Reduction of Bank Erosion

Action C1

LIFE09 NAT/IE/000220 BLACKWATER SAMOK

June 2015

The IRD Duhallow LIFE Project is supported through the LIFE financial instrument of the European Community.

Contents

Executive Summary

The target of addressing 0.44km of river bank was achieved through a combination of an innovative river bank reprofiling/revetment technique developed by the project, willow spiling and historic revetment reinforcement. The original target was exceeded, with 0.52km of riverbank addressed. A novel low impact soft engineering technique was developed using a combination of locally sourced natural material, rock and publically donated used Christmas trees.

Project innovation

A novel "best practice technique" was developed in partnership with the Kanturk Angling Club who had secured funding through LEADER and Inland Fisheries Ireland. This is an excellent example of the multiplier effect of two EU funding streams working together. Whilst this LIFE project action (Action C1) was delayed through licensing, the LIFE team provided technical advice to the LEADER funded project. The project innovation was developed at this 1km site (Natura 2000: River Dalua outside of Kanturk) and in excess of 360m severely eroding river bank was addressed. The technique was refined and augmented further by involving LIFE participants (RSS) to flood proof the site by planting trees and through the placement of Christmas trees along more erosion vulnerable locations. This technique involves re-profiling of the river bank and protecting the toe of the eroding bank using rock, the removal and replacement of the natural turf on the bank (an essential element due to the late seasonal stage that the work was carried out), planting of willow stakes and securing of used Christmas trees to fencing posts driven into the ground. In addition to this willow fascines (bundles of willow slips laid horizontally) were also buried within the redesigned bank. The bank was then fenced (the fence line moved back by 3m from the river bank) using the projects flood friendly fencing technique. The Telegraph described it as the ‘greenest solution’ to recycling Christmas trees (Lean, 2012).

Rehabilitation of IFI revetment work (180m):

Southern Regional Fisheries Board carried out log Christmas tree revetment work (O’Grady, 2006) along the river outside Freemount in the late 1990's under the EU Structural Funded Tourism Angling Programme in 1999. Some of this work was beginning to fail but had the

potential to be restored through careful placement of stone, placement of fresh used Christmas trees and extensive planting of willow. Over 1000 Christmas trees were donated by the public in 2012 for this work after advertisements placed in the LIFE newsletter, radio interviews and announcements at the local Roman Catholic Mass and Protestant Church services.

Willow spiling (195m):

Willow spiling (weave) was trialled on the River Allow and was shown to be successful along two locations (immediately downstream of Freemount and Metal Bridge area). Trials along other stretches proved less successful (upstream of Freemount) as rate of river bank erosion was too severe for the technique to meet with any success.

Bank revetment (145m):

The bank revetment technique was successfully applied to a 145m section of the River Dalua portion of the SAC. This site now forms part of a demonstration site for best practice river bank revetment on the River Blackwater.

Background

River erosion in the River Allow catchment and associated sedimentation of the river bed habitat was found to be high during initial studies carried out by the project (Blackwater SAMOK, 2011). Anon (2010) identified river bank erosion as a significant pressure in the catchment. The original LIFE proposal was to utilise the Christmas tree log technique as described in O'Grady (2006) to carry out bank revetment along 0.44km of river channel bank. However, at the onset of the project, it was discovered that previous river bank revetment work, using the same technique, was carried out by the Southern Regional Fisheries Board in the late 1990's with mixed success. Although it worked well in some locations it was less successful at other sites and led to some apprehension within the landowner community.

Riverbank erosion is a natural process that is important for a functioning river ecosystem (Florsheim, *et al.*, 2008). Excessive erosion may be the result of human activity (Anstead, 2012) through such activities as land management and livestock over grazing (Yamani, *et al.*, 2011). With regards to the latter, soil erosion via livestock poaching at feeding points and bank edges not protected by fencing may produce long-term degradation of a channel (Neill & Hey, 1992). A source of silt and materials in rivers is erosion of riverbanks (Scottish Environment Protection Agency, 2012). Fine sediment and silt that arises from riverbank erosion can be problematic for many fish and invertebrate species in the rivers (Sear, *et al.*, 2003).

