The Zoological Society of London's Citizen Science, European Eel monitoring project Report 2012

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ZSL in partnership with Kingston University, The Wandle Trust, Medway Valley Countryside Partnership, North West Kent Countryside Partnership, The Thames Rivers Restoration Trust, London Wildlife Trust with Friends of The River Crane Environment, Thames 21, The Wildfowl and Wetland Trust and The Thames Anglers Conservancy. Kindly funded by the Esmée Fairbairn Foundation and the Environment Agency.

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Executive Summary

Over the past 30 years it has become apparent that European Eel (*Anguilla anguilla*) recruitment into European rivers has declined rapidly and despite the increased awareness of the situation, and the development of action plans and legislation at local, national and European levels, numbers do not appear to be recovering on a large scale. In 2008 the International Union for Conservation of Nature classified the species as Critically Endangered.

In 2005 ZSL set up its European eel monitoring programme to assess the presence of migrating juvenile eels, identify restrictions to their movements and gather long term data on trends in eel recruitment in the Thames catchment.

In 2011, in order to expand this monitoring programme, ZSL began to engage the general public and enlist the help of volunteers. ZSL now works with 10 partnership organisations and, to date, has trained 167 volunteers to become Citizen Scientists involved in the eel monitoring project. During the upstream juvenile eel migration period, April-October, Citizen Scientists check eel traps twice a week at eight monitoring sites in the Thames catchment. The number and size of all trapped eels are recorded and data are uploaded on to the ZSL database. At the end of the monitoring season these data are feed into the Environment Agency's Eel Management Plan for the Thames River Basin District.

The programme fulfils an important research and educational role in the drive to improve rivers for eels. In the future, ZSL will work with its Citizen Science partners to emphasise the part they can play in helping this iconic species. A particular problem in the River Thames catchment is the number of barriers, such as weirs, that prevent or hinder upstream migration and reduce the amount of available habitat to eels. We are working with our partners to identify the most significant barriers and build eel passes over a number of them to facilitate eel migration. Together, we can build capacity in the sector as a whole to tackle issues threatening the conservation of the European eel.

The Citizen Science European eel monitoring project will continue for the 2013 upstream juvenile eel migration period, however, In order to maintain conservation effort and build upon the valuable foundation that has been developed, ZSL will need to raise funds for the programme from spring 2014.

1. Introduction

1.1. Background

On the River Thames the upstream freshwater migration of the European eel starts in mid to late April when water temperatures reach 14°C, the critical minimum threshold temperature for eel movement. There are plenty of accounts of the historic abundance of eels in the Thames with Londoners helping themselves as the 'river edges turned black with the countless bodies of wriggling elvers' during the migration. In 1832, Dr William Roots of Kingston upon Thames, perhaps the first eel citizen scientist, had a go at counting the number of elvers traveling upstream. He tied a length of string across the margin of the river and estimated 1600 elvers per minute passed over it (Wheeler, 1979). In recent years, more sophisticated monitoring programmes across Europe indicate that recruitment in rivers has declined dramatically when compared to pre-1980's levels. When comparing ZSL's own trapping data on the River Darent between 2005 and 2010 to a study using the same methodology by Knights and Naismith (1988), a recruitment decline of over 99% is apparent (Gollock *et al.,* 2011).

The eel's life history is complex; it includes a 10 000km round trip migration from the Sargasso Sea to Europe and back (Schmidt 1922). Despite considerable amounts of research, the complexity behind its lifecycle makes it very difficult to determine the most significant reasons for the decline. A few researchers argue that what we are seeing is part of natural fluctuations in recruitment, but there are a number of proposed causal factors which may all contribute to the decline. These factors include; changes in oceanic currents, barriers to freshwater migration, overfishing, loss of freshwater habitat, pollution (particularly lipophillic substances such as PCBs), poor condition of escaping silver eels and the effects of the swim bladder parasite *Anguillicola crassus* .

