



LIFE Project Number
LIFE13 NAT/IE/000144

FINAL Report
Covering the project activities from 01/07/2014 to 31/08/2020

22/10/2021

Sustainable land use management for the conservation of the freshwater pearl mussel
KerryLIFE

Project Data

Project location	South West Ireland
Project start date:	16/06/2014
Project end date:	31/12/2019 Extension date: 31/08/2020
Total Project duration (in months)	75 months (including Extension of 9 months)
Total budget	€ 5,010,581
Total eligible budget	€ 5,010,581
EU contribution:	€ 2,439,234
(%) of total costs	50%
(%) of eligible costs	50%

Beneficiary Data

Name Beneficiary	National Parks and Wildlife Service of the Department of Housing, Local Government and Heritage
Contact person	Ms Claire Cooper
Postal address	90 North King Street, Dublin 7, Ireland, D07 N7CV
Visit address	KerryLIFE Project Office, Glencar Community Centre, Shanacashel, Glencar, Co. Kerry V93 R963
Telephone	+353-1-888 3206
Fax:	+353-1-888 3272
E-mail	claire.cooper@housing.gov.ie
Project Website	www.kerrylife.ie

1. List of contents

1. List of contents
2. Executive Summary
3. Introduction
 - 3.1 Description of background, problem and objectives
 - 3.2 Expected longer term results
4. Administrative part
 - 4.1 Description of the management system
 - 4.2 Evaluation of the management system
5. Technical part
 - 5.1 Technical progress, per task
 - A. Preparatory actions, elaboration of management plans and/or of action plans
 - C. Concrete conservation actions
 - D. Monitoring of the impact of the project actions
 - F. Overall project operation and monitoring of the project progress
 - 5.2 Dissemination actions
 - 5.2.1 Objectives
 - 5.2.2. Dissemination: overview per activity
 - E. Public awareness
 - 5.3 Evaluation of Project Implementation
 - 5.4 Analysis of long-term benefits
 - 5.4.1 Environmental benefits
 - a. Direct/quantitative environmental benefits
 - b. relevance for environmentally significant issues or policy areas
 - 5.4.2 Long-term benefits and sustainability
 - a. Long-term / qualitative environmental benefits
 - b. Long-term / qualitative economic benefits
 - c. Long term / qualitative social benefits
 - d. Continuation of the project actions by beneficiaries/stakeholders
 - 5.4.3 Replicability, demonstration, transferability, cooperation
 - 5.4.4 Best Practice lessons
 - 5.4.5 Innovation and demonstration value
 - 5.4.6 Long term indicators of the project success
6. Comments on the financial report
 - 6.1 Summary of Costs Incurred
 - 6.2 Accounting system
 - 6.3 Partnership arrangements
 - 6.4 Auditor's report/declaration
 - 6.5 Summary of costs per action

List of key-words and abbreviations

Coillte	Coillte Teoranta
CP	Common Provisions, 2013
DAFM	Nitrates, Biodiversity and Engineering Division of the Department of Agriculture, Food and the Marine
DHLGH	Department of Housing, Local Government and Heritage
FPM	Freshwater Pearl Mussel (<i>Margaritifera margaritifera</i>)
FS-DAFM	Forest Service of the Department of Agriculture, Food and the Marine
PAS	Public Appointment Service
PMG	Project Management Group
PSG	Project Stakeholder Group
RSS	Rural Social Scheme Participant
SKDP	South Kerry Development Partnership Ltd

List of figures

Figure 1 KerryLIFE Project Management Structure

Figure 2 Gantt chart outlining variation between proposed work and actual work during the project.

Figure 3 Open field drain at Gearha North, Blackwater catchment in 2016 (L), 2017 (C), and 2018 (R) following re-vegetation over the period of the KerryLIFE project.

Figure 4 Changes in scores for CSAs across project farm plans

Figure 5 Diagram indicating changes in soil P index sampled during the KerryLIFE project.

Figure 6 Example of drinking point before (September 2015) and after (September 2016) the fencing of the access point to the watercourse and the installation of a water trough

Figure 7 Firebreak with build-up of dead *Molinia* grass (L), willow strikes planted at Bohaculia (C) and a prescribed burn firebreak being implemented at Bohaculia (R)

Figure 8 Monitoring photo taken in the Blackwater catchment in 2015 (left) and (right), in 2018 following implementation of farm plan measures to address CSAs

Figure 9: Discussion group in Blackwater

Figure 10: A KerryLIFE forestry workshop event attended by project partners in the Blackwater catchment.

List of tables

Table 1 Catchment area, farmland, number of farms, number of KerryLIFE farms, size of farms, Special Area of Conservation (SAC).

Table 2 List of Native Woodland Establishment, Conservation and Conversion trials on private land.

Table 3 Summary of population monitoring per catchment and year.

Table 4 List of project publications

Table 5 Action by action comparison of results achieved against objectives

Table 6 Summary of project costs incurred

Table 7 KerryLIFE Cost Centre, Sub-head and Expenditure Categories.

Table 8 List of deliverables

2. Executive Summary

The freshwater pearl mussel (*Margaritifera margaritifera*) is a large, long-lived, bivalve mollusc found in clean, fast-flowing rivers. The species is critically endangered, mainly because of habitat deterioration resulting from a combination of sedimentation and nutrient enrichment together with hydrological and morphological changes in their rivers. In many of these, riverbeds have become too clogged with silt, algae and rooted plants for young mussels to survive, while in other adult mussels have become stressed and are prematurely dying.

The pressures affecting the mussels' habitat come from a wide variety of point sources and/or diffuse sources throughout the catchments. The role of pollution (e.g. excess sediment and plant nutrients) associated with the farming and forestry sectors, together with changes in flow caused by land drainage, have been highlighted as important contributors to the species' decline.

In recognition of this, the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht (now in the Department of Housing, Local Government and Heritage) brought together the key stakeholders in agriculture, forestry and community development to develop and demonstrate practical conservation measures to improve the conservation of freshwater pearl mussel populations in two catchment . This resulted in the project called "*Sustainable land use management for the conservation of the freshwater pearl mussel*", or KerryLIFE project (LIFE13 NAT/IE/000144).

The project was coordinated by the NPWS who took responsibility for the day-to-day management. The six Associated Beneficiaries were the Nitrates, Biodiversity and Engineering and Forest Service Divisions of the Department of Agriculture, Food and the Marine, Coillte Teoranta, Teagasc – Agriculture and Food Development Authority, South Kerry Development Partnership CLG, and Pobal. Each beneficiary supplied technical and financial support throughout the project and worked closely with the Blackwater and Glencar Communities who provided local context and invaluable insights to the issues

The project operated between July 2014 and August 2020 in the Blackwater and Caragh freshwater pearl mussel catchments, situated on the Iveragh Peninsula in southwest Ireland and are designated as Special Areas of Conservation (SAC). Both river systems are capable of supporting in excess of 2.75 million adult freshwater pearl mussel and are widely distributed within their respective river networks. Some stretches of both river systems are close to favourable conservation condition however, the overall conservation condition of the two populations has been assessed as unfavourable.

The overall objectives of KerryLIFE were as follows:

- To demonstrate effective conservation measures that will restore the freshwater pearl mussel to favourable conservation condition in the Caragh and Blackwater catchments.
- To enhance awareness and understanding of the freshwater pearl mussel amongst local stakeholders.
- To demonstrate sustainable management techniques for farming and forestry in freshwater pearl mussel catchments.
- To provide guidance for farming and forestry practices that support the conservation of freshwater pearl mussels.

The KerryLIFE project was structured around 36 actions that formed the basis of the work programme for the project. A six person team made up of a Team Leader, a Scientific Advisor,

a Farm Advisor, an Administration Officer, a Research Assistant and a Rural Social Scheme Participant were appointed to deliver the project. The Project Team reported to the Project Management Group (PMG) who were advised by a Project Stakeholder Group (PSG) made up of representatives of the communities, farming and forestry organisations, fishery interests, academic institutions and relevant Public Authorities.

The project worked closely with farmers and forest-owners within the two SACs. The original targets area of 2,500 ha of farmland and 515 ha of forestry (in both public and private ownership) were exceeded with 5,038 ha of farmland and 542 ha of forest being involved.

Farmland actions focused on drain management and riparian buffers at 863 locations; laying of 2,911 m of hedgerows; optimising of grazing across 457 ha, nutrient management planning on 38 farms, including nutrient reduction measures on 501 ha of farmland; and the provision of 262 drinking water facilities for livestock. The farm measures delivered immediate improvements in condition where an action was implemented and were deemed successful at reducing the overall impact of agriculture on water quality.

Forestry actions focused on (1) trialling techniques to restructure 178 ha of commercial conifer plantation into long-term retention woodland through a mix of motor manual and mechanised techniques; and (2) trialling the establishment of new woodlands, the restoration of existing native woodland and the conversion of conifer plantation to native woodland under the Native Woodland Scheme across 47 ha of farmland. The restructuring techniques demonstrated were effective at reducing siltation and nutrient losses during operations but despite applying an extensive range of mitigation measures losses to watercourses were still observed. Nevertheless, the techniques demonstrated by the project potentially expand the management options available to forest practitioners.

The monitoring actions allowed the benefits of the conservation actions to be measured and evaluated. These included the monitoring of freshwater pearl mussels together with a range of biological (i.e. algae, macrophytes, and macroinvertebrates) and physical (i.e. water chemistry, silt, turbidity, flow, sediment provenance and redox) attributes of their habitat. The monitoring programme established a baseline dataset which allowed the project to track changes in the river and to evaluate project actions.

The project aimed to add value through initiatives such as trialling a farm brand for sustainably reared traditional cattle breeds that supported the conservation of the freshwater pearl mussels; the development of a consumer supplier network of businesses in the project area; and the creation of three looped recreational walkways to promote the project objectives to a wide audience and provide a valuable amenity for the local communities.

The project's dissemination actions included a dedicated website; social media accounts; media releases; newspaper articles; and radio interviews and television segments. The project provided educational, training workshops and demonstration events to farmers, forest-owners, regulators and members of the general public, and facilitated visits from a range of organisations to see the work of the project.

From 1 July 2014 to 31 August 2020, the actual cost of the project amounts to €4,301,698.71. Total contributions from the Coordinating Beneficiary and Associated Beneficiaries (excluding EU) amounted to €2,150,849.35. The lower than expected final expenditure resulted from lower time inputs of permanent staff among several beneficiaries and lower travel cost incurred.

This reduced the available budget and expenditure was adjusted accordingly without impacting on the delivery of the projects objectives.

By bringing stakeholders together and working closely with landowners, the project demonstrated measures to address sources of sediment and nutrients and changes in hydro-morphology that contributed to the restoration of the freshwater pearl mussel's habitat in the Blackwater and the Caragh catchments.

The key deliverables and outputs of the project included

- improved freshwater pearl mussel habitat condition and juvenile mussel survival through a reduction in siltation and nutrient enrichment.
- the production of 40 farm management plans across 5,038 ha of farmland and 14 forest management plans across 542 ha.
- tested and evaluated methodologies for the sustainable land use management for agriculture and forest sectors.
- critical source areas were identified and mitigation measures implemented.
- nutrient management plans were developed and implemented on participating farms.
- the sustainable management of drains, the provision of 262 alternative drinking water facilities, the management of sediment in 437 ha of critical source areas and nutrients across 501 ha of farmland.
- the restructuring of 178 ha of commercial conifer plantations into long-term retention woodland and implementing actions relating to establishment and restoration of native woodlands under the Native Woodland Scheme on 47.5 ha.
- up skilling and training of farmers and forest-owners.
- production of information notes for agriculture and forestry sectors.
- a raised awareness of freshwater pearl mussels and the importance of the SAC among farmers, forest-owners and communities.
- collation of extensive baseline information on the condition of the freshwater pearl mussel populations and their habitat.

3. Introduction

3.1 Description of background, problem and objectives

The freshwater pearl mussel (*Margaritifera margaritifera*) is one of the most critically endangered species in Europe. Individuals can grow to 13 cm, slowly building up thick calcareous shells in rivers with relatively soft water and low levels of calcium. The freshwater pearl mussel has a complex life cycle. Mussels have a complex life cycle producing free-living glochidial larvae that require an intermediary fish, typically Atlantic salmon and sea trout in Ireland to complete their life cycle. After 9 months, the larvae develop into juvenile mussels and drop off their hosts where they bury into gravel and sand substrate in the of the river bed, feeding, breathing and growing for the first five years. Once large enough to withstand the flows they will settle part buried in the river bed where they filter-feed, living for over 100 years. In many rivers, riverbeds have become too clogged with silt, algae and rooted plants for young mussels to survive, while in others adult mussels have become stressed and are prematurely dying owing to habitat deterioration. The pressures affecting the mussels' habitat come from a wide variety of point sources or diffuse sources throughout the catchment. The role of pollution (e.g. excess sediment and plant nutrients) associated with the farming and forestry sectors, together with changes in flow caused by land drainage have been highlighted as important contributors to the species' decline, affecting in particular where juvenile mussel live in the bed of the river. The KerryLIFE project focused on these principal land uses, farming and forestry, in two target catchments both of which are designated as Special Areas of Conservation (SACs).

The KerryLIFE project was a partnership project between the Department of Culture, Heritage and the Gaeltacht (now in the Department of Housing, Local Government, and Heritage), Department of Agriculture, Food and the Marine (the Nitrates, Biodiversity and Engineering Division and the Forest Service), Teagasc, Coillte, South Kerry Development Partnership and Pobal. These key stakeholders with backgrounds in nature conservancy, agriculture, forestry and rural and social development, worked together with the two local communities to demonstrate practical conservation measures designed to address the principal pressures and threats affecting freshwater pearl mussels.

The project operated between July 2014 and August 2020 in two freshwater pearl mussel catchments, the Blackwater and Caragh, situated on the Iveragh Peninsula in southwest Ireland. These rivers are part of the Killarney National Park, MacGillycuddy Reeks, and Caragh Catchment SAC (Site Code IE000365) and Blackwater (Kerry) (Site Code IE002173) SAC. Both river systems are capable of supporting in excess of 2.75 million adult freshwater pearl mussel widely distributed within their respective river networks. The populations occupy approximately 50 km of river channel across the project area.

The project worked closely with farmers and forest-owners within these two SACs. The original target area was 2,500 ha of farmland and 515 ha of forestry (in both public and private ownership) was exceeded with 5,038 ha of farmland and 542 ha of forest involved. The project aimed to improve the habitat quality for adults across 20% of the recorded habitat and improve 5% of the juvenile habitat. Specifically the concrete conservation actions include drainage management to reduce sediment and nutrient loads, retrofitting and creating riparian woodland, and restructuring commercial conifer plantations to long-term retention woodland using sensitive techniques.

The objectives of the project were as follows:

- To demonstrate effective conservation measures that will restore the freshwater pearl mussel to favourable conservation condition in the Caragh and Blackwater catchments.
- To enhance awareness and understanding of the freshwater pearl mussel amongst local stakeholders.
- To demonstrate sustainable management techniques for farming and forestry in freshwater pearl mussel catchments.
- To provide guidance for farming and forestry practices that support the conservation of freshwater pearl mussels.

The project was approved in 2014, commenced on 16th June 2014 and finished on 31st August 2020.

3.2 Expected longer term results

The expected longer term results of the project include

- improvements of conservation condition of 10 km of in-stream habitat for mussels
- reduction of nutrient and sediment inputs from diffuse sources through implementation of practical conservation measures across 5,038 ha of farmland and 542 ha of forestry.
- restructuring of 178 ha of commercial conifer plantation to long-term retention woodland and open habitat.
- raising awareness of freshwater pearl mussels and dissemination of information regarding habitat management and the education of the public on the importance of the species
- development of support mechanisms to sustain the long term delivery of the project objectives and optimal management practices to support the restoration and conservation of this species, and the provision of same to Government Agencies and Departments, for their use in the formulation of relevant national and local policies, including those within future Rural Development Programmes, Ireland Forestry Policy and Ireland's Natura 2000 Priority Action Framework.

The overall outcome of the project was that the actions undertaken were generally successful. However, it was not possible to document improvements of recruitment of juvenile freshwater pearl mussels in the project area during the project period, principally because it is very difficult to detect these small mussels. Nevertheless, streams within the project area are part of an ongoing monitoring programme, which will provide evidence of the success of the project actions over the longer term.

4. Administrative part

4.1 Description of the management system

The project started in June 2014 on the signing of the Grant Agreement between the Coordinating Beneficiary and the European Commission. KerryLIFE was a partnership project between seven organisations: the Department of Housing, Local Government and Heritage¹, Department of Agriculture, Food and the Marine, Forest Service, Coillte, Teagasc, South Kerry Development Partnership CLG and Pobal.

The Coordinating Beneficiary recruited and managed the Project Team, oversaw the governance of the project and led on monitoring of the freshwater pearl mussel. Teagasc took responsibility for the management of the services involving a Walsh Fellowship Researcher. They worked with the University of Dundee in Scotland, who supplied the researcher (an MPhil student), and Teagasc met the costs involved as part of their financial contribution. Coillte took responsibility for the procurement and management of forest contractors engaged in the implementation of actions on their properties. The FS-DAFM, in their statutory role both licenced forestry operations and administered the payments to recipients under the Native Woodland Scheme (DAFM, 2000, 2008, 2015a, 2015b, 2016 sets out the regulatory framework), and also advised on forest policy. DAFM provided advice on agricultural policy. South Kerry Development Partnership and Pobal jointly managed the input of Rural Social Scheme Participants (RSS) and led on the establishment of added value initiatives.

The Coordinating Beneficiary recruited the Team Leader, (TL), Scientific Advisor (SA), a Farm Advisor (FA) and Administrative Officer (AO) in conformity with the Code of Practice for Appointment to Positions in the Civil and Public Service under sanction by the Public Appointments Service (PAS). See Action A.1 for further details.

The Project Team answered directly to a Project Management Group (PMG) who met regularly to review progress and offer advice. The PMG was comprised of representatives of all project beneficiaries (DHLGH, DAFM, FS-DAFM, Coillte, Teagasc, SKDP, and Pobal) and a representative from each of the two farming communities. A Project Stakeholder Group (PSG) made up of the members of the PMG and representatives of the local community, farming and forestry organisations, fishery interests, academic institutions and relevant Public Authorities was established to inform, support and advise the PMG and Project Team on the delivery of the project actions.

On their appointment, and throughout the duration of the project, the Project Team were responsible for the day-to-day management of the project, as detailed in the application. The initial 18 months period involved the main preparatory A actions, gathering the necessary information, office provision, public meetings, developing selection criteria, site selection and the production of farm and forest plans outlining all works to be completed. In addition, the Project Team put in place the necessary framework for D, E and F Actions. The concrete conservation actions C started in early 2015 and on completion were inspected by the Project Team prior to payment with this process continuing to the end of project.

¹ The Coordinating Beneficiary's name changed on several occasions during the lifetime of the project from the initial Department of Arts, Heritage and the Gaeltacht (DAHG), to Department of Culture, Heritage and the Gaeltacht (DCHG) and finally to the Department of Housing, Local Government and Heritage (DHLGH) to

The Project Team's role was as follows:

Team Leader: was responsible for overseeing the day-to-day implementation of all project actions, monitoring, dissemination and reporting activities; management of the Project Team; liaising with and reporting to the Coordinating Beneficiary, Associated Beneficiaries, Project Management Group and Project Stakeholder.

Scientific Advisor: was involved in the monitoring of project actions in line with project objectives and expected results. The Scientific Advisor also led on the preparation of forest management plans and operational plans and oversaw their implementation.

Farm Advisor: was involved in the preparation of farm management plans, oversaw their implementation and supported farmers in delivering the measures on their farm.

Administration Officer: was responsible for day-to-day operation of project administration and finances including maintenance of up to date financial records for all project actions.

Research Assistant: was responsible for the sediment and flow monitoring.

Rural Social Scheme Participant: provided support with general administration, mapping and data management and assisted with field survey.

