Case study 39. Dunruchan Farm Peatland Restoration Project

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Main driver: Natural Flood Management (NFM)

Project stage: Constructed 2016

Photo 1: (A) Dunruchan Farm before peatland restoration work began in January 2016. (B) The same location following work in September 2016 (source: River Forth Rivers Trust).

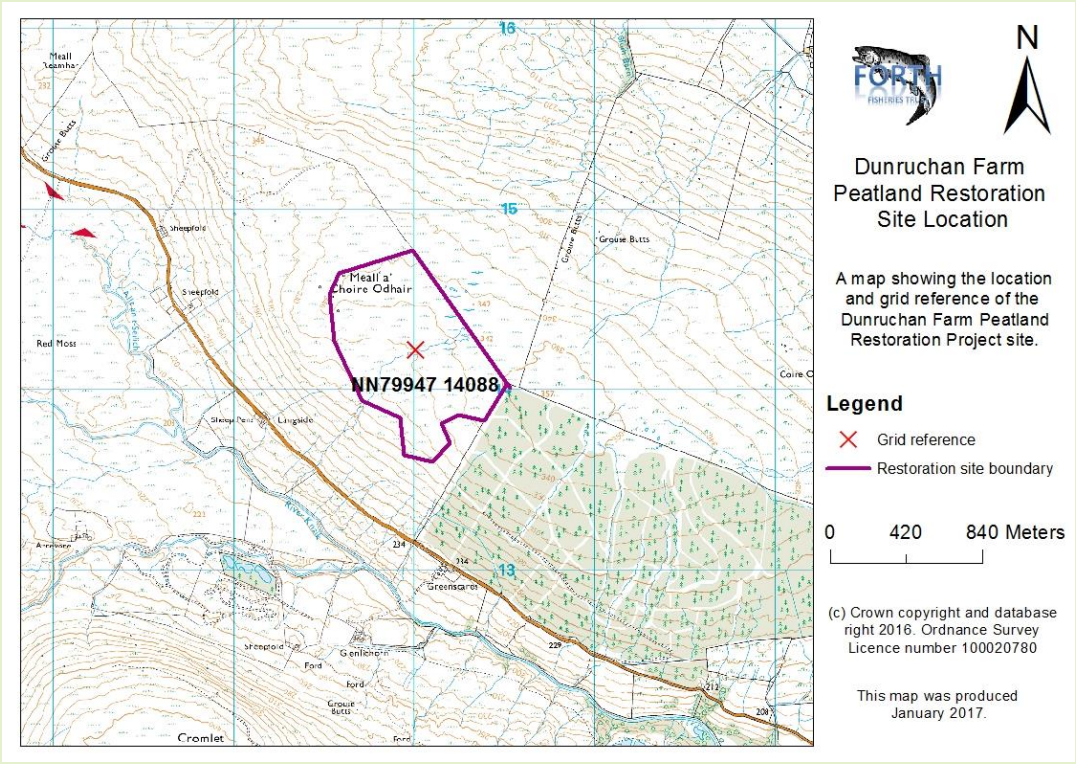
Project summary:

The Allan Water catchment has 3 Potentially Vulnerable Areas to flood risk as determined in the National Flood Risk Assessment 2009. The scoping study for this project used hydrological modelling that identified the Knaik subcatchment as contributing on average 23% of the flood peak which occurs in the most downstream PVA in the catchment. Hillsides with fast flow pathways due to hill grips is one reason the Knaik subcatchment has such an impact on the Allan Water flood peak. The project identified an area of the Knaik subcatchment where extensive hill grips were present and work was possible. By using measures such as peat dams and wooden sediment traps, fast water conveyance was attenuated and the blanket bog habitat was restored.

Key facts:

The Dunruchan Farm Peatland Restoration Project restored 48.2ha of extensively drained upland blanket bog at just under 300m altitude by using approximately 790 peat dams, 10.4km (10,365m) ditch and gully reprofiling, 6 wooden sediment traps, one 10m bund, 30m worth of in-ditch bunds and 7 plastic dams.