In 2007, in recognition of this worrying decline in recruitment, the European Union adopted Council Regulation No. 1100/2007 establishing measures for the recovery of European eel stocks. The regulation called on the UK and other member states to develop eel management plans. The European Commission approved the UK's Eel Management Plans in March 2010. In addition the European eel has been categorised as critically endangered in the International Union for Conservation of Nature Red List of Threatened Species since 2008.

1.2. Yellow Eel populations in the Thames River catchment

Monitoring of the eel populations in the Thames catchment by the Environment Agency (EA) and its predecessors has been carried out using a variety of different methods. The most recent comprehensive review of monitoring data (Knights, 2005) concluded that the distribution of adult eels in the Thames

catchment fits the pattern seen in other UK east coast rivers. Mean densities and biomass decline with distance from the Atlantic but mean body length increases. The limit of the Thames eel population's appears to be at approximately 60km upstream in the main channel and the tributaries.

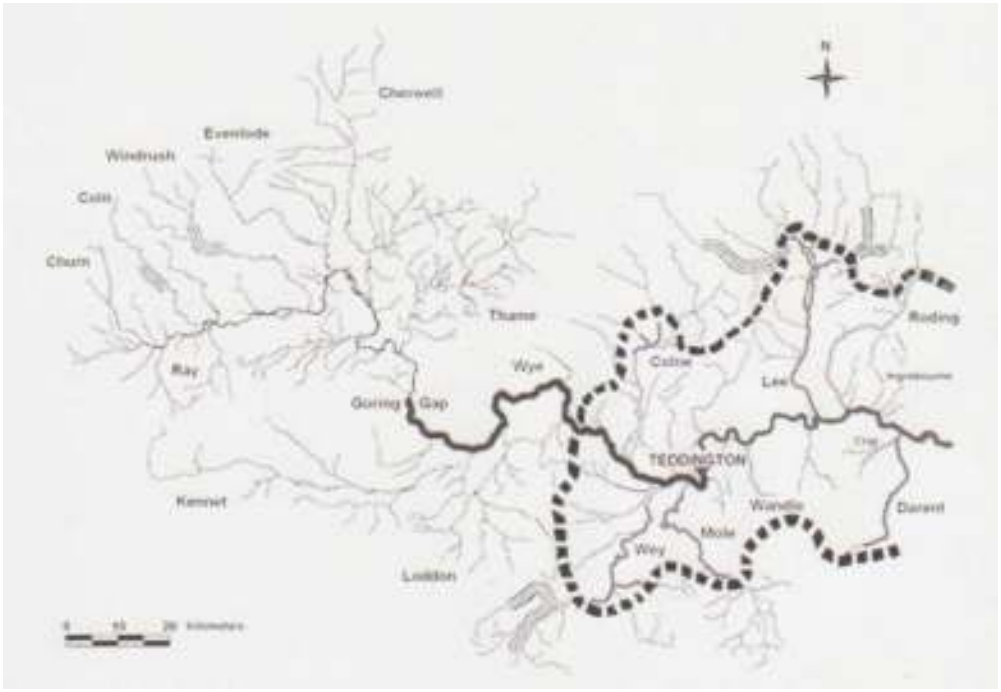

Figure 1: Distribution of eels in the Thames catchment in recent years the core occupied area is delineated by heavy dotted line (From Knights, 2005).

1.3. ZSL monitoring programme

ZSL's current European eel monitoring programme started in 2005. Its aim is to assess the status and trends in numbers of migrating elvers (defined as eels below 120mm) and juvenile (yellow) eels in the tidal Thames and its tributaries, and identify potential restrictions to their movements.

