Wye and Usk Foundation
Action for fisheries

Final Report

Covering project activities from 1st Jan 2010 to 31st December 2013

ISAC

Irfon Special Area of Conservation project

LIFE08NAT/UK/000201

In partnership with:

Cyfoeth Naturiol Cymru
Natural Resources Wales

THE RIVERS TRUST
where there's water there's life
The new name for the Association of Rivers Trusts

national museum wales
amgueddfa cymru

LIFE Project Number

LIFE08NAT/UK/000201 Final report
Covering the project activities from 01/01/2010 to 31/12/2013

Reporting Date
22/04/2012

LIFE+ PROJECT NAME or Acronym
Irfon Special Area of Conservation project (ISAC)

Project Data

Project location	River Wye SAC Mid Wales
Project start date:	01/01/2010
Project end date:	15/09/2013 **Extension date:** 31/12/2013
Total Project duration (in months)	48 months (including **Extension of** 3**months**)
Total budget	€ 1,244,552
Total eligible budget	€1,244,552
EU contribution:	€622,276
(%) of total costs	50%
(%) of eligible costs	50%

Beneficiary Data

Name Beneficiary	Wye and Usk Foundation
Contact person	Mr Simon Evans (project manager)
Postal address	Unit 4, Talgarth Business Park, Trefecca Road, Talgarth, Brecon, LD3 0PQ
Visit address	Unit 4, Talgarth Business Park, Trefecca Road, Talgarth, Brecon, LD3 0PQ
Telephone	00 44 1874 711714
Fax:	n/a
E-mail	simon@wyeuskfoundation.org
Project Website	http://www.wyeuskfoundation.org/isac/

1.1 List of abbreviations and acronyms used

AC	Afonydd Cymru
CCW	Countryside Council for Wales
GIS	Geographic Information System
GPS	Global Positioning System
EAW	Environment Agency (Wales)
FCW	Forestry Commission Wales *(previously referred to as Assembly Woodland Estate)*
FWPM	Freshwater Pearl Mussel
HSA	Hydrological Source Areas *(the wetland areas from which 1st order streams arise)*
JNCC	Joint Nature Conservation Committee
MOA	Memorandum of Agreement
NRW	National Resources Wales
RT	The Rivers Trust *(previously referred to as Association of Rivers Trusts)*
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
WCC	White clawed crayfish
WFD	Water Framework Directive
WUF	Wye and Usk Foundation

2. Executive Summary

The Wye has a catchment area of 4,285km^2 and includes five significant sized tributaries (of which, reaches of three are included in the SAC). This presents something of a challenge for organisations with responsibilities and ambitions to restore the SAC to favourable conservation status. Previous projects have taken on manageable sized areas or issues (such as fish passage) in order to deliver restorations and improvements. The Life + fund offered the chance to work on a catchment scale and deliver something for all the Annex I and II habitats and species. Our knowledge of the Wye drove the decision to select an appropriately sized sub-catchment that included the full range of SAC habitats and species that were recoverable within a short time frame. The River Irfon exactly fitted this description.

The project objectives were as follows:

- Managing/restoring Natura 2000 SAC designated riparian stream habitats in the Irfon catchment, thus increasing the numbers and range of River Wye Natura 2000 species.
- Assisting in climate proofing the Wye SAC.
- Adhere to the Ecosystem Approach (IUCN 2003) for the conservation of biodiversity: in addition to operating at an appropriate scale for the designated habitats and species, the objectives included developing wider socio-economic benefits which will provide the driver for the long term maintenance of conservation actions.
- The formalising and expanding of records for SAC species within the Irfon to allow for better protection and targeting of restoration action.
- Demonstrating the benefits of river catchment based NGO/GO partnerships in delivering the aims of the Habitats and Water Framework Directive

Actions and means involved:

- Baseline surveys of SAC species distribution within project area and identification of 15 priority hydrological sources in need of restoration/reclamation.
- The re-establishment of appropriate hydrological management within 10+ defined areas by re-instating appropriate hydrological systems.
- Ameliorated the negative effects of acid rain on the Irfon SAC by the appropriate management of water quality through the best practice combination of hydrological source liming and sand liming.
- Restoration of the semi-natural riparian corridor along 30km of stream by exclusion of stock and improvement and management of the shading regime.
- Determining the current range of white clawed crayfish and guiding re-introductions into suitable streams.
- Determining status and range of freshwater pearl mussel and from that, the development of appropriate actions.

The results:

- Baseline information established of SAC features within the SAC, discovering a previously unknown population of FWPM in the process.
- Methodology developed for the restoration of peatlands, post forest clearance.

- Changed approach and attitude of foresters for the benefit of the SAC.
- Restored hydrological function of 10 HSAs in the afforested upper catchment.
- Developed sand liming methodologies which enabled the restoration of 13km of the middle and upper Irfon SAC (and associated tributaries') water chemistry to circum-neutral and naturalisation of the hydrology.
- Developed improved methodology for restoring riparian habitat of upland streams that increases the speed in which the amount of in-channel cover is enhanced.
- 32km of improved and enhanced habitat for spawning & juvenile habitat for Atlantic salmon, giving measurable increased juvenile densities.
- 32km of improved habitat for bullhead.
- 14km of improved habitat for white clawed crayfish.
- 3 years of successful captive breeding of white clawed crayfish. Methodologies used disseminated throughout the UK.
- Length of stream populated by white clawed crayfish increased from 7km to 17km by establishing 2 new populations.
- 30km of improved habitat for brook and river lamprey.
- 24km of improved habitat for sea lamprey.
- Improved spawning conditions for allis and twaite shad
- 2 new otter breeding territories established in the previously acid headwaters.
- Established a healthy and well documented reserve of SAC species within the Irfon to aid the Wye SAC achieving favourable conservation status.

Summary of the Main Report

Surveys and Consents

Initial surveys were carried out to direct the project actions. In the forest, Google earth was employed to gauge the basic outline of former wetlands followed by ground surveys directed towards confirming and mapping those original hydrological source areas (HSAs) that had been lost due to commercial forestry plantations. This was complicated by the failure of GPS devices to work under forest canopy, while felled areas enabled accurate assessment of the extent of previous wetlands. Some were delineated by patches of stunted or poorly growing trees but only where the aggressive drainage necessary for the forestry had failed.

The riparian habitat survey entailed a 126km walkover of SAC listed streams, noting such features as livestock access, shading, coarse woody debris, pollution, erosion, fine sediment and SAC features. The data was committed to GIS and from this, plans were drawn up to rectify the many problems found and to restore connectivity within the catchment.

Due to the high level of designations in the area and the fragmented ownership a large number of consents were required to deliver the project. These included permission from statutory bodies to work in the SAC for each site, endangered species handling consents, riparian owners, forest owners, land drainage consent and a discharge consent in respect of adding limestone.

The white clawed crayfish survey confirmed that populations had retreated to a small number of areas mostly outside the SAC boundaries. By contrast the freshwater pearl mussel survey, carried out by snorkel and glass floored box, confirmed for the first time a large but rather superannuated population at a few sites in the main Irfon.

Procurement of rights
Procurement of rights to carry out project actions in the forest were part of the original project submission. With the amalgamation of Forestry Commission Wales into Natural Resources Wales, it became possible to carry out the works without having to pay for long term removal from forest planting plans, although funds were still required to carry out the proposed drain blocking. It was also possible with the new body to agree actions beyond the life of the project and agreements were signed to this effect. In respect of project targets, enough HSAs were secured in this way.

Concrete Conservation Actions: Restoration of water quality, improving riparian habitats, captive breeding of white clawed crayfish and freshwater pearl mussel.

Following a site visit to a neighbouring LIFE+ project, an assessment was made of how we should achieve forest drain blocking using peat rather than sheet pilings, based on their experiences. The first stage was the removal of mature trees and following the exceptional rainfall in 2012, machinery was modified specifically to enable drain blocking to take place in very wet conditions. In total 10 sources covering 23.5ha of deep peat were taken out of forestry and restored. In addition agreements were signed to restore a further 12 sources covering 87ha by 2018, as the forest is sequentially felled.

The other component of improving water quality in the afforested sections was ‘sand liming’. Specifically this is the addition of random sized limestone particles into all the first and second order streams, where this is practical. The aim is that these particles become part of the bed and influence pHs favourably in the stony interstices of the stream bed. Diatom and water chemistry monitoring allowed doses to be adjusted annually and the SAC features have recovered as a result.

On the SAC tributaries, little or no tree management had taken place for decades and sheep were damaging the unfenced banks. Trees were thinned to achieve bank stability and let in light to heavily shaded sections. In all cases a double bank fence followed but not before the channel had been ‘roughened’ by the pinning in of hawthorn trees and the pleaching of hazel and alder to provide marginal cover and trap silt. This was proven to be effective at increasing Atlantic salmon numbers and the monitoring confirmed reach scale improvements as well as local benefits.

Having determined that there had been no natural recruitment of freshwater pearl mussel, it was felt that a breeding programme was the best route to safeguard this species. Additional facilities were constructed at Abercynrig hatchery, Brecon to accommodate a few adult specimens with the aim of developing a source of juvenile mussels. Despite some initial setbacks, 18,000 1 month old mussels were released back to the river and 35,000 are being grown on in the hatchery for releases in 2018.

The initial survey showed that the Irfon’s population of white clawed crayfish had contracted to a small population in just a 3 streams (2 of which were outside the SAC). It was believed that one of the principal causes – sheep dip poisoning was now eliminated so the central issue

was one of ensuring that breeding populations be reintroduced to major streams within the historic geologically determined range. Clearly, this would require the acquisition of additional specimens and these were obtained as 'berried' (egg carrying) females from a tributary of the Monnow (the lowest major tributary of the Wye) which held healthy populations. Juveniles were then reared also at Abercynrig and finally translocated to the Afon Chwefru (2012 and 2013) and Cneiddion (after project end), rivers that once supported large populations. Monitoring the following year confirmed that they had established.

Monitoring.
The project monitoring programme included assessments of changes in the populations of white clawed crayfish, freshwater pearl mussel, Atlantic salmon, lamprey species and bullhead as well as making an assessment of the catchment for otter.

Of particular interest is the successful use of diatom analysis to monitor and direct the limestone introductions. Quarterly sampling has enabled the project to monitor the effects of acid flushes in relation to the liming dose. Water chemistry and pH is also monitored quarterly.

An interesting finding was that it was determined that the NRW methodology for assessing lamprey was probably giving a false negative when determining if the species was in favourable conservation status. This finding has been fed back to JNCC assessment.

Dissemination
The important work of disseminating the project was through a wide variety of ways, including: TV appearances, stimulating articles in the press, press releases, information boards, a dedicated website, a layman's report, public presentations, scientific papers, E-news updates, Twitter, workshops and river walks.

The feedback received has come from as far away as America, Australia and South Africa and has been positive.

Evaluation of Project Implementation
The project has exceeded is aims and objectives but the response of the SAC features appears to have been mixed.

Salmon and otter have recolonized the formerly acidified section as the acid waters problem was resolved but the expected increase in bullhead did not occur, probably due to waterfalls acting as barriers to (re)colonisation.

The habitat works has exceeded our expectation in terms of salmon with juvenile salmon number increasing by $0.5m^2$ within the reaches improved compared to those not improved. We have found and protected more wet alder carr (2.0ha) that we expected. *Ranunculus* has expanded its range and is spread through the middle and lower system and with time will reach the project target. We have created a large amount of extra suitable juvenile lamprey habitat and it is being utilised but monitoring was not able to confirm this on a catchment scale due to flaw in the technique. Bullhead numbers appear to have remained unchanged and is still in unfavourable condition for reasons not yet determined.

Shad populations in the lower reaches are healthy are showing evidence of increasing. Allis shad was confirmed in the Wye for the first time.

The captive breeding of crayfish has seen 2,483 1 year olds released establishing two new populations within their former range. The captive breeding of freshwater mussels had early problems which were resolved latterly in the project and 35,000 are due for release in 2017.

Long term benefits

The delineation of the SAC and the distribution of its features in the catchment are not evenly spread. We recommended that the SAC is extended to include the areas recovered from acidity and those areas re colonised (by its anadromous species) that has occurred post removal of man-made obstructions since the designation. Also, the majority of the white-clawed crayfish population in the catchment lives outside the SAC, typically in lower order streams. The third best population of freshwater pearl mussel in Wales wass not included in the original.

The project investment will be sustained in large part due to the realisation of the value of the ecosystem services it has enhanced. There is already a market in place set up by WUF which realises the economic benefits of any improvements to the fishery downstream called the Wye and Usk Passport. WUF is also working with farmers and water companies to set up a market to use deep peat as a water store to support low flows rather than grow trees (whilst at same time in another project, increasing broadleaf tree cover where it is needed in the catchment)

Added to this, Welsh Government policy is changing, in part stimulated by this project and the RSPB's LIFE+ project in North Wales and peat restoration is a henceforth a priority.

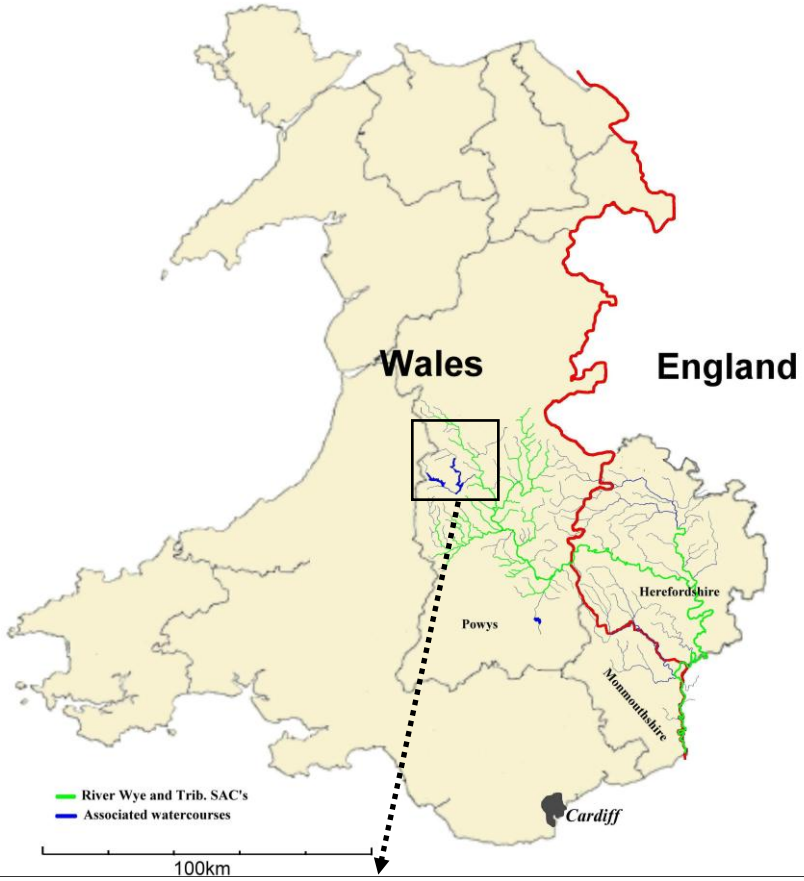
A significant threat is the unregulated expansion and intensification of agriculture. In the past two years poultry production has increased in the Ithon sub-catchment of the Wye with negative impacts of the SAC through increased sediment and phosphate levels. In Herefordshire soil loss from farm land has reached levels (>1m/t/p/a) that require urgent action, but the UK government is reducing regulation. A substantial amount of abstraction (including all trickle irrigation for crops) is not included in the regulatory regimen.

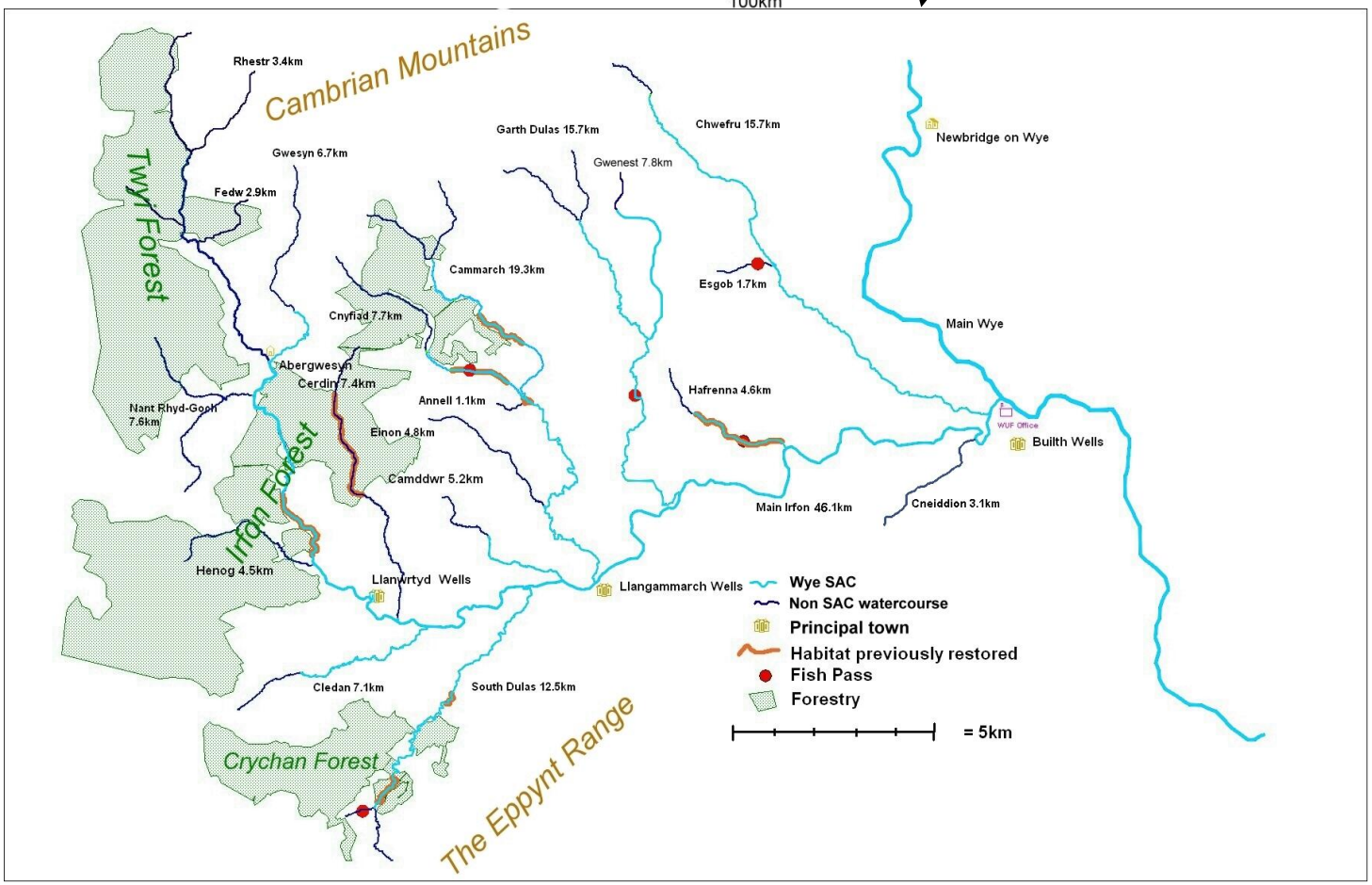
Table 1. PROJECT COSTS

	Cost category	Costs incurred within the project duration
1	Personnel	**750,278**
2.	Travel	**66,668**
3.	External assistance	**78,130**
4.	Durables: total <u>non-depreciated</u> cost	
	- *Infrastructure sub-tot.*	**140,576**
	- *Equipment sub-tot.*	**37,682**
	- *Prototypes sub-tot.*	**0**
5.	Purchase/lease of land	**0**
6.	Consumables	**39,410**
7.	Other costs	**50,804**
8.	Overheads	**81,003**
	Total	**€1,244,552**

Incentives such as low tariffs for anaerobic digesters are skewing agricultural planning resulting in inappropriate crop choices in the lower Wye SAC. Agricultural and to a lesser extent forestry practices are the principal threat to the Wye SAC.

