ISAC The Irfon Special Area of Conservation Project

END OF PROJECT REPORT JAN 2014

INTRODUCTION

The River Irfon rises on the slopes of Bryn Garw, approximately 550 metres above sea level in the Cambrian Mountains of mid Wales. It flows initially in a southerly direction through The Devil's Staircase and along a rugged, steep sided valley to Abergwesyn. From there it continues through the secluded valleys of the National Nature Reserve to Llanwrtyd Wells, where it turns east, to flow through Llangammarch Wells and Garth before finally joining the river Wye at Builth Wells.

The Irfon catchment covers an area of 293km^2 and along with the Ithon, is one of two major tributaries of the upper Wye. Its name is a derivative of 'Afon' which, like the English 'Avon', literally means 'river.'

The river valley is steeped in Welsh history. At Cilmery, Llywelyn ap Gruffydd, the last Welsh Prince of Wales, was killed following his retreat after the battle of Painscastle in 1282. The Cammarch Hotel on the banks of the Irfon in Llangammarch Wells is also said to have been the location for the last wife sale in Wales!

The river is highly protected under European and UK law, with both SAC and SSSI designations. It is an important spawning area for Atlantic salmon; sea, river and brook lamprey are present in the main river and also spawn in the tributaries; bullhead are abundant in most areas and twaite shad spawn in the lowest 4km. Brown trout are widely distributed and are believed to exhibit considerable genetic diversity. The Irfon is revered by anglers as one of the best grayling rivers in the UK.

In addition to fish, the river is host to an array of rare flora and fauna including otters, white clawed crayfish, freshwater pearl mussels, sandpipers, dippers, kingfishers, sand martins and various types of ranunculus.

The catchment is predominately farmed for livestock (74%) although much of the upper reaches are afforested with commercial plantations of conifers.

NEED FOR THE PROJECT

Despite the diversity of flora and fauna, the Irfon faces a number of threats. In addition to climate change and acidification, threats also arise mainly from intensification of land use and the inappropriate management of the riparian zone.

Acidity
pH levels in the upper Irfon commonly fell to below 4.5 after rainfall during the autumn and winter. A pH of 4 is around 100 times more acid than fish can survive. A pH of 2.6 was recorded at the top of the river in 2013.

Damage to streams by livestock
Sheep numbers in the upper Wye catchment have doubled twice since the introduction of the Common Agricultural Policy in the 1970s. Although numbers have dropped slightly in recent years, the upshot is that stocking levels have resulted in overgrazing of unprotected streams. This physical damage affects almost all SAC features negatively.

Over-shading
Until the late 1950s, streams in the Irfon had their riparian alder rotationally coppiced for firewood, charcoal and clog making. This tree management stopped abruptly and the resultant multi-stem coppice regrowth created dense shading on much of the tributary system, reducing in-channel production and leaving the banks bare and prone to erosion. These trees are often very unstable and prone to topple.

Siltation
Silt levels in the Irfon remain relatively low but, in common with the rest of the rivers in the area, have more than doubled (since the early 1970s) due to a mix of increased intensity of land use practices (grazing and forestry).

Pesticides
Despite the recent removal of Synthetic Pyrethroid (SP) dips from the veterinary approved list, stocks of the chemical remain. They are also still widely used in forestry during the early stages of tree establishment. In addition, organophosphates are still approved for use on livestock. These toxic substances enter watercourses either deliberately or accidentally.

Invasive Species
American signal crayfish out-compete our native white claws and carry plague, to which our indigenous species are very susceptible. Invasive weeds damage bank integrity - rivers are highly effective disseminators of these plants.

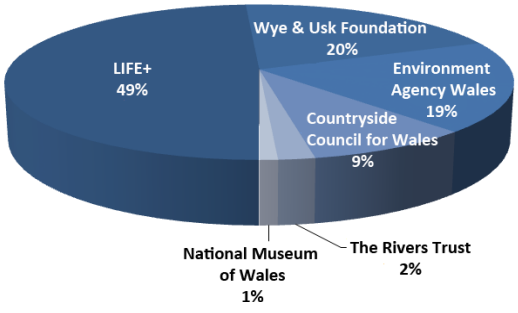
LIFE+

The European Union Life+ Nature fund supports actions to restore Special Areas of Conservation (SACs), such as the Wye and Usk. In 2008, the Wye & Usk Foundation submitted a bid to correct the problems causing the acidification of the Irfon's headwaters, restore the habitat of the middle and lower catchment and recover the populations of freshwater pearl mussel and white clawed crayfish. After a rigorous justification phase, we were fortunate to be one of four successful UK candidates in 2010.

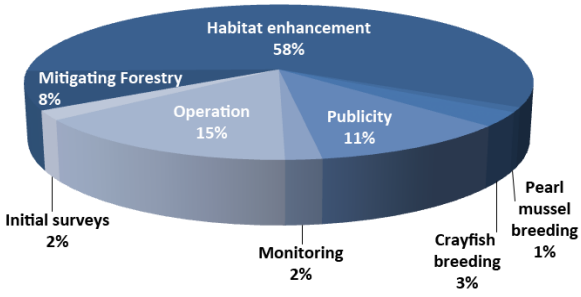
Starting later that year, the Irfon Special Area of Conservation (ISAC) project was a four year €1.27m partnership between the Foundation, Environment Agency Wales, the National Museum of Wales and The Rivers Trust, with Countryside Council for Wales making a significant financial contribution (EAW & CCW are now part of Natural Resources Wales). The project was supported by the European Commission, who supplied 50% of the funds via the LIFE+ Nature programme.

