

**Hay-meadow restoration and
controlling the abundance of
Filipendula ulmaria L. on the
Middle Shannon Callows**

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**For an MSc in Plant Ecology, NUI
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Background

The Middle-Shannon Callows are one of the few remaining relatively unregulated river floodplains in western Europe. About a quarter of the floodplain grasslands are managed as traditional permanent hay-meadows which are cut annually for hay that is valued for its high quality (Heery, 2003). This low-intensity management, practiced for centuries, has created a species-rich mosaic of different plant communities. The area is designated a SAC due to the presence of extensive areas of two Annex I listed grassland habitats which Ireland has a legal obligation to protect. The “callows” also supports a large number of important bird populations and it is therefore also a SPA.

In recent years, due to increased summer flooding, meadows were not cut annually; some not for many years, and this, along with the wet conditions, resulted in a significant increase in the abundance of the competitive tall herb, *Filipendula ulmaria* (meadowsweet). In areas where meadowsweet dominated the sward, there was a marked decrease in plant species richness and consequently the value of hay for local farmers (Maher, 2013).

The high biodiversity value of these Callows is matched by the traditional farming that, if not continued, would lead to land abandonment and a reduction in the social rural fabric of significant areas of Roscommon, since the county is bordered by two floodplain-rich rivers.

This research, started January 2013, addresses the recent problems by comparing the effectiveness of different cutting regimes for restoring meadows to high conservation status and hay value for local farmers. Farmers’ continued management is necessary in maintaining meadow biodiversity, while also preserving the cultural heritage of the region.

Five widely-spaced experimental sites were selected, two of which are in Roscommon (Drumlosh & Cloonburren), based on farmer advice and co-operation. The effects of three treatments are being compared; (a) control (one summer cut as carried out by farmer), (b) two summer cuts (July & September), (c) two summer cuts plus strewing of species-rich green hay. Treatments were applied in summer 2013 and were repeated over two years. Vegetation was studied annually to monitor changes in species composition. A questionnaire study which seeks to document the management practices and their effects on the plant communities will include a range of Roscommon floodplain farmers. Research outputs will provide the Co. Co. with knowledge of tested restoration measures and inform farmers of practical methods to restore hay quality and sward biodiversity. It is planned to publish an information pamphlet for stakeholders and interested bodies.

The restoration guidelines would also be applicable to other areas of callow-land within Roscommon such as the Suck callows and Lough Ree. The plant communities will be classified and documented, adding to the vegetation database for Roscommon. The documentation of flood-land farm management practices past and present will inform wildlife practitioners on methods for maintaining species-rich habitats on the callows as well as contributing to the cultural heritage information for the County. The results will be brought to a national and international audience by presenting papers at conferences in Ireland and abroad, as well as publishing the research findings in international scientific journals. On a broader level, the project emphasises the intrinsic link between traditional low-intensity farming practices and the conservation of biodiversity within County Roscommon. The importance of these low-intensity farming practices on the Callows

and the research project itself, have been publicised in the Irish Farmers Journal (08/02/2014) and more recently at Teagasc's biodiversity conference, "Farmland Biodiversity with 2020 Vision" (21-22/10/2015).

References

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Maher, C.A. (2013) The River Shannon Callows, Ireland: An examination of how flooding patterns and farming practices affect plant communities and dipteran assemblages on unregulated floodplain meadows. PhD thesis, NUI Galway.

Methodology, approach and preliminary results

Year 1 January 2013-October 2013

- 1) With reference to Maher (2013) and from information given by local land-owners, wildlife rangers and the IFA, five sites were selected based on the predominance of *F. ulmaria*, the perception of the farmer that it was a problem and his/her interest in addressing the problem. Sites were also selected to maximise their distribution along the river from Athlone to Banagher.
- 2) In June 2013, a series of plots 4m x 4m were set up in the area of maximum *F. ulmaria* cover. Four plots were assigned control status, i.e. they would be cut by the farmer at the 'normal' cutting time (this was in the week of July 15th in 2013) and four plots were set aside for a second cut (by hand) in September. Four further plots, also cut in July by the farmer, were

strewn with locally-obtained species-rich hay cut in July 2013.