Maps 1 and 2.
<u>The project area.</u>





3. Introduction

The Irfon is a 300km2 sub-catchment of the river Wye and an important component of the Wye SAC. The catchment is predominately livestock grazing and moorland (70%), Forestry (23%) with only 3% given to urbanisation and transport. The geology ranges from hard quartz and schists of the upper reaches to softer shales and clays in the middle and lower reaches.

All the listed species and habitats in the Wye SAC are found in the catchment. The geology in large part defines their historic distribution.

The project set out to work on the whole catchment, assisting in climate proofing the catchment by restoring connectivity, expand the knowledge regarding the distribution of SAC features within the project area, and demonstrate the potential of NGO/GO partnerships in delivering the aims of the WFD and habitats directives

Using the principles of the ecosystem approach, the project set out to correct the following pressures that were affecting the SAC.

- Acid water flushes that were arising from the afforested peatlands in the headwaters and impacting the top 13km of the SAC. Liming and restoration of peat function were the chosen restoration strategies.

- Degraded riparian habitat due to overgrazing by sheep and lack of management of riparian trees in the middle and lower reaches that were restricting numbers of salmon, bullhead, white clawed crayfish and lamprey sp. through a programme of fencing, shade management and addition of instream cover.

- Superannuation of the freshwater pearl mussel population, solution: captive breeding and re-introduction

- Recent severe decline of the white clawed crayfish population: captive breeding and re-introduction, now that the water quality issues have been addressed.

In total the project aimed to:

- Recover 10 hydrological source areas
- Put in place a liming programme to recover water quality
- Protect and enhance 30km of SAC designation riparian corridor
- Establish successful hatchery programmes for FWPM and WCC
- Disseminate the results

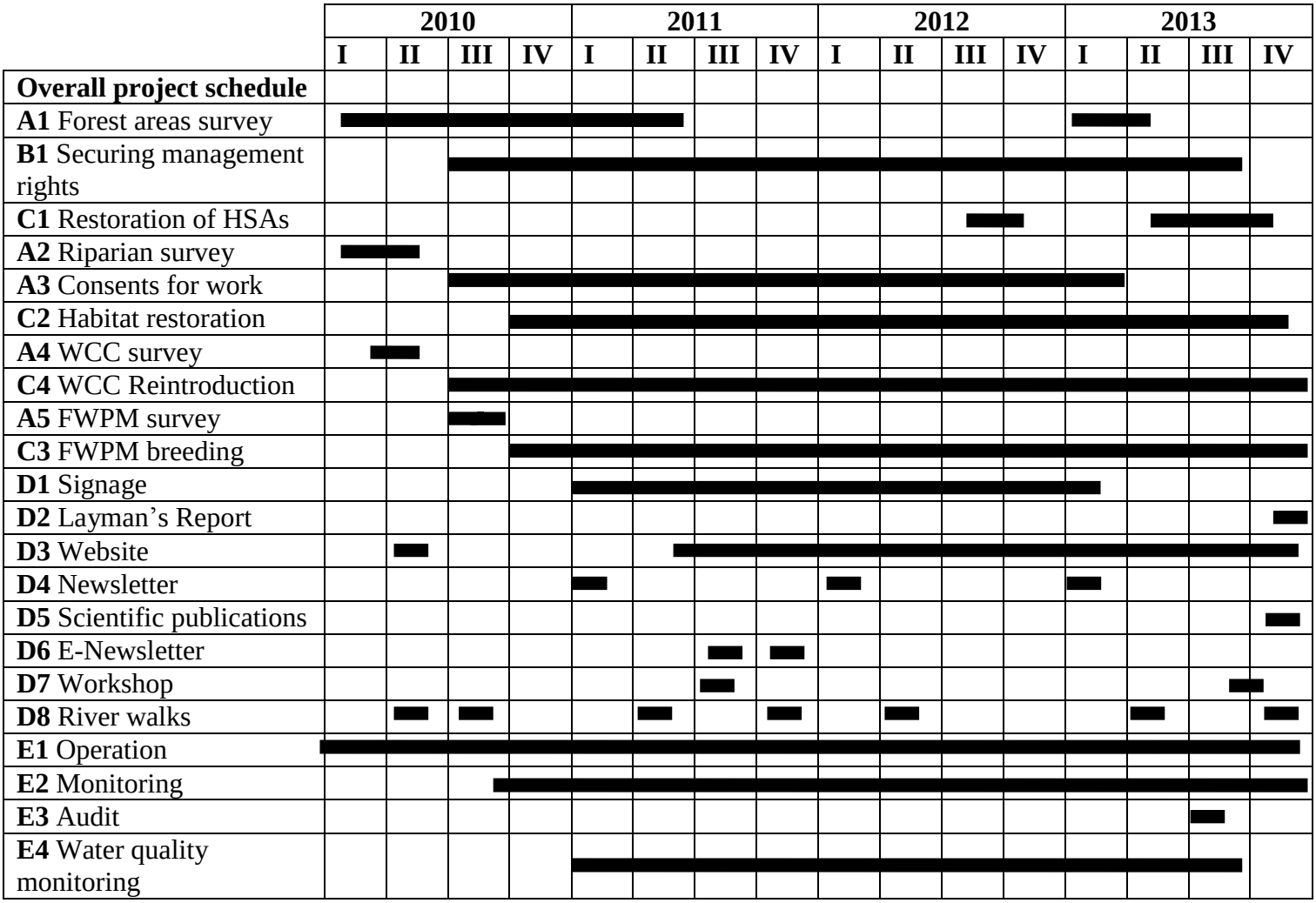
Table 2. Forecast change in SAC features

SAC feature (code)	Foreseen in the revised proposal
Habitats	
Ranunculus sp habitat (3260)	2.7ha increase
wet alder carr woodland protected (91E0)	1.3ha increase
Species	
Atlantic salmon (*Salmo salar*) (1106)	28,000 extra juveniles
Bullhead (*Cotus Gobio*) (1163)	30,000 extra individuals
Sea lamprey (*Petromyzon marinus*) (1095)	100 extra
Brook/river lamprey (*Lampetra planeri)(*1096)	500 additional
Shad (*Alosa fallax*) (1103)	400 additional
Otter *(lutra lutra)* (1355)	4 additional
White clawed crayfish *(Austropotamobius pallipes (1092*	4,000 breeding adults by 2018
Freshwater pearl mussel *Margaritifera margaritifera* (1029)	1,000 breeding adults by 2035 (1092)

4. Administration

4.1 Description of the management system

The project actions progressed in a sequential way at different rates. The A2-A3-C2 and A4-C4 were the smoothest, whilst A1-B1-C1 was the most challenging. Overall progress is best summarised in the following chart:



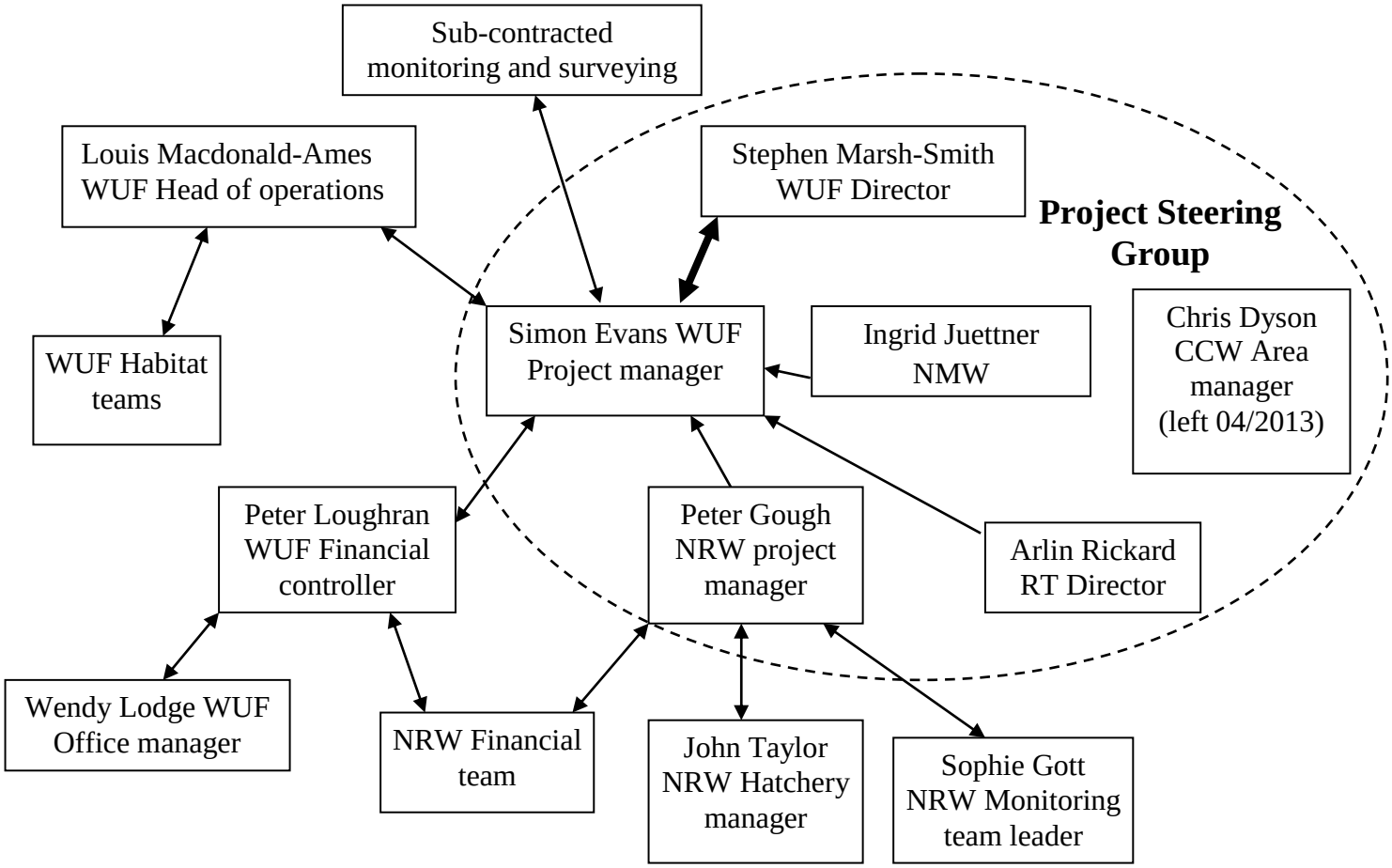
The project was led by the Wye and Usk Foundation who were the co-ordinating beneficiary. At the start of the project the associated beneficiaries were The Association of Rivers Trusts (who renamed themselves The Rivers Trust during the course of the project) and Environment Agency Wales. Co-financing was provided by Countryside Council for Wales, who after providing all the co-financing merged with EAW to form Natural Resources Wales.

Each beneficiary had responsibility for a specific number of actions and outputs that were delivered to an agreed timescale, budget and standard which was set out in the partnership agreements. Regular project meetings were held in addition to informal contact typical of long standing partnerships that are covering multiple projects and initiatives.

Additional liaison occurred between the financial staff of each organisation.

Meetings were held regularly between WUF and other beneficiaries and are listed in annex 7.1 with relevant sections of the minutes. The project was discussed within each WUF steering group meeting. The constituents are listed here: www.wyeuskfoundation.org/whoswho.php.
The National Museum of Wales was added to the project as an associated beneficiary in December 2010 and joined steering group meetings from that point.

The project management structure for the majority of the project and project staff's respective positions at the end of the project is shown below. In 2013 due to formation of National Resources Wales, and with all actions agreed and progressing smoothly for each beneficiary, it was agreed that Chris Dyson should step down from the management group.



The project submitted the following reports to the Commission
- Inception Report in June 2010
- Progress Report in April 2011
- Interim report in December 2011
- Mid-term report April 2012
- Interim report in March 2013
- Final report in July 2014

This is broadly in line with the original timescale. The mid-term report was delayed due to reduced expenditure due to changes in the actions B1 and C1 and the fall in the value of the € against the £. The project was extended by 3 months primarily to ensure effective dissemination of its findings and outcomes.

The Association of Rivers Trusts changed their name to the Rivers Trust in June 2011.

Description of changes due to amendments to the Grant Agreement.

The project submitted 2 modification requests which were granted by the commission. The 1st in 2010 was informally agreed during the project revision stage and officially approved in December 2010. This request added the National Museum of Wales to deliver action E4.

A 2nd was submitted in June 2013 which extended the project to 31st Dec 2013, adjusted the budgets and clarified the formation of Natural Resource Wales from the merger of the project beneficiary Environment Agency (Wales) and the project co-financier Countryside Council for Wales and also the name change of the Association of Rivers Trusts to The Rivers Trust.

Partnership agreements were agreed in due time and submitted to the EC at the following points:
Inception report (submitted July 2010)
- Environment Agency (Wales)
- Association of Rivers Trusts

Modification request (submitted September 2010)
- National Museum of Wales

4.2 Evaluation of the management system

Project management process

Within this project WUF and to a lesser extent RT (both NGOs) worked closely with CCW, EAW who are statutory bodies and NMW (a research body). This has been a constructive process. Staff in each organisation have developed excellent working relationships at appropriate levels. Greater understanding of each partner's activities and objectives has been achieved during the partnership.

During the course of the project, the partnership agreements drawn up at the start served as useful reference documents for both parties.

Suppliers for the project were selected according to WUF existing procurement procedure which is included in Annex 7.1.

Training of staff was undertaken to comply with the requirements of each beneficiary's health and safety policy. Further training took place in the handling of whiteclawed crayfish which was required in order to gain the license to collect the broodstock for action C3.

Communication with the Commission and Monitoring team.

The monitoring team has been exceptionally helpful: response to queries has been prompt and informative whilst the visits have helped steer delivery and clearly communicated the Commission's objectives.

The response of the commission has often been delayed and change in personnel has limited communication. The project's default has been to communicate with John Houston of Astrale.

5. Technical Section

5.1.1 A1 Forest Survey

Possible locations of hydrological source areas (HSAs) were identified using Google Earth in March 2010. After gaining consent to access the forest, this was followed by a ground truthing exercise during which the surface drainage network was mapped. Finally, the species and age of tree cover for each coupe and the planned felling date was recorded. This was used to target the restoration works. All results have been entered onto GIS.

The survey was hampered by the poor performance of GPS systems under forest canopies and the problems of movement within areas of ten to twenty year old forest.

The area is characterised by a single, heavily drained afforested blanket bog, as shown in Fig 1. This made accurate delineation of afforested sources almost impossible.

Fig 1. Afforested blanket bog in the Twyi Forest

When the coupe containing five of the six HSAs of the Ffos Tawr was felled in the first quarter of 2011, it was apparent that all the HSAs could have been accurately mapped in only a few hours, post felling. This coincided with negotiations with the private and public forestry interests moving to an approach of clear forest / restore natural hydrology / limited replant of areas suitable for forestry. This allowed the survey to be reduced to simply identifying source rich coupes and move the discussions on to changing the felling programme to enable the required number of HSAs to be recovered.

The survey ceased in January 2013 and the results are shown in annex 7.2.A1

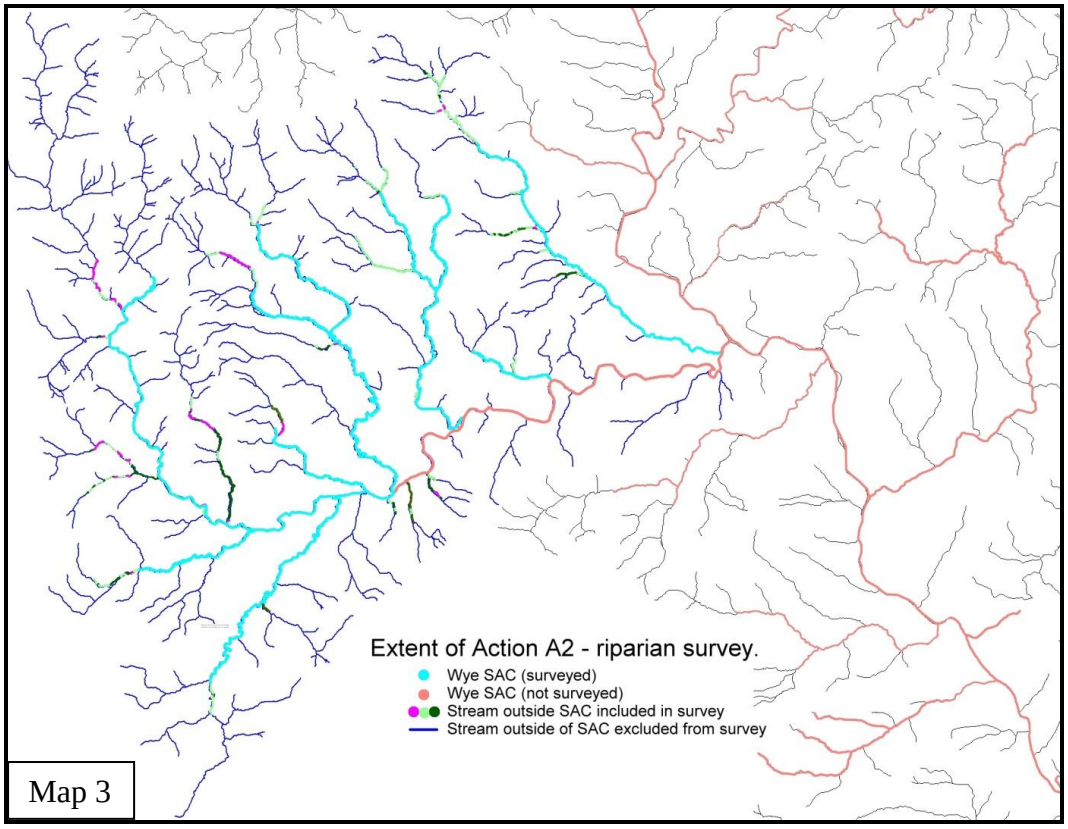
The action was completed in full at a cost of €4,010.