In year one, ZSL deployed simple eel traps, as shown in figure 2, at barriers on the river Darent, Roding , Mole and Wandle. The trap is based on the Naismith & Knights (1988) design. It provides a gently sloping 'ladder' leading to a holding tank, with a flow of water running down the ladder to attract migrating eels. The ladder is made from a length of household guttering which is roughly lined with garden net to provide a suitable substrate for the eels to climb on. The ladder rests on the riverbed and the mesh left to trail in the water for approximately one metre. The traps are placed below weirs. Water is gravity fed from the top of the weir using three centimetre diameter plastic water-pipe. The pipe supplies water into the holding tank and along the ladder. The holding tank is made from a 25 litre cold-water tank with windows in the sides to prevent it filling up and over-spilling and allowing the eels to swim out, these windows are covered in a double layer of one millimetre mesh to prevent the eels from escaping. The tank lid was held in place by a metal brace which also supports the siphon pipe

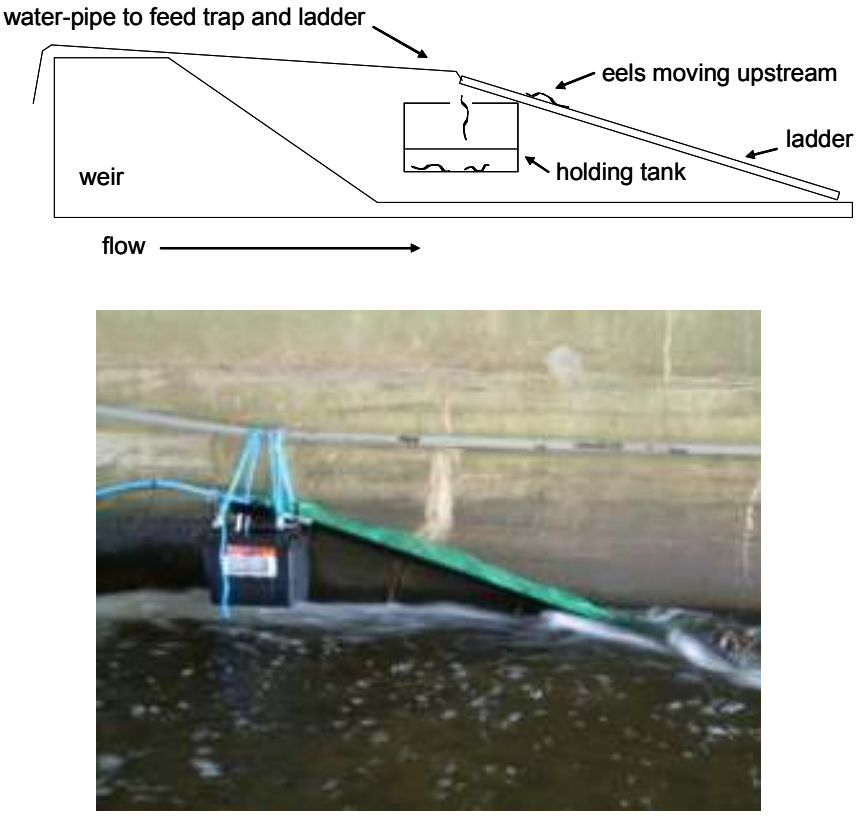

Figure 2: elver trap schematic and an elver trap on the River Roding.

From 2005 to the present, during the migration season, traps have been checked twice per week by ZSL field staff. Any eels found are measured and released upstream of the trap site. The programme is run in partnership with the EA and all data feeds into the Eel Management Plan for the Thames River Basin**.**

1.4. Citizen Science monitoring programme

ZSL has a track record of running citizen science projects. By harnessing the good will and expertise of volunteers we have greatly increased our capacity to achieve our conservation objectives. In 2010, with thanks to generous funding from the Esmee Fairbairn Foundation, we set about expanding the eel monitoring programme by working in partnership with a variety of other organisations and enlisting the help of volunteer, citizen scientists. For the Citizen Science (CS) sites ZSL and the EA provide the trap, monitoring equipment, training and some recruitment of volunteers whilst the partnership organisation coordinates trap checking and reports any faults with the trap

