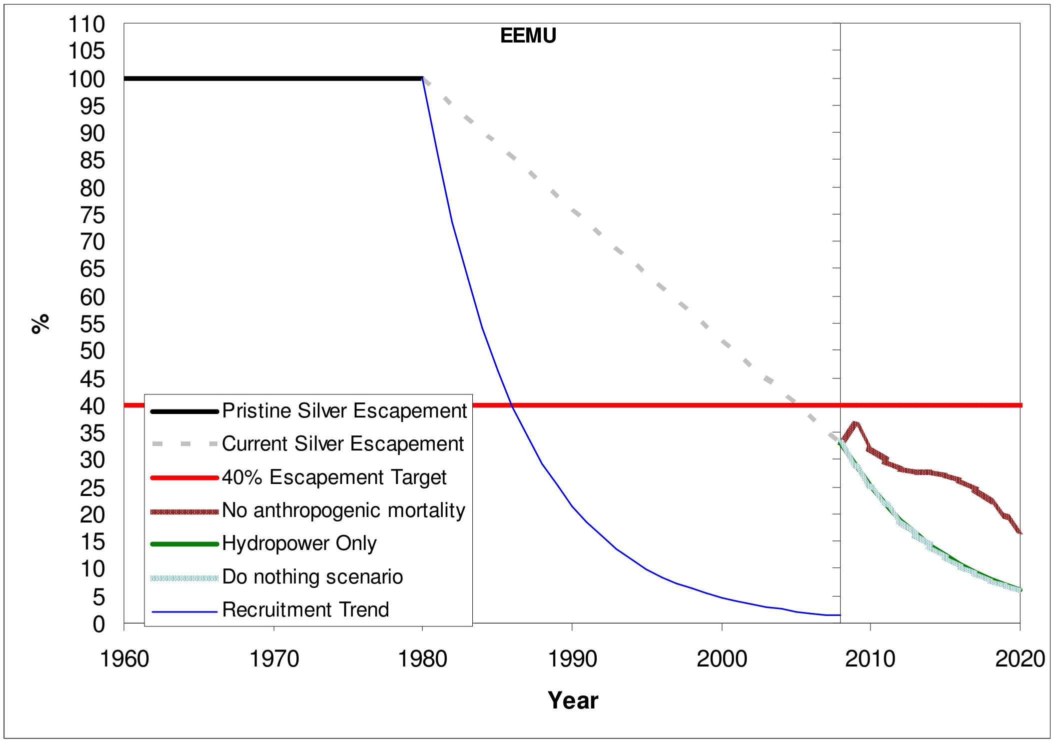
It is clear from the figures shown below that only the SERBD and the SWRBD are meeting their escapement target in 2008. However, it is also clear that this situation is unlikely to be sustainable even within the short-term future due to the legacy of poor and declining recruitment in the last 18 years.

In the cases of the ShIRBD, NWIRBD, WRBD, EEMU, and nationally, complete closure of the fisheries, including illegal and unreported fishing, will not achieve an escapement that will reach the target. The WRBD would almost reach target for one year before falling steadily. However, complete avoidance of hydropower mortality is sufficient to achieve the target in the NWIRBD. The target can be sustained almost up to 2020 provided the fishery is also closed within the NWIRBD. The SHIRBD and EEMU with both fishery and hydropower mortality reduced to zero will not achieve target.

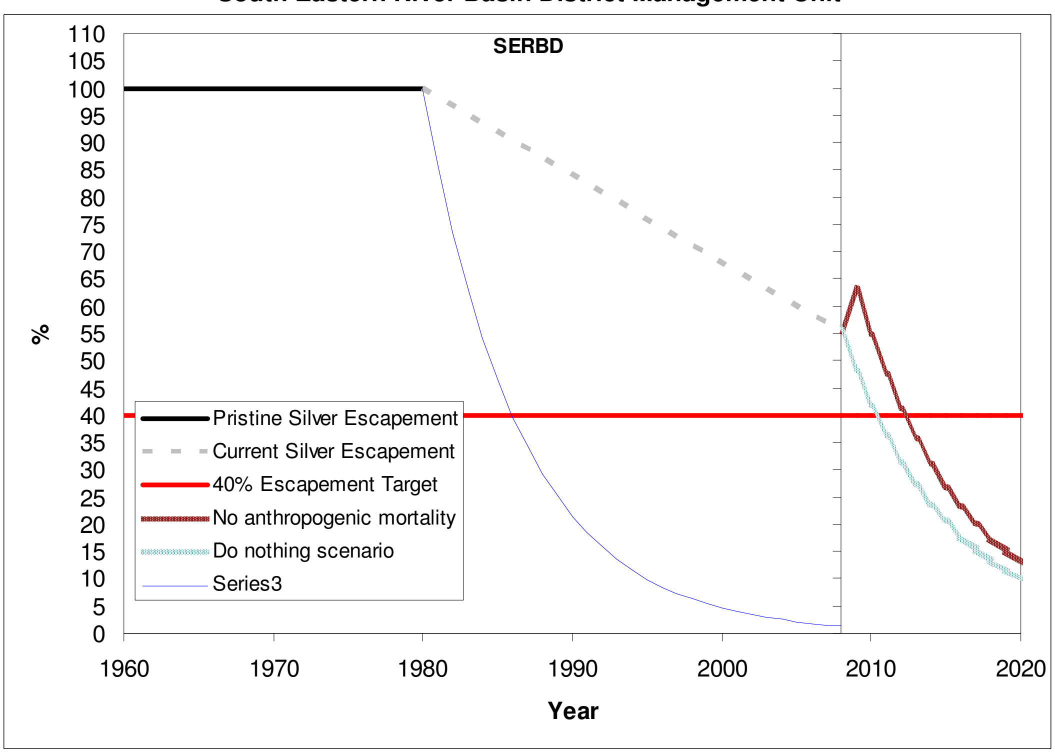
Based on best available information, the data indicates that stocks are in a seriously depleted condition and are likely to deteriorate further given the recent extremely low recruitment of juveniles. For Ireland to achieve the 40% target in the short term, mortality must be reduced to a minimum, eel habitat protected and a major targeted stocking programme implemented and/or a marked improvement in natural recruitment. However, the bottom line is that regardless of which management actions are taken, achieving the 40% EU target in the long term will require a recovery of recruitment arising from concerted international action. An international stock assessment, such as that of Astrom and Dekker (2007), is required to determine the level of reduction of anthropogenic mortality that is required across Europe to lead to such a recovery. Consequently, in the following chapter the model described earlier will be modified in order to determine the level of anthropogenic mortality within each RBD and the impact of proposed management measures on this level of mortality. In this way management measures can be evaluated in terms of achieving the recovery of the stock in the long term (under the assumption that the rest of Europe will achieve the same low rate of mortality). This can be considered an interim target, similar to those proposed by the WGEEL in 2008, to achieving recovery of recruitment and consequent ability to maintain escapement at or above the 40% EU target.

In the following figures, the dotted grey line for current escapement is only indicating the level of change from pristine (left end) and current escapement (right end where it cuts the y-axis). It does not infer a linear rate of change between 1980 and 2008.

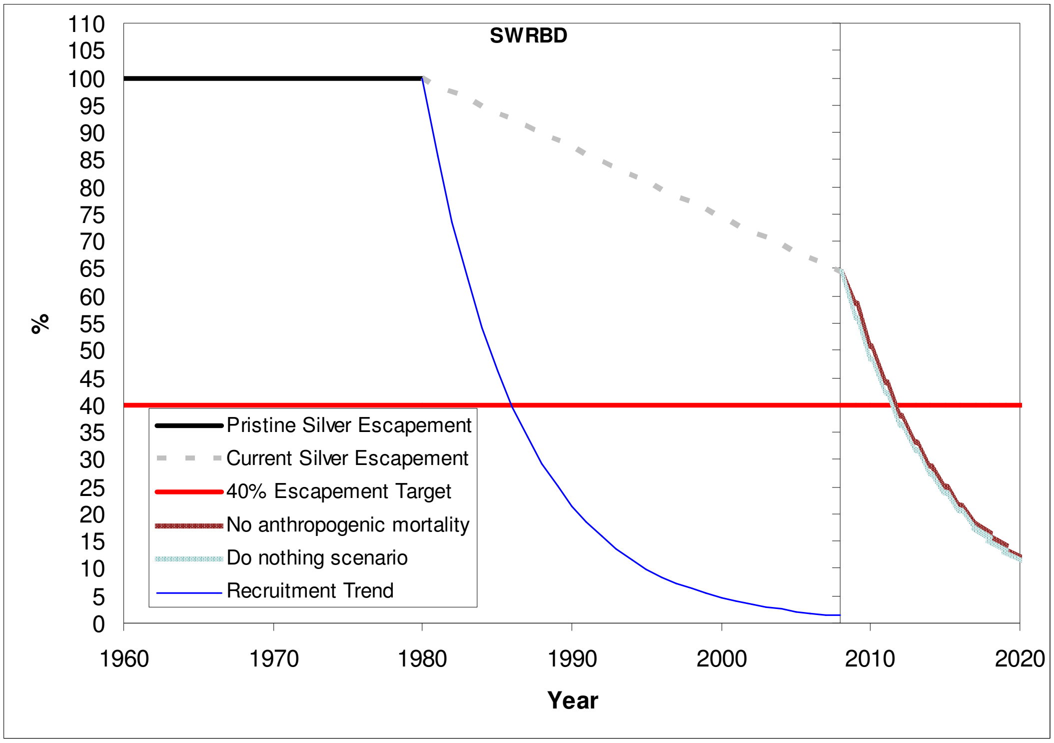
Eastern eel Management Unit



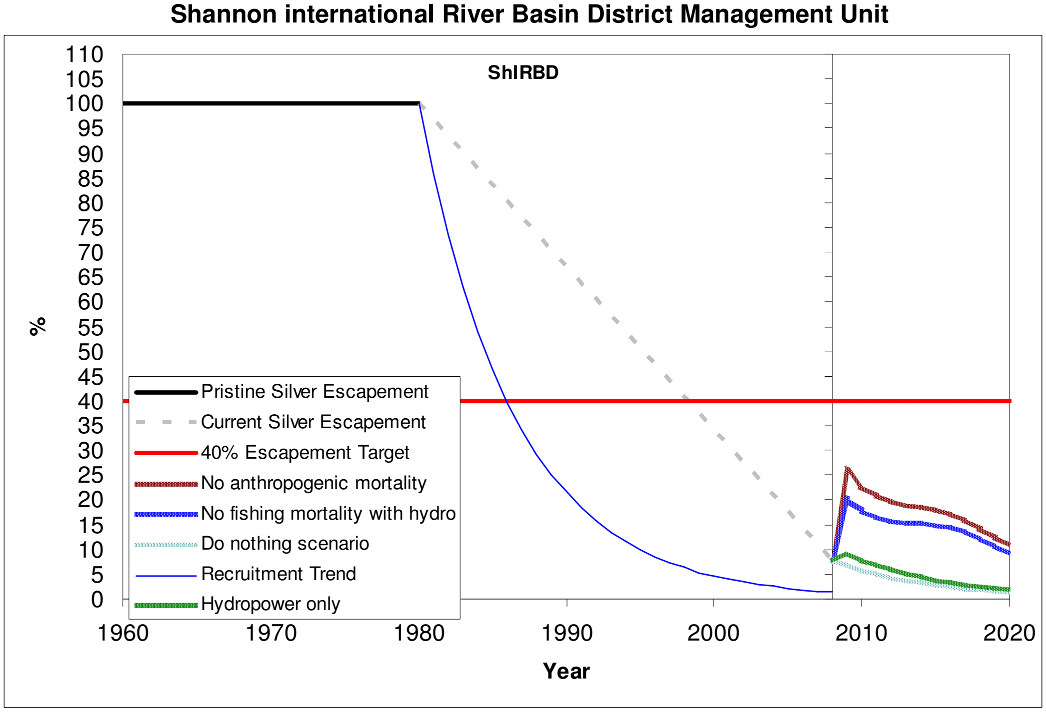
South Eastern River Basin District Management Unit



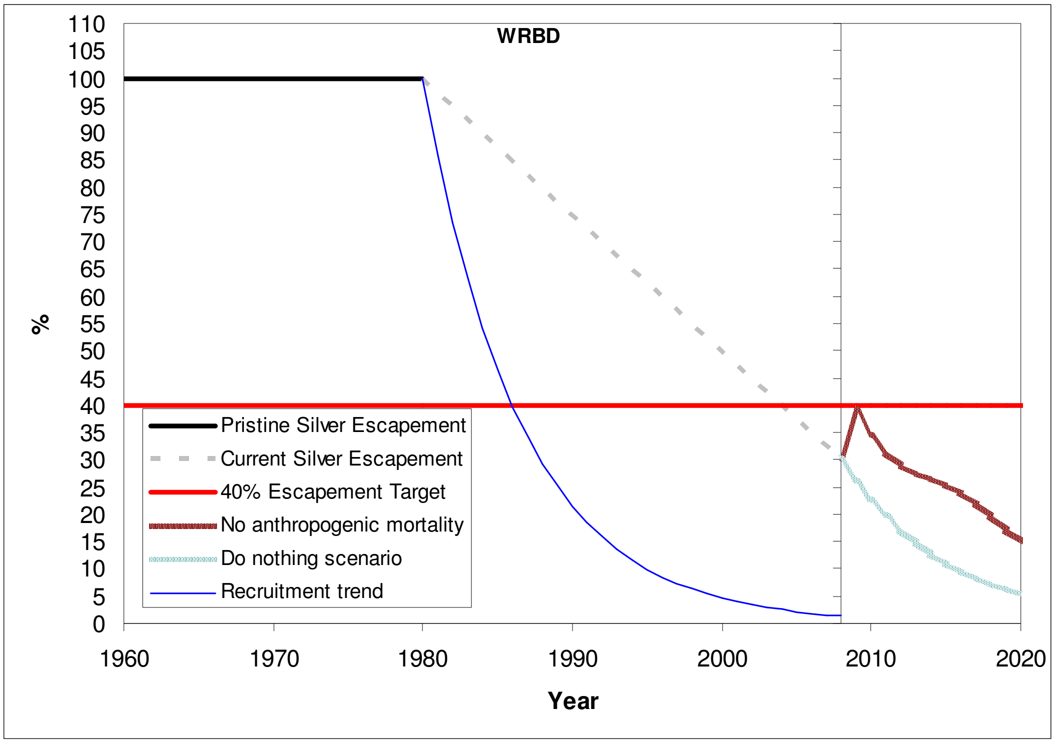
South Western River Basin District Management Unit



