Case Study Description

Shannon River Basin

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1 Introduction

The River Shannon, Ireland's largest river system, has a network of lakes in which European eel is an important natural component of the fish assemblages. Like many other European rivers, the hydrological features of the River Shannon have been altered during development of navigation routes, by weirs constructed for flood control and when it was harnessed for hydroelectricity generation (Cullen, 2002). These and other environmental changes are reflected in the history of its eel fisheries and have stimulated a series of research activities that are ongoing (Moriarty, 1982, McCarthy *et al*., 1999, McCarthy & Cullen, 2000 a, 2000 b, 2002, Cullen & McCarthy, 2000, 2002, 2003, Arai *et al.*, 2006)

The Shannon river basin district (Fig 1), defined with respect to the objectives of Water Framework Directive, includes an area of about 18,000 km^2 , mostly in the lowland central area of the Republic of Ireland but with a small part (6km^2) of the upper River Shannon basin extending across the border to Northern Ireland. It includes areas referable to Ecoregion 17 (rivers, lakes) and Ecoregion 1 (transitional and coastal waters). It has been estimated that there are more than 1,600 lakes, totalling about 440km^2 surface areas, though the majority are less than 0.5km^2, and about 16,000 km of river channel in the river basin district. The area includes about 73 % agricultural land and 12 % wetland, mostly peatland habitat. Carboniferous limestone dominates the geological substrates. However, there are also areas of bedded shales and sandstones of Namurian age in the west on both sides of the Shannon estuary. The River Shannon (Fig 1), which discharges to a 97 km long, 5,002km^2 estuary, drains an area of approximately 11,700 km^2, upstream of upstream from Limerick. The total water surface area is about 4100 km^2 but the ten larger lakes represent 90% of the total lake area. Most of the lakes are shallow and mesotrophic to eutrophic the three largest, Loughs Allen (35 km^2) Ree (105 km^2) and Derg (117 km^2), are in a series of lakes though which the main river channel flows. The gradient is remarkably low, with the river rising at about 152 m above sea level and then flowing southwards with only a 12 m drop in altitude over 185 km, before finally descending more rapidly to sea level.

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Slime - Study Leading to Informed Management of Eels
Sixth Framework Programme, Priority 8.1, Policy-oriented research, Scientific Support to Policies.

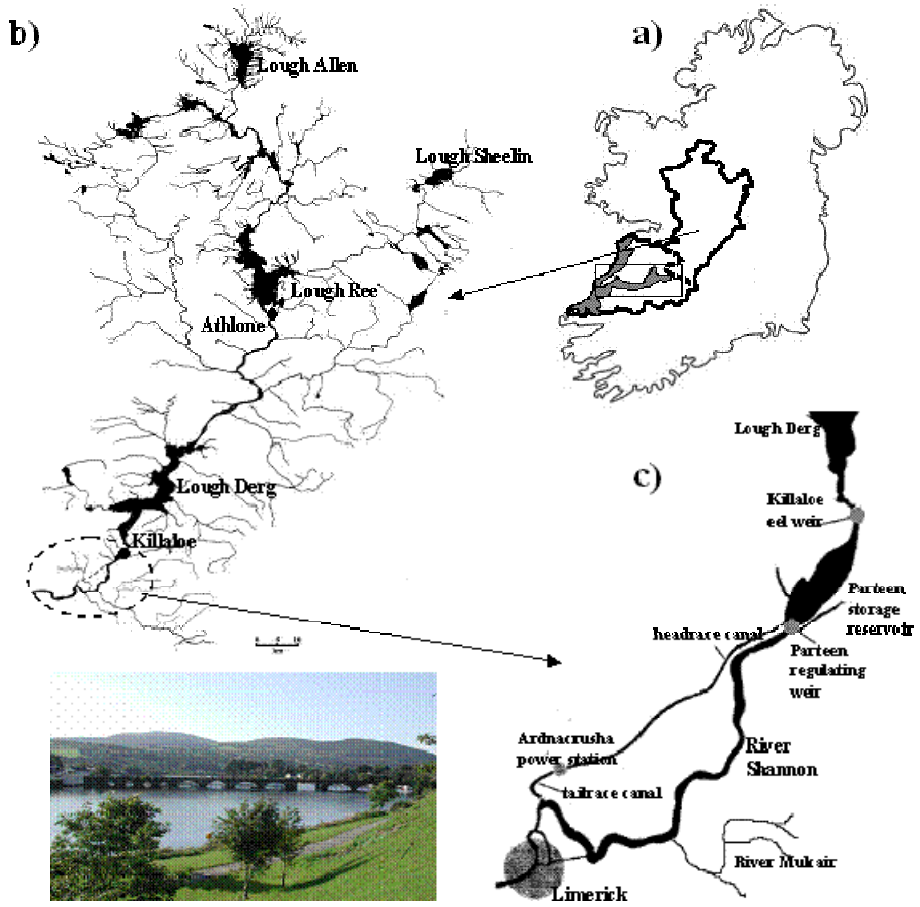
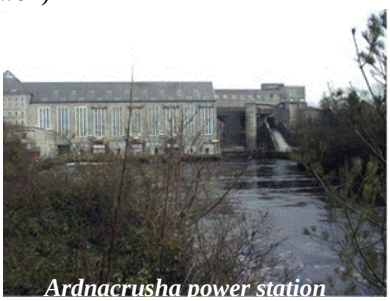