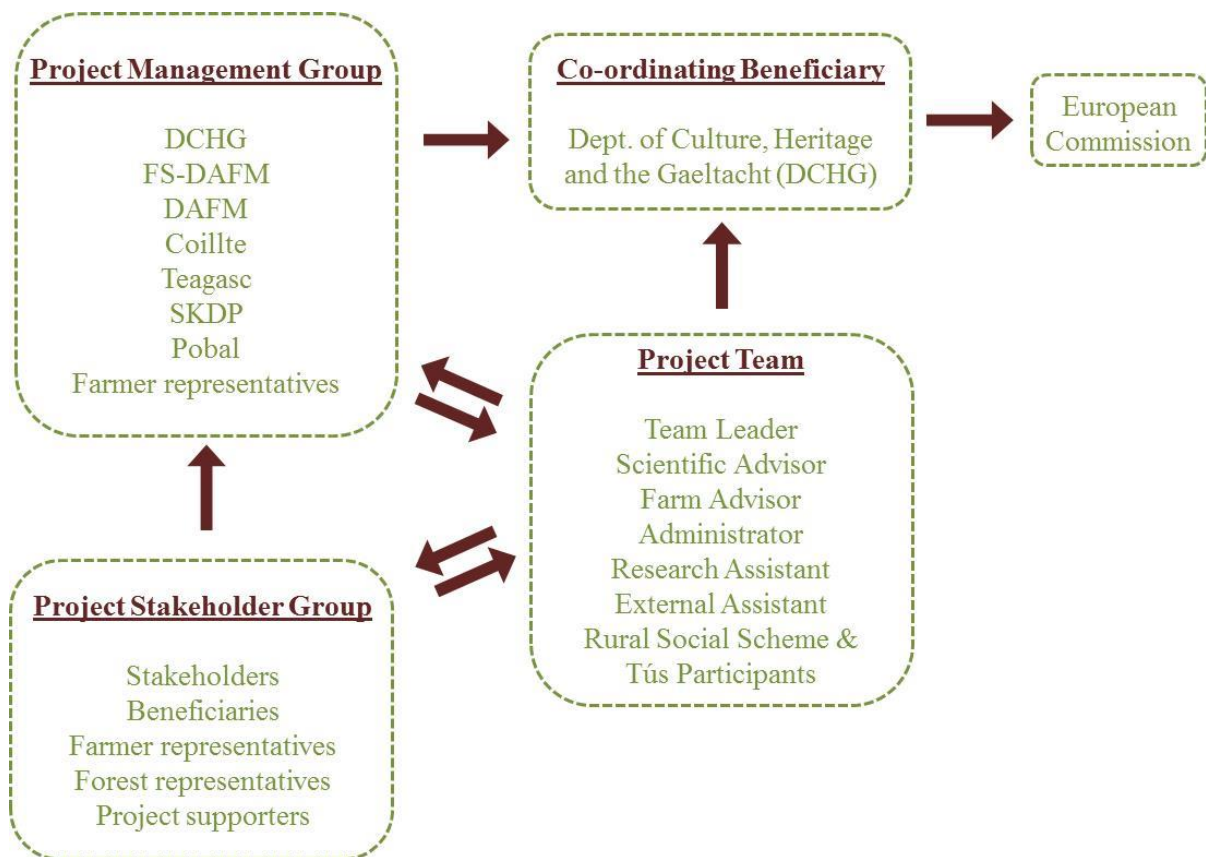
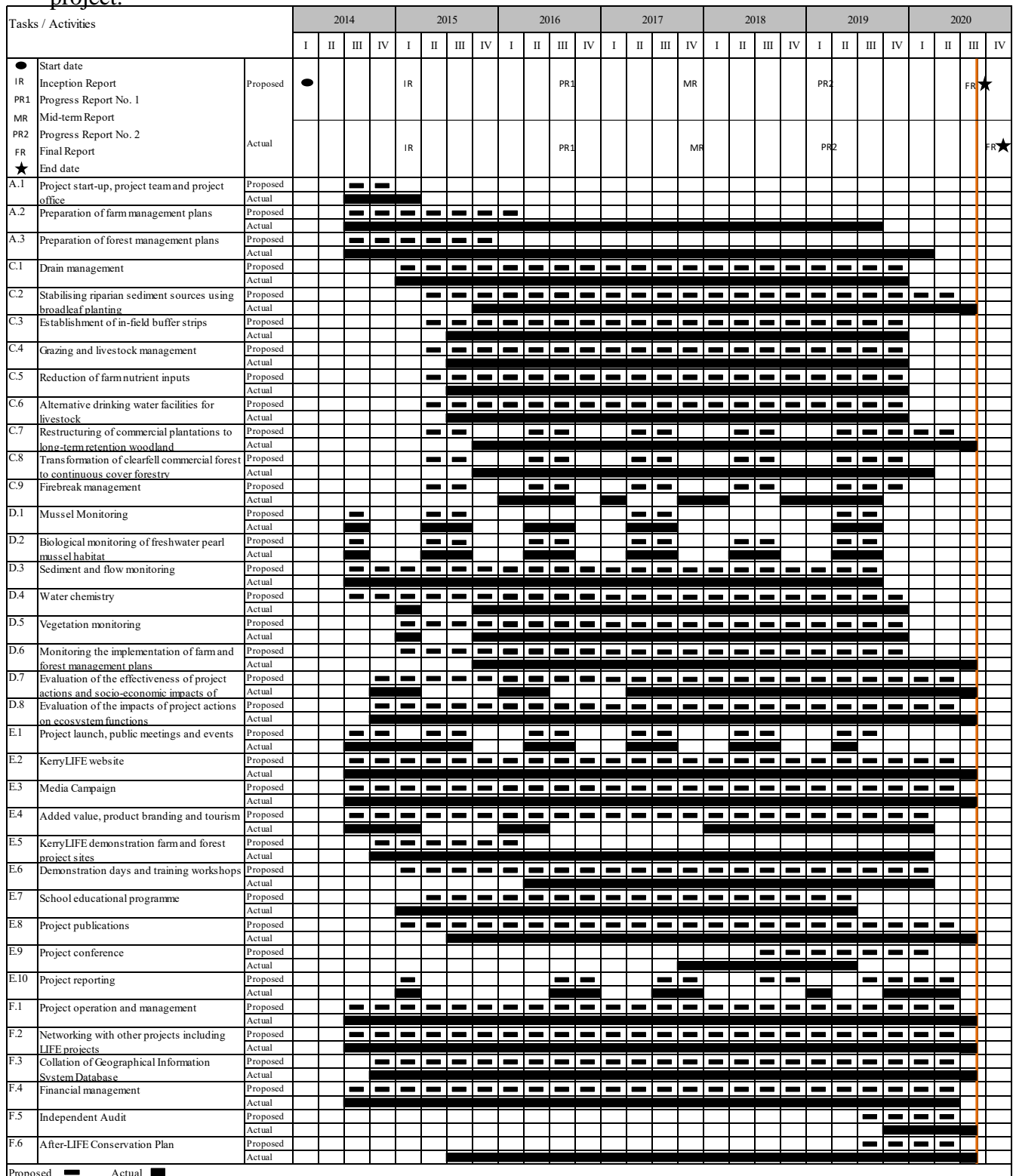


Figure 1 KerryLIFE project management structure

The Gantt chart illustrates the comparison between the schedule of proposed work as set out in the Grant Agreement and the actual work completed during the life of the project.

Figure 2: Gantt chart outlining variation between proposed work and actual work during the project.



4.2 Evaluation of the management system

The management structure and administration procedures set out in the Grant Agreement and respective Partnership Agreements were adhered and provided an effective framework to deliver this ambitious multidisciplinary project.

The project benefited from recruiting a strong team who were responsible for the day-to-day implementation of the project. The Project Team reported directly to the Project Management Group (PMG). PMG meetings were held regularly. The TL, assisted by the other core team members provided the PMG with an action by action update of the implementation since the previous meeting and set out the forthcoming work programme. PMG meetings were well attended by representatives of the beneficiaries and each provided technical and administrative input that aided the Project Team in the delivery of the project. These meetings also served as a platform through which any difficulties, risks or opportunities could be discussed and a way forward identified and agreed. Some topics identified during the PMG meeting that required more detailed discussion were delegated to relevant partners. All beneficiaries had the option of attending these meetings and the outcome was reported to the full PMG.

The Project Stakeholder Group was also effective in informing and providing advice to the PMG and Project Team. It did not meet as often as envisaged in the Grant Agreement as over time the Project Team developed effective one-to-one working relationships with local stakeholders operating in the area.

Payments were processed by the Project Team through the Coordinating Beneficiary's Finance Unit who processed the payment to suppliers or grantees. This provided an important financial check for the project and no problems were encountered with this approach. As none of the Associated Beneficiaries received financial contribution from the programme there were no issues when it came to financial allocation. There were delays in receiving requested financial information from Beneficiaries which delayed the submitting of reports.

Some Beneficiaries did not meet their full financial contribution to the project as set out in the Grant Agreement, while others exceeded their contributions. The overall contribution by Irish Beneficiary's was 15% less than foreseen and the final spend was adjusted accordingly. The shortfall in the contribution was mainly linked to reduced inputs of permanent staff time and associated travel expenditure. Additional workloads were placed on the core Project Team for the delivery of aspects of the project that were envisaged to be implemented by permanent staff of the Beneficiaries. This together with the increased number of farms; complexity in implementing forestry trials and delays in filling vacancies on the core Project Team resulted in some changes to the schedule, nevertheless the project was delivered in full.

5. Technical part (50 pages)

5.1 Technical progress per action

A: Preparatory actions, elaboration of management plans and/or of action plans

A.1 Project start-up, Project Team and Project Office

Action	Target/Deliverable	Date Due	Result
A.1	Recruit Project Team and set up office	31/12/2014	6 person team recruited and office set up

A six person Project Team was recruited to run the project. In September 2014, the Coordinating Beneficiary advertised in the national press the posts of Team Leader, (TL), Scientific Advisor (SA), a Farm Advisor (FA) and an Administration Officer (AO) in conformity with the Code of Practice for Appointment to Positions in the Civil and Public Service under sanction by PAS. Four separate interview boards were convened under independent chairpersons and competency based interviews were conducted in line with best practice. A panel for each position was established for the duration of the project. The following staff were appointed in late November/early December 2014: Richard O’Callaghan (TL), Dr Paul Phelan (SA), Padraig Cronin (FA) and Nuala McDaid (AO). The panel was drawn from on two occasions; in 2016, the AO resigned and was replaced by Steve Lynott, in 2019 the FA resigned and was replaced by Colin Gallagher via a secondment from the Department of Agriculture, Food and the Marine. In 2019, the AO retired and was replaced by Barry Mellett via secondment from the Coordinating Beneficiary for the remainder of the project. The Project Team were employed by the Coordinating Beneficiary on fixed-term temporary whole-time or half-time contracts for the duration of the project. The Research Assistant was appointed under the Walsh Fellowship Programme through an open competition administered jointly by Teagasc and the University of Dundee. The successful candidate was Karen O’Neill who started in June 2015. The Rural Social Scheme Participant assigned to the project was co-managed by the South Kerry Development Partnership and Pobal. In May 2016, Jennifer Griffin was assigned to the project and remained with the project until January 2017 and was replaced by Ian Foley in April 2017. Several other RSS participants assisted the project with specific tasks from time to time.

The Project Team answered directly to a Project Management Group (PMG) who met regularly to review progress and offer advice. The PMG was established in Q2-2014 and was comprised of representatives of all project beneficiaries and a representative from each of the two farming communities involved.

A Project Stakeholder Group (PSG) made up of the members of the PMG and representatives of the local community, farming and forestry organisations, fishery interests, academic institutions and relevant Public Authorities was established in Q3-2015 to inform, support and advise the PMG and Project Team on the delivery of the project actions. The meetings were well attended and a wide range of topics have been covered.

The project office was established in the Glencar Community Centre, providing a crucial platform for the Project Team to engage with the local communities. The rental income provided the community with an immediate benefit. The Project Team purchased all necessary equipment to fit out the office and undertake fieldwork including computers, printers, scanners, photocopier, projectors, GPS equipment and cameras and telephones.

A.2 Preparation of farm management plans

Action	Target/Deliverable	Date Due	Result
A.2	Production of 25 farm management plans covering ~2,500 ha	31/03/2016	48 farms (5,713.8 ha) surveyed. 40 farm plans signed (5,038 ha).

Once the Project Team were appointed they immediately began engaging with farmers through a series of public meetings and farm visits. Early engagement with farmers in the Caragh and Blackwater freshwater pearl mussel catchments through public meetings and farm visits was key to securing their buy-in. Farmers were given details about the project and were invited to submit an expression of interest in working with the project. 124 expressions of interest were received from the 212 farmers in the project area. In response to the very high level of interest, the Project Team jointly with the PMG, increased the number of places to be offered. A robust and transparent selection procedure was developed to select farmers that enabled the project to achieve its objectives. The selection process (*Annex A02-01*) was applied to all farms in the project area. Farmers were then ranked from highest to lowest separately by catchment and whether they expressed interest in participating in the project. 50 farmers were invited to join, 22 from the Blackwater and 28 from the Caragh, however, only 40 farmers joined the project.

The Project Team commenced carrying out detailed farm surveys and developed bespoke farm management plans which detailed the conservation actions to be implemented by the farmer. Preparation of farm management plans involved; (1) documenting management practices on farms, (2) mapping of all habitats present, (3) mapping of sources of sediment and nutrients, (4) mapping of pathways to freshwater pearl mussel habitat (e.g. drains; streams; and rivers), (5) risk assessment of pressures identified and (6) selection of conservation measures.

The measures included drain management, laying of hedgerows, optimising of grazing, nutrient management planning and the provision of drinking water facilities for livestock. Each plan identified the measures required, the location and the costs involved. Prior to finalising each plan, the Farm Advisor walked the farm with the farmer, explaining to him/her the issues identified and the reason for the proposed conservation measures. These farm walks were invaluable, as the farmer could input directly into the design of the plan.

The finalised plan consisted of maps showing the external farm boundary and farm plots overlain the Natura 2000 designation, the location of drain and sediment reduction measures (Actions C.1-C.4 and C.6) and the location of nutrient management plan measures (Action C.5). Accompanying tables briefly described the measure and the payment rate. The farm plan was accompanied by a signed written contract setting out the terms and conditions.

Payments for measures were paid in two instalments each year across the term of the plan. Progress was reviewed annually under Action D.6 and measures that are satisfactorily completed were paid. In total, over 1,600 measures were implemented across 5,038 ha of farmland.

In total, the project worked with 42 farmers covering 5,038 ha of farmland exceeding the target set in the Grant Agreement. 37 farmers implemented only agricultural measures. 3 farmers implemented both agricultural and woodland measures on their farms. A further 2 implemented only woodland measures under Action C.2 on their farms. A list of participants is available in *Annex A02-04*.

The increase in farm participants and the large size of farms selected significantly increased the workload for the Project Team. SKDP personnel assisted in carrying out farm surveys and external farm planning support were also procured to support the Project Team with the survey

work. All farms were surveyed by Q2-2016, just 3 months later than originally set out in the Grant Agreement for 25 farms. Sign up by farmers was on a rolling basis with the final plan being signed in Q4-2018. The implementation of farm plans was monitored under Action D06 with each plan reviewed annually. Plans were revised to reflect changes in plot scores and in some cases the inclusion of additional measures.

Table 1: Catchment area, farmland, number of farms, number of KerryLIFE farms, size of farms, Special Area of Conservation (SAC).

<i>Description</i>	<i>Caragh</i>	<i>Blackwater</i>
<i>Special Area of Conservation</i>	<i>IE000365</i>	<i>IE000365 / IE002173</i>
<i>Catchment area (Ha)</i>	<i>13,368</i>	<i>8,831</i>
<i>Area of farmland in catchment (Ha)</i>	<i>7,951</i>	<i>5,533</i>
<i>Area of KerryLIFE farmland (Ha)</i>	<i>3,124</i>	<i>1,914</i>
<i>No. of farms in catchment</i>	<i>125</i>	<i>87</i>
<i>No. of KerryLIFE farm only participants</i>	<i>19</i>	<i>18</i>
<i>No. of KerryLIFE dual farm & forest participants</i>	<i>1</i>	<i>2</i>
<i>No. of KerryLIFE forestry only participants</i>	<i>2</i>	<i>0</i>
<i>Average farm size in catchment</i>	<i>83.6</i>	<i>85.0</i>
<i>Average size of KerryLIFE farms</i>	<i>156.2</i>	<i>95.7</i>

A.3 Preparation of forest management plans

Action	Target/Deliverable	Date Due	Result
A.3	8 plans covering 485 ha public forest 2 plans covering 30 ha private forest	Prepare plans 31/12/2015 Start implementation on one site by 31/08/2015	8 plans covering 495 ha of public forestry; 22 detailed operation plans; 12 for C.7; 1 for C.8 and 9 for C.9; 5 plans covering 47.6 ha of private forestry; List of forest properties

Forest management plans were developed for eight high risk publicly owned (i.e. Coillte-owned) forests covering 495 ha. The characteristics of forests within the project area reflect previous forest policies involving the planting of large areas of deep peats with conifer monocultures. While such planting no longer takes place under current forest policies, the forests in the two catchments are indicative of these so-called ‘legacy forests’, which pose real and unavoidable challenges regarding ongoing management, removal and appropriate post-removal management options.

The preparation of each forest management plan involved; (1) documenting current and past management practices, (2) source mapping of sediment and nutrients, and (3) mapping of pathways (e.g. drains, streams, rivers) to the freshwater pearl mussel. The resulting data were used to carry out an integrated risk assessment (4) and to inform the selection of restructuring trials (5).

The results of the risk assessment revealed a high level of risk throughout the properties, driven largely by soil type, drainage network, cultivation type and wind exposure. Yield class (a proxy for nutrient risk), revealed that 37% of the forest area had a high yield class (>16 yield class). Ground vegetation beneath the standing conifer canopy was either absent or intermittent across 98% of the planted area and all eight forest properties were planted on peat soils. Windblown trees were observed in sub-compartments to varying extents from present in pockets across 218.9 ha to being widespread across 64 ha. The results of the hydrological surveys revealed a very high level of hydrological connectivity, with 399 ha of forest properties discharging either

directly into the main rivers or tributaries. 28% of the forest compartments had gradients in excess of 10%.

For each forestry trial implemented under KerryLIFE, a detailed operational plan was drawn up. In total 22 operational plans were prepared. 12 covered the restructuring of 178 ha of conifer plantation into long-term retention woodland, retaining unplanted areas under Action C.7, 1 involved a continuous cover forestry (CCF) trial under Action C.8 covering 2.5 ha and 9 operational plans were prepared for firebreak trials covering 2,918 m under Action C.9. The operational plans formed the basis of licence applications and each operational plan was subject to appropriate assessment screening. Further details on the trials are provided under Actions C.7, C.8 and C.9 and a list of forest properties is provided in Annex A03-01.

Nine plans, under Action C.2 for woodland measures on private property, were also developed with associated applications under the Native Woodland Scheme. An Independent Forester surveyed the sites, developed the applications with the input from an Ecologist and Archaeologist. Four plans were for native woodland establishment covering 27.17 ha, four for restoration of existing native woodlands covering 14.91 ha and one conversion from conifer to broadleaf forestry (via replacement at clearfelling) covering 5.5 ha were submitted and approved by the Forest Service. Eight of the nine private plans were implemented, thus achieving the target within the lifetime of the project. Further details on the native woodland trials are described under Action C.2.

C: Concrete conservation actions

C.1 Drain management

Action	Target/Deliverable	Date Due	Result
C.1	1,500 locations on farms and in forests	30/06/2020	2,829 locations on farms and in forests.

This action aimed to significantly reduce sediment losses from drains by slowing and impeding flows through the drainage network. At the outset of the project, very little was known about the extent of drains on farms or in forests.

A hydrological audit was conducted on all participating farm and forests covering 5,532.9 ha. The audit revealed 267.9 km of drains on project farms with a density of 53 m of drain per hectare and 79 km of drains in project forests with a density of 146 m per hectare.

The information from the hydrological audits, together with information gathered during the farm and forest surveys under Action A.2 and A.3 were used to select measures to address the issues observed. A total of 2,829 individual measures were implemented on project sites under this action and are summarised below.

Re-wetting/re-vegetating of drains - 277 drains, extending to ~c. 76 km of drainage channel were allowed to re-vegetate. Farmers were more willing to adopt this passive technique to trap eroding sediment from adjoining farm land. Rapid re-vegetation occurred in drains within a short period thus disrupting the transport of sediment to the river.