Research opportunities to look into the impact of the project on downstream flood risk and wider ecosystem benefits are currently being investigated. The Knaik subcatchment covers 39km² while the restored area is 0.482km² (1.2%), and so the effect may only be local. If the project's impact is considered as part of a wider network of NFM measures in the Allan Water catchment, however, the cumulative impact may be more significant.



Map 1: Location of Dunruchan Farm Peatland Restoration Project (source: River

1. Contact details

Contact details	
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2. Location and catchment description

Catchment summary	
National Grid Reference:	NN79947 14088
Town, County, Country:	Braco, Perthshire, Scotland, UK
Regional Flood and Coastal Committee (RFCC) region:	Not applicable
Catchment name(s) and size (km^2):	Allan Water, 216km^2
River name(s) and typology:	River Knaik, step pool channel Allan Water, inactive single thread channel
Water Framework Directive water body reference:	4606 River Knaik; 6833 Allan Water (Greenloaning to Dunblane); and 6832 Allan Water (d/s of Dunblane)

Land use, soil type, geology, mean annual rainfall:	Land use is mainly mixed livestock. Annual rainfall is 1,000 to 2,000mm depending on whether it is recorded in the lowlands or the uplands.

3. Background summary of the catchment

Socioeconomic/historic context

Since the late 1940s to 1980s the agricultural department has funded the drainage of the uplands of the Allan Water catchment to improve upland grazing quality. Farmers and shooting interests have carried out prescribed burning (muirburn) of the heather moorland uplands to varying degrees over the years in order to improve grazing for livestock and grouse. The agriculture and game land use has led to an upland area with high water conveyance and little native woodland left.

In the middle to lower reaches of the Allan Water, human intervention has been common over the years for agriculture, industry and infrastructure. The water table was lowered in the 1940s after the Second World War when a rocky outcrop at Kinbuck Bridge which maintained a high water table on the floodplain was removed by dynamiting to create more agricultural land by the river. These actions may have resulted in a knick point forming that lowered the river bed and made the floodplain less accessible to flood events. In addition, the river has been straightened between Blackford and Greenloaning – a little over 6km in length. Historically, most of the length of the Allan Water from Blackford to Ashfield was dredged until the late 1980s. This has resulted in high banks, exacerbated by having flood embankments on top, and resulting in further disconnection of the river from its floodplain and increased water conveyance downstream.

Flood risk problem(s)

There are 3 Potentially Vulnerable Areas in the Allan Water catchment; the first is around the town of Braco, the second around the town of Blackford, and the third around Dunblane and the Bridge of Allan. The last of the 3 Potentially Vulnerable Areas is the one that is most commonly affected by flood risk. It has £550,000 annual average damages caused by flooding and has suffered from significant flood events in 1984, 1985, 1993, 2006 and 2012.

Bridge of Allan has a flood protection embankment that will be upgraded and rebuilt to withstand 1 in 50 year events, which will help dramatically. However, Bridge of Allan will not be protected from larger flood events should they occur and the town's position close to the tidal limit means that, if a flood event synchronises with a high tide, that may also increase flood risk. Therefore, NFM has a role to play in the upstream catchment to make the flood protection system more resilient to more frequent and larger flood events caused by climate change and/or to contribute to attenuating flood peaks that synchronise with high tides.

The 3 Potentially Vulnerable Areas all suffer from a mix of fluvial flooding (from the Allan Water or smaller tributaries) and pluvial (surface water). Scottish Water will be carrying out a study on surface water flooding in the Dunblane and Bridge of Allan, and Blackford Potentially Vulnerable Areas over the next 5 years as part of the Forth Local Flood Risk Management Plan.

The Allan Water Improvement Project, based at the River Forth Fisheries Trust, continues to communicate with the local authorities and to engage with landowners and managers to deliver NFM projects in the Allan Water catchment to supplement the Forth Local Flood Risk Management Plan and attenuate flood risk to Potentially Vulnerable Areas.