This action was delivered outside the SAC.

5.1.2 A2 Riparian Survey

A walk over survey was completed in June 2010 and results uploaded onto GIS. The parameters of the survey are included in annex 7.2 A2. From this the overall work plan was developed, which has formed the basis for consenting of the habitat works and the identification of the re-introduction sites for the crayfish.

126.3km of river was surveyed for the presence of livestock access, shading, coarse woody debris, pollution, erosion, fine sediment and SAC features.



Map 3

The survey encompassed streams upstream of the SAC, and important tributaries to both the known range of Atlantic salmon and white clawed crayfish within the catchment, and to record areas upstream that might be impacting on the SAC, especially upstream of possible crayfish introduction sites. The extent of the survey is shown in Annex 7.2.A2.

In September 2010 a habitat restoration work plan was created which has prioritised stretches based on the degree of damage, impacts on other downstream sections and their importance for the target species and habitats the project is working to restore. This plan was constantly under revision as the project developed. (Annex 7.2 A2)

In 2011 a refining survey was undertaken. This re-categorised shading and included the sections of the upper Irfon recently recovered in action C1.

The action was completed on time at a cost of €5,886

The maps showing the results for shading, existing fencing and bankside erosion points are included in annex 7.2.A2.

93% of this action took place within the SAC and 7% outside. This was necessary to encompass the likely range of Annex II features.

5.1.3 A3 Consents for work

The following consents have been obtained during the course of the project:

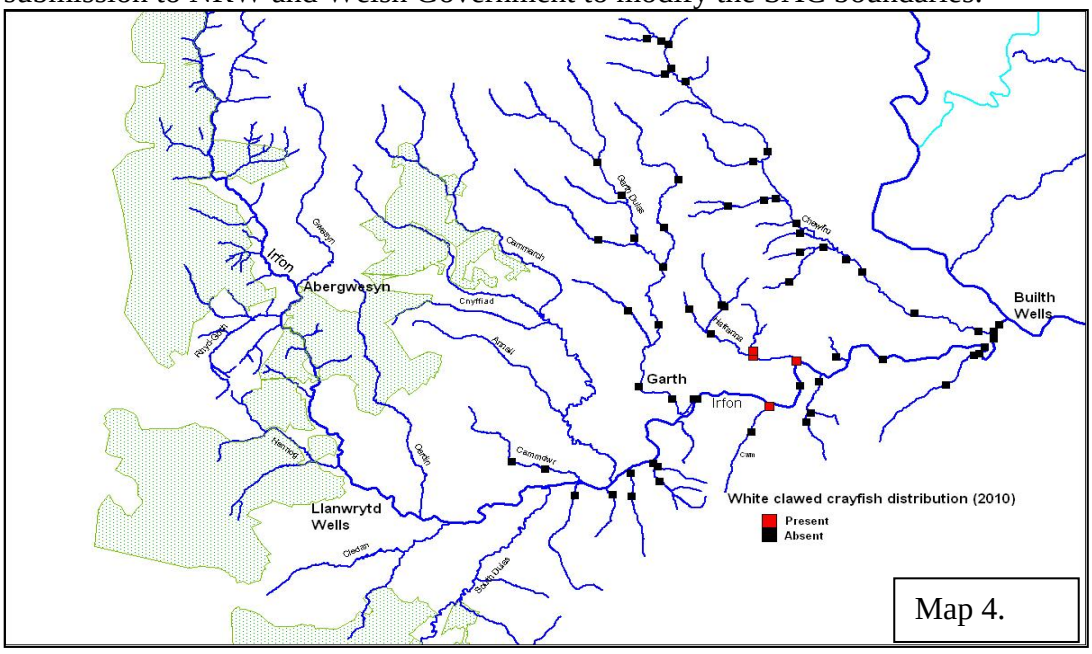
Consent	Month obtained	Purpose/notes
Forest Design Plan	July 2010	To speed up felling licence applications
Owners consent	48 consented 6 refusals	For habitat works to proceed. The refusals have not affected plans for catchment.
Felling licence	9 received	To fell > $5m^3$ of timber per quarter. Not required at every site.
Section 28	48 received	To work in an SAC. Issued to the landowner.
Section 15	1 received	For grant payment to the landowner to manage the SAC.
Permission to access forest areas	April 2010	To survey the forests and conduct monitoring.
Discharge Consent	June 2011	To introduce $CaCO^3$ to the river. Existing consent expanded to include Ffos Tawr.
Licence to remove FWPM	June 2010	Required for actions A4 and C3.
Licence to handle crayfish	May 2011	Required for action C4.
Land drainage consent	1 refused	For in-stream structures.

All consents to complete C1, C2, C3 and C4 fully were obtained.

The actions was completed on time in full at a cost of €33,310

5.1.4 A4 White clawed crayfish (WCC) survey

60 sites across the Lower and Middle Irfon catchment that encompassed the historic range of White clawed crayfish were sampled in May 2010. The absence of crayfish was confirmed within their former strongholds of the Lower Irfon and Chwefru. The population in the Hafrenna/Tryesgur remains strong and a previously unknown population was found in the Cwm. Both the Cwm and the Tryesgur are outside the SAC and this forms part of the submission to NRW and Welsh Government to modify the SAC boundaries.



Map 4.

The action was completed in June 2010 with a cost of €5,020.

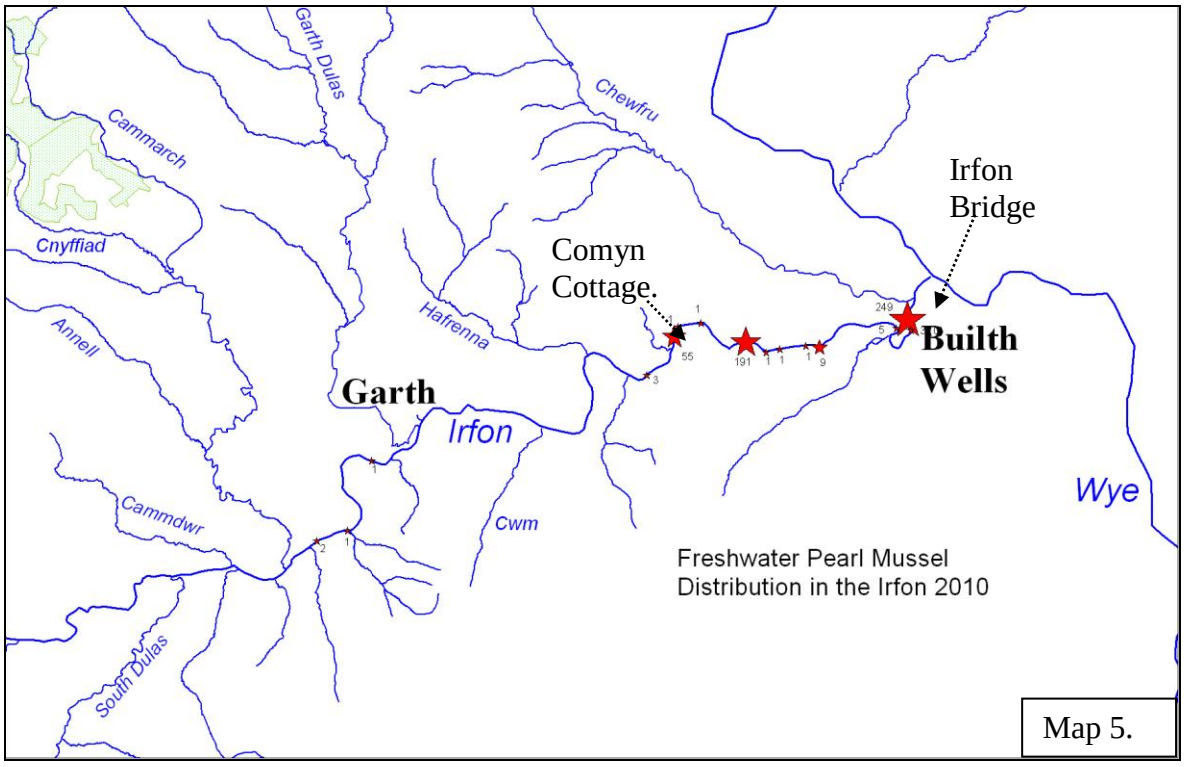
During the 2011 electro-fishing survey (E2) white clawed crayfish were confirmed at a further upstream site on the Hafrenna, from which they were absent in the 2010 survey.

To encompass the full habitat range of this species and to potentially identify donor populations to restock the SAC 65% of this action took place in streams that were not including in the SAC.

The full survey is included in annex 7.2.A4.

5.1.5 A5 Freshwater pearl mussel survey

The presence of freshwater pearl mussel was suspected in the Irfon but had not been confirmed at the start of the project. The survey, conducted according to Natura 2000 guidelines, was completed in Spring 2010 found 525 adult mussels in the lower 16km of the river. This confirmed that the Irfon has the 3rd largest population in Wales for the species. The survey was extended into the Garth Dulas, given its suitable habitat, but no more mussels were found.



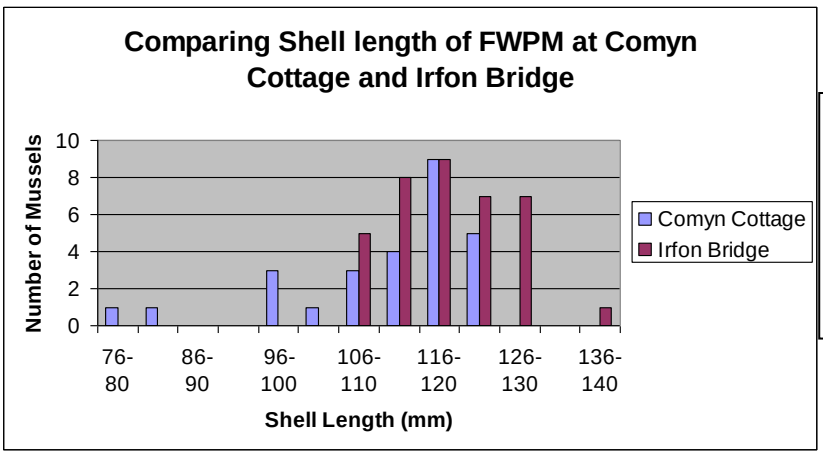


Fig. 2. Shell length measured at two of the mussel beds found in the survey.
The location of the 2 sites, Comyn cottage and Irfon Bridge, is shown in Map 5.

The smallest mussels were around 70mm (approximately 30 years old) and gravel searches in the area around the youngest population found no juvenile mussels. This confirmed that the population is super-annuated, the most recent recruitment having taken place from the more upstream beds**.**

Mussels removed from the bed at Irfon Bridge and taken to Abercynrig hatchery, spatted (released milt and eggs to water column) strongly. To attempt to confirm if natural encystment was still occurring, trout and salmon parr were caught by electro-fishing in October 2010 from the section of the river with the strongest mussel populations. Juvenile salmonids were not present in large numbers at the sites chosen and only 3 salmon fry, 5 salmon parr, 5 trout fry and 1 adult trout were caught. Dissection found no glochidea encystment or scarring from previous encystment in any of the fish.

There is a strong case for inclusion of FWPM in the SAC listing and this will form part of the submission to NRW and Welsh Government to modify the SAC (see section 5.4.1).

This action was completed on schedule in October 2010 at a cost of €4,266.

5.1.6 B1 Procurement of management rights within the forestry areas

The sections of the Tywi and Irfon forests from which the acidity that afflicts the SAC arise are divided into two distinct types of management. The Irfon forest and the northern third of the Tywi forest form part of the Welsh Estate, which is managed by Natural Resources Wales. The lower two thirds of the Tywi forest, known as Nant yr Hwch, are privately owned and managed by UPM Tilhill and Andrew Bronwin. A smaller eastern section of forest that includes parts of the Fedw and Rhiw catchments is under separate ownership and managed by Scottish Woodlands.

For the publically owned forest the following timeline was developed.

Jan 2010	Discussions started with Forestry Commission Wales during which they made us aware of the constraints the project needed to operate within. Discussions then paused until completion of the forest survey.
Oct 2010	Discussion restarted and preliminary results of the survey supplied.
Jan 2011	Agreement reached in principle for the works.
Mar 2011	Agreement of type of works reached.
May 2011	Agreement of scope of works reached.
May-Jul 2011	MOA between FC and ISAC drawn up.
Aug 2011	MOA agreed and FC issued tenders for the work.
Sept 2011	Trees removed from Tawr 5.
Aug 2012	First attempt at drain blocking
Aug 2012	Modification of forwarder
Sept - Oct 2012	Blocking of Tawr 1,2,3,4 and 5 and Twlc 4
Jun – Sept 2013	Blocking of Twlc 2,3,5 and 6

We received a commitment from FCW in Jan 2013 that ensured that all drains will be blocked in the areas identified as HSA's as the forest is rotationally cleared and that they will be left as open areas. In September 2013 we gained an additional commitment that all the drains in open areas not blocked in this project will be blocked in 2014.

Following restoration of natural hydrology, only ground that is dry enough to grow trees without drainage will be replanted. Within the duration of the project this led to the recovery of function of 10 HSAs covering around 23ha at a cost of £18,000. A further commitment was secured in Jan 2013 for an additional 81.3ha to be taken out of forestry and have its natural drainage restored by 2017 as the forest is rotationally cleared.

A signed copy of the MOA between the project and FCW is included in Annex 7.2.B1

In the privately owned area, due to the problems identifying the areas of interest within the large expanse of afforested blanket bog described in A1, discussions have moved more slowly. The eastern section of the forest under the management of Scottish Woodland and Andrew Bronwin does not include any significant sources so we have not progressed beyond an initial contact.

The following timeline has developed for the privately owned areas managed by UPM Tilhill.

Jul 2010	Contact established with UPM Tilhill and project explained
Nov 2010	Inconclusive results of survey were passed on. Further information requirements determined (including mapping of drainage).
Aug 2011	Approach that had been developed with FCW was taken to UPM and accepted. Within the private forest only 2 of the priority sources are being cleared within the life of the project. This means additional clearance and loss of production costs will have to be met by the project.
Nov 2011	Agreement with UPM Tilhill for them to act a honest brokers
June 2012	Trees removed from source of Nant Hir
July 2013	Unacceptable offer received from UPM Tilhill
July 2013	Andrew Bronwin engaged as a third party to ensure best value in securing management rights.
Aug 2013	Offer made to UPM Tillhill by WUF.
Sept 2013	Revised offer made to owner of forest.
Sept 2013	Negotiations called off by WUF as government policy appeared to be changing in our favour and the work could not be completed before the end of the project.

The project was conceived at a time when forestry interests were extremely reluctant to accept that there was any negative impact of their operations on the aquatic environment. This would have necessitated taking forests out of their control to enable C1 to proceed and recover the SAC. During the duration of the project there was a dawning within forestry interests and from the Welsh Government from a position of intransigence/denial to an increasing acceptance of their impacts on rivers and a willingness to find a solution. We believe this movement has been accelerated by the pressure of this project as a readymade solution and by the compilation and presentation of the increasing weight of evidence of the impacts (Action E4) and the likely benefits of restoring upland hydrology.

An additional incentive was the classification of the upper Irfon waterbody as failing good ecological status under the Water Framework Directive for pH in 2009. Also, the emergence of Natural resources Wales from the three legacy bodies FCW, CCW and EAW.This caused the staff in FCW to accept the impacts they are having on the SAC and elsewhere.

2013 heralded the publication of the green paper of the Welsh Government's Environment Bill which it intended to become law in 2016. A central tenet of the paper was the inclusion of the consideration of the ecosystem approach and the value of ecosystem services. During the bill's consultation phase, the removal of all trees from blanket bog was cited as an example of this. At this stage the project withdrew from negotiations with the owner of the private forest.

The revisions to this action had a number of benefits to the project and the SAC:

- We have been able to realise the hope for benefits to the Irfon SAC without incurring the costs or liabilities associated with ownership.
- It will ensure appropriate management for the foreseeable future and will take us to the point when on-going natural recovery from acidity is expected to have reached the point that water flows from forested areas will be in the pH range capable of supporting the SAC species.

We did not lease or buy any forest areas so spend for this action was only €11,669 compared to the original budget of €142,350 but outcomes remain within the parameters of the grant agreement.

The action was delayed and modified but delivered its output of 10 HSAs to allow Action C1 to complete.

This action took place entirely outside the SAC.

5.1.7 C1

a) Restoration of 10 hydrological sources within the Irfon catchment

In April 2010 Dr Stephen Marsh-Smith and Simon Evans visited the blanket bog restoration LIFE + project in North Wales (LIFE06 NAT/UK/000134). This project had determined the most effective techniques for the restoration of hydrological function of drained peat lands. In May 2011 they published some very encouraging results which indicate what we could expect from this project's actions in terms of normalised flows and reduced sediment budgets.

We adapted their methodology for a forestry situation and this is included in Annex 7.2.C1.

After gaining consent and planning the work (B1) work progressed as follows:

In the first half of 2011, mature coniferous trees were harvested from the sources Tawr 1,2,3 and 4 as part of the overall forest plan. In September 2011 the project funded premature tree removal from Twlc 4 and Tawr 5.

Figure 3. The modified grab on the forwarder

Drain blocking was due to commence in April 2012 but was hampered by an exceptionally wet Spring/Summer. Following a failed attempt to use a swing shovel in August, plans to convert the grab of a forwarder (a forestry vehicle designed to extract timber from the forest 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 into and around the bogs. On 18th September 2012 work started using this innovation.

Figure 4. Blocking drains at the source of the Ffos Twlc

Progress is summarised in the table below.

Year	Source blocked	Area (ha)	Drains blocked (m)
2012	Tawr 1	3.9	940
2012	Tawr 2	1.8	952
2012	Tawr 3	1.9	443
2012	Tawr 5	0.7	538
2012	Twlc 4	2.0	887
2013	Twlc 1	4.9	0
2013	Twlc 2	5.7	1,220
2013	Twlc 3	0.4	200
2013	Twlc 5	0.3	234
2013	Twlc 6	1.9	852
Total	**10**	**23.5ha**	**6,266m**

Maps of these sites and photos and video of the work taking place are included in Annex 7.2.C1.