Protective buffers (5m, 10m or 30m wide) - were installed along 5.9 km of river on farms to intercept sediment transported by overland flow to the river. The buffers also excluded livestock from grazing the river bank except for short periods each year.

Peat or plastic dams - were installed on 122 drains to block water flow and to raise the water table.

Log dams - a form of leaky dam constructed from felled tree trunks were installed at 1,436 forest locations. Dams were installed in series along mound furrows and drains to slow the flow of water through the forest floor and to promote colonisation of wetland plants such as *Sphagnum* moss

Silt fences - were constructed ‘in-the-dry’ along mound furrows at 374 forest locations. The silt fences were designed to strip sediment mobilised during operations being transported through overland flow reaching the main drainage network and watercourse in which it is more difficult to capture sediment. The silt fences also slowed the movement of water along the artificial furrows reducing erosion.



Figure 3 Open field drain at Gearha North, Blackwater catchment in 2016 (L), 2017 (C), and 2018 (R) following re-vegetation over the period of the KerryLIFE project.

Log bridges - were constructed at 17 locations across watercourses in forest sites where no alternative route was available.

Spilled drainage – was trialled at 6 locations where notches were created along an existing drain to allow water to flow into an intact and functioning buffer zone.

Other measures trialled included *birch bundle leaky dams* (2), and *coir rolls* (5).

The measures implemented by KerryLIFE as described above, were demonstrated as being effective at breaking the pathway between sources of sediment and/or nutrients and the pearl mussel’s habitat (the receptor). However, the efficacy of the measures implemented in relation to improving hydrological function was variable, with drain blocking being the most effective.

C.2 Stabilising riparian sediment sources using broadleaf planting

Action	Target/Deliverable	Date Due	Result
C.2	15 ha of woodland established; 10 ha of existing woodland conserved; 15 ha of conifer plantation converted to native woodland	31/03/2016	27.2 ha of woodland established; 14.9 ha existing woodland conserved ² ; 5.5 ha of conifer plantation converted to native woodland

Strategic and targeted tree planting at vulnerable locations along channels was proposed to reduce sediment and nutrient run-off and the undercutting and slumping of river banks. The tree planting was envisaged to be delivered through the Native Woodland Scheme (NWS) under three categories: establishment of new native woodland (15 ha), conservation of existing woodland (10 ha) and conversion of conifer plantation to native woodland (15 ha). Potential

² A further woodland conservation application covering 3.5 ha at Dromdoory, Caragh was prepared under the project and has been approved by the Forest Service. Due to contractor availability and Covid-19 restrictions the works were not carried out within the lifetime of the project.

sites identified through the farm surveys did not however meet the schemes specifications due to their small size, linear shape and high cost per unit area (fencing/management). Farmers and landowner's also had a low willingness to plant trees on their more agriculturally productive land.

Expressions of interest were invited from the wider community to identify sites capable of satisfying the NWS specifications. All operations were designed to minimise the risks posed to water quality. These included reduced or no ground disturbance; no new drainage; blocking of existing drains to break connectivity to natural watercourses; no use of fertiliser, herbicide or insecticide; and retention of open spaces and wetland features. Finalised applications were AA Screened and Natura Impact Statement were prepared and submitted to the Forest Service as part of the licencing process. In total, trials were implemented across 5 sites covering 47.6 ha. A description of the three categories is provided below and the list of sites provided in Table 2.

Establishment of native woodland was implemented at four locations covering 27.2 ha. These new woodlands were developed with a new planting scenario of pre-dominantly of birch with some enrichment planting of oak, rowan and Scots pine. While, every effort was made to design the woodlands to provide physical buffers for more intensive land uses, it was not possible due to issues beyond the project scope such as land ownership.

Other initiatives incorporated into the design of the woodlands included drain blocking both in the wet and the dry; reduced or no ground preparation; no fertiliser or pesticide applications. Three of the new woodlands adjoined existing native woodlands, therefore increasing the extent of these woodlands.

Conservation of existing native woodland was implemented at three locations covering 14.9 ha of woodland. These sites were a mix of Oak- Holly woodland with some areas containing Annex I (91A0) woodland habitat. The primary measures implemented included the erection of a deer proof fence to eliminate browsing pressure; drain blocking to break pathways from which nutrients and sediment could be lost from the woodland; supplementary planting; and removal of invasive species (i.e. *Rhododendron*).

Conversion: One privately owned conifer plantation 5.5 ha in area was restructured from a commercial conifer plantation to long-term retention woodland with open spaces, watercourse setbacks and buffer zones. This was a two phased operation, involving first the sensitive harvesting of the mainly Sitka spruce crop prior to the trees reaching maturity. A large number of silt fences, within the ploughed furrows between the rows of trees were installed to prevent sediment from entering the watercourses (natural and naturalised streams) flowing through and along the boundary of the site. The second phase involved the establishment of a native woodland using the same approaches as described above.

As demonstration trials, the project endeavoured to adapt the Native Woodland Scheme to better support the conservation of freshwater pearl mussels and the FS-DAFM facilitated requests for such adaptations as far as possible under the scheme. Nevertheless, additional refinements such as reduced tree-stocking rates and increased flexibility regarding areas of biodiversity enhancement, which would have further supported improved management of the freshwater pearl mussel catchments were not accommodated. Experience of measures developed by the project could be considered for future adaptations of the NWS.

Table 2: List of Native Woodland Establishment, Conservation and Conversion trials on private land.

<i>Site</i>	<i>Establishment (Ha)</i>	<i>Conservation (Ha)</i>	<i>Conversion (Ha)</i>
<i>Lyranes</i>	<i>10.1</i>	<i>4.9</i>	
<i>Canknoogheda</i>	<i>7.8</i>		
<i>Keeas /Glanmakee</i>	<i>7.1</i>	<i>1.3</i>	
<i>Derrylicka</i>	<i>2.2</i>	<i>8.7</i>	
<i>Derrygarrane South</i>			<i>5.5</i>
<i>Total (Ha)</i>	<i>27.2</i>	<i>14.9</i>	<i>5.5</i>

C.3 Establishment of in-field buffer strips

Action	Target/Deliverable	Date Due	Result
C.3	600 m of new hedgerows; 600 m of hedgerow re-laid; 1,500 m of in-field buffers	30/06/2020	3,211 m of new hedgerows; 0 m of hedgerow re-laid; 382 m of in-field buffers

This action comprised three main measures; planting new hedgerows; relaying existing hedgerows and creation of in-field buffer strips. A total of 3,211 m of new hedgerow and 382 m of in-field buffers were achieved.

New hedgerows: Hedgerows are an important part of the Irish landscape and they allow farmers to divide their grassland into smaller grazing pastures for livestock or to define ownership boundaries. Restructuring of agricultural land through the removal of hedgerows and other field boundaries has resulted in the creation of long, uninterrupted field systems where surface water runoff is unimpeded, resulting in the erosion of soils and the transport of nutrients from farmland to freshwater pearl mussel habitat.

3,211 meters of new hedgerow were established as part of the project. Hedgerows were planted between October and April by participating farmers. Six plants per metre of locally-sourced whitethorn, blackthorn or holly were planted in a double row inside a stock proof fence. Hedgerows provide a natural physical barrier that slows the flow of overland runoff, reducing the amount of sediment and diffuse pollution such as phosphorus reaching the river. They can be particularly effective on sloping grassland fields along watercourses. When positioned close to a source such as improved grassland in receipt of organic and inorganic fertilisers they have been shown to have the potential to reduce phosphorus transfers to watercourses. They increase the interception and absorption of rainfall and prevent soil, sediment and nutrient loss from fields. Research has shown that in temperate lowland settings, the hydrological functioning of hedgerow soils enhanced water storage during periods of heavy rain and take longer to reach maximum water content during storms compared to pasture fields.

Relaying hedgerows: During the farm surveys, existing hedgerows were recorded for each plot on the participating farms. The hedgerows were in good condition and advice from leading practitioners was that the hedgerow types typical to the catchments were not suitable for relaying due to factors such as hedgerows being too mature, unsuitable species composition or structural complexity (e.g. laid on an earthen bank). The relaying hedgerow target was replaced with new hedgerow planting.

In-field buffers: 382 m of in-field buffers were established along contours. These buffers were initially left unmanaged to promote vegetation recovery to reduce surface runoff by interrupting the hydrological connectivity; reducing phosphorus losses by increasing infiltration and intercepting sediments. Light grazing or mowing was carried out once a year to keep vegetation in check. The lower than expected uptake of this element can be explained by a reluctance to

sub-divide fields, into smaller units, owing to difficulty in working with machinery in these smaller units. Also many of the participant farmers did not have long sloping fields on their farms.

This action was effective at reinstating field boundaries and as the hedgerow mature they will increase localised infiltration to the ground water table, slow overland flow and intercept plant nutrients and sediment from upslope areas.

C.4 Grazing and livestock management

Action	Target/Deliverable	Date Due	Result
C.4	375 ha of critical source and transport areas identified and managed	30/06/2020	437 ha of CSA managed; 100 feed stations; 42.6 km of fencing; 20 gateways; 10 footbridges

A shift from the traditional mixed farming system (relying largely on native breeds of sheep and cattle) to the suckler cow based systems (continental-cross dominated) has resulted in an intensification of farming activity on more accessible low-lying parts of farms close to the river. This activity has resulted in the development of critical source and transport areas (CSA) where sources of either sediment and /or nutrients occur. Examples include poached pastures and river banks, supplementary feeding stations; access points, and track ways. Where these sources interact with a pathway they can be transported to the river thus impacting the mussel’s habitat.

During the farm surveys, 437 ha of critical source and transport areas were identified on project farms. Each CSA was scored annually using a five point scoring system, 1 being the lowest quality and 5 the highest. Areas that scored 3 or higher received a results based payment determined by the ecological condition of the plot. Farmers were given advice on how to reduce silt/sediment loss from their plots and increase their score.

As an indication of its effectiveness Schulte *et al.* (2009) demonstrated that when best practices to control sediment loss were targeted at CSAs comprising just 6% of a catchment area this resulted in a decrease of 31-61% in sediment export when compared to conventional management practices. Implementation of grazing and livestock management in critical source areas covered 7% and 12% of participating farms in the Caragh and Blackwater respectively.

The area in the two lowest scores (88 ha) decreased by 50% between year 1 and year 3 of the farm plans, while the area with the highest score increased from 36 ha to 229 ha in the same period (Figure 4). There were positive reactions to this from farmers and much of the improvements made to CSAs were made in year one of the farm plans. The average plot size of CSAs was 2.3 ha but plots greater than 5 ha also experienced improved scores with 13 out of 20 of these plots increasing by at least one score between year one and year three.

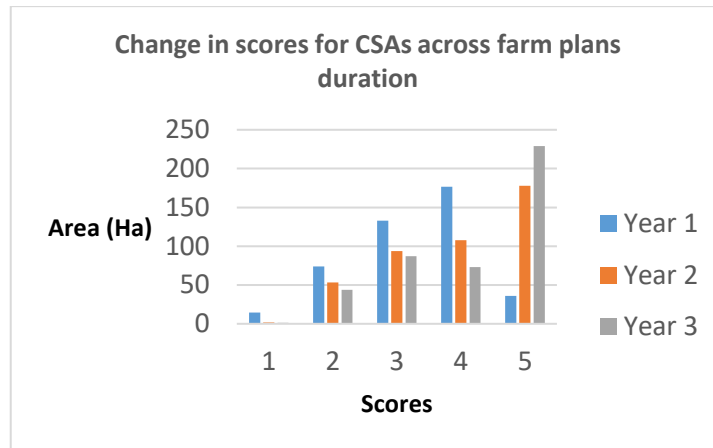


Figure 4 Changes in scores for CSAs across project farm plans

Grazing and supplementary feeding management strategies were developed, where required, to aid with the management of CSAs or the implementation of nutrient management plans. Approximately 42,654 m of fencing was installed to exclude livestock from freshwater pearl mussel habitat or to enhance livestock management (grazing and supplementary feeding). With new fences installed, farmers could now use rotation systems to ensure that land was optimally grazed, thus reducing ground disturbance overall.

On some farms, as part of the livestock management action, the number of cattle were reduced or the animals were split into smaller herds. Wintering of livestock outdoors between two blocks of land and pre-positioning winter fodder in the fields before winter was found to have positive outcome in terms of CSA scores 100 new feed sites were implemented, 20 new gates /access points have been created and 10 new cattle or sheep foot bridges have been installed as part of these livestock management actions.

Despite the natural constraints facing farmers in terms of high annual rainfall and sloping land the implementation of these measures were excellent. The improvement in condition has demonstrated that targeting CSAs could significantly improve the environmental efficiency and is a cost effectiveness of mitigation measures (Doody *et al.*, 2012; O’Callaghan *et al.*, 2018).

C.5 Reduction of farm nutrient inputs

Action	Target/Deliverable	Date Due	Result
C.5	375 ha of nutrient management plan measures	30/06/2020	Bespoke nutrient management planning system developed; Area based measures implemented across 501 ha of farm land on 39 farms; Soil nutrient testing on 530 ha; Nutrient reduction measures implemented on 503.7 ha; 62 cattle and 20 ewes destocked from project farms.

Increased importation of chemical fertilisers onto farms, increased slurry production and changing livestock management have resulted in increased losses of nutrients, especially phosphorus, which is generally considered to be the limiting factor for algal growth in freshwaters. This leads to increased macro-algal and macrophyte production, which poses a threat to mussels as the increased plant life also reduces oxygen levels available at night time as plants respire.

Nutrient inputs on farms are concentrated in low-lying areas adjacent to and upslope of freshwater pearl mussel habitat. A bespoke nutrient management planning system tailored for the requirements of the freshwater pearl mussel in high rainfall areas and challenging physical

settings was developed. This novel approach was designed to reduce nutrient inputs both at a farm-level and, crucially, at a field level.

39 farmers implemented nutrient management plans across their farms. Information on stocking rates, fertiliser use and animal housing was gathered through a questionnaire. 530 ha of land in receipt of organic or inorganic fertiliser and classified as “green land” was soil-tested in Q1-2016 and each field was risk-assessed using the modified Phosphorus Risk Score (mPRS; Magette *et al.* 2007) which scored a field for its connectivity to watercourses, soil type and slope. The information was inputted into the project’s nutrient management plan calculator in order to select the combination of measures, considering the specific circumstances on the farm, which maximised the potential to balance the farm nutrient budget, therefore reducing excess losses to the river network.

Farm level measures included stock reduction, conversion to traditional cattle breeds, switching to non-phosphorus containing chemical fertiliser and alteration of grazing patterns. Across the participating farms, a total of 52 suckler cows, 10 cattle and 20 ewes were removed from farms, resulting in an estimated reduction of 624 kg of P and 4,084 kg of N entering the project catchments each year. Conversion from large continental breeds to smaller traditional breeds took place on two farms, with Charolais and Limousine cattle replaced with Hereford and shorthorn cattle. One participant farmer has since converted the majority of herd to traditional breeds as they are better suited to his land.

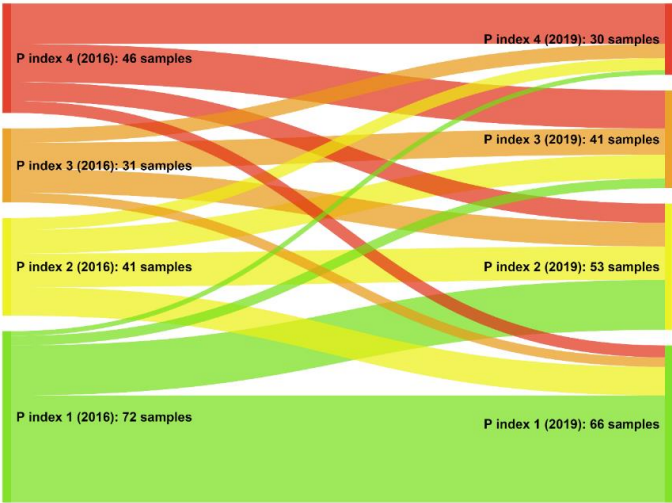


Figure 5 Diagram indicating changes in soil P index sampled during the KerryLIFE project.

Switching to non-phosphorus chemical fertiliser was found to be a very effective and cost efficient method of reducing nutrient inputs. It resulted in a total reduction of 3,428 kg of P entering the catchments representing a reduction of 83% in chemical P that was imported on to farms. It proved a positive measure with farmers as the results of soil tests could show that applying P was surplus to requirements for grass growth and the switch to a nitrogen only fertiliser represented savings of up to 30% in their fertiliser costs. This measure was implemented with an estimated cost effectiveness of €1.62 Kg of P removed. This compares with an estimated cost effectiveness of €38.36 per Kg of P removed under the stock reduction measure.

Despite the potential risks for farmers in spreading slurry during summer months instead of the preferred early months of year there was a good response to this option with 25 farmers

conducting summer only spreading of slurry on 146.4 ha. 53.9 ha of this land received split applications of slurry between 1st May and 1st September and this had a higher predicted effectiveness in reduction of nutrient runoff than just one summer application.

C.6 Alternative drinking water facilities

Action	Target/Deliverable	Date Due	Result
C.6	20 alternative drinking water facilities	30/06/2020	262 alternative drinking water facilities

Livestock in the project area get nearly all of their water for drinking by accessing rivers, streams and drains. When livestock, especially cattle, enter watercourses they can destabilise the bank river causing it to collapse, foul the water with excreta, trample mussels and disturb their habitat. This action aimed to demonstrate alternative drinking water facilities and the conditions under which to use them.

During the farm surveys (Action A.2), much higher levels of animal access to freshwater pearl mussel habitat and priority watercourses was observed than was anticipated. The project responded by increasing the number of alternative drinking water facilities offered to farmers. Four water-trough designs were trialled in a range of situations on project farms. There were three water-trough types for cattle (plastic water-trough, concrete water-trough and nose pumps) and one for sheep (plastic water-trough).

Water troughs were installed by the participating farmer with the Project Team providing technical advice where needed. In many cases the farmers own knowledge of their farms in siting and supplying water to individual troughs was relied on. Mountain streams were the main supply for the gravity fed water troughs. For nosepumps, large streams and rivers were used to supply the water, which worked well. A filter and no return valve was attached to the inlet of the pipe to improve efficiency of the unit. Cattle required some time to get used to the nosepump but habituated, thereafter and were happy to use them. On mixed farms, the sheep and lambs were observed drinking out of cattle water troughs which was an unexpected bonus. Farmers chose to install bigger troughs or concrete troughs, as they saw the benefits, and covered the extra cost themselves.



Figure 6 Example of drinking point before (September 2015) and after (September 2016) the fencing of the access point to the watercourse and the installation of a water trough.

Approximately 1,024 cattle were excluded from entering freshwater pearl mussel connected watercourses to access drinking water. The impact of this measure was evident immediately in a 100% reduction in livestock damage to mussels and their habitat and a 100% reduction in cattle urination and defecation on pearl mussels in these locations. The measure has also

contributed to a reduction in sediment losses from more than 50% of locations as ground vegetation recovers, reducing the level of bare soil.

Some farmers were reluctant at first to use the water-troughs, however they can now see the benefits of a clean supply of water for their livestock and reduced erosion of their riverbanks. The facilities have added value for the overall farming enterprise as the troughs and nose pumps can result in reduced soil damage, improved grass coverage and a reduced risk of injury, disease, liver fluke, lameness and ulcers to livestock that were previously entering watercourses or wet/boggy areas.

C.7 Restructuring of commercial plantation to long-term retention woodland

Action	Target/Deliverable	Date Due	Result
C.7	Restructure 175 ha of commercial plantation to long-term retention woodland	30/06/2020	178 ha restructured from commercial conifer plantation to long-term retention woodland and open habitat.

Conifer plantations in the project area are traditionally managed under a clearfell silvicultural system, with a crop cycle of approximately 40 years involving drainage, ground preparation, planting, fertiliser application, road construction, thinning, clearfell harvesting, timber extraction and replanting. As the plantations mainly occur on peaty, erodible soils on steep slopes these operations can result in siltation and nutrient enrichment of freshwater pearl mussel habitat.

This action focused on trialling techniques to permanently restructure conifer forests into long-term retention woodland. Arising from the high level of risk determined during the source and pathway mapping and the risk assessment in Action A03, methods of restructuring that minimised sediment and/or nutrient losses during implementation were trialled across 178 ha of commercial conifer plantation. These restructuring techniques are grouped into manual, mechanised or a combination of both and are briefly described below.