One of the main causes for the reduction in Freshwater Pearl Mussel population, in Irish rivers, has been the increase in sediment movement through rivers and its settlement onto the river bed (Anon, 2004). Fine sediment replaces clean, oxygenated water in the interstitial spaces of the clean gravel. This fine sediment can affect juvenile pearl mussels and salmonid fishes, which depend on a plentiful supply of oxygen to their habitat (Walsh, Neill, & Lucey, 2012).

The Upper Blackwater and particularly the Allow River is heavily silted as a result of land use practises and river erosion. Significant bank erosion leading to silting of the channel can also potentially impact on salmon spawning beds (Anon, 2004). Action C1 of the Blackwater SAMOK LIFE Project (DuhallowLIFE) is specifically aimed at reducing bank erosion. This report documents improvement of river habitat following riverbank restoration works.

Site Description

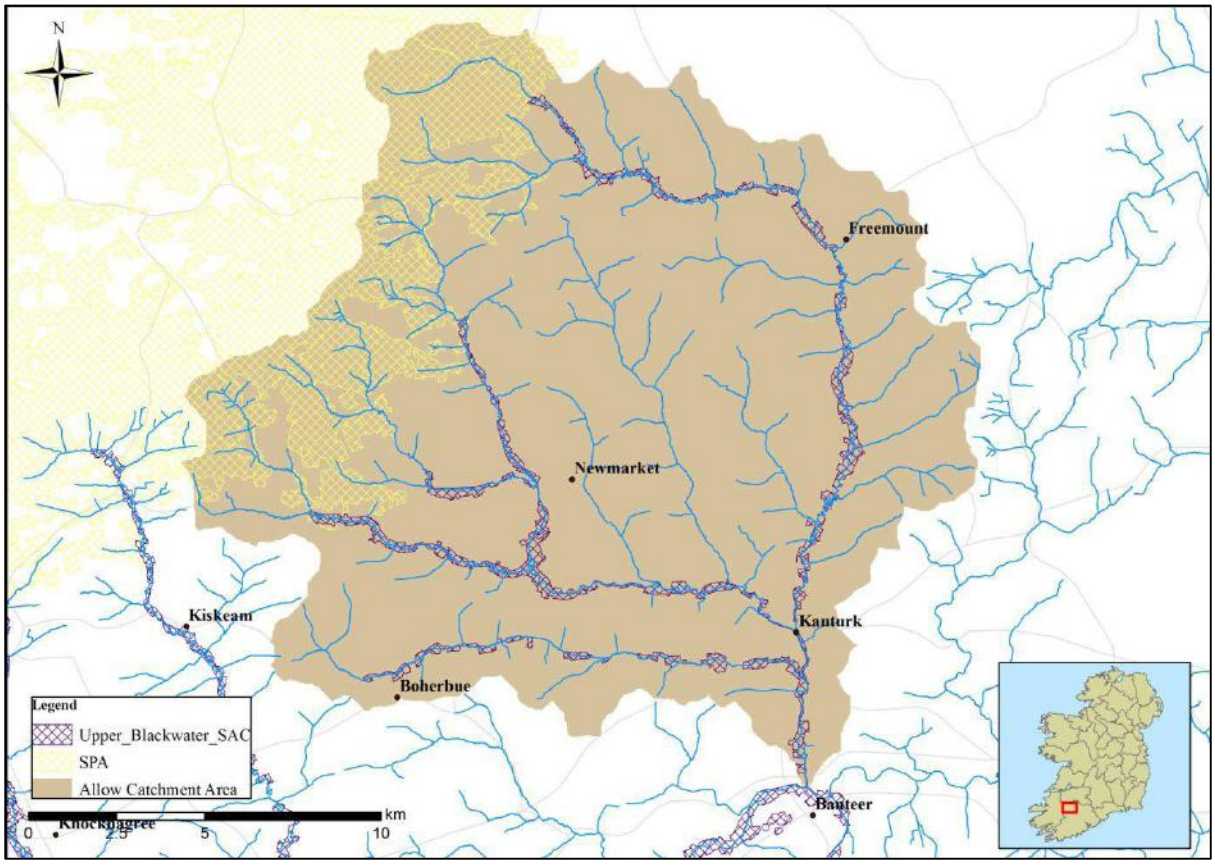

Figure 1 River Allow catchment area targeted by the DuhallowLIFE Project (LIFE09 NAT/IE/000220 Blackwater SAMOK)

The River Allow catchment is 310km^2 (Figure 1). The three major tributaries that drain the catchment are the Rivers Allow, Dalua and Brogeen. The main agricultural land use in the catchment is pasture with dairying and sucklers forming the majority of farming practices.