Fig.1. Maps showing: (A) Ireland, with Shannon WFD river basin district (coastal / transitional waters shaded) and River Shannon basin; (B) Lakes and tributaries of the Shannon River basin and (C) Lower Shannon River, with the locations of the Ardnacrusha hydroelectricity facilities indicated. (photo:Killaloe eel weir)


Ardnacrusha power station

The principal rivers flowing to the Shannon estuary are the River Feale (1153 km^2, 34.6 m^3sec^{-1}), River Maigue (1075 km^2, 15.6 m^3sec^{-1}), and River Fergus (881 km^2, 25.7 m^3sec^{-1}).The Ardnacrusha generating station (86 MW), constructed between 1925 and 1929, is located 3km upstream of the tidal limit of the river at Limerick city (Fig 1) and it harnesses 10,400km^2 of the catchment area upstream. In 1931 it supplied 96% of Ireland's electricity needs. A 12.6km headrace canal supplies the power station with the up to 400m^3sec^{-1} water supply needed for maximum generation levels. A 2.4 km long tailrace canal returns the station discharge back to the River Shannon. The Parteen regulating weir, located at the head of the headrace canal, servers to divert the main flow of the River Shannon to the power station. A storage reservoir immediately upstream of the regulating weir provides supplementary impounded water. A statutory 10m^3sec^{-1} compensatory flow must discharged to the main river channel. The mean annual flow of the River Shannon at Killaoe, located 3km upstream of the regulating weir, is 186m^3sec^{-1}. The mean summer discharge is 99 m^3sec^{-1} and the mean winter discharge is 274 $m^3sec^{-}1$. However, flows may be as low as 10-15 m^3sec^{-1} in dry summers or over 700 m^3sec^{-1} in major floods.


Parteen regulating weir

2 Fishing capacity.

Glass eel, elver and eel fingerlings are captured on the lower Shannon and in estuarine tributaries for stocking in River Shannon lakes. These are non-commercial activities, with the exception of a small pilot-scale glass eel fishery. Yellow and silver eel fishing, which were once commercial operations, are undertaken since 1992 as monitored scientific surveys of eel stocks on behalf of the fishery owner (Electricity Supply Board, ESB). Yellow eel fishing in the ESB controlled freshwater parts of the Shannon system involves a series of authorised (2 person) crews who are assigned to specific fishing zones. They typically use 5-6m open boats, equipped with outboard engines, and are permitted to fish either with fyke nets (maximum 50 nets) or longlines (maximum 1000 earthworm baited hooks per night) The silver eel fishery, is also a now primarily undertaken as part of an extensive eel stock monitoring programme. Fishing occurs either at specially constructed eel weirs, of varying sizes, or using winged-coghill nets set at lake-outlets and various other locations in the upper catchment. Prior to 1992, though good records are available for silver eel fishing at the major weirs, it is known that extensive illegal eel fishing occurred, and this involved fishing methods similar to those used in present day surveys. However, no reliable quantitative information on the fishing capacity or catches of unauthorised fishermen is available.