This action has led to changes in how the afforested blanket bog is to be managed in Wales. Please see section 5.4 for further details.

b) Restoring Water Quality

In 1998, (North American Journal of Fisheries Management **18**: 347-360 *Clayton, Dannaway et al*) published a study of the beneficial effect of introducing sand sized lime directly to lower order streams. In September 2006 WUF trialled this as an alternative to the hydrological source liming that we were conducting at the time in the ERDF pHish project with favourable results.

The technique simply involves depositing an annual dose of approximately 1.5 to 3 tonnes of limestone particles into a first or second order stream. The particles become progressively integrated with the substrate and provide real protection from acid events to fish eggs and

invertebrates. Diatom and water quality analysis shows the effects to be enduring for at least two years. Another advantage of sand liming is that important wetlands and peat are not damaged, reducing potential emissions of CO^2 and NH^4. As atmospheric depositions of H^+ reduce, doses can be adjusted accordingly.

The technique was extended to other sites where source liming was not practical, including the Nant Rhiw within the Irfon forest in 2008. Unfortunately the cessation of monitoring at the end of the pHish project, meant that the efficacy on a catchment scale was not monitored. The December 2010 survey conducted under action E4 changed this, confirming the effect on the Nant Rhiw (pH 6.9 with acidophobic *Ephemeridae sp.* present) whilst the adjacent afforested but un-limed Pen Cloddiad remained severely acidified (see fig 5.). This was the start of a close linkage between this action and action E4, the results of which were delivered to the project management team in real time and guided this action.

The result in the Nant Rhiw promoted an expansion in the sand liming network (from 19 to 24) sites and dosage (from 34 to 73 tonnes) in April 2011.

The monitoring in 2011 showed a clear effect of this increase but also indicated that the Nant Hir remained a problem. WUF located an old farm access track within the forest that was blocked with wind-blown trees. Clearing of these fallen trees opened up an additional 4 liming sites in the Nant Hir sub-catchment and these were included within the April 2012 treatment.

In September 2012 the diatom monitoring indicated a reduced efficacy of liming when applied in high water and WUF responded by applying a repeat dosage in October 2012. A decision that saved the gains made earlier in the project.

During the course of the project the top of the Pen Cloddiad was retained as a control site whilst the Nant Rhiw continued to be limed. The impact of the liming is shown below:

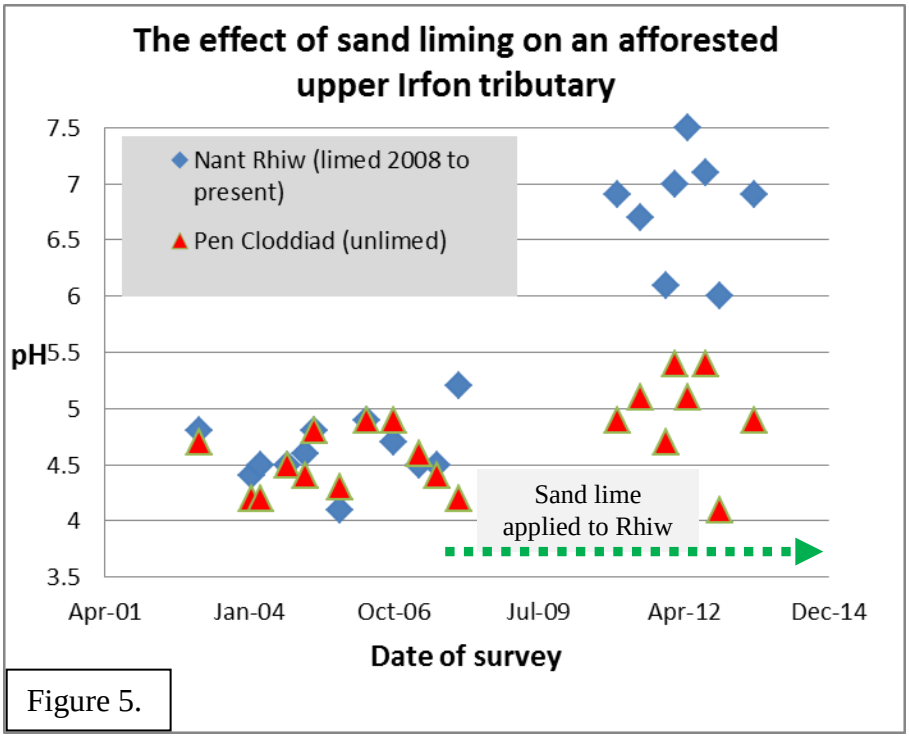


Figure 5.

The end of the C action section shows where the project applied sand lime. It now appears that this is the best option for sites where the hydrological source is afforested.

This action was completed in Sept 2013 for a cost of €39,320.

This action took place entirely outside the SAC.

5.1.8 C2a Tree management

In 2007 WUF conducted a trial on a tributary in an adjacent catchment during which the hazel was pleached into the channel rather being removed during the coppicing process. The intention was to increase the amount of lateral woody debris in the channel, accelerate the recovery process, increase channel structure and provide high flow refugia. In 2010 we studied the electro-fishing data for this stream and its near neighbours. Prior to the work the site had been performing in line with its neighbours, but since the works it has been showing a 473% increase in salmon fry numbers and a 176% increase in salmon parr.

This modification to the technique proposed in the application was approved after the inception report and employed in the project from September 2010. It has extended the tree work to include some of the less heavily shaded areas. This has increased the budgeted cost of this action by €85,750. Results of this year's electro-fishing show a similar or better effect at the sites completed last winter (see section 5.3.1).

Work started in September 2010 with 6,896m of heavy coppicing of the over shaded lower Chwefru and 8,369m of the moderately to heavily shaded sections of the South Dulas. In addition 3,152m of the Garth Dulas, including a section heavily degraded by uncontrolled livestock access, was also targeted although tree work at this site was limited to the pleaching in of woody debris.

Figs.6 and 7 The Lower Chwefru before and after tree management works and prior to stock exclusion

All the sites and their associated before and after photos are show in annex 7.2.C2. The summary of the annual totals is shown in the C2 summary table on page 24.

The project has paid in full for 2 quad bikes and the part cost of a third. We were able to buy three second hand bikes within the project budget. Experience has shown us it is most cost effective to conduct tree works with two teams each staffed by three, but when fencing it is more cost effective to run three teams each staffed with two. The same applies to the purchase of chainsaws.

Having access to a third bike for during the fencing period ensured the project is delivered efficiently, with damage to fields kept to an absolute minimum.

This action was completed in full in Oct 2013 for a cost of €220,853

5.1.9 C2b Stock exclusion

Fencing works started in April 2011 protecting the sites improved in C2a and fencing sites where tree cover was limited but the survey had shown stock access pressures. The first year's fencing and provision of alternative water was completed in late October 2011.

Fig 8. Fencing the middle Chwefru

During the first year of the project we trialled using collars on the posts to reduce risk of them rotting. This was found to be expensive and time consuming and analysis found that using highway class 4 posts which are guaranteed for 15 years was preferable. Techniques used were adapted to flood risk at each site. The standard 'stock fencing' (pig netting with 2 strands of wire) was replaced with 7 strand high tensile in sites prone to inundation. Posts were replaced with strainers in sites where flood flows were likely to be contrary to the fence line.

All the sites with associated before and after photos are show in annex 7.2.C2. The summary of the annual totals is shown in the table summarising C2.

The action was completed on schedule by WUF in November 2013 at a cost of €338,891

5.1.10 C2c Instream works

The part of this action concerned with the construction of high flow refugia is now being delivered within C2a.

The survey found the expected natural geomorphology dominated across the project area and this action was limited to the stabilisation of river banks required to secure functional fence lines.

South Dulas	9 soft revetments
Cammdwr	1 soft revetment of over 600m in length
Garth Dulas	3 soft revetments
Chwefru	3 revetments plus introduction of coarse woody debris at another site
Cammarch	3 soft revetments

In 2012 we extended the riparian survey to include upper middle reaches of the main stem of the Irfon after the acid water amelioration work conducted in C1 had brought them into a condition where by habitat could be the limiting factor. Aerial surveys showed this area to need extensive works, but ground verification found that it was a lightly grazed naturally unstable section and no action was required.

A maps showing the location of all soft revetments are included in Annex 7.2.C2

Fig. 9. Installing a soft revetment at Dolderwen on the Lower Garth Dulas

Figs 10 and 11 Garth Dulas at Dolderwen before and after bank protection with timber (and increasing cover) and fencing.

The action has developed and refined the methodology of pinning hardwood shrubs such as hawthorn (*C. monogyna*) into the bank. The methodology is included in annex 7.2.C2c.

This action was completed in August 2013 at a cost of €9,763

C2 summary.

Summary of actions C2a, b and c

Action	C2a	C2b	C2c	C2	
	Tree work	New fencing	In channel works	Total restored	
Stream	Single bank length			Double bank improved	Year completed
Chwefru	6,896m	4,152m	1	4,808m	2011
South Dulas	8,369m	7,668m	9	6,426m	2011
Garth Dulas	3,152m	1,772m	3	1,576m	2011
Garth Dulas	8,600m	5,650m		5,897m	2012
Cledan	2,135m	1,470m	1	1,067m	2012
Chwefru	8,910m	4,309m		5,193m	2013
Cammarch	4,598m	1,255m		5,256m	2013
Cnyfiad	3,381m	1,090m		1,791m	2013
Camddwr	1,026m	811m		513m	2013
Achieved total	**47,067m**	**28,177m**	**14**	**32,527m**	
Project target				30,000m	

5.1.11 C3. Development of assisted breeding programme for freshwater pear mussel

Introduction
The Freshwater Pearl Mussel (FWPM) (*Magaritifera magaritifera*) is endangered and under serious threat of extinction throughout its European range (Young *et al*., 2001) It is one of two Margaritifera species to appear on the International Union for the Conservation of Nature and Natural Resources red data list (IUCN, 2008). The FWPM is also listed as a priority species in the UK Biodiversity Action Plan and the Environment Agency are lead partners.

The FWPM is unusual in that part of its lifecycle involve parasitizing juvenile salmonids, by encysting on the gills over their first winter.

The decline in numbers is due to several factors relating to human activity including pearl fishing, habitat destruction, sedimentation, eutrophication, river engineering and pollution. Recent surveys have demonstrated that there has been no juvenile recruitment in populations in England and Wales for several decades and that numbers are decreasing at a rate of 50% every 10 years.

Objectives
The specific objectives of this part of the ISAC project were:

1. Establish the baseline population of the FWPM in the River Irfon and estimate its viability and potential for recruitment.
2. Take a proportion of the population into captivity and instigate a captive breeding programme.
3. Establish the most suitable salmonid host and attempt to achieve optimal encystment rates of glochidia (larval development stage of the juvenile mussel that attaches to fish gill tissue).
4. Collect excysted viable juveniles in June and rear in experimental systems
5. Return reared juveniles to the Irfon catchment.

Figure 12. FWPM adults collected from the River Irfon and transferred to breeding tanks at Abercynrig Hatchery

Spatting and encystment
Adult FWPM breed during the early summer (males release sperm which is filtered by the female) and the fertilised egg/larvae develop over the summer until they are mature enough to be release as glochidia, the final larval stage. This usually happens around the end of August.

At Abercynrig the adult mussel tanks are connected to brown trout rearing tanks in July in anticipation of spatting so that the water flowing through the mussel tanks passes into the

trout tanks. At the end of October, when spatting is assumed to have finished, a sample of trout are checked for encystment.

- Successful encystment was achieved in 2010 and 2012, for unknown reasons the FWPM did not spat in 2011.
- Initial levels of encystment can be very high, 2000+ glochidia per fish but there is a substantial drop off over the winter.
- Mean levels of encystment for 2011 and 2013 were 465 and 715 glochidia per fish respectively, measured in June just prior to drop off.

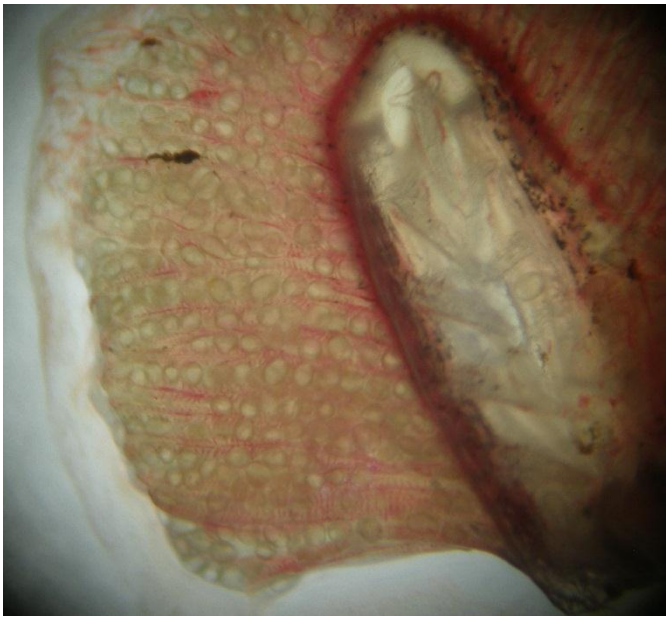


Figure 13. First gill arch of a brown trout at Cynrig Hatchery showing encysted mussels (Glochidia) in the gill filaments in November.

During the final stages of encystment (late May/early June) trout were transferred from a river water supply to a re-circulated, clean water system to prevent contamination when collecting juveniles.

Juvenile collection

Mussel drop off or excystment usually follows a rise in temperature but can be fairly well predicted following mean daily temperatures. Plankton nets are fixed to the tank outlets of the re-circulation system to collect the excysted mussels.

- Experience at Cynrig has shown that between 2,200 and 2,600 (i.e. 22-26 days at 10^0 C) degree days are required for the glochidia to complete maturation and transform into juvenile mussels capable of surviving when they drop off the gills of the trout.
- Juveniles continue to drop over a period of 1 month, peaking mid-way through this period.
- Newly excysted juveniles are between 250-350µm in length (0.25-0.35mm)
- Between 30-60% of newly excysted juveniles appear to be non-viable.

Juvenile Rearing

Juveniles were collected from the plankton nets every day during June/July and counted under a stereo zoom microscope. Juveniles were transferred to experimental rearing systems testing the suitability of water quality, substrate, food type and temperature. Two types of system were used, one of which was a controlled river water system with natural gravel substrate (semi-natural) and a more intensive controlled water quality/temperature, feeding and substrate re-circulated system.

Figure 14. Seminatural rearing trough

Figure 15. Recirculated rearing system

- In 2011 approximately 100,000 juvenile mussels were collected, 30,000 going into the semi-natural trough and 70,000 housed in the experimental aquaria.
- In 2013, despite expectations only, 38,000 mussels were collected with 18,000 transferred to an updated experimental aquaria system and 20,000 suspended in mesh baskets for immediate release back to the Irfon.
- Initial growth in experimental aquaria was good with juveniles preferring a substrate with some organic silt to purely bland gravel or artificial media.
- Survival in experimental aquaria was good to 3 months post drop off (approximately 50%) but in all cases following this there was a rapid mortality with very few juveniles surviving past 6 months.
- Semi-natural rearing systems will be examined for juveniles in 2014/15

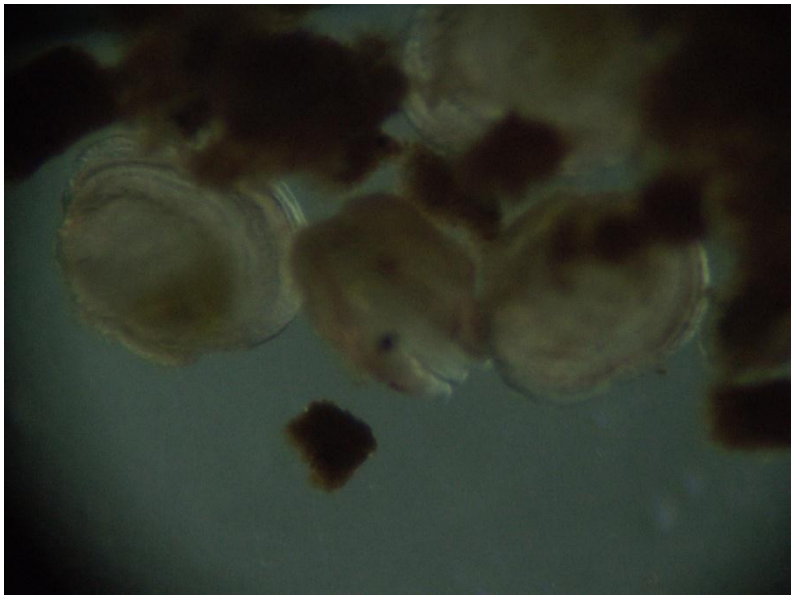


Figure 16. 1 month old juvenile FWPM with visible growth rings

This action is ongoing, supported by NRW. By December 2013 it had cost €12,079

5.1.12 C4 Re-introduction of white clawed crayfish into designated streams

This action was completed by Natural Resources Wales (NRW).

The baseline 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.

Fig. 17. 6*4m Rearing building designed and erected April 2011

Culture System

Over the winter of 2010/2011 a new facility was designed and built at the NRW Cynrig Hatchery. This system was constructed from three 1m diameter and two 1.5m glass reinforced plastic holding tanks, and pump and header tanks both at 250 litres volume. This gave a total volume of 3000 litres (See Fig. 18.). With a culture area of some 6.8m^2 this system has the potential to rear in the region of 1000+ juveniles to Spring 0+. Water was sourced from a borehole supply with <5 % exchanged daily. Water temperature was maintained between 11^{0}C and 13^{0}C through the use of a chiller/heater system. Ultra violet filtration was used to preserve water quality and reduce the prevalence of pathogens within the holding facility.

Another smaller unit was run in tandem (2012/2013) to increase capacity. This consisted two 1m diameter circular glass reinforced plastic holding tanks, and pump and header tanks both at 120 litres volume. This gave a total system volume of 750 litres. Water was sourced from a borehole supply with approximately 10% exchanged every two days.