PROJECT FINANCE

ISAC FUNDING



ISAC SPEND BY ACTIONS



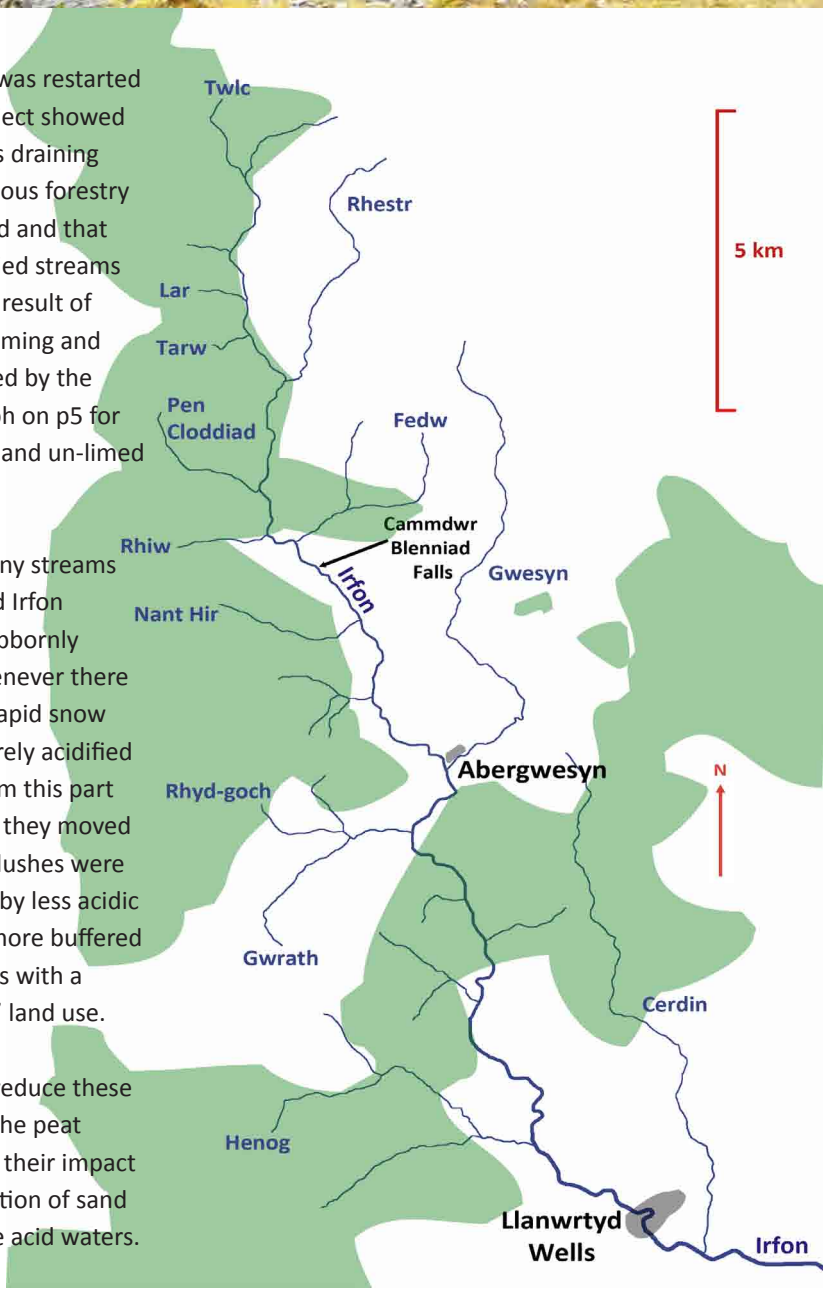
MITIGATING THE EFFECTS OF COMMERCIAL FORESTRY

Since the 1970s the predominant land use in the headwaters of the Irfon has been coniferous forests, both publically and privately owned (shown as the green areas on the map to the right). This, combined with acid rain, has meant that the otherwise pristine upper reaches of the Irfon have been affected by acidity to such an extent that they have been unable to support any fish life. To make things worse, the extreme drainage of the deep peat soils required to grow trees on the bogs had also led to rapid run-off and reduced the ability of the landscape to store water. Worse still, drying peat releases large amounts of carbon dioxide. The project had the ambitious aim of recovering the 18km section of the Irfon between the falls at Cammdwr Blenniad and Llanwrtyd Wells that was so damaged by acidity and adverse flows.

Detailed monitoring of pH, diatoms (single cell organisms) and water quality by the National Museum of Wales during the Wye & Usk Foundation's pHish project (2002-2008) was restarted within ISAC. This project showed that river catchments draining grassland and deciduous forestry were seldom acidified and that some formerly acidified streams were recovering as a result of hydrological source liming and sand liming completed by the Foundation (see graph on p5 for comparison of limed and un-limed streams).

When we started many streams draining the Twyi and Irfon forests remained stubbornly acidic, however. Whenever there was heavy rain or a rapid snow melt, flushes of severely acidified water flowed out from this part of the catchment. As they moved downstream, these flushes were steadily ameliorated by less acidic streams flowing off more buffered geology or from areas with a more 'water friendly' land use.

ISAC's target was to reduce these flushes by restoring the peat bogs and to diminish their impact through the introduction of sand lime to neutralise the acid waters.



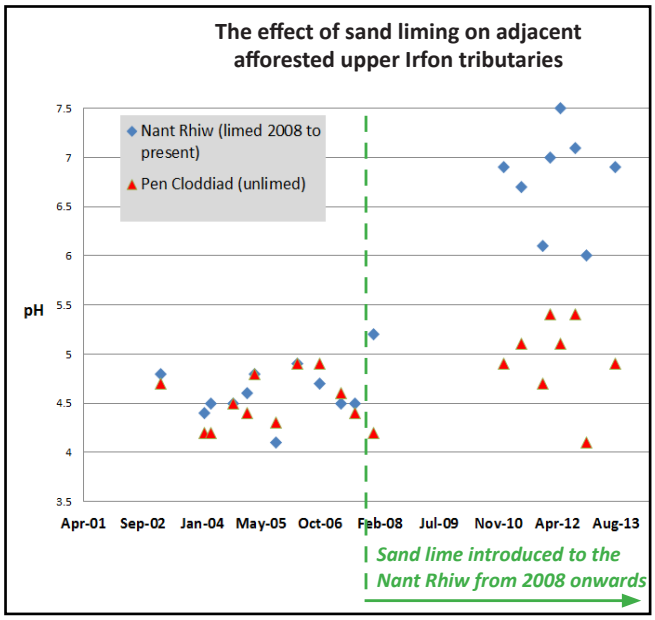
RESTORING WATER QUALITY BY LIMING

The technique of sand liming involves the annual introduction of ungraded limestone sand direct into the channel of the 1st and 2nd order tributaries (photo opposite). Over the course of the project an average of 97 tonnes of lime per year was spread across the 33 sites. There was one treatment in the spring of each year and another in the autumn of 2012 after the heavy flows of that summer.

The resultant changes in the pH of the streams appear to be proportional to the amount of sand lime applied and the distribution of sites within the sub-catchment. This means the technique is able to be adapted to take into account the results of the project's monitoring.

