Case Study Description

River Severn and Estuary

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This report was completed in April 2006, and contains data up to 2004 (glass eel: 2005). Information was drawn from the Environment Agency's Draft Severn Eel Management Plan (Environment Agency, 2006).

1 Introduction

The River Severn rises on Plynlymon in Mid-Wales and flows 350 km through Powys, Shropshire, Worcestershire and Gloucestershire where it meets the sea in the Bristol Channel. For the purposes of this report, the Severn estuary extends downstream from Gloucester to a line drawn between Beachley on the western side and Avonmouth on the east. The section between Gloucester and Tewkesbury is tidal, and Tewkesbury is taken as the upstream limit of tidal influence. Major tributaries which join the Severn include the Vyrnwy, the Stour, the Teme and the Warwickshire Avon. These rivers drain a large part of the English Midlands and mid-Wales which is predominantly rural in character with urban centres in the West Midlands that occur at intervals along the main river (see Figure 1).

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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.

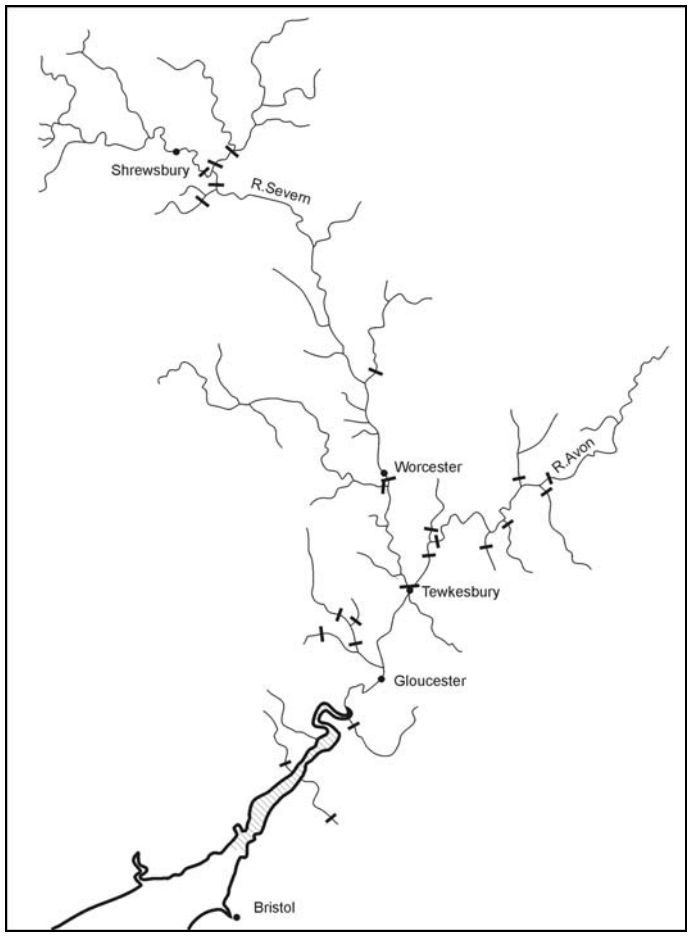

Figure 1. The River Severn and neighbouring catchments.

The river has been extensively managed to control flooding, particularly in the lower and tidal reaches where low lying land has been reclaimed for agriculture. Weirs have been built on watercourses of all sizes to provide water power. Although the mills are almost all obsolete, many weirs are still in place and maintained to control flow and for aesthetic purposes, and they will still pose a hindrance to eel migrating upstream.

The estuary widens downstream of Gloucester into a basin that fills and empties with the tides. The funnel shape of the Bristol Channel, the high tidal range (13.2m mean spring at Avonmouth) and the south westerly orientation of the estuary all combine to promote strong glass eel recruitment. In the past, the marshes and creeks bordering the estuary would have provided nursery areas for young eels, but the construction of flood-control tidal flaps since the middle of the last century on these streams/run-offs is considered to have reduced access to these areas.

Flood control and agriculture impacts on the higher reaches of the Severn. Two large water supply reservoirs are located close to the headwaters. Through the Midlands, the river has been impacted by eutrophication, but nutrient loading from point sources such as industry and sewage treatment works has been greatly reduced in the last 20 years. Diffuse pollution is still an issue and persistent chemicals from a range of sources are known to impact on fish stocks.

The Severn catchment supports a diverse range of fisheries, including coarse, salmonid and eel. Coarse angling is the most popular form of recreational fishing. There are commercial fisheries that target salmon and eel, mainly on the lower and tidal river. Fishing for eel (yellow

and silver) and elvers (glass eel) is carried out under licence granted by the Environment Agency.