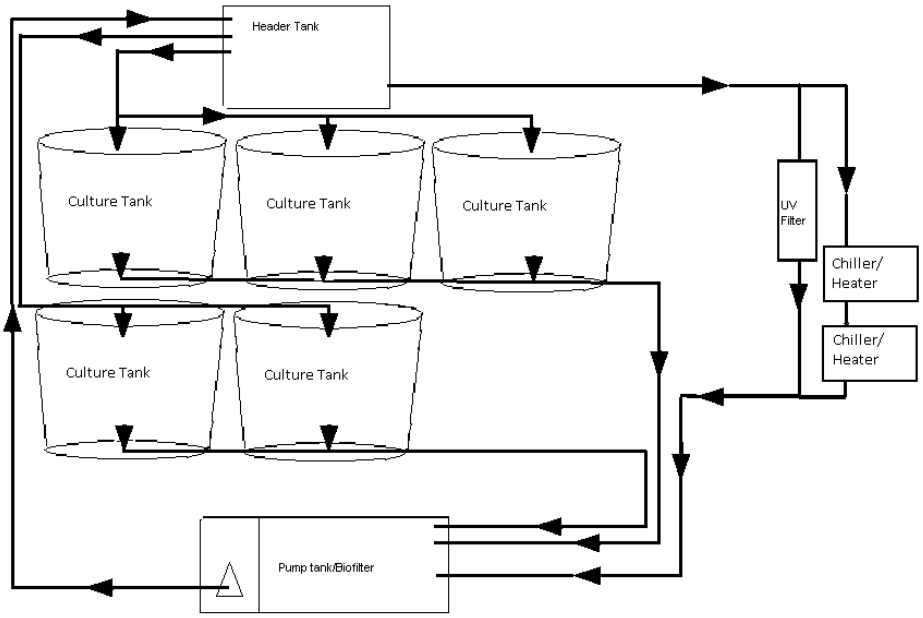


Fig.18. Recirculation system design for maternal incubation

Broodstock

During May and June each year, berried (egg-laden) females were collected from the Rhymney in South Wales and the Escley brook in the Monnow system. Relevant licences were obtained depending on location from Natural England and Countryside Council for Wales (Now Natural Resources Wales). Berried females were taken by hand and transported in small amounts of water in sealed containers with a hessian cloth substrate. Air holes were drilled into the lids of the containers. No more than two females were transported in each container. Temperature was maintained at $<12^0$C through packing with ice in polystyrene boxes.

Fig.19 Berried female white-clawed crayfish

On return to the culture facility temperatures were equalised between transport containers and holding tanks to prevent any thermal shock. Animals were then transferred to chosen tanks. Refuge was provided for the adult females in the form of lengths of two inch and one point five inch plastic pipe. They were fed twice weekly with a mixture of cat food, bloodworm and mixed vegetable matter.

Fig.20. Recirculation system for maternal incubation

During 2011 due to delays in obtaining a licence from Natural England, collection from the Escley took place far later than was hoped. As a result females were found to be carrying stage 1 juveniles rather than eggs. Due to the potential risk of shedding juveniles during transport a decision was taken to only remove two animals. On arrival at the culture unit it was found that only one juvenile had been shed from the two females.

Juvenile Culture

Over the course of the project a number of different types of rearing substrate were trialled to optimise growth and survival. The majority of tanks were given a semi-natural substrate consisting of gravel and Bio-Bunn artificial salmonid hatching substrate. In others the gravel was withheld and the Bio-Bunn offered as the only form of refuge. To ensure any hatching juveniles had sufficient food, live artemia were fed sparingly every two days as of early June.

During early July when independent juveniles were spotted in the tanks, feeding was stepped up to a daily ration of artemia along with frozen cyclops.

Fig.21 Juveniles with Bio-Bunn substrate

Fig.22. Recently hatched stage 1 juvenile

Shortly after the juveniles were spotted, the adult females were removed from the holding system to prevent maternal cannibalisation. The females were subsequently returned to their stream of origin.

As the juveniles grew, the feeding regime changed accordingly with artemia and cyclops phased out and replaced with daphnia and different sizes of bloodworm.

Juvenile Survival

Due to the nature of the holding conditions it proved difficult to estimate numbers of juveniles present or survival rates without physically removing the animals and counting them through progressive life stages. This was decided against to avoid stress and potential physical damage to the animals, especially if handled inadvertently shortly after moulting. It was possible to estimate initial egg numbers using a carapace length/pleopodal egg number regression model after Saez-Royuela et al. 2006 (see Annex 7.2.C4.). The use of log data is recommended to stabilise the variance in fecundity in crustaceans.

During 2011 there were survival issues in tanks 3 and 4 with mortality rates of 16% and 39% respectively. This mortality took place almost immediately after moult between stages 1 and 2 while the exoskeleton was still soft. Signs of haemorrhaging and potential elevated stress during the moulting phase pointed to an internal bacterial infection as is often found in juvenile lobster. Therapeutic treatments were trialled with unsatisfactory results. It was then discovered that on further examination of mortalities under the microscope, there were a number of hydra (*Cnidaria Spp*.) thought to be *Hydra viridis* present. Further investigation indicated that hydra can cause mortality in juvenile shrimp with some evidence to suggest that they can damage larval fish. In hindsight it is probable that the marks thought to be haemorrhaging were in fact where the hydra had discharged the stinging barbs it uses to predate on zooplankton into the soft shell of the developing crayfish. Remaining juvenile crayfish were transferred to an empty tanks with an immediate cessation of mortality.

Stocking

Juveniles were released in the Spring, 11 months after they were taken into captivity as brooded eggs. At this point they had reached a total length of some 25-40mm. They were

again transported in small amounts of water in sealed containers with a hessian cloth substrate. On arrival at the release site temperatures were checked and the transport water altered accordingly to prevent thermal shock on release. The juveniles were released into the Chwefru (a lower Irfon tributary) at sites recently improved by habitat work. This was at the upstream end of their historic range with the intention being to facilitate downstream colonisation.

Date	Number Released	Upstream NGR	Downstream NGR
08/05/2012	533	SN9875953879	SN9915453590
09/05/2013	253	SN9875953879	SN9915453590
10/05/2013	602	SN9981153020	SN9993052718
13/05/2013	30	SN9981153020	SN9993052718
Total	1418		

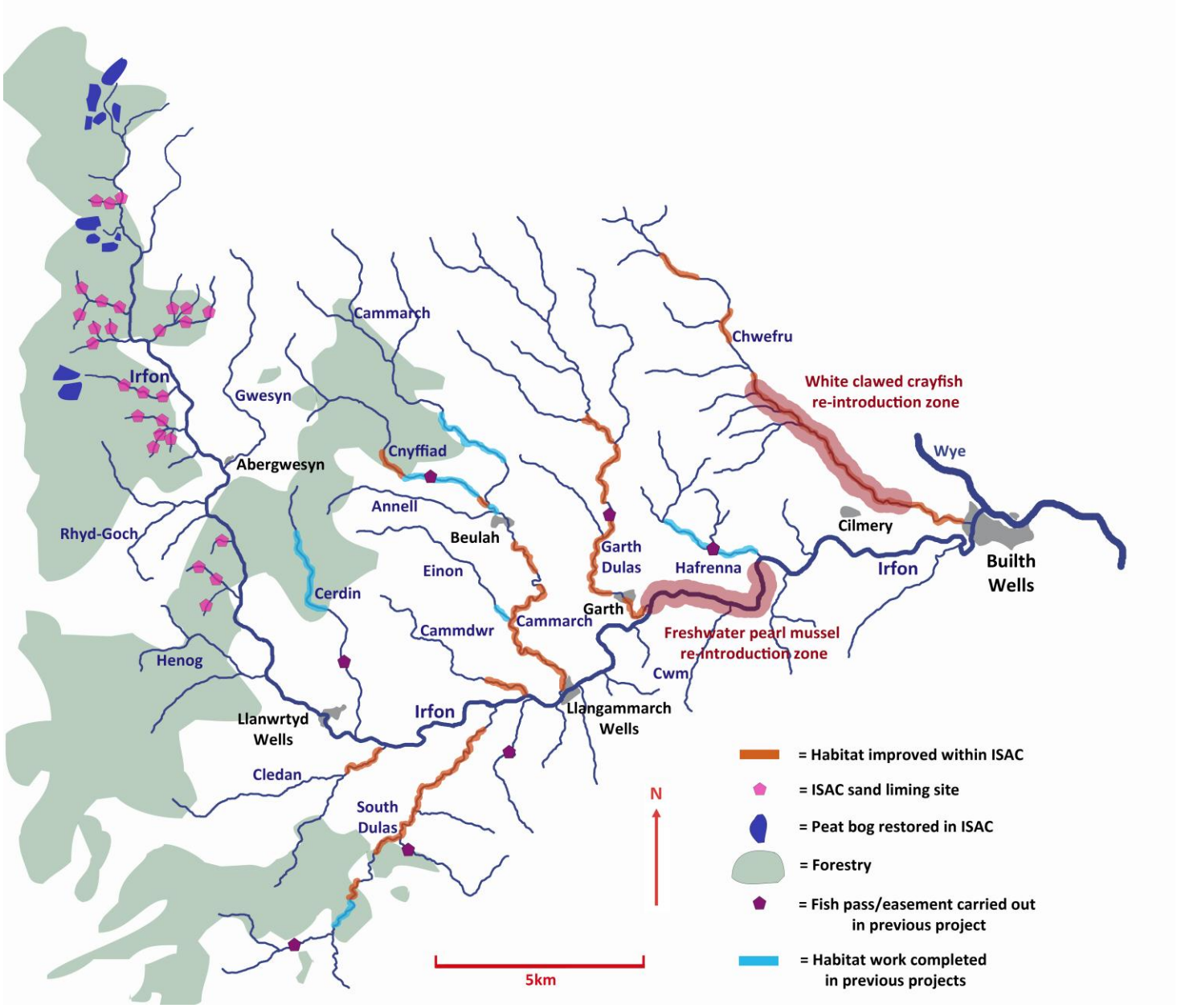
Stocking numbers and site location

Fig.23 Juvenile crayfish ready for release

Based on past survival rates, and the absence of any noticeable mortality, it is thought that there will be in the region of 950 to 1200 juveniles available for release in spring 2014.

A full report on this action is included in Annex 7.2. C4.

NRW have decided to continue to fund this action after the end of the ISAC project. Up until December 2013 it had cost €35,753



Map 6. Summary of C actions in the catchment.

5.1.13 E2 Monitoring

Project monitoring was limited to only SAC features and habitats during the revision process. The loss of the monitoring of the hydrological effects of C1 has hampered the ability to take the forest actions forward both during and, more importantly, after the end of the project.

The project conducted the following monitoring for the features of the SAC based on the monitoring plan approved in the final document.

All monitoring except for the salmonid surveys followed the recommendations of the Conserving Natura 2000 Rivers Monitoring series.

The action was completed in full on time at a cost of €93,056

White Clawed Crayfish
The survey was changed from a trapping survey to a refugia survey 6 months into the project. The initial baseline was established in 2010 and is reported in action A4.

The post-work refugia survey took place in June/July 2013 and the full report is in annex 7.2.E2. It found no expansion or contraction in the range determined in 2010.

The fisheries monitoring conducted in August 2013 however found two 1 year old crayfish in the section of the Chwefru that was stocked from Abercynrig under action C4 in 2012. This is at the upstream limit of the historic range of crayfish in this stream and both confirms that the stocking was successful and offers hope for downstream re-colonisation of this important stream.

Freshwater Pearl Mussel
In the summer of 2010 NRW Cynrig Hatchery staff carried out an extensive survey of the main Irfon and lower tributaries (action A5). The baseline survey found that mussels were located in several discrete pockets mainly in the lower 6km of the River. This is the first confirmation of a FWPM population in the Irfon. In total 525 FWPM were found in the initial survey, no mussels were found above a point 15.5 km upstream from the confluence of the main River Wye.

Only 3.2% of the mussels found were less than 96mm in length indicating that they may be less than 50 years of age, 90% of the mussels found had shell lengths of between106-130mm with an estimated age of between 80-100+ years.

In July 2013 the three main beds (80% of total population) were surveyed. Mussel numbers had declined by 12% at Irfon bridge, 15% at Glan-y-Afon but increased by 60% at the Comyn cottage site. This increase was due to a further population being found in what had previously be thought to be unsuitable habitat (small patch of gravel within a bedrock section).

Please see annex 7.2 E2

***Ranunculus* sp. habitat**

A rapid assessment survey was conducted in May/June 2010 after the initial walk over survey. Sites where *Ranunculus* sp. was present were marked with GPS and area of coverage of the habitat type was recorded. This was uploaded to a GIS layer which was used as baseline for the 2013 survey.

This survey was repeated in July 2013.

The results of both surveys are included in annex 7.2.E2

Fisheries monitoring: (Atlantic salmon (*Salmo salar*), River/Brook Lamprey (*Lampetra planeri*), Sea Lamprey (*Petromyzon marinus*), Bullhead (*Cotus gobio*)

This work was carried out by Natural Resources Wales (NRW).

In order to assess the impacts of the habitat restoration and the liming work, a survey programme was established to monitor the populations of salmon, bullhead and lamprey (brook, river and sea). The programme comprised four years of fish monitoring, with 74 salmon and bullhead surveys carried out annually and 30 lamprey surveys carried out in years 1 and 4. The sites were selected, some from existing NRW survey sites, some new, to give complete coverage of the whole of the Irfon catchment, not just to the boundaries of the SAC. The main focus of the monitoring was:

- The main Irfon and tributaries upstream of Llanwrtyd Wells, to monitor the response to the liming.
- The main tributaries downstream of Llanwrtyd Wells, to monitor the response to habitat work.
- To look at the distribution of SAC features across the whole catchment – including streams never fished before.

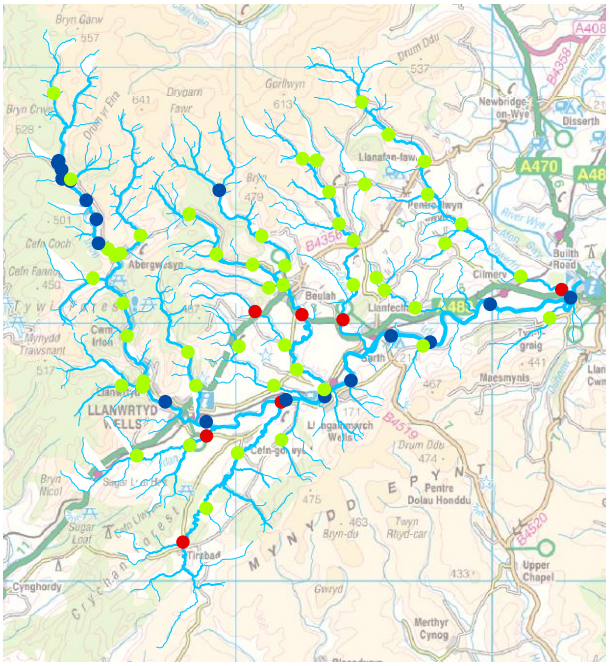


Figure 25 - Salmon and bullhead survey sites in the Irfon catchment. Surveyed annually 2010 to 2013. Red denotes a fully quantitative survey (Q); Green, a semi-quantitative survey (SQ); and Blue, a 5-minute riffle Minimum Estimate survey (ME).

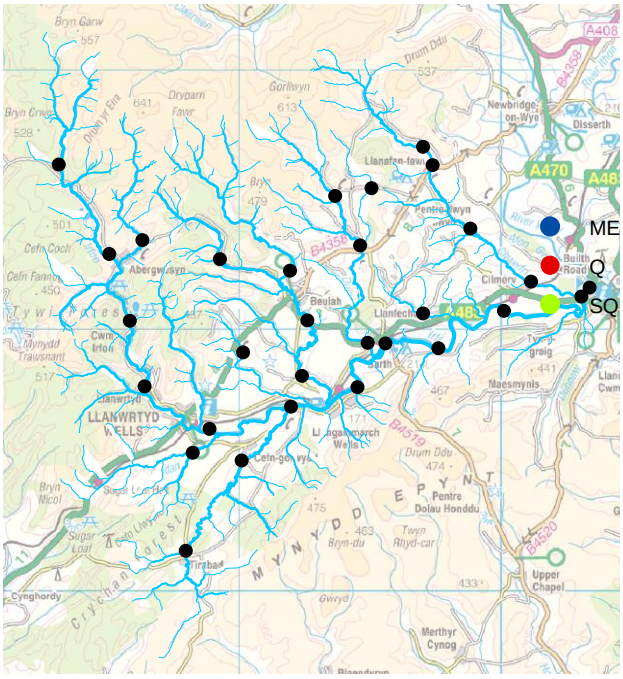


Figure 26 - Lamprey survey sites on the Irfon, surveyed in 2010 and 2013.

The sites were all fished using Environment Agency standards (salmon, bullhead) or JNCC electric fishing in rivers standards (lamprey). The Environment Agency standards were used for salmon and bullhead to ensure consistency with previous surveys.

The salmon and bullhead surveys comprised a mixture of 5-minute minimum estimate riffle surveys (ME), and semi and fully quantitative surveys (SQ and Q). Quantitative catch depletion surveys were carried out at the seven sites in the Irfon which were already part of the NRW temporal (annual) quantitative survey programme, thus ensuring a consistent methodology and fish population estimates comparable with their previous survey data. Semi-quantitative (single run) surveys were carried out at most of the remaining sites, ensuring good spatial coverage, and comparability across the catchment. The minimum estimate riffle surveys were used on the main Irfon where it was too wide to undertake a Q or SQ survey, or in the upland reaches where only a presence or absence of species was needed. No population estimates are available from an ME survey.

All the surveys were carried out each year as planned, but it is worth noting that higher flows due to the very wet summer in 2012 may have negatively impacted the results of that year: stunned fish are more difficult to catch in faster more coloured flows and the river is wider reducing the density of fish. This highlights the importance of having collected a good set of baseline data in 2010 with which to compare each, thus mitigating against year on year variability in survey conditions.

The lamprey surveys, where suitable habitat was appropriate (silt and organic matter), were surveyed using a quadrat and a timed catch depletion method. This gave a fully quantitative estimate of the lamprey populations present in that quadrat. Multiple surveys were undertaken at each site, across a range of substrates, to give a good indication of populations present. Where silt was limited, relative assessments were used, which involved electric fishing any small amounts of suitable habitat and recording the number of lamprey per m^2. This gave a rough estimate for density, and information on presence or absence of the different lamprey species.

Future monitoring should help to pick up any long term trends. Importantly, this project has given us valuable data on bullhead and lamprey populations in the catchment, which can be used in the next round of Condition Assessments, and information on the monitoring techniques with which we have contributed to the JNCC Common Standards Methodology Review.

A number of areas of work outside of the SAC designated part of the catchment have been identified through the project; these include several pipe bridges that potentially impede salmon migration; livestock poaching of banks and excessive siltation. These issues will be addressed over the coming years as part of the NRW WFD measures and the EU Fisheries Funded Sir Maesyfed Salar 2012 project.

Some monitoring of the catchment will continue through the NRW Core Fish Monitoring Programme, though this will not be as extensive as the project monitoring, with just 17 SQ and 7 ME surveys carried out on a 6 year rolling programme (next survey year is 2014) and the 7 Q surveys carried out annually. These will give us data with which to continue monitoring improvements in the catchment.