Other environmental problems

Watercourses in the Allan Water catchment suffer from impacted natural morphology due to channel straightening, grey bank protection and embankments. There is diffuse pollution from agriculture with many unfenced ditches used to water cattle. Road culverts and weirs are having an impact on fish migration and there is a lack of native woodland throughout the catchment, particularly riparian

woodland. Giant Hogweed (*Heracleum mantegazzianum*), an invasive non-native species, is present in the Allan Water catchment and has been treated annually for the past 4 years.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood risk problem(s) and solution(s)

A hydrological modelling study carried out in the Allan Water catchment as part of the Allan Water NFM techniques and scoping study (Halcrow and CRESS 2011) identified the Knaik subcatchment as contributing on average 23% of the flood peak that occurs in Bridge of Allan. As a result, walkovers and satellite imagery were used to identify potential NFM projects in the Knaik subcatchment area that could attenuate the Knaik's contribution to the downstream flood peak.

NFM projects that had a source of funding were identified before engaging with the landowners and farm tenants in the area to identify NFM projects that were achievable and compatible with the land use by the farm tenant/land occupier. The Dunruchan Farm Peatland Restoration Project was the most achievable of identified NFM projects following this process.

The landowner was supportive of the project and the land occupier saw benefits in improved access to and across the site that the project would deliver. However, the land occupier had concerns about any pools of deep water on the site that could result in livestock fatalities.

The River Forth Fisheries Trust was the funding recipient and project managed the Dunruchan Farm Peatland Restoration Project, and so the land occupier had no financial or administrative concerns. As a result, the benefit of improved access to the site was attractive enough for the farm tenant to allow the project to go ahead.

What was the design rationale?

The project involved approximately 790 peat dams, 10.4km (10,365m) ditch and gully reprofiling, 6 wooden sediment traps, one 10m bund, 30m worth of in-ditch bunds and 7 plastic dams covering an area of 48.2ha. Peat dams and in-ditch bunds were used in ditches/grips to provide storage, to raise the water table and to promote overland flow through sphagnum-rich vegetation during rainfall events. The plastic dams had a similar function, but were used at the downstream end of ditches to provide an extra strong and secure terminal dam in case an upstream dam failed. The wooden sediment traps were used at downstream pinch points on the site to catch particulate organic carbon sediments leaving the restoration site. The gaps between the sediment trap boards allowed water to be stored temporarily during high rainfall events. The bund provides temporary water storage during rainfall events and promotes overland flow through sphagnum-rich vegetation.

Design of all structures were based on Yorkshire Peatland Partnership guidance (http://www.yppartnership.org.uk/restoration/technical-guidance-notes/), which is seen as being best practice in the peatland restoration sector (design guidance can be vague in some areas). There were issues with the wooden sediment traps and they required extra attention to get it right. Wooden sediment traps should:

- be lower than the bank height of the ditch
- have suitably sized V-notches to relieve pressure on the structure
- have splash plates to avoid scour
- extend into the side of the bank at least 0.6m to be secure

There is a risk that ditches which convey a lot of water will, after a short period of time, bypass or otherwise damage the structure.

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	Knaik subcatchment 39km^2
Types of measures/interventions used (Working with Natural Processes and traditional):	Working with Natural Processes/Natural Flood Management (WWNP/NFM)
Numbers of measures/interventions used (Working with Natural Processes and traditional):	829 structures 10.4km ditch and gully reprofiling
Standard of protection for project as a whole:	All WWNP/NFM
Estimated number of properties protected:	Unknown – the project will form part of a network of small measures that will have a larger impact on flood risk attenuation.

How effective has the project been?