Manual restructuring

Halo-thinning is a restructuring technique that removes unwanted conifer trees in a circle (i.e. halo) around a target broadleaf tree, to release that tree from competition and to facilitate desirable natural vegetation. Tree removal is by manually felling or ring-barking. Through repeated application over a period of years, such halos are enlarged until the entire conifer canopy is replaced. This technique was applied within one young conifer stand and elsewhere as part of the gradual restructuring to open habitat with some cover of woodland.

Ring barking involves cutting away a section of bark completely around a target tree. This initially starves the roots of sugars/photosynthates produced by the needles/leaves which gradually kills the entire tree over a 2-5 year period. Once dead, these trees tend to snap rather than uproot reducing the risk of sediment loss from upended rootplates. As the needles drop, the increased light reaching the forest floor promotes re-colonisation by ground flora, which benefits from the gradual release of nutrients from the decaying needles.

Replanting – Five sites covering 50.2 ha were replanted under the Native Woodland Scheme with birch pioneer woodland enrichment planting of Scots Pine, Rowan and Oak using pit-planting and no fertiliser, pesticide or herbicide.

Mechanised restructuring

Sensitive harvesting – involving a harvester only was implemented at Garrane. Trees were felled to waste and no timber was extracted as part of the operations.

Sensitive harvesting/ extraction – involving a harvester/forwarder combination was implemented at Slievaduff, Tooreenafersha and Garrane covering 37.7 ha. This approach was similar to how conventional clearfell and extraction is undertaken. However the project devised an extensive range of mitigation measures to minimise potential losses of sediment and nutrients. These were installed at much higher densities than would be typically required in similar operations.

Skylining/cable – consisting of a pulley system, one end of which was attached to an anchor tree and the other to a tractor-mounted winch. The felled logs were attached to a moving carriage on the cable and the logs winched to the road. Cabling was implemented at Tooreenafersha in conjunction with conventional harvesting and forwarding method. The conditions available for skylining were limited across the surveyed forest properties due to the slopes, infrastructure and the availability of stable anchor trees. Skylining was effective at reducing the traffic at key locations but alternative measures such as lop-top brash mats provided a similar level of ground protection.

Heli-logging – A feasibility study into the use of helicopters (heli-logging) for the management of high risk locations was carried out. This approach has potential benefits to the felling and harvesting of trees in some instances as the risk is transferred from the forest site to the processing site. However, trees still need to be felled by a harvester machine prior to extraction.

Mix manual and mechanised sensitive restructuring

Chainsaw fell-to-machine – where trees were felled with a chainsaw towards the harvester machine, thereby extending its reach and allowing more trees to be processed from the harvesting rack.

Chainsaw fell-to-waste where trees were felled with a chainsaw or *harvester fell-to-waste* where trees are felled with a harvester- these approaches were used where timber extraction was not planned. The harvester was used in instances of complex wind-throw.

An extensive suite of mitigation measures were deployed as part of the restructuring trials in order to reduce sediment and nutrient losses and to reduce the hydrological connectivity including

- nutrient interception measures such as birch and grass over-sowing, brash export;
- sediment control measures, such as lop-and-top brash mats, silt fencing in the dry;
- hydrological measures such as log-dams, peat/plastic piling dams, leaving trees in-situ;
- invasive species control.

The techniques implemented enabled the restructuring of commercial forests into long-term retention woodlands. The risk of sediment and nutrient loss was reduced and the measures contributed to the partial re-wetting of project areas. However, in practice the mitigation measures did not eliminate all sediment/nutrient losses and therefore residual risks posed from forest operations remained.

C.8 Transformation of conventional clearfell managed commercial forest to continuous cover forestry

Action	Target/Deliverable	Date Due	Result
C.8	Not specified	31/12/2019	2.8 ha continuous cover trial

Continuous Cover Forestry (CCF) is a form of forest management where the forest canopy is retained throughout the lifetime of the forest and individual or small groups of trees are removed at certain times thus allowing light to reach the forest floor for new seedlings to grow. Gradually, over time the forest will develop into a mixed age forest with different layers beneath the canopy.

The forest property initially identified for this trial was wind-damaged between the time of the project application and the implementation of trials. Of the 541 ha of forestry surveyed in the Caragh and Blackwater catchments no area was found to be suitable for CCF forestry due to soil type, tree age, wind-throw risk due to wind exposure and/or inadequate infrastructure. However, following a further review, a small 2.5 ha trial site where conditions were close to being suitable was identified. The forester marked out the trees along short (50m – 100m) extraction racks. These were then harvested and extracted using a small-scale harvester and forwarding machinery to the existing road. While the smaller and light machine reduced the risk of soil damage, there was limited brash (small diameter woody material) available to protect the ground during the operation. Access from the forest out on to the forest track proved difficult to manage resulting in cutting of the track surface. Reducing the angle of approach on to the track reduced this to an extent but it was not always possible and the tracks on the forwarder were changed to further reduce the damage.

CCF is often proposed as an alternative management technique to clearfelling in Ireland. However, opportunities to apply CCF to existing forests within the two catchments were almost totally absent, due to peat soils, steep slopes, high annual rainfall and high wind exposure conditions, all of which contribute to instability. These same conditions can be found in many freshwater pearl mussel catchments and other water-sensitive upland catchments, suggesting that the application of CCF in this regard might have a minimum application in such areas.

C.9 Firebreak management

Action	Target/Deliverable	Date Due	Result
C.9	1,500 m controlled burning 1,500 m willow firebreak Information pamphlet	31/12/2016	532 m of prescribed burning firebreak; 1,276 m of willow firebreak; 1,110 m of grazed firebreak. Total = 2,918 m Information pamphlet (See E08-05)

The threat of wildfire to forestry is growing partly as a consequence of changes in how land is managed under various agriculture and social policies. The most widely used method of fire protection in Ireland is the practice of grubbing. Grubbing is where the ground vegetation is scraped off to the bare soil in a 6 m wide strip to remove fuel and prevent a fire reaching the forest. However, this exposes bare soil to weathering and mobilisation, and silt and sediment can be transported to watercourses. Three alternative firebreak methods, prescribed burning, grazed and planting of willow were trialled and demonstrated. Firebreak trial sites were identified as part of the preparation of the forest management plans (Action A.3).

Prescribed burning: A prescribed burn is a technique where the quantity of flammable vegetation is reduced by controlled burning thereby reducing the risk of a wildfire spreading into adjacent plantations. These burns were carried in accordance with the DAFM Prescribed Burning Code of Practice. A written prescribed burning plan was prepared by the Project Team and Forest Service personnel to guide the operation. The Project Team also notified An Garda Síochána of the intention to burn, as is required. This method proved extremely challenging due to the mix of wet ground conditions, wet weather and high winds in these areas, particularly before the closed period for burning in Ireland (1st March – 31st August) came into effect.



Figure 7: Firebreak with build-up of dead *Molinia* grass (L), willow strikes planted at Bohaculia (C) and a prescribed burn firebreak being implemented at Bohaculia (R)

Grazed firebreak: This approach involved fencing off 6 m wide strips along the edge the forest properties and setting up grazing permit agreements between forest owner and an adjacent landowner with cattle. The cattle grazed the vegetation within the firebreak for short periods e.g. 1-2 weeks during the summer to reduce the amount of flammable material available.

Willow firebreak: Willow planting is a form of a “green firebreak”. Whereas the traditional approach to firebreaks has been to remove vegetation levels, green firebreaks seek instead to establish lines of less flammable vegetation. 30 cm long willow cuttings of local provenance were planted by ‘striking’ the lower end of the cutting into the ground to a depth of 10 cm arranged in rows of three plants, spaced 1 m apart. The establishment of the willow was variable due to deer browsing pressure and the soil type (peat).

Of the three techniques trialled, the most viable was found to be the grazed firebreak, once the initial set up was achieved.

D: Monitoring of the impact of project actions

D.1 Mussel monitoring population

Action	Target/Deliverable	Date Due	Result
D.1	36 monitoring transects; 3 reports on the condition of the freshwater pearl mussel population	31/12/2019	152 monitoring transects sampled 3 reports on the condition of the freshwater pearl mussel population

Monitoring of the large, widespread and dense populations of freshwater pearl mussels in catchments the Blackwater and Caragh involved the following three elements density, demography and distribution. A baseline survey was carried out in 2014, with repeat monitoring in 2016, 2017 and 2019. From 2016 onwards an updated monitoring method³ in which up to 11 transects along a 100m stretch of habitat were monitored rather than a single transect as per the baseline survey, was initiated. This provided a more thorough understanding of the mussel population, habitat condition and potential for juvenile habitat within the survey reach.

Density - the number of adult mussels were counted in quadrats across a combination of fixed permanent transects or newly established transects. A total of 152 transects comprising 1,612 quadrats (1 m²) were undertaken across four survey years in both catchments (Table 3).

Demography - Population structure was assessed by measuring the length of mussels both visible on the river bed and those hidden in the substratum in small (0.5 m x 0.5 m = 0.25 m²) quadrats of juvenile habitat. All mussels are carefully replaced in their habitat. A total of 76 juvenile quadrats were monitored.

Distribution - Distribution surveys undertaken by Ross (1999) were digitised and re-surveyed in 2018 and 2019 to check for extensions or contractions of the populations in the two river systems.

Table 3 Summary of population monitoring per catchment and year.

Catchment	Year	No. of transects	No. quadrats	No. juvenile quadrats
Caragh	2014	6	58	8
	2016	38	484	8
	2019	36	258	18
Blackwater	2014	9	97	8
	2016	48	521	16
	2019	15	194	18
Total		152	1612	76

A mussel ageing study was conducted as part of the KerryLIFE project and the findings are summarised in Mussel Monitoring Report No. 2 (pages 40 to 47 *Annex D01-02*). The results were also included in a national mussel ageing study (Moorkens & Killeen, 2018) and is expected to be published as a peer review publication.

KerryLIFE collaborated with study into the genetic diversity of mussels in Ireland commissioned by the Coordinating Beneficiary and conducted by Irish and German researchers. Live mussels were carefully collected from six locations in the project area, transported to Co Cork for genetic sampling and returned (live) to the river on the same day.

³ The revised methodology was developed based on work undertaken in Ireland (including the KerryLIFE rivers) and the UK and was published by the Coordinating Beneficiary in 2020 as Irish Wildlife Manual No. 122) and a peer review scientific article by Killeen & Moorkens, 2020.

The results were published in Geist *et al.* (2018) and has contributed a greater understanding of genetic diversity in freshwater pearl mussel populations in Ireland and across Europe⁴.

Three reports covering 2014, 2016-2017 and 2019 were prepared under this action, see *Annexes D01-01, D01-02 and D01-03* respectively. These data were cross analysed as part of the Ecosystem Services report (D08) together with monitoring data on habitat (D02), sediment, flow and redox (D03) and water chemistry (D04).

D.2 Biological monitoring of freshwater pearl mussel habitat

Action	Target/Deliverable	Date Due	Result
D.2	5 annual reports on the biological monitoring of FPM habitat; monitoring of macroinvertebrates and macrophytes on 3 occasions	31/12/2019	5 annual (2015-2019) habitat reports (<i>D02-01, D02-02, D02-05, D02-06, D02-07</i>) Macroinvertebrates and macrophytes on f4 occasions with reports (<i>D02-03, D02-04, D02-08, D02-09</i>)

The biological condition of the freshwater pearl mussel's habitat was monitored using three principal components (1) filamentous algae, (2) macrophytes and (3) macroinvertebrates.

Filamentous algae – Visual assessments of the presence of green trailing filamentous algal species and diatom growth were recorded to detect changes in trophic state from oligotrophic to mesotrophic or eutrophic conditions.

Macrophytes –The presence of rooted macrophytes were recorded to detect changes in trophic state of the river and declining juvenile habitat conditions. Visual assessments of percentage cover of macrophytes were recorded at 222 sites. Dedicated macrophyte surveys were carried out at 20 sites on four occasions during the project to track changes in the river ecosystem.

Macroinvertebrates – Macroinvertebrates were monitored by specialist contractors at 20 sites on four occasions during the project to track changes in the river ecosystem. Q-values were assigned to each sample.

Data for each of these components were collected through dedicated field surveys or while undertaking other monitoring (e.g. freshwater pearl mussel population assessments under D.1, sediment and flow monitoring under D.3 and water-chemistry monitoring under D.4).

Dedicated surveys were separated into spatial sites monitored at least once each year and high frequency sites which were monitored biweekly throughout the growing season from April to September.

Spatial sites: 24 sites were monitored annually between 2015 and 2019. In 2018, all 24 spatial sites were monitored twice (May and Aug/Sep) timed to assess the condition of the habitat when it is expected to be at its best and worst condition.

Frequent sites: 6 sites were monitored biweekly throughout the growing season resulting in between 64 and 74 samples being collected. This high frequency monitoring allowed changes in habitat condition to be tracked and provided information on both the severity and duration of algal blooms or siltation events that can affect pearl mussels.

⁴ Geist, J., Moorkens, E., Killeen, I., Feind, S., Stoeckle, B., O Connor, Á. and Kuehn, R. (2018) Genetic structure of Irish freshwater pearl mussels (*Margaritifera margaritifera* and *Margaritifera durrovensis*): validity of subspecies, roles of host fish, and conservation implications. *Aquatic Conservation: Marine and Freshwater Ecosystems*

Five annual reports on the biological monitoring of pearl mussel habitat and four reports on macroinvertebrates and macrophytes covering 2015 to 2019 were prepared under this action, see *Annexes D02-01 to D02-09*

These data were cross analysed as part of the Ecosystem Services report (D08) together with monitoring data on mussel populations (D01), sediment, flow and redox (D03) and water chemistry (D04).

D.3 Sediment and flow monitoring

Action	Target/Deliverable	Date Due	Result
D.3	5 annual reports on turbidity 5 annual reports on redox	31/12/2019	Annual reports on turbidity and reports on redox (<i>D03-01 to D03-08</i>) Thesis O'Neill (2019) Sustainable Land-Use Management for the Conservation of the Freshwater Pearl mussel: Sediment Flux and provenance (<i>D03-09</i>)

The physical condition of freshwater pearl mussel habitat was monitored using five principal components (1) turbidity, (2) flow, (3) redox, (4) visual sediment assessments (cover and infiltration), and (5) sediment fingerprinting. The monitoring of sediment and flow was undertaken principally by the research assistant.

(1) *Turbidity*: Turbidity sondes (YSI) were deployed at the outflow of three sub-catchments, (the Owenroe and Bridia in the Caragh and the Kealduff in the Blackwater). These instruments recorded turbidity, conductivity, and temperature at intervals of 15 minutes. 400 automatic water samples and grab samples were collected to calculate suspended sediment concentrations. Two further turbidity sondes were deployed on three occasions for a total of 38 weeks to monitor the effects of concrete conservation actions under Action C.7.

(2) *Flow / depth gauges*: Water level or depth gauges were deployed at the same locations as (1) above. Loggers recorded water level at 15 minute intervals. Nine flow transects were completed using an electronic current meter and the resultant data were combined with the water level data to model discharge.

(3) *Redox*: Portable redox probes were used to determine the reduction potential (Eh) between the open water and the interstitial river bed habitat at 5cm depth. Redox potential is a “proxy” for the ability to obtain oxygen within the river bed sediment. Losses in redox of over 20% in this habitat are unlikely to be compatible with juvenile survival Geist & Auerswald (2007). Redox monitoring was undertaken at all spatial sites (as per D.2) each year. The Project Team attended a workshop in Munich with international experts on the application of redox (and other) methodologies for monitoring mussel habitat.

(4) *Visual sediment cover*: Visual assessments of fine sediment cover were undertaken at all mussel monitoring (Action D.1), biological monitoring (Action D.2) and water chemistry (Action D.4) sites using the method outlined in Moorkens (2020). The Research Assistant also recorded visual sediment cover across 150 1m wide transects. Silt infiltration into the substrate was also monitored using a kicked silt-plume NPWS methodology at all mussel and mussel habitat monitoring sites (D.1 and D.2).

(5) *Sediment fingerprinting*: Sediment fingerprinting or provenance was used to identify non-point sources of sediment using a suite of radionuclides, magnetic tracers and organic content to distinguish the sources of sediment trace. Source samples were taken from 300 locations on

project farms, forests and other land uses e.g. roadways and river banks within the project area. River sediment was collected in 12 time-integrated-sediment-samplers (TISS) which collected passively suspended sediments from the river. Bed sediment was collected through the deployment of 24 bed-load samplers and drum 36 re-suspension. Six lake sediment cores were collected Caragh Lake in Q3-2017. The results were used to calculate what contribution each source made to the river.

River Habitat Assessment Technique: the entire length of the Owenroe, Bridia and Kealduff rivers (10.5 km in total) were surveyed to assess modification of the river channel and assist in identifying geomorphological pressures that may be impacting on the freshwater pearl mussel habitat.

Rain gauges: Two rain gauges were deployed; one each in the Owenroe and Kealduff sub-catchments. These data were supplemented by four rainfall gauges maintained by Met Eireann (the Irish Meteorological Service).

Annual reports were prepared on turbidity for 2015-2018 and on redox for 2015-2019 (See *Annexes D03-01 - D03-09*). A Masters of Philosophy thesis by Karen O’Neill entitled “Sustainable Land Use Management for the Conservation of the Freshwater Pearl Mussel: Sediment Flux and Provenance 2019 (*D03-10*) was also produced. These data were also cross analysed as part of the Ecosystem Services report (D08) together with monitoring data on mussel populations (D01), biological habitat (D02) and water chemistry (D04).

D.4 Water chemistry

Action	Target/Deliverable	Date Due	Result
D.4	500 samples 5 annual water chemistry reports	31/12/2019	660 samples collected and analysed; 5 annual water chemistry reports (<i>D04-01 - D04-05</i>)

Water chemistry monitoring was performed to track background changes in water quality over the lifetime of the project and to evaluate the effectiveness of concrete conservation actions associated with nutrient management on farms and harvesting of conifers.

660 samples were collected from 18 sites on the main river channels and from 25 in streams/drains associated with project forests and farm on 15 occasions between December 2015 and May 2019.

Water samples were analysed for total phosphorus, molybdate reactive phosphorus, total nitrogen, total oxidised nitrogen, ammonia, nitrate, alkalinity, colour and dissolved organic carbon by a specialist laboratory capable of analysing low limits of detection.

The results were interpreted in line with the CEN Standard for Freshwater Pearl Mussels (NSAI 2019) and the Water Framework Directive.

Five annual reports on the water chemistry covering years 2015 to 2019 were prepared under this action, see *Annexes D04-01 to D04-05*. These data were also cross analysed as part of the Ecosystem Services report (D08) together with monitoring data on mussel populations (D01), biological habitat (D02) and sediment, flow and redox (D03).

D.5 Vegetation monitoring

Action	Deliverable	Date Due	Result
D.5	1 report on browsing protection measures for trees	31/12/2019	1 report on browsing protection measures for trees (<i>D05-01</i>)

Baseline vegetation surveys (broad vegetation types, natural regeneration rates, ground vegetation, yield class and windblow status) of forests were completed at 125 locations (sub-compartments) covering a total of 541 ha of private and public forestry

Detailed 1m² vegetation relevés were collected from 38 locations to monitor the implementation of halo-thinning, Birch seed trials and grass over-sowing under Actions C.7 and the willow firebreak and prescribed burning under C.9.

Habitat mapping was completed and digitised across 5,700 ha of farmland. The condition of critical source and transport areas was scored annually.

Aquatic and amphibious vegetation was recorded in 1,750 farm drains extending 267.9 km and in 448 forest drains covering 79 km.

Fixed-point photography (FFP) was taken at both farm and forest sites to track direct and indirect changes in vegetation before, during and after the implementation of measures and to illustrate the effectiveness of the concrete conservation measures (e.g. recovery of vegetation and reduction in bare soil at cattle drinking facilities).

A study into the efficacy of browsing protection measures for trees was completed (see Annex *D05-01*).

