

www.defra.gov.uk

Eel Management plans for the United Kingdom Severn River Basin District

Date published: March 2010

Contents

1. [Introduction](#)
2. [Description of the Severn River Basin District](#)
 - 2.1 [The Severn River Basin District](#)
 - 2.2 [Current eel population](#)
 - 2.3 [The Fishery](#)
 - 2.4 [Silver eel escapement](#)
 - 2.5 [Eel mortality and available habitat](#)
3. [Restocking](#)
 - 3.1 [Habitat to be restocked](#)
 - 3.2 [Past restocking](#)
 - 3.3 [Potential restocking in the Severn RBD](#)
 - 3.4 [Eels to be restocked in 2009](#)
 - 3.5 [Compliance with restocking requirements in the Regulation](#)
4. [Monitoring](#)
 - 4.1 [Assessment of silver eel escapement](#)
 - 4.2 [Price Monitoring and reporting system](#)
 - 4.3 [Catch and effort sampling system](#)
 - 4.4 [Traceability of live imported and exported eels](#)
5. [Measures](#)
 - 5.1 [Measures to meet Escapement Objective](#)
 - 5.2 [Measures taken 2007 to 2009](#)
 - 5.3 [Measures to be taken 2009 to 2012](#)
 - 5.4 [Measures to be taken beyond 2012 to achieve Escapement Objective](#)
6. [Control and Enforcement](#)
7. [Modification of Eel Management Plans](#)

1. Introduction

This Eel Management Plan for the Severn River Basin District (RBD) aims to describe the current status of eel populations, assess compliance with the target set out in Council Regulation No 1100/2007, and detail management measures to increase silver eel escapement. This will contribute to the recovery of the stock of European eel.

2 Description of the Severn River Basin District

2.1 The Severn River Basin District

The Severn RBD covers an area of 21,590 km² and encompasses the main River Severn, its tributaries, and several rivers joining the estuary, including the Bristol Avon to the south, and the Wye, Usk and Welsh Valleys rivers (Rhymney, Ebbw, Taff and Ely) to the north (Figure 2.1). The numbers and areas of four main water body types, as defined by the Water Framework Directive, are shown in Table 2.1 (Defra 2005).

Water body type	Number present	Length/Area
Rivers with catchments greater than 10 km ²	748	7,107 km 9726.0 (ha)
Lakes with areas greater than 0.5 km ²	35	33 km ² 6158.6 (ha)
Transitional water bodies	1	547 km ²
Coastal water bodies	0	

Table 2.1 Water bodies in the Severn RBD.

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. The Severn is tidal up to Tewkesbury. Major tributaries that join the River 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 that are predominantly rural in character, but with urban centres in the West Midlands occurring at intervals along the main river (Figure 2.1).

The rivers that drain into the Severn estuary vary in their geography. The Wye, Usk and Bristol Avon drain predominantly rural catchments with a few large urban centres, notably Bristol. The catchments generally support livestock farming in the upper reaches, with arable and improved pasture lower down. The Bristol Avon is more heavily populated in its lower reaches.



Figure 2.1 The River Severn RBD.

The Welsh Valleys rivers are very different, having been heavily modified in the past to serve the needs of the large coal and steel industry. The catchments are generally short, steep and heavily populated although some livestock farming is supported in the upper reaches.

Existing Environment Agency information on obstructions to fish movement within the Severn RBD was collated. An initial assessment on the likelihood of eels being able to pass these obstructions has been made. These are shown in Figure 2.2.

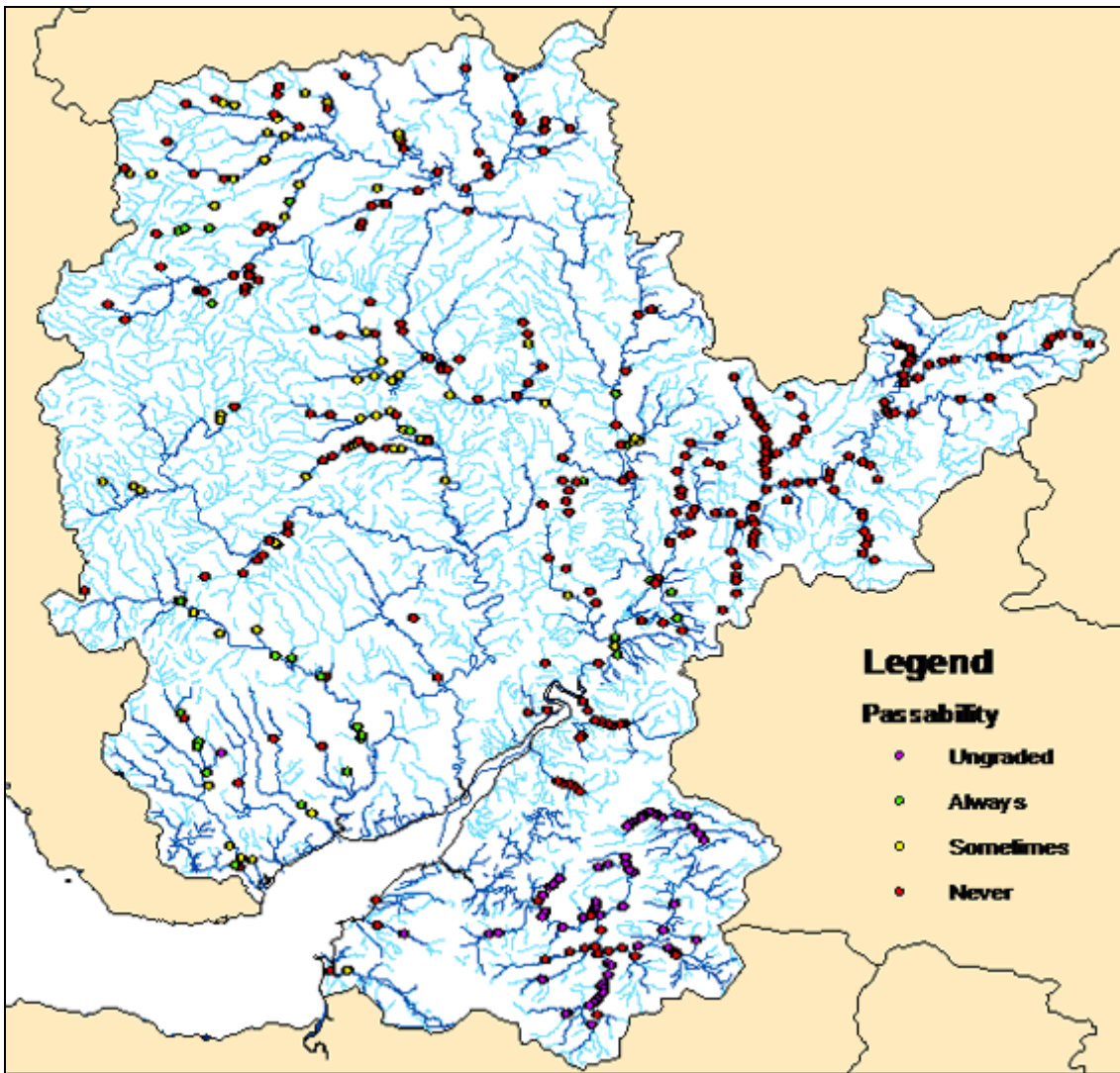


Figure 2.2 Distribution of obstructions in the Severn catchment.

The estuary of the River Severn 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 (13.2 m mean spring at Avonmouth) and the south westerly orientation of the estuary all combine to promote strong glass eel recruitment. In the past these juveniles would then have had access to the marshes and creeks bordering the estuary, and to the freshwater rivers.

Throughout the RBD, two factors have combined to reduce access to these juvenile areas: flood defence engineering and weir construction. Many of the rivers in the RBD have been extensively managed to control flooding, particularly in the lower and tidal reaches where low-lying land has been reclaimed for agriculture, and flood-control tidal flaps have been in operation since the middle of the last century. These actions have reduced access and removed eel habitat.

Many of the rivers within the RBD are open to navigation, including the main River Severn, the Warwickshire Avon and the Bristol Avon. A series of weirs and locks allow boat movement, but may pose a significant hindrance to eel upstream migration. Smaller non-navigable tributaries also have many obsolete mills with associated weirs that restrict the distribution of eels.

All of the heavily modified Welsh Valleys rivers have sections impounded by large weirs that once would have provided water and power to local industry, they also have some extensive culverted sections. These rivers would have been readily accessible to immigrating elvers, and this is still the case on the Ebbw and Rhymney. In 2001, the Cardiff Bay barrage closed off the combined estuaries of the rivers Taff and Ely, requiring glass eel to access these rivers via either the fish pass, or one of the large navigation locks.

The main river areas of the Usk and Wye are relatively unmodified and remain largely accessible to eels throughout their length. The main river Wye has no weirs. The Usk has few; most of which are believed to be easily passable, whilst others have fish passes. Two large tributaries of the Wye, the Monnow and the Lugg, are substantially impounded by a single weir, and by a multitude of smaller weirs, respectively.

2.2 Current eel population

2.2.1 Glass eel recruitment

There is no fishery-independent monitoring of glass eel recruitment in the Severn RBD.

2.2.2 Yellow Eel Distribution

Within the Severn RBD, 395 sites are monitored for fish, by the Environment Agency, on a six year rolling programme (i.e. around 65 are sampled each year). An additional 149 sites are sampled on an annual basis and a further 68 sites are surveyed as part of the Water Framework Directive programme of monitoring. All these 623 sites are multi-species surveys and may therefore underestimate the true density of eel (Knights et al., 2001). To support these surveys there is some high quality survey information for the River Severn itself, gathered over a number of years and including five sites surveyed specifically for eel. It is intended for the purpose of this Eel Management Plan, to use the information from the River Severn as a surrogate for the whole RBD when considering compliance with the escapement target.

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 (Figure 2.3). Where data showed that eel were present during the early 1980s, they were also recorded at electric fishing surveys carried out between 2001-05. Moreover, several of the sites where eel were not recorded during the early 1980s had eel present in the more recent 2001-05 surveys.