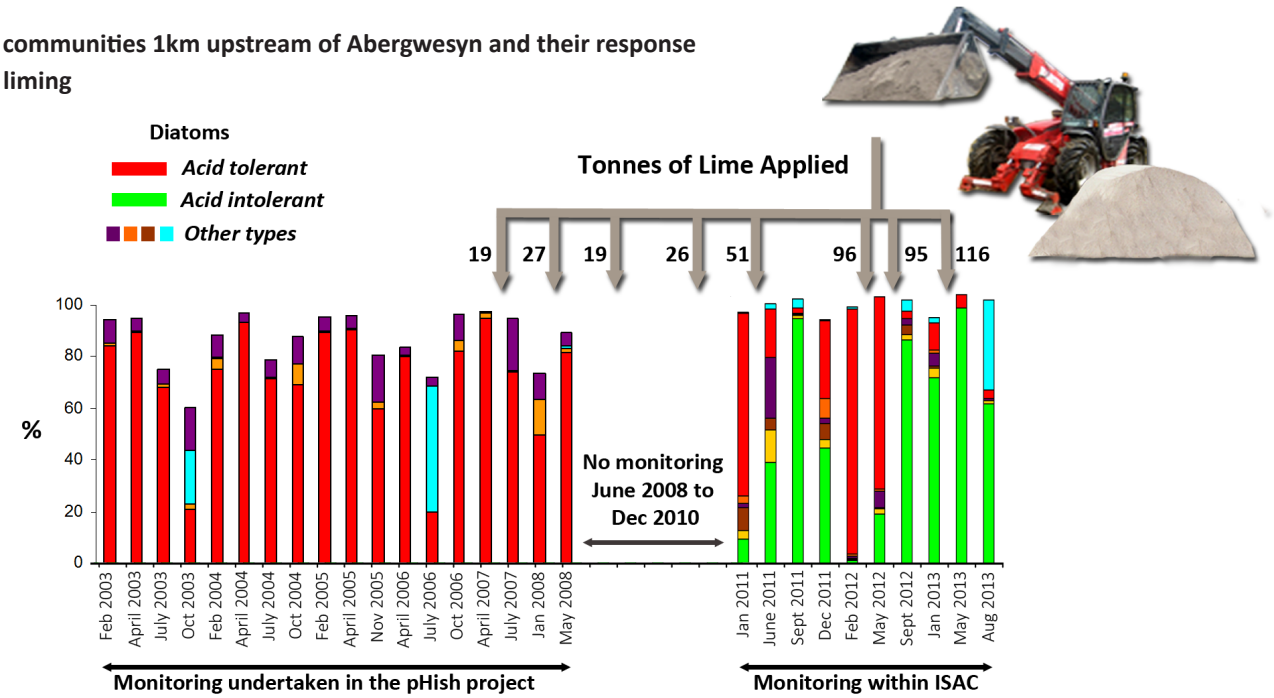
During the past 4 years we have recorded several acid episodes that would otherwise have wiped out fish life as far downstream as Llanwrtyd Wells with pHs of 4.5 (Dec 11), 3.7 (Dec 12) and 2.6 (April 13) being recorded in the main stem, upstream of the first limed tributary. These flushes could not have been worse timed - the two most sensitive stages of a salmon's lifecycle to low pH are when the eggs are eying (late Dec) and when the alevins are hatching out (April).

However, in all these cases the pH recovered rapidly as the acidity was buffered by tributaries that had been limed, rather than the previous slow recovery as the flush moved downstream towards Llanwrtyd.



The graph below shows the change in the diatom community at a point 1km above Abergwesyn. The deterioration during the wet summer of 2012 is obvious (a high % of acid tolerant diatoms shown in red). It was this that caused us to add an extra dose of lime in autumn 2012 that, in hindsight, may have protected the SAC from the acid events in the winter of 2012/13.

Diatom communities 1km upstream of Abergwesyn and their response to sand liming



RESTORING THE HYDROLOGY

Sand liming is only ever going to be an interim solution. Returning the headwaters to their natural state and a continuing reduction in atmospheric pollution is the only way of restoring fully the water quality and natural flows.

After ten months of survey work followed by eighteen months of negotiations, a written agreement with the Forestry Commission committed them to remove coniferous trees and block the forestry drainage within areas that were once wetland sources, reducing the “flashy” nature of forestry run-off as well as preventing sudden drops in pH. These were areas where forestry was making a loss anyway. Despite the drainage, tree growth is stunted on the wet, deep peat soils.

To block the drains we adapted techniques developed in another LIFE+ project restoring blanket bogs in north Wales. Using specialist heavy plant, peat is placed and compacted into a modified section of the drain, creating a plug or dam. Moving downhill, several more dams are then built at 1 to 10m intervals, depending on the drains’ gradient, creating pools of standing water that are rapidly colonised by sphagnum moss and other plant species.

Just when we were ready to start work in 2012 the rain started...and didn’t stop during the spring and summer. Even with the efficient forestry drainage system, the bogs never dried out sufficiently to allow machines to move across them. Following a failed attempt in August to use brash mats and a swing shovel, and still with no sign of an end to the monsoon-like conditions, plans to convert a forwarder (a forestry vehicle designed to extract timber in any conditions) were developed. This machine has 3 times the reach of a swing shovel, meaning it could stay on the brash mats and move easily around the bogs. On 18th September 2012 work started using this innovation.

On a day in late September 2012, we restored a small hydrological source at the top of the Ffos y Lar tributary. The natural bog was just over 1 hectare in size with 8.6 hectares of forestry draining into it. The work involved building 33 peat dams and completely filling in one steeper drain. The next weekend approximately 60mm of rain fell, yet by 8am on the following Monday the last two dams built on the drain were still not full (they were by 10am). The restoration of these peat bogs represents a considerable amount of additional water storage for progressive release during lower flows. Similarly, when blocking another drain during heavy rain, the whole spate was contained in the new dams. The discharge time of a couple of hundred metres of drain had changed from minutes to half a day – inspiring stuff!

By mid October 2012, the risk of losing the forwarder became so severe that we stopped work for the year. Despite numerous holdups, a couple of false starts and a monsoon-like summer, we had restored the hydrological function of seven bogs draining into three tributaries at the very top of the catchment. No less important, we had established a modus operandi to be used elsewhere.