The majority (70%) of the soils in the Allow catchment are deep, poorly drained mineral soils. Blanket peat covers approximately 5% of the catchment, mostly in upland reaches. Mineral alluvium is associated with the river channels, while shallow well drained mineral soils make up the remaining soil type in the catchment (EPA/Teagasc, 2006; Tedd, 2014).

The River Allow catchment rivers (Allow, Dalua, Brogeen, Glenlara and Owenkeale) form part of the Blackwater River (Cork/Waterford) Special Area of Conservation (Natura 2000 site code: 002170). These tributaries provide important habitat for Freshwater pearl mussel *Margaritifera margaritifera*, Atlantic salmon *Salmo salar* and European otter *Lutra lutra*, all of which a listed in the Annex II of EU Habitats Directive.

The upper reaches of the Allow catchment contain the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle Special Protection Area, which was designated as such for Hen Harrier *Circus cyaneus* (listed in Annex I of the EU Bird's Directive).

Methods

Three methods were utilised to address over 440m of river bank erosion and provide demonstration sites for stakeholders with an interest in (e.g. state regulators) and affected by (e.g. landowners, Coillte, etc.) excessive river bank erosion. A range of techniques were tested at a number of locations and these are discussed within the text below. In addition, an innovative best practice technique was developed to address more severely eroding river banks, which utilises a minimum of hard material by mimicking natural channel characteristics and places an emphasis on regeneration of the riparian vegetation.

Techniques:

1. Log - Christmas tree revetment restoration.

Log Christmas tree technique: This technique developed by Inland Fisheries Ireland (O'Grady, 2006) utilises a combination of telegraph poles and Christmas trees to protect excessively eroding river banks. The poles (25-35cm diameter) are placed parallel to the current along the toe of the eroding bank. Poles are cut to lengths to fit the curvature of each eroding bend. Christmas trees are attached (6" nails or screws) to the poles and overlapped providing continuous cover along the top of the pole. The aim of the Christmas trees is to provide a buffer to the bank from erosion during high water events and to trap sediment in suspension. This deposited sediment forms a fertile secondary bank on which riparian vegetation can grow providing further protection to the river bank as the Christmas tree rot away. The area is fenced to keep out grazing animals and to allow for plant regeneration which will in turn provide further habitat and river bank protection. The accumulation of this sedimentation is known as a secondary bank (O'Grady, 2006). Willow stakes and slips can be planted here to provide increased protection over time.

Retrofitting degraded Log Christmas tree revetment: The technique has been successfully trialled in rivers throughout the West of Ireland (Shannon International River Basin District Project, 2008) and was trialled in Duhallow in tributaries of the upper Blackwater, including the Rivers Allow and Owentaraglin. Some of the work carried out on the River Allow, conducted in 1999 funded under the Tourism Angling Measure (EU Structural Funds) had come under pressure due to changing hydrological characteristics upstream. In addition, in some locations the fence line along the river banks was too close to the river edge allowing bovines to graze re-established riparian vegetation, thereby undermining the protection work. Walk over surveys in 2010 identified a number of areas where these structures were under threat of failure and a restoration programme was initiated. This involved the placement of stone beneath logs which were being exposed due to river bed down cutting (an issue identified by the project (Blackwater SAMOK, 2011)) and placement of new Christmas trees on top of these logs. These Christmas trees were jammed in between the logs and the eroding banks to provide maximum protection during high water events. Locally sourced willow stakes were planted on the bank side of the logs and up along the banks where possible.