- 3) Relevés 2m x 2m were taken in each plot per site prior to cutting and variables such as mean sward height (5 measurements), sward density (5 categories) and percent forb, grass/sedge and bryophyte cover estimated. Total relevés (no. of plots) = 60. Relevés were first taken in 2013 and repeated in 2014 and 2015.
- 4) A sub-sample 50cm x 50cm for biomass was cut to 2cm above ground from a specified corner of each plot in early July, prior to cutting in 2013. A further sub-sample was taken prior to the second cutting in September. Samples were stored in a freezer and are currently being dried, sorted into *F. ulmaria* /other forbs/grass & sedge and each weighed separately. Bryophytes are negligible due to the height of cut above ground (similar to what a farmer might cut). Biomass was sampled again in 2015.

Year 2: November 2013 - October 2014

Preliminary Results and work undertaken

- 1) Data analysis of relevés taken in Year 1 reveals site variability within the main wet grassland plant community. Soils have been sampled and profiles described; analysis yet to be carried out will include pH and loss-on-ignition
 - 2) Preliminary results from plot relevés indicate that already the second cut has had the effect of slightly increasing species richness
 - 3) Preliminary biomass results show that in most sites *F. ulmaria* comprises over 50% of biomass, with graminoids making up most of the remainder; biomass of other forbs was between 15-20%.
- 4) Field surveying was repeated and soil samples taken from each site
 - 5) To get a deeper understanding of the causes of *F. ulmaria* increased dominance, additional adjacent hay-meadow strips were selected for a lower *F. ulmaria* cover. Relevés have been taken and the farmers will be targeted for the questionnaire.

Year 3: November 2014 - October 2015

- 1) Field surveying carried out for the final time
- 2) Data analysis of relevés after 2 years of treatments carried out using a General Linear Mixed Model (GLM) revealing a significant effect of treatment on species richness. PerManova analysis also showed treatment to have a significant effect in changing plant community composition.
- 3) The restoration treatment of two cuts + strewing green hay was the only treatment which had a significant effect on increasing species richness, although all treatments, including the control, increased species richness after two years. Both restoration treatments, two cuts & two cuts + strewing, had a significant effect on changing plant community composition, with both treatments having a significantly positive impact on important meadow species such as *Rhinanthus minor*.
- 4) Soil analysis was carried out showing variation between sites for pH and loss-on-ignition, reflecting the variability observed at the plant community level.
- 5) Biomass was re-sampled in the final field season and preliminary

results show marked differences between sites in response to biomass change. Percentage biomass of *F. ulmaria* shows a general decrease but may not be significantly affected by treatment.

- 6) A mini-paper was published for a Teagasc farmland biodiversity conference on restoring species richness to the hay-meadows.
- 7) Potential collaboration with floodplain meadows conservation group in the UK on *F. ulmaria* trials was initiated.

On-going work

- 1) Further data analysis on changes in biomass and plant community changes
- 2) Piloting management questionnaire with farmers outside the study group
- 3) Writing a mini-paper for a colloquium for researchers in plant and animal ecology in NUI Galway to be held on 4th December 2015
- 4) Applied to give an oral presentation at SRUC-SEPA Conference, *What Future for our Farming Systems?: Environmental Challenges and Integrated Solutions*, March 2016, Edinburgh, Scotland.

Year 4: November 2015 - October 2016

- 1) Finalise and initiate the questionnaire amongst farmers a) where plots have been situated, b) farmers of adjacent strips less dominated by *F. ulmaria*, c) other farmers with nearby hay-meadows on the same or adjacent callows
- 2) Collate questionnaire data and expand questionnaire to other stakeholder e.g. wildlife rangers and agri-environment planners
- 3) Based on all results, devise a draft protocol of best practice for farmers for restoration of the hay-

meadows which can feed into the newly launched RBAPS (Results based agri-environmental protection scheme) project.