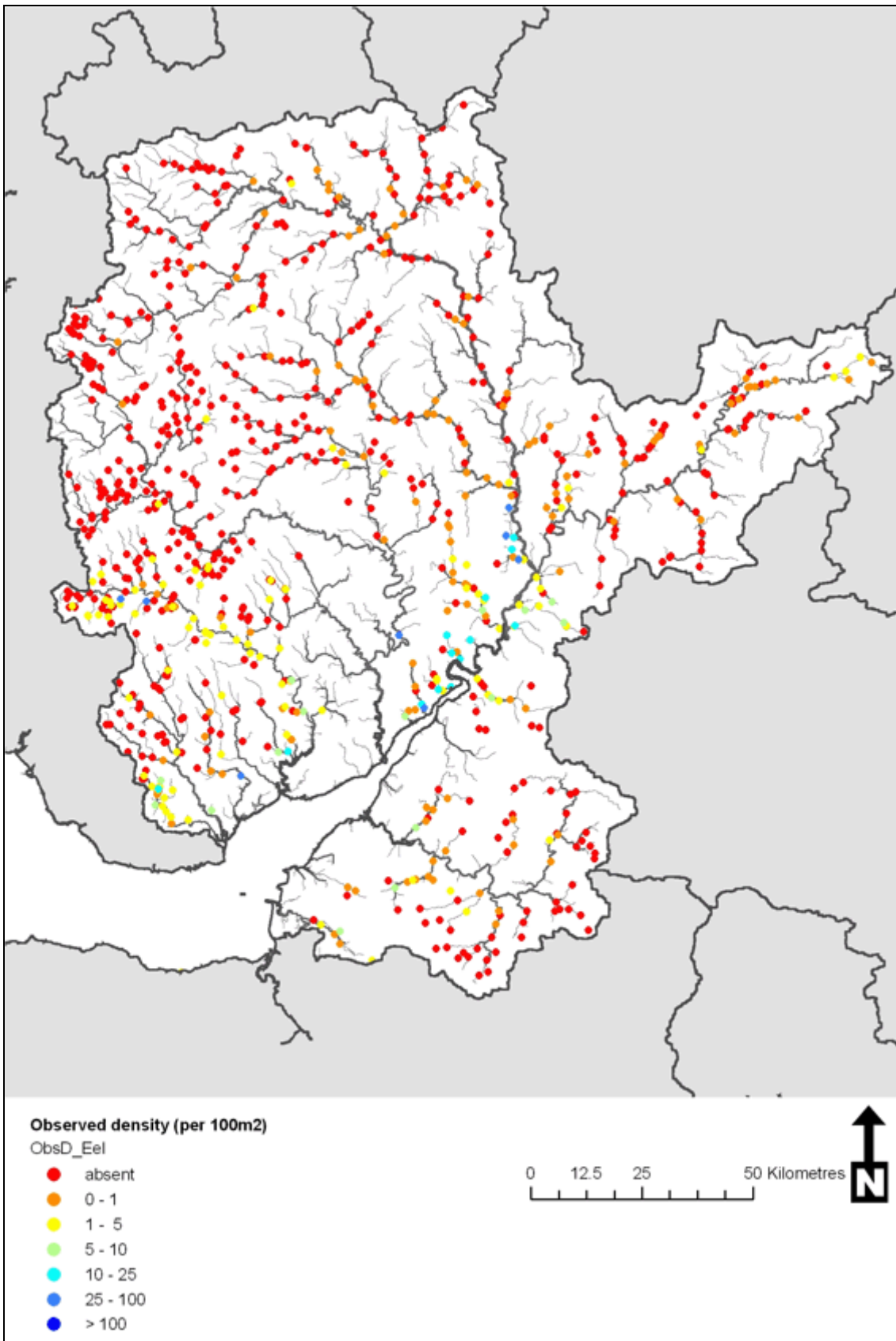


Figure 2.3 Distribution of eel in the Severn Catchment (2001-05 survey data combined).

2.2.3 Abundance and Biomass in the River Severn

An extensive investigation of eel distribution, abundance, ages and growth was carried out during 1983 and 1984 at a total of 109 sites in the River Severn catchment (Aprahamian, 1986 & 1988). In 1998, 24 of these sites were resurveyed and, in 1999, 16 of the 24 sites surveyed in 1998 were surveyed again (Knights *et al.* 2001). Five sites of those fished in 1983, 1998 and 1999 were resurveyed annually from 2002 to 2005. Since 2005, five of the original 1983 and 1999 survey sites have been surveyed annually for eel. The data for 2005 have not been included, as they were not comparable with those of the earlier surveys due to problems with the sampling method.

For analysis, the repeat survey sites have been grouped into zones (Figure 2.4): note that the sites surveyed since 2006 are in zones B and D only.

- Zone A – Outer Severn Estuary tributaries
- Zone B – Inner Severn Estuary tributaries
- Zone C – Tributaries between Gloucester and Tewkesbury
- Zone D – Tributaries between Tewkesbury and Worcester (excluding the Warwickshire Avon and River Teme catchments)

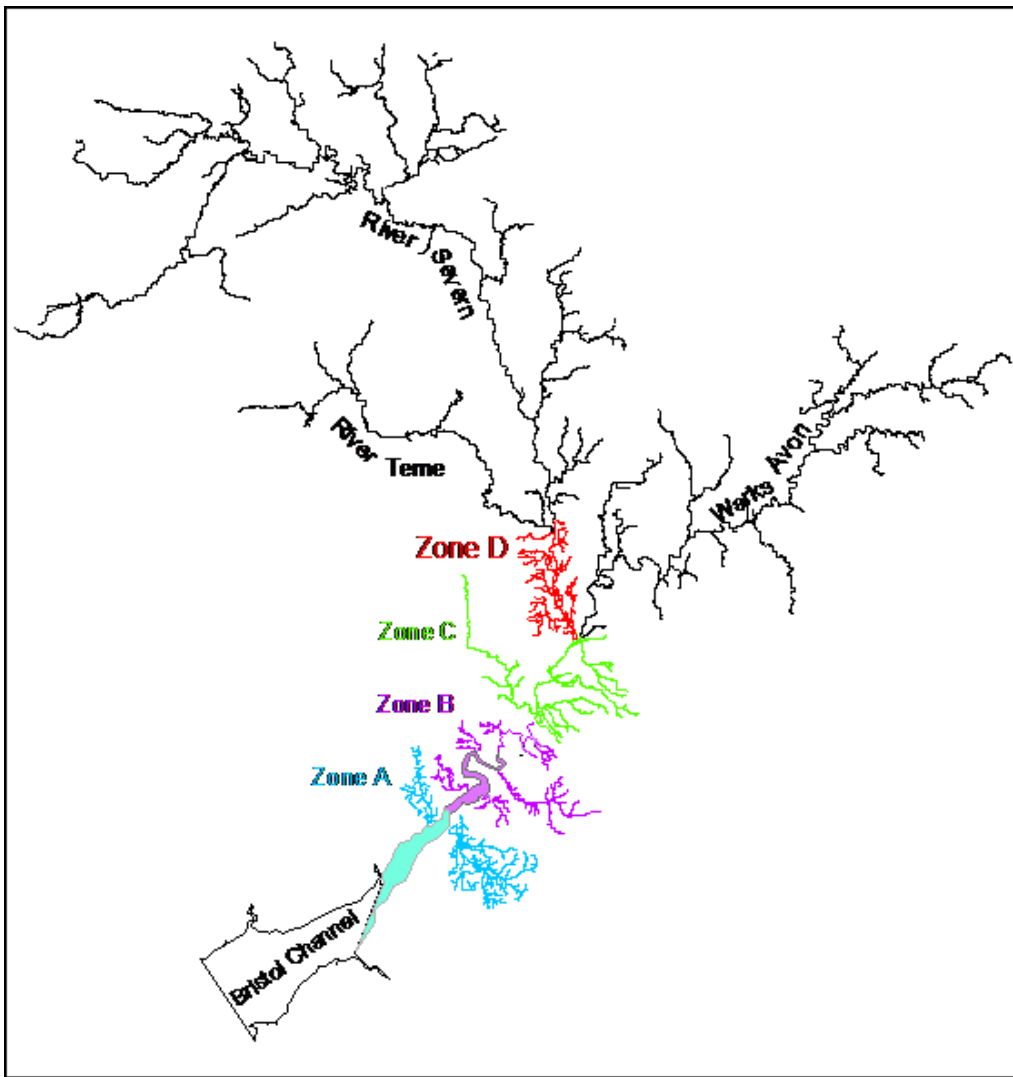


Figure 2.4 Eel survey zones on the lower Severn catchment (see text for details)

The density in numbers and biomass of eel in the four zones are shown in Figures 2.5 and 2.6. Overall (all zones), there is little evidence of any change in either density or biomass over the period, with most recent zonal densities all exceeding those measured in the early 1980s. There is evidence of a considerable change in certain zones during the time period, some of which can be explained. For example, the recent improvement in the status of the population in Zone D has been attributed to habitat improvement following the discontinuation of channel dredging. Similarly the high catches in 2003 in Zone B are skewed by an unusually large number of eels less than 100 mm long resulting in a high estimate of density. This was thought to be due to the warm spring and hot summer promoting early entry into the river of these young eels. In Zone C, the density in 1983 and 1998 was much higher than has been recorded subsequently, until a very high density was recorded in 2005, but the reasons for this have not been identified.

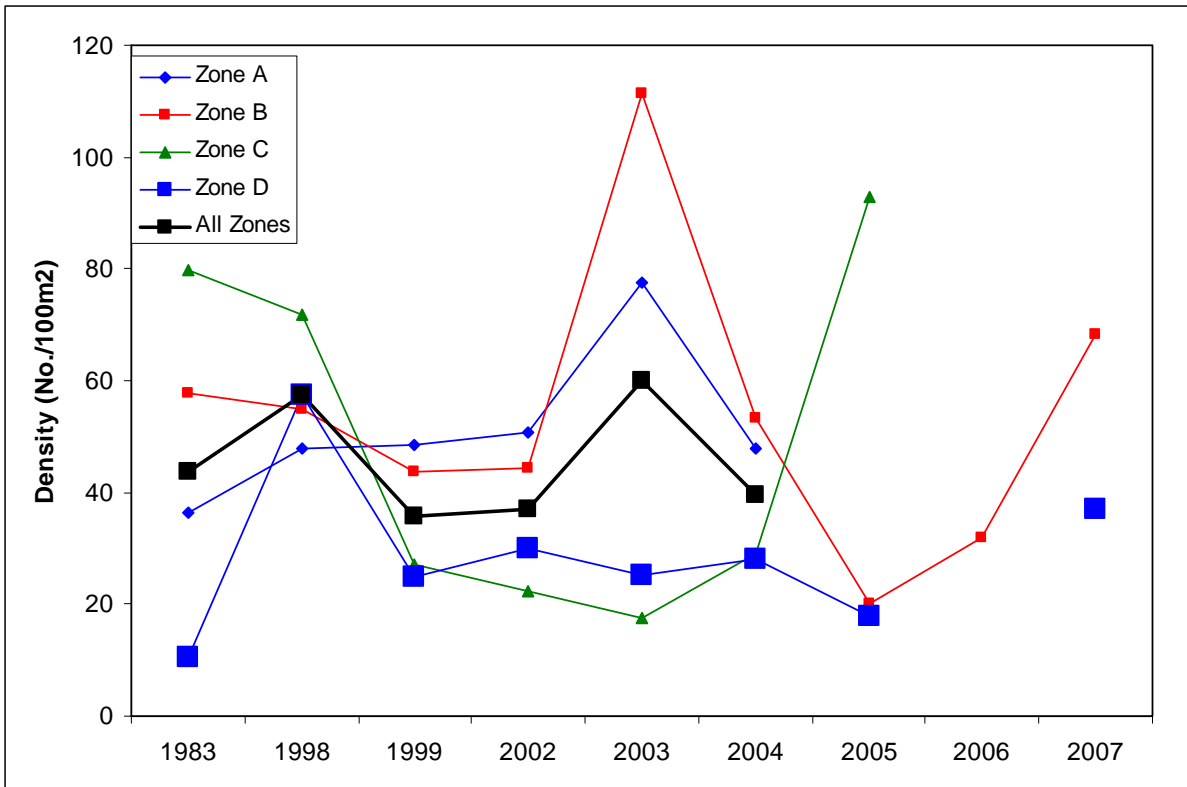


Figure 2.5 Density of eel in survey zones 1983 – 2007 (note, time is not continuous).