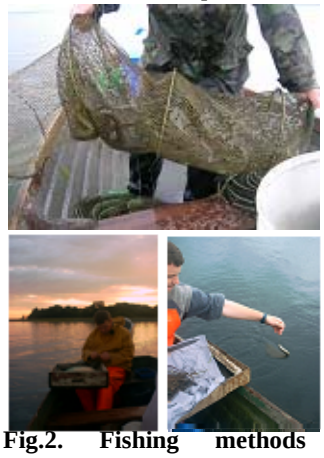
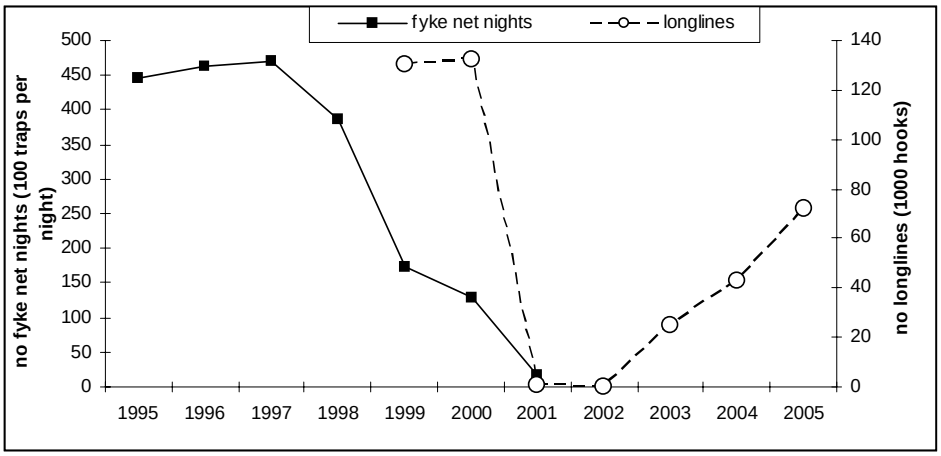


Fig.2. Fishing methods (upper photo: fyke net fishrmen; down: setting and lifting of longline.

3 Fishing effort

Yellow eel fishing effort has varied over the time period 1992 to 2006. In 1992-1994 a small number of monitored crews operated on Loughs Derg and Ree but since 1995 the number of crews was increased and fishing was extended to include most of the river's lake habitats. The maximum number of crews (N=47) was authorised in 1997 and all fishing was then done using fyke-nets. Subsequently, an increasing proportion of the crews were permitted to fish using longlines. In 2005 there were 15 fyke-net crews and 15 longline crews. The maximum fishing effort occurred in 1997, when there were over 1020 fyke-net nights (100 traps) settings recorded. The between year variation in fishing effort in the Shannon catchment is summarised in Fig 3. In 2001 the fishery management decided to restrict fishing on Lough Derg, as a stock conservation measure, other than for experimental purposes.

Fig.3. Fishing effort on Lough Derg 1995-2005 given as an equivalent of 100 fyke net traps or one longline with 1000 baited hooks set over the 1 night.



Silver eel fishing effort has also varied over the 1992-2005 period, with some commercial weirs (e.g. at Athlone and Clonlara) ceasing to function. A progressive shift in fishing effort to the middle and upper parts of the catchment has also occurred (Fig 4).