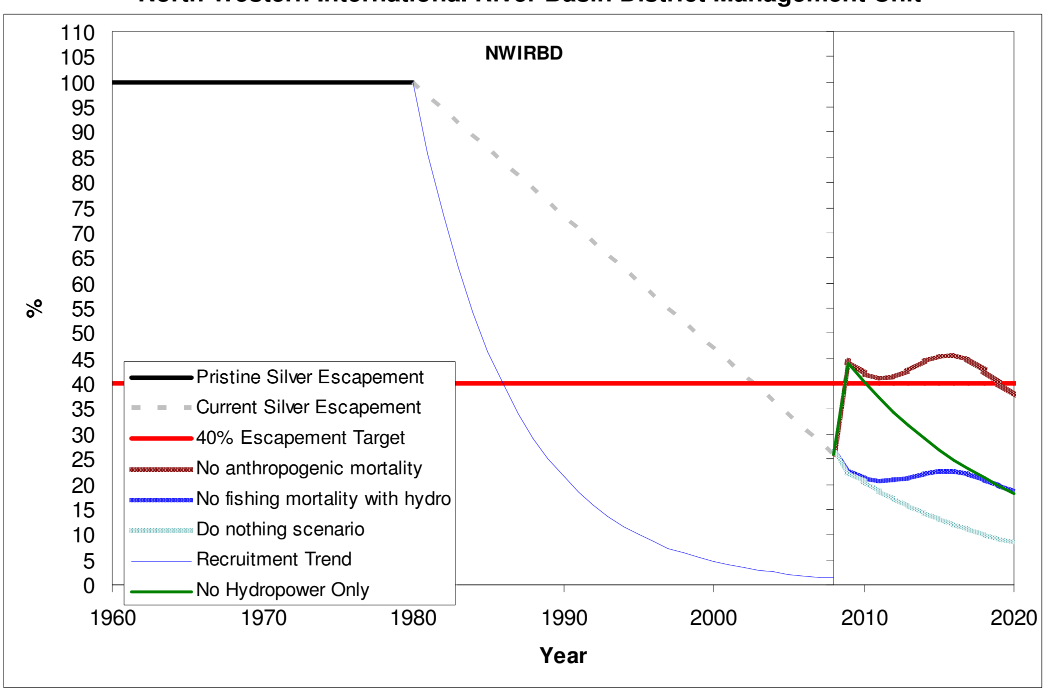
Shannon international River Basin District Management Unit



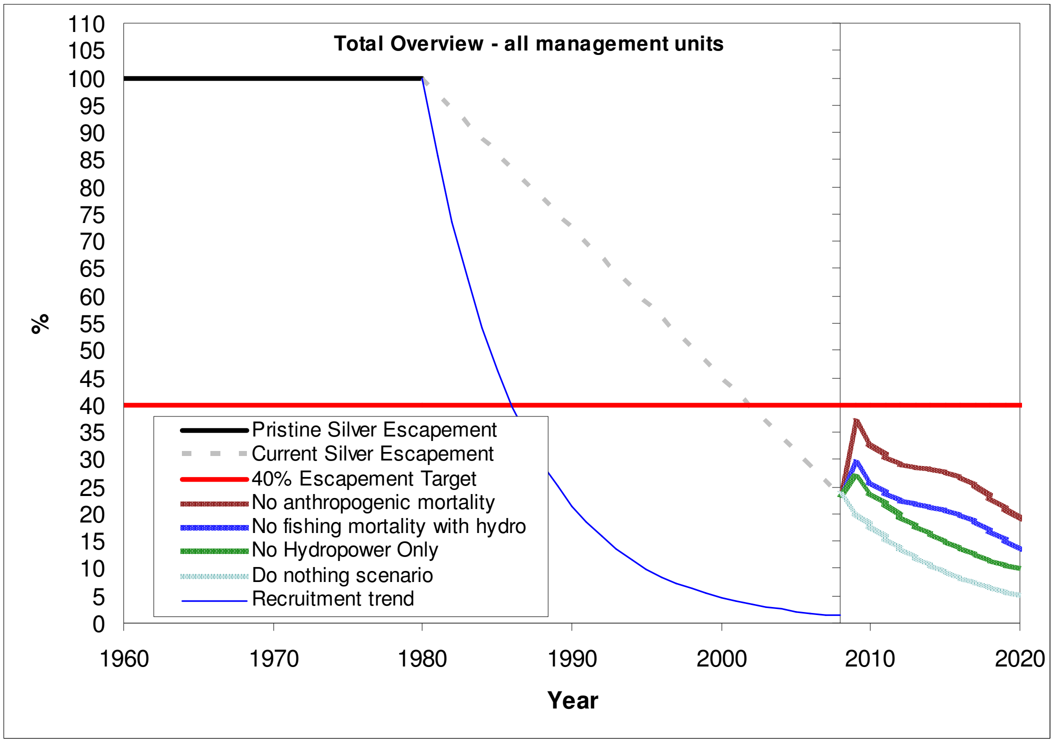
Western River Basin District Management Unit



North Western International River Basin District Management Unit



Total Overview – all management units



5.3 Timescales

The EU Regulation sets a biomass target based on achieving a level of silver eel escapement to be achieved in the longterm. As discussed in Section 5.2.4.4 of this report, reaching the target escapement with zero anthropogenic mortality may only be briefly achievable, if at all. Due to the legacy of poor recent recruitment, it is predicted that silver eel escapement will fall significantly in the coming years. It was difficult to assess a timeframe for recovering the predicted downward trend in escapement in the absence of knowing what the European recruitment levels will be in the near future and in the absence of a clear timeframe from the EU.

To facilitate setting a timescale to recovery it was decided to adopt the approach used by Astrom and Dekker (2007) in predicting the recovery time for recruitment under different reduced levels of mortality. Two assumptions were made: the first that Europe responds in a similar fashion to reducing mortality and the second, that as recruitment recovers towards historical, the Spawning Stock Biomass is recovering towards the target. Therefore, recruitment recovery is used as an INTERIM, or alternative, target towards the escapement target. It is also possible that the EU biomass target may be reached in a shorter timescale than full historical recruitment.

5.3.1 Time scale to recovery

Given the long period of decline in eel recruitment that has been observed, an analysis of possible recovery times in response to mortality reductions has been published (Åström & Dekker, 2007). The need for mortality reduction was quantified, indicating that no long-term recovery can be expected if fishery mortality remains above 15% of the current level. This breakpoint for recovery corresponds to around 60% of presently achievable spawner escapement.

Figure 5.12 (from Åström & Dekker, 2007) gives a broader picture of the relation between time until full recruitment recovery and proportional fishery mortality rate still allowed after fishery reductions (current European lifetime instantaneous fishing mortality is approximately $F = 3.25$). It is evident that even if the European fishery is completely closed and none of the released eels are killed by hydropower, recruitment is anticipated to fully recover first after about 80 years. Retaining any fishery markedly prolongs the recovery time, finally approaching infinity as 15% of the current EU fishery pressure is retained. Parameter values regarding the fishery pressure and life span represent an approximate average of the whole European eel population (mostly derived from Dekker, 2000a).

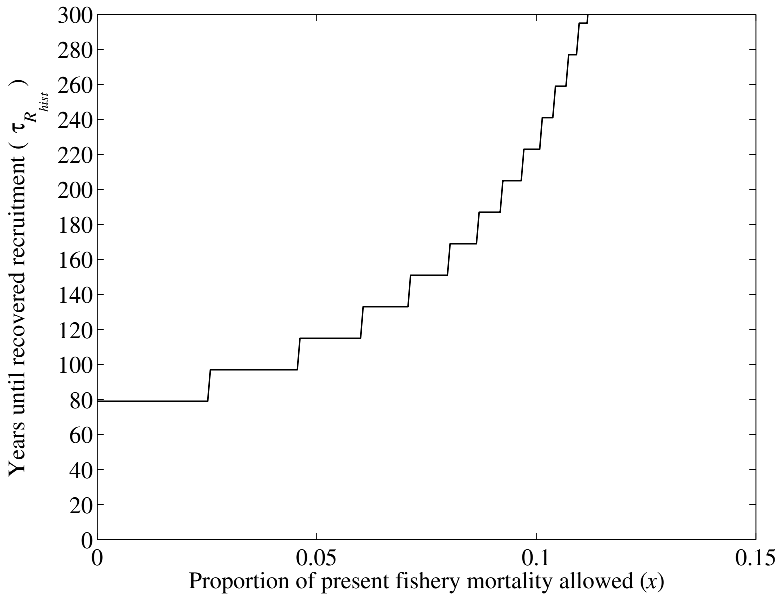


Figure 5.12. The time required for full recruitment recovery at the population level as consequence of the proportion of current fishing mortality still in practice after fishery reductions. Parameter values used represent an approximate average for the fishery pressures and life span of the whole eel population (mainly from Dekker, 2000b). From Åström & Dekker, 2007.

Åström & Dekker (2007) also numerically calculated the possible development of the recruitment over time after restricting fishery. Figure 5.12 illustrates the anticipated recruitment for two different levels of fishery restrictions; complete fishery closure and reducing the fishery by 85%, the latter representing the breakpoint between long-term recovery and continued long-term decline. Note that the wavelike pattern in Figure 5.12 is largely the result of simplifying assumptions in the model. Nevertheless, the clear answer whether long-term recovery will be reached or not, cannot be determined until more than one eel generation time has passed. It is also clear that the recovery will be slow. The long history of poor recruitment will lead to a 'shadow effect' where escapement will increase temporarily, as escapement is facilitated for the eels already in the system, and then drop as the cohorts from the recent period of poor recruitment progress towards silvering age (Figure 5.12).

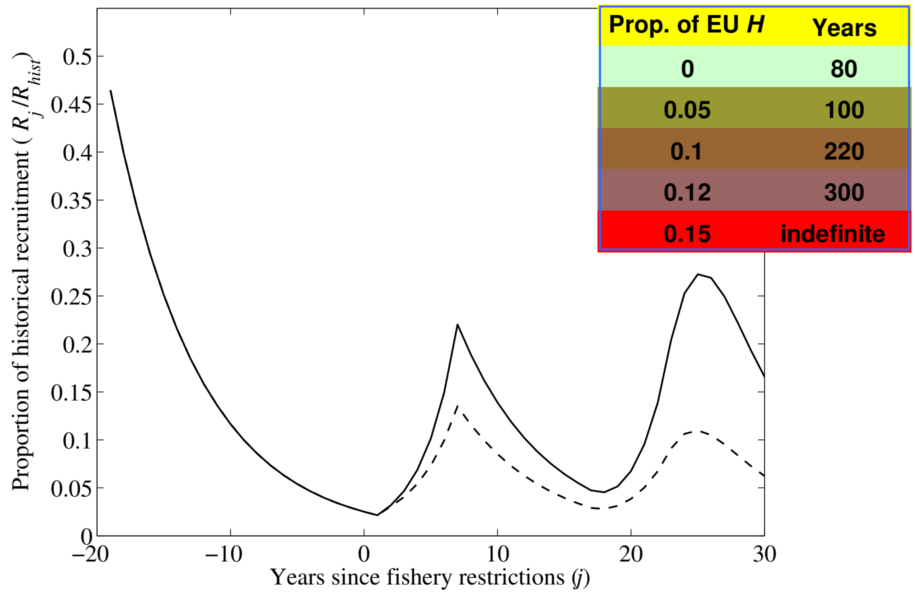


Figure 5.12. Expected recruitment (expressed as proportion of historical recruitment) after a complete fishery closure at j = 0 (solid line) or only restricting fishery to the breakpoint (15 % of current fishery pressure) where no long-term recovery occur (dashed line). Figure modified from Åström & Dekker (2007).

5.3.2 Time scale for achievement of the escapement target

International scientific advice is to reduce the level of anthropogenic mortality to as close to zero as possible to achieve recovery of the stock (ICES 2008). An 85% reduction of anthropogenic pressure is estimated to be required to prevent continued decline from the current extremely low level of recruitment without achieving any longterm recovery (Astrom and Dekker 2007). The lower the anthropogenic pressure the greater the likelihood of recovery and the quicker the recovery will occur (Fig. 5.12). The appropriate management actions and timeframe to achieve recovery are discussed in Chapter 8.

5.3.3 The effect of management measures on anthropogenic mortality

The model for estimating actual and potential silver eel escapement (see chapter 5) was modified to be based on eel numbers rather than eel biomass. Commercial catch weight frequency distributions for brown and silver eels (n > 2300) were investigated for a number of catchments in 2008 (Corrib, Mask, Conn, Oughter, Erne, Waterford Estuary, Slaney Estuary, Shannon) (Central Fisheries Board, Marine Institute, McCarthy pers. comm.). These size frequencies were used to convert the catch weights within those catchments to numbers of eels. The data were pooled to provide a national average weight distribution which was used to calculate numbers from the catches in all other catchments. Because the model was now based on numbers rather than weight, natural mortality was imposed on the brown eel catch in order to determine the number of potential silver eels removed by the fishery. The brown eel catch was assigned the same maturation rate distribution as before (see section 5.2.4.2). Natural survival was estimated at 86% per annum. This level of survival was derived from a lifetime estimate for the non-Biscay stock as a whole spread over the residence time of Irish eels (Dekker 2004).

Calculations of the instantaneous rates of fishing and turbine mortality were calculated based on silver eels alone i.e. brown eels caught by the fishery were converted to potential silver eels in order to quantify the pressure of the fishery on the stock.