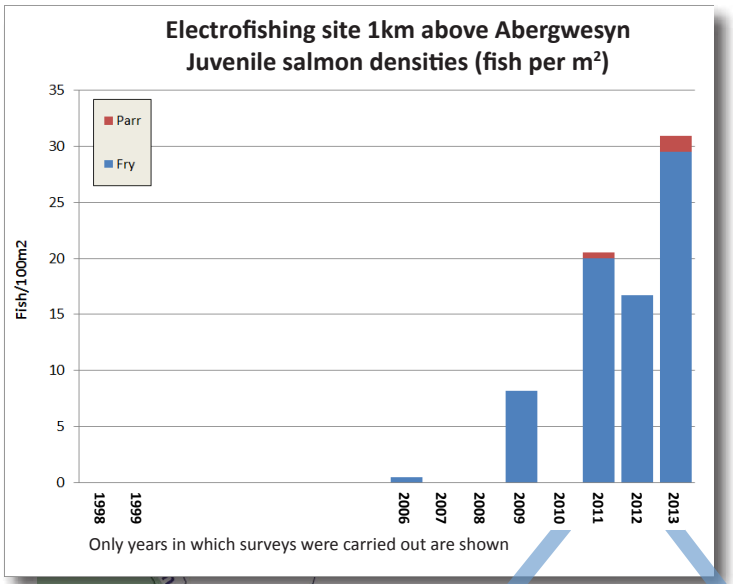
In 2013 a further 4 sources were dammed in the Ffos Twlc catchment by Natural Resources Wales. This completed the original target of restoring 10 bogs. In addition, an agreement was reached with NRW that the bogs within remaining forestry would have their drains blocked and would be not replanted after subsequent clearances over the next 4 years. This agreement has been enshrined within the forest design plans.

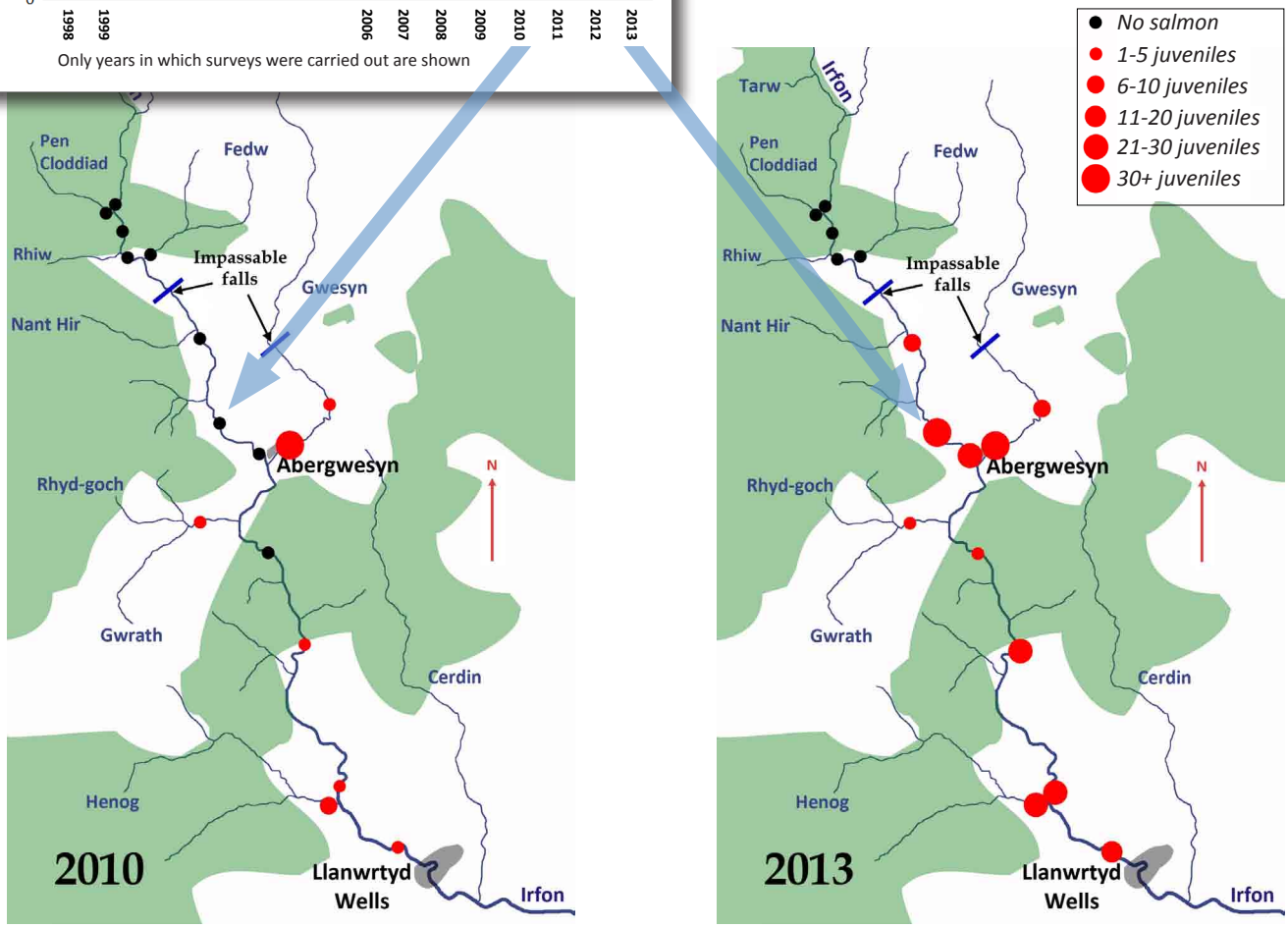
RESULTS

The project has achieved both its aims of recovering 10 hydrological sources and restoring the water quality downstream of Cammdwr Blenniad. Salmon populations in the upper Irfon have responded encouragingly, as can be seen in the graph and maps below.

Blocking forestry drains has a number of additional benefits. The absence of vegetation under the heavy shading of the forest canopy has caused the drains to erode through the peat, allowing large amounts of fine sediment to be washed downstream. Re-flooding the surrounding peat also reduces carbon dioxide and methane emissions. The most important benefit to the river, however, is the naturalisation of flows. Another LIFE+ project restoring peat lands in North Wales found that not only were the peaks of any flood reduced but also that fifteen days after rainfall, the flows were 400% higher in systems where the drains had been blocked. If this approach can be adopted across all forestry in the upper Wye and Irfon, there is an opportunity to restore flows to how they were described in the past. It would also help to support downstream abstractions for public water supply. The adage "the solution to pollution is dilution" would be given more relevance.