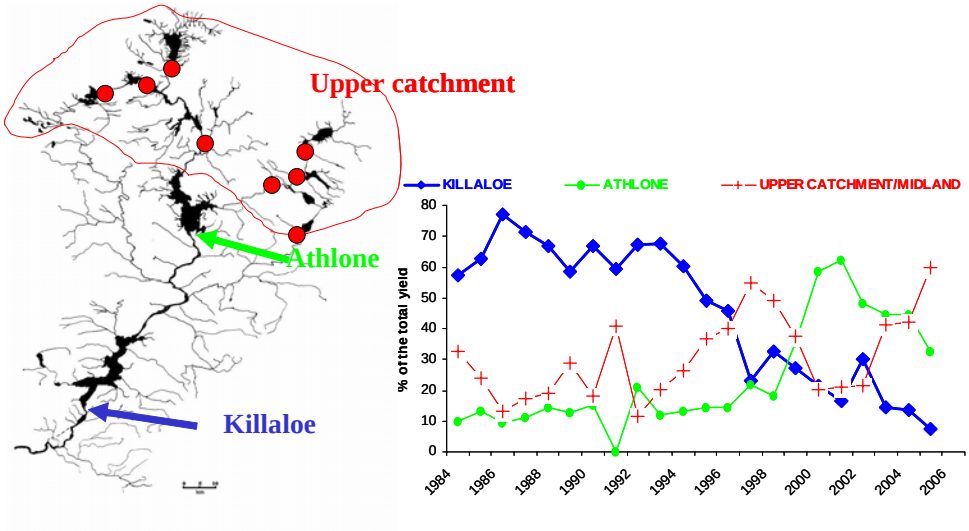


Fig.4. Long term variation in the percentage of the total annual Shannon silver eel yield captured at the Killaloe weir, Athlone and upper catchment 1984-2006.

4 Catches and landings.

Reliable data on yellow eel landings are only available from 1992 and these are summarised in Fig 5. Catch data for silver eel fishing in the River Shannon, recorded at commercial weirs from 1981 and in monitored fishing from 1992 are presented in Fig 6. Significant declines have been recorded in both the yellow and silver eel catches in the Shannon system.

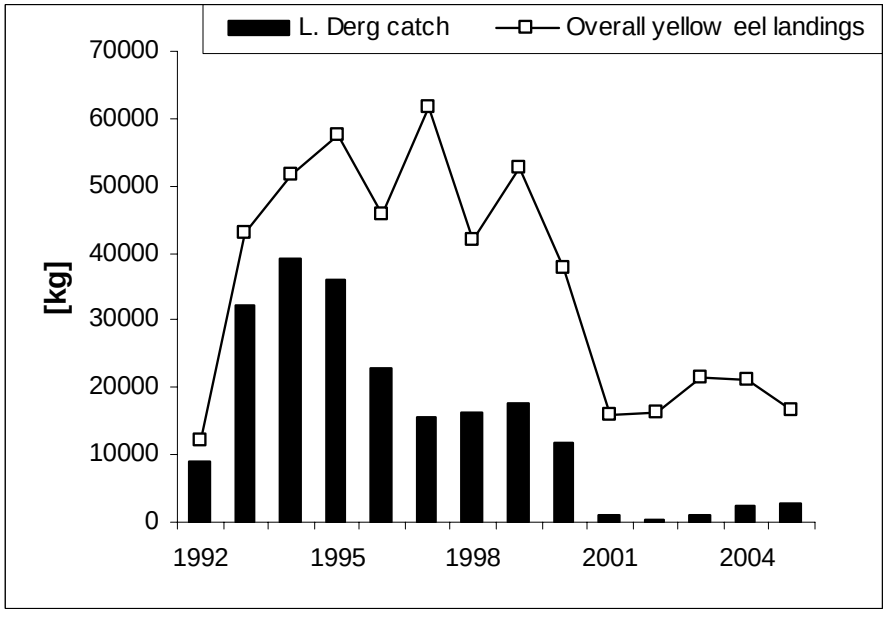


Fig 5. Overall total yellow eel landings for Shannon system and Lough Derg total catches 1992-2005