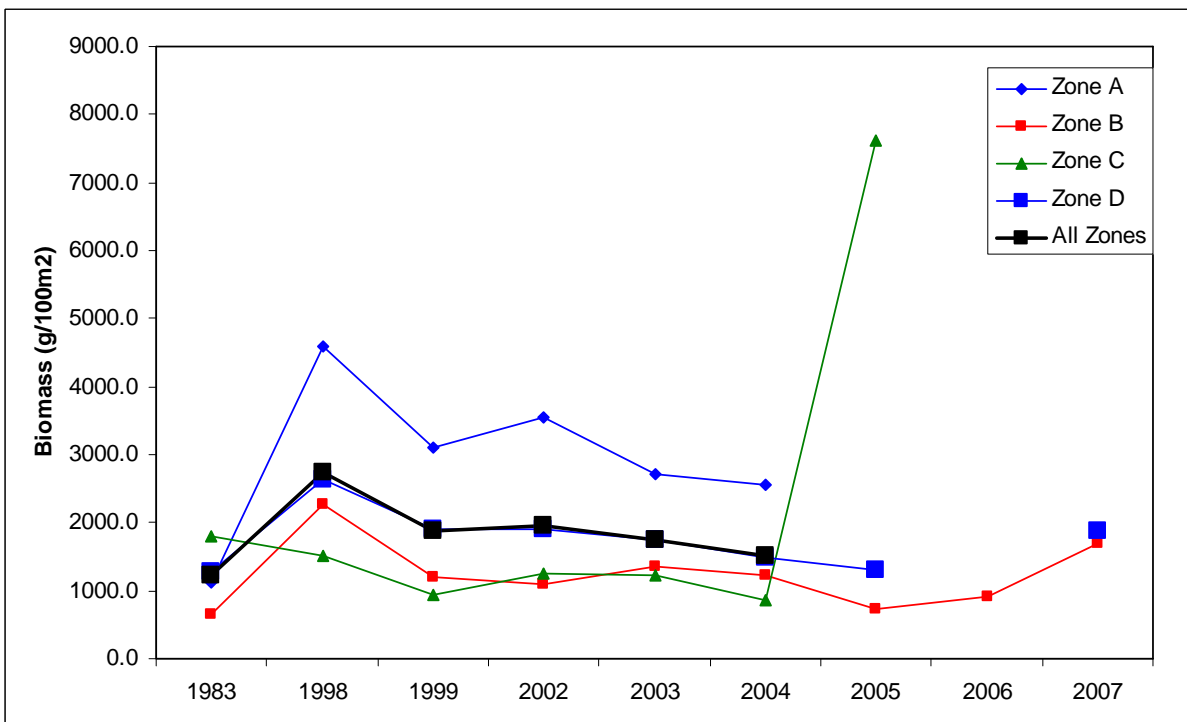


Figure 2.6 Biomass of eel in survey zones 1983 – 2007 (note, time is not continuous).

2.2.4 Population size structure in the River Severn

In addition to examining data for trends in population densities and biomasses, it is important to consider changes in size components of the populations. Information on eel length can be a useful way of examining trends, providing that standard sampling methods and sites are used for the comparisons (since different methods and habitats result in different size selectivity). For example, an increasing average length over time suggests that recruitment of small eels is declining.

In the Severn, eels less than 150 mm tend to be 3 years old or younger sexually undifferentiated eels (Aprahamian 1985). Those 150 mm to 450 mm are young sexually undifferentiated eels, immature males and females and mature males. Eels longer than 450 mm are almost all female.

Densities of juvenile eel less than 150 mm long (age 1 – 3 years) in some zones have varied considerably between consecutive years, densities in the most recent years surveyed all exceed those observed in the early 1980s (Figure 2.7). None of the differences within zones, over time were found to be statistically significant ($P > 0.05$; Kruskal Wallis analysis).

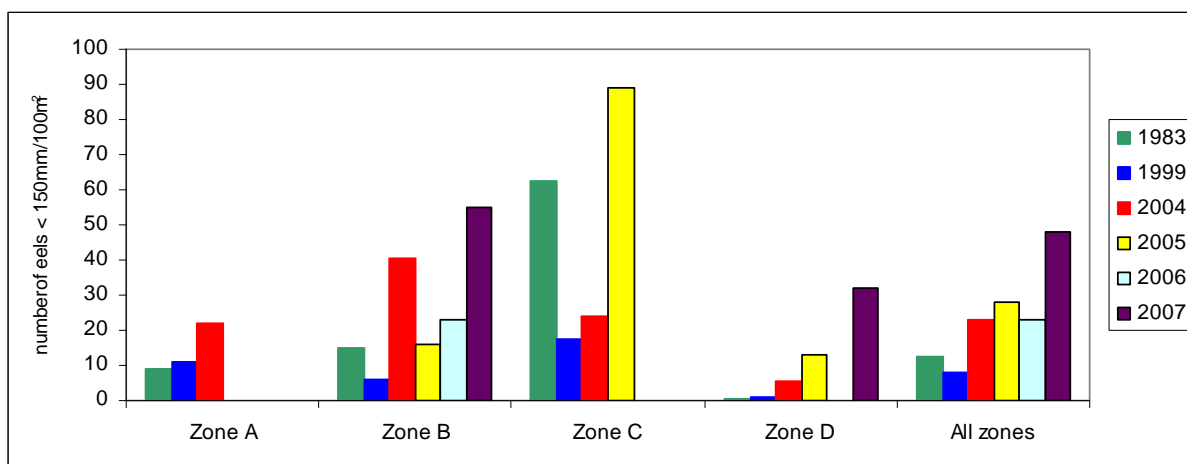


Figure 2.7 Density of eels <150mm in 1983, 1999 and 2004 to 2007.

There was a little change in the overall density of eel longer than 450 mm (all assumed to be female) in the pooled data for all zones from 1983 to 1999, and 2004 to 2007 (Figure 2.8). The density of eel longer than 450 mm in Zone A showed a small decrease in 2004 in comparison to 1983 and 1999. Eels longer than 450 mm were absent from Zone C in 2004 and 2005 (the last year surveyed). In Zone D there was an increase from 1983 to 1999 and then a considerable decrease since 2004. None of the differences shown were found to be statistically significant within zones and across the time period (Kruskal Wallis). However, there were generally fewer eels found in each zone in recent years when compared to the early 1980s.

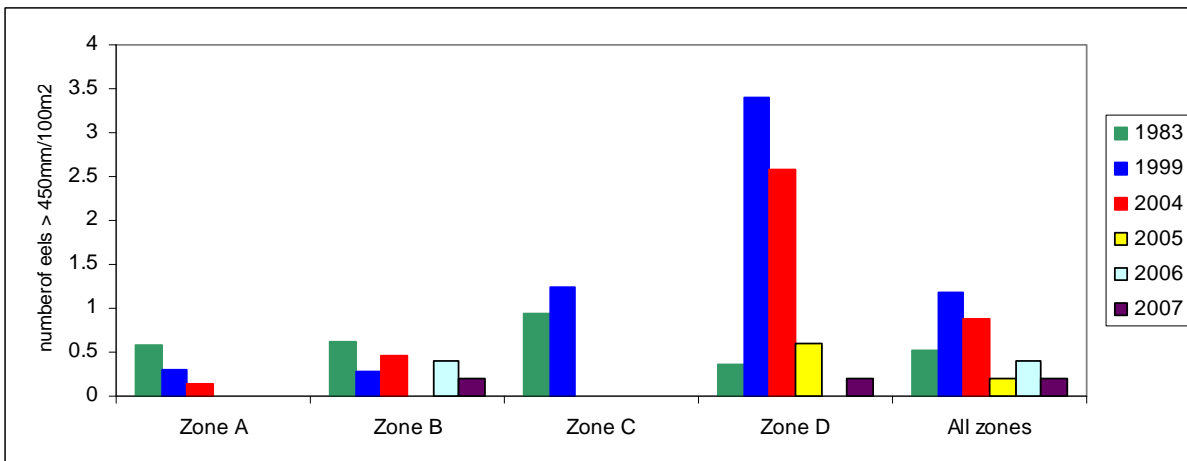


Figure 2.8 Density of eel >450 mm in 1983/4, 1999 and 2004 to 2007.

We conclude from these analyses that, overall, the eel population downstream from Worcester (Zones A to D) has shown little change since the early 1980s, over the time period when average recruitment to Europe has declined substantially. However, there has been a general decline in densities of larger eels in recent years.

The density and biomass of eel in the middle reaches of the Severn and Avon catchments were low during the 1980s, but have not been surveyed in more recent years.

2.2.5 Eel Populations in North Wessex

The eel populations of an area in England known as North Wessex were considered by Knights (2007). Wessex is the name of a former Anglo-Saxon Kingdom and then Earldom that has not been in existence since the year 1066. It is however still used for an area of the South West of England including parts of the counties of Somerset, Dorset, Hampshire and Wiltshire. Some of these areas are within the Severn RBD.

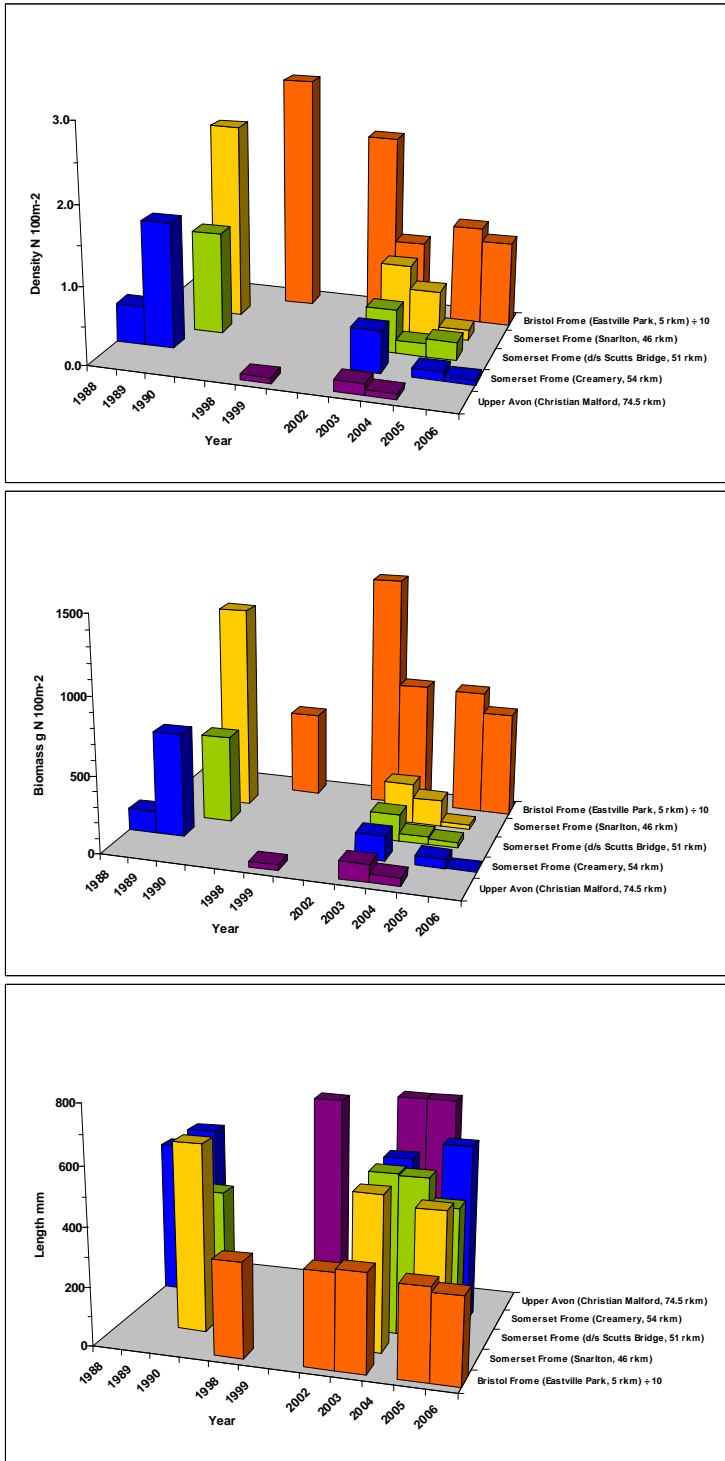


Figure 2.9 Density, biomass and mean length at five matching sites in the Avon catchment between 1988 and 2006. (reproduced from Knights 2007)