We were unable to fund monitoring of flows within this project but the observations following our work in the Irfon bogs last autumn indicate that the benefits of a more stable flow are being realised.





RESTORING HABITAT IN THE IRFON'S MIDDLE AND LOWER TRIBUTARIES

The middle and lower reaches of the Irfon are not at risk from acidification and support populations of all the features of the Wye SAC. Otter, brook and river lamprey, rannunculus, bullhead and Atlantic salmon are all present in fair numbers. Sea lamprey spawn in the main stem as far upstream as Llanwrtyd Wells, while the lowest 4km of the river is the spawning ground for the furthest running twaite shad in the world (170km from sea). White clawed crayfish only just remain, however. The project's target was to improve 30km of riparian corridor for the benefit of all these species.

In 2010, 108km of the tributary network was surveyed for livestock access, over-shading, coarse woody debris, pollution, erosion, fine sediment and the presence of any SAC features. This enabled us to devise a work plan and identify suitable locations for the re-introduction of white clawed crayfish.

It has long been recognised that quantity and quality of habitat is a determining factor in the survival of any species. WUF has been improving stream corridors since 1998 and has now completed 272km throughout the Wye and Usk catchments. Periodic monitoring, combined with observations of the evolvement of the stream corridor post cessation of stock grazing, suggest that it takes 5-7 years for these upland channels to narrow and 'roughen up' and that the response of the fishery and wider ecosystem has been proportional to this roughening. Building on some experimental work in 2007 on the Usk, this project allowed us to test whether the addition of channel roughening to the prescription would give more immediate benefits to the SAC features.

The section of the Irfon catchment that was targeted for habitat restoration supported a strong population of juvenile salmon prior to the project commencing, with a mean density of 0.48 fish per m^2.

Habitat restoration work began in the autumn of 2010 after consent from landowners had been obtained. Depending on specific need, this included adding lateral riparian cover (pleaching and pinning alder, hawthorn, hazel and willow into the river's edge), stock exclusion and coppicing of over-shaded sections. The aim was to increase habitat diversity in the streams and the amount of in-river cover fish had from predators. The deposits of silt in the lee of the pleached trees are also ideal for juvenile lamprey. Extra cover along the banks, increased biodiversity and reduced siltation of the rest of the channel benefits salmon, bullhead and crayfish. Finally, the reduction in extreme shade promotes the growth of ranunculus.

By improving long reaches on each of the streams (average 6.1km) and by comparing both control and restored sites annually to a baseline established at the start of the project, it was possible to remove the natural, annual variations many salmon populations show and to demonstrate that increases were not due to immigration at the expense of surrounding sites.

MONITORING

A monitoring programme was established in 2010 to quantify the distribution of SAC features (salmon, bullhead, lamprey) within the system and assess the effects of the project's actions.

From this programme, 33 sites were selected for electrofishing. The criteria for these sites was that they were outside the acidified section of the catchment and supported a density of juvenile salmon of 0.2 fish per m^2 at some point during the project. 18 of these sites had recent historic data allowing for longer term comparison.

The monitoring sites were established independently and before the habitat work plan had been devised, permitting an unbiased assessment of the effectiveness of the project. By the end of the 3-year improvement programme, 13 of the monitoring sites fell within improved reaches and 19 sites remained as controls. One site was discounted from the analysis in 2013 due to a cattle drinking point being established in the middle of the site!

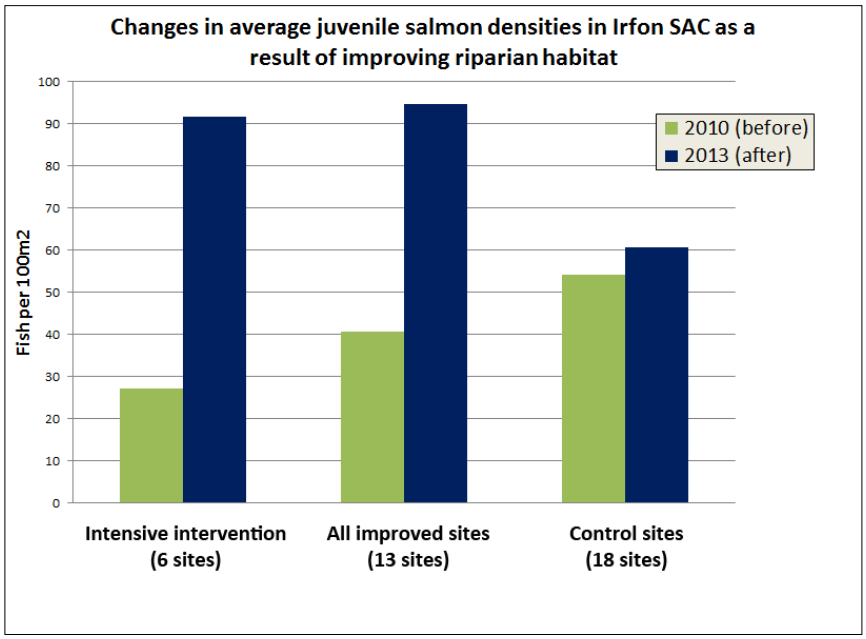
Above: NRW staff electrofishing the Irfon in 2013 as part of the lamprey monitoring and (inset) a juvenile sea lamprey that was caught during the survey.

Habitat improvement work on the Chwefru. WUF staff are pleaching alder into the banks to 'roughen' the stream. This protects the banks and provides cover for fish from predators.

RESULTS

Along any given length of river (reach), the degree of intervention varied from intensive (as shown in the Chwefru photo on the previous page) to zero, where the reach encompassed short sections of natural habitat with no need for improvement.

The effect of restoration work at a reach scale has been assessed by comparing each year's results for a site with the 2010 baseline and assessing whether salmon densities have increased or decreased. The population of sites in improved reaches performed in a significantly different way (better!) to the control sites.



The overall population of juvenile salmon increased by an average of 238% (0.64 fish per m^2) at the sites where material was pleached or pinned into the river (intensive intervention). At all sites in the improved reaches populations increased by 133% (0.54 fish per m^2) over the duration of the project, compared to an increase of 12% (0.07 fish per m^2) at the control sites, as shown in the graph above.