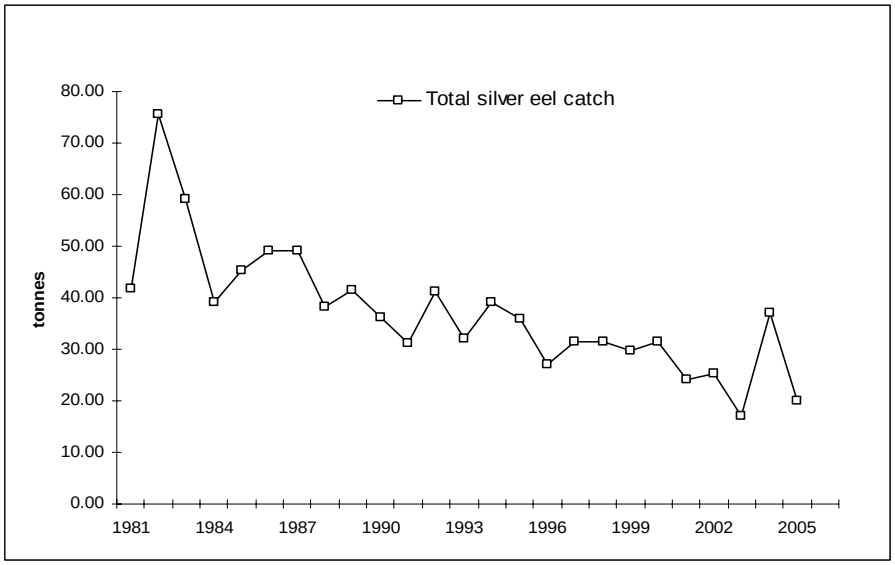


Fig 6. Decline in silver eel populations, as indicated by the annual catches for the entire fishery.

5 Catch per Unit of Effort

Catch per unit effort for yellow eel fishing is recorded as the weight of eels per fyke-net trap per night setting or as weight of eels captured per 100 hooks for longline fishing. These CPUE indices are calculated using log book records or during routine monitoring of fishing crews, when additional biometric data are also recorded. Silver eel fishing effort is generally recorded as catch per night for specific fishing sites and these data are used for monitoring within season and between year patterns of silver eel capture for the various fishing sites.

6 Scientific surveys of the stock.

6.1 Recruitment surveys

Juvenile eel recruitment to the River Shannon is monitored by recording catches of elvers and fingerlings at traps located at the Ardnacrusha and Parteen dams (Fig 7&8). In addition, information on stocking of juvenile eels, obtained in the Shannon estuary and other adjacent rivers (Fig 9) is recorded annually. An experimental glass eel fishery was initiated in the Shannon estuary in 1997. Summary details of the recruitment pattern from 1959 for the Shannon are presented in Fig 9.

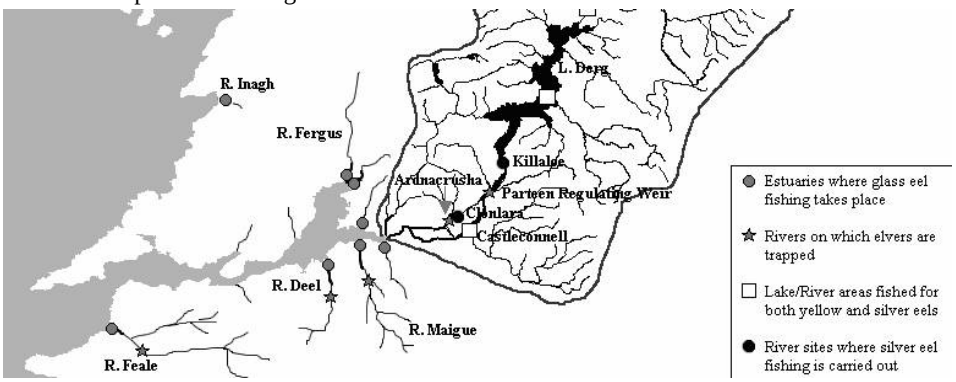


Fig.7. Shannon river estuary-locations of glass eel fishing and trapping facilities.

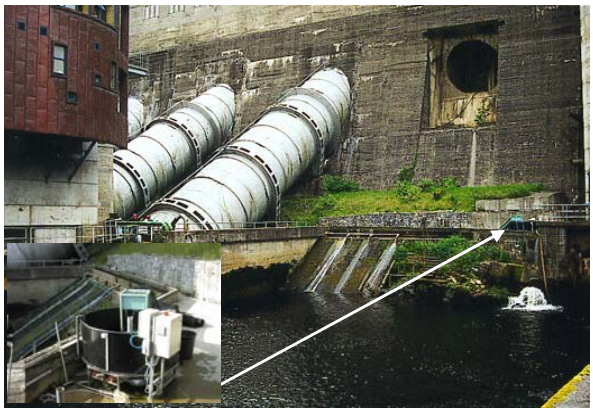


Fig.8. Ardnacrusha elver trap.