2 Fishing capacity

In 2005 there were 413 licence holders: elver dip nets (402), Gloucester Wing Nets (3), Small wingless traps (3), Winged traps/fykes (4), Weir traps (1).

The trend in fishing capacity for glass eels in the Severn is similar to that reported for England and Wales as a whole (Figure 2).

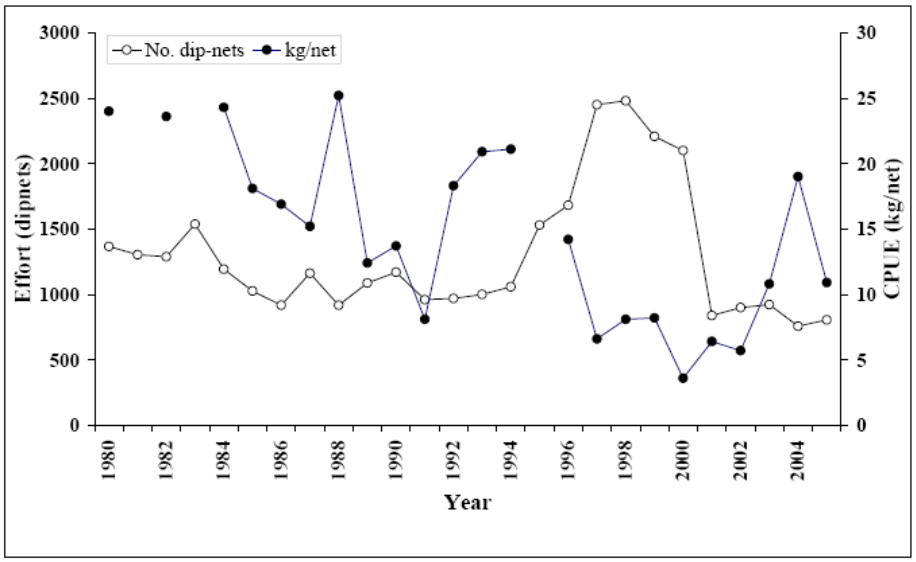

Figure 2. England and Wales glass eel fishery effort as number of licensed dip-nets per year and CPUE (from C&E export estimates) in kg/net, 1980-2005.

3 Fishing effort

Fishing effort is measured as the number of licenses sold, as presented below for the period 2002 to 2004, from Environment Agency records.

	2002		2003		2004	
	Licensed nets/traps	Catch (kg)	Licensed nets/traps	Catch (kg)	Licensed nets/traps	Catch (kg)
Glass eels	569	290	487	877	513	577
Yellow/Silver eels	80	156	53	980	47	569

4 Catches and Landings

The catch data for all life stages of eels declared to the Environment Agency are sparse and considered to be unreliable. In recent years, nett export data from HM Customs & Excise (C&E) suggests that the declared catch has been under-reported by a factor of between 3.4 and ~15 times. Also, the glass eel/elver data are collated at the national level but 95% of the catch is believed to derive from the Severn fishery

Glass eels/elvers: annual catches varied widely between years over the period 1972 to 1983 (~10 to 70 t) but have declined in subsequent years, with annual catches of <1 t in 2002 to 2004 (based on Cefas/EA catch records) (Figure 3). Nett exports in 2002 to 2004 varied between 5 and 15 t (C&E data).