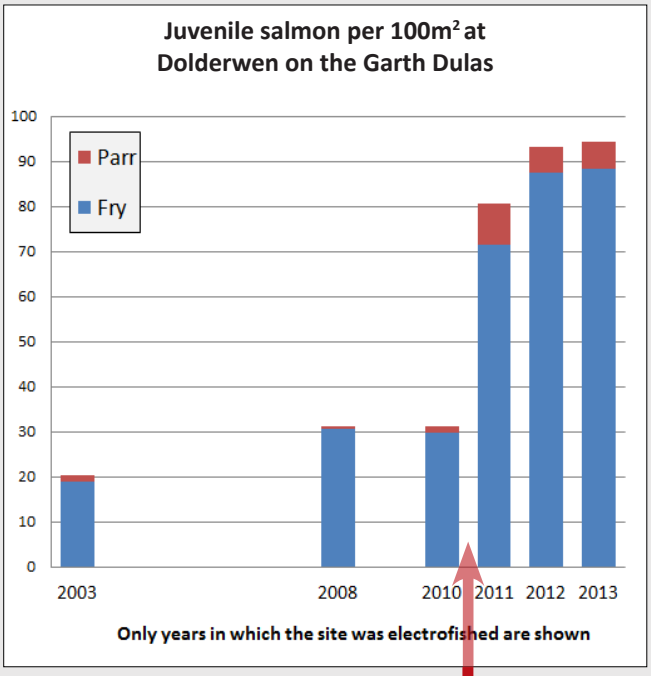
We were able to draw the following conclusions that have direct relevance to any other projects looking to enhance populations of Atlantic salmon:

1. Habitat restoration for salmon fisheries must be targeted at sections where habitat is the limiting factor. It must also be done at a scale that takes into account all juvenile life stages – egg, alevin, fry and parr. By targeting a catchment where habitat was the limiting factor and addressing the issue there has been a strong response in the salmon population.

The photo above left on the preceding page shows the state of the Garth Dulas (one of the Irfon's main tributaries) at Dolderwen during our initial survey work in 2010. Livestock had free rein to eat the river bank vegetation and as a result, the stream provided no cover for fish and was contributing to siltation problems further downstream.

In spring 2011 WUF installed a revetment and fenced off the stream (photo above centre). This repaired the erosion and provided cover to juvenile fish from predators.

The final photo was taken in summer 2013 and shows Dolderwen 18 months after the work took place. Electrofishing showed an immediate and significant jump in juvenile salmon densities at the site, as demonstrated by the graph to the right.



2. High energy upland streams respond more slowly than lowland streams to the cessation of grazing the riparian vegetation. The addition of in-stream cover had a direct effect of fish populations.

3. Over a whole reach, significant enhancement of salmon populations is possible by improving habitat at all the sites that require work within that reach.

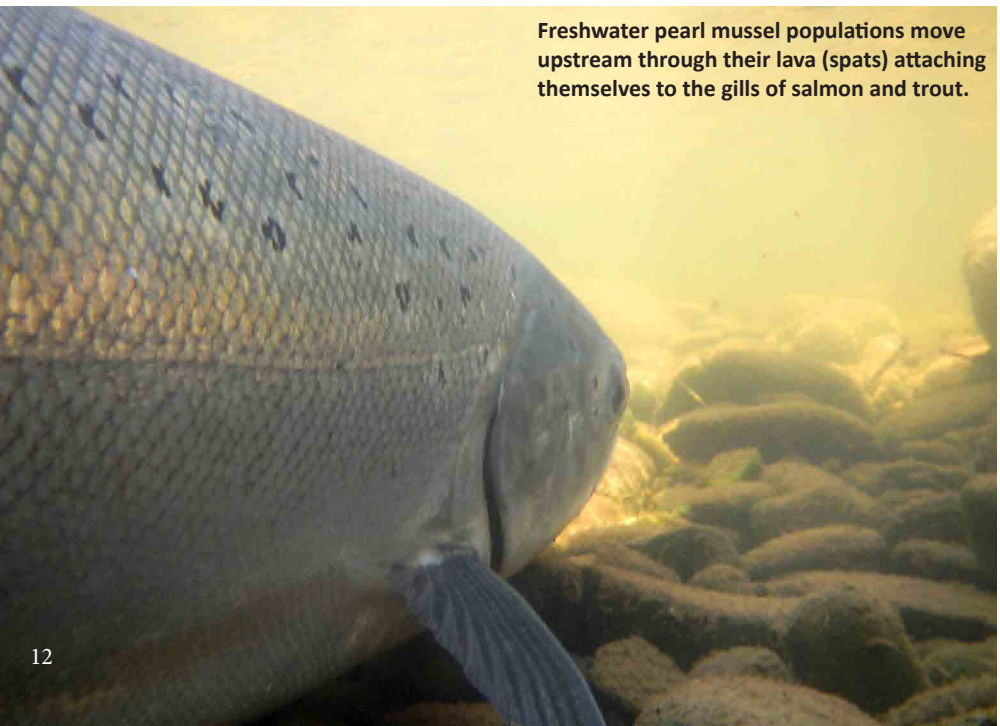
The reason why salmon densities increase after habitat restoration is likely to be a combination of improved habitat structure, reduced quantities of sediment in the river channel and reduced opportunities for avian predators.

FRESH WATER PEARL MUSSELS

In 2010 Environment Agency Wales conducted a snorkel survey to establish if the Irfon had any pearl mussels. Amazingly, they discovered the 3rd best population in Wales. However, these mussels had stopped reproducing between 30 and 50 years ago (they live to over 100 years), a common problem with the species right across their range. Whilst the cause of this is unknown the date at which the mussels stopped reproducing coincides with the acidification of the headwaters and the expansion of the sheep flock with resultant trebling of the levels of fine sediment in the river.

This project has sought to correct both these pressures, offering real hope for this beleaguered species. In the short term, however, we set about establishing the ability to captive breed them.

At Abercynrig hatchery, trout were exposed to Irfon mussel spat (spawn) which attached themselves to their gills (the normal route for their upstream re-colonisation). In 2011, 100,000 juvenile FWPM were collected as they dropped off the gills and then split between experimental aquaria with a closed circuit re-circulation system and troughs in a semi-natural environment.