Knights (2007) considered multi-species electric fishing data for the Somerset rivers, and separately for the Bristol Avon catchment. For the Somerset Rivers only the River Axe is within the Severn RBD, but the main findings for all rivers was that, generally site densities and biomasses have declined between the early 1990s and 2006. Overall, mean density and biomass in 1994-2006 were 37% and 48% of the 1991-1993 values respectively, although no significant changes in mean length or length class frequency were detected.

On the Bristol Avon catchment, analysis of the historical survey data (Knights 2007) suggests that density and biomass on the Somerset Frome (upper catchment sites, >46 km from tide) have fallen significantly, by approximately 75% since the late 1980s ($P < 0.009$ and $P < 0.009$ respectively). Similarly, densities and biomass for sites in the Bristol Frome (5 km from tide) have fallen in recent years, but this trend is not significant, Figure 2.9. However there have been no changes in mean length per site throughout the period.

2.2.6. Estimation of silver eel output.

Silver eel estimation was made using the data collected at 109 sites within the Severn catchment in 1983/84 as this was the most extensive survey carried out and there appears to have been no change in density and biomass over the intervening years (section 2.2.3). The probability model estimated silver eel output for the Severn to be 9.5 kg / ha for the reach of river downstream of Worcester and 8.2 kg / ha for the section of river upstream of Worcester including the Avon and teme catchments. Overall the output was estimated to be 8.4 kg / ha. The estimated total silver eel output for the Severn RBD is 133.4 t / yr.

2.3 The Fishery

2.3.1 Introduction

Licences to fish for eels and glass eels commercially are issued by the Environment Agency on a Regional basis. The Severn RBD is located within three Environment Agency Regions: Wales, South West and Midlands.

The eel fishery in the Severn RBD is extensive. The number of licenses issued from 2005 to 2007 for the three Regions that contain parts of the Severn RBD is shown in Table 2.2. Two important points should be considered when looking at these data

- The number of licences issued is not the same as the number of fishermen. One fisherman is able to set many traps and fykes. The only fishing gear operated by a single person are dip nets, fixed traps, and Gloucester Wing Nets.
- The number of licences issued does not equal the number of fishermen within the Severn RBD. There are fisheries within areas of all three Environment Agency Regions that are outside of the Severn RBD.

Fishing Method	Region Year	Licensed instruments								
		EA Wales			Midlands Region			South West Region		
		2005	2006	2007	2005	2006	2007	2005	2006	2007
Elver Dip Nets		167	166	142	402	333	323	228	197	221
Gloucester Wing Nets		0	0	0	2	2	0	0	0	0
Small Wingless Traps		50	91	31	32	51	31	18	22	43
Winged Traps/Fykes		34	72	43	87	37	38	381	510	348
Fixed Traps		0	0	1	1	1	0	10	5	8

Table 2.2 Number of eel licences issued by the three Environment Agency Regions that comprise areas of the Severn RBD, 2005 to 2007.

2.3.2 The elver (glass eel) fishery

Glass eel fishing in England and Wales is conducted mainly on the River Severn and, to a lesser extent, on the Rivers Wye, Parrett and Usk, and some North West rivers (see North West EMP); all of these, except for the River Parrett and North West rivers, are within the Severn RBD. The glass eels move upstream on spring tides from mid-February through to mid-May. On the River Severn, they are caught first near Sharpness and can be followed upstream each subsequent night as far as Tewkesbury.

Since 2005, eel and glass eel fishermen have had to annually declare their weight of catches and the river where they were taken. A total of 774 kg of glass eels were declared as caught in the Severn RBD in 2005, 684 kg in 2006 and 1,254 kg in 2007. The rivers where these were caught are shown in Table 2.3.

River	Percentage of declared catch 2005 to 2007
Severn	59
Usk	8
Wye	24
Welsh Valley Rivers	2
Axe	4
Bristol Avon	1
Unknown	1

Table 2.3 Declared elver and glass eel catch in Severn RBD rivers, 2005 to 2007

Around 90% of the licensed glass eel netsmen returned a satisfactory catch declaration (92% in 2006, 89% in 2007). Although it is likely that the values in Table 2.3 are gross underestimates, they do indicate the relative importance of the elver fisheries in the Severn RBD rivers, compared to the UK catch as a whole. The declared catches in each month for the whole Severn RBD are shown in Figure 2.10.

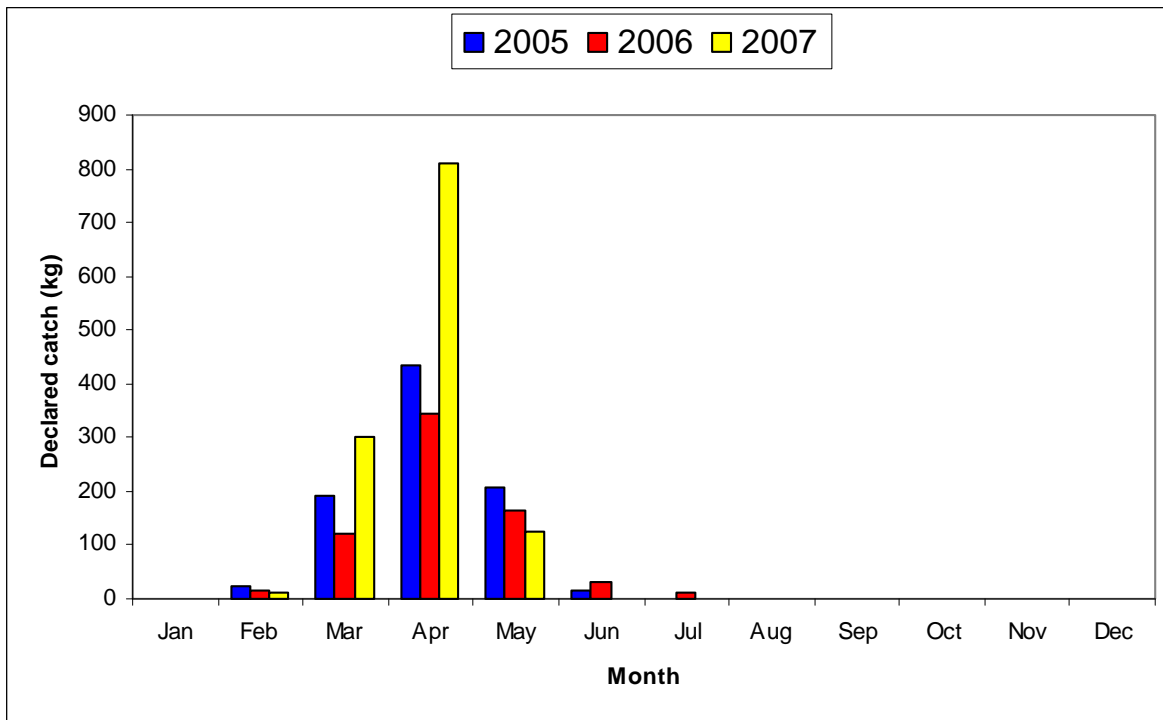


Figure 2.10 Declared monthly glass eel catch in Severn RBD, 2005 to 2007

2.3.3 Yellow and silver eel fisheries

Recreational Fishery

The recreational fishery for eels within the Severn RBD is small. The vast majority of eel are captured whilst anglers are fishing for other coarse and game species and, in these circumstances, eel are usually returned to the water.

In 2007 a total of 195,900 fishing licences were sold in the Environment Agency areas of Lower Severn, Upper Severn, North Wessex and Wales. These encompass the Severn RBD but also other areas outside of the RBD. A survey of anglers, carried out in the 1990s, indicated that the average distance travelled to fish by a licence holder was 20 miles and that 35% fished predominantly on rivers (National Rivers Authority 1995). Assuming that each angler catches one eel per season (Appendix 4) then approximately 68,000 eels are caught by recreational anglers each year. The level of post release mortality has not been assessed.

There are some reservoirs and still waters where eels are fished for recreationally on the Wye and Usk catchments, with large specimens being targeted by specialist anglers (S. Arbutnot, Environment Agency, pers. comm.). Again these would be returned alive to the water.

Commercial Fishery

Commercial yellow and silver eel fisheries in the River Severn are relatively small at the moment but have been quite considerable in the past when putcheons, fyke nets, eel racks and wing nets have been used. Of these the most effective was probably the Gloucester wing net stretched from bank to bank. 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, when 13 operators caught about

9 tonnes. From 1982 to 1984, seven men took a total catch of 2 tonnes each year. There is no gear-specific information on more recent catches.

The declared catch data from 2005 to 2007 are shown in Table 2.4 for different rivers in the RBD. The distribution of catches through the months in 2005 to 2007 are shown in Figures 2.11 and 2.12. As with the glass eel fishery, comparison of UK nett export data with the total declared UK catches in recent years suggests that the declared catch has been under-reported by a factor of around 6 (Walker et al., 2007). As nett export data are reported for international trade, it is not possible to assess potential under reporting at a RBD level.

River	Declared catch (kg)					
	Yellow eels			Silver eels		
	2005	2006	2007	2005	2006	2007
Severn	61	-	-	6	8	-
Welsh Valley Rivers	-	23	-	1	10	-
Bristol Avon	389	75	-	389	129	124
Warks. Avon	115	72	-	-	-	-
Unknown River/Stillwater	3,584	2,615	892	23	821	9
Total	4,088	2,785	892	419	968	133

Table 2.4 Declared yellow and silver eel catches for rivers in Severn RBD in 2005 to 2007. Catches from unknown rivers and stillwaters in the three Regions of the Environment Agency are included, although they may not have been caught in the Severn RBD.