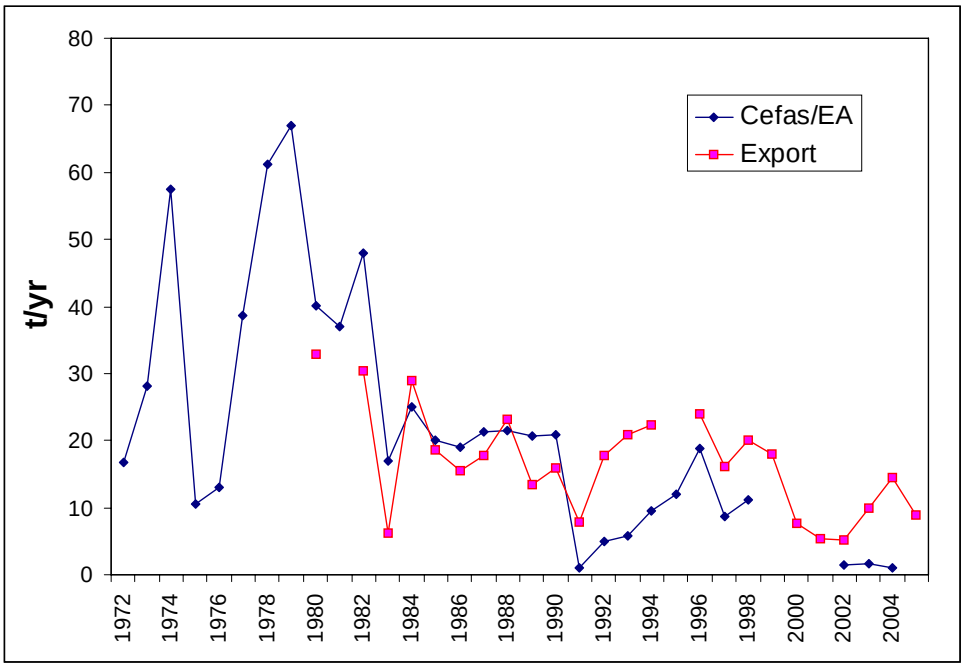

Figure 3. Annual UK (England and Wales) catch of glass eel (tonnes) from Cefas/Environment Agency and nett export estimates between 1972 and 2005. It is assumed that > 95% is taken from the Severn Estuary.

High elver prices has led to an increase in illegal exploitation in recent years, often using unlawful methods, such as fishing from boats or using non-compliant nets or traps.

Yellow and silver eel fisheries in the River Severn were relatively small in the 1980s (probably only 20 fishermen catching a total of about 5 t per annum) and primarily existed for home consumption. The bulk of the silver eel catch on the Severn was taken in wing nets stretched from bank to bank. From 1982 to 1984, 7 men took a total catch of 2 t compared with 13 operators catching about 9 t in 1976. It is difficult to estimate the landings before 1970, but local fishermen have stated that the average nightly catch per net was about 500 kg in the 1930s compared with 75 kg in 1976.

5 Catch per Unit of Effort

Glass eels: The Severn glass eel fishery accounts for about 95% of the catch for England and Wales, so the national CPUE data should reflect trends in the Severn fishery. CPUE for England and Wales, as derived from numbers of license and export estimates, declined from the mid-1980s to 2002, but has shown some increase again in most recent years (Figure 2).

Yellow/silver eels: CPUE data for England and Wales are presented as an index of change in the Severn fishery, but note that the Severn fishery constitutes a far smaller proportion of the national yellow/silver eel catch than the proportion accounted for by the glass eel catch. CPUE as kg/instrument varied between 100 and 210 kg over the period 1983 to 1999, declined sharply to 25 kg in 2003, but has increased towards the previous range over the last two years (Figure 4).

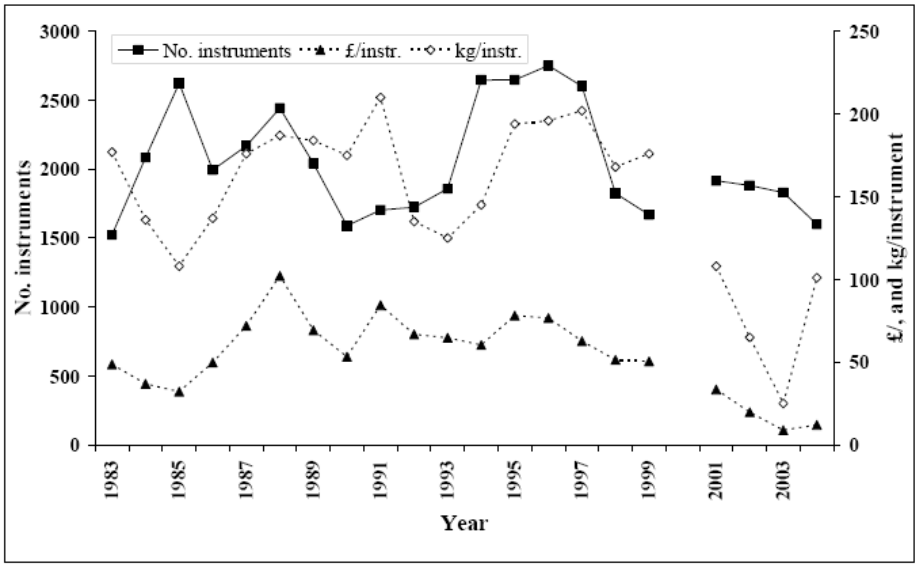

Figure 4. England and Wales yellow and silver eel fisheries: numbers of instruments, CPUE as kg/instrument, and £/instrument (based on C&E export data), 1983-2004.

6 Scientific surveys of the stock

6.1 Recruitment surveys

There is no fishery-independent measure of glass eel/elver recruitment.