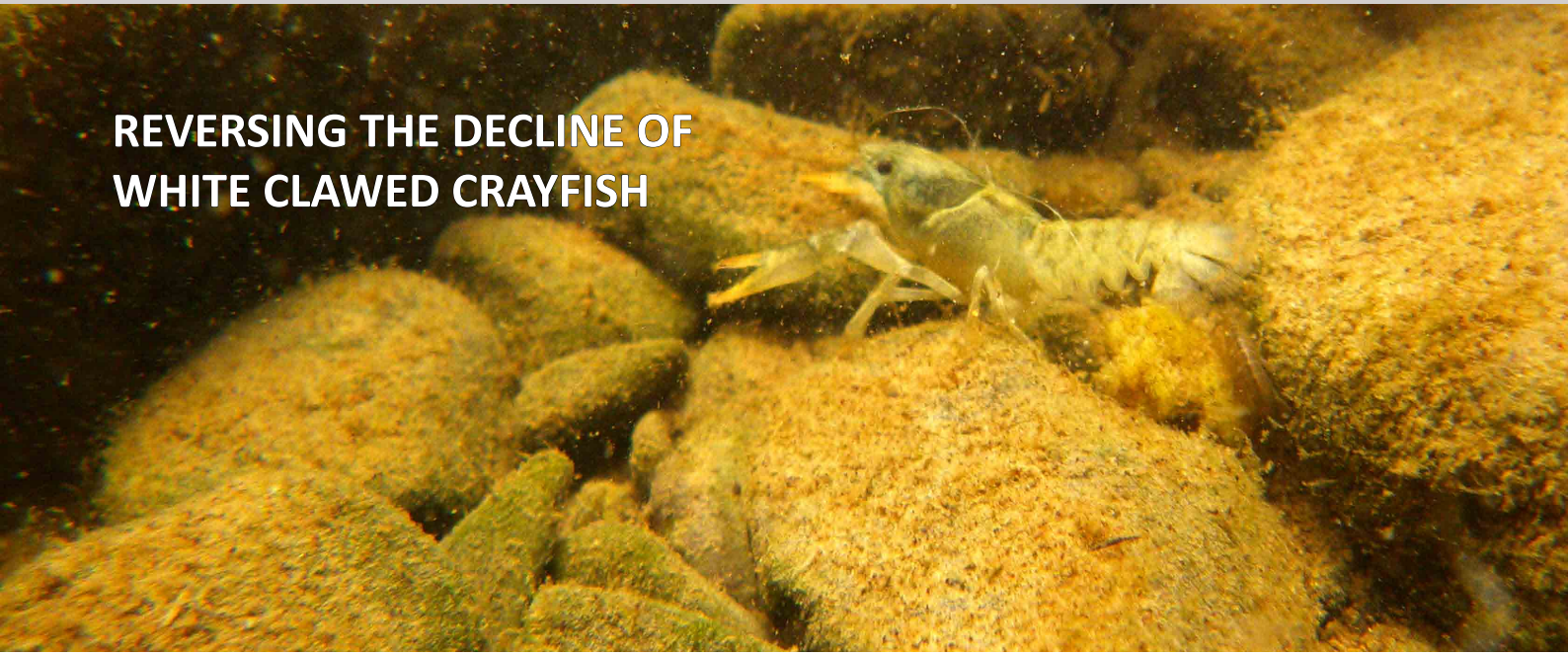


Freshwater pearl mussel populations move upstream through their lava (spats) attaching themselves to the gills of salmon and trout.

Juvenile mussels in the experimental rearing systems were observed to be filter feeding from a few weeks of age. Their growth and the survival of juveniles were encouraging for the first 5 months. The aquaria system, however, was discontinued in December 2011 due to very high mortalities. Those juveniles in the semi-natural environment continue to be cultured for release in 2017.

19 more adult mussels that were collected from the lower Irfon in July 2012 spatted in August 2012, encysting 2,000 trout. From these, over 600,000 juveniles were collected in June 2013. Half of these were put back into the river (based on techniques developed in the USA), whilst the other half went into a modified rearing system to filter feed from day one.

Finally, in 2013 NRW repeated the mussel survey. Rather worryingly, numbers in the wild had declined even further in the lower reaches of the Irfon. Pearl mussels are a rare and important species that are on the brink of extinction. They remain one of the “canaries” of the river and the success in restoring the Irfon will bring about success in saving the pearl mussel.



REVERSING THE DECLINE OF WHITE CLAWED CRAYFISH

Another important indicator and SAC annex ll species is our native white clawed crayfish, which is also besieged on all fronts. Those white claws that survived toxic sheep dips are now threatened with elimination from crayfish plague and habitat degradation. They were once common throughout the entire Wye system but now only small pockets of survivors are found in certain tributaries. The principle for the rejuvenation of salmon, pearl mussel and white claws remains the same: we need to remove the adverse conditions, particularly water pollutants, and restore good habitats. Much of what is good for one species is good for all three.

The base line surveys conducted in 2010 found that the range of the native white clawed crayfish was much smaller than originally thought when designing the project. This necessitated a change in how the project would improve crayfish numbers and distribution. We had originally intended to catch crayfish from streams that had healthy populations and transfer them to those without. The survey found instead that the Irfon's crayfish were only just 'hanging on' with populations remaining at only 4 of the 70 sites surveyed. Our solution was to use Abercynrig hatchery for captive breeding. This necessitated a modification request being submitted to the EC which was approved in December 2010.

Over the winter of 2010/11, a new facility was built at Abercynrig hatchery with the capacity to rear over 1,000 crayfish per year. Staff from EAW (now Natural Resources Wales) have been working closely with the South West Crayfish Partnership both before and for the duration of the ISAC project. The SWCP is a large partnership of organisations working to conserve white clawed crayfish through translocation and the creation of ark sites, outreach and captive breeding.

During October of 2012 Oliver Brown (NRW) co-hosted a captive breeding workshop with Jen Nightingale (Bristol Conservation and Science Foundation) under the SWCP umbrella. Berried (egg-laden) females were collected from the river Rhymney in South Wales and the Escley Brook in the Monnow system in April and May 2011. Approximately 90% of the juveniles survived to hatch and 60% to 12 months. 530 juveniles were released into a site of recently improved habitat on the Chwefru (a lower Irfon tributary) in May 2012, at the upstream end of their historic range. The aim was to allow for downstream colonisation of the rest of the middle and lower Chwefru.