$\Psi = C_s + E + \Psi_b$

(Ψ) potential silver eels, (C_s): silver eel catch, (E): escapement, (Ψ_b): potential silver eels from brown eel catch.

$\Psi_b = \sum_1^n (C_b).(P_n).(e^{-M})^n$

(C_b): brown eel catch, (P_n): proportion of brown eel catch maturing in (n) years, (M): natural mortality.

$F = -\ln((\Psi - C_s - \Psi_b) / \Psi)$

$T = -\ln(((\Psi - Cs - \Psi b)*\partial) / \Psi)$

$H = F + T$

(H): anthropogenic mortality, (F): fishing mortality, (T): turbine mortality, (∂): proportion of run surviving turbine

An interface tool was developed for the mortality based model to provide support to managers towards achieving the recovery target in Ireland while providing the potential for managers to balance costs and support decisions between stakeholders. In addition, in order to maximise the transparency of the scientific advice and the potential for stakeholder input, it was aimed to utilize, as far as possible, a simple structure involving tangible, concrete parameters. The tool synthesized the information available in an objective and systematic manner to estimate pristine and current escapement, estimate current anthropogenic mortality at the RBD scale (i.e. fisheries, hydropower) and provide timeframes to recovery under various management scenarios (eg. fisheries restrictions, trap and transport around hydropower). Outputs from the interface tool are presented in each RBD plan (Chapter 8) and are summarized in Chapter 9 of the National Report.

6 Stocking

Currently in Ireland there are two types of stocking carried out, both coming under the heading of "assisted migration" upstream. Purchase of glass eel for stocking from outside the state does not currently take place. During the monitoring programme 2009-2011 (see Chapter 7), an evaluation of recruitment levels will take place. This will facilitate an assessment of possible stocking strategies as a useful tool to aid stock recovery. This assessment will be guided by the Eel Scientific Committee. Any stocking taking place can, and will be, included in the assessment of the local stocks and the modelling of escapement and stock recovery.

6.1 Assisted Migration

Assisted migration of upstream migrating pigmented elvers takes place, by way of e.g. eel ladders, in the Shannon (Ardnacrusha) and Erne (Cathaleens Falls) and of pigmented young eel (bootlace) on the Shannon (Parteen). It is proposed to **continue** this operation.

Currently, small amounts of additional glass eel and elver are taken in the Shannon estuary and in neighbouring catchments and these are stocked into the Shannon above Ardnacrusha and Parteen. Given the widespread presence of *Anguillicola* and the move towards risk averse management strategies at low recruitment levels, this practice will be **discontinued**.

It is proposed that in the event of recovering recruitment, a stocking strategy will be developed by stocking "surplus" recruits into good quality (e.g. low contaminants, no *Anguillicola*) catchments where stocks are identified to be low. Stocking will be for conservation and will be undertaken in a risk averse manner using the stocking strategy devised by WGEEL (ICES, 2006) shown below.

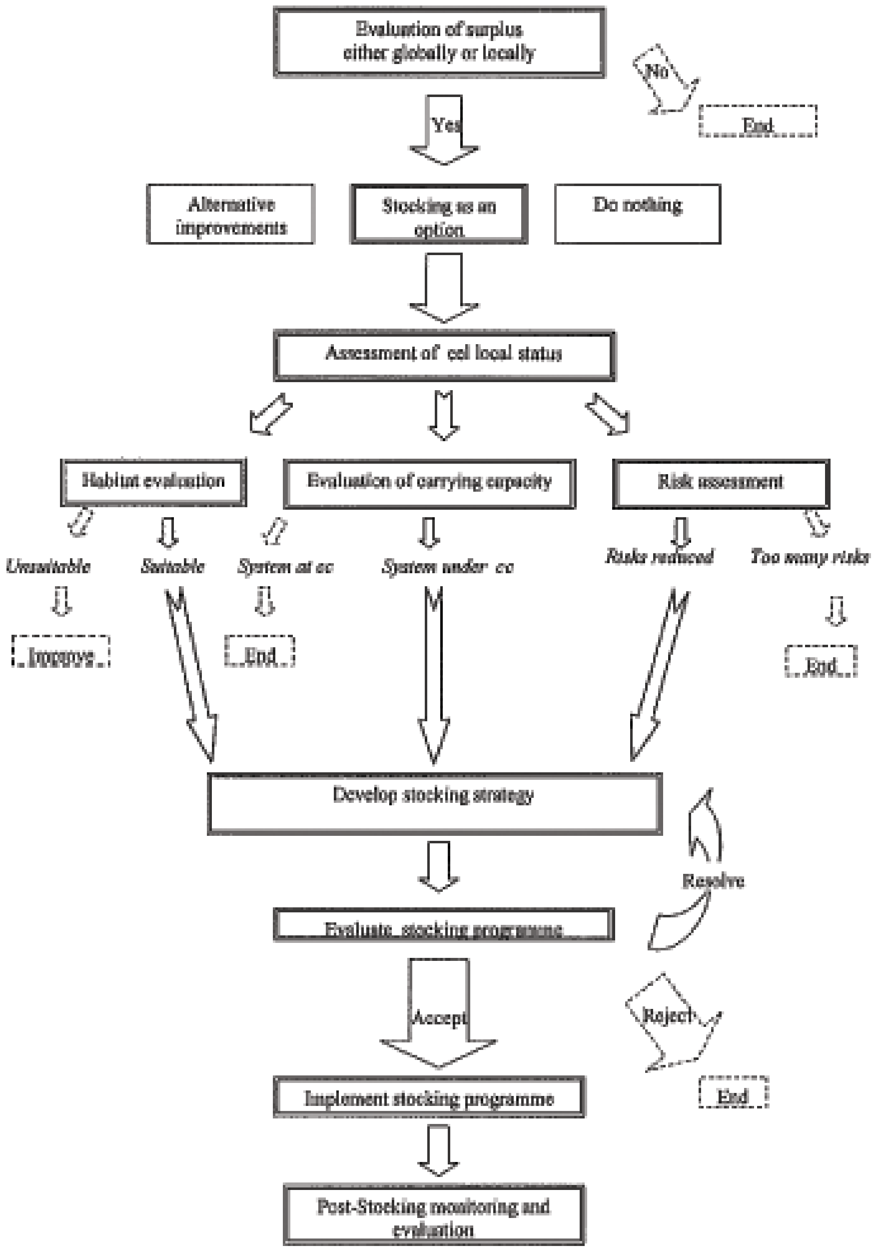


Figure 7.6. Stocking strategy – overview of decision process. The inner box ("Develop stocking strategy") is further detailed in Figure 7.7.

Taken from: ICES, 2006.

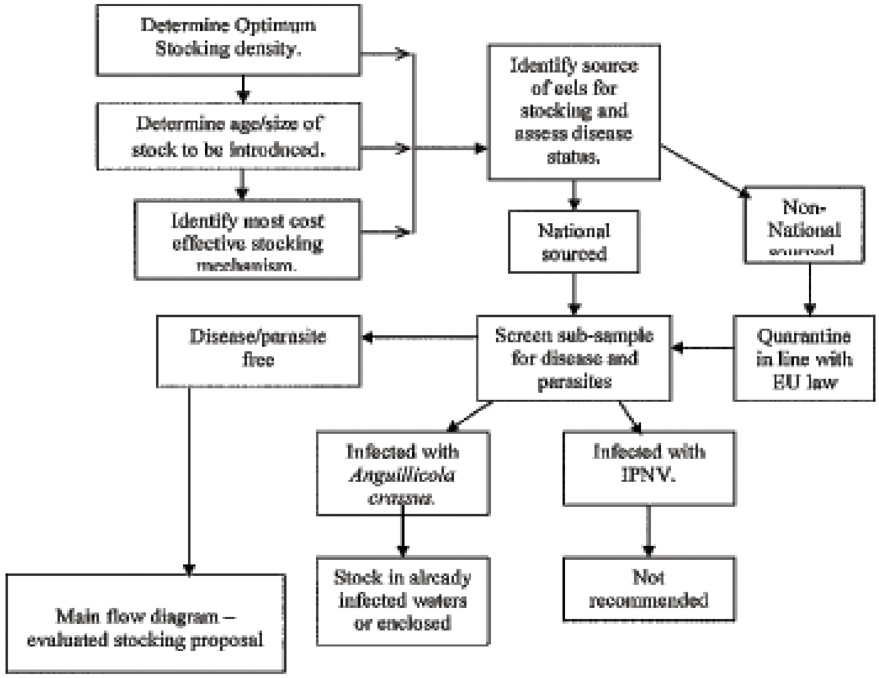


Figure 7.7. Development of a stocking strategy. This diagram is an elaboration of the inner box of Figure 7.6.

Taken from: ICES, 2006.

7 National Policy for Sampling Catch and Surveys (Scientific/Technical & Survey Support for Regulation)

Every three years, each Member State must submit details of:

- monitoring,
- effectiveness and outcome of Eel Management Plans
- contemporary silver eel escapement
- non-fishery mortality
- policy regarding enhancement/stocking

The following sections cover monitoring of implementation and effectiveness of Management Actions (Management Action Targets – see Chapter 8 for Management Actions) and also monitoring of the impact of management actions on the eel stock (Eel Stock Targets).

7.1 Management Action Targets

The management actions proposed include:

1. Reduction of fishery to achieve EU target
2. Mitigation of hydropower
3. Ensure upstream migration at barriers
4. Improve water quality

See Chapter 8 of the National Report and the RBD Eel Management Plans.

Management Action No. 1: Reduction of fishery to achieve EU target

Action 1a: Cease fishery and close market

Timescale: 2009
Review: 2012, 2015, 2018

Monitoring Actions:	Cessation of the fishery will be monitored and enforced in accordance with legislation Impact on eel stock will be assessed – see eel target monitoring below

Management Action No. 2: Mitigation of hydropower

Action 2a: Trap & Transport

Timescale: 2009 - 2011
Review: 2012, 2015, 2018 and annual review of quantity Trapped & Transported v escapement estimate

Monitoring Actions:	Determine annual escapement and use to guide amount to be transported Monitor quality of transported eels to ensure minimal damage Monitor & Sign-off on quantity transported

Hydropower impact is a function of immediate turbine mortality (i.e. % of run killed by turbine), delayed turbine morbidity (i.e. % of run injured by turbine) and the size of the run. The quantities of silver eels requiring trap and transport around turbines, therefore, requires information on these parameters.

Action 2b: Quantify Turbine Mortality and morbidity

Timescale: 2009 -2011 with precision estimate
Review: 2012, 2015, 2018

Monitoring Actions:	Quantify the level of mortality (& morbidity) at each power turbine Quantify the possible escapement through by-pass channels Estimate precision and variation due to environmental conditions

Almost half of the wetted area of Ireland is upstream of hydropower barriers that are known to impact on eel. The average reported mortality for turbine passage is 28.5% (ICES estimate). Mortality rates are highly variable and there is inevitable size selectivity. Empirical data is currently lacking for Ireland. Such barriers may impact significantly on Ireland's ability to meet eel escapement targets and Ireland's ability to produce large female eels needed to support a stock recovery. It is essential that estimates of mortality and morbidity are undertaken for the hydropower facilities (Table 7.1).

A standard methodology should be developed by the Eel Scientific Committee and employed to enable reasonably precise estimates of turbine mortality and morbidity to be calculated. This information will allow an estimate of the requirement of trap and transport to be calculated.

Table 7.1. Hydropower turbines requiring mortality and morbidity estimates. The turbines are shown in order of biological importance and investigation of lower priority turbines will be subject to availability of resources.

Location	**Priority**	**Required precision**	**Method**
Erne	High	To be confirmed	Hydro-acoustics/tags
Shannon (Ardnacrusha)	High	To be confirmed	Hydro-acoustics/tags
Ballysadare	Medium	To be confirmed	Hydro-acoustics/tags
Lee	Low	To be confirmed	Hydro-acoustics/tags
Slaney	Low	To be confirmed	Hydro-acoustics/tags

Action 2c: New turbine Installations
Ensure that all new installations should include an evaluation of all direct and indirect impacts on eels and that measures are undertaken so as to minimise these impacts. The efficacy of screens should be monitored for at least the first 3 years following installation (see section 3.5.2.2 of the National Report).

Action 2d: Engineered solutions
A long term strategy that may involve turbine design and modification and modification/creation of alternative downstream routes. Trap and transport will be employed until the efficacy of engineered solutions has been demonstrated (see section 3.5.1 of the National Report).

Action 2e: Other solutions (e.g. Migromat ™)
Aids to increase the efficiency of mitigation measures will be evaluated on an on-going basis as appropriate.

Management Action No. 3: Ensure upstream migration at barriers

Action 3a: Existing barriers (including small weirs etc.)
It is not currently known to what extent existing barriers impede upstream migration of eels in Ireland. This will be dealt with through the monitoring programme described in 7.2.4 of the National Report. Following this evaluation, management measures will be considered as appropriate with a view to improving accessibility and negating any current impact.

Action 3b: New potential barriers
Ensure that all new installations should include an evaluation of all direct and indirect impacts on eels and that measures are undertaken so as to negate these impacts (see section 3.5.2.2 of the National Report).

Action 3c: Assisted migration and stocking

In the event of a stocking programme being shown to be likely to yield a net benefit to the stock, this will be carried out in accordance with Chapter 6 of the National Report.

Management Action No. 4: Improve water quality

Action 4a: Ensure compliance with the Water Framework Directive
Timescale: 2015
Review: 2012, 2015, 2018

Monitoring Actions: Include eel in the fish monitoring elements of the WFD
Undertake further eel quality monitoring (EUFP7 EELIAD)

7.2 Eel Stock Targets

A close link between the management actions and eel-stock targets will be established. This will allow for a direct feedback to management based on response of the stock to management actions. The methods to evaluate management measures and the response of the eel life stages are set out below.

Monitoring Objective 1: Synthesise available information into a model based management advice tool.