All fisheries survey data is included in annex 7.2 E2.

Twaite and Allis Shad (*Alosa alosa* and *Alosa fallax*)

In 2010 and 2012 CCW conducted studies of shad spawning in the lower Irfon as per the Natura 2000 guidelines. The Lower Irfon was thought to the upstream limit of shad penetration with the Wye system, but the 2012 survey found shad eggs some 9km further upstream on the main stem of the Wye at Brynderwen.

In 2012 the highest number of shad eggs per sample in the whole of the Wye system were collected from the lower Irfon. Confirming its importance as a spawning site for the species.

Genetic analysis was completed on the shad eggs and found that the Wye population was a mix of twaite (70%), allis (1%) and twaite/allis hybrids (29%). One egg collected at the bottom of the Wye only showed allis markers. This is the first time allis shad have been confirmed in the Wye population.

The reports that detail these surveys are shown in Annex 7.2.E2

Further to this the two major shad holding pools: Black pool and Larder pool just upstream of Builth Wells were observed annually. In 2012 spring flows were too high during the shad migration for observation to be possible.

In 2010 it was estimated that over 600 twaite shad were present in these two pools on the 6th June.
On the 2nd June 2011 it was estimated that around 600 twaite shad were present
On the 30th May 2013 it was estimated that around 800 twaite shad were present.

The EC monitoring visit in June 2011 was shown the shad shoaling in the Black pool prior to spawning.

The shad population appears healthy and stable in the lower Irfon.

Otter (*Lutra lutra*)

The initial walkover riparian survey in 2010 found signs of otter (spraint, holts, couchs, hovers and slides) in every km catchment except for the river Gwesyn and the Irfon upstream of Abergwesyn.

The repeat survey in 2013 also found signs of otter across the whole of the Irfon SAC included the lower Gwesyn and also to have colonised the Irfon above they SAC boundary showing that otter had responded to the improving conditions in the formerly acidified section

The population of otter is healthy and stable within the project area.

5.1.14 E3 Audits

The project was included in the Annual Wye and Usk Foundation Audits of 2011, 2012, 2013 and 2014. In 2014 the project was formally audited by Mazars and the resultant audit certificate is included in Annex 8.

The action was completed in full and on time for a cost of €4,054.

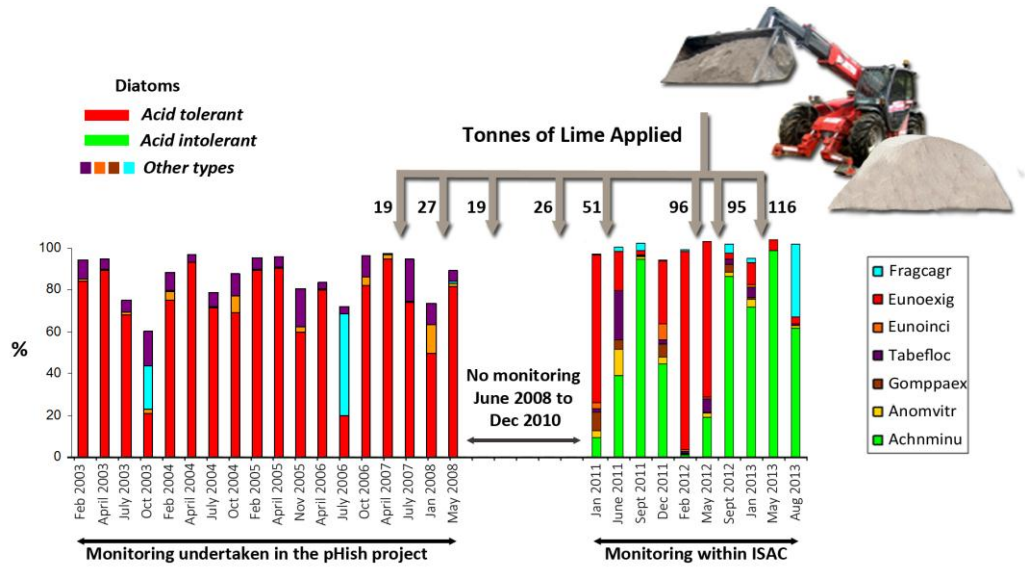
5.1.15 E4 Water quality monitoring

A diatom and water chemistry monitoring network was established in the upper Irfon catchment in order to target and refine Action C1 and assess its benefits within a realistic timescale. This was achieved through fieldwork with ten monitoring surveys of diatoms and water chemistry being conducted between January 2011 and August 2013, and laboratory research to analyse diatom assemblages.

Diatom species composition was analysed to assess effects of liming (interventions under C1) at 9 sites on the main River Irfon and at 13 tributaries. Diatoms were analysed at limed river sites and at some sites without liming to assess variation in species composition without interventions. Water chemistry (pH, conductivity, calcium, aluminium, iron, lead and zinc) was determined at the same sites to assess variability of acidity and ion concentrations with and without, and prior to and after interventions (liming). The field surveys were conducted four times per year in Winter, Spring, Autumn and Summer.

Diatom monitoring has proved to be an effective and reliable method and has informed management and guided interventions (liming of acid waters) in this catchment within the given timeframe. The results confirmed that liming led to chemical recovery by reducing acidity in the main River Irfon and its tributaries, followed by the establishment of salmon populations in previously depopulated sections of the Irfon.

Fig 27. The effect of the sand liming in C1 on the diatom community of the Upper Irfon



The action was completed in full and on time at a cost of €52,700

Further details are included in annex 7.2.E4.

A presentation on the results is available here.
http://www.wyeuskfoundation.org/isac/publicity.php

5.2 Dissemination

5.2.1 Objectives

The project had the following objectives:
- Demonstration of best practice to conserve/restore SAC features.
- Raising awareness of the SAC, its features and the Habitats Directive.
- Raising awareness of the LIFE + fund and the work of the Co-ordinating and associate beneficiaries

In the latter stages of the project the dissemination went wider that anticipated in the project application:

In Aug 2012, the project went to Australia following invitation from New South Wales Government (at no cost to the project). Appearing on Australian national and regional TV and radio, culminating in being the key note presentation at the National fisheries conference in Gold Coast.

On the 6th Aug 2013, the One Show broadcast a feature on the liming in the Irfon to over 5 million viewers.
http://www.bbc.co.uk/programmes/p01drrz7

The January 2014 edition of Trout and Salmon, Britain's biggest fishing magazine carried an article titled "Fishless no longer". A copy can be downloaded from here:
http://www.wyeuskfoundation.org/isac/publications.php

5.2.2 D1 Erection of Project Signage

Three large project signs (1.2m x 0.6m) were designed by WUF to be erected at separate sites. These bilingual signs gave information on the project's area, its objectives, the species it would benefit and the project's partners, along with their logos. The first sign was put up at WUF's Head Office in July 2011, initially at Llanstephan and subsequently at Talgarth where it will remain unless further office moves occur. The second site was at Pwll Bo picnic site in the Irfon forest. Discussions with the then Forestry Commission started in November 2011 with installation by FC in May 2012. This sign is in

Fig. 28 The project sign erected by NRW at the Pwll Bo picnic site on the Upper Irfon

a prominent position in the Pwll Bo site car park set into a wooden lecturn/frame. The final sign was erected at the Abercynrig Hatchery in 2011.

WUF made 2 approaches to the council at Builth Wells with the aim of erecting a 4th sign at the junction of the Irfon and the Wye, but these came to nothing.

Smaller project signs were installed by WUF staff at all sites of riparian habitat restoration. These signs included the LIFE + logo and those of the project partners. All equipment purchased by the project had LIFE + stickers and the Wye and Usk Foundation's vehicle logo was adapted to include the Natura 2000 and Life+ logos.

All project signage used is shown in Annex 7.3 D1

This action cost €3,754

5.2.3 D2 Website update

A specific website for the project was designed, created and embedded into the Wye & Usk Foundation site in the 'Projects' section. The ISAC project site had a unique design (other projects have a one-page summary based on the standard WUF webpage) and 'went live' in 2011.

It is available here: http://www.wyeuskfoundation.org/isac/

Literary and graphic content for the site was provided by WUF with our normal website hosts (Lawyers Online, based in Hereford) providing the technical and design expertise.

The site includes full details on the rationale behind the project, the objectives, area maps and descriptions, links to other LIFE + Projects, work completed and the results. It also gives all the related publications and video links. The 25 pages were continuously updated during the duration of the project and the site advertised on the WUF site's front page as our 'flagship project.' It was also referred to as such in every E-newsletter sent out by the WUF (average 1 per week).

5.2.4 D3 Layman's Report

The Layman's Report ("ISAC: End of Project Report") was published in Dec 2013 and circulated to 15,000 individuals on WUF's database. Recipients included anglers, river and land owners and many others with an interest in rivers. A further 2,000 copies have been distributed subsequently to interested parties.

Work started on the Layman's Report in the autumn of 2013. Literary and photographic content was provided in-house, as was the graphic design of the report. Following a standard procurement process, the printing and distribution work was awarded to Diamond

Publications, who we have used for over ten years. A downloadable PDF version of the report is available on the WUF and ISAC websites.

The 2nd modulation which extended the project by 3 months allowed for the results of the final monitoring to be included in the report.

The Layman's Report was well-received. Comments and feedback included....

"Thank you for the report on the ISAC project. It does indicate both the damage done to our uplands and the ability (with a lot of well planned hard work and finance) to mitigate some of these deleterious effects on our uplands streams. I would like to thank you and the team for undertaking this work and hope that some of the lessons learnt can be applied to other catchments where desirable.
Well done to all and keep up the good work!"
I. G. from Ceredigion

"On behalf of WSFOA I would also like to add my thanks and congratulations to your WUF team for a very impressive project that has been shown, by independent monitoring, to be highly effective. It gives those of us owners who keep subscribing to the River Improvement Fund the encouragement that it is money very well spent".
M.T. from Worcestershire - Chairman, Wye Salmon Fishery Owners' Association

"I received your ISAC report by post this morning, and was highly impressed by the impact of the restoration work you have been carrying out. I am secretary of the Coniston & Crake Catchment Partnership, which is part of the South Cumbria Rivers Trust. I wonder whether it would be possible for you to let me have 3 more copies of the Report, two for colleagues, and one for a sceptical landowner? I am on your supporters and mailing lists.
Many thanks, and congratulations on what you are achieving!"
L. H. from Cumbria

And from further afield:

"I have just received a copy of the 'ISAC – end of project report', and was delighted to read it from cover to cover. The informative document highlights the project's many achievements and I think the entire project team can be justly proud of its accomplishment. Restoration projects within the US could learn a great deal from the many aspects of this project, and I will be citing this as an excellent example of a successful, multi-faceted, and multi-stakeholder project.
Please convey my sincere congratulations to the entire project team, and support staff."
A. D. P. D. from Applied Ecological Solutions Inc., Kansas, USA

This action cost €18,549.

5.2.5 D4 Newsletter

The project's progress was reported in detail within three editions of the WUF newsletter/magazine - "News from the Rivers" – in 2011, 2012 and 2013. These publications are produced and distributed in the Spring (usually early March). "News from the Rivers" was not published in 2014 although the Layman's Report was effectively the 4th of these newsletters, distributed at the end of the project as detailed above.

Content and graphic design for the WUF newsletters were provided in-house (except the graphic design for the 2011 edition) and was printed externally by Impact Print (2011) or Diamond Publications (2012 & 2013). Approximately 15,000 copies were distributed each year to the same WUF mailing list used for the Layman's Report. Copies of these newsletters can be found on the WUF website in downloadable .pdf format.

Details of the objectives and results from the ISAC project were given in all four of these publications. In addition, the front cover included the strapline "ISAC – Latest News from Our LIFE+ Funded Project," along with the LIFE+ logo.

pdf copies can be downloaded from:
http://www.wyeuskfoundation.org/news/newsletter.php

The project was billed in proportion to the space devoted to the project in each newsletter and so by we were able to reduce the cost from the budgeted €67,000 to €29,525

5.2.6 D5 Publication of scientific results

The project has stimulated 2 scientific publications (with 3 more in preparation), 1 scientific poster and 17 presentations.

Publications completed

Brown, O. (2011). Crayfish culture – its role in the conservation of the white-clawed crayfish. *Conservation Land Management*, **9 (2)**, 7-10.

Grimstead, C, Brown, O. (2012). Crayfish at Cynrig. *Natur Cymru - Nature of Wales*, **42**, 44-45.

Publications in preparation

Juetner I, Evans S, Marsh-Smith S, Gott S, Gough P. (2014) Response of diatom and fish communities to catchment scale sand liming

Evans S, Marsh-Smith S, Gott S, Gough P. (2014) Managing riparian habitat for the benefit of Atlantic Salmon (*Salmo salar*).

Poster

Evans, S, Marsh-Smith S, Gott S, Gough P. (2013) Managing Riparian Habitat for the Benefit of Atlantic Salmon (*Salmo salar*) in Upland Wales.

- Atlantic Salmon Trust: Salmon Stocking Conference. 27th -28th November 2013. Marriot Hotel, Glasgow
- River Restoration Centre Annual conference 7th and 8th May 2014.

Gott S, (2014) The Irfon Life Project.
- Institute of Fisheries management Lamprey Conference 2014

Copies of these posters are included in annex 7.3.D5

Presentations

Brown, O. (2012). Investigating husbandry techniques for the culture of white clawed crayfish *Austropot amobius pallipes.* White-clawed crayfish captive breeding workshop. 3rd October 2012 at Bristol Zoo Gardens.

Brown, O. (2012). Crayfish culture – Rearing of juvenile crayfish at EAW Cynrig Fish Culture Unit. Poster presentation, Environment Agency Board visit to Wales, Wales Millennium Centre – 18 October 2012

Brown, O. (2013). Investigating husbandry techniques for the culture of white clawed crayfish *Austropotamobius pallipes.* The Rivers Trust Autumn Conference 2013. Wednesday 30th October 2013 Caer Beris Manor, Builth Wells, Powys LD2 3NP.

Evans, S (2011) The ISAC project (1hr version)
- Abergavenny U3A 26th May 2011
- ISAC workshop 13th Sept 2011
- WUF Annual Meeting 25th Oct 2011
- Camarthanshire fisheries AM 2nd Nov 2011

Evans, S (2011) The ISAC project (20min version)
- River Restoration Centre annual conference (linking with the RESTORE Project)

Evans, S (2012) The ISAC project (1hr version)
- Abergavenny Probus 18th Jan 2012
- Wye and Usk Annual meeting: 19th Oct
- Gwent Wildlife Trust 13th November
- Key note presentation: Recreational Fisheries Conference, Gold coast, Australia Aug 12th 2012

Marsh-Smith S (2012) Techniques to ameliorate acid waters. Dart Fisheries Association annual meeting. 18th March 2012

Evans, S (2013) The ISAC project 1hr version
- ISAC workshop 31st Oct 2013
- Wye and Usk Annual meeting: 20th Oct 2013

Evans, S (2013) The ISAC project – The results (20 min version)
- River Restoration Centre Annual Conference (linking with the RESTORE project)

Marsh – Smith S (2013) The ISAC project. Annual Meeting of Institute of Fisheries Management (Cardiff October 2013)

All presentations featured the Life+ and Natura 2000 logo prominently.

This action cost €1,431 and the costs of the remaining work, writing up the last two papers, will be taken by NRW, WUF and NWM.

5.2.7 D6 European distributed E-newsletter

This action was initially to be delivered by The Rivers Trust.

There were problems with the flow of information from WUF to RT. The project reports were key points in the compilation of actions and attainments and provided a time to reflect on project delivery. The efficient management structure designed to ensure effective delivery of the C actions was not able to provide copy to RT on a bi-monthly basis.

In total 3 E-newsletters were circulated to RT's European network. These are included in annex 7.3.D6

It was deemed early on that The Rivers Trust would focus on delivering the workshops, and WUF would include information of the project's progress periodically within its own E-Newsletter which is distributed on an average of one per week. This newsletter is received by 4,500 people in 16 countries. An example is included in the Annex 7.3.D6

This action cost €2,171

5.2.8 D7 Workshop

The project hosted a well-received workshop in September 2010 at the Caerberis hotel within the Irfon catchment. It was attended by 107 people with 34 coming on the field trip on the 2nd day.

Fig. 29 & 30. The seminar and field trip of the 2011 conference

A full list of presentations is included in annex 7.3.D7.

Following a modulation request to extend the project a 2nd 'wrap-up' workshop was approved.

This workshop in October 2013 presented the project's results and findings and was also hosted at the Caerberis hotel. It was attended by 104 people with 29 coming on the 2nd day field trip to look at the sites where the project's C actions had been delivered.

5.2.9 D8 River walks

The project has run the following river walks which have proven to be very popular.

- 2 field trips as part of the workshops,
- 6 half-day late spring river walks through the Hay Festival to show people the features of the SAC, explain their importance and the threats they face
- 2 full day Winter river walks to take people to see sites where the project has been doing and to see salmon spawning. The Winter walk in 2011 was cancelled due to extreme weather, as a combination of very low overnight temperatures and deep snow the night before rendered the catchment inaccessible by bus. In 2012, heavy rainfall the day before brought the whole catchment into full flood.

Fig 31. Spawning sea lamprey photographed on the 2011 spring river walk

A total of 270 people attended the walks. All people attending the river walks were given handouts which featured the Natura 2000 and Life+ logos prominently. An example of these handouts is included in annex 7.3 D8.

5.3 Evaluation of project implementation

5.3.1 Impact on species targeted

Task	Foreseen in the revised proposal	Achieved	Evaluation
A actions	Establish distribution and status of SAC features within the Irfon	Yes	Data from surveys supplied to local records centre
C1- Liming of acidified headwaters and restoration of 10 hydrological sources	Stabilisation of Atlantic salmon population in upper Irfon and main stem. 13,000 extra parr	96,000 extra parr	Included as part of the fisheries monitoring
	Upstream colonisation of bullhead (1163) into the formerly acidified section. 15,000 new individuals.	No	Fisheries monitoring, see note below.
	4 additional otter (1355)	Yes	Walk over. See note below
C2- Habitat restoration	1.3ha of new *Ranunculus* sp habitat (3260)	.17ha	GIS and field survey: see note below
	0.75ha of wet alder carr woodland protected (91E0)	2.0ha	GIS and field survey: see note below.
	5,000 additional crayfish (1092)	No	A4 found no existing populations in the sites identified for C2 to increase.
	100 additional sea lamprey (1095)	N/A	Fisheries analysis see notes below
	500 additional brook/river lamprey (1096)	N/A	Fisheries analysis see notes below
	400 additional shad (1103)	N/A	Not able to be determined by egg survey: see note below
	15,000 additional Atlantic salmon parr (1106)	114,500 additional parr	Fisheries analysis, see notes below
	15,000 additional bullhead (1163)	To be determined	Fisheries analysis, see notes below
	10 additional otter (1355)	N/A	Walk over, see note below

C3 – Assisted breeding programme for *Margaritifera margaritifera*	4,000 breeding adults (1029)	20,000 1 month old released. Est. 100,000 juveniles in hatchery	Hatchery stock due for for release in 2017 See note below
C4 – Assisted breeding programme for *Austropotamobius pallipes*	1,000 breeding adults by 2035 (1092)	To be determined	2,483 1 year old crayfish released

Notes on table above:

Wet Alder Carr
The survey confirmed 3 sites of habitat type 9E10 that had not previously been recorded totalling 2.0ha; predominately in old river channels adjacent to the lower Cammarch. These were protected from damage by livestock during the project.