6.2 Yellow eel surveys

6.2.1 Distribution

Currently, eel are well distributed throughout the Severn catchment, although few appear to penetrate the source streams arising from the Cambrian mountains. Eel are also absent from rivers draining the Birmingham conurbation. Where data showed that eel were present during the early 1980s, eel were also recorded between 2001–2005. In addition, several of the sites where eel were absent during the early 1980s had eel present in 2001–2005.

6.2.2 Abundance and density

An extensive investigation of eel distribution, abundance, age and growth was carried out during 1983 and 1984 at a total of 109 sites (Aprahamian, 1986 & 1988). In 1998, 24 of these sites were resurveyed and, in 1999, 16 of the 24 sites surveyed in 1998 were resurveyed (Knights *et al*. 2001). Ten sites of those fished in 1983, 1998 and 1999 have been resurveyed on an annual basis since 2002. Overall, there is little evidence of any change in either density or biomass over the period, though there is evidence of a systematic change in certain areas, with densities decreasing in some areas while increasing in others, the latter attributed to habitat improvement following the discontinuing of channel dredging.

6.3 Silver eel surveys

There is one operational fixed eel trap on a weir on the River Avon, used to catch silver eels during their autumn migration. In 2005, this trap was operated on behalf of the Environment Agency to collect silver eels for monitoring purposes.

7 Catch composition by age and length

No data for fisheries catches, but survey data provides length and age for yellow eels across the catchment.

8 Other biological sampling (age and growth, weight, sex, maturity, fecundity)

An extensive survey of the biological characteristic of the eel population in the Severn was carried out in 1983/84, a detailed survey was undertaken in 1998 & 1999 and sampling has been carried out at ten sites in the lower reaches on an annual basis since 2001. Biological data collected consists of density, biomass, size and age structure, growth, production and sex composition of the yellow eel population and the age and size structure for the silver eel population. Details can be found in Aprahanian (1986, 1987, 1988), Knights et al., (2001), and Ibbotson et al., (2002).

9 Literature references.

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Ibbotson, A., Smith, J., Scarlett, P. and Aprahamian, M.W. (2002). Colonisation of freshwater habitats by the European eel, *Anguilla anguilla*. *Freshwater Biology* 47: 1696-1706.

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10 Application of Models

For the purposes of testing models in SLIME, it was decided to focus on the inner estuary and freshwater portion of the Severn catchment and exclude the outer estuary and the effects of the glass eel/elver fishery.

The SMEP model was applied to the Severn dataset.

10.1 SMEP

The Severn population was appropriate for modelling with SMEP because catchment data were readily available, along with eel population data sufficient to inform the parameters file.

10.1.1 Parameter Setting

Growth: At the time of the workshop, SMEP applied growth according to the Von Bertalanffy model, and 'UK eel' default values for L_∞ and k were used. It was recognised, however, that the VB model is probably not appropriate for simulating growth of eel, and this is an area of continued model development. The α and β values for the length/weight regression were derived from Severn eel survey data.

Recruitment: No direct recruitment measures were available for the Severn, but recruitment of glass eels under present and historic conditions were estimated, based on recent annual catches by the fishery, the assumption that the fishery presently exploits 10% of the glass eel run, and that the declining trend in CPUE for the UK fishery between 1980 and recent years is a reasonable reflection of changes in glass eel recruitment. At present, around 95% of the UK glass eel catch is taken from the Severn Estuary.

Carrying Capacity (biomass): maximum densities observed for streams were converted to biomass, although these may still be well below maximum possible biomass of yellow eel standing stock. Both the concept, and representative values, of carrying capacity for eel require further exploration.

10.1.2 Population Data

The most complete data set for yellow eel was for 1983, so this was used as a reference year, against which to compare the model outputs in terms of the yellow eel production.

10.1.3 Model Outputs

The model predicted that silver eel escapement today would be around 25% of that produced under 'pristine' conditions of recruitment, access and habitat/environmental quality issues, and that the majority of silver eels would be male under both sets of conditions.

The model performed well in simulating the yellow eel population under present-day conditions, when compared to available survey data, with predicted yellow eel densities predicted by the model for reaches 3 to 5 are similar in magnitude to those observed at sites within these reaches in recent years.

10.1.4 Conclusion

SMEP has definite potential for modelling eel populations and silver eel output from the Severn and other large UK catchments which include such a diversity of habitats, but does require further parameter testing and model development. Further modelling should examine the effects of increasing the productive area of the catchment, to simulate improvements to habitat quality or the removal of migratory barriers, with or without any improvement in recruitment to the system. Such simulations would be possible with SMEP if a GIS catchment description package was used to inform the 'barriers to migration' and 'habitat/environment quality' input options.