This survival rate was lower than the 70-80% achieved in previous years. This was predominantly down to a proliferation of Hydra (a tiny, predatory aquatic creature similar to a coral polyp) in the rearing tanks which impacted negatively on the recently hatched crayfish. This was remedied in 2012 and 885 juveniles were released in the spring of 2013.

Encouragingly, the fish monitoring survey of the Chwefru in 2013 recorded 3 white clawed crayfish at 2 sites within the section into which 530 were introduced in 2012. The collection of females in 2013 was successful and it is predicted that in excess of 1,000 juveniles will be released in 2014.

PROJECT COMMUNICATION, DISSEMINATION AND CONCLUSIONS

It is important that we inform people of what we have done, what has and has not worked and what we have learnt. There have been presentations to over 3,000 people, including talks at conferences in England, Wales, Scotland, Germany and, as a key note speaker, in Australia!

The initial workshop in 2011 demonstrated what ISAC was doing and was repeated in 2013, this time to present the results. The project has also issued 3 newsletters so far that have been circulated to over 20,000 people annually and has its own website at www.wyeuskfoundation.org/isac

We have found one of the best ways to communicate the aims and objectives is to invite people to see what the project is doing. The Foundation has run 12 river walks to explain the project - the photo above shows the one from the 2011 workshop.

One encouraging result of the above has been the increasing interest of the Welsh Government and Natural Resources Wales in the project and its findings, which are being used to shape future policy.

CONCLUSIONS

ISAC has met or exceeded nearly all its targets for a considerably lower expenditure than initially planned and achieved its original aim of "establishing a healthy and well documented reserve of SAC species within the Irfon to aid the Wye SAC in achieving favourable conservation status."

The project has moved SAC management on in a number of important ways:

1. It developed a method of improving stream habitat that leads to immediate and substantive increases in salmon numbers in upland streams.

2. It has developed a cost effective method for correcting the problems of acid waters.

3. It has changed how forest areas are being managed to the benefit of rivers and the advantages of this will continue to be realised over the next few years.

4. It has developed a methodology for consistent captive breeding of white clawed crayfish.

5. It has proven the benefit of catchment based NGO/governmental agencies partnerships in delivering the Habitats and Water Framework directives.

There are a large number of economic benefits that arise both from the project itself and the changes in future management that the project has stimulated. Two principle areas are in water retention in the headwaters and the improvement in the salmon rod fishery. The former is yet to be quantified as flow monitoring was excluded from the project but provisional analysis suggest a cost benefit for restoration of upland afforested peat bogs to be in the region of 40 to 1.

Salmon have a substantial economic value. The species is intrinsic to the culture of the region (illustrated by the carved salmon at the confluence of the Irfon and Wye) whilst the value of each rod caught salmon is around £2,500. This gives a payback for the project of 4.2 to 1 over the next 15 years.

PROJECT SUMMARY

ISAC ACHIEVEMENTS AGAINST TARGETS

Output	Target	Result
Project Spend	€1,626,449	€1,267,529
Survey and map the habitat within the Irfon SAC	To target habitat works	Yes
Identify priority hydrological sources	15	23
White clawed crayfish	Determine range	Yes
Freshwater pearl mussel	Determine status and range	Yes
Restore afforested hydrological sources	10	10 so far
Water chemistry	Bring Irfon SAC to around neutral pH	Irfon SAC now between pH 6 and 8.
Improved habitat for Atlantic salmon and bullhead	30km	32.0km
Improved habitat for white clawed crayfish	14km	16.1km
Improved habitat for brook and river lamprey	30km	32.0km
Improved habitat for sea lamprey	24km	30.4km
New otter territories established in headwaters	2	Undetermined*
New populations of crayfish established	2	1
Freshwater pearl mussel	Perfect captive breeding	On-going
Project signage at key locations	4	3
Newsletters	4	4
Scientific papers	2	2
Workshops	1	2
River walks	4	12

* Signs of otters have been found throughout the formerly acidified area. However, only genetic sampling can determine the exact number.

Project Partners & Contributors: EU Life +, National Museum of Wales (NMW), Natural Resources Wales (NRW), Wye & Usk Foundation (WUF), The Rivers Trust (RT)

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LIFE project number and title: ISAC 08 LIFE08NAT/UK/000201

Project information is also available on the LIFE project database at: http://ec.europa.eu/environment/life/

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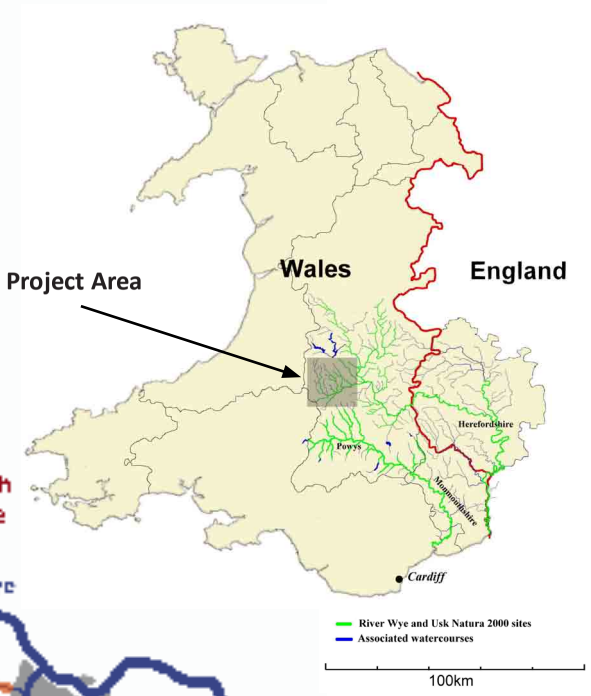
ISAC PROJECT WORK MAP



Irfon
Gwesyn
Cammarch
Chwefru
White clawed crayfish re-introduction zone
Wye
Cryffiad
Abergwesyn
Annell
Rhyd-Goch
Beulah
Elnon
Cerdin
Garth Dulas
Hafrenna
Cilmery
Irfon
Builth Wells
Garth
Canrhiwiar
Cammarch
Freshwater pearl mussel re-introduction zone
Henog
Cwm
Irfon
Llangammarch Wells
Llanwrtyd Wells
Cledan
South Dulas
N
5km

= Habitat improved within ISAC
= ISAC sand liming site
= Peat bog restored in ISAC
= Forestry
= Fish pass/easement carried out in previous project
= Habitat work completed in previous projects

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