Maps of the newly protected alder carr are included in Annex 7.2 C2

***Ranunculus* sp habitat**
The riparian survey found the distribution of *Ranunculus* to be limited to the main stem around Llangammarch Wells, the lower reaches of the South Dulas, the top of the Chwefru and the top of the Cammdwr.

At the end of the project, reflecting the increase in light reaching the channel *Ranunculus* habitat coverage had expanded in the lower South Dulas, spread throughout the Chwefru and established in the Cammarch and Garth Dulas. All the lower tributaries of the Irfon now hold good reservoirs of this habitat. In total 1,712m2 of additional Ranunculus habitat has been created.

It is expected that over the next 5 years *Ranunculus* will establish further in the Garth Dulas and Chwefru and it is expected to flourish once again in these streams, raising the total coverage to the project target.

This habitat is a listed feature of the SAC. Its decline on the main stem is due to series of wet springs/summers and unsustainable land-use in the wider catchment (see section 5.4) resulting in extremely turbid conditions and high phosphate level's. In light of this the improvement in distribution in the irfon is a notable positive sign.

WUF is working on the problem of diffuse pollution from agriculture elsewhere in the catchment with our WHIP2 project.

Maps of this habitat in the Irfon in 2010 and 2013 are included in annex 7.2.E2.

Atlantic salmon (*Salmo salar*)
Salmon were found in varying numbers across most of the Irfon catchment, with the exception of the inaccessible reaches upstream of waterfalls and some man-made obstructions in tributaries outside the SAC.

To monitor the impact of the liming part of the project, the upper Irfon was surveyed in three distinct reaches; upstream of the Devil's Staircase impassable waterfall; between this waterfall and Abergwesyn; and Abergwesyn downstream to Llanwrtyd Wells. The less acidified river Gwesyn joins the Irfon at Abergwesyn and is thought to have somewhat of a buffering impact on the Irfon from Abergwesyn downstream. Salmon were only considered in the accessible reaches.

Previous projects conducted between 2006 and 2009 to improve the water quality of the Irfon had resulted in the presence of salmon as far upstream as Abergwysen, the whole accessible length of the SAC, but these records were intermittent and numbers relatively low. By 2013, after 4 years of the project (notably doubling the lime dosage), the numbers of juvenile salmon in the reach between the Devil's Staircase falls (upstream limit of Salmon) and Abergwesyn had increased substantially, as had the numbers in the rest of the main Irfon. It would seem that adult salmon positively responded to the stabilisation and increase in pH as a result of action C1.

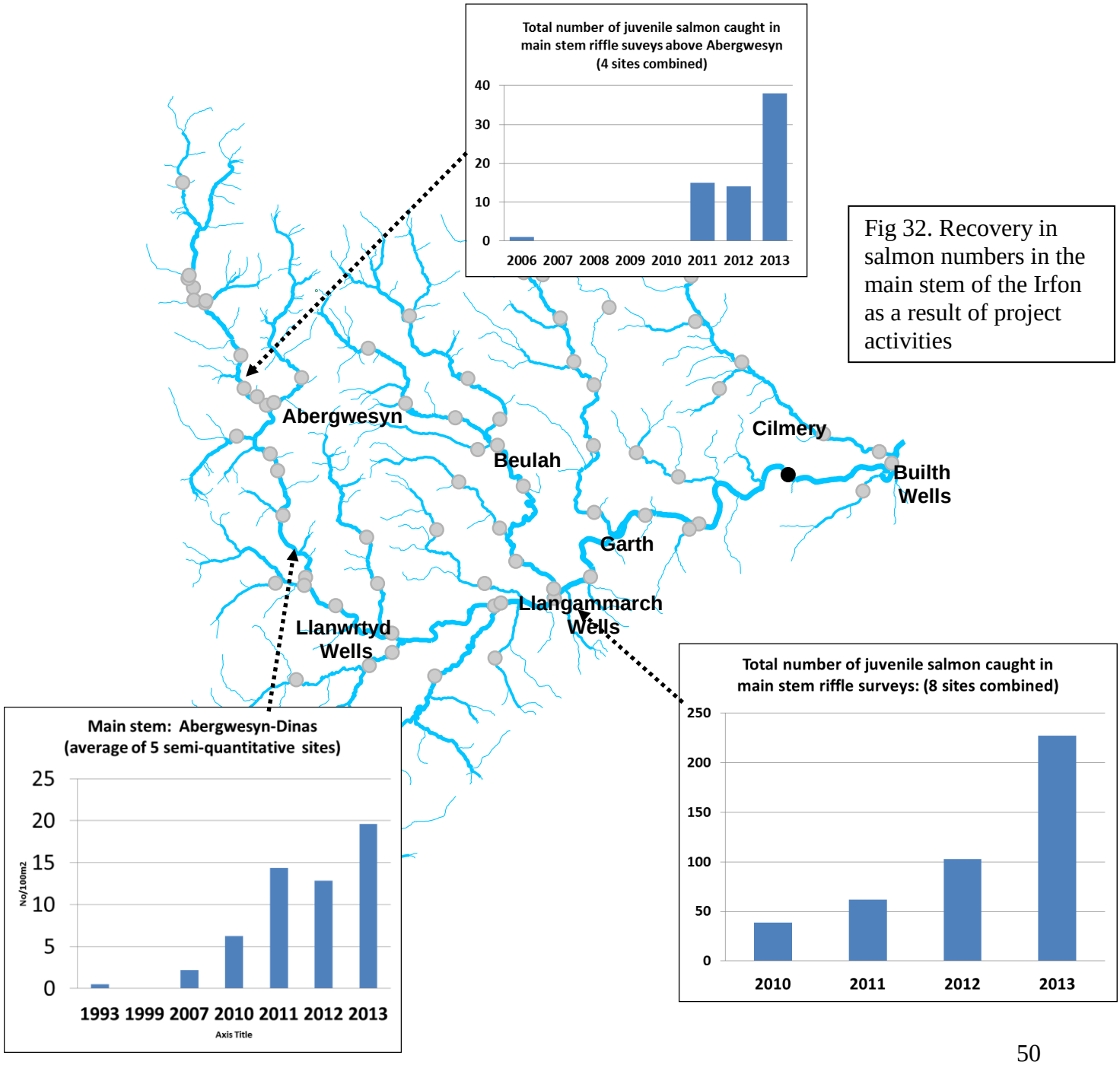


Fig 32. Recovery in salmon numbers in the main stem of the Irfon as a result of project activities

To monitor the response of salmon and bullhead to the habitat restoration work in the tributaries, sites were spread throughout the length of the rivers, at fairly regular intervals. The sites were picked before the reaches for habitat improvement were identified, and as a result, some survey sites were directly impacted by habitat works, fenced or coppiced (direct), some were within habitat improved reaches but not directly impacted (reach), and some were outside of the habitat improved reaches completely, i.e. outside of the SAC (control). The survey results were compared yearly to the 2010 baseline data.

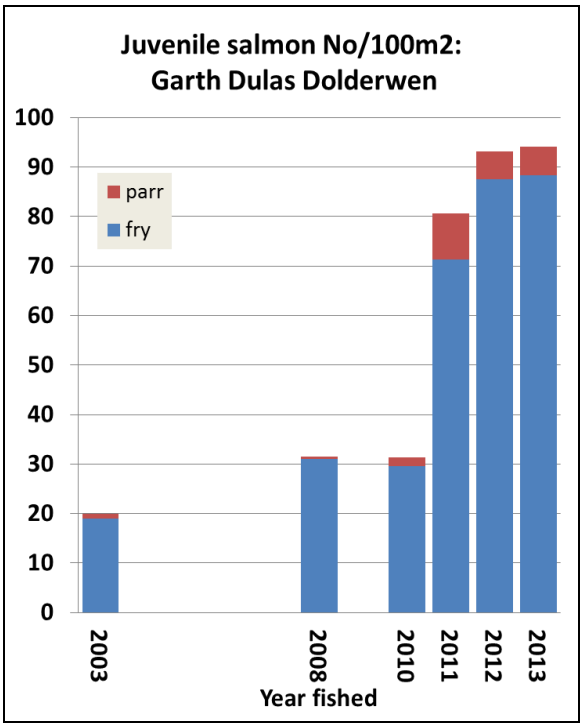


Fig 33. Spawning sea lamprey photographed on the 2011 spring river walk

All of the direct habitat improvement sites showed increased densities of salmon by 2013, as compared to the baseline in 2010, several showing this immediate response. Whilst this is a clear and positive result, we can't discount the honeypot effect, attracting fish from nearby unimproved stretches, hence the need for us to look at a reach scale.

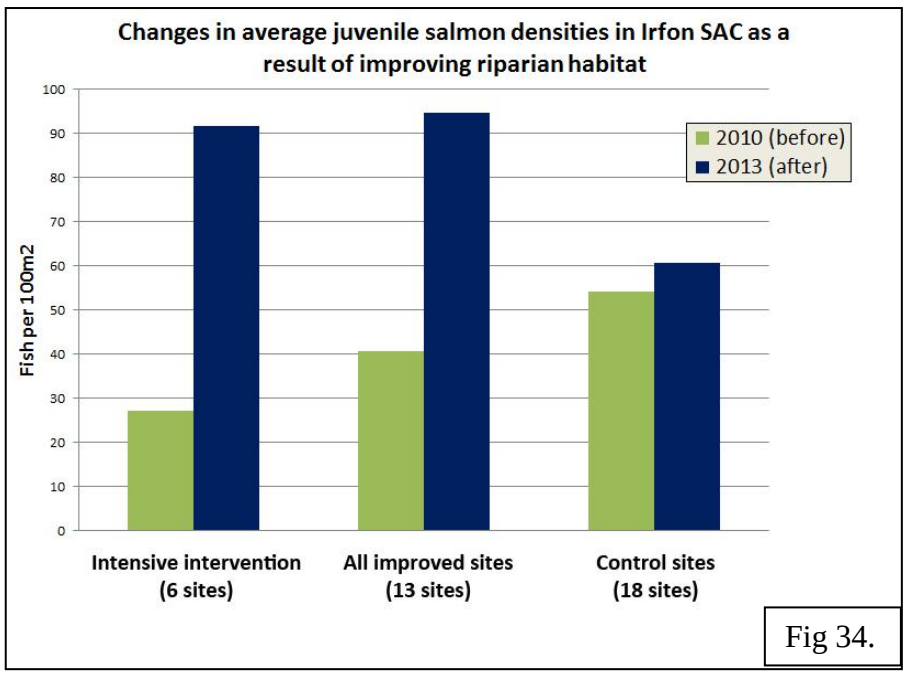


Fig 34.

Within any given, unimpacted fish population, you could reasonably expect to see about half the number of sites increase in densities, and about half decrease. When we compared all of the sites within the impacted reaches with the baseline control data of 2010, prior to any habitat work, we recorded increased densities at 100% of the sites in 2011 (3/3); 88% of the sites in 2012 (7/8); and 93% of the sites in 2013 (13/14). It is important to note that both at the local (direct)

scale and the reach scale, the increase in densities shown in the 2013 results is higher than that seen in the control sites. 2013 was a good year for fish across the Wye and and there was a notable increase in densities across the Irfon catchment, however, the survey results indicate the increase is greater in the habitat improved reaches.

Bullhead (*Cotus gobio*)
We were unable to find evidence of an increase in bullhead numbers, linked to the project, and bullhead would currently fail their Condition Assessments within the Irfon. It is thought that this species is less responsive than salmon and that their recovery, especially in acidified reaches may be substantially slower and limited by the 3 natural falls on the Irfon between Llanwrtyd Wells and Abergwesyn (fig

Fig 35. Washpool waterfall which is believed to be preventing colonisation of the formerly acidified area by bullhead.

Sea and brook lamprey (*Lampetra* sp.)
Sampling difficulties for juvenile lamprey mean that a trend is harder to pick up in the short term. The chosen method of enhancing lamprey habitat entailed pleaching woody debris into the margins and creating areas for fine sediments to deposit. The current sampling method involves placing a quadrant on the bed and electrofishing to draw the ammocoetes out of the substrate. It was impossible to place a quadrant within the pleached in material. This meant the actual effect of the project was understated. Exploratory electro-fishing within the pleached in material indicated the lamprey had colonised the newly created habitat.

All three lamprey species would currently fail their Condition Assessments. We believe this is a process failure caused by a flaw in the recommended sampling procedure. This has been fed into JNCC and an alternative sampling procedure recommended.

Freshwater pearl mussel (*Margaritifera margaritifera*)
An ageing population of FWPM exists in the lower Irfon with no signs of recruitment for 50+ years. Although the population is probably non-viable in its current state, there are enough individuals capable of breeding and enough genetic variation to warrant an attempt to save the population. Captive breeding is probably the only method capable of restoring this population and it is vital that juvenile culture methods are further refined to increase survival of individuals to be returned to the wild.

The project has developed the knowledge base of how to captive breed Freshwater pearl mussel. It is also hoped that the habitat restoration will create less sediment mobility which would assist in the survival of young FWPMs

White clawed crayfish (*Austropotamobius pallipes)*
The survey conducted in A4 revealed a marked contraction in the range of white clawed crayfish since the previous survey a decade ago. There were no existing populations within the streams targeted for C2, although encouragingly the principal remaining population was in a stream that had had its habitat restored in 1998. This necessitated a change in approach that was approved in the September 2010 modulation.

Rather than improving habitat for the existing crayfish populations, ideal crayfish habitat was created for crayfish raised in the hatchery to be stocked into. As of June 2014 2,483 1 year old crayfish have been stocked into 2 streams at the upstream limit of the former known range. This has delayed the achievement of the full benefits of action C1 and C2 for around 10 years.

The success achieved by Ollie Brown at Abercynrig hatchery in captive breeding white clawed crayfish has been unparalleled in the UK and served as an inspiration for others trying to save this beleaguered species.

5.3.2 Impact on other species

Diatoms
The diatoms communities changed according to the liming works as described in annex 7.2 E4.

Brown trout (*Salmo trutta*)
Brown trout were a by-catch in the fisheries monitoring. All fish were absent from surveys upstream of the Devil's staircase waterfalls at the confluence of Nant Cloddiad and Irfon until 2013 when a brown trout was recorded at the site immediately upstream of the falls. It is believed that an isolated population of brown trout lived in the unforested Nant Rhestr, (a small tributary that drains from the east into the Irfon upstream of the Devil's staircase) but that they did not live in the main Irfon due to acidity. It is hoped that improvements in the water quality through this project will facilitate the brown trout population recovery and the presence of fish in the site upstream of the falls is an encouraging start.

Macro-Invertebrates
These were not studied in the project but populations are responsive to changes in pH (particularly *Emphemeroptera and Tricoperta* families.) and it is reasonable to assume that the amelioration of the acid waters problem in the upper reaches of the SAC will have led to the restoration of an appropriate invertebrate community. The presence of an acidophobic *Hepatgeniidae* sp nymph on a stone picked up for diatom collection in the Nant Rhiw was the conclusive evidence that the acid waters problem in that stream had been corrected. This was corroborated later upon analysis of the diatom sample.

All other project monitoring of species and habitat outside the SAC listing was removed during the approval process.

5.3.3 Indirect impacts

Restoration of blanket bog

The work to restore natural hydrological function entailed the restoration of the water table in 23.5ha of severely degraded afforested blanket bog. This will in time restore its function as a carbon store.

Further to this, as shown in B1, the project has helped changed Welsh Government policy as to the planting of forests on deep peat and the blanket bog at the top of the Irfon is one of the top 10 sites for peatland restoration. http://www.forestry.gov.uk/fr/INFD-8Z7BSH

5.4 Analysis of long term benefits

5.4.1 Environmental benefits

In addition to the benefits listed in 5.3 our feedback relates to SAC Boundaries and Annex II species list as tools for protection.

Freshwater pearl mussel
It had not been known for certain that there were FWPM in the Irfon, let alone a population that amounted to the third best in Wales (as found at the start of ISAC). This species was not included in the Annex II at the time of original listing. We suggest that this is done retrospectively and that all measures to save this species are carried out on the Irfon, but noting below.

Boundaries of SAC within ISAC Project area
It should be remembered that the ISAC project took place in just one Wye SAC sub-catchment and that the project area – the boundary of the SAC itself - was frequently chosen as the upstream limit to which salmon (rather than any other Annex II species) was perceived to have reached at the time of designation. Sometimes this was a natural boundary (often when the stream was > 2m wide) on other occasions it was where some manmade barrier or the lower limit of acidification that constrained access. By way of comparison the range of the White clawed crayfish was often found to be restricted to streams < 2m, placing the majority of the population outside the SAC.

The situation on the Irfon and elsewhere in the Wye system is that the majority of white clawed crayfish lie outside the SAC. This was a significant problem in the active phase of the project as the commission proscribed their re-introduction into the smaller order tributaries and crucially the project was not able to fence out these very important components of the catchment. In an ideal world we would like to see all the lower stream order components of the SAC streams included in the SAC and treated with equal priority. We noted during our trip to speak at the Life + conference in Westphalia, Germany, that here the SAC boundaries were taken to include first order streams where bullhead and crayfish were found.

Boundaries of whole Wye SAC
However, in considering any boundary change of the SAC, the most important in the Wye SAC would surely be the river Lugg SSSI. Considered by the UK government to be important enough for this status, SAC listing stopped at the Hampton Court weir where the fish pass had been removed to accommodate a water wheel and now formed a barely passable barrier to salmon. Between 2003 and 2012, the Environment Agency and WUF have constructed fish passes at this and other obstacles upstream allowing salmon and sea lamprey to penetrate 32km further upstream. The upper reaches of the Arrow (the Lugg's main tributary) support one of the healthiest populations of white clawed crayfish in the Wye catchment and this sub-catchment contains large amounts of *Ranunculus* sp. habitat. The Lugg and its main tributary, the Arrow, are significant areas for the designated species and habitats of the Wye SAC and need the fullest protection.