This is currently not known. The Allan Water Improvement Project is seeking research collaborations that can investigate the impact of the Dunruchan Farm Peatland Restoration Project on downstream flood risk and the cumulative impact it has alongside a network of other medium to small NFM measures in the Allan Water catchment. Photo 1 shows 'before' and 'after' photographs of part of the restoration site. As is clear in the comparison, old ditches and grips that conveyed water quickly from the site have been reprofiled and dammed, creating a slower flow pathway. The ditch sides have been reprofiled and vegetated, reducing peatland erosion which contributes dissolved and particulate organic carbon to downstream waterbodies. More photographs can be found on the interactive map at: http://www.fishforth.co.uk/rfft/projects-2/allan-water-improvement-project/

5. Project construction

How were individual measures constructed?

Excavators constructed peat dams and bunds by excavating wet peat from behind the area they intended to build a ditch or bund, using that peat to create a peat dam above the height of the ditch to promote overland flow and then adding turfs to the dam to promote vegetation growth. The ditch behind the dam fills up with water after construction and sphagnum starts to recolonise and kickstart the peat formation process again. Excavators are used to reprofile ditches and gullies by removing the steepness from the slope and putting turfs on the bare peat face to revegetate it.

Plastic piling was locked together by hand and then placed on top of selected peat dams. The bucket on the excavator was then used to push the piling sheets into the dam.

Wooden sediment traps were the most challenging feature to construct. The trap was constructed following the Yorkshire Peatland Partnership guidance. The bank sides were pulled back by the excavator. The trap was put in place using the excavator and someone on the ground to guide the actions and to knock the sediment trap into the correct position and depth within the ditch/gully.

How long were measures designed to last?

The contract period for the grant is 10 years. Therefore the most degradable measure, which is the wooden sediment traps, were built to last that length of time. The peat-based structures should last indefinitely unless tampered with.

Were there any landowner or legal requirements which needed consideration?

The site required engagement and agreement from both the landowner, Drummond Estates, and the farm tenant (land occupier). Although the landowner was supportive of the project, the farm tenant had concerns regarding pools of water and the risk to livestock from drowning.

A meeting was held at the farm tenant's property with Scottish Natural Heritage's Peatland Action Officer for the area to allow for an open discussion about the work and what the possible effects might be. It was ascertained that the site currently poses a risk to livestock due to the steep eroded gullies and ditches; this work could improve some of those issues. The River Forth Fisheries Trust offered some works to improve access across the site at a cost of less than £1,000, which the farm tenant saw the advantage in. These small benefits were enough to persuade the farm tenant to allow the project to go ahead since the River Forth Fisheries Trust would take on the administration, management and finance of the project. The small expenditure of less than £1,000 for access improvements allowed a restoration project with £38,000 capital cost funding to go ahead.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2015: Engaged farm tenant, applied for funding and put work out to tender Early 2016: Construction began and completed
How was the project funded:	Capital cost of project funded by Scottish Natural Heritage's Peatland Action Fund Engagement and project management funded by Scottish Government
Total cash cost of project (£):	Capital cost: £37,872
Overall cost and cost breakdown for WWNP/NFM measures (£):	Overall cost: £44,485 Administration and management: £6,613 Capital cost: £37,872 Peat depth survey: £358 Peatland restoration: £37,514
WWNP/NFM costs as a % of overall project costs:	All
Unit breakdown of costs for WWNP/NFM measures:	762 peat dams@ £8.50 per dam 10km ditch and gully reprofiling @ £1.95 per metre 6 wooden sediment traps @ £211 per trap 7 plastic dam installations @ £180 per dam One 10m bund and 30m worth of ditch bunds @ £7.40 per metre One day's work (extra dams and reprofiling) @ £840 per day
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not available

7. Wider benefits

What wider benefits has the project achieved?

The wider benefits of the project are:

- restoring natural functionality and carbon sequestration of the blanket bog by raising the water table, which contributes towards attenuating climate change
- creating a slower pathway for water leaving the blanket bog to contribute to attenuating downstream flood risk
- reducing dissolved and particulate organic carbon from leaving the site via eroded bare peat which affects downstream water quality and important fish spawning habitat
- improving the farm tenant's access across the site and reducing the risk of livestock fatalities by reprofiling gullies
- leaving a positive legacy that will generate interest and more peatland restoration work in the future in this area

Beneficiaries from the work carried out will include:

- farm tenant and landlord
- downstream inhabitants in flood risk areas closest to the site
- fisher people
- bird watchers
- hill walkers
- environmental restoration project officers
- potentially more landowners and managers with an interest in having the same work done on their land

How much habitat has been created, improved or restored?