All of the eel data collected from the range of surveys described below will be collated, analysed and used to develop a model(s) to provide 'integrated' management advice for the sustainable management of eel stocks nationally. The currently available tool-box for stock assessment is insufficient to accurately and robustly predict actual escapement. Further development of such approaches is a conservation priority. Furthermore, it is critical to the success of both the management and monitoring programmes that the data is collected and collated in a co-ordinated, logical and systematic way and that a method is developed to integrate this information in a management tool.

7.2.1 Silver Eel Escapement

Monitoring Objective 2: Estimate Silver Eel Escapement
Ultimately, Council Regulation (EC) No 1100/2007 targets silver eel escapement. Ireland is therefore required to provide an estimate of contemporary silver eel escapement. The Regulation also requires post-evaluation of management actions by their impact directly on silver eel escapement. Quantitative estimates of silver eel escapement are required both to establish current escapement and to monitor changes in escapement relative to this benchmark. Furthermore, the sex, age, length and weight profile of migrating silver eels are important for relating recruitment or brown eel stocks to silver eel escapement. Quantifying migrating silver eel between September and December each year is a difficult and expensive process but it is the only way of ultimately calibrating the outputs of the assessments.

Silver eels will be assessed by fishing index stations on an annual basis on the Corrib, Erne, Shannon and Burrishoole catchments, (Table 7.2). Trial fishing at other locations using coghill nets, mark-recapture and technology options such as electronic counters or DIDSON technology will be evaluated. Subject to this evaluation, it is proposed to survey a series of additional index locations on a three year rolling basis (Table 7.2).

Significant investment has been made in relation to the installation of fish counting technologies on many major catchments. While these technologies are specifically designed to count salmon, consideration will be given to investigating their potential to assess/quantify silver eel escapement. In the absence of a commercial fishery the counters might also be used to identify when significant runs were underway

Table 7.2. The locations where silver eel escapement will be measured. The investigation of lower priority catchments will be subject to availability of resources.

Catchment	Priority	2009	2010	2011	Method
Corrib	High	√		√	Coghill net / Mark-recapture
Erne	High	√	√	√	Mark-recapture
Shannon	High	√	√	√	Coghill net / Mark-recapture
Burrishoole	High	√	√	√	Trap
Mask	Medium		√		Coghill net / Mark-recapture
Muchno	Medium			√	Coghill net / Mark-recapture
Waterville	Medium			√	Fish Counter

Little is known about escapement of silver eel from transitional waters (estuaries, embayments etc). Improved assessment of transitional water stock density and distribution is required to allow the determination of transitional water silver escapement. Methodologies are currently lacking in Europe and a significant effort will be made to develop appropriate methodologies in conjunction with the ICES Working Group on Eel.

7.2.2 Brown Eel Stock Assessment

Brown-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement, particularly within transitional waters where silver eel escapement is extremely difficult to measure directly. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, and the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year. Furthermore, individuals from this sample will be used to determine levels of contaminants and parasites to assess spawner quality. Two classes of survey methodologies will be employed; eel specific surveys and multi-species surveys, mainly involving standardised fyke netting and electro-fishing.

Fyke net surveys carried out between 1960 and 1980 by State Fisheries Scientists will provide a useful bench mark against which to assess the changes in stock. The brown eel monitoring strategy will rely largely on the use of standard fyke nets. Relative density will be established based on catch per unit (scientific-survey) effort.

Water Framework Directive surveys will be undertaken on lakes (fyke nets, gill-nets and hydroacoustics) rivers (electro-fishing and fyke nets) and transitional waters (fyke nets, seine nets & beam trawls) in 2009 which will add significantly to the monitoring requirements nationally.

7.2.3 Eel specific surveys

Monitoring Objective 2.1: Estimate Silver Eel Escapement – Using Indirect Assessment from Brown Eel Stock
This will be achieved by eel specific targeted quantitative surveys involving stock assessment at selected locations.

Monitoring Objective 3: Monitor the impact of fishery closure on brown eel stock structure
Targeted annual fyke net surveys to show trends in brown eel stock structure.

Monitoring Objective 4: Inter-Calibration with Water Framework Sampling
The brown eel stock will be assessed in a number of lakes using WFD surveys and targeted eel stock surveys to establish inter-calibration between both survey methods.

Monitoring Objective 5: Compare current and historic brown eel stocks
Catchments where historic quantitative eel survey data is available will be re-surveyed. This will provide current data on brown eel abundance and serve as a proxy to estimate relative changes in silver eel escapement.

Monitoring Objective 6: Establish baseline data to track changes in eel stock over time
Eel specific surveys will be carried out in a number of waterbodies between 2009 and 2011 to provide a baseline for tri-annual tracking brown eel stock changes (Table 7.3). WFD / Fishery Board and ESB river and lake multi-species surveys will provide additional baseline data.

Table 7.3. The locations in which eel specific surveys will be carried out and the monitoring objectives they are intended to contribute to fulfilling.

	Year			Monitoring objective					
Location	**‘09**	**‘10**	**‘11**	**O. 2.1**	**O. 3**	**O. 4**	**O. 5**	**O. 6**	**O. 7**
L. Derg	√	√	√	√	√	√	√	√	√
Lower Corrib	√			√	√	√	√	√	√
Burrishoole	√			√		√	√	√	√
L. Ramor		√		√	√	√		√	√
L. Arrow		√		√		√	√	√	√
L. Mask			√	√		√	√	√	√
L. Cullen	√			√		√	√	√	√
Upper Corrib	√			√			√	√	√
L. Conn	√			√			√	√	√
L. Oughter		√		√			√	√	√
Dromore L.			√	√			√	√	√
L. Ree		√		√			√	√	√
L. Allen			√	√			√	√	√
L. Inchiquin			√	√			√	√	√
Ballynahinch			√	√			√	√	√
Upper Erne		√		√				√	√
Waterford Estuary	√			√	√			√	√
Slaney estuary		√		√	√			√	√
Lady’s Island lake			√	√	√			√	√
Ballysadare estuary	√			√				√	√

7.2.4 Multi-species surveys and eel specific surveys.

Monitoring Objective 7: Evaluate impedance of upstream colonisation: migration and water quality effects.
The large number of water-bodies to be surveyed under the WFD & CFB / RFB electro-fishing surveys (Table 4) will aid determination of the impact of barriers and water quality on upstream migration of eels. The methodology can be based on analysis of electro-fishing data and barrier information logistic regression. Lasne & Laffaille (2007) used such a methodology to prioritise barriers for mitigation.

Monitoring Objective 8: Determine parasite prevalence and eel quality
The range of monitoring surveys outlined and Water Framework Directive fish monitoring surveys will provide material to determine parasite prevalence and eel quality (PCB levels, fat content, heavy metals). While it is intended that parasite screening be carried out in all sites the intensity of the eel quality aspects of the programme will be determined by available resources.

Table 7.4. The sampling intensity of the WFD multi-species surveys and the objectives they are intended to contribute to fulfilling.

WFD Sampling in 2009	Objective 5	Objective 6	Objective 7	Objective 8
29 transitional waters	√		√	√
26 lakes	√	√	√	√
52 rivers (wadeable)	√	√	√	√
40 rivers (boat)	√	√	√	√

7.3 Recruitment (Glass Eel/Elver)

Recruitment of glass eel / elver to Ireland will depend on European wide management action and will not, of itself, provide a means to post-evaluate Irish management actions specifically. However, monitoring of recruitment is critical to evaluating the overall success of the eel regulation and is required by ICES for stock assessment. This information is also required to project the recovery in Irish eel stocks.

An assessment of the availability of glass eel for stocking will be undertaken in early spring at a number of estuarine locations. The identification of substantial resources of glass eel will be evaluated for stocking as outlined in Chapter 6.

It is also intended that trends in runs of glass eel/elver arriving in Irish waters be monitored quantitatively at sentinel sites, as recommended in the Eel Review (2004). Essential locations with existing data series are the Erne and the Shannon. It would be desirable to include a number of additional locations with regard to biological and practical considerations.

7.4 Surveys

Some of the surveys described above will benefit from the engagement of experienced fishermen. It is intended, where practicable, to carry out these surveys using contracted experienced fishermen engaged through a process of tendering.

7.5 Stocking

Should a source of excess glass eels or elvers be identified, this resource will be used in a biologically risk averse way following ICES (2008) advice. Should such a programme get approval, monitoring and stocking and post-evaluation of effectiveness could be undertaken within the programme outlined above.

7.6 Other Research Elements

Predator Impact

It is desirable to estimate the impact of predators on eel stocks nationally and to collaborate in international initiatives in this regard.

By-Catch

Evaluate the impact of the by-catch of other fisheries (e.g. green crab) on eel stocks and to collaborate in international initiatives in this regard.

Recreational Fisheries

Monitor the recreational fisheries to ensure minimum mortality and compliance with catch and release objectives.

7.7 Data Collection Regulation

Ireland is committed to compliance with the Data Collection Regulation and submitted a provisional plan for sampling eel catch in 2009 and 2010 to the EU. Given the cessation of the eel fishery there will be no obligation to undertake catch sampling under the DCR, at least for the next three years.

8 Management Measures

Scientific advice has indicated levels of silver eel escapement from freshwaters is currently approximately 24% of pristine production (EU target = 40%) on a national level (see Section 5.2.3.4) and that this will decline as a consequence of poor and declining recruitment over the last 18+ years (see Section 5.2.4.4). International stock assessment has related the likelihood and time-frame of recovering recruitment to different reduced levels of anthropogenic mortality. Recovering recruitment will allow Ireland to define management measures that ensure 40% escapement in the future. In the interim, recovery of recruitment is an appropriate alternative target that can be directly linked to management actions (see section 5.3 of the National Plan).

Anthropogenic (human) mortality must be reduced across Europe by 85%, on average, just to halt the decline in the extremely low level of current recruitment. It should be noted that current recruitment is expected to lead to much lower levels of silver eel escapement than currently observed. Merely halting the decline is scientifically unacceptable and management actions must aim above this level. The closer to zero that mortality is reduced, the more assured we are of achieving a recovery and the quicker the recovery will occur (see Section 5.3).

8.1 Management Actions

Management Action No. 1: Reduction of fishery to achieve EU target

Action 1a: Cease fishery and close eel market
Timescale: 2009
Review: 2012, 2015, 2018
Consequently, there will be a need for an increase in targeted eel protection and patrols for eels.

Freshwater
Given the implications of the scientific advice, the consideration of practical management implications and the need to conserve and recover the stock in the shortest possible timeframe (contingent upon equivalent actions across Europe), the precautionary approach is being adopted in accordance with the recommendations of the National Eel Working Group and the eel fishery will be ceased and the market closed.

Tidal and Transitional Water
Given the absence of appropriate methods for estimating eel stock densities in transitional waters, the implications of the scientific advice on the general status of the stock, the consideration of practical management implications and the need to conserve and recover the stock in the shortest possible timeframe (contingent upon equivalent actions across Europe), the precautionary approach is being adopted in accordance with the recommendations of the National Eel Working Group and the eel fishery in transitional and tidal waters will also be ceased and the market closed.

Action 1b: Recreational fishery
The proposed legislation will prohibit the possession of live eels and this will extend to cover recreational angling.

Action 1c: Diversification of fishery
CFB and eel fishermen will be engaged in investigating possible diversification for the former commercial fishermen.

Management Action No. 2: Mitigation of hydropower
Develop best practice document on the safe passage of eels through hydro-electric power stations and other barriers including water abstraction points.

Action 2a: Trap & Transport

Review: 2012, 2015, 2018 and annual review of quantity trapped & transported vs. escapement estimate.

Action: In the first three years of the EMP the following are the proposed trap and transport actions. These will be regularly reviewed and updated.

Shannon: Trap and transport 30% of the annual escapement

	catch target (t)	% of expected silver eel run	Proportion of EU H achieved – fishery closed	Approx. timeframe to recovery (y)
2009	not defined	30	0.045	95
2010	not defined	30	0.045	95
2011	not defined	30	0.045	95

Erne: Trap and transport the following

	catch target (t)	% of expected silver eel run	Proportion of EU H achieved – fishery closed	Approx. timeframe to recovery (y)
2009	22	36	0.092	200
2010	34	54	0.075	140
2011	39	63	0.05	100

Lee: Trap and transport 500kg of the annual escapement

	catch target (t)	% of expected silver eel run	Proportion of EU H achieved – fishery closed	Approx. timeframe to recovery (y)
2009	0.5	34	0.007	80
2010	0.5	34	0.007	80
2011	0.5	34	0.007	80

The survey plan for monitoring the proportion of the silver eel run transported around turbines will be reviewed by the Eel Scientific Committee. The Committee will also review the trap and transport protocol.

Action 2b: Quantify Turbine Mortality and morbidity

Timescale: 2009 with precision estimate
Review: 2012, 2015, 2018

Almost half of the wetted area of Ireland is upstream of hydropower barriers that are known to impact on eel. The average reported mortality for turbine passage is 28.5% (ICES estimate). Mortality rates are highly variable and there is inevitable size selectivity. Empirical data is currently lacking for Ireland. Such barriers may impact significantly on Ireland's ability to meet eel escapement targets and Ireland's ability to produce large female eels needed to support a stock recovery. It is desirable that estimates of mortality and morbidity are undertaken for the hydropower facilities on each catchment.

A standard methodology should be employed to enable reasonably precise estimates of turbine mortality and morbidity to be calculated. This will be developed by the Eel Scientific Committee. This information will allow an estimate of the requirement of trap and transport to be calculated.

***Action 2c**: Engineered solutions*
A longterm strategy involving turbine design and modification. Trap and transport will be employed until the efficacy of engineered solutions has been demonstrated (see section 3.5.1 of the National Report).

***Action 2d:** Other solutions (e.g. Migromat ™)*
Aids to increase the efficiency of mitigation measures will be evaluated on an on-going basis as appropriate.

***Action 2e:** New turbine Installations*

Ensure that all new installations should include an evaluation of all direct and indirect impacts on eels and that measures are undertaken so as to negate these impacts. The efficacy of screens should be monitored for at least the first 3 years following installation (see section 3.5.2.2 of the National Report).