2. Methods

2.1. CS monitoring Sites.

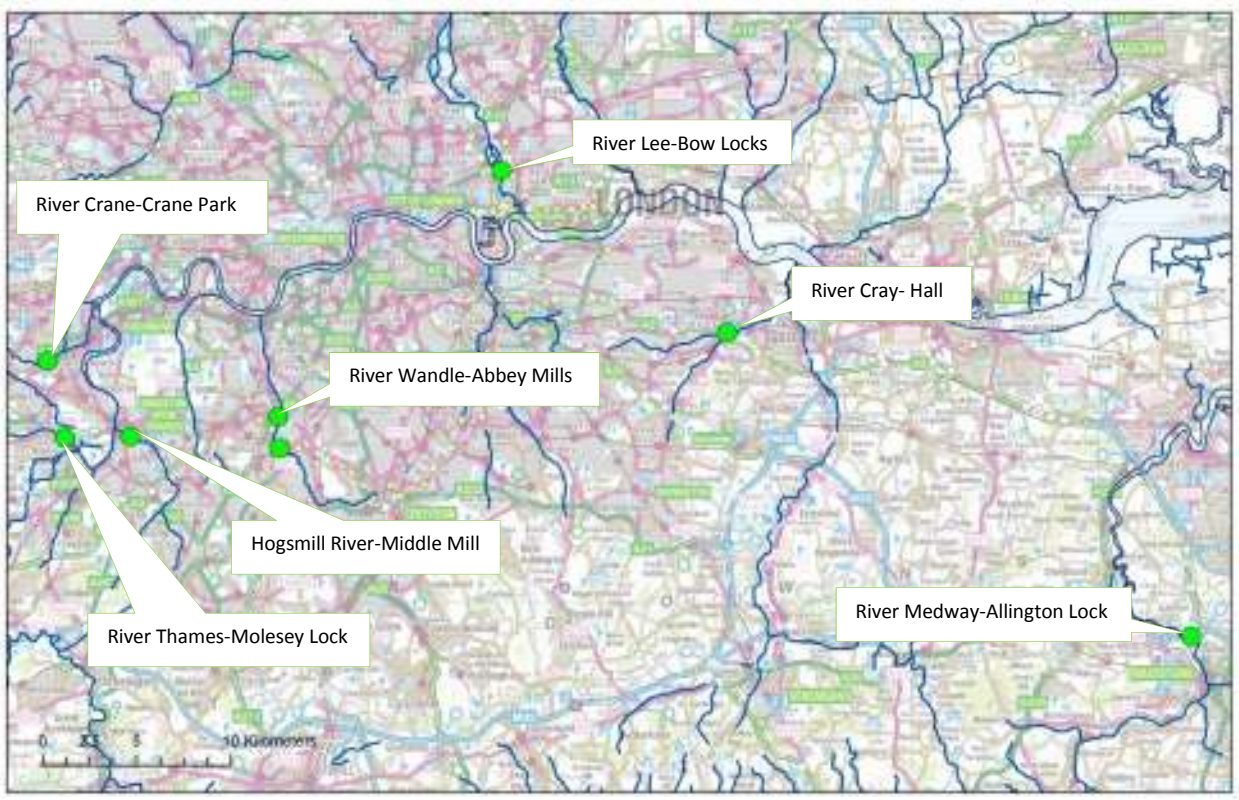

Figure 3: Map of the Thames catchment showing the 2012 CS trap sites

The trap sites were chosen based on a number of factors that included possible barriers to migration, the availability of local volunteers, accessibility, health and safety implications, freedom from theft and vandalism and practical application of trap design. In 2011 CS Traps were located on four tributaries of the Thames; The River Crane at Crane Park, Hogsmill River at Middle Mill, River Cray at Hall Place and the River Wandle at Merton Abbey Mills and one site on the Thames itself at Teddington Lock. At the end of the second season of CS monitoring we have expanded the number of trap sites to seven CS traps on the lower Thames tributaries and one on the Thames at Molesey lock (figure 3).