The work focused on Log Christmas tree revetment was carried out by Inland Fisheries Ireland (formerly the South-western Fisheries Board) at a site downstream of the Allow Bridge, near Freemount Village (ITM: 539330, 613734). Monitoring was carried out using before and after photographs to record recovery and the change in vegetation cover along the face of the riverbank.

2. River bank reprofiling and DuhallowLIFE+ revetment technique

This technique involved the sloping back of the severely eroding river bank. In the Allow Catchment, eroding banks range from 0.5m up to in excess of 2m in height and therefore provide a challenge from an engineering perspective. The technique involves the minimal use of rock in combination with river bank reprofiling, utilisation of the original grass turf where available, planting of native trees especially willow, utilisation of used Christmas trees and fencing, and the management of grazing animals. Environmental considerations include the prevention of localised silt disturbance and instream disturbance.

This work was carried out under planning license following a detailed Appropriate Assessment procedure. The revetment technique was trialled by the DuhallowLIFE+ team in partnership with the local Kanturk Trout Anglers Club for a river reach covering 1km on the River Dalua

and funded through the EU LEADER programme, Inland Fisheries Ireland Atlantic Salmon Conservation Stamp Fund and IRD Duhallow's own resources and volunteers. The initial work was carried out under license through a Notifiable Action Notice with NPWS.

Step by step method.

- Rock was placed at the base of the eroding bank parallel with the river flow and inside the water edge.
- The grass sod was peeled back for approximately 1.5m in the field (top of eroding bank) and banked.
- Soil was then removed by carefully pulling back the bank with the bucket of a track machine and stored adjacent to the site to be replaced immediately once the re-profiling work was done (i.e. within hours).
- The aim was for a new bank slope of between 45^{o} and 30^{o}.
- Willow brush bundles or "fascines" were buried beneath the placed sloped soil parallel with the river.
- The banked sod (peeled grass strips) were then placed back onto the new sloped bank and watered to encourage immediate growth.
- Large willow stakes (10cm to 30cm in diameter) were also placed at 1m intervals to accelerate the growth or the riparian zone.
- Christmas trees were then secured on the more vulnerable portions of the bank (lower portion) by screwing them to live willow stakes to provide initial buffering and protection from flooding (should flooding occur soon after the completion of works). In some instances, where the willow was judged to be too soft to hold in screws, fencing posts (cut in half) were used instead.
- The site was then fenced off using the innovative "flood friendly fencing" technique developed by the Life project.

Environmental mitigations

The work was carried out during low water flows to reduce the risk of silt loss. A silt curtain was deployed parallel to the river bank and water flow to contain any silt in suspension. This was pumped back into containment areas in the adjacent field and allowed to filter back to the main channel ensuring that any fine material was removed. Water samples were taken 25m

upstream and downstream (of the receiving water) of the works to assess the success of this technique of silt trapping. Monitoring was carried out using before and after photographs to record any changes in the riverbank profile (Figure 3). Electrofishing data is also available for this site. An increase in fish numbers was noted post works, with greatest results evident for the target fish group; young of the year salmon fry (0.028 salmon fry/m^2 in 2011 and 0.132/m^2 in 2014).

3. Willow weave or "spiling"

Spiling is a traditional technique used in temperate regions of the world for the prevention of erosion to river and stream banks. Willow, because of its suppleness and ease to work with, together with its ability to root easily and grow quickly is often used. In addition, it grows naturally in wet areas so is able to withstand a certain amount of inundation and ground saturation due to flooding. The technique involves the cutting of live willow rods, which are woven between live willow uprights secured in the ground. The area can then be backfilled with soil for the willow to root into.

Willow spiling (weave) was trialled at three sites along the River Allow. The technique is not suitable for rapidly eroding sites and/or sites where the growing substrate is too hard (e.g. some boulder clays or gravel banks).

Three sites were selected. Two locations were located downstream of Freemount (immediately downstream of Allow bridge – ITM: 539331, 613732) and the second upstream of the Metal Bridge (ITM: 539405, 611917). A third site was located upstream of Freemount (ITM: 538677, 614539). The latter site failed due to severity of erosion.