The same applies to the Monnow: again at the time of listing, three significant weirs prevented salmon and other migratory fish from ascending. A fish pass now permits access and two further significant upstream barriers have been removed altogether. The headwater tributaries also contain strong populations of white clawed crayfish. This substantial sub

catchment, together with the Lugg, amounts to some 35% of the Wye's total catchment which is not appropriately listed.

5.4.2 Long term benefits and sustainability

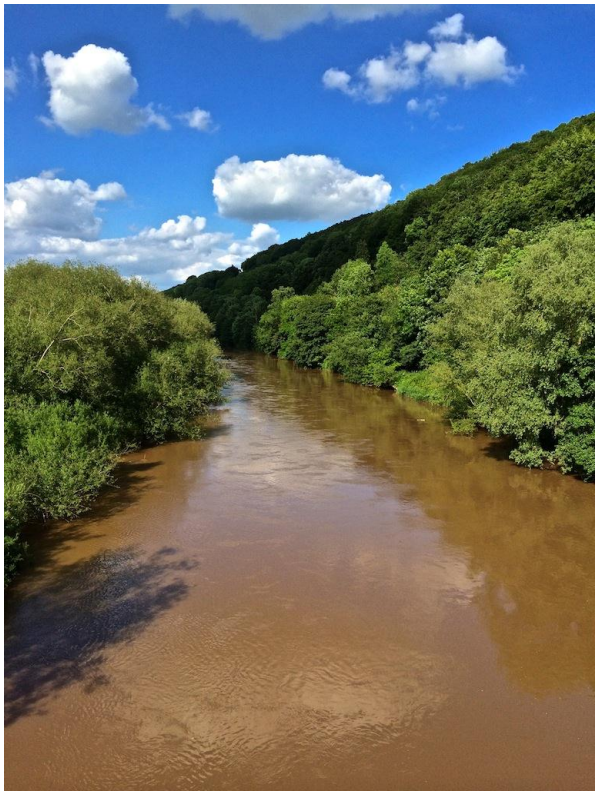
Ensuring the continued benefit of the work carried out in ISAC is to be delivered in the following ways:

General (role of Rural Development Plan and Water Framework Directive)
The primary risks to the Irfon catchment arise from agriculture and forestry. Due to limited income from agricultural activity the choices made by farmers in Wales are in large part governed by the single farm payment and the conditions attached to it.

Within Wales the government and stakeholders are moving to change current agricultural practices towards a more sustainable and environmental friendly regimen on provision of ecosystem services rather than agricultural production, stimulated by a number of exemplars including an initiative called the Pontbren project.

http://europeanlandowners.org/files/Awards/Soil/Soil%20award%20winner%202013-2014%20Pontbren.pdf

These need to be delivered both through encouragement and grants but also through adequate enforcement in common binding rules. It is sadly all too common a sight to see a farmer abusing his soils or impacting on the SAC for dubious short term gain at the expense downstream users and the SAC.



The current soil protection review is woefully ineffective and the regulators appear unable to act. In Wales the common binding rules farmers operate under are currently being reviewed and appear to be about to be tightened In the English part of the SAC where the problem is more severe, what rules there are, are being eased by the current government following a promise by the UK Prime Minister in July.

In combination with this project, which has been well received by the decision makers in Wales, plus the change in priorities as we move towards paid ecosystem services (more quickly in Wales due to the upcoming Environment Bill; currently at White paper stage); the future for the management of the Welsh part of the catchment is looking more positive than when the project started.

Fig: 36 The lower Wye SAC in June 2014 with severely elevated sediment levels as a result of unstainable run off from potato and asparagus fields.

The WFD is proving to be a positive driver for funding and policy change on how we, as a society, manage our upland areas, especially those with deep

peat reserves. It is proving less of a driver on the more productive agricultural land where the disconnect between economic development and sustainability is most pronounced.

Maintenance of improved habitat

The Foundation has been fencing tributaries for over sixteen years. We have an existing programme of maintenance and repair across the 270km already completed. Success in restoring salmon to the river has benefited our fisheries letting scheme - The Passport http://www.wyeuskfoundation.org/fishing/booking_office/
This enables us to transfer the benefit of success in the tributaries to riparian owners downstream, who in turn support the work of WUF including maintenance. The Passport is the delivery mechanism for a true paid ecosystem service.

Liming

Liming will need to continue in the short to medium term and the cost of that can also be accommodated from the owners' contributions which are in part stimulated by the Passport scheme.

Continued forest drain blocking

As forest coupes are sequentially felled, further opportunities to continue with drain blocking will occur. We have an undertaking with NRW that this will happen in their section of the forest but we shall apply for funding to do the same in other parts of the Wye catchment that are owned privately.

WUF is hosting the catchment partnership for the Wye. Within this partnership we are seeking resolution to the problems with low flows and flooding that affect the wye catchment and the peat reserves at the top of the catchment will play an important role in delivering this.

White clawed crayfish and FWPM introductions

In 2014 NRW reviewed their use of hatcheries in Wales. The outcome of this review (if accepted) will be the continuation of the Abercynrig hatchery as a centre of excellence for the captive breeding of white clawed crayfish and Freshwater pearl mussel.

In March 2014 a further 1000 crayfish where stocked into Irfon tributaries establishing a new population in the Cneiddion so by delivering the project target of 2 new populations (Chwefru and Cneiddion)
http://www.bbc.co.uk/news/uk-wales-mid-wales-27335062

Monitoring

Monitoring of the SAC features will continue by both NRW and WUF to determine favourable status. In addition WUF will continue to deliver investigative electrofishing and water quality monitoring to define problems that require addressing.

One of the difficulties we faced was that a whole catchment approach was not permitted as within LIFE + rules work should be confined to SAC listed areas. For rivers and streams, that is a significant handicap as it excludes the headwaters and the land, from which many oof the problems and issues are derived.

Other economic benefits

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 principal 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 suggests a cost benefit for restoration of upland afforested peat bogs to be in the region of 40 to 1. This is being quantified and developed further in the catchment partnership that WUF is hosting.

In the future we will revalue our peatlands at the top of the catchment in terms of the other ecosystem services they provide beyond timber production. The project has played an important role in stimulating this process and it is up to WUF and the Welsh Government to take it to the next stage.

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 to the economy 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.

5.4.3 Transferability

The techniques used in this project have moved the management of upland SAC rivers forward and the concept and techniques are directly transferable to rivers in the West and North of the UK and the western maritime region of Europe.

Concept design and delivery.
Having a Rivers Trust, or other delivery focused NGO, is ideal for LIFE+ Nature projects. Running costs are kept to minimum and delivery is the focus of the organisation. Basing the project on the ecosystem approach is a proven methodology and recommended.

Techniques
The revised methodology for habitat restoration is easy to implement and is effective.
The revised methodology for crayfish breeding has been detailed and is being implemented elsewhere.
The sand liming methodology has been described and is being implemented elsewhere.

Cost benefit
Salmon hatcheries are commonly seen as an alternative for improving salmon stocks by mitigating problems rather than correcting them.

This year there has been a review of hatchery operations in Wales which prompted WUF to review the cost benefit of the ISAC work compared to hatchery stocking for salmon alone. Hatcheries have annual running costs, whilst the methods employed in ISAC are an initial capital outlay for 20 years benefit, with the exception of the sand liming which is an annual cost.

There is a known revenue value for salmon that arises from the rod fishery (see previous section).

Cost per returning salmon (not allowing for inflation)		
	ISAC	Hatchery
1 year	£844	£70
10 years	£86	£701
20 years	£48	£1402

This analysis does not take into account the wider benefits to other species, WFD status etc., that arise as a result of correcting defined environmental problems and restoring ecosystem function.

5.4.4 Best practice lessons

This project has refined existing best practice in 6 main areas:-

Establishing baseline of SAC features
This was one of the principle aims of the project and by investing around €20,000 at the start of the project an accurate baseline was established that expanded considerably on the existing records and has allowed for the project to be refined in the first modulation and delivered for maximum benefit.

Managing upland habitats for salmonids
This project has provided evidence that habitat restoration can realise reach scale benefits in salmon populations. There is a significant shortage of this sort of data and we expect to show that analysis of our results add significantly to our knowledge base. The addition of introducing lateral woody debris to the standard prescription of creating dappled shade and excluding stock has realised improvements from year 1. This has been disseminated to others involved in improving salmon numbers and is now being implemented widely across the UK. Later this year a paper will be published in a scientific journal to disseminate this further.

Sand liming to mitigate for acid waters
Sand liming was known to be a cost effective solution to the problems of acid waters, but the way titration levels were calculated in this project offer an effective solution to the problem that has bedevilled many liming projects. The monitoring in E4 that was added in the first modulation has allowed this to be determined. This has been disseminated to other rivers and SACs in the UK that have an issue with acid waters such as the river Dart in Devon and the Bladnoch SAC in Galloway where the method has been implemented successfully.

Captive breeding of crayfish
Previous attempts to captive breed white clawed crayfish had often ended in failure in the UK. The diligent work at Abercynrig hatchery by NRW has developed the methodology such that crayfish have been successfully reared for 3 consecutive years. This methodology has been disseminated through 2 published papers and presentations to the South West Crayfish Group.

Partnership working
The project had the aim of demonstrating the benefits of river catchment based NGO/GO partnerships in delivering the aims of the Habitats and Water Framework Directive.

Within this project NRW, NWM, WUF and RT have delivered aspects of the projects that reflect their respective skills bases. This has been done on a basis of subsidiarity, integrity, openness and honesty. In this way the project has been delivered effectively and it is being seen as a model for other groups in the UK, Australia and America.

Blocking of forestry drains
In the past it was assumed that you had to wait for 18months after felling to allow for surface vegetation to grow before you could create effective peat plugs. This project has proven that

provided you raise the top of the plug above the surrounding surface, you can all but follow the harvester.

5.4.5 Innovation and demonstration value

This was a LIFE+ Nature project and as such was based on existing best practice that has been refined during the project.

WUF is the first Rivers Trust in the UK to be the lead beneficiary for a LIFE project. It has demonstrated the value of using LIFE funds and what can be done with them and this being taken up by other UK rivers trusts that look after SAC's. To our knowledge 3 bids currently being prepared.

5.4.6 Long term indicators of project success

The ongoing project benefits will be assessed through the 3 year rolling fisheries monitoring and the 5 year rolling assessment of favourable conservation status by NRW.

6. Financial report

6.1. Summary of costs incurred

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement*	Costs incurred within the project duration	%**
1.	Personnel	**793,370**	**750,278**	**94.6%**
2.	Travel	**41,569**	**66,668**	**160.4%**
3.	External assistance	**146,816**	**78,130**	**53.2%**
4.	Durables: total non-depreciated cost			
	- *Infrastructure sub-tot.*	**200,012**	**140,576**	**70.3%**
	- *Equipment sub-tot.*	**65,112**	**37,682**	**57.9%**
	- *Prototypes sub-tot.*	**0**	**0**	
5.	Purchase/lease of land	**150,977**	**0**	**0.0%**
6.	Consumables	**36,769**	**39,410**	**107.2%**
7.	Other costs	**109,280**	**50,804**	**46.5%**
8.	Overheads	**82,553**	**81,003**	**98.1%**
	TOTAL	**1,626,458**	**1,244,552**	**76.5%**

Explanation of changes

Change in exchange rate
Generally the project has underspent as it was written using an exchange rate of 1.4€:1£ and has operated at an exchange rate of around 1.2€:1£

Other specific reasons for changes are listed below:

Underspend in external assistance of 46.8% (€68,686)
The underspend has arisen as a result of several actions underspending in this category
C1 underspent by €14,469 as NRW/Forestry Commission Wales did not bill the project for their time.
C2c underspent by €20,295 as the survey (A2) found the catchment to be in a semi natural state so we did not need high cost in stream river restoration.
E2 underspent by €15,878 as the lamprey monitoring was included within NRW's wider fisheries survey.

Underspend in infrastructure by 29.7% (€59,436)
This relates to 2 main areas. By buying fencing materials in bulk we were able to reduce costs by around €20,000 over the course of the project.

We did not use sheet piling to block drains but rather peat plugs saving €16,195

Purchase/lease of land
As the project developed we were able to modify the forest design plan for the Tywi forest. This negated the need to purchase/lease land.

Underspend in other costs of 53.5% (€58,476)
Rather than having a specific project newsletter (D4) it was approved that it would be included within WUF's annual newsletter and costs split on a per page basis, and the final newsletter was the project specific Layman's report. In this way we were able to reduce the printing and distribution costs attributable to D4 from €67,000 to €14,697.

6.2. Accounting system

WUF used a system whereby financial information is recorded on Sage 50 Accounts Plus 2010 and ISAC is a separate department (Code 30) to all other projects within this system.

The Project Manager, Simon Evans, approved all costs allocated to the project.

All expenditure is supported by invoices and, when required, all invoices are marked "ISAC". This is in the invoice approval stamp box where the invoices are signed by Simon Evans.

Excel spreadsheets are deployed to split costs between departments on a basis agreed with the commission. Motor costs are charged on an agreed mileage rate, overheads are charged at 7% of the projects costs.

Staff costs are apportioned on a well-established time/project based on signed and authorised timesheets. Office staff use monthly electronic timesheets (an Excel workbook). Habitat staff use weekly manual timesheets. All office staff timesheets are approved by Simon Evans who signs each monthly timesheet. Simon Evans's timesheets are countersigned by the Director, Dr. Stephen Marsh-Smith. Habitat staff timesheets are approved and countersigned by the Head of Operations, Louis Macdonald –Ames.

Only eligible expenditure is allocated to the ISAC project, any ineligible expenditure is allocated to WUF.

This information is fed into the toolkit provided by LIFE+. Additionally, spreadsheets have been set up to collect financial data against the individual project actions. The toolkit has also been supplied to the associated beneficiaries together with examples of how this should be completed.

Upon receipt of the completed toolkit with supporting information associated beneficiaries spend is also entered by item on WUF's Sage 50 accounts to provide an auditable trail for the project.

Response to Commission letter dated 20 Jul 2012
1. **Q18**. Evidence that ART cannot recover VAT. A. Letter from HM Revenue & Customs enclosed (Ref 1)
2. **Q21**. Provide the internal project codes used in the internal accounting systems. A. WUF – department 10, RT - WUF Life, NRW – REWA000691 and NMW – B006.
3. **Q28**. Supporting authentic documents for personnel costs. A. Enclosed. (Refs 3a WUF, 3b NRW, 3c NMW and 3d RT). See audit report for payment evidence for NRW.
4. **Q31**. Supporting evidence for the calculation of travel costs for all partners. A. WUF rates calculation enclosed (Ref 4). Not available for NRW, other partners use actual costs (as per claim forms).
5. **Q33**. External assistance copy invoices. A. Enclosed (Ref 5).
6. **Q35**. Durable goods – infrastructure copy invoices. A. Enclosed (Ref 6).
7. **Q38**. Durable goods – equipment copy invoices. A. Enclosed (Ref 7).
8. **Q41**. Other costs copy invoices. A. Enclosed (Ref 8).

6.3. Partnership arrangements

The associated beneficiaries supply copies of all approved invoices to the coordinating beneficiary. They also enter the information in the financial tables which are then checked by Peter Loughran, Finance Officer for the coordinating beneficiary.

6.4. Auditors report

The project was completed by:
Mazars LLP. 8 New Fields, 2 Stinsford road, Nuffield, Poole, Dorset. BH17 0NF

Audit report is included in financial report

6.5 Summary of costs by action

Action no.	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.a Infra-structure	4.b Equip-ment	4.c Prototype	5. Purchase or lease of land	6. Consumables	7. Other costs	TOTAL
A1	Forest Survey	3,834	52	0	0	74	0	0	50	0	**4,010**
A2	Riparian Survey	4,163	0	1,649	0	74	0	0	0	0	**5,886**
A3	Consents for work	33,208	102	0	0	0	0	0	0	0	**33,310**
A4	Crayfish survey	845	343	3,758	0	74	0	0	0	0	**5,020**
A5	Freshwater pearl mussel survey	3,995	11	0	0	74	0	0	186	0	**4,266**
B1	Procurement of management rights within forestry	6,758	303	4,608	0	0	0	0	0	0	**11,669**
C1	Hydrological Source restoration	18,226	363	9,471	0	989	0	0	10,271	0	**39,320**
C2a	Tree work	152,691	20,402	12,828	0	10,307	0	0	18,835	5,790	**220,853**
C2b	Stock exclusion	146,793	25,705	18,000	134715	2,412	0	0	8,327	2,939	**338,891**
C2c	In-river works	3,650	0	4,078	0	174	0	0	1,861	0	**9,763**
C3	FWPM breeding	11,879	126	0	0	74	0	0	0	0	**12,079**
C4	WCC translocation	23,260	32	0	5,861	6,311	0	0	0	289	**35,753**
D1	Signage	2,969	0	0	0	0	0	0	0	785	**3,754**
D2	Laymans report	3,910	0	14,639	0	0	0	0	0	0	**18,549**
D3	Website	10,335	116	4,795	0	0	0	0	0	2,657	**17,903**
D4	Newsletter	13,674	0	0	0	1,405	0	0	0	14,447	**29,525**
D5	Peer reviewed publications	1,378	53	0	0	0	0	0	0	0	**1,431**
D6	E Newsletter	1,771	0	0	0	0	0	0	0	400	**2,171**
D7	Workshop	18,879	268	5,010	0	0	0	0	0	3,826	**27,983**
D8	River walks	10,179	2,110	0	0	0	0	0	0	0	**12,289**
E1	Operation	161,233	4,670	1,596	0	2,531	0	0	0	631	**170,661**
E2	Monitoring	54,181	8,796	16,727	0	12,167	0	0	1,185	0	**93,056**
E3	External Audits	1,035	0	3019	0	0	0	0	0	0	**4,054**
E4	Water Quality Monitoring	40,491	6,305	0	0	0	0	0	774	5,130	**52,700**
Over-heads											**80,846**
	TOTAL	**729,337**	**69,757**	**99,927**	**140,576**	**36,666**	**0**	**0**	**41,489**	**37,144**	**1,235,742**

When we were negotiating to lease land in action B1, we needed a 2nd opinion to ensure best value for the project. This required the hiring of an external consultant and added an external assistance cost to an action that was not predicting one.

Until this point we were under the impression that cost by action was an internal document for our use only. The differences between the total figure in table 6.5 and the audited figure in table 6.1 have probably occurred as a result of backdated changes in methods of costing hourly rates, recovery rates for vehicle costs etc.

All other discrepancies in this report have been explained in section 6.1.