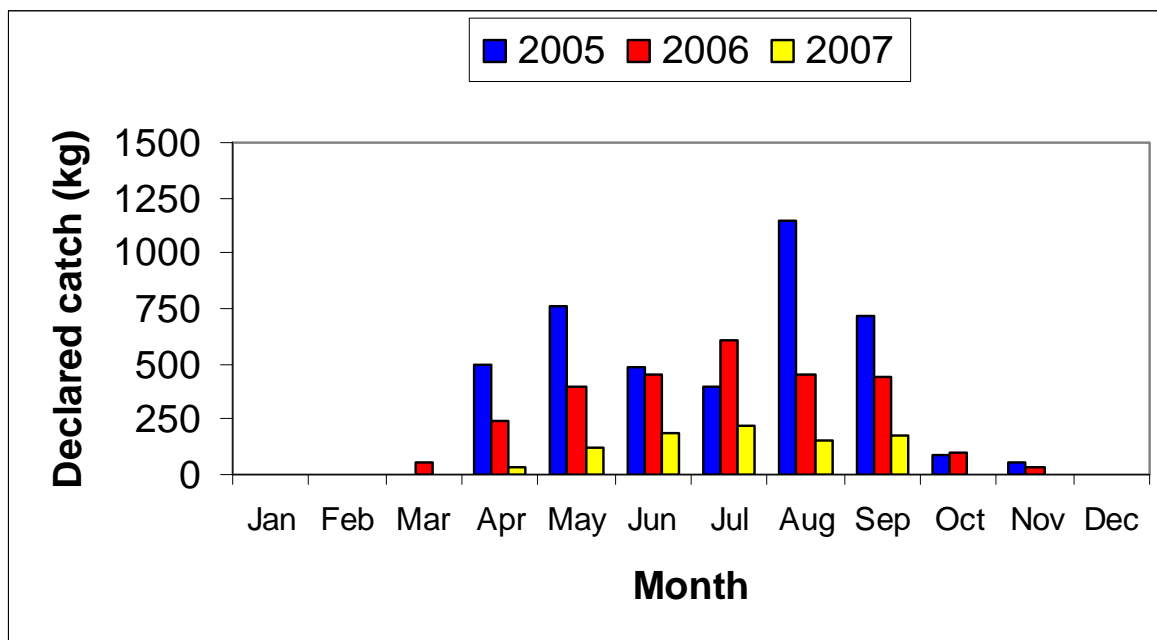


Figure 2.11 Declared monthly catches of yellow eels in the Severn RBD, 2005 to 2007.

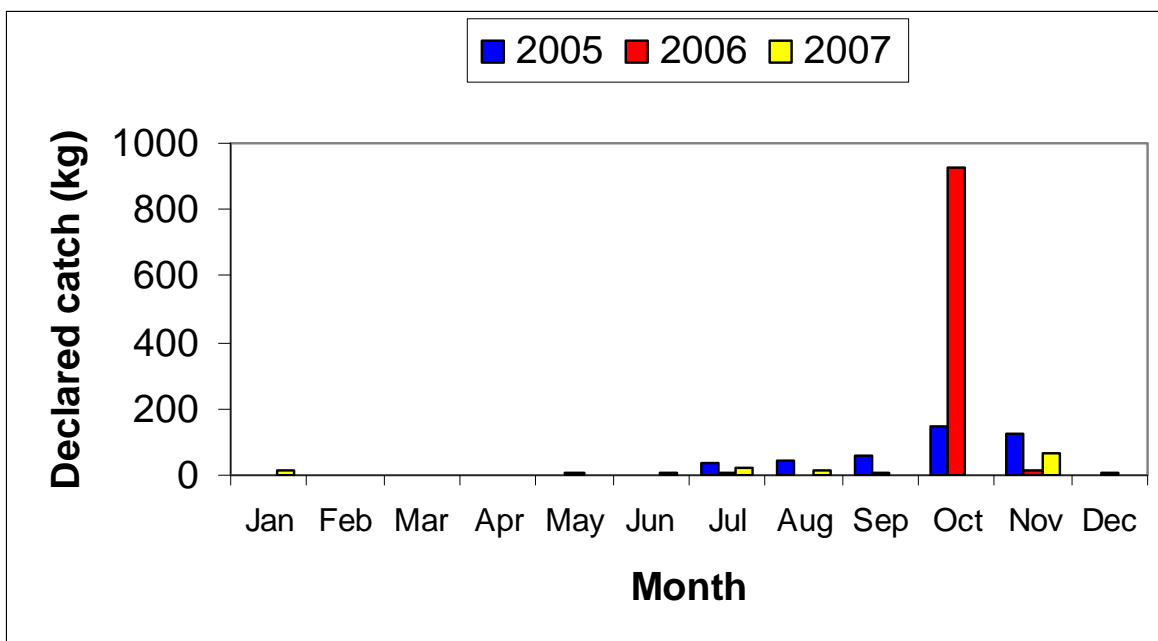


Figure 2.12 Declared monthly catches of silver eels in the Severn RBD, 2005 to 2007.

2.4 Estimates of silver eel escapement

There was no direct measure of silver eel escapement in the Severn RBD before anthropogenic influence on stocks and there has been none carried out in recent years. The probability model estimated silver eel output for the Severn to be 8.4 kg/ha. For the Severn to be non-compliant the “pristine” escapement would need to be in excess of 21kg/ha. A comparison with other rivers (Table 1; in Eel Management Plan overview for England and Wales) would suggest that the present output is higher than productive Irish rivers and a “pristine” output of ~20kg/ha would not appear unreasonable when compared to other large river systems such as the Loire (France) and Bann (N. Ireland). It is therefore suggested that the Severn and by association the Severn RBD is compliant with the 40% escapement target.

The estimated escapement for the section of river downstream of Worcester is 9,5 kg/ha. As this section of river is considered to be at carrying capacity (Arahamian, 2000) this level of escapement could be taken as a reasonable reference level for silver eel escapement from the Severn.

The data from the 1983/4 electric fishing surveys of the Severn catchment were also applied to the Reference Condition Model (RCM: Appendix 3) to assess compliance with pristine conditions (Figure 2.13). This was an eel-specific survey covering the whole of the Severn catchment. Since the “reference rivers” for the RCM were surveyed during this time period, the comparison does not include any potential effects of more recent reductions in recruitment, but does take account of habitat availability and obstacles/barriers to eel dispersion throughout the catchment. Comparison of the 1983/4 situation (area under the curve) with that estimated by the RCM suggests that the potential production of silver eels from the Severn in 1983/4 represented 41% of the reference (“pristine”) conditions.

In its basic form, the RCM assumes uniform habitat available upstream of the tidal limit. If it is weighted according to the amount of habitat available to eel at various distances from the tidal limit then the decline is estimated at 34% of reference conditions.

The information from recent eel-specific electric fishing surveys of the lower catchment suggests no major change in yellow eel populations since 2000, compared to those in 1983/4, and therefore silver eel escapement levels should be similar. This leads to the conclusion that the current production of silver eels from the Severn represents 34% of reference conditions and the target defined by the Regulation is not met.

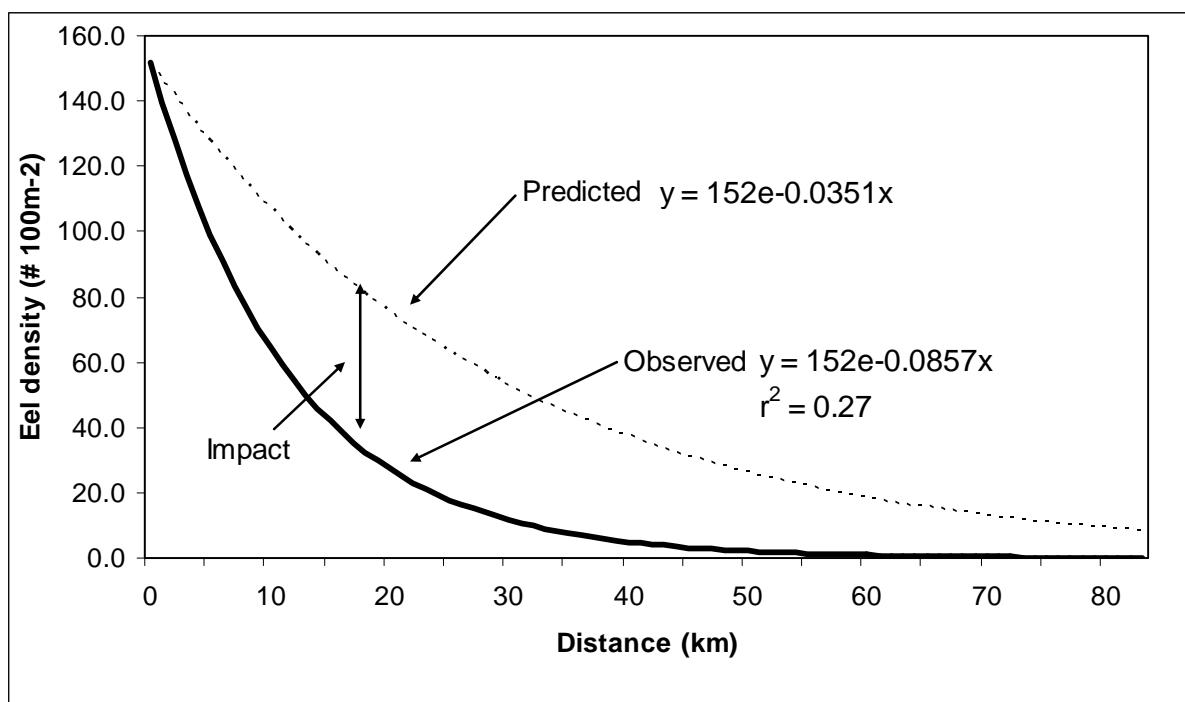


Figure 2.13 The predicted (dotted line) and observed rate of decline in eel density in 1983/4 (bold line) with distance upstream from tidal waters

2.5 Eel mortality and available habitat

2.5.1 Eel Habitat

Though quantitative data are limited, there is believed to have been a loss of habitat in the Severn catchment over the last half-century, mainly due to the construction of barriers (see later), which may have resulted in a reduction in potential silver eel production. Subsequent improvement in both physical and chemical (see later) quality of the habitat is considered to be the main reason why eels are now found at sites where they were absent in 1983/4. If, as suggested, compliance with the escapement target relates to the habitat available to eel during the middle of the last century, then it is essential that this loss of habitat is quantified and addressed in order to work towards achieving compliance with the target.