D.6 Monitoring the implementation of farm and forest management plans

Action	Target/Deliverable	Date Due	Result
D.6	NA	31/12/2019	NA

Farm plans: Implementation of project actions on participating farms commenced in Q2-2016. Annual reviews of each farm plan were undertaken in early summer of 2017, 2018 and 2019. The review involved the farm advisor walking each farm with the farmer, if possible, to establish what measures and/or the results had been delivered on the project farms by the date of the review. Annual monitoring of the condition of the critical source areas (CSA) were also completed as part of the review and allowed the Project Team and farmers to track changes on their farm. The results of the review determined what payments the farmer received that year as only fully implemented or delivered measures were paid on. This provided a good incentive for farmers to have as much of their work done as possible in advance of the review. As the project progressed and farm plans were reviewed, some plans were amended, with measures added or removed, as more suitable alternative actions were identified or as farmers made different choices. Overall there was a very high level of implementation of actions within farm plans. The results of the review and any amendments to the farm plan were recorded by the Project Team.



Figure 8 Monitoring photo taken in the Blackwater catchment in 2015 (left) and (right), in 2018 following implementation of farm plan measures to address CSAs

Forest plans: Implementation of restructuring trials under Actions C07-C09 on public forests and private forests on farms under Action C02 commenced in Q4-2015. The monitoring of the restructuring of conifer plantation was undertaken jointly by Coillte, an Independent Forester and by the KerryLIFE Scientific Officer. Regular site visits were necessary to ensure that specific issues that arose during the operations were addressed.

D.7 Evaluation of the impacts of project actions and socio-economic impacts of project

Action	Target/Deliverable	Date Due	Result
D.7	Report on the socio-economic impact of the project and cost-effectiveness of project actions.	31/12/2019	Report on the socio-economic impact of the project (<i>D07-01</i>)

This action examined the impacts of the KerryLIFE project on the Caragh and Blackwater catchments. The work was undertaken by a consortium of social geographers who were awarded the work after tendering process.

The researchers conducted a desk-based review of the relevant literature, including looking at the evaluations of other similar projects and generated a profile of the area based on geography, population, activity maps and land use from publically held sources. This secondary data collection fed into two instruments to enable the collection of primary data, through survey questionnaires of all participating households and to the wider community / citizens across the catchments. A mixed-methods approach of questionnaires, face-to-face meetings / interviews / conversations with farmers and members of their household and on-site visits to farms to view practices and investments and to hear from farmers about their experiences, perspectives and recommendations was employed. The questionnaire was collected in-person from all households, thus affording participants the opportunity to talk to the researchers and to expand on their experiences and recommendations. There was a 100% response rate to the evaluation by participants. The questionnaire for the general public mirrored some of the indicators that were in the farming households' questionnaire, and captured data on attitudes to landscape and the role of farmers as custodians of the landscape.

Stakeholders, including local businesses, community and statutory sector representatives participated in a round of one-to-one interviews.

The evaluation findings were then framed in a Social-Ecological System to conceptualise the KerryLIFE project across its key elements, the catchments (resource system); the freshwater pearl mussel; farming and forestry (resource units of interest); the Project Management and

Stakeholder Groups (governance system); the project staff, farmers, and foresters (actors); and the institutional, policy, governance, social, cultural and economic settings the project operated within.

A report entitled KerryLIFE Socio-Economic Evaluation (*Annex D07-01*) was produced and launched by Minister of State for Heritage and Electoral Reform, Malcolm Noonan, T.D.

D.8 Evaluation of the impacts of project actions on ecosystem functions

Action	Target/Deliverable	Date Due	Result
D.8	Report on ecosystem services	31/12/2019	Study on ecosystem services (<i>D08-01</i>)

This action carried out an assessment of the impacts of the concrete conservation on the ecosystem functions in the Caragh and Blackwater river catchments arising from the KerryLIFE project. This was achieved by cross analysing the monitoring efforts, in particular Actions D.1. - D.6, made during the KerryLIFE project and relating them to the condition of freshwater pearl mussel in the rivers of both catchments, and the ecosystem services provided by mussels and their habitat.

A report entitled Review of Environmental monitoring during the KerryLIFE with respect to requirements of the freshwater mussel *Margaritifera margaritifera* and the impact of project actions on ecosystem functions was produced (*see Annex D07-01*).

F.1 Project operation and management

Action	Target/Deliverable	Date Due	Result
F.1	Establish Project Management and Stakeholder Groups	31/12/2019	16 Project Management Group Meetings and 6 Project Stakeholder Group Meetings

The Project Team was employed specifically to implement and manage the LIFE project. The recruitment of the Project Team is described in the Action A.1 above. As previously, mentioned, the overall project operation (F Actions) was managed by the Project Team and overseen by the Project Management Group (PMG). The PMG was comprised of representatives from the Coordinating and six Associated Beneficiaries, a representative of the SKDP Agriculture sub-committee and two representatives from the farmers involved. At the PMG meetings, the Project Team provide an update of the work done and outline the work for the next time period. Specific issues were discussed drawing from the expertise of the multidisciplinary group. The Project Management Group (PMG) held an average of three meetings per year. The Team Leader and the Coordinator of the Project for the Coordinating Beneficiary and the representatives of the Associated Beneficiaries were in regular contact with each other outside of these meetings. In addition, dedicated meetings with individual members or sub-groups of the PMG were held to work through technical issues that arose during the implementation of forestry, agriculture or monitoring actions.

A Project Stakeholder Group made up of representatives of the local community, farming and forestry organisations, fishery interests, academic institutions and relevant Public Authorities met with the PMG and Project Team. The PSG informed, supported and advised the PMG and Project Team on the delivery of the project actions. The PSG met on five occasions.

F.2 Networking with other projects, including LIFE projects

Action	Target/Deliverable	Date Due	Result
F.2	NA	31/12/2019	NA

The exchange of knowledge and ideas and the opportunity to learn from others experience has proven invaluable in the operation of the KerryLIFE project. To achieve this, early contact with national and international projects was established and maintained contact throughout the lifetime of the project. A database of relevant project was established on the project's website.

Members of the Project Team visited projects in Ireland such as the Burren Farming for Conservation Project, AranLIFE, the Ballinderry River's Trust, WISER and Raptor LIFE and in the UK, the Pearls in Peril Project and Wild Ennerdale, and the UC4LIFE project in Sweden. In 2016, the project participated in a workshop on stream substrates in Munich which focused on technical aspects of monitoring sediments using redox as a proxy for juvenile habitat condition. The Project Manager and Administration Officer also attended three very beneficial workshops run by the LIFE Monitoring group NEEMO on planning for the AfterLIFE, risk management and a specialist platform on Invertebrates in the LIFE programme, all affording excellent opportunities to network with other projects.

The Project Team and Beneficiaries delivered 29 oral presentations, attended 10 seminars, participated in four workshops, and attended 18 networking events. This has included presentations to

- Ad-hoc Forestry Group attended by the Minister of State for Food, Forestry and Horticulture, Mr Andrew Doyle, T.D
- UC4LIFE Conference
- Irish Freshwater Scientists Association Annual Meeting

The project participated in the Environmental Protection Agency's Blue Dot Programme and the National Rural Network sub-committee on Biodiversity.

The project also participated in a number of public events to promote the natural world, including Knowing Nature, Wild Derrynane, Iveragh Learning and the Dark Skies Symposium. Together with the Pearl Mussel Project, a group of participant farmers attended the Burren Winterage School and Festival which allowed farmers to hear about each other's work and practice in conserving nature on their farms.

KerryLIFE hosted visits from the Living Bog Project (LIFE14 NAT/IE000144), Raptor LIFE, Triple Lakes (LIFE13 NAT/SE/000116), Stržen (LIFE16 NAT/SI/000708) and Urban Rivers (LIFE17 ENV/IE/000281) to explain about the project's work and to give advice on the management of a LIFE project. In addition to other LIFE projects, KerryLIFE hosted a range of groups undertaking fact finding visits prior to their involvement in applying to LIFE projects, as well as, Oregon Foresters Small Forest Owners Association, Local Authorities Water Programme, Agricultural Sustainable and Support Advisory Service and participant on the COST Action on Payment for Ecosystem Services – Woodlands for Water.

KerryLIFE worked closely with the Department of Agriculture, Food and the Marine on the development of European Innovation Partnerships initiative (EIP) for the freshwater pearl mussel called the Pearl Mussel Project, funded under the Rural Development Programme 2014 – 2020. The Team Leader represented KerryLIFE on the Pearl Mussel Project and McGillicuddy Reeks EIP Operational Groups.

KerryLIFE also contributed to a number of research projects, facilitating the genetic sampling of freshwater pearl mussels as part of a National study into the diversity of *Margaritifera margaritifera* and *M. m. durrovensis*; the EPA COSAINT project on cattle drinking points in rivers; the Teagasc/Bord Bia pilot study on farmland habitats, Kerry Spotted Slug Project with National University of Ireland (Galway), Irish Natural Capital Accounting for Sustainable Environments (INCASE), ESDecide and Smarter Bufferz Project.

F.3 Development of the project data management systems

Action	Target/Deliverable	Date Due	Result
F.3	NA	31/12/2019	

KerryLIFE used a dedicated share-file server to store, manage and back-up all project data. The project adhered to the Coordinating Beneficiary's data policy for the development and maintenance of data resources produced and held by the project. All farm, forest, habitat and monitoring data were managed through a dedicated ArcGIS Geographical Information System (GIS) and associated databases. Financial information was managed in line with both the LIFE Programme's and the Coordinating Beneficiaries financial management systems.

F.4 Financial management

Action	Target/Deliverable	Date Due	Result
F.4	Full financial accountability	31/08/2020	Fully compliant

The KerryLIFE partners agreed at the outset for the Project Team to manage general expenditure of the KerryLIFE project on behalf of all Beneficiaries. This included costings, purchase of equipment, and procurement of external assistance and processing of payments to process. This ensured the smooth and efficient financial management of the project. The Associated Beneficiaries provided relevant financial material (e.g. timesheets, travel claims, invoices and grants) to the core Project Team on a regular basis who entered the information into a single consolidated cost statement for the project. Each entry recorded which beneficiary was responsible for the expenditure. High-level financial oversight and reporting was undertaken by the Coordinating Beneficiary's Accountant and an Assistant Principal Officer. Individual cost statements for each Beneficiary with cross-reference to the consolidated cost statement were prepared and each Beneficiary authorised their own expenditure. The Coordinating Beneficiary authorised the consolidated cost statement.

F.5 Independent audit

Action	Target/Deliverable	Date Due	Result
F.5	Independent Audit	31/08/2020	Independent Audit Report (Annex F05-01)

This action was required under Article 31 of the Common Provision to verify the financial statements produced as part of the KerryLIFE project. It verified the respecting of national legislation and accounting rules and certified that all costs incurred respected the LIFE standard administrative provisions. The audit was conducted by Mazars Ireland, a firm specialising in audit and assurance, consultancy, corporate finance and tax. The Project Team, together with the Coordinating and Associated Beneficiaries supplied all the necessary information to Mazars. The auditor found the financial report was a true and fair view of the expenses and income of the project.

F.6 AfterLIFE Conservation Plan

Action	Target/Deliverable	Date Due	Result
F.6	AfterLIFE Conservation Plan	30/09/2020	AfterLIFE plan (Annex F06-01)

The freshwater pearl mussel is a long-lived water dependent species and there is a well-documented lag period between taking conservation actions and seeing the recovery in the project actions from the outset.

During the lifetime of the project, principles of sustainability were embedded in the project. As part of this approach the Team Leader and the NPWS, worked closely with the DAFM in the development of a follow-on conservation project for the freshwater pearl mussel. This resulted in the aforementioned “Pearl Mussel Project” which was launched in 2018 and is funded within the Rural Development Programme (RDP) 2014-2020 under the European Innovation Partnership-Agri Operational Group measure. This programme has a budget of €10 million and operates in the two KerryLIFE catchments as well as six other nationally important freshwater pearl mussel catchments. Arrangements were put in place to ensure a smooth transition of KerryLIFE farmers across to the follow on project and 95% of KerryLIFE farmers have now joined the follow-on project.

Payments to the private landowners who established new or conserved existing native and converted conifer plantation to native woodland as part of the KerryLIFE project will be eligible to receive a once off maintenance grant four years after approval (subject to the terms and conditions of the Native Woodland Scheme) and an annual premium for a period of 7 years and 15 years, depending on which element of the NWS applies. The Forest Service will continue to monitor the effectiveness of the new planting scenarios trialled on project sites. The experiences gained during the trialling of the various forest-related techniques and approaches will prove invaluable in informing the treatments of forests in other pearl mussel catchments, and indeed, in the catchments of other protected freshwater species and habitats, and high status water bodies. It will also inform the evolution of procedures the FS-DAFM uses in relation to Appropriate Assessment.

In relation to the KerryLIFE walkways developed under Action E.4, Coillte together with the South Kerry Development Partnership, Lickeen Field Development Group and the Glencar Cattle Show have put in place a memo of understanding which outlines the maintenance of the walkways for an initial 10 year period.

The monitoring of the condition of freshwater pearl mussel population and habitat in the Caragh and Blackwater rivers will be continued as part of the national surveillance and monitoring programme.

Further details on the after LIFE conservation proposals are outlined in the KerryLIFE after LIFE plan

5.2 Dissemination actions

5.2.1 Objectives

Dissemination of information to raise public awareness and provide technical advice to farmers and foresters was an important part of the KerryLIFE. The objectives for KerryLIFE were

- to provide suitable information to raise awareness of the ecological importance of the freshwater pearl mussel
- to provide information to a wider audience of the present threats and possible solutions in the management of these important rivers and their catchments
- to develop local amenities that have the potential to add value to farm incomes
- to increase knowledge in the scientific and policy arena on the ecological makeup of the island and the effects of specific management techniques and policies on them.

These objectives were achieved at a broad level through the use of a website and social media and at a local level through public meetings, farm and forest walks and through public events.

On a national and international level the project facilitated college visits, undergraduate studies, information meetings combined with farm walks and have participated in conferences both national and international.

5.2.2. Dissemination: overview per activity
E.1 Project launch, public meeting and events

Action	Target/Deliverable	Date Due	Result
E.1	1 project launch; 12 public meetings / events; 5 annual celebrations	30/09/2020	1 launch - Sept 2015 18 public meetings 5 annual celebrations / Pearl Shield

The KerryLIFE project was launched by Minister of State for Disapora Affairs (formerly Minister for Arts, Heritage and the Gaeltacht), Jimmy Deenihan, T.D. on the 19th September 2015 at a public event held in the Cappanalea Outdoor Education Centre.

Five annual celebrations of the project were held through the annual ‘Pearl Shield’ challenge matches. The ‘Pearl Shield’ embraced the strong sporting tradition in the area and brought together the communities that comprised the KerryLIFE project area. The event alternated between the communities. The winning team received the KerryLIFE Pearl Shield trophy and each child received a KerryLIFE medal presented by a local sporting star such as Kerry footballers Tadgh Morley (a participant farmer) and Killian Spillane.

The project held 18 public events to raise awareness of the project, freshwater pearl mussels and other wildlife in the project area. These events typically were held in the evening or over weekend and targeted farmers, local community members or the general public. Events included information sessions, ‘KerryLIFE Mid-summer Moth Madness’ which focused on the very rare White Prominent Moth and the lesser horseshoe bat, jointly with the Vincent Wildlife Trust to 25th birthday of the LIFE programme, talk on the land ownership and archaeology in the area, and a visit from the Dr Guy Consolmagno, Head of the Vatican Observatory.

The project participated twice in the IPB⁵ Pride of Place Award, an all-island competition that acknowledges the work that communities are doing all over the island of Ireland. The first was with the Glencar Community in 2017 followed by the Blackwater Women’s Group in 2018. These events allowed the project to develop relationships with the wider community and demonstrate the successful integration of the project with these two communities.

The project linked into local and national initiatives that promote natural heritage and science such as the Kerry Science Festival, National Science Week, BT Young Scientist Competition, Heritage Week, ESB Tree Week, Wild Derrynane Weekend, and Knowing Nature. For four years, the project ran a stand at Europe’s largest agricultural show (attracting an average crowd of 280,000 visitors over three days), the National Ploughing. Thus widening the reach of the project to a national platform. The stand was honoured to be visited by the Minister for Culture, Heritage and the Gaeltacht, Heather Humphreys, T.D. and An Uachtarán na hEireann (President of Ireland) Michael D. Higgins.

Overall, these events were very successful in increasing public awareness of the project and promoting the crucial role played by the European Union in funding conservation projects that benefit local communities.

⁵ IPB Insurance are the headline sponsor of the IPB Pride of Place awards in association with Co-operation Ireland and Local Authorities, North and South.

E.2 KerryLIFE website

Action	Target/Deliverable	Date Due	Result
E.2	A website	31/12/2019	Dedicated website; Twitter; Facebook; Instagram

A dedicated project website, www.kerrylife.ie⁶ was launched in 2015. The website was designed to be easy to navigate with a consistent style throughout. Other services incorporated into the site include a search function, a contact form and an option to sign up for project newsletters. In addition, there was a password protection section used to share project documents with the project partners. The Project Team had administrator access to the website so that new content was added and improvements made as required. The website contained links to the EU LIFE webpage, all the project beneficiaries and to other relevant projects across Europe. At the end of the project, the content of the website was transferred to dedicated webpages on the Coordinating Beneficiary's website <https://www.npws.ie/research-projects/kerrylife>.

The project also used the popular social media platforms of Twitter @kerry_life and Facebook www.facebook.com/kerrylife to disseminate information about the project. The project's twitter account had 643 followers with 154 tweets issued. 98,131 impressions and 8,145 interactions through this channel. The project's Facebook page had 766 followers and 746 likes. The posts on Facebook reached 43,235 impressions, with a reach of 25,971 people. The social media platforms linked to the projects website and all were updated to highlight specific items of interest and the projects progress.

As part of Biodiversity Week, KerryLIFE took over the Department of Culture, Heritage and the Gaeltacht's Instagram Account furthering the reach of the project to a much wider and more diverse audience.

E.3 Media campaign

Action	Target/Deliverable	Date Due	Result
E.3	Media campaign	31/12/2019	Successful campaign involving 31 articles; 2 television features; and 6 radio interviews

The Project was committed to raising the profile of the project and awareness of the freshwater pearl mussel and achieved this through various media platforms during the lifetime of the project.

The media campaign resulted in 31 articles published in local, regional and national publications, including ten project based pictures being published. Details of press releases and the printed articles are included in *Annexes E03-01* and *E03-09*. Many of the articles resulted from press releases issued directly to media outlets as well through the press offices of the Beneficiaries. Others opportunities were generated in response to the project's profile.

Through print and broadcast media to maximise awareness of freshwater pearl mussel and to ensure a growing public awareness of the project.

The project featured on both television and radio. KerryLIFE featured in the RTE (Irish National Television) prime time show '10 things to know about water' focusing on sediment fingerprinting, work being undertaken by Teagasc in the project. The project also featured on EcoEye, an environmental magazine show. The episode on the loss of Ireland's high status rivers and lakes focused on the freshwater pearl mussel as an indicator of continued good water

⁶ Web content was transferred to Coordinating Beneficiary's own page with effect from June 2021.

quality and the conservation of the freshwater pearl mussel. Filming included an interview with a participant farmer, Team Leader, Scientific Advisor, Research Assistant and Coillte representative. The episode included a river walk with the children from the local national school run by the project. Both these television features have been broadcast several times since their initial broadcast and are also available on the RTE player, a digital media playback service. Details of broadcast media events to date are included in *Annex E03-33*

The Project Team and several beneficiary’s undertook radio interviews on their involvement in the project. Mr John Foley, a KerryLIFE farm participant who represented the project at the National Biodiversity Conference was interviewed on Morning Ireland, Ireland’s premier morning radio show along with Dr Ciaran O’Keeffe, chair of the KerryLIFE project.

KerryLIFE and the LIFE programme also featured in Ireland’s National Biodiversity Action Plan 2017-2021 and in Ireland’s River Basin Management Plan.

E.4 Added value, product branding and tourism

Action	Target/Deliverable	Date Due	Result
E.4	NA	31/12/2019	3 looped walking trails; Notice board; farm produce marketing plan; directory of local businesses.

The future of farming in marginal agricultural areas such as in the Caragh and Blackwater catchments is dependent on building linkages with tourism and farm diversification.