2.2. CS Trap Design

The simple and easy deployment of the traps used since 2005 proved problematic when working with Citizen scientists. In 2011, the first CS monitoring season, the light weight traps (Figure 2) were prone to being damaged by high river water levels at a number of sites. Volunteers can be discouraged from monitoring if

traps break regularly. In response, this year we have developed more robust traps. New trap designs are included in the discussion section of this report.

2.3. Licensing

Licences were obtained from the EA for the trapping of eels under the Salmon and Freshwater Fisheries Act, 1975 and permissions obtained from landowners where appropriate.

2.4. Health and Safety and Volunteer Training

Risk Assessments were carried out for each site in compliance with the ZSL, EA and the partnership organisation's policies. The most important element of the programme is that all involved are working safely. To that end all our citizen scientists are obliged to attend a training session before they join the programme. Training principally consists of a health and safety briefing but also includes information on eel biology and instruction on how to collect the data and upload it to the ZSL website. Since the start of the CS monitoring over 167 citizen scientists have attended a training session.

Figure 4: Training sessions on the River Lee and The Hogsmill River

2.5. Catch Handling

Trained CS volunteers check the traps twice per week during the monitoring period, from mid-April to the end of September. Eels are removed from the trap and held in a bucket of river water. They are measured from the tip of the snout to the tail tip in mm. Eels are returned to the river upstream of the trap as migration behaviour suggests they will continue upstream against the flow and therefore will not be recaptured.

2.6. Data Entry

Data are entered into the ZSL database by citizen scientists using a simple on line form (MachForm). They enter the date of monitoring, their name, the number of eels and lengths. There is also an optional section

to add notes on any problems with the trap and other points of interest. All uploaded data are checked and standardized by the ZSL project officer. Any data anomalies or trap faults are followed up with a phone call to the site coordinator or a visit to fix the trap.

2.7. Outreach, CS recruitment and Feedback

As part of the recruitment drive for volunteers The ZSL project officer has given a number of talks on the project at universities, colleges, friends of groups and fishing clubs. Articles have been written for publications such as 'Talk of the Thames' (www.thamesweb.com), 'The Thames Guardian' (www.riverthamessociety.org.uk), 'The GiGler Newsletter' (www.gigl.org.uk) and others. In addition ZSL have showcased the project at river festivals and public events such as the Thames River Festival.

Once recruited we try to maintain long term engagement in the project by regularly updating our CS volunteers. Good practice for any CS project includes providing feedback to volunteers (Silvertown 2009). It serves to increase the sense of community ownership around a project. We send out regular bulletins to our trap coordinators via e-mail and keep our Facebook page updated with the latest CS findings. In addition, at the end of the first two migration seasons, all our CS volunteers have been invited to the 'Citizen Science Eel Forum' at ZSL London Zoo. This year's forum included talks that offer practical information on improving London's rivers for eels. The forum encouraged a free-flow exchange of information and ideas between Citizen Scientists and the invited expert speakers.

Figure 5: CS volunteers and site coordinators at the 2012, ZSL Citizen Science Eel forum

3. Citizen Science Data

3.1 Elver and Yellow eel catch

Figure 6 shows the abundance of elvers and yellow eels caught at each site during 2012. Catch per unit effort (CPUE), shown in figure 7, was calculated based on the number of eels caught per day of active sampling.

Figure 6: Abundance of elvers and yellow eels caught at each site during 2012.

Trap site	total	Yellow eel	elvers	% elvers
River Medway-Allington Lock	1079	102	977	91%
River Cray- Hall Place	1	0	1	100%
River Lee-Bow Locks	13	0	13	100%
River Wandle-Abbey Mills	139	120	19	14%
River Crane-Crane Park	0	-	-	-
Hogsmill River-Middle Mill	1	1	0	0%
River Thames-Molesey Lock	133	103	30	23%
Total	**1366**		**1040**	**76%**

The greatest numbers of eels were caught On the Medway at Allington Lock which had a CPUE of 10.8. Then there is a sharp drop to the Wandle at Abbey Mills (139) and The River Thames at Molesey (133). The only site to record no eels is the River Crane at Crane Park.