Results

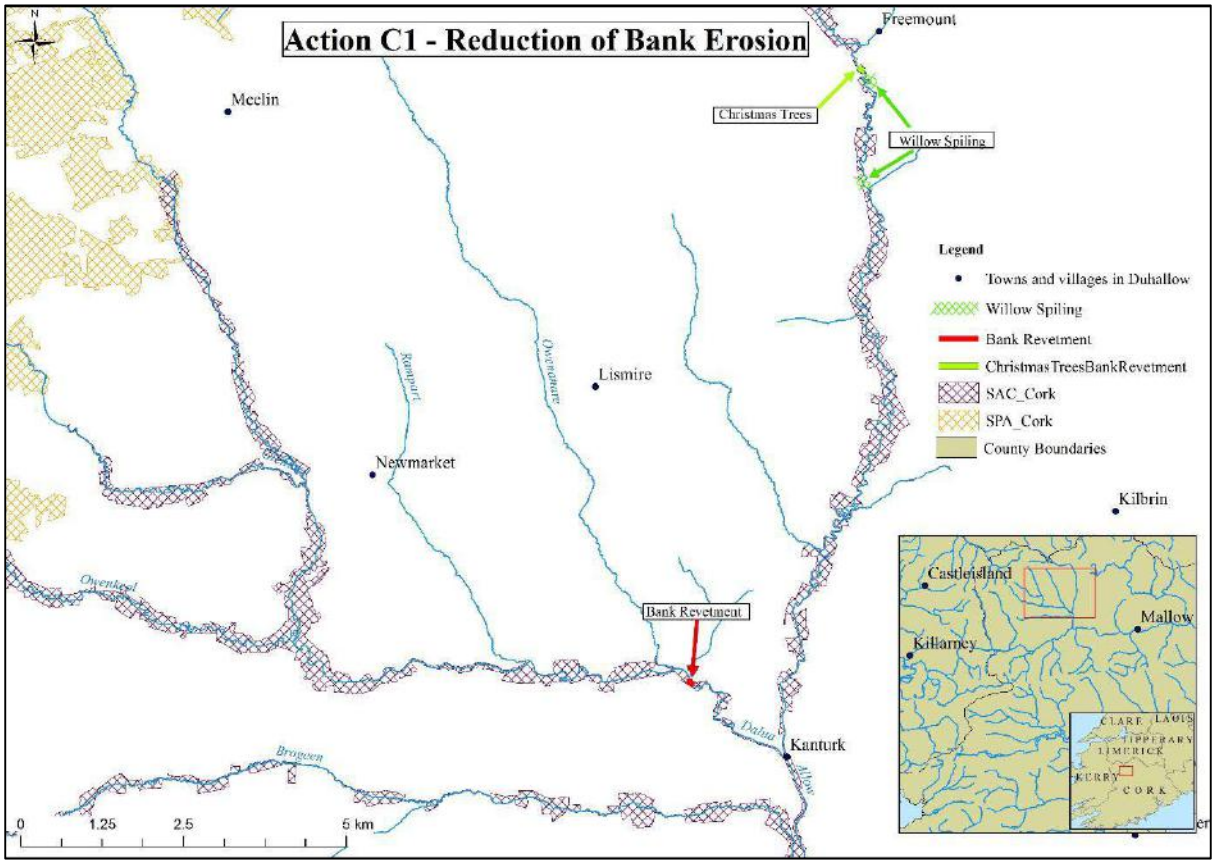

Figure 2 Locations riverbank erosion protection works conducted by the LIFE Project.

Before	After
Repair of IFI restoration works (Allow River)	
 April 2011	 June 2015
Riverbank restoration (Dalua River)	
 April 2014	 June 2015
Willow Spiling (Allow River)	
 April 2011	 June 2015 (Willow and Alder were planted behind the spiling works)

Figure 3 Before and after photographs of the three sites where bank restoration and erosion prevention was conducted by the LIFE project

Table 1 Results of water samples taken upstream and downstream of the riverbank restoration site on the Dalua River. Samples were taken while the works were taking place.