Farm produce brand: The main beef system on KerryLIFE farms is suckler to weanlings whereby calves born in the spring are kept for 7 or 8 months and sold on to farmers elsewhere in the country to be finished for slaughter. This system has resulted in a shift from smaller, hardier traditional breeds to larger less hardy continental breeds. This action aimed to developed a beef initiative to add value to the traditional breeds with the view that premium price would be paid for the beef produced. A proof of concept trial was undertaken on a two farms selected following a census of cattle on participating farms. Calves were fed a specially devised feed developed by Agri-King to supplement the diet of the weanlings. After the cattle were slaughtered, a tasting trial was carried out and a marketing plan was also prepared.

Directory of Local Businesses: A network of 20 local businesses in the project area was established. Details of this network were included on the project’s website.

KerryLIFE walking trail: The Recreation Officers in South Kerry Development Partnership (SKDP) and Coillte together with the project team developed three looped walkways: Lickeen, Castlerock and KerryLIFE in the project area. These walkways linked into the existing Kerry Way, which is Ireland’s longest (>200 km) and most popular walking trail. A screening statement was prepared for the walkways. Works to establish the walking routes commenced in 2018. Signage was strategically placed to promote the freshwater pearl mussel and the KerryLIFE project along the trail.

Farm-based tourism infrastructure: The project collaborated with Kerry County Council to expand the Kerry International Dark Sky Reserve into the Blackwater and Caragh catchments.

E.5 KerryLIFE demonstration farm and forest project sites

Action	Target/Deliverable	Date Due	Result
E.5	4 demonstration sites	31/12/2019	1 dedicated demonstration farm; seven other farms used for targeted demonstrations events; 4 forest properties used for demonstration events

The original application had envisaged that four sites, two farms (one in each catchment) and two forests (one private and one public) would be established to demonstrate the project actions. Selection criteria for demonstration sites included farm or forest type, measure types demonstrated, and accessibility (distance and parking).

Farm demonstration sites: One farm in the Blackwater met most of the criteria however no farm in the Caragh satisfied the criteria. As a result, the Project Team proceeded with using the Blackwater demonstration farm and carried out targeted demonstrations on other projects farms which had good examples of specific measures. This approach proved very successful. Host farmers were proud to showcase their farm and the measures they implemented on their farm to their neighbours and to farmers visiting from the other catchment or elsewhere in the country. As a series of demonstration events took place, the rotation of demonstration farms/sites lessened the burden on any one host farmer and encouraged attendance.

Forest demonstration sites: Forest properties by their nature have better infrastructure than farms for setting up demonstration site. Similar to the farms, individual forest sites were used to demonstrate the range of restructuring techniques and measures at different stages of implementation and under different site conditions.

Demonstration farms and forests were selected for the purpose of learning and sharing ideas between farmers, foresters and stakeholder on issues surrounding land use and pearl mussel conservation.



Fig. 9: Discussion group in Blackwater

E.6 Training workshops and demonstration events

Action	Target/Deliverable	Date Due	Result
E.6	10 demonstration and 10 training events; Annual reports on all events	31/12/2019	19 demonstration and 13 training events 4 annual reports on workshops and demonstration events (E06-01 to E06-04)

A total of 32 demonstration events and training workshops were held. Demonstration events and training workshops were used held to build awareness of conservation issues on farm and in forests, and to demonstrate measures that can be used to address them.

The project held 19 demonstration events, 11 of which were targeted farmers, and 7 targeted forestry stakeholders and 1 that targeted both farmers and foresters. The farm demonstration

events were structured around the implementation of concrete conservation actions (e.g. installation of nose pumps Action C.6 or the implementation of nutrient management plans Action C.5). Demonstration events took place on different demonstration sites (Action E05) giving participants the opportunity to see measures in different settings and the solutions used by the host farmers. These events typically generated much discussion between farmers on how to manage issues and the sharing and creation of new knowledge.

The forestry demonstration events were focused on the forest management and on restructuring techniques trialled by the project. Demonstration events were often held on forests site with proposed operations in order to work through the sensitivities of the site and the operational plans. Subsequent demonstration events were held in sites with active or recently completed operations. These on-site visits were very important for breaking down language barriers between the various stakeholders and to highlight practical considerations for the successful implementation of measures. These events were vital to promote conservation management to farmers and forest owners in the project catchments in south Kerry.

The project held 13 training workshops. 3 were targeted at the forest sector and focused on developing public and private forest management plans and the restructuring of conifer plantations or the establishment of native woodlands. 8 training workshops targeted farmers and covered themes relevant to delivering the measures under Actions C01-C06. The project also co-hosted two training workshops, one with DCHG and two pearl mussel experts for 35 NPWS scientific and regional staff from across the country, and second with the Forest Service for foresters on identification of Annex I habitats and the freshwater pearl mussels.

Details of the training workshops and demonstration events are summarised in annual reports for 2016 -2019 in *Annexes E06-01 to E06-04*.

Figure 10: A KerryLIFE forestry workshop event attended by project partners in the Blackwater catchment.



E.7 Schools education programme

Action	Target/Deliverable	Date Due	Result
E.7	19 educational events	31/08/2020	24 educational events for 398 national school children; 187 secondary students; 177 undergraduates; and 5 work placements. Total = 767 Collage of logo entries (<i>E07-01</i>) and List of educational visits (<i>E07-02</i>)

A schools education programme was delivered to 585 school children and 177 undergraduate students through 24 events. The schools programme started with a logo design competition among national schools in the region. 93 entries were received and local artists Pauline Bewick and Poppy Melia adjudicated. A collage of the entries is shown in *Annex E07-01*.

School visits and field studies were designed to explain the biology and ecology of the freshwater pearl mussel but they also provided information on the wider biodiversity that occurs in the Iveragh Peninsula from bats, to moths, plants and habitats. The programme also aimed to explain the connection between farming and forestry practices and water quality and the conservation of freshwater pearl mussels.

Field visits with Inland Fisheries Ireland was held in May 2016 where macroinvertebrates were identified and fish caught using electrofishing. The project held a river walk with students from the local national school that coincided with the filming of the Eco Eye episode. All school visits completed are listed in *Annex E07-02*.

The educational programme linked into local and national events such as Kerry Science Week, National Science Week, and the ESB National Tree Week.

Four undergraduates completed Work Placement as part of their degree programme in Wildlife Biology, Wildlife Biology and Tourism or Agricultural Science, based in the Institute of Technology Tralee. One graduate completed an internship with project. The undergraduates The intern joined the project through The European Mobility, Training and Employability Promotion Programme for Young People from Castilla Y Leon in Spain. The objective of the placements/internship were: to improve participants skills in areas such as ecology, farm planning, report writing and communications while also gaining experience as part of a multidisciplinary team.

E.8 Project publications

Action	Target/Deliverable	Date Due	Result
E.8	1 Project brochure; 4 Newsletters; 8 Information notes; 3 Peer reviewed scientific papers	31/08/2020	See Table 4

This action involved the dissemination of the project findings and the production of a series of information notes that describe the techniques and measures demonstrated by the project. The list of outputs are listed in Table 4.

Table 4: List of project publications

Annex	Description
<i>E08-01</i>	A pop-up-stand
<i>E08-02</i>	Brochure
<i>E08-03</i>	Bookmark
<i>E08-04</i>	A6 poster
<i>E08-05</i>	Drain management Guide
<i>E08-06</i>	Firebreaks Guide

E08-07	Forest Restructuring Guide
E08-08	Livestock and Grazing Management Guide
E08-09	Silt fencing Guide
E08-10	Log dams Guide
E08-11	Halo-thinning Guide
E08-12	Grass re-seeding Guide
E08-13	Newsletter
E08-14	Cattle drinking troughs
E08-15	Riparian fencing
E08-16	Nutrient management planning
E08-17	Crossing points for livestock
E08-18	Wall poster
E08-19	Book chapter

Information notes focused on detailing the methodology used under the KerryLIFE project that will aid the land managers in freshwater pearl mussels and also relevant to other high status water bodies. The project published a chapter in a book entitled '*Farming for Nature – The role of results based payments*' which also provided accounts of two former LIFE projects, the BurrenLIFE / Burren Farming for Conservation Programme and the AranLIFE Project. The Research Assistant produced a thesis entitled '*Sustainable Land-Use Management for the Conservation of the Freshwater Pearl Mussel: Sediment Flux and Provenance*'. As described in Action D01, the project collaborated with research into the genetic diversity of mussels in Ireland which resulted in a peer reviewed paper by Geist *et al.* (2018). Further scientific publications resulting from the work undertaken by the project are being worked on.

E.9 Project conference

Action	Target/Deliverable	Date Due	Result
E.9	Conference event	31/08/2020	Conference and Conference proceedings (E9-01)

A conference was organised as part of the project's dissemination programme. The conference was held in the Blackwater Community Hall in May 2019. The one-day conference included presentations from speakers to disseminate the project's findings and to provide context for the work of the project. Aside from the Project Team, invited speakers included four participant farmers, research assistant, national freshwater pearl mussel expert and a representative of the Pearl Mussel Project, the follow-on Agri-environment project for freshwater pearl mussels. The papers covered the project's work and the achievements in conserving freshwater pearl mussels. Of particular interest were the insights that the project farmers had into the work that they had undertaken on their own farms. The presentations were followed by visits to two demonstration sites, a farm in Bohaculia and a forest in Slievaduff. A dedicated scientific meeting/workshop planned for spring 2020 however did not proceed due to the Covid 19 Pandemic.

E.10 Project reporting

Action	Target/Deliverable	Date Due	Result
E.10	Inception Report; Progress Report 1; Mid-term Report; Progress Report 2; Layman's Report; Final Report	31/08/2020	Inception Report; Progress Report 1; Mid-term Report; Progress Report 2; Layman's Report; Final Report

This action was to inform the EU LIFE unit and External Monitoring Team of the project's progress and achievement of milestones and deliverables through the submission of reports in line with an agreed reporting schedule. The Project Team, in conjunction with the Coordinating and Associated Beneficiaries, prepared an inception report after 9 months that reviewed the feasibility of the project submitted in the funding application. Following this two progress reports and one mid-term report were submitted in 2016, 2018 and 2019.

5.3 Evaluation of Project Implementation

KerryLIFE was an ambitious project which was successful in achieving its objectives of demonstrating sustainable land use management practices for the conservation of the freshwater pearl mussel. The overall project structure, consisting of a dedicated Project Team supported by the Project Management Group and Project Stakeholder Group proved to be an effective model in the delivery of the project. The Project Team were able to commit fully to its implementation for the duration of the project, while the Project Management and Stakeholder Groups provided a broad range of experience that could be drawn on at any time to ensure the smooth and effective operation of the project.

As a multi-partner project, the Project Team established its own identity providing the Project Team an opportunity to engage without being unduly effected by farmers, foresters and local community member's past interactions with beneficiaries and to allay fears they held about further restrictions being placed on their farming or forest activities.

The farms plans worked well in achieving the environmental objectives of reducing sediment and nutrient inputs and contributing to restoration of the hydrological conditions required by pearl mussels. The plans were clear and were easy to follow. The one-off prepayment on signing their contract to get farmers started, and also the withholding of all other payments until the measures were completed or the result achieved incentivised farmers to deliver actions early. Farmers reported good levels of trust, relationship building and knowledge exchange with the Project Team. The increase in farms participating in the project greatly extended its influence within the community; however it added a significant additional survey and administration load to the Team.

The preparation of forest management plans and the implementation of restructuring trials proved challenging due to the high level of risk revealed by the risk assessment. The operational plans formed the basis for which trials were implemented and were refined through learnings from one operation to the next. These operational plans proved to be a very effective means of communicating among stakeholders what measures were to be implemented, not just when and how but also the purpose of the measures.

Due to the complexities arising from the high levels of risks identified in the operational plans, issues arose with regard to time-frames associated with meeting the regulatory requirements. Considerable time was required to compile the NISs for the various trials, and once submitted to the Forest Service alongside the relevant licence and / or grant scheme applications, the regulatory process itself created issues due to the time taken to undertake the various assessments and referrals. In several cases, the Forest Service also sought further information from the project regarding specific applications quite late in the regulatory process, often for details not required in the initial application. However, the FS-DAFM focused on the KerryLIFE projects as a discrete batch of applications, and close contact ensured that issues that arose were resolved as effectively and quickly as possible. The completion of most forest operations was also restricted to between April and October under the Forestry and Freshwater Pearl Mussel Requirements (Forest Service, 2008), with the exception of planting operations, which took place during the plants' dormancy periods between October to April.

The two Natura 2000 sites involved also had a very high number of qualifying interests which needed to be considered in the preparation of NIS's associated with project actions to assess the potential impact they could have on other qualifying interests as well as the freshwater pearl mussel.

Weather conditions presented challenges for both farming and forest trials either delaying or limiting the implementation of measures such as spilt application of slurry as part of nutrient management plans on farm, prescribed burning trials on firebreaks and monitoring (accessing rivers). The project had to adopt flexible work practices to ensure that these measures were implemented.

In the latter stages of the project, improved scientific evidence on the critical role of hydrological function on pearl mussels became available, which together with the project's experience highlighted that the continuation of intensive agriculture and forest practices will prevent the achievement of the conservation of freshwater pearl mussels. While it was in part too late for KerryLIFE to act on this to a greater extent, the project's outcomes strongly influenced the Pearl Mussel Project to focus on protecting wetlands and peatland habitats and addressing negative hydrological conditions on farms.

There were two amendments to the original Grant Agreement. The EU LIFE Unit requested a change in the partnership structure to include Pobal as an Associated Beneficiary due to the involvement of Rural Social Scheme Participants in the project and to move the costs involved for the Research Assistant from personnel to External assistance. KerryLIFE requested the reallocation of DAFM-FS personnel cost to external assistance to fund the restructuring of conifer plantations; the transfer of DHLGH personnel costs to external assistance for mussel monitoring; the reorganisation of costs to facilitate the increase in farms involved by the project; and a time extension to enable the completion of forestry operations that were delayed due to obtaining licences and due to Covid 19 pandemic.

Overall the project implementation went well, the delays as a result of the issues stated left the project behind schedule and therefore a time extension was necessary to ensure the project was fully implemented.

Table 5: Action by action comparison of results achieved against objectives

Task	Foreseen in the Grant Agreement	Achieved	Evaluation
A.1	Project Team in place and project office set up within five months of start date.	A six person Project Team were recruited. The core Project Team were recruited in Q4-2014. The Research Assistant was recruited Q2-2015. The Rural Social Scheme Participant was assigned in Q2-2016. The office was set up in Q4-2014	Project Team and project office were achieved as expected. Slight delay in recruiting Research Assistant and assigning RSS Participant. Delays in filling vacancies that arose during lifetime of project.
A.2	Production of 25 farm management plans covering 2,500 ha of farmland	40 farm management plans produced covering 5,038 ha of farmland	The increase in farms resulted in the task taking 3 months longer.
A.3	Production of forest management plans covering 485 ha of public and 30 ha of private land.	8 plans for public forests covering 495 ha and 9 plans for private land covering 47.56 ha produced. 22 individual operational plans prepared to implement trials under Action C02, C07 – C08.	Detailed operational plans were developed to implement proposed measures in forest management plans. Plans for private sites adhered to the NWS procedures.
C.1	Management of drains at 1,500 locations on farms and forests	Management interventions implemented at 2,829 locations on farms and forests	Some drain management measures foreseen on farms were instead implemented on project forests
C.2	Establishment of 40 ha of native woodland to stabilise riparian sediments	4 woodland establishment sites 27.17 ha (two of which expanded existing woodlands) 4 woodland conservation sites 14.91 ha 1 conversion site 5.5 ha.	Strategic tree planting at vulnerable locations was not achievable under NWS scheme and was replaced with more conventional applications. Implementation was delayed due to identification of sites and lengthy licencing procedures, including the production of NIS's. 1 additional woodland conservation site of 3.51 ha was approved but not implemented within the lifetime of the project due to contract availability.
C.3	600 m of new hedgerow, 600 m of re-laying hedgerow and 1,500 m of in-field buffers. Total length = 2,700 m	3,211 m of new hedgerow and 382 m of in-field buffers have been achieved. Total length = 3,593 m	The condition of existing hedgerows on farms was better than expected and therefore no hedges were re-laid. The physical situations the in-field buffers were designed for were not present on participating farms. These sub-targets were replaced with the planting of additional hedgerows. Low levels of interest from participants in the action for in-field buffer strips.

Task	Foreseen in the Grant Agreement	Achieved	Evaluation
C.4	Reduce vegetation damage and soil erosion across 375 ha of critical source and transport areas. Establish 100 alternative feeding stations Erect 5,000 m of fencing	Sediment reduction measures implemented across 437 ha. 100 alternative feed stations established Erected 42.6km of fencing; 20 gateways; 10 footbridges	Improvements in the condition of the critical source and transport areas were observed in all categories. Fencing has eliminated cattle access to pearl mussel habitat and improved grazing management
C.5	Reduce nutrient inputs across 375 ha of farmland.	Bespoke nutrient management planning system developed; Area based measures implemented across 501 ha of farm land on 39 farms; Soil nutrient testing on 530 ha; Nutrient reduction measures implemented on 503.7 ha; 62 cattle and 20 ewes destocked from project farms.	The reduction in livestock potentially benefitted the whole farm.
C.6	Establishment of 20 alternative drinking water facilities	262 alternative drinking water facilities installed.	The need for water-facilities was much greater than envisaged in the grant agreement. This measure has been invaluable in reducing/eliminating cattle access to pearl mussel habitat and reducing river bank erosion.
C.7	Restructure 175 ha of conifer forest to long-term protective woodland	178 ha of commercial conifer plantation have been restructured to long-term retention woodland. A feasibility study into the use of heli-logging.	Techniques demonstrated were partially effective at reducing sediment and nutrients during operations in the restructuring of forests to protective habitats.
C.8	Trial continuous cover forestry	2.8 ha continuous cover forestry trail completed.	The original property identified was unsuitable and was subject to wind-throw between the application stage and project start. An alternative site was identified. Limited availability of existing forest sites suitable for CCF in project area due to soil type, wind exposure, stand age and environmental sensitivities.
C.9	3,000 m of firebreak trials	3 types of firebreak demonstrated - Prescribed burning; grazed firebreaks; and willow planting across 2,918 m	Unsuitable weather and ground conditions impacted prescribed burning trials. Grazed firebreaks were considered the most effective once established
D.1	Monitor 36 transects. Training on mussel surveying Prepare 3 reports	152 transects surveyed across four years. The Project Team were trained to survey mussels and their habitat. 3 reports were prepared	Increased number of transects monitored using improved methodology resulting in higher quality data. Monitoring was conducted over four occasions rather than the three proposed.
D.2	Biological monitoring of freshwater pearl mussel habitat using filamentous algae, macrophytes and macroinvertebrates. Produce five annual reports on biological monitoring	222 locations for biological monitoring have been surveyed to date. 20 locations were sampled for macroinvertebrates on 4 occasions; 20 locations were sampled for macrophytes on 4 occasions. 24 locations were sampled as part of a spatial monitoring on five occasions; 6 locations were sampled as part of a high frequency monitoring; and 152 locations as part of the D01 monitoring for pearl mussel populations and habitat.	Biological data on the freshwater pearl mussel habitat was collected from both dedicated surveys and during other surveys using a standardised method increasing our understanding patterns in the biota spatially and temporally.