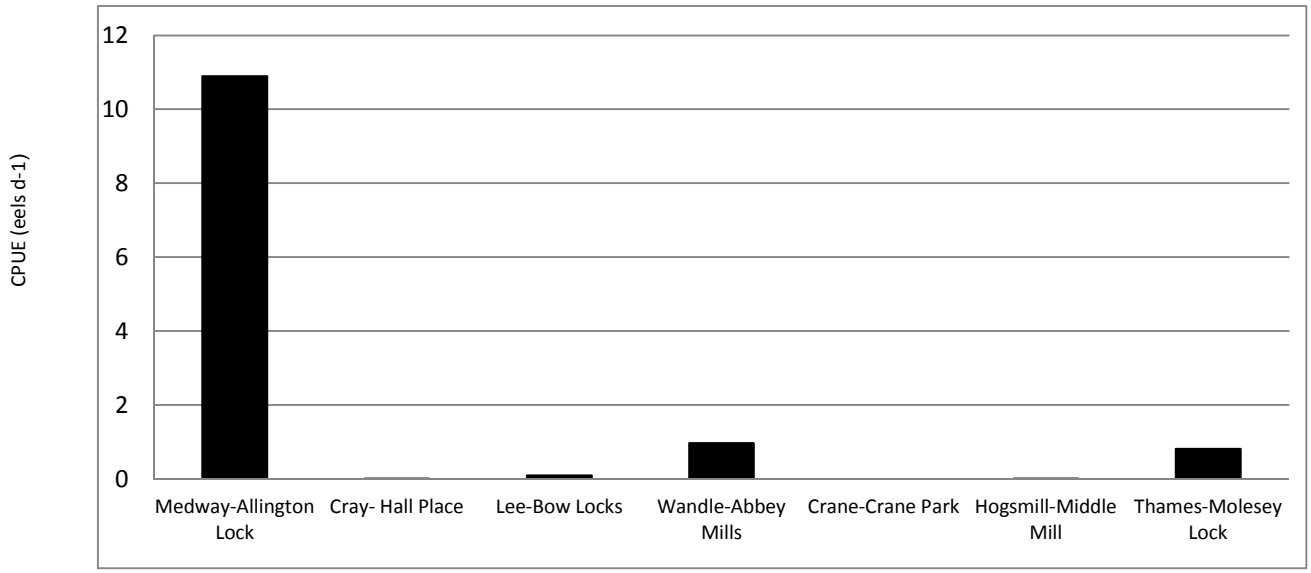

Figure 7: Catch Per Unit Effort (CPUE) for each in 2012.

4. Discussion

4.1. River Medway - Allington Lock

Grid Reference: TQ 74843 58171

Partners: Medway Valley Countryside Partnership

This was the first season of monitoring on the River Medway at Allington Lock and has been the most productive site with a total of 1079 juvenile eels caught of which 91% were elvers. In addition to catching eels, the trap also caught 8119 Chinese mitten crab, *Eriocheir sinensis,* an invasive non-native species. The supply of live chinese mitten crab has allowed the project to form links with researchers at Royal Holloway University of London (RHUL). They are looking at the size distribution of the crab samples from Allington Lock and comparing them with previous collections. The aim is to gauge if the crabs are part of a resident population or part of a larger migration up the Medway past Allington Lock. The crab samples may also contribute to a future Masters Research programme at RHUL, a PhD at Leeds University and also researchers at Newcastle and St Andrews who are looking at the effects of mitten crabs on sediment stability.

In addition to mitten crabs 14 sea lamprey (*Petromyzon marinus*) were caught by the trap. The sea lamprey, a protected Annex II species, is a jawless fish resembling an eel. These trapped individuals appear to be the first reports from the Medway in recent history. It is an anadromous species, spending its adult life as a parasite in the ocean before entering rivers looking for clean gravel for spawning. Ammocoetes, larval sea lamprey, spend the first few years living in river silt or sand before migrating to the ocean.