2.5.2 Barriers to migration

The legacy of an industrial history is that the natural hydrology of many of the rivers in the Severn RBD have been significantly changed by weirs, sluices, bridges and dams. These can create barriers to fish migration, including the upstream movement of eels. A recent assessment has identified 448 potential obstructions within the river basin, Table 2.5

River catchment	Obstruction identified				
	Mills and Sluices	Weirs	Bridge sills	Dams	Unknown
Warwickshire Avon	31	90			
Bristol Avon	5	71	2		
Somerset Rivers	1	1			
South Wales Rivers		19			1
Severn	2	126		9	28
Usk		14	5		
Wye		36	7		

Table 2.5 Obstructions identified within the Severn River Basin District

The passability of these obstructions has been assessed, based on expert opinion, (Figure 2.2, Table 2.6) and many are considered to be complete barriers to eel migration, with large areas of eel-producing habitat upstream unavailable to the eel population. This area of habitat unavailable to eel is being quantified, but the results will not be available before this first version of the EMP is submitted

Passability	Number of obstructions
Passable (Always)	35
Semi passable (Sometimes)	63
Impassable (Never)	282
Unknown (Ungraded)	68

Table 2.6 Passability of obstructions in the Severn RBD

There is particular concern for obstructions that are low down on river systems, including weirs and tidal flap gates for land drainage purposes. These can prevent or restrict access to large areas of eel habitat. This includes the Caldicot and Wentloog levels in south east Wales, which are thought to be capable of supporting significant eel populations but are believed to be poorly accessible at the moment, due to at least 24 sea outfalls.

Similarly on the Bristol Avon, catchment gates and tidal sluices maintaining water levels in the harbour act as important migration barriers on the navigable section. Eel populations are only high in the lowermost reaches, and decline upstream. A major barrier may also be posed by the Frenchay Gauging Station, which leaves more than 60km of river length in the upper Bristol Frome catchment relatively under-utilised (Knights, 2007).

2.5.3 Entrainment and Hydropower

There is currently no information on the level of eel entrainment within the Severn RBD, although there is anecdotal evidence of eels lost at a pumping station on the Somerset Axe in 2007 (P. Sibley, Environment Agency, pers. com.)

In the Severn RBD there are at least 8 hydropower installations recorded by the British Hydropower Association (www.british-hydro.org) or from the Environment Agency's

permitting database. The mortality of eel at these installations has not been estimated. A further hydropower turbine is planned for the River Monnow. This will be an Archimedean screw turbine, which experiments at a site on the River Dart in Cornwall seem to suggest does not cause damage or mortality to downstream moving fish, including eels (Kibel, 2008). There is no information on the effect of screw turbines on upstream eel migration.

2.5.4 Predation

The Severn RBD comprised 13% of the freshwater and lake habitat in England and Wales (A Walker, CEFAS, pers. com.), and may expect to constitute 13% of eel consumption by cormorants: 3.8 to 5.6 tonnes (Appendix 6). With the average length of eel taken at 40-55 cm (Carss and Marzano 2005) or 150-200g this suggests 25,000 to 37,000 eels consumed by cormorants within the Severn RBD each year.

Predation of eel by other species is considered in Section 1.4.4 of the Overview.

2.5.5 Water quality and pollution

The General Quality Assessment (GQA: Overview Section 1.4.2.2) results for the Severn RBD in 2005 are shown in Figures 2.14 and 2.15. These indicate that chemical quality (dissolved oxygen, biochemical oxygen demand and ammonia) for 94% of rivers was Good or Fair, with 71% classified as Good or Very Good. Biological GQA (based on the presence of macro-invertebrates) showed that 94% of the rivers were classed as Good or Fair, with 67% classified as Good or Very Good.

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.

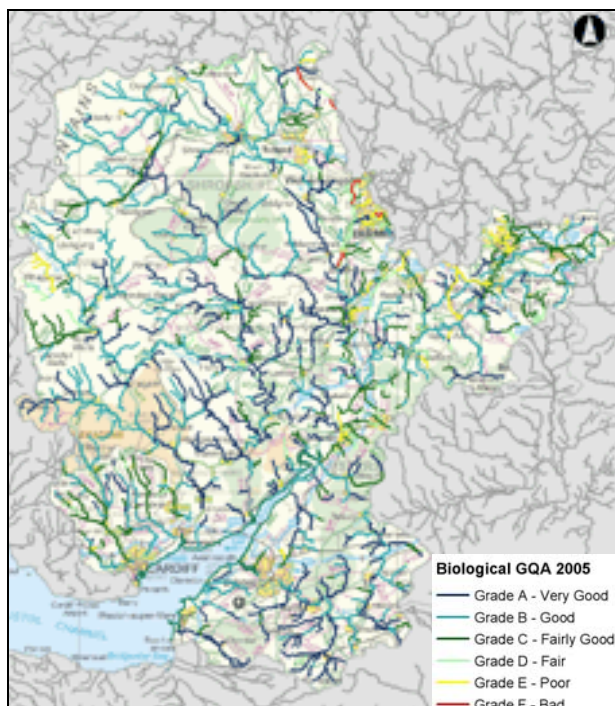


Figure 2.14 Biological GQA Grades for Severn RBD

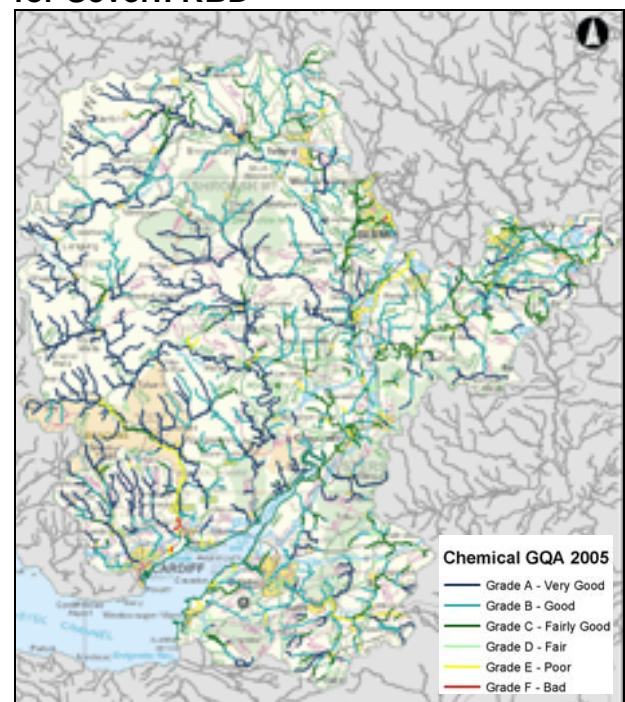


Figure 2.15 Chemical GQA Grades for Severn RBD

2.5.6 Pathogens and parasites

The first reported incidence of *Anguillicoloides (Anguillicola) crassus* (Overview Section 1.4.6) in the Severn RBD was in 1991 in 10% of eels in a sample from Lower Lode near Tewkesbury. By 1998 the parasite was found to be present throughout the Severn catchment and in the River Taff. In 2005 *A. crassus* was detected in a sample of glass eels from the Severn.

3 Restocking

3.1 Habitat to be restocked

This has yet to be quantified, but guidelines for stocking are described in Appendix 7.

3.2 Past restocking

The Severn is a good source of glass eels for stocking both in the UK and abroad. The method used to catch them confers a relatively high survival rate in comparison with glass eels caught by trawling, and so they are considered to be of particularly high quality. Stocking has been carried out at a number of sites in the Severn RBD in the past, including 405 kg in 1979. Glass eels from the Severn have also been stocked into Lough Neagh (N. Ireland) since 1984.

There is evidence from the Severn that glass eel stocked in the middle reaches did grow substantially faster than those recruiting naturally to the lower reaches (Aprahamian, 1987). However, there have been no assessments of what the production of eel might have been if the glass eel had been left *in situ*.

3.3 Potential restocking in the Severn RBD

It is possible to use the Reference Condition Model to estimate the increase in eel numbers needed to meet the 40% escapement target. At present, using the River Severn as an index for the whole RBD, the escapement is calculated to be 34% of reference condition. This current situation and the curve that would occur at 40% of the reference condition are shown in Figure 3.1. The difference between these curves is the number of additional eels required to meet the 40% escapement target.

To ensure production of female eel, stocking should be carried out at a low density and for riverine environments a density of 1-2 glass eel m⁻² is recommended (Knights and White 1998). Studies from around Europe have shown survival rates to silver eel of 10-40% (ICES 2007).

By stocking the area of habitat on the River Severn from 10-80 km upstream of the tidal limit, a total area of approximately 60km², with sufficient glass eels to increase the population to meet the 40% escapement target and assuming a 15% survival of glass eels to silver eel, it is estimated that 7,350,000 glass eels (2.45 tonnes) will need to be stocked annually on the River Severn, effectively a stocking rate of 0.1225 glass eel m⁻². As stocking will be carried out at a density of 1 glass eel per

square metre, the frequency of stocking in any particular reach would be once every 8 years.

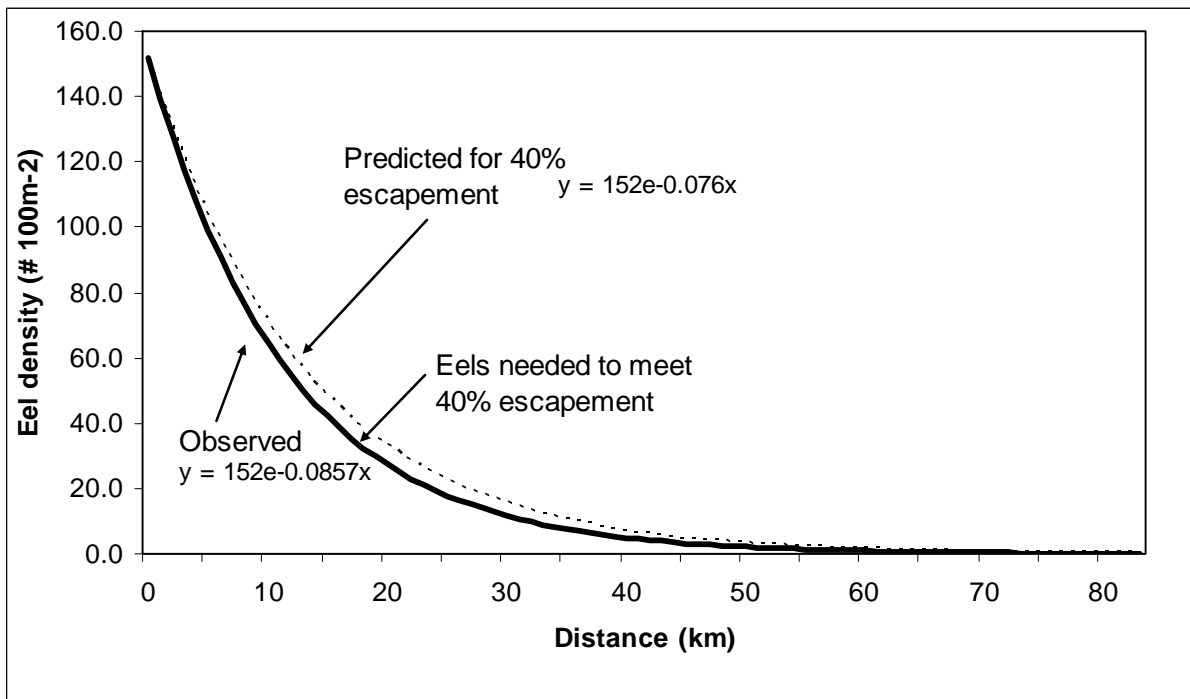


Figure 3.1 Reference Condition Model and glass eel stocking required to meet escapement target

If this stocking density was extrapolated to the habitat in the entire Severn RBD a total of 34.6 million glass eels per year would be required (11.5 tonnes).