Task	Foreseen in the Grant Agreement	Achieved	Evaluation
D.3	Monitoring sediment and flow in pearl mussel habitat. 5 annual reports on turbidity 5 annual reports on redox	A wide range of techniques from turbidity sondes, flow loggers, Time Integrated Samplers, bedload samplers, rainfall meters and were deployed. Redox probes were used to assess juvenile habitat condition. Annual reports on turbidity and redox (D03-01 to D03-08); 1 thesis (D03-09)	This complex action was led by the Research Assistant, and whose work was supplemented by the core Project Team.
D.4	Analyse 500 water samples	660 samples were collected from 18 sites on the main river channels and from 25 in streams/drains associated with project forests and farm on 15 occasions.	A broader range of sites was required to monitor trends in water chemistry across the catchments and the effectiveness of concrete conservation actions.
D.5	Vegetation monitoring	5,700 ha of farmland was surveyed; 48 relevés and 2,200 drains surveyed for vegetation analysis; Fixed point photography stations established.	
D.6	Monitoring the implementation of actions on project farms and forests	Reviews of farms were completed in 4 occasions. The implementation of forest measures was monitored during the active phases of the operations.	The annual review of farms ensured measures were completed and payments released
D.7	Report on socio-economics impacts of the project and cost-effectiveness of project actions	Studies into the socio-economic impact of the project and cost-effectiveness of project actions completed.	Reports on socio-economic impacts of the project and the cost-effectiveness of the project actions
D.8	Report on ecosystem functions	Collection of data was completed under Actions A02, A03, C01-C09 and D01-D07. The data was compiled and cross analysed.	Report entitled Review of Environmental monitoring during the KerryLIFE with respect to requirements of the freshwater mussel <i>Margaritifera margaritifera</i> and the impact of project actions on ecosystem functions
E.1	1 project launch 5 annual celebrations 12 public events	The project was launched by Minister Deenihan in 2015; 5 annual celebrations held through the KerryLIFE Pearl Shield challenge matches; 18 Public events such as moth trapping and bat walk to mark the LIFE programme's 25 th Birthday Participated in 6 other public events organised by third parties e.g. Kerry Science Festival	
E.2	Project website	A well maintained website, Twitter and Facebook accounts	
E.3	Media campaign	32 articles generated; 2 television features; 5 radio interviews	Effective media campaign delivered
E.4	Added value, branding and tourism	3 looped walking trails 7.6 km in length; notice board; farm produce marketing plan; directory of local businesses.	
E.5	2 demonstration farms and 2 demonstration forest	1 dedicated farm demonstration; 7 action specific demonstration farms and 4 action specific demonstration forest sites.	A number of farms and forests were used to host events to best demonstrate the topic being covered. Farmers have taken pride in hosting the events and were very accommodating.

Task	Foreseen in the Grant Agreement	Achieved	Evaluation
E.6	10 training workshops and 10 demonstration events	19 demonstration events and 13 training workshops were delivered to farmers, forest owners and regulators.	
E.7	Schools educational programme	24 educational events for 776 school visits and 2 field visits have been achieved to date. A logo design competition received 93 entries. The project has hosted 5 work placement undergraduate and graduates to date.	This programme was very effective at engaging with school children.
E.8	Production of one brochure, 4 newsletters, 8 information notes, one project booklet and 3 peer reviewed papers.	One pop-up stand, 2000 copies of brochure, 1000 project book marks, 2000 A6 posters, 12 information notes, 1 book chapter, 1 academic thesis, contributed to pearl mussel genetic and aging studies	
E.9	Project conference	Conference held in May 2019.	
E.10	Inception report; Progress report No. 1; Mid-term Report Progress Report No. 2; Final Report; Layman's Report	All reports prepared and submitted	
F.1	Establish Project Management Group (PMG) and Project Stakeholder Group (PSG)	PMG established in Q2-2014 and PSG in Q4-2015. 16 PMG meetings and 6 PSG meetings held in lifetime of the project	The project built up good one to one working relationships with the stakeholders so fewer meetings held than expected.
F.2	Networking	Project established good links with other projects and key stakeholder. The project presented 23 papers/posters at a national and international meetings and conferences allowing knowledge transfer from the project to other projects.	
F.3	Project data management system	The project developed a comprehensive data management system for farms, forests, monitoring, public awareness and financial data sets. The project adhered to the Coordinating Beneficiary's Data Policy.	
F.4	Financial management	Project finances managed in line with Coordinating Beneficiary procedures.	
F.5	Independent audit	Independent audit completed and report prepared	
F.6	AfterLIFE Conservation Plan	Project's agricultural actions are being continued by the Pearl Mussel Project, a European Innovation Partnership project for freshwater pearl mussels until 2023. Forestry premiums continue for between 7 and 15 years.	

5.4 Analysis of long-term benefits

5.4.1 Environmental benefits

a. Direct/quantitative environmental benefits

The KerryLIFE project aimed to improve the conservation of freshwater pearl mussels in two Natura 2000 sites, the Killarney National Park, McGillycuddy and Caragh Catchment SAC and the Blackwater (Kerry) River SAC. The actions implemented on project farms to reduce sediment and nutrients and to restore the hydrological conditions have had an immediate direct benefit to the freshwater pearl mussel and to the wider environment. For instance, the erection of fencing and the provision of alternative drinking water facilities has resulted in removing >1,000 cattle from watercourses and pearl mussel habitat. The creation of buffers along 6 km of river and the re-vegetating of 74 km of drains has broken the pathway between source areas and the river and while also reducing the intensity of land use in the catchments. Other measures such as the reduction in phosphorus (P) inputs on farms was immediate but the associated reduction in the soil P content will take longer to be seen due to the lag period between implementing the measures and seeing the response.

The environmental benefits of the forestry trials were mixed as the project focused on the restructuring of commercial conifer plantations to long-term retention woodlands. This transformation was considered at the time of the project inception as being a concrete measure to prevent siltation and nutrient loss to watercourses. The trials demonstrated did reduce siltation and nutrient losses during operations but despite extraordinary mitigation efforts, losses of silt and nutrients to waterways were observed during and after the operations. This was especially the case when machinery (harvester/forwarder) was involved in the felling or harvesting of trees.

b. Relevance for environmentally significant issues or policy

Freshwater mussels are one of the most endangered group of species worldwide. The learnings from the KerryLIFE project have been incorporated into the follow-on Pearl Mussel Project European Innovation Partnership in the project area and six additional freshwater pearl mussel catchments. The forest restructuring techniques demonstrated expand the management options available to the forest practitioners in sensitively restructuring forests to support the freshwater pearl mussel habitat requirements. The learnings are expected to inform future forest policy, especially with regard to freshwater pearl mussel catchments and other high status water bodies.

The scientific monitoring undertaken by the project has provided insights into how subtle changes in land use affect water quality and the condition of pearl mussel habitat. It also provided empirical evidence of the frequency and duration of algal blooms and elevated nutrient concentrations that can be missed by standard monitoring approaches. The project's contribution to a genetic study on mussels has shed light on the uniqueness of the genetic structure and diversity of both the Caragh and Blackwater populations in an Irish and European context and which will underpin the conservation policy with regard to conservation units for decades to come.

While the foremost focus of the KerryLIFE project was to support the implementation of the Habitats Directive with respect to restoring the freshwater pearl mussel population and its habitat to favourable conservation condition, the efforts of the project also contributed to the implementation of the Water Framework and the Shellfish Waters Directives.

5.4.2 Long-term benefits and sustainability

a. Long-term benefits and sustainability

The KerryLIFE project demonstrated practical trials to address the principal threats affecting the freshwater pearl mussel in the Caragh and Blackwater catchments arising from farms and forests. Many direct benefits were achieved during the lifetime of the project, however for others there will be a lag or time delay between when the measure was put in place and when the desired biological response is borne out in the natural environment. The time delay in achieving the improvement can be short, less than a year in some cases such as the excluding livestock from a watercourse. For others, there are complex interacting factors, including existing water quality, natural settings, climate, resource availability, scale and other land uses meaning it may take years or even decades to achieve an improvement. The continuation of measures put in place during KerryLIFE in the follow-up Pearl Mussel Project and expansion to other farms in the catchments will allow the necessary time for the full effect of the measures to be seen. The project has also increased the understanding among land managers of the relationship between the activities they carry out on their farms and forests and the condition of the natural environment, including the rivers.

b. Long-term / qualitative economic benefits

The KerryLIFE Project has had significant socio-economic impacts in both the short and long term. Farmers perceived that KerryLIFE had improved their household income, which will be continued under the Pearl Mussel Project. The investments of capital works such as fencing, water drinking facilities will support farmers in how they manage their farms in the coming years. The designation of the Caragh and Blackwater catchment as Special Areas of Conservation has been particularly important for local and regional development as they have helped attract funding through the LIFE Programme and subsequently through the European Innovation Partnership Programme that would otherwise not have come to the area. 74% of the KerryLIFE's spend was determined as occurring within the region. Much of the materials used by the Project Team, farmers and forest contractors were sourced locally helping to sustain local businesses. The continuation of payments through the Forest Service's premium payments and through participation of farmers in the Pearl Mussel Project will extend the economic impact of the project. Projects such as KerryLIFE therefore make an important contribution to the local economy.

c. Long-term / qualitative social benefits

Social benefits are the total benefit to society from producing or consuming a good or service. Through their involvement in the project, farmers; forest-owners; and forest workers were provided with an opportunity to share their knowledge about the river and their farms or forests with scientists and other professional practitioners. They have felt listened to and their willingness to participate was crucial in the delivery of the project. Through workshops, demonstration events and public events held by the project, farmers and forest-owners have built on their understanding of the role they each play in protecting water quality and the wider environment with many reporting they thought more about farming heritage and their local environment. The vast majority of farmers considered that their farms were better for wildlife and for the environment following the interventions taken through the project. This increased awareness of the environment will strengthen their commitment to conservation initiatives. The actions taken by participants on their land has and will continue to reduce sediment and nutrient losses to the river network, therefore improving water quality. This is important as angling, kayaking and outdoor pursuits are important recreational activities for the local community and for visitors to the project area. The walkways developed by the project provide an important amenity that can be used to promote well-being and allow connection to the KerryLIFE project.

d. Continuation of the project actions by the beneficiary or by other stakeholders

The continuation of the farm and forest actions has been a central goal of the project from the outset. The successful transition of farmers from KerryLIFE into the follow-up Pearl Mussel Project has ensured that measures implemented under KerryLIFE have continued. The farmers will continue to be rewarded for the delivery of cleaner water and higher levels of biodiversity. The forest measures on Coillte owned land have been assigned a biodiversity objective and will be managed accordingly. The woodlands established and managed under the Native Woodland Scheme regulated by the Forest Service will see participants continue to receive premium payments for between 7 and 15 years and, as per scheme requirements, future management will be based on Continuous Cover Forestry (CCF). The information notes produced by the project will inform farmer and forest-owners of appropriate land use management methods available. The project also had a focus on tourism and sustainability as economic drivers. KerryLIFE established a series of walkways and supported the expansion of the Dark Sky Reserve. The project highlighted the landscape and natural heritage as an important economic resource. Many of the actions in the project aimed to strengthen the management of these resources for the benefit of the local community and visitor alike.

5.4.3 *Replicability, demonstration, transferability, cooperation:*

The KerryLIFE project has built on the model developed by the Burren and Aran LIFE projects and adapted it to a water-dependent species, the challenges posed were interconnected and hence the approach demonstrated by KerryLIFE can be replicated and transferred to other catchments with similar climatic, geological and geographic conditions including the rest of Ireland and further afield, particularly to catchments with high status objectives under the Water Framework Directive. The Pearl Mussel Project has used the measures demonstrated in KerryLIFE in six other catchments. The Wild Atlantic Nature IP project will also implement similar measures.

The techniques developed for restructuring forests into long-term retention woodland and the operational planning template developed provide an invaluable models for use in other suitable situations. The native woodland trials demonstrated are transferable to drier, mineral soil dominated catchments holding freshwater pearl mussel populations characterised by relatively low densities and restricted distributions. Most of the natural habitats in such catchments have been converted to arable cropland or fertilised grasslands that runs right up to the river. In these situations, tree planting can provide the benefits of bank stabilisation, buffer against animal entry to the river, filtration of nutrients and silt and shading in conditions of higher temperature and lower precipitation.

The research into sediment fingerprinting is fully transferable and provides valuable information on which land uses are disproportionately contributing to siltation pressures in a catchments. This information can then be used to underpin targeting of measures.

5.4.4 *Best Practice lessons*

An important early decision taken by the project was to set up the project office within the project area. This proved invaluable as it immediately raised the profile of the project and facilitated strong engagement with the community. It demonstrated buy-in to working with and alongside the community and the Project Team were quickly included in wider community events and initiatives such as the Pride of Place, Glencar Cattle Show, Blackwater Sports Day and County Clean-Up Day. This approach should be replicated as best practice for other projects were possible.

Another important approach was in ensuring that there was flexibility in how measures were devised and implemented. This was key to the success of the project. Farmers and forest-owners were often quick to offer practical solutions to issues on their land or express preferences that were better suited their specific situation.

While, the farmers were responsible for implementing the measures on their farms, the project was reliant on sub-contractors to implement the forestry measures. Multiple procurement procedures with different successful bidders resulted in the Project Team having to train new sub-contractors. While this is very beneficial for the sub-contractors, it required significant resources on the Project Team in a relative short project. The use of a small number of contractors appointed and trained at the outset would therefore be strongly recommended.

5.4.5 *Innovation and demonstration value*

The project focused on testing, evaluating and demonstrating sustainable land use management practices for the farming and forestry sectors. The bespoke farm management system for freshwater pearl mussel, especially the nutrient management planning approach to reduce inputs of farm nutrients was innovative and can be applied in other catchments sensitive to nutrient enrichment. The project brought together result-based actions linked to improvements of habitat condition and actions-based measures that supported the freshwater pearl mussels. Lessons from other project were adapted for local application and participating farmers developed solutions alongside the Project Team. This hybrid model can be readily be adapted for use in other catchments with water quality pressures. Within the farm management plans, a bespoke nutrient management planning system was developed. This built on the modified Phosphorus Risk Score devised by Magette *et al.* 2006 and was adapted to farm type within the project area and the higher water quality requirements of freshwater pearl mussels. A wide range of novel forest restructuring techniques and mitigation measures were also trialled that expand the management options available to the foresters in the context of restructuring high risk forests to protective habitat that support the requirements of a site.

The research into sediment fingerprinting is fully transferable and provides valuable information on which land uses are disproportionately contributing to siltation pressures ion a catchments, thus underpinning better targeting of measures.

5.4.6 *Long term indicators of the project success*

The decisive indicator of the project's success will ultimately be the achievement of favourable conservation condition of the pearl mussel population and their supporting habitat in the Caragh and Blackwater rivers. The measures taken on project sites have had an immediate impact on reducing sediment and nutrients and disrupting pathways and the initial stages of improvement have been observed on project sites and in the river. Monitoring has detected improvements in some habitat stretches within the lifetime of the project and attributed these to the measures taken by the project.

It is well documented that that there is a lag period between when measures are taken and when the desired response is achieved in the environment. This is very much the case for water dependent species and habitats due to the direct and indirect impacts of land use in the surrounding land. Therefore the effect of the measures is expected to increase over time. The data collected on project farms and forests, together with the biological, chemical and physical monitoring of pearl mussel populations and associated habitats established a comprehensive baseline through which changes in the catchments and the recovery of the pearl mussel

population can be tracked. Nevertheless, it is important to remember that while the project increased the number of participants involved in the project, this amounted to small proportion of the farmland and forestry⁷ in the catchments. Ultimately, a whole catchment approach is needed in order to achieve the restoration and maintenance of these pearl mussel populations. The transition of 95% of KerryLIFE farmer participants to the Pearl Mussel Project which now has over 70% of all eligible farmers in Caragh and Blackwater catchments has been hugely positive. This ensures that farmers continue to be recognised and financially rewarded for delivering environmental benefits that support freshwater pearl mussel populations. Their continued participation with future conservation initiatives will also be a key indicator of the success of the project.

⁷ 18% of farmers and 27% of farmland; 8% of forestry in the project area were involved in the project

6. Financial Part

All monetary transactions were processed through a single suspense account held by the Coordinating Beneficiary. The six Associated Beneficiaries did not benefit financially from the EU contribution or overheads, as set out in their respective Partnership Agreements. Instead, the EU contribution and overheads were administrated by the Coordinating Beneficiary. The day to day expenditure was managed by the Project Team on behalf of the Beneficiaries and was paid out through the KerryLIFE suspense Account with two exceptions: Teagasc, procured the services of the University of Dundee who appointed the Research Assistant under the Walsh Fellowship Programme and the Forest Service issued payments under Native Woodland Scheme's directly to the landowner or their registered forester for works on both Public and Private Lands.

The project budget was estimated at €5,010,581 with an expected EU contribution of €2,439,924. From 1 July 2014 to 31 August 2020, the overall actual cost of the project amounts to €4,301,698.71. Based on this figure, the EU contribution amounts to €2,150,849.

6.1. Summary of Costs Incurred

The original budget was estimated at €5,010,581 with an EU contribution of €2,439,924. From 1 July 2014 to 31 August 2020, the costs incurred amounted to €4,301,698.71. This equates to 85.85% of the original budget (Table 6). Based on this figure, the expected EU contribution amounts to €2,150,849.

Table 6: Summary of project costs incurred

PROJECT COSTS INCURRED			
Cost category	Budget according to the Amended Grant agreement	Costs incurred within the project duration	%
1. Personnel	1,980,057	1,748,125.84	88.29
2. Travel	287,048	132,846.83	46.28
3. External assistance	1,849,963	1,582,091.57	85.24
4. Durables: total <u>non-depreciated</u> cost			
- <i>Infrastructure sub-tot.</i>	119,365	116,520.55	97.62
- <i>Equipment sub-tot.</i>	94,750	47,896.06	50.55
- <i>Prototypes sub-tot.</i>			
5. Consumables	82,983	98,965.92	119.26
6. Other costs	277,250	293,832.40	105.98
7. Overheads	319,165	281,419.54	88.17
TOTAL	5,010,581	4,301,698.71	85.85

Total contributions from the Coordinating Beneficiary and Associated Beneficiaries (excluding EU) amount to €2,150,849.35 which included direct financial contribution to the value of: €1,516,986.62 and benefit in kind payments to the value of €633,862.73.

The sum of the public organisations' contributions (as Coordinating Beneficiary and/or Associated Beneficiaries) to the project exceeds the sum of the salary costs of the civil servants charged to the project in compliance with Article 24.2.

Based on the co-financing rate, the European Commission's contribution was estimated as €2,150,849.

The lower than expected final expenditure resulted from lower time inputs of permanent staff among several beneficiaries and lower travel cost incurred. This reduced the available budget and expenditure was adjusted accordingly without affecting the delivery of the projects objectives.

F.1 Personnel (KLP001)

Spending on Personnel was 88.29% (€1,748,125.84 of €1,980,057) of the cost category. Actual salaries for personnel hired exclusively for the project amounted to €1,178,629.46. The core Project Team were in place from November 2014 to August 2020. The Coordinating Beneficiary and Associated Beneficiaries payment-in-kind expenditure on personnel who inputted to the project was €569,496.38, 40% lower than was foreseen in the Grant Agreement. The time inputted by permanent staff to the some actions was lower than foreseen and was offset in part by the Forest Service allocating funding for native woodland on Public Land.

F.2 Travel & Subsistence (KLP002)

Spending on Travel & Subsistence was 46.28% (€132,846.83 of €287,048) of the cost category. Actual travel and subsistence incurred by personnel hired exclusively for the project amounted to €68,480.49. Benefit in kind related travel and subsistence incurred by permanent staff of the Coordinating and Associated Beneficiaries amounted to €64,366.34. Expenditure on travel and subsistence was lower than was expected by both the Project Team and the Beneficiaries due to use of teleconference calls and car-pooling.

F.3 External Assistance (KLP003)

Spending on External Assistance was 85.52% (€1,582,091.57 of €1,849,963) of the cost category. The under spend relates to action costs coming in lower than budgeted.

F.4a Durable Goods – Infrastructure (KLP004)

Spending on Durable Goods – Infrastructure was 97.62% (€116,520.55 of €119,365) of the cost category. The majority of expenditure relates to the installation of fencing on farms and forest and water troughs on farms.

F.4b Durable Goods – Equipment (KLP005)

Spending on Durable Goods – Equipment was 50.55% (€47,896.06 of €94,750) of the cost category. The under-spend relates to the much lower cost of equipment required for the looped walk ways.

F.4c Durable Goods – Prototype (No KLP Code)

Not applicable

Depreciation of durable goods

All durable goods were incurred by public authorities and were intrinsically connected with implementation of the project and were considered eligible in full. The Beneficiaries undertake to continue to assign these goods definitively to nature conservation activities beyond the end of the project.

F.5 Land purchase / long-term lease (KLP006)

Not applicable

F.6 Consumables (KLP007)

Spending on Consumables was 119.26% (€98,965.92 of €82,983) of the cost category. The increased expenditure on consumables relates to the re-categorisation of seed and saplings used in Action C07 from External Assistance to Consumables following consultation with the LIFE monitor. Coillte's own nurseries supplied this material due to limited availability of supplies. These costs have been reported under Coillte's individual Statement of Expenditure. Note: this change was below the threshold specified in Article 15.2 of the CP.

F.7 Other Costs (KLP008)

Spending on Other Costs was 105.98% (€293,832.40 of €277,250) of the cost category.