Location	Suspended Solids	Total Phosphate
Upstream	**2**	**0.15**
Upstream	**1**	**0.14**
Upstream	**3**	**0.14**
Downstream	**3**	**0.2**
Downstream	**3**	**0.17**
Downstream	**5**	**0.19**

Conclusions

Riverbank erosion is a natural process in river dynamics (Papanicolaou, *et al.*, 2006). However, the contribution of sediment due to erosion varies and increases as river form becomes more unstable (Rosgen 1996). In low energy catchments, riverbank erosion can contribute up to 37% of riverbed sediment (Papanicolaou, *et al.*, 2006). This can rise to as high as 80% in unstable catchments (Simon & Darby, 2002). Erosion rates measured in the Allow catchment ranged from 0cm to 374cm per annum (Blackwater SAMOK, 2011). The higher levels of erosion rates are not only a concern from a river ecological perspective but are also an issue for farmers and landowners with land along the river. This fact provided an argument for the LIFE team to get co-operation from the landowners to consider and work with the team to develop environmentally friendly river bank restoration options The objective of improved riverbank stability was mutually beneficial to farmers and the SAC. This approach also facilitated improved working relations and a partnership approach to the roll out of other of the LIFE project actions including addressing broader issues affecting the SAC.

The restoration work techniques described were successfully trialled and are viable options for SAC rivers similar to the River Allow and Blackwater. Whilst Log-Christmas tree revetment augmentation and willow spiling were found to be effective under certain conditions (i.e. where log revetment was already in place or in relatively low energy reaches), the eco-friendly river bank revetment option developed by the LIFE project as best practice, was found to be most effective for banks affected by higher erosion rates. The technique uses a minimum of hard engineering material (e.g. between 20-40% of rock utilised by traditional rock armouring techniques), and emphasises natural channel and riparian regeneration using natural material and trees of local provenance. The technique also involves increasing channel capacity by grading back the bank increasing the riparian surface area for biodiversity and relieving pressure from the river instream channel (preventing excessive down cutting) during high water

events, thereby reducing flood risk. The sites designed and restored by this LIFE project now serve as demonstration sites and have been visited by 20 groups, averaging 35 individuals per visiting group. The site also serves as a regular fishing beat for angling competitions and is therefore on continual show for visiting and local anglers. An information sign explaining the works was erected to show case the work for field trips, workshops and the public. The site now forms part of the EPA training course for their Catchments Science programme, which provides training for state regulatory agency and industry in Catchment Management.

The three methods used are three entirely different techniques. Two of the techniques, repair of IFI works on the Allow and re-profiling of the riverbank on the Dalua, were adaptations of the procedure outlined by O'Grady (2006). Re-profiling the riverbank greatly decreases the pressure from high energy, high water events (RRC, 2000). Repairing the IFI works and spiling the riverbank are examples of how riparian and riverside vegetation can be used to protect riverbanks that are vulnerable to excess erosion. The presence of new vegetation at these sites subsequent to work done, suggests more stability and greater protection from excess erosion (Anstead, 2012; Hubble, *et al*, 2010; Little, *et al*., 2008).

The water sample results show that if the correct measures are put in place a task as big as re-profiling 100m of riverbank can be achieved with minimal disturbance to the river. The three samples taken downstream show no significant difference to those taken upstream. Each set of samples (one upstream and one downstream) were taken at four hour intervals in order to get representative samples throughout the timeline of the works.

The methods used at each site are tried and tested techniques for addressing excess erosion and sedimentation of riverbed. Each technique has shown to provide sufficient conditions for plant growth and regeneration, and thus protect the riverbanks.

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Appendix 1. Bank reprofiling technique

Figure 4 Geotextile silt curtain erected parallel to the riverbank prior to works.

Figure 5 The silt curtain is installed in such a way to ensure that silty water is retained.

Figure 6 Rock placed at toe of bank. Note the colour of the water within the silt curtain compared to water outside.

Figure 7 Pump (foreground) pumping silted water from within the silt curtain. The water was pumped out into the field, where it drained into the soil.

Figure 8 Riverbank has been reprofiled and the origin top sod replaced.

Figure 9 Christmas trees secured to the newly reprofiled bank ensure added protection while willow stakes and fascines root and grow.