Management Action No. 3: Ensure upstream migration at barriers

Action 3a: Existing barriers
It is not currently known to what extent existing barriers impede upstream migration of eels in Ireland. See Chapter 7 of the National Report for details on monitoring associated with this management action. Following this evaluation, management measures will be considered as appropriate. In the meantime, assisted migration should continue at current locations (Ch. 6)

Action 3b: New potential barriers
Ensure that all new installations should include an evaluation of all direct and indirect impacts on eels and that measures are undertaken so as to minimise these impacts (see section 3.5.2.2 of the National Report).

Action 3c: Assisted migration and stocking
In the event of a stocking programme being shown to be likely to yield a net benefit to the stock, this will be carried out in accordance with Chapter 6 of the National Report.

Management Action No. 4: Improve water quality

Action 4a: Ensure compliance with the Water Framework Directive
Timescale: 2009-2015
Review: 2012, 2015, 2018

Action 4b: Fish Health and Biosecurity Issues
Timescale: 2009
Review: 2012, 2015, 2018

Ensure compliance with the Fish Health Directive for all movements of eels, including elver transport, stocking and trap and transport of silver eel. Introduce measures to protect biosecurity of waterbodies to prevent the introduction and spread of exotic species, diseases and parasites.

8.2 Projected impact of management actions

The management actions proposed will result in no fishing mortality and markedly lower turbine mortality. According to the stock assessment of Astrom and Dekker (2007), this should result in recovery of recruitment within approximately 90 years and achievement of the EU escapement biomass target in a similar or shorter timeframe, assuming the average European anthropogenic mortality is reduced to a comparable level.

8.3 Raising awareness of the state of the stock

Raising public awareness among the wider public on eels as a species in serious decline through educational and awareness raising programmes.

Ensure that consideration of eels is included in Environmental Impact Assessment, Water Framework Directive Programme of Measures, and relevant land and foreshore management (e.g. drainage and dredging operations.

9 Summary of individual RBD targets

Estimates of historic production without anthropogenic impact, current escapement and their ratio (%) are summarised for each Eel Management Unit in Table 9.1. As discussed in Section 5.3 of the National Report, it was not currently possible to define management actions and a timeframe to achieve the EU biomass target, so an alternative target of timeframe to full recovery of recruitment was defined. The timeframes to recovery associated with the management actions reducing mortality are summarised for each EMU in Table 9.2. With the proposed management actions for 2009-2011, all EMUs, and Ireland as a whole, are contributing to a recovery of recruitment at the 100 year timeframe or less. It is imperative that equivalent EU-wide action is taken at this level so as not to diminish the impact of Ireland's contribution.

Table 9.1. Estimates of pristine production and current escapement of silver eel and the % escapement for freshwater catchments given in parentheses. Note the EU target is 40%

	Pristine Production (t)	Current Escapement (t) & (% of Pristine Escapement)	Projected Escapement average, 2009-2011, with no management action	Projected Escapement average 2009-2011, with proposed management actions[1]
EEMU	22	7 (33%)	5.5 (25%)	7.2 (33%)
SERBD	16	9 (55%)	6.6 (41%)	7.6 (48%)
SWRBD	26	17 (64%)	12.6 (48%)	12.8 (49%)
SHIRBD	214	18 (8%)	13.4 (6%)	41.3 (19%)
WRBD	170	51 (30%)	38.8 (23%)	58.4 (34%)
NWIRBD	147	38 (26%)	30.3 (18%)	40.6 (28%)
National	595	140 (24%)	107.1 (18%)	173.3 (29%)

[1] Fishery cessation and market closure and trap and transport mitigation of hydropower mortality

Table 9.2. Timeframe for recovery of recruitment associated with the currently proposed management actions.

		Z	Mortality (%)	Timeframe to recovery
EU	Current	3.25	96	extinction
EU	Minimum target to stop decline	0.49	39	indefinite
EEMU	Current (2001-2007)	0.46	37	>>350 years
	Proposed management	0.01	1	80 years
SERBD	Current (2001-2007)	0.15	13	95 years
	Proposed management	0.00	0	80 years
SWRBD	Current (2001-2007)	0.03	3	85 years
	Proposed management	0.02	2	80 years
SHIRBD	Current (2001-2007)	0.74	52	extinction
	Proposed management	0.14	13	95 years
WRBD	Current (2001-2007)	0.63	47	extinction
	Proposed management	0.02	2	80-85 years
NWIRBD	Current (no byelaw)	0.66	48	extinction
	Proposed management	0.16	15	100 years
Overall total	Current (no byelaw)	0.59	45	extinction
	Proposed management	0.09	9	90 years

10 References

Amiro, P.G. (1993). Habitat measurement and population estimation of juvenile Atlantic salmon. In; R.J. Gibson and R.E. Cutting (ed). Production of juvenile Atlantic salmon in natural waters. Can. Spec. Publ. *Fish. Aquat. Sci.,* **118;** 81-97.

Anon. (2007). Guidelines on the planning, Design, Construction and Operation of Small-Scale Hydro-Electric Schemes and Fisheries. *Central Fisheries Board & DCENR; Dublin*; 52pp.

Arai, T., Kotake, A., & McCarthy T.K. (2006). Habitat use of European eel in Irish waters. *Estuarine, Coastal and Shelf Science*. (in press).

Åström, M. & Dekker, W. (2007). When will the eel recover? A full life-cycle model. – ICES *Journal of Marine Science*, **64;** 1–8.

Dekker, W. (2000 b). The fractal geometry of the European eel stock. *ICES Journal of Marine Science*, **57;** 109-121.

Dekker, W. (2004). A procrustian assessment of the European eel stock. *ICES Journal of Marine Science*, **57**; 938-947.

Dekker W., Pawson M., Walker A., Rosell R., Evans D., Briand C., Castelnaud G., Lambert P., Beaulaton L., Åström M., Wickström H., Poole R., McCarthy T.K., Blaszkowski M., de Leo G. and Bevacqua D. (2006). *Report of FP6-project FP6-022488, Restoration of the European eel population; pilot studies for a scientific framework in support of sustainable management; SLIME. 19 pp. + CD.*

Harrod C., Grey J., McCarthy T.K. & Morrissey M. (2005). Stable isotope analyses provide new insights into ecological plasticity in a mixohaline population of European eel. *Oecologia*, **144;** 673-683.

ICES, (2003). Report of the EIFAC/ICES Working Group on Eels, 2-6 September 2002, Nantes, France. *ICES CM 2003/ACFM;06.*

ICES, (2006). The report of the 2006 Session of the Joint EIFAC/ICES Working Group on Eels. Rome, Jan., 2006; *ICES CM 2006/ACFM:16.*

ICES, (2008). The report of the 2007 Session of the Joint EIFAC/ICES Working Group on Eels. Bordeaux, Sept. 2007; *ICES CM 2007/ACFM;23.*

Kelly, F., Champ, T., McDonnell, N., Kelly-Quinn, M., Harrison, S., Arbuthnott, A., Giller, P., Joy, M., McCarthy, K., cullen, P., Harrod, C., Jordan, P., Grigiths, D. and Rosell, R. (2007). Investigation Of The Relationship Between Fish Stocks, Ecological Quality Ratings (Qvalues), Environmental Factors And Degree Of Eutrohpication. Environmental RTDI Programme 2000–2006 (2000-MS-4-M1) *Environmental Protection Agency, Johnstown Castle, Co. Wexford.* 133 pp.

Knights, B & White, EM. (1998). Enhancing immigration and recruitment of eels; the use of passes and associated trapping systems. *Fisheries Management and Ecology,* **5;**459-471.

Lasne, E. & Lafaille, P. (2007). Analysis of distribution patterns of yellow European eels in the Loire catchment using logistic models based on presence-absence of different size-classes, *in*: (2007). *Ecol. freshw. fish 17(1).*

Matthews, M., Evans, D., Rosell, R. Moriarty, C. & Marsh, I. (2001). Erne Eel Enhancement Programme. EU Programme for Peace & Reconciliation Project No. EU 15. *Northern Regional Fisheries Board, Donegal*; 348pp.

McCarthy T.K., O'Farrell M., McGovern P. & Duke A. (1994). Elver Management Programme; *Feasibility Study Report, Forbairt, Dublin*, 90pp.

McGinnity P., Gargan P., Roche W., Mills P., & McGarrigle M. 2003 Quantification of the freshwater salmon habitat asset in Ireland using data interpreted in a GIS platform. *Irish Freshwater Fisheries Ecology and Management Series; No. 3, Central Fisheries Board, Dublin, Ireland*, 132pp.

Moriarty, C. (1975). The small fyke net as a sampling instrument in eel research. *EIFAC/T23 (Suppl. 1*), 507-518.

Moriarty, C. (1988). The Eel in Ireland. *The Went Memorial Lecture, Occasional paper in Irish Science & Technology,* **4**; 9pp.

Moriarty, C. & Dekker, W. (1997). Management of the Europeran eel. Second report of the EC concerted action AIR- A94-1939. *Marine Institute, Dublin*; 110pp.

Poole, W.R. (1990). Summer fyke nets as a method of eel capture in a salmonid fishery. *Aquaculture and Fisheries Management*, **21**; 259-262.

Poole, W.R., Reynolds, J.D.R. & Moriarty, C. (1990). Observations on the silver eel migrations of the Burrishoole river system, Ireland. 1959 to 1988. *Int. Revue Ges Hydrobiol.*, **75 (6);** 807-815.

Poole, W.R. (1994). A population study of the European Eel (*Anguilla anguilla* (L.)) in the Burrishoole System, Ireland, with special reference to growth and movement. *PhD Thesis, Dublin University*, 416pp.

Poole W.R. & Reynolds J.D. (1996). Age and growth of yellow eel, *Anguilla anguilla (L),* determined by two different methods. *Ecology of Freshwater Fish,* **5 (2);** 86-95.

Rogan, G. (2003). Report for Ireland. In Carss, D. & Marzano, M. (2003). Reducing the conflict between Cormorants and fisheries on a pan-European scale, Redcafe Summary and National Overviews, (edited by D N Carss and M Marzano), final report of Concerted Action Q5CA-2000-31387; 374pp.

Rosgen, D.L. (1994). A classification of natural rivers. *Catena,* **22**; 169-199.

Santillo, D., Johnston, P., Labunska, I, & Brigden, K. (2005). Swimming in chemicals. *Greenpeace Research Laboratories technical note* 12/2005.

Shreve, R.L. (1967). Infinite topologically random channel networks. *Journal of Geology*, **75**: 179–186.

Solomon, DJ, & Beach, MH. (2004) Fish pass design for eel and elver (*Anguilla anguilla*). *Research and Development Technical Report W2-070/TR1. Environment Agency, Bristol.*

Strahler, A. N. (1952). Hyposmetric (area-altitude) analysis of erosional topography. *Bulletin of the Geological Association of America*, **63**; 1117-1142.

Tesch, F.W. (2003). The Eel.

Warrer-Hansen, I. (1997). Eel farming in recirculation systems. *BIM Aquaculture Explained* **19**; 55 pp.

Appendix 1 – Habitat descriptions, production estimates and current escapement estimates for catchments included in the Eel Management Plans submitted by the Republic of Ireland.

Figures in bold represent catchment specific estimates derived from direct or catch based methods rather than the national model.

Catchment surface area (km2)	Cat. (km2)
Fluvial wetted area (ha)	Fluv. (ha)
Lake wetted area (ha)	Lake (ha)
Non-calcareous geology (%)	N.-calc. (%)
Estimated pristine production (kg)	Prist. Pot. (kg)
Estimated current potential production (kg)	Curr. Pot. (kg)
Estimated current escapement (kg)	Curr. Esc. (kg)

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Castletown (River)	Dundalk	62	10	4	88	32	24	-
Dee (River)	Dundalk	389	122	87	2	1027	677	-
Fane (River)	Dundalk	128	21	553	0	2854	1881	-
Flurry (River)	Dundalk	30	1	0	60	3	2	-
Glyde (River)	Dundalk	360	100	138	0	1183	781	-
Termonfeckin	Drogheda	27	4	0	0	20	14	-
Boyne (River)	Drogheda	2613	878	1488	2	11621	7676	-
Delvin (River)	Drogheda	77	19	4	4	112	73	-
Nanny (River)	Drogheda	223	61	0	5	294	195	-
Ballough (Stream)	Dublin	33	10	0	0	50	32	-
Ballyboghil	Dublin	45	11	0	0	55	37	-
Broad Meadow (River)	Dublin	172	57	0	0	283	187	-
Dargle (River)	Dublin	128	41	39	78	208	125	-
Dodder (River)	Dublin	113	44	27	50	245	156	-
Liffey (River)	Dublin	1150	464	2024	21	2000	1331	-
Newcastle [Wicklow]	Dublin	19	4	0	100	8	5	-
Newtownmountkennedy	Dublin	17	4	0	100	8	4	-
Rathnew (River)	Dublin	21	5	0	100	10	6	-
Shanganagh	Dublin	40	8	1	94	19	10	-
Tolka (River)	Dublin	151	44	0	0	219	145	-
Vartry (River)	Dublin	104	24	282	100	591	336	-
Avoca (River)	Wexford	646	224	212	100	843	480	-
Potter's (River)	Wexford	45	12	1	100	25	15	-
Redcross (River)	Wexford	37	11	0	100	21	12	-
Three Mile Water	Wexford	28	6	0	100	12	7	-
EEMU Total		6657	2182	4861	21	21742	14189	7700
(Roe Faughan etc)	Loughs Agency	888	312.2	39	100	679	386.425	-
Abbey (River)	Ballyshannon	42	11	165	29	720	466	-
Ballintra (River)	Ballyshannon	84	41	306	63	1061	663	-
Bungosteen (River)	Ballyshannon	37	18	24	100	81	47	-
Drowes (River)	Ballyshannon	117	43	2220	0	11253	7420	-
Duff (River)	Ballyshannon	86	47	4	0	254	168	-
Eany (Water)	Ballyshannon	109	66	28	26	393	254	-
Erne (River)	Ballyshannon	33	1	236	59	753	473	-