F.8 Overheads (KLP009)

Overheads were calculated as a flat-rate of 7% of eligible direct costs, as per the Common Provisions. The total eligible direct costs was €4,020,279.17, the overheads allocated to the project was calculated at €281,419.54.

Value Added Tax (VAT)

Five of the Beneficiaries are not eligible to reclaim any VAT from Revenue. Letters confirming their status have been provided in *Annexes S6.1-02 to S6.1-06*. Only non-recoverable VAT was reported for Teagasc and the rates effective throughout the project are described in *Annex S6.1-07*. All Coillte expenditure in the project was reported excluding VAT.

6.3. Accounting system

The accounting system was undertaken in line with the Common Provisions of the LIFE programme and adhered to relevant procurement, travel and subsistence and financial management rules of the Coordinating Beneficiary.

- funds lodged by the European Commission and Coordinating/Associated Beneficiaries were recorded in a dedicated Suspense Account used solely for the purposes of the KerryLIFE project.
- costs were recorded in the General Ledger by Cost Centre, Subhead item and Project Code (financial category (F1-F8)) detail thus allocating costs to each individual expenditure areas.
- payments directly processed by the Project Team were approved through the Coordinating Beneficiary's hierarchy as appropriate. Two signatures of authorising officers approved by the Department's Management Accounting Committee were required to certify all items of expenditure for payment.
- payments processed by Associated Beneficiaries on behalf of the project were agreed in advance with the Project Manager and processed in line with their organisations internal procedures. Supporting documentation were provided to the Project Team periodically.
- procurement of goods and services were carried out by the Project Team in line with Coordinating Beneficiary's and the Office of Government Procurement policy.
- the Coordinating Beneficiary's finance unit generated monthly transactions report for verification and reconciliation.
- high-level financial oversight and reporting was undertaken by the Coordinating Beneficiary's Accountant and an Assistant Principal Officer.
- records were maintained on all transactions using the reporting templates provided in the LIFE Toolkit.

- a consolidated Statement of Expenditure (*Annex F04-01*), and individual Statements of Expenditure for the Coordinating Beneficiary (*Annex F04-02*) and each Associated Beneficiaries (*Annexes F04-03 to F04-08*) were also prepared. The signed Statement of Expenditure has been included in soft copy.
- at the end of the project all transactions were subjected to a full independent audit and were found to be compliant (*Annex F05-01*).

Table 7. KerryLIFE Cost Centre, Sub-head and Expenditure Categories.

Business Unit	Cost centre	Sub-head	Description	Project code	EU Financial Code
KerryLIFE	H2150	650235	Personnel	KLP001	F1
			Travel and subsistence	KLP002	F2
			External assistance	KLP003	F3
			Durable goods – Infrastructure	KLP004	F4a
			Durable goods – Equipment	KLP005	F4b
			Durable goods – Prototype	NA	F4c
			Land purchase / long-term lease / one-off compensation	KLP006	F5
			Consumables	KLP007	F6
			Other costs	KLP008	F7
			Overheads	KLP009	F8

6.3. Partnership arrangements

Separate partnership agreements between the Coordinating Beneficiary, and each of the original five Associated Beneficiaries were established following the award of the Grant (*Annexes F01-01 to F01-05*). A partnership agreement was established when Pobal joined the project and SKDP's original partnership agreement was amended to reflect the transfer of some responsibilities across to Pobal (*Annex F01-06 & F01-07*). The partnership agreements reflected the commitments outlined in the grant agreement and specified the Coordinating and Associated Beneficiaries roles and responsibilities in the delivery of the project actions.

6.4. Auditor's report/declaration

The Coordinating Beneficiary procured an independent auditor to undertake an audit in line with Article 31 of the grant agreement. Following a tendering process in line with Departmental Procurement Policy, Mazars were awarded the contract to undertake the independent audit on the KerryLIFE project. See auditor's report *Annex F05-01*

Appointed Independent Auditor Details: Mazars, Harcourt Centre, Block 3 Harcourt Road, Dublin 2, Ireland, www.mazars.ie

7.5 Summary of costs per action

Action no.	Short name of action	F.1 Personnel	F.2 Travel and subsistence	F.3 External Assistance	F.4a Infrastructure	F.4b Equipment	F.5 Purchase or lease of land	F.6 Consumables	F.7 Other costs	Total
A01	Project start up	69,188.68	6,219.06	-	-	-	-	-	4,012.22	79,419.96
A02	Farm plans	106,403.58	7,730.58	35,202.67	-	-	-	-	1,611.17	150,948.00
A03	Forest plans	65,903.52	5,219.72	78,895.13	-	-	-	-	-	150,018.37
C01	Drain management	35,777.18	336.20	166,776.85	9,710.22	-	-	14,079.80	13,149.19	239,829.44
C02	Riparian planting	30,365.03	5,152.45	315,205.10	25,302.00	-	-	57.21	-	376,081.79
C03	Buffers and hedgerows	10,277.41	214.47	74,005.27	13,771.11	36.91	-	10.19	-	98,315.36
C04	Livestock management	65,088.72	323.99	142,356.10	47,075.89	2,129.09	-	-	120,464.26	377,438.05
C05	Nutrient plans	51,690.39	1,268.91	191.55	67.30	-	-	-	146,667.45	199,885.60
C06	Alternative drinking facilities	12,014.31	14.01	34,980.86	20,594.03	25,601.39	-	-	320.60	93,525.20
C07	Sensitive harvesting	142,584.61	7,418.47	312,219.26	-	-	-	48,879.17	-	511,101.51
C08	CCF trial	4,123.57	121.38	1,475.00	-	-	-	-	-	5,719.95
C09	Firebreaks	7,861.71	414.48	9,782.43	-	-	-	-	-	18,058.62
D01	Mussel population monitoring	24,028.85	3,733.87	93,203.25	-	-	-	913.50	-	121,879.47
D02	Mussel habitat monitoring	33,810.68	4,416.32	30,767.21	-	-	-	-	-	68,994.21
D03	Sediment/flow monitoring	110,453.16	11,794.49	92,491.33	-	14,577.63	-	22,219.36	663.41	252,199.38
D04	Water chemistry	10,785.00	1,564.64	36,058.93	-	-	-	-	-	48,408.57
D05	Vegetation monitoring	20,568.44	159.96	-	-	-	-	67.94	-	20,796.34
D06	Implementation monitoring	84,993.73	1,995.90	55,135.00	-	-	-	-	-	142,124.63

Action no.	Short name of action	F.1 Personnel	F.2 Travel and subsistence	F.3 External Assistance	F.4a Infrastructure	F.4b Equipment	F.5 Purchase or lease of land	F.6 Consumables	F.7 Other costs	Total
D07	Socio-economic impact	27,425.11	89.70	12,915.00	-	-	-	-	-	40,429.81
D08	Ecosystem services	3,202.97	-	-	-	-	-	-	-	3,202.97
E01	Project launch	25,400.48	5,426.15	1,925.00	-	-	-	2,527.64	1,500.00	36,779.27
E02	Website	8,583.46	95.10	5,656.41	-	-	-	-	-	14,334.97
E03	Media campaign	7,685.67	1,113.97	-	-	-	-	-	-	8,799.64
E04	Added value	40,110.02	1,689.52	25,346.40	-	-	-	88.34	-	67,234.28
E05	Demonstration sites	2,585.35	383.14	762.20	-	-	-	-	-	3,730.69
E06	Demonstration events	12,156.32	1,396.86	501.51	-	-	-	-	-	14,054.69
E07	Education programme	6,578.24	334.02	-	-	-	-	-	914.75	7,827.01
E08	Project publications	72,339.29	-	1,577.00	-	-	-	9,372.77	2,619.90	85,908.96
E09	Project conference	11,745.00	980.06	3,400.00	-	-	-	750.00	-	16,875.06
E10	Project reporting	68,334.59	-	-	-	-	-	-	-	68,334.59
F01	Project operation	337,714.24	43,959.58	29,542.18	-	5,551.04	-	-	-	416,767.04
F02	Networking	35,984.01	17,431.52	4,379.93	-	-	-	-	1,909.45	59,704.91
F03	Data management	68,957.03	720.97	120.00	-	-	-	-	-	69,798.00
F04	Financial management	120,830.79	1,127.34	-	-	-	-	-	-	121,958.13
F05	Auditor	12,574.70	-	17,220.00	-	-	-	-	-	29,794.70
F06	Afterlife plan	-	-	-	-	-	-	-	-	-
Overheads										281,419.54
	Total	1,748,125.84	132,846.83	1,582,091.57	116,520.55	47,896.06	-	98,965.92	293,832.40	4,301,698.71

Table Annex A: List of deliverables

Annex	Title	Submitted to EC
A02-01	Farm selection criteria	MTR
A02-02	Blackwater farm management plan	MTR
A02-03	Caragh farm management plan	MTR
A02-04	List of KerryLIFE participating farmers	MTR
A03-01	List of KerryLIFE forest properties	MTR
A03-02	Garrane Forest Management Plan	MTR
A03-03	Derrygarrane South Forest Management Plan	MTR
A03-04	Bohaculia Forest Management Plan	FR
A03-05	Eskine Forest Management Plan	FR
A03-06	Gearha North Forest Management Plan	FR
A03-07	Gortfadda Forest Management Plan	FR
A03-08	Slievaduff Forest Management Plan	FR
A03-09	Tooreenahone Forest Management Plan	FR
A03-10	Tooreenafersha Forest Management Plan	FR
A03-11	Lyranes	FR
A03-12	Canknoogheda	FR
A03-13	Keas/Glanmakee	FR
A03-14	Derrylicka	FR
A03-15	Forest Risk Assessment	FR
D01-01	<i>Margaritifera</i> Monitoring 2014 Report	MTR
D01-02	<i>Margaritifera</i> Monitoring 2016 2017 Report	MTR
D01-03	<i>Margaritifera</i> Monitoring 2019 Report	FR
D02-01	<i>Margaritifera</i> Habitat 2015 Report	MTR
D02-02	Macroinvertebrates and Macrophyte Report 2016	MTR
D02-03	<i>Margaritifera</i> Habitat 2016 Report	MTR
D02-04	Macroinvertebrates and Macrophyte Report 2017	MTR
D02-05	<i>Margaritifera</i> Habitat 2017 Report	FR
D02-06	Macroinvertebrates and Macrophyte Report 2018	FR
D02-07	<i>Margaritifera</i> Habitat 2018 Report	FR
D02-08	Macroinvertebrates and Macrophyte Report 2019	FR
D02-09	<i>Margaritifera</i> Habitat 2019 Report	FR
D03-01	Redox Report 2015	MTR
D03-02	Redox Report 2016	MTR
D03-03	Redox Report 2017	FR
D03-04	Redox Report 2018	FR
D03-05	Redox Report 2019	FR
D03-06	Turbidity Report 2015	MTR
D03-07	Turbidity Report 2016	MTR
D03-08	Turbidity Report 2017	FR
D03-10	Thesis - O'Neill (2019) Sustainable Land-Use Management for the Conservation of the Freshwater Pearl mussel: Sediment Flux and provenance	FR
D04-01	Water Chemistry Report 2015	MTR
D04-02	Water Chemistry Report 2016	MTR
D04-03	Water Chemistry Report 2017	FR
D04-04	Water Chemistry Report 2018	FR
D04-05	Water Chemistry Report 2019	FR
D05-01	Browsing protection measures for trees report	FR
D07-01	Report on the socio-economic impact of the project	FR
D07-02	Cost-effectiveness of project actions	FR

Annex	Title	Submitted to EC
D08-01	Report on the environmental impact of the project	FR
E01-01	Promotional Poster Overview A1 A	MTR
E01-02	Promotional Poster Farming A1 B	MTR
E01-03	Promotional Poster Forestry A1 C	MTR
E01-04	Promotional Poster Biodiversity A1 D	MTR
E01-05	Promotional Poster freshwater pearl mussel A1 E	MTR
E01-06	Promotional Poster Expected results A1 F	MTR
E01-07	Promotional Poster Action A1 G	MTR
E03-01	List of press releases	FR
E03-02	Minister Deenihan welcomes €5 million conservation project for South Kerry	MTR
E03-03	New EU Project to Help Protect Pearl Water Mussels in South Kerry	MTR
E03-04	Opening of the KerryLIFE Project Office	MTR
E03-05	Minister of State Deenihan launches the KerryLIFE project	MTR
E03-06	KerryLIFE U10 & U12 'Pearl Shield' Football Competitions	MTR
E03-07	The Pope's Astronomer Visits KerryLIFE Project Glencar	MTR
E03-08	Kerry student a winner	MTR
E03-09	List of articles	FR
E03-10	€5 million conservation project for South Kerry - Radio Kerry	MTR
E03-11	€5m for conservation of freshwater pearl mussels in Kerry - Farmland Ecology	MTR
E03-12	Restoration of pearl mussel stocks in south Kerry - KerryEye	MTR
E03-13	Deenihan's €5m mussels project - Daily Mail	MTR
E03-14	€5m project to help restore rare pearl mussel - Irish Examiner	MTR
E03-15	€5m mussel project in South Kerry - Kerryman	MTR
E03-16	Pearl mussel project will bring €3.8m to Kerry - Irish Examiner	MTR
E03-17	Pearl mussel plan will be worth €3.7m to south Kerry - Irish Examiner	MTR
E03-18	€4m investment in Kerry's pearls - Kerryman South	MTR
E03-19	Another Life Column - Irish Times	MTR
E03-20	Mussel project boost for south Kerry - Kerryman	MTR
E03-21	Mussel project boost for south Kerry - Kerryman South	MTR
E03-22	Farmers to flex mussels - Sunday World	MTR
E03-23	10 Things to Know about... Episode 5:Water - RTE	MTR
E03-24	€3.8m for pearl mussel preservation project in Kerry - Irish Examiner	MTR
E03-25	Farmers to take part shortly in KerryLIFE mussel project - Radio Kerry	MTR
E03-26	Increasing mussel strength - Irish Farmers Journal	MTR
E03-27	Focus Project - Irish Farmers Journal	MTR
E03-28	Bringing farmers together - Irish Farmers Journal	MTR
E03-29	Templenoe triumph in EU-funded competition - Kerryman	MTR
E03-30	Pope's astronomer eyes Glencar mussels - KerryEye	MTR
E03-31	Saving the freshwater pearl mussel - Teagasc Today's Farming	MTR
E03-32	Caragh National Land & Habitat Mapping in Ireland	MTR
E03-33	List of broadcast media	FR
E03-34	KerryLIFE Beef Brand Tasting	PR2
E03-35	KerryLIFE reveal new sustainable beef production programme	PR2
E03-36	Sustainable beef focus in Glencar	PR2
E03-37	Blackwater Women's Group have Pride of Place	PR2
E03-38	Project shows that sustainable and efficient farming go hand in hand	PR2
E03-39	Ireland's woodlands and forests: a renewed focus under the 2nd cycle of the River Basin Management Plan	FR
E03-40	Agritime Radio Interview - KerryLIFE & FPM	-
E03-41	KerryLIFE 5th pearl shield 2019	FR

Annex	Title	Submitted to EC
E03-42	KerryLIFE Pearl Shield Competition Results	FR
E03-43	KerryLIFE Socio-Economic Report	FR
E03-44	Tributes paid to farmers involved in KerryLIFE project	FR
E03-45	KerryLIFE scheme review: pays farmers for ecosystem services	FR
E03-46	Project shows that sustainable and efficient farming go hand in hand	FR
E03-47	10 things to know about.... Episode 5: Water	-
E03-48	Business show Interview	-
E03-49	Morning Ireland - National Biodiversity Conference Radio Interview	-
E03-50	Eco eye Television Show	-
E03-51	Agritime Radio Interview - Socio-Economic Report	-
E06-01	Demonstration Events 2015/16 Report	MTR
E06-02	Demonstration Events 2017 Report	MTR
E06-03	Demonstration Events 2018 Report	FR
E06-04	Demonstration Events 2019 Report	FR
E07-01	Collage of logo design competition entries	MTR
E07-02	List of KerryLIFE educational events	MTR
E08-01	KerryLIFE Pop-up stand	MTR
E08-02	KerryLIFE Brochure	MTR
E08-03	KerryLIFE Bookmark	MTR
E08-04	KerryLIFE Poster (A6)	MTR
E08-05	Drain management	MTR
E08-06	Firebreaks	FR
E08-07	Forest Restructuring	FR
E08-08	Livestock and Grazing Management	FR
E08-09	Silt fencing	FR
E08-10	Log dams	FR
E08-11	Halo-thinning	FR
E08-12	Grass re-seeding	FR
E08-13	Newsletter)	MTR
E08-14	Cattle drinking troughs	FR
E08-15	Riparian fencing	FR
E08-16	Nutrient management planning	FR
E08-17	Crossing points for livestock	FR
E08-18	Freshwater pearl mussel wall poster	FR
E08-19	Book chapter – Farming for Nature	FR
E10-01	Inception report (IR)	IR
E10-02	Progress Report No. 1 (PR1)	PR1
E10-03	Mid-term Report (MTR)	MTR
E10-04	Progress Report No. 2 (PR2)	PR2
E10-05	Final Report (FR)	FR
E10-06	Layman's Report	FR
F01-01	List of administrative and financial documentation	FR
F01-02	Project indicators table	FR
F05-01	Audit Report	FR
F06-01	AfterLIFE Conservation Plan	FR

References

DAFM (2000). Forest Harvesting and the Environment Guidelines. Department of Agriculture, Food & the Marine, Johnstown Castle Estate, Co Wexford.

DAFM (2008). Forestry and Freshwater Pearl Mussel Requirements: Site Assessment and Mitigation Measures. Department of Agriculture, Food & the Marine, Johnstown Castle Estate, Co Wexford.

DAFM (2015a). Native Woodland Conservation Scheme: September 2015. Department of Agriculture, Food & the Marine, Johnstown Castle Estate, Co. Wexford.

DAFM (2015b). Native Woodland Establishment GPC9 & GPC10: Silvicultural Standards – September 2015. Department of Agriculture, Food & the Marine, Johnstown Castle Estate, Co. Wexford.

DAFM (2016). Environmental Requirements for Afforestation. Department of Agriculture, Food & the Marine, Johnstown Castle Estate, Co Wexford.

Doody, D., Archibald, M. Foy, B. & Flynn, R.M. (2012). Approaches to the implementation of the Water Framework Directive: Targeting mitigation measures at critical source areas of diffuse phosphorus in Irish catchments. *Journal of Environmental Management* 93(1), 225-34

Geist, J. and Auerswald, K. (2007) ‘Physicochemical stream bed characteristics and recruitment of the freshwater pearl mussel (*Margaritifera margaritifera*)’, *Freshwater Biology*, 52(12), pp. 2299–2316.

Magette, W.L., Hallissey, R., Hughes, K. & Cosgrove, E. (2007). Eutrophication from agricultural sources: Field- and Catchment-scale Risk Assessment. Environmental Protection Agency

Moorkens, E.A. & Killeen, I.J. (2018). Study to age a range of populations of freshwater pearl mussels (*Margaritifera margaritifera*) in the Republic of Ireland. Unpublished report for the Department of Culture, Heritage, and the Gaeltacht.

Moorkens, E.A. & Killeen, I.J. (2020) Monitoring Populations of the Freshwater Pearl Mussel, *Margaritifera margaritifera*, Stage 3 and Stage 4 Survey. Irish Wildlife Manuals, No. 122. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

NSAI (2017) ‘Water quality - Guidance standard on monitoring freshwater pearl mussel (*Margaritifera margaritifera*) populations and their environment’, p. I.S. EN 16859.

O’Callaghan, P., Kelly-Quinn, M., Jennings, E., Antunes, P., O’Sullivan, M., Fenton, O. & Ó hUallacháin, D. (2019) ‘The Environmental Impact of Cattle Access to Watercourses: A Review’, *Journal of Environmental Quality*, 48(2), pp. 340–351.

Ross, E.D. (1999) A survey of four rivers in the south-west of Ireland for the freshwater pearl mussel, *Margaritifera margaritifera* (L.). Unpublished Report, Duchas, the Heritage Service (National Parks and Wildlife Services), Ireland

Schulte, R. P. et al. (2009) 'Lough Melvin: Developing cost-effective measures to prevent phosphorus enrichment of a unique aquatic habitat', *Tearmann: Irish Journal of Agri-Environmental Research*, 7, pp. 211–228.