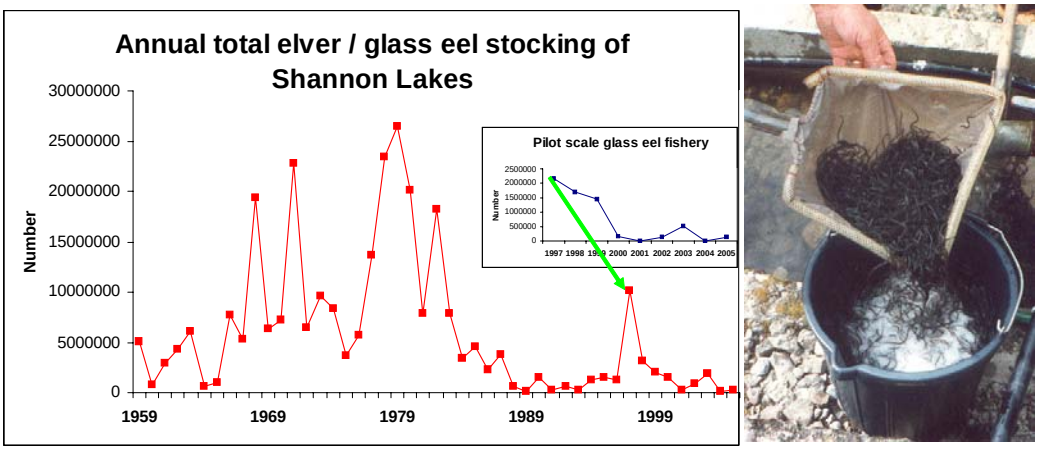


Fig.9. Long term data series for eels stocked into the River Shannon expressed in terms of numbers of elver equivalents stocked per annum (number of glass eels captured since 1997 when pilot glass eel fishery started).

6.2 Yellow eel surveys

Annual yellow eel surveys are undertaken, by monitoring all authorised crews and analyses of log book data. In addition, eel sales points are monitored and commercial records are related to fishing crew catch statistics. Fishery independent surveys, mostly involving standardised longline fishing protocols, are also undertaken in the 10 major lakes of the river system. Some electrical surveys of riverine eel populations are also undertaken from time to time.

Silver eel surveys

Silver eel catch statistics are monitored each year at a series of locations in the River Shannon catchment area. Authorised crews and operators of ESB owned commercial weirs are required to keep daily records of catches and fishing conditions. Hydrometric and other environmental data are compiled annually and these are used in analyses of within and between fishing season variations in silver eel catches. Information on silver eel migrations and fishery yields have been published previously (McCarthy&Cullen, 2000). In the upper catchment silver eel movements, and capture rates, reflect the underlying lunar periodicity to a greater extent than at sites such as the Killaloe eel weir. In the lower Shannon the regulation of the river for hydroelectricity generation strongly influences patterns of eel movement, as reflected in Killaloe weir catches. The silver eel weirs and other sites are also being used for tag/ recapture studies on eel migration rates and for estimation of eel weir capture rates.

7 Model applications:

The Shannon eel stock and fishery have been evaluated using a length-structured VPA (Dekker 1993, 1996, 2000), statistical analysis programme (Dekker 2004) and the Swedish analytical model. Because of the high complexity of the whole Shannon system, data from Lough Derg, the biggest lake, was chosen for evaluation of these models. The preliminary results provided interesting perspectives on the changes that have been taking place in the Lough Derg eel population and on the possible outcomes from alternative management options that may be implemented for stock conservation purposes. The Demographic Camargue model has been applied to data for the whole Shannon system. However due to the data constraints (i.e limited time series relative to eel maturation cycle in the Shannon) it was not possible to use this model as effectively as was initially anticipated.

8 References:

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