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Erne (Roi NI)	Ballyshannon	4415	1348	24612	0	**116633**	85155	-
Eske (River)	Ballyshannon	114	53	474	64	1595	990	-
Glen (River)	Ballyshannon	87	43	69	100	216	124	-
Glenaddragh (River)	Ballyshannon	39	17	4	100	41	23	-
Laghy (Stream)	Ballyshannon	39	18	28	59	146	92	-
Oily (River)	Ballyshannon	47	24	39	83	154	92	-
Owenwee (River)	Ballyshannon	25	9	78	99	171	98	-
Aghaweel (River)	Letterkenny	10	2	0	100	4	2	-
Ballyboe (River)	Letterkenny	9	2	0	100	4	2	-
Big (Burn)	Letterkenny	13	4	14	99	35	21	-
Bracky (River)	Letterkenny	24	13	0	100	25	14	-
Bunlin (River)	Letterkenny	10	3	4	98	14	8	-
Burnfoot	Letterkenny	53	12	0	97	24	14	-
Burnside (River)	Letterkenny	12	3	0	100	6	4	-
Clady (River)	Letterkenny	89	26	391	100	806	461	-
Clonmany (River)	Letterkenny	55	17	0	100	33	18	-
Crana (River)	Letterkenny	99	45	16	98	122	70	-
Culoort (River)	Letterkenny	29	9	0	100	17	10	-
Derryart (River)	Letterkenny	20	7	9	100	31	18	-
Donagh (River)	Letterkenny	34	16	0	96	33	19	-
Drumhallagh (River)	Letterkenny	15	5	0	100	10	6	-
Dunglow (River)	Letterkenny	40	8	225	100	450	257	-
Duntally (River)	Letterkenny	10	3	11	88	32	19	-
Duvoge (River)	Letterkenny	20.595	5.21	125.46	100	253	143.776	-
Faymore (River)	Letterkenny	17	7	3	96	21	11	-
Glen (River)	Letterkenny	17	4	7	100	21	13	-
Glenalla (River)	Letterkenny	20	6	17	100	44	26	-
Glenna (River)	Letterkenny	23	8	21	92	63	37	-
Glennagannon (River)	Letterkenny	29	14	18	99	63	36	-
Glenvar (River)	Letterkenny	13	4	0	100	8	4	-
Gweebarra (River)	Letterkenny	94	34	133	100	323	184	-
Gweedore (River)	Letterkenny	50	14	188	100	390	223	-
Isle (Burn)	Letterkenny	60	20	0	45	72	47	-
Lackagh (River)	Letterkenny	126	42	532	99	1127	647	-
Leannan (River)	Letterkenny	256	124	550	99	1323	753	-
Loughkeel (Burn)	Letterkenny	6	2	61	100	122	70	-
Mill (River)	Letterkenny	44	15	0	96	31	17	-
Owenawillin	Letterkenny	5	2	33	100	68	38	-
Owencronahulla	Letterkenny	19	6	2	100	15	8	-
Owenea (River)	Letterkenny	126	69	223	100	564	323	-
Owenerk (River)	Letterkenny	21	6	1	100	14	8	-
Owennamarve (River)	Letterkenny	26	8	154	100	313	178	-
Owentocker (River)	Letterkenny	43	23	18	99	80	46	-
Owentully	Letterkenny	9	2	0	98	4	3	-
Ray (River)	Letterkenny	51	19	59	95	163	94	-
Straid (River)	Letterkenny	21	8	0	100	15	9	-
Swilly (River)	Letterkenny	97	45	24	100	133	76	-
Tullaghobegly (River)	Letterkenny	30	10	149	86	375	224	-
Foyle (Roi NI)	Loughs Agency	2919	1114	1544	100	5137	2924	-
NWIRBD Total		10828	3835	32859	53	146538	103533	60381
Annestown (Stream)	Waterford	24	5	0	100	10	5	-

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Aughnavaud (River)	Waterford	31	6	0	100	12	7	-
Ballymoat (Stream)	Waterford	17	6	8	100	27	15	-
Barrow (River)	Waterford	2812	909	6	23	3910	2551	-
Black Water	Waterford	177	35	6	76	109	66	-
Brickey (River)	Waterford	41	5	0	41	19	11	-
Clodiagh (River)	Waterford	131	44	21	99	128	73	-
Colligan (River)	Waterford	4	28	0	52	95	60	-
Corock (River)	Waterford	148	53	0	100	102	58	-
Dalligan (River)	Waterford	20	5	0	100	10	6	-
Dawn (River)	Waterford	43	13	32	100	87	49	-
Glen (River)	Waterford	44	7	0	34	28	18	-
John's River	Waterford	52	15	0	100	29	17	-
Lingaun (River)	Waterford	92	28	1	81	73	43	-
Mahon (River)	Waterford	98	25	0	100	48	28	-
Nore (River)	Waterford	2446	861	17	10	4099	2696	-
Owenduff (River)	Waterford	111	17	0	100	33	19	-
Pil (River)	Waterford	85	19	3	42	81	50	-
Pollmounty (River)	Waterford	48	8	0	100	15	9	-
Suir (River)	Waterford	2728	1156	46	23	5137	3348	-
Tay (River)	Waterford	68	20	0	100	39	23	-
Whelanbridge (River)	Waterford	22	6	29	100	68	39	-
Blackwater (River)	Wexford	45	10	0	100	19	11	-
Duncormick	Wexford	38	12	0	99	24	13	-
Inch (River)	Wexford	70	20	1	100	41	23	-
Owenavorragh (River)	Wexford	161	51	0	100	99	57	-
Slaney (River)	Wexford	1631	649	7	98	1308	745	-
Sow (River)	Wexford	88	25	0	93	54	32	-
SERBD Total		11275	4038	178	7	15700	10071	91000
Ardigeen (River)	Cork	134.016	36.30	0.00	70.54	103	63	-
Ardrigole (River)	Cork	28.018	14.20	41.58	100.00	108	61	-
Bandon (River)	Cork	513.305	197.05	69.51	73.19	732	449	-
Bawnaknockane (River)	Cork	40.798	11.27	0.00	100.00	22	12	-
Coomhola (River)	Cork	65.766	31.94	21.11	100.00	103	58	-
Dungourney (River)	Cork	52.559	10.85	21.32	70.61	91	20	-
Four Mile (Water)	Cork	32.560	13.05	0.00	100.00	25	39	-
Glashaboy (River)	Cork	142.489	34.35	0.64	99.86	68	89	-
Glengarriff (River)	Cork	42.335	18.02	63.26	100.00	157	13	-
Ilen (River)	Cork	240.088	95.78	8.00	99.27	203	56	-
Keal (Stream)	Cork	7.503	1.36	0.00	100.00	3	11	-
Leamawaddra (River)	Cork	20.685	4.84	0.00	100.00	9	1920	-
Lee (River)	Cork	1185.053	372.79	1277.98	97.11	753	12	-
Mealagh (River)	Cork	55.528	24.26	22.29	100.00	90	7	-
Owenboy (River)	Cork	116.415	30.94	0.00	71.92	86	28	-
Owennacurra (River)	Cork	105.951	22.90	0.00	95.35	47	28	-
Owvane (River)	Cork	78.266	32.46	5.79	100.00	74	135	-
Roury (River)	Cork	36.631	8.29	16.97	100.00	49	54	-
Stick (River)	Cork	41.133	8.74	0.17	55.56	29	18	-
Behy (River)	Kerry	45.988	12.07	169.18	99.86	351	200	-
Blackwater (River)	Kerry	88.291	35.87	45.95	100.00	158	90	-
Caol	Kerry	3.453	0.52	0.00	100.00	1	1	-
Caragh (River)	Kerry	165.528	67.22	720.65	96.48	1607	927	-
Carhan (River)	Kerry	27.176	7.06	1.00	100.00	16	9	-

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Cloonee (River)	Kerry	28.537	7.92	245.81	100.00	490	279	-
Coomnahorna (River)	Kerry	9.306	4.15	0.00	100.00	8	82	-
Cottoners (River)	Kerry	33.637	14.01	42.67	83.82	137	92	-
Croanshagh (River)	Kerry	38.485	21.28	62.28	100.00	161	1772	-
Currane (River)	Kerry	116.833	32.99	1577.11	100.00	3112	56	-
Emlagh (River)	Kerry	21.928	9.81	0.00	56.83	32	6	-
Emlaghmore (River)	Kerry	20.144	5.40	0.00	100.00	10	19	-
Ferta (River)	Kerry	53.361	16.97	0.48	100.00	34	47	-
Finnihy (River)	Kerry	31.843	11.04	19.72	92.16	67	14	-
Gowla (River)	Kerry	4.864	2.07	0.00	100.00	4	116	-
Inny (River)	Kerry	121.391	47.34	3.18	100.00	98	1	-
Kealincha (River)	Kerry	21.022	9.80	0.00	100.00	19	7100	-
Laune (River)	Kerry	779.434	309.70	2906.35	49.20	11182	5	-
Lough Fadda (Stream)	Kerry	22.192	9.30	76.74	100.00	166	341	-
Maine (River)	Kerry	317.448	108.53	0.43	6.75	519	51	-
Milltown (River)	Kerry	28.852	6.29	0.00	100.00	12	14	-
Owenalondrig (River)	Kerry	26.038	6.94	5.83	100.00	25	60	-
Owenascaul (River)	Kerry	39.102	13.44	27.92	83.48	101	53	-
Owenshagh (River)	Kerry	31.284	23.46	2.18	100.00	50	12	-
Owreagh (River)	Kerry	19.083	7.90	2.73	100.00	21	42	-
Roughty (River)	Kerry	202.338	95.93	21.66	97.63	236	28	-
Sheen (River)	Kerry	93.348	48.05	0.96	100.00	95	74	-
Sneem (River)	Kerry	62.751	26.15	40.76	100.00	129	3	-
Staigue (River)	Kerry	8.402	2.56	0.00	100.00	5	6	-
Tahilla (River)	Kerry	17.273	4.91	0.88	100.00	11	2463	-
Blackwater (River)	Lismore	2435.778	997.25	10.48	38.34	3836	152	-
Bride (River)	Lismore	370.620	104.44	0.00	83.87	253	39	-
Finisk (River)	Lismore	104.200	32.81	0.00	84.28	79	7	-
Glenshelane (River)	Lismore	43.358	11.11	0.00	96.55	23	2	-
Goish (River)	Lismore	24.075	5.22	0.00	92.87	11	95	-
Licky (River)	Lismore	44.531	9.83	0.00	95.63	20	11	-
Tourig (River)	Lismore	42.444	8.32	0.00	91.43	18	47	-
Womanagh (River)	Lismore	133.829	25.80	0.00	67.60	75	48	-
SWRBD Total		8617	3133	7534	70	25924	17396	14700
Ballinglen (River)	Ballina	44	19	1	0	99	64	-
Belderg (River)	Ballina	21	5	45	100	97	55	-
Bellananaminnaun (River)	Ballina	19	7	0	0	35	23	-
Bellawaddy (River)	Ballina	19	6	0	0	30	19	-
Brusna (River)	Ballina	96	46	5	23	218	144	-
Cloonaghmore (River)	Ballina	133	55	4	0	293	194	-
Easky (River)	Ballina	99	55	138	46	690	440	-
Glenulra (River)	Ballina	8	3	0	0	15	9	-
Leaffony (River)	Ballina	35	10	0	0	50	33	-
Moy (River)	Ballina	1977	867	7552	26	**46445**	22893	-
Owenykeevan (River)	Ballina	22	5	0	0	25	17	-
Ballinaboy (River)	Ballinakill	31	6	513	100	1003	577	-
Bundorragha (River)	Ballinakill	48	15	214	100	443	252	-
Bunowen (River)	Ballinakill	76	34	14	100	93	53	-
Carrowbeg (River)	Ballinakill	44	16	47	53	212	133	-
Carrownisky (River)	Ballinakill	51	19	76	100	184	105	-
Cleggan (River)	Ballinakill	11	2	14	94	34	20	-

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Culfin (River)	Ballinakill	21	8	216	100	433	247	-
Dawros (River)	Ballinakill	53	27	175	76	538	329	-
Erriff (River)	Ballinakill	167	74	184	95	538	310	-
Owenglin (River)	Ballinakill	37	21	56	91	170	100	-
Owennadornaun	Ballinakill	15	4	24	100	54	31	-
Owenwee (River)	Ballinakill	46	18	81	100	191	109	-
Traheen (River)	Ballinakill	6	2	4	75	16	10	-
Bellagarvaun	Bangor	35	13	23	99	71	40	-
Bunnahowna (River)	Bangor	10	3	0	62	9	5	-
Carrowsallagh (River)	Bangor	9	2	14	25	67	44	-
Cartron (River)	Bangor	12	3	17	96	41	23	-
Glenamoy (River)	Bangor	85	29	2	90	69	41	-
Gweedaney	Bangor	13	3	0	100	6	4	-
Moyour (River)	Bangor	44	16	61	24	327	214	-
Muingnabo (River)	Bangor	37	14	1	100	29	17	-
Newport (River)	Bangor	147	61	445	61	1578	991	-
Owenduff	Bangor	128	64	39	99	202	114	-
Owengarve (River)	Bangor	29	11	0	67	32	19	-
Owenmore (River)	Bangor	334	149	1003	37	4433	2844	-
Owennabrockagh	Bangor	23	12	19	60	98	62	-
Rossow (River)	Bangor	9	0	0	12	0	1	-
Srahmore (River)	Bangor	84	25	450	96	**427**	**617**	**617**
Ballynahinch (River)	Connemara	173	66	1152	79	3131	1886	-
Cashla (River)	Connemara	78	24	477	100	968	552	-
Gowlabeg (River)	Connemara	11	2	29	100	60	34	-
Invermore (River)	Connemara	37	9	291	100	580	330	-
Owengowla	Connemara	34	9	196	100	396	228	-
Screeb	Connemara	41	10	333	79	882	533	-
Stream (L. Carrafinla)	Connemara	7	0	71	100	137	78	-
Stream (L. Inverbeg)	Connemara	14	3	100	100	199	113	-
Stream (L. Nafurnace)	Connemara	23	4	85	100	172	98	-
Stream (L. Scannive)	Connemara	16	3	157	100	309	176	-
Clarinbridge (River)	Galway	116	23	2	0	124	81	-
Corrib (River)	Galway	3136	847	28022	18	**82059**	**48455**	**13371**
Crumlin (River)	Galway	24	6	167	100	334	190	-
Kilcolgan (River)	Galway	354	104	304	0	2029	1338	-
Knock (River)	Galway	24	7	64	100	137	78	-
Owenboliska	Galway	90	32	319	100	678	386	-
Owenriff [South Galway]	Galway	17	6	83	100	172	97	-
Ballysadare (River)	Sligo	640	256	1556	14	8239	5408	-
Carney (River)	Sligo	14	5	0	0	25	15	-
Drumcliff (River)	Sligo	61	26	115	0	701	462	-
Dunneill (River)	Sligo	25	11	0	38	42	27	-
Garvogue (River)	Sligo	369	141	1642	19	**9609**	5092	-
Grange (River)	Sligo	35	14	0	0	70	46	-
Willsborough (Stream)	Sligo	19	6	4	0	50	34	-
WRBD Total		9433	3342	46602	33	170397	96940	51100
Aille (River)	Galway	66	20	0	0	99	66	-
Feohanagh (River)	Kerry	30	11	2	100	25	15	-
Lee (River)	Kerry	99	35	0	23	150	97	-
Owencashla (River)	Kerry	17	6	28	100	66	38	-