After May 25th this trap was only active for forty eight hours per week. We reduced the amount of trapping time for two reasons; processing the catches of elvers was taking to much volunteer time and the trap was blocking the passage of sea lamprey.

Since the end of the 2012 trapping season we have reviewed the efficiency and usability of this trap. Modifications will be made for the start of the 2013 monitoring season to reduce the weight of the trap and make it easier to lift out of the eel pass. In addition a separating mesh will be fixed in the trap to keep the CMCs from the eels and alterations will be made to the trap door to make it easier to remove the trapped eels.

Figure 8: The bespoke trap positioned at the top of Allington lock eel pass.

River Cray- Hall Place

Partners: North West Kent Countryside Partnership

Grid reference: TQ 50209 74261

This is the second year of monitoring at Hall place on the River Cray. The trap design for this site is as shown in figure 2. In 2011, no eels were caught and in 2012, one eel was caught. The lack of eels migrating up the River Cray is most probably due to Vitbe Sluice (show in figure 9). Vitbe sluice forms a barrier to not only eels, but all upstream fish migration. Removal of the barrier is a Water Framework Directive priority for the EA who are currently considering their options for the site following this summer's trail adjustments to the structure. North West Kent Countryside Partnership and ZSL are supportive of plans improve fish and other eel passage at the barrier.

Figure 9: Vitbe sluice on the River Cray

River Lee-Bow Locks

Partners: Thames 21

Grid reference: TQ 38252 82860

2012 was the first monitoring season at Bow Locks on the River Lee. ZSL and Thames 21 worked with the Canal and Rivers Trust and the EA to integrate an eel trap into the exiting eel pass at the site. As shown in figure 10 the trap is positioned on the 'out flow' pipe of the eel pass. Eels crawl up the bristle board ramp (not visible in figure 10) to the apex of the pass. Once at the top they drop down the pipe which had formerly guided them into the River Lee Navigation from the tidal section of the river.

13 eels were caught, of which all were elvers. The largest elver caught measured 96mm in length. In addition to gaining data on eel movement at the site CS volunteers have routinely cleaned the pump screen in order to keep the pass operating properly.

Figure 10: The modified eel pass with trap at Bow Locks on the River Lee

River Wandle-Abbey Mills

Partners: The Wandle Trust

Grid reference: TQ2639469823

In 2011 ZSL ran a pilot study at this site using two traps as shown in figure 2. The traps proved unsuitable for the site. In September 2011 The Wandle Trust built the permanent eel pass and trap (figure 11) over the weir at Abbey Mills. 139 eels used the pass during the 2012 monitoring period of which 14% were elvers. In

addition to a trap the Wandle Trust installed CCTV on the pass. This proved invaluable in studying the behaviour of the eels using the pass and informed important modifications to the pass to improve its efficiency.

The Wandle Trust worked with Jiamin Xu, a masters student from Kings College, University of London. Jiamin's dissertation concluded that minor design changes in pass design can lead to changes in eel behaviour in the pass. Her report is available through the Wandle Trust (www.wandletrust.org).

Figure 11: a) the eel pass and, b) trap at Merton Abbey Mills on the River Wandle.

River Crane-Crane Park

Grid Reference: TQ2639469823

Partners: The London Wildlife Trust (LWT) and Friends of River Crane Environment (FORCE)

At the end of a second year of monitoring on the River Crane at Crane Park, using a simple trap (figure 2), we are yet to record the presence of upstream migrating eels in the river. In response to the apparent lack of upstream migrating eels ZSL, LWT and FORCE undertook a survey of the barriers in the lower River Crane to elucidate the causes behind the absence of trapped eels. The report concludes that the issue of barriers to migration in the downstream reach of the River Crane is superseded by a more pressing need to restore and rehabilitate the general ecological health of this stretch of the river. Eel migration into the Crane can be facilitated by adding passes onto two barriers on the Duke of Northhumberland's River, a tributary of the River Crane. The full report can be obtained from ZSL.