3.4 Eel to be restocked in 2009

There are no plans to carry out large scale eel restocking within the Severn RBD at present. The numbers of eels required and the cost of these would be prohibitively expensive. Small scale targeted releases of eels in suitable areas would be considered as a means of increasing spawning escapement of silver eel.

The information required to maximise the benefit and adequately reduce the risks of this stocking is not available for the Severn RBD at the moment. It is anticipated that in the early years of this Eel Management Plan information on habitat, accessibility and native populations will be gathered to enable some eel releases to be made.

3.5 Compliance with restocking requirements in the Regulation.

This is addressed in Appendix 7.

4 Monitoring

In the Severn RBD the rivers Severn and Usk will be monitored biennially for yellow eel at 10 sites within each catchment. Glass eel will be monitored annually on the Severn at Strensham and on the Severn at Abbey Mill. Silver eel escapement will be monitored on the River Leadon at Wedderburn Bridge (Figure 4.1).

Monitoring of the fisheries will continue to be through catch returns and the monitoring of import and export data.

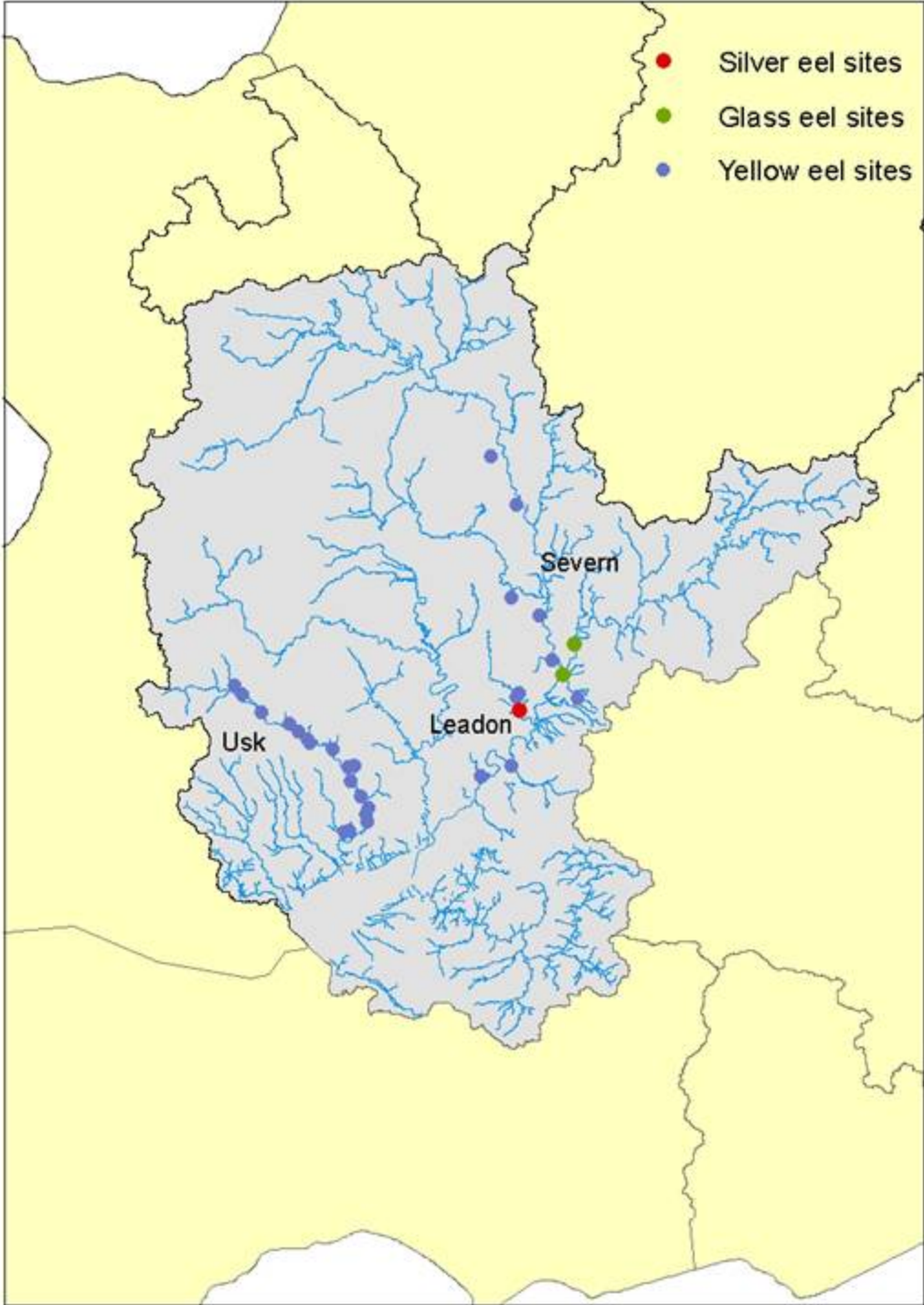


Figure 4.1. Eel index monitoring sites within the Severn RBD.

4.1 Assessment of silver eel escapement

Ongoing work to improve the assessment of compliance with the silver eel escapement target is described in Section 1.6.1 of the Overview.

4.2 Price monitoring system

This is addressed in Appendix 8.

4.3 Catch and effort sampling system

This is addressed in Appendix 9.

4.4 Origin and traceability of live eels

This is addressed in Appendix 10.

5 Measures

The Probability Mode has been used to assess whether the Severn RBD meets the target of 40% of the silver eel escapement that would be produced under undisturbed conditions. From the data available, it is considered that the Severn and by association the Severn RBD is compliant with the 40% escapement target. For the Severn to be non-compliant the “pristine” escapement would need to be in excess of 21kg/ha. A comparison with other rivers (Table 1; in Eel Management Plan overview for England and Wales) would suggest that the present output is higher than productive Irish rivers and a “pristine” output of ~20kg/ha would not appear unreasonable when compared to other large river systems such as the Loire (France) and Bann (N. Ireland).

The yellow and silver eel fishery is currently small, comprising less than 4% of the estimated total silver eel biomass from the Severn RBD. Impacts of other anthropogenic mortality factors on silver eel are considered minimal against the total RBD eel producing habitat.

The stock as measured in 1983 would reflect the period of relatively high and consistent glass eel recruitment in the 1970s. The decline in recruitment of glass eels to the Severn started in 1983/4, when the glass eel catch fell to 50% of the average catch observed in the previous 10 years (P. Wood personal communication).

Comparison of the 1983/4 data with the reference state identified by the RCM suggested that the output from the Severn may have been just below (34%) the 40% escapement target at that time. Data presented suggests that in the Lower Severn (all zones) there has been little change in the density of young eel of ages 1-3 (less than 150 mm long) in the population since 1983. The fact that the densities and biomass between 1983 and 2007 are similar would suggest that escapement is similar to what it had been prior to 1980, assuming the same amount and quality of habitat. The results must be interpreted with care, as comparable data were available for only 10 sites, and water quality has improved over the last 20 years. In addition the sites are all in the lower reaches and thus would be expected to be the last to

show the effect of any decline in recruitment. It is accepted that this assessment does not relate to escapement in the absence of anthropogenic factors.

The major pressure thought to be operating on eel populations is poor access to habitat because of obstructions. Many of these have been in place on the main river for over a century, and it may be that the Severn has had densities lower than would be predicted from the RCM for a long time (the model assumes that the reference condition is taken as the habitat available prior to the 1980s).

In summary, the River Severn, and by inference, the Severn RBD is complying with the 40% escapement target but there is still concern over:

- 1) Perceived loss of freshwater habitat available over the last half century, particularly in the lower reaches.
- 2) Poor access to eel habitat leading to high density-dependent mortality in the lower reaches.

5.1 Measures to meet Escapement Objective

Reduction of the fishery pressure.

If the decline in the glass eel catch (to around 10 tonnes annually) and CPUE reflect a decline in recruitment of some 70%, then the fact that potential current output is similar to that in the early 1980s suggests that the glass eel fishery is not having an impact and that there has been a decline in density-dependent mortality that compensates for any reductions in recruitment to the estuary.

Closing the glass eel fishery without increasing the amount of habitat or improving access is likely to result in an increase in density-dependent mortality in the estuary and lower reaches of rivers, and no long-term increase in silver eel output. However, it is essential that exploitation is sustainable and it is important that the Environment Agency works closely with the industry to ensure awareness of the eel issue and the need to deliver the 40% escapement target. The information from the eel fishery is of poor quality and, although a new catch return system was imposed in 2005, there still remains a large proportion of the catch that has not been allocated to a river. The quality of data gathered in future years needs to be improved. This will be addressed through the measures described in Appendix 9.

Whilst this information is being collected and a better assessment of the eel fishery is made, the fishery should be kept within its existing limits by not allowing the number of instruments to be increased nor the geographical area over which they are currently fished. This would be as a precaution until more detailed information is gathered on stocks and the fishery.

If in the future the fishery is found to be affecting eel populations beyond a level that complies with the regulation, The Environment Agency has the powers to bring in a byelaw to limit the fishery by reducing season length. At present the Agency cannot refuse a licence or restrict where fishers can and cannot fish within the existing boundaries

Improving access and habitat.

This is addressed in Section 1.4.2 of the Overview, and detailed below.

There is perceived to have been a loss of habitat in the Severn catchment over the last half-century, which may have resulted in a reduction in silver eel production, particularly in the lower reaches.

Habitat improvement is considered to be the main reason why the density and biomass of eel in the middle Severn is currently higher than in 1983/4. Opportunities may exist to open up areas of existing estuarine habitat, allowing young eels access. This includes the Caldicot and Wentloog levels in south east Wales, which are thought to be capable of supporting significant eel populations but are believed to be poorly accessible at the moment.

It is not possible, at present, to quantify the benefits of improving access for eel to these habitats, due to limitations of the geographical data systems. However, GIS data and processes are being developed which will provide this assessment in the near future.

Stocking of glass eel

This is addressed in Section 1.4.5 of the Overview and in Appendix 7.

Predator control

No action will be taken to control predators (see Overview Section 1.4.4).

5.2 Measures taken 2007 to 2009

Monitoring

- Improved quality of eel data collected during multi-species electric fishing surveys at 623 sites.
- Monitoring at ten sites on the Severn catchment and four sites in north Wessex, surveyed biennially by electric fishing, where eel are the target species.
- Investigation of Caldicot and Wentloog “Reen” system, including fyke netting surveys to provide eel production data, and a feasibility study for improving eel passage through tidal flap gates, sluices and other barriers.