		Cat. (km2)	Fluv. (ha)	Lake (ha)	N.-calc. (%)	Prist. Pot. (kg)	Curr. Pot. (kg)	Curr. Esc. (kg)
Owenmore (River)	Kerry	30	8	77	100	164	93	-
Owennafeana (River)	Kerry	15	5	0	100	10	6	-
Scorid (River)	Kerry	16	4	43	100	91	52	-
Ahacronane (River)	Limerick	23	7	0	0	35	24	-
Annageeragh (River)	Limerick	66	19	150	0	840	553	-
Annagh (River)	Limerick	45	13	1	0	70	48	-
Aughaveema	Limerick	16	4	1	0	25	19	-
Aughyvackeen (River)	Limerick	55	14	9	0	114	74	-
Ballincurra (Creek)	Limerick	32	5	0	0	25	18	-
Ballyline (River)	Limerick	43	8	0	0	40	26	-
Ballyvaskin (River)	Limerick	2	0	0	0	0	1	-
Brick (River)	Limerick	178	55	0	10	257	168	-
Cloon (River)	Limerick	59	14	0	0	70	47	-
Cloonbony (River)	Limerick	12	4	0	0	20	13	-
Crompaun (River)	Limerick	18	5	0	21	22	14	-
Deel (River)	Limerick	488	174	12	1	919	607	-
Doonbeg (River)	Limerick	113	32	49	0	403	266	-
Feale (River)	Limerick	659	251	0	0	1248	825	-
Fergus (River)	Limerick	626	149	602	6	3597	2370	-
Freagh (River)	Limerick	4	1	0	0	5	3	-
Galey (River)	Limerick	203	79	0	0	393	261	-
Glencorbly (River)	Limerick	27	6	0	0	30	19	-
Inagh (River)	Limerick	170	61	112	0	860	569	-
Maigue (River)	Limerick	840	286	6	5	1408	929	-
Moy (River)	Limerick	16	4	4	0	40	28	-
Owenagarney [Ratty] (Riv)	Limerick	186	50	327	27	1565	1018	-
Shannon (River)	Limerick	11644	3695	38771	8	200839	**85659**	**11000**
Skivileen (River)	Limerick	89	27	44	0	353	231	-
White (River)	Limerick	75	23	0	0	114	76	-
SHIRBD Total		15959	5076	40241	9	213895	94233	17629

Appendix 2. Table of contaminant levels in seven samples of eels from Irish waters.

	PARAMETER	ICES	MSC/05/1119	MSC/05/1120	MSC/05/1121	MSC/05/1122	MSC/05/1140	MSC/07/1133	MSC/07/1134	UNITS	BASIS
			Waterford	Mayo	Galway	Monaghan	Mayo	Mayo	Mayo		
			Yellow eel	Silver eel	Silver eel	Silver eel	Silver eel	Silver eel	Yellow eel		
	Sample ID		MSC-05/1119	MSC-05/1120	MSC-05/1121	MSC-05/1122	MSC-05/1140	MSC/07/1133	MSC/07/1134		
	Location		River Suir	Pontoon/Moy	River Corrib	River Fane	Burrishoole	Burrishoole	L. Feeagh		
	Mean Length (cm)		40.1 (46.9)	47.5 (53.1)	46.4 (52.2)	45.7(43.7)	48.8 (52.8)				
	Std. Dev. (cm)		9.92 (10.7)	8.73 (6.17)	9.54 (6.97)	11.6(9.62)	9.69 (4.29)				
	RSD (%)		24.8 (22.8)	18.4 (11.6)	20.6 (13.4)	25.3 (22.1)	19.8 (8.14)				
	95thile		60.0 (61.5)	60.4 (62.6)	61.8 (59.5)	65.1(58.6)	59.0 (57.6)				
	Variance		98.4 (113)	76.2 (38.1)	90.9 (48.6)	134 (92.7)	93.9 (18.4)				
	Mean Age (yrs)[1]		16	19.8	19.4	17.9	32.3				
ORGANOCHLORINES	**β-HCH**	**HCHB**	nd	0.14	0.06	0.20	0.31			ug/kg	wet
	α-HCH	**HCHA**	nd	0.21	0.22	0.19	0.29			ug/kg	wet
	γ-HCH	**HCHG**	0.21	0.16	nd	0.29	0.45			ug/kg	wet
	δ-HCH	**HCHD**	nd	nd	nd	nd	nd			ug/kg	wet
	o,p-DDT	**DDTOP**	0.04	0.04	0.04	nd	0.07			ug/kg	wet
	p,p'-DDT	**DDTPP**	0.31	0.27	0.14	0.17	0.55			ug/kg	wet
	o,p-DDD	**TDEOP**	0.09	nd	0.06	0.05	nd			ug/kg	wet
	p,p'-DDD	**TDEPP**	2.70	0.55	0.21	1.90	0.67			ug/kg	wet
	o,p-DDE	**DDEOP**	0.05	nd	nd	nd	nd			ug/kg	wet
	p,p'-DDE	**DDEPP**	7.10	3.20	1.60	5.00	3.10			ug/kg	wet
	Hexachlorobenzene	**HCB**	nd	nd	nd	nd	nd			ug/kg	wet
	Heptachlor	**HEPC**	nd	nd	nd	nd	nd			ug/kg	wet
	cis Heptachlorepoxide	**HCEPC**	0.11	0.45	0.32	0.19	0.88			ug/kg	wet
	trans Heptachlorepoxide	**HCEPT**	nd	nd	nd	nd	nd			ug/kg	wet
	Aldrin	**ALD**	nd	nd	nd	nd	nd			ug/kg	wet
	Toxaphene 26	**PCC26**	nd	nd	nd	nd	0.86			ug/kg	wet
	Toxaphene 50	**PCC50**	nd	nd	nd	nd	1.20			ug/kg	wet
	Toxaphene 62	**PCC62**	nd	nd	nd	nd	nd			ug/kg	wet

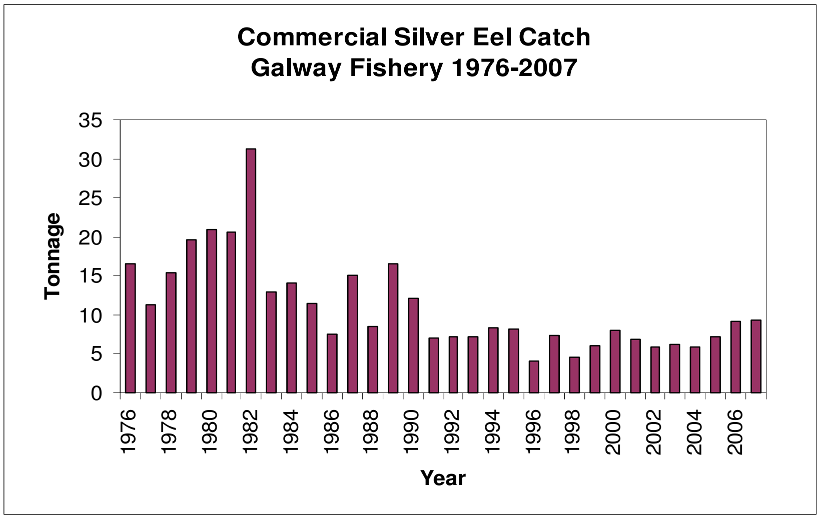
	Octachlorstyrene	**OCS**	nd	0.07	nd	nd	0.14			ug/kg	wet
	Dieldrin	**DIELD**	2.00	1.40	2.20	2.10	3.50			ug/kg	wet
	Endrin	**END**	nd	nd	nd	nd	0.16			ug/kg	wet
	Mirex	**MIREX**	nd	0.05	0.02	nd	0.20			ug/kg	wet
	Endosulphane sulphate	**ENDS**	nd	nd	nd	nd	nd			ug/kg	wet
	α-Endosulphane	**ENDA**	nd	nd	nd	nd	nd			ug/kg	wet
	β-Endosulphane	**ENDB**	nd	nd	nd	nd	nd			ug/kg	wet
	γ-Chlordane	**TCDAN**	nd	0.08	0.11	0.06	0.10			ug/kg	wet
	α-Chlordane	**CCDAN**	0.08	0.28	0.15	0.10	0.86			ug/kg	wet
	Oxychlordane	**OCDAN**	nd	nd	nd	nd	0.29			ug/kg	wet
	Transnonachlor	**TNONC**	0.26	0.72	0.48	0.28	1.60			ug/kg	wet
HBCD	**α-HBCD**	**HBCDA**	8.90	na	na	6.00	na			ug/kg	wet
	β-HBCD	**HBCDB**	0.48	na	na	0.18	na			ug/kg	wet
	γ-HBCD	**HBCDG**	0.58	na	na	0.20	na			ug/kg	wet
PBBs	**PBB #15**	**PBB15**	0.0015	nd	nd	nd	nd			ug/kg	wet
	PBB #49	**PBB49**	nd	nd	nd	nd	nd			ug/kg	wet
	PBB #52	**PBB52**	0.0031	nd	nd	nd	nd			ug/kg	wet
	PBB #101		0.0011	0.0018	nd	nd	0.004			ug/kg	wet
	PBB #153		nd	nd	nd	nd	0.0027			ug/kg	wet
BFRs	**BDE #17**	**BDE17**	0.011	0.0016	nd	0.0042	nd	<0.01	<0.01	ug/kg	wet
	BDE #28	**BDE28**	0.065	0.017	0.007	0.038	0.0061	<0.01	<0.01	ug/kg	wet
	BDE #47	**BDE47**	5.2	1.7	0.77	1.8	0.52	0.25	0.17	ug/kg	wet
	BDE #49							0.04	0.03	ug/kg	wet
	BDE #66	**BDE66**	0.099	0.053	0.015	0.064	0.017	0.01	<0.01	ug/kg	wet
	BDE#71							<0.01	<0.01	ug/kg	wet
	BDE#77							<0.01	<0.01	ug/kg	wet
	BDE #85	**BDE85**	nd	nd	nd	nd	nd	<0.01	<0.01	ug/kg	wet
	BDE #99	**BDE99**	0.16	0.025	0.017	0.1	0.024	0.02	<0.01	ug/kg	wet
	BDE #100	**BD100**	1.3	0.33	0.2	0.4	0.16	0.12	0.08	ug/kg	wet
	BDE #119							0.01	<0.01	ug/kg	wet
	BDE #126							<0.01	<0.01	ug/kg	wet
	BDE #138	**BD138**	nd	nd	nd	nd	nd	<0.01	<0.01	ug/kg	wet