Hogsmill River-Middle Mill

Grid Reference: TQ1854268751

Partners: Kingston University

In 2011 we monitored at Middle Mill on the Hogsmill with a simple trap (figure 2). No eels were recorded in 2011. In 2012, with funding from the EA, we replaced the trap with the more robust trap shown in figure 12. Eels move up the brush substrate lined lower section of the pass. Halfway up the pass, they enter the trap chamber and pass through two funnel shaped restricted apertures. Once in the trap they are unable to locate the exit. These new trap designs were intended as pilots for review at the end of the first season of trapping. In the 2012 season we recorded 1 eel at this site.

This is perhaps the most interesting anomaly uncovered by the CS project to date. There are no obvious barriers downstream of Middle Mill. Further research is required to ascertain why we aren't recording greater numbers of migrating eels at this site.

Figure 12: a) The eel pass with trap on the Hogsmill River at Middle Mill and, b) open lid aerial view of trap .

River Thames-Molesey Lock

Grid Reference: TQ 515 168

Partners: Thames Anglers Conservancy

This was the first year's monitoring at this site. The trap design at Molesey (figure 12) is similar in design to the trap on the Hogsmill. The mesh size on this trap was constructed at 6mm however. Small elvers were seen escaping from the trap. The trap will be fitted with a smaller mesh, ready for the 2013 migration season. Despite the trap issues, 133 eels were recorded, of which 23% (30) were elvers. Data from this site

raises important questions as it illustrates that eels are passing the mouths of tributaries such as the Crane, Cray and Hosgmill where we have recorded zero, one and one eel respectively over two years of CS monitoring.

Figure 12: The eel pass and trap on the River Thames at Molesey lock with members of the Thames Anglers Conservancy.

4. The Future of the CS programme

Trap designs for Allington Lock and the River Thames at Molesey will be improved for the 2013 monitoring season. In addition, we hope to add new monitoring sites; on the River Ash, with the Spelthorne Natural History Society; the River Brent with the Thames Rivers Restoration Trust and potentially on the River Thames at Teddington Lock with Ham United. The project has also attracted the interest of river managers in other regions of the UK, interested in applying our model to their catchments.

In their book on public participation in environmental research, Dickinson and Booney (2012) illustrate that CS programmes show varying degrees of emphasis on three main areas; research, education and stewardship. To date the emphasis of our project has been on research and education. In the future we want to emphasise the role of our volunteers as stewards of London's rivers and work with our CS partners to aid upstream eel migration in the Thames catchment. River barriers such as weirs prevent or hinder upstream migration and reduce the amount of available habitat to eels. The EA has identified 2393 barriers within the Thames catchment. To provide passes to all these barriers is a monumental task, but The CS programme will add much needed capacity to tackle the problem. With our partners and under guidance from the EA, we will work to build more eel passes by raising funds to engage pass construction companies or, where appropriate, support volunteer groups to do the work necessary to aid upstream eel passage. In

many cases, this can simply be a case of bolting eel pass tiles or simple bristle board passes (figure 13) along the margins of sloping weirs. Both provide a suitable substrate through which eels can 'crawl' over barriers.

Figure 13: a) an eel pass tile and, b) a simple bristle board pass

This year we have conducted river barrier surveys on the River Crane and Darent, both will form the basis of grant applications to secure money to improve eel passage on these rivers.

Working with CS volunteers has allowed us to spread the monitoring programme over a much wider area of the Thames catchment and by working in partnership with other organisations we can build capacity in the sector as a whole to tackle the issues facing the European eel in freshwater.

ZSL is working hard to secure funding for this programme beyond the lifetime of the grant from Esmee Fairbairn Foundation which expires in February 2014.

Acknowledgements

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Photo Credits

All photos are ZSL other than figure 8 (Paul Clark, NHM), figure 11 (Tim Longstaff, Wandle Trust) and figure 13 (EA)

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