Improving access and habitat

- Installation of Pontymoel fish pass on Lywd
- Installation of vertical slot fish pass around Osbaston weir on River Monnow

- Collaboration with the Wye and Usk Foundation to remove or modify barriers and install fish passes on the Lugg and Arrow
- Discussions undertaken with the Cardiff Harbour Authority concerning operation of the Cardiff Bay Barrage for the benefit of glass eel migration. This will increase eel access to a significant area of habitat with the RBD
- Replacement of fish pass at Blackweir on River Taff with vertical slot pass to ease passage of eel upstream of Cardiff Bay Barrage

5.3 Measures to be taken 2009 to 2012

The following measures are planned to be implemented from July 2009:

Monitoring

- Continue monitoring of eel populations via multi-species electric fishing surveys and eel-specific surveys. A further ten sites on the Usk catchment will be surveyed specifically for eel, on a biennial basis in the future. In addition, glass eel trapping will be carried out at two sites to assess recruitment. Potential sites for silver eel monitoring will also be investigated, although there are no longer any fixed fishing installations that could be re-commissioned.
- Monitor the success of any novel eel passage solutions implemented in the RBD
- Continue to monitor commercial eel fisheries through catch returns and through the assessment of import and export data. Illegal exploitation of yellow eel and glass eels will be targeted by enforcement teams

Improving access and habitat

In 2009/2010 it is proposed to install 9 passes and remove 5 obstructions in Severn RBD (Figure 5.1).

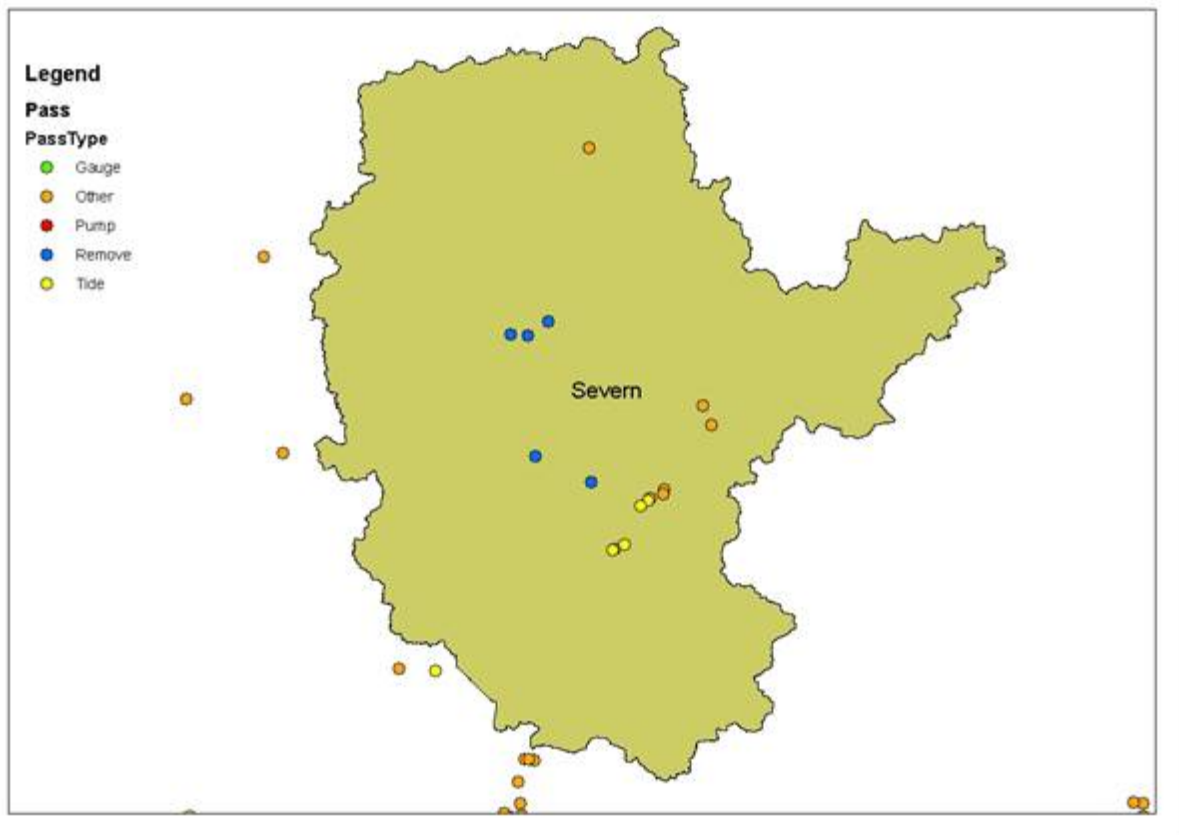


Figure 5.1 Location of eel passes to be installed and removed in Severn RBD in 2009 / 2010.

In addition we will be:

- Assessing the major obstructions to glass eel migration in the River Severn catchment and into the Caldicot and Wentloog Reens. Action plans will be produced, prioritising sites for glass eel passes to be installed, with target dates for those which are achievable within 5 years.
- Continuing to improve eel passage throughout the Wye and Usk systems.
- Continuing to influence the operation of Cardiff Bay Barrage to benefit eel migration.
- Assessing habitat and obstruction on rivers Ebbw, Sirhowy & Rhymney to include consideration of the passage of eel.
- Inputting into the Programme of Measures for the Water Framework Directive as a good opportunity for improving habitat and access for eel populations. All opportunities will be taken to influence waterbodies for the benefit of eel populations.

Stocking of glass eel

- Further consideration will be given to stocking within the Severn RBD and a stocking plan for the release of glass eels will be produced. This will include pre and post stocking surveys to identify the effectiveness of glass eel releases on silver eel escapement.

Stakeholder engagement

- An Eel Management Plan Implementation Group will be convened comprising representatives of the Environment Agency Area Teams with responsibility for the Severn RBD. This will make decisions on best use of limited resources.
- The Environment Agency will liaise with the Gloucestershire Wildlife Trust to promote eel management.

All of these actions will be subject to resources being available. The actions proposed in the period from 2009 to 2012 are detailed in Table 5.1. Measures that will have a DIRECT effect on silver eel escapement are qualified in terms of their presumed benefit, where short = <5 years, medium = 5-15 years and long = > 15 years. Note that only the shortest term is given and that the classification is for the time to effect silver eel escapement and not the time for the measure to be implemented.

Issue	Actions to be carried out (subject to resources being available)	Timescale
Exploitation	<ul style="list-style-type: none"> • Monitor commercial eel fisheries through catch returns and through the assessment of import and export data. • Illegal exploitation of yellow eel and glass eels will be targeted by enforcement teams • Initiate a price monitoring and reporting system for eels less than 12cm long. • Initiate a system to ensure the traceability of all live eels imported or exported from the UK • If necessary bring in byelaws to limit fisheries and protect stocks 	<ul style="list-style-type: none"> • short • short
Habitat	<ul style="list-style-type: none"> • Produce maps of available & potentially available eel habitat within the River basin district, identify significant areas for habitat restoration works • Use the Environment Agency's consenting of works on rivers and stillwaters and their own works programme to improve eel producing habitat • Identify waterbodies within the Water Framework Directive Programme of Measures with significant opportunities for improving eel habitat • Identify all surface water abstraction points and hydropower installations within the RBD and quantify their impact on eel populations 	<ul style="list-style-type: none"> • medium
Passage	<ul style="list-style-type: none"> • Produce plan of priority actions for facilitating eel passage throughout the RBD, taking into account area of available upstream habitat and cost. • Ease barriers to eel migration on the Severn, Wye, Usk, Taff and Lwyd systems • Continue discussions with the Cardiff Harbour Authority concerning operation of the Cardiff Bay Barrage for the benefit of glass eel migration • Research into the potential for replacing tidal flap gates with structures that will allow eel passage into the drain systems in lower rivers and estuaries • Identify waterbodies within the Water Framework Directive Programme of 	<ul style="list-style-type: none"> • medium

	Measures with significant opportunities for improving eel passage	
Stocking	<ul style="list-style-type: none"> Identify areas for restocking within the RBD Undertake pilot study with effective pre and post stocking evaluation to determine the contribution that stocking makes to the spawning stock If economically and scientifically justifiable produce plan for stocking across the RBD 	
Monitoring	<ul style="list-style-type: none"> Continue to gather information on yellow eel density and biomass throughout the RBD. Begin glass eel trapping at two sites to assess recruitment. Investigate sites for silver eel monitoring. Further development of models to assess compliance with target (RCM and SMEP) Monitor success of novel eel passage solutions 	
Resources	<ul style="list-style-type: none"> Obtain funding: through partnerships with other organisations; bids to the Agency's project pot (~£150k annually); from the European Fisheries Fund and from Interreg 	

Table 5.1 Proposed actions 2009-2012

5.4 Measures beyond 2012 to achieve the Escapement Objective

It is intended that, in the period 2009 to 2012, actions will be reviewed in response to improved information on the effectiveness of the measures identified above.

An approximate timeline for achieving the 40% escapement target is shown in Figure 5.1 (see Section 1.4.7 of the Overview). This assumes that remedial actions would begin in 2009, a one-generation (15 years) lag before these actions lead to improved escapement; and a 0.5% increase in escapement each year. The RBD is predicted to meet compliance in 2032.

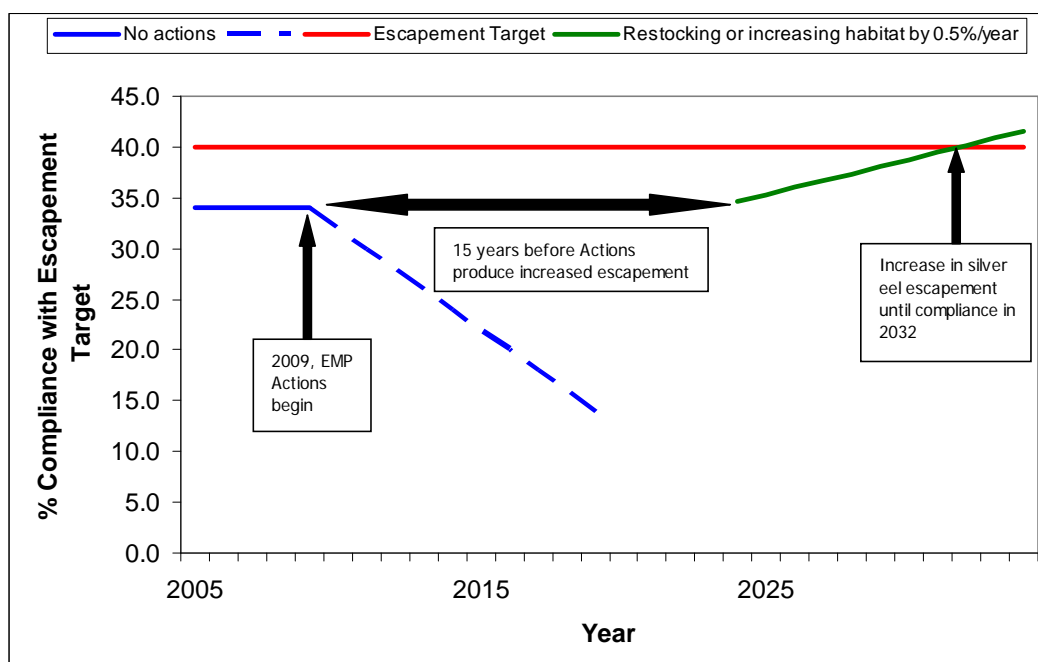


Figure 5.1 Estimated timeline for meeting 40% escapement in the Severn RBD.

6 Control and Enforcement

These are addressed in Appendix 12.

7 Modification of Eel Management Plans

EMPs will be updated as and when new data become available. New data will feed into the ICES / EIFAC Eel Working Group country report for the UK and will be reviewed for the next reporting round in 2012.