	BDE #153	**BD153**	0.072	0.055	0.031	0.12	0.052	0.05	0.02	ug/kg	wet
	BDE #154	**BD154**	0.2	0.13	0.09	0.2	0.095	0.05	0.03	ug/kg	wet
	BDE #183	**BD183**	nd	0.0038	nd	0.022	0.0076	<0.01	<0.01	ug/kg	wet
	TBBPA	**TBBPA**	nd	nd	nd	nd	nd				
WHO-PCBs	**3,3',4,4'-Tetra-CB 77**	**CB77**	nd	nd	nd	nd	nd	<0.0002	0.0005	ug/kg	wet
	3,4,4',5-Tetra-CB 81	**CB81**	nd	nd	nd	nd	nd	0.00002	<0.00002	ug/kg	wet
	3,3',4,4',5-Penta-CB 126	**CB126**	0.0063	nd	nd	0.0023	0.0028	0.002	0.001	ug/kg	wet
	3,3',4,4',5,5'-Hexa-CB 169	**CB169**	0.002	0.0012	0.0013	0.0013	0.0018	0.001	<0.0006	ug/kg	wet
	2,3,3',4,4'-Penta-CB 105	**CB105**	0.853	0.188	0.075	0.429	0.381	0.09	0.04	ug/kg	wet
	2,3,4,4',5-Penta-CB 114	**CB114**	0.043	0.01	0.0084	0.036	0.022	<0.01	<0.01	ug/kg	wet
	2',3,4,4',5-Penta-CB 123	**CB123**	0.043	0.012	nd	0.026	nd	0.01	<0.01	ug/kg	wet
	2,3,3',4,4',5,-Hexa-CB 156	**CB156**	0.311	0.075	0.037	0.17	0.168	0.06	0.03	ug/kg	wet
	2,3,3',4,4',5'-Hexa-CB 157	**CB157**	0.072	0.013	0.012	0.042	0.033	0.02	0.01	ug/kg	wet
	2,3',4,4',5,5'-Hexa-CB 167	**CB167**	0.215	0.046	0.038	0.084	0.094	0.04	0.03	ug/kg	wet
	2,3,3',4,4',5,5'-Hepta-CB 189	**CB189**	0.032	0.011	0.013	0.019	0.016	0.02	<0.01	ug/kg	wet
MARKER PCBs	**PCB #28**	**CB28**	0.58	0.03	0.03	0.35	0.03	0.02	0.02	ug/kg	wet
	PCB #52	**CB52**	1.4	0.13	0.06	0.9	0.21	0.12	0.06	ug/kg	wet
	PCB #101	**CB101**	1.55	0.2	0.11	0.69	0.27	0.23	0.10	ug/kg	wet
	PCB #118	**CB118**	2.78	0.56	0.28	1.5	1.08	0.43	0.23	ug/kg	wet
	PCB #138	**CB138**	4.11	1.01	0.56	1.83	2.13	1.31	0.77	ug/kg	wet
	PCB #153	**CB153**	5.3	1.19	0.64	1.62	2.09	1.33	0.89	ug/kg	wet
	PCB #180	**CB180**	2.33	0.51	0.26	0.75	0.96	0.42	0.30	ug/kg	wet
DIOXIN & FURAN	**2.3.7.8-Tetra-CDD**	**TCDD**	0.000042	0.000029	0.000023	0.000026	0.000055	0.00003	0.00002	ug/kg	wet
	1.2.3.7.8-Penta-CDD	**CDD1N**	0.0001	0.000083	0.000091	0.000085	0.002	0.0013	0.0007	ug/kg	wet
	1.2.3.4.7.8-Hexa-CDD	**CDD4X**	0.000032	0.000081	0.000035	0.000062	0.0053	0.0028	0.0012	ug/kg	wet
	1.2.3.6.7.8-Hexa-CDD	**CDD6X**	0.00016	0.00017	0.0001	0.00023	0.013	0.0066	0.0030	ug/kg	wet
	1.2.3.7.8.9-Hexa-CDD	**CDD9X**	0.000044	0.000037	nd	0.000031	0.0022	0.0236	0.0005	ug/kg	wet
	1.2.3.4.6.7.8-Hepta-CDD	**CDD6P**	0.0001	0.00011	0.000048	0.00008	0.013	<0.00002	0.004	ug/kg	wet
	OCDD	**CDDO**	nd	nd	nd	nd	0.042	0.02	0.013	ug/kg	wet
	2.3.7.8-Tetra-CDF	**CDF2T**	nd	nd	nd	nd	nd	<0.00002	<0.00001	ug/kg	wet
	1.2.3.7.8-Penta-CDF	**CDFP2**	0.000024	0.000014	0.000016	0.000017	0.000085	0.00002	<0.00001	ug/kg	wet
	2.3.4.7.8-Penta-CDF	**CDF2N**	0.00015	0.0001	0.000064	0.000086	0.00012	0.0001	0.0001	ug/kg	wet

	1.2.3.4.7.8-Hexa-CDF	CDFDX	0.000053	0.000059	0.000032	0.000062	0.00022	0.0001	0.0001	ug/kg	wet
	1.2.3.6.7.8-Hexa-CDF	CDF6X	0.000033	0.000035	0.000024	0.000033	0.00012	0.0001	0.00004	ug/kg	wet
	1.2.3.7.8.9-Hexa-CDF	CDF9X	nd	nd	nd	nd	nd	<0.00001	<0.00001	ug/kg	wet
	2.3.4.6.7.8-Hexa-CDF	CDF4X	0.000085	0.000086	0.000077	0.000066	0.00025	0.0001	0.00003	ug/kg	wet
	1.2.3.4.6.7.8-Hepta-CDF	CDF6P	0.000041	nd	nd	nd	0.000088	0.0001	0.00003	ug/kg	wet
	1.2.3.4.7.8.9-Hepta-CDF	CDF9P	nd	nd	nd	nd	nd	<0.00001	<0.00001	ug/kg	wet
	OCDF	CDFO	nd	nd	nd	nd	0.000067	<0.00001	<0.00001	ug/kg	wet
NON-WHO PCBS	PCB#18	CB18						<0.01	<0.01	ug/kg	wet
	PCB#31	CB31						<0.01	<0.01	ug/kg	wet
	PCB#47	CB47						nd	nd	ug/kg	wet
	PCB#49	CB49						nd	nd	ug/kg	wet
	PCB#51	CB51						nd	nd	ug/kg	wet
	PCB#99	CB99						0.28	0.14	ug/kg	wet
	PCB#128	CB128						0.13	0.07	ug/kg	wet

Appendix 3 – Calculation of historic catch based potential production estimates.

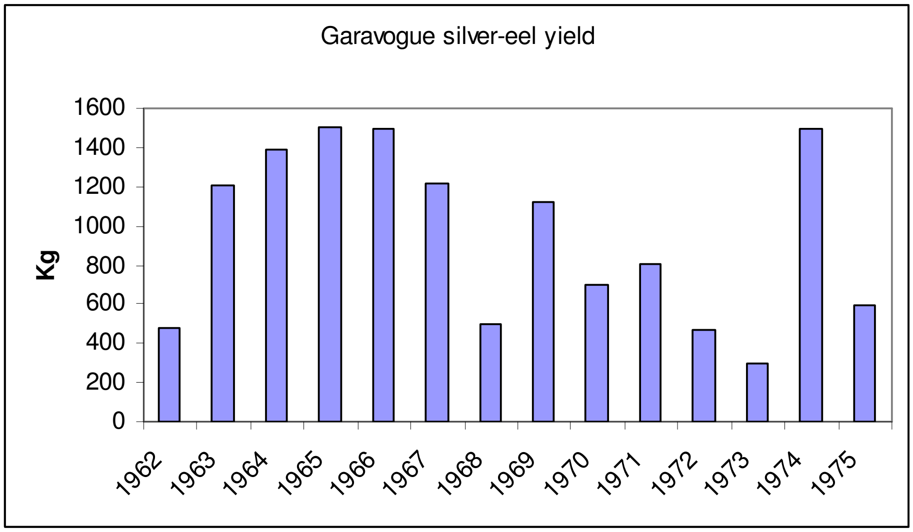
Corrib and the Galway Fishery



Corrib historic productivity			
Galway weir silver eel catch [1976-1982]	19.4	tonnes	1
Escapement [Galway weir efficiency 35%]	38.8	tonnes	2
Average non-weir silver eel catch [2001-2007]	7.2	tonnes	
Average Galway weir silver eel catch as a percentage of the total Corrib silver eel catch [2001-2007]	51.0	%	
Estimated historic non-Galway weir silver eel catch (assuming the same level of effort as currently observed)	18.6	tonnes	3
Average brown eel catch [2001-2007]	9.0	tonnes	
Proportion of licences un-reported in WRBD (2001-2007)	0.3		
Illegal yield as a proportion of reported yield (based on DEMCAM estimate for Shannon)	0.4		
Estimate of under-reported historic silver eel non-weir catch	13.4	tonnes	4
Average brown eel catch (reported & unreported & illegal) [2001-2007]	15.5	tonnes	5
Silver eel running to Galway	50.0	tonnes	1+2
Silver eel production	82.1	tonnes	1+2+3+4
Potential silver eel production	97.5	tonnes	1+2+3+4+5
Wetted area of Corrib catchment	28869.0	ha	
Potential silver eel productivity	**3.38**	**kg/ha**	

Data provided by: Western Regional Fisheries Board, Galway Fishery, McCarthy & McGovern

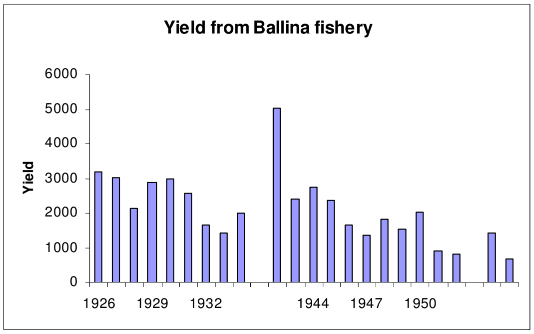
Garavogue

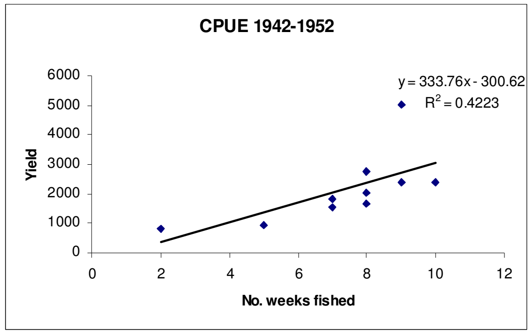


Garavogue			
Garavogue reported silver eel average catch [1962-1975]	0.9	tonnes	
Effort	50	%	
Proportion Under-reported	0.3		
Minimum silver run (average catch)	2.1804	tonnes	**1**
Escapement	4.4	tonnes	**2**
Brown eel catch on Garavogue (2000-2007)	1.738	tonnes	
Non-weir silver eel catch on Garravogue (2000-2007)	0.016	tonnes	
Proportion of licences un-reported in WRBD (2001-2007)	0.3		
Illegal yield as a proportion of reported yield (based on DEMCAM estimate for Shannon)	0.4		
Total average brown eel catch [2000-2007]	3.0	tonnes	**3**
Total average non weir silver catch [2000-2007]	0.0	tonnes	**4**
Silver eel running to Ballina	6.5	tonnes	**1+2**
Silver eel production	6.6	tonnes	**1+2+3**
Potential silver eel production	9.6	tonnes	**1+2+3+4**
Wetted area of Garravogue catchment	1783.0	ha	
Potential silver eel productivity	**5.39**	**kg/ha**	

Data provided by: North Western Regional Fisheries Board

Moy (Ballina Fishery)



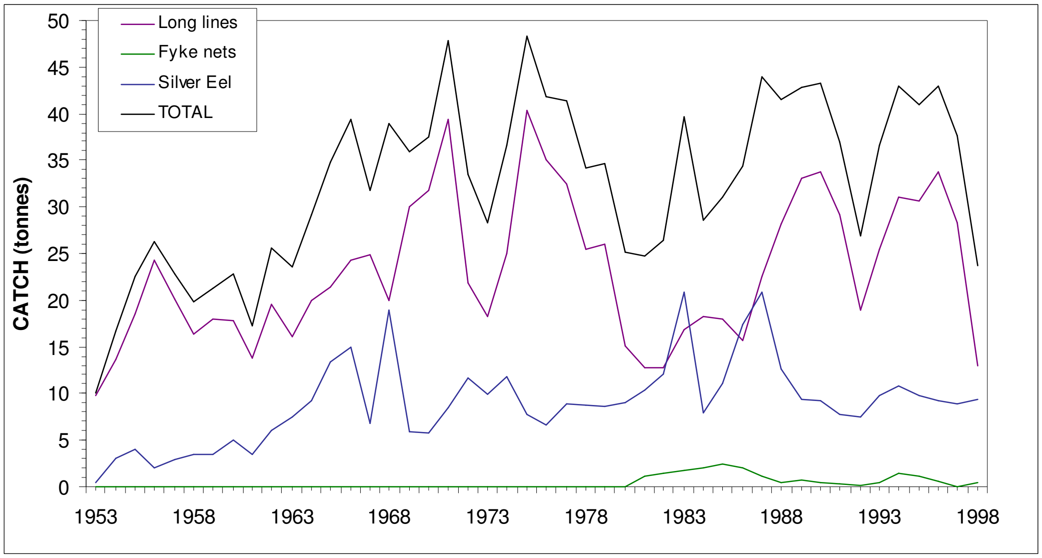


Effort data are provided for the period 1942-2952 (a period over which the yield declined). There is a clear relationship between the number of weeks fished and the yield over this period. Therefore, we can estimate that if the full season of 11 weeks had been fished each year, the expected annual catch from 1942-1952 would have been 3,417kg. This figure agrees reasonably well with the yields achieved from 1925-1930.

Moy			
Ballina-weir silver eel catch [1942-1952]	3.4	tonnes	1
Escapement past Ballina (efficiency assumed same as Galway weir)	6.8	tonnes	2
Verscoyle weir (yield averaged 7.5 times Ballina weir)	25.6	tonnes	
Average non-weir silver eel catch [2001-2007]	2.0	tonnes	
Proportion of licences un-reported in WRBD (2001-2007)	0.3		
Illegal yield as a proportion of reported yield (based on DEMCAM estimate for Shannon)	0.4		
Total estimated non-Ballina silver eel catch	29.1	tonnes	3
Average brown eel catch [2000-2007]	4.0	tonnes	
Total average brown eel catch including under-reporting [2001-2007]	7.0	tonnes	4
Silver eel running to Ballina	10.3	tonnes	1+2
Silver eel production	39.4	tonnes	1+2+3
Potential silver eel production	46.4	tonnes	1+2+3+4
Wetted area of Moy catchment	8418.0	ha	
Potential silver eel productivity	**5.52**	**kg/ha**	

Data provided by: North Western Regional Fisheries Board, Moy Fishery

The Erne System



Declared catches of brown eel (taken by long line and fyke net) and silver eel from the Erne (1953-1998).

ERNE			kg		
Silver catch	Reported catch	Average 1955-1982	9245	kg	1
	Unreported catch	at least same as catch	9245	kg	2
	Escapement	18% efficiency	51358	kg	3
Brown catch	Reported catch	Average 1955-1982	23393	kg	4
	Unreported catch	at least same as catch	23393	kg	5
Potential silver eel production			116633	kg	1+2+3+4+5
Wetted area			25959	ha	
Potential silver eel productivity			**4.5**	**kg/ha**	

Data provided by: Northern Regional Fisheries Board, Dept. Culture Arts & Leisure Northern Ireland & Agri-food & Biosciences Institute Northern Ireland