A total of 48.2ha of upland blanket bog peatland has been restored during the project. Blanket bog habitat is a globally important habitat type due to its ability to sequester carbon. Scotland contains 7–12.6% of the world's blanket bog, but much of it is in a poor condition. The habitat is protected under EC Habitats Directive Annex 1 and it is included in the UK Biodiversity Action Plan as a priority habitat. Therefore the project was able to restore an internationally important habitat, which allows it to regain functionality. It is likely that the River Knaik subcatchment of 39km² will see the biggest benefits from this habitat at a local scale.

The River Knaik Water Body ID 4606) is classed as having 'good ecological status' and therefore the project did not contribute to Water Framework Directive improvements on the local water body.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

An annual check is made by an officer from the Allan Water Improvement Project to ensure structures maintain functionality. Otherwise maintenance is not required unless a structure is compromised.

Is the project being monitored?

There has been a water level pressure gauge in the River Knaik below the restoration site and a rain gauge in the Knaik subcatchment area since the pre-restoration works. A further 3 water level pressure gauges in the subcatchment and 2 rain gauges are in the process of being made fully operational. However, none of the hydrological data have been analysed yet.

A pre-restoration vegetation survey was carried out on the restoration site and there is a history of bird surveying in the area. However, data have not yet been analysed in terms of 'before' and 'after 'peatland restoration impact on vegetation or bird communities onsite/locally.

Has adaptive management been needed?

Yes – 2 wooden sediment traps failed within a few weeks of the contractor leaving site because they were not built to an appropriate standard for the site conditions present. The contractor was brought back onsite to repair the damaged wooden sediment traps and to reinforce them and the other wooden sediment traps so that they are of an appropriate design specification for the amount of water the ditch/gully can convey. The work involved:

- widening V-notches
- improving splash plates
- ensuring wooden sediment traps are built into the bank at least 0.6m on either side
- structural reinforcement with extra vertical posts
- and ensuring the height of the wooden sediment trap is below the bank height

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

The project would not have been possible if Scottish Natural Heritage's Peatland Action Fund, which funded the work, had not allowed the River Forth Fisheries Trust to act as the agent and funding recipient on behalf of the land occupier. Having a robust and well-written invitation to tender and tender selection process helped to protect the project during tendering and delivery, and to choose the best contractor for delivering the project to a high standard.

Despite the best efforts of the Dunruchan Farm Peatland Project there were still a number of issues that arose. Leaving a large time contingency in the project timeline between the completion of works and the funder's deadline will provide a safety buffer for unforeseen delays. These are common, particularly when working in the uplands during winter months, and should allow the funder’s deadline for submission of final claims and reports with greater ease. Ensuring the project team listed in the tender is the same as the project team working on site (especially the site supervisor) is essential to ensure the team have the skills and experience to carry out the work specified in the contractor’s tender.

Project management time, which was not funded in this project by the grant for the restoration work, took up a lot of time. A project manager should be prepared to be onsite when required and to investigate any onsite incidents to ensure the contractor adheres to the health and safety policy and environment policy stated in their tender. Maintaining regular and clear communication with the contractor's site supervisor and project manager is also crucial to increase project efficiency. It is important to spend time walking over the site to ensure work is done to a satisfactory level and that anything which is not is re-done or corrected.

Some built features can function temporarily, but may not last the test of time if constructed to an unsatisfactory specification for the particular site. The Dunruchan Farm Restoration Project suffered from this issue with the wooden sediment traps, but the project was able to correct it by asking the contractor to return to site.

Lastly, it is important to examine invoices received from the contractor ensure they are not charging for work they did not carry out.

10. Bibliography

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Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's Joint Flood and Coastal Erosion Risk Management Research and Development Programme.