- 4) Provide input to NPWS on-going policy for regional sustainable farming on the R Shannon
- 5) Present work highlighting the importance of traditional farming practices to the Roscommon public at the Roscommon Lamb Festival
- 6) Write up MSc thesis to include two key papers on vegetation and farming practice on the R Shannon and on experimental approach to addressing the *F. ulmaria* problem
- 7) Publish and disseminate information leaflet and make available the results of the research to Roscommon County Council

Costs

The main expense, outside tuition fees, for 2015 was the costs incurred travelling to and from the study sites when carrying out fieldwork. Sites were first inspected in late April and early May to see if the flood had receded and to ascertain if some sites remained flooded longer than others. In mid-May the experimental plots were re-found, from bamboo markers left the previous year, and marked out again using new bamboo canes. Surveying the plots, using the relevé method (where all plant species in each plot are identified and percentage cover estimated along with sward height measured), commenced in mid-June and finished in mid-July. This was consistent with surveys done in previous years. There were twelve plots at each of the five sites, so 60 plots were surveyed in total. In mid-July a 50cm x 50cm biomass sample was taken from each of the 60 plots and these samples were stored in a freezer in the lab until they were sorted and analysed later in the month. All markers were removed from the meadows after fieldwork was finished.

Thirty days of fieldwork were carried out in 2015. Other expenses incurred from fieldwork were consumables such as bamboo canes, spray paint, notepads and a hand held trimmer for taking biomass samples.

Appendix 1 Output from research to date

- Owens, J & Sheehy Skeffington, M (2013) Controlling the abundance of tall herb *Filipendula ulmaria* on the River Shannon Callows. Botany and Plant Science Seminar, NUIG 22 Oct 2013. Oral presentation
- Owens, J & Sheehy Skeffington, M (2014) Controlling the abundance of tall herb *Filipendula ulmaria* on the River Shannon Callows. Environ, Trinity College Dublin 26th-28th Feb 2014. Oral presentation
- Owens, J, Maher, C, Sheehy Skeffington, M (2014) Restoring species richness and forage value to hay meadows on Middle-Shannon Callows SAC. Irish Plant Scientists' Association Meeting, UCC, Cork 28th-29th April 2014. Oral presentation
- Owens, J, Maher, C, Collin, L, Petitjean, Q, Sheehy Skeffington, M (2014) Restoring plant species richness and forage quality to hay meadows on the River Shannon, Ireland. British Ecological Society Annual Meeting/Société Française d'Écologie, Lille, December 6th-8th, 2014. Oral presentation
- Owens, J, Maher, C, Sheehy Skeffington, M (2015) Restoring plant species richness and forage quality to hay meadows on the River Shannon Callows. Environ, IT Sligo 8th-10th April 2015. Oral presentation
- Owens, J, Gourlaouen, N, Maher, C, Sheehy Skeffington, M (2015) Restoring species richness to hay-meadows on the River Shannon Callows. Teagasc Biodiversity Conference, Portlaoise 21st-22nd October 2015. Mini-paper and oral presentation

Invited presentations:

- Owens, J, Maher, C, Sheehy Skeffington, M (2014) Controlling *Filipendula ulmaria* to restore species richness and hay quality on the Middle Shannon Callows, Ireland. Floodplain Meadows Partnership conference, Wiltshire, England 14th-15th May 2014. Poster presentation.
- Owens, J, Maher, C, Sheehy Skeffington, M (2014) Controlling the abundance of *Filipendula ulmaria* and restoring meadows on the Shannon Callows. NPWS Shannon Callows focus group meeting, Banagher, Co. Offaly 13th Aug 2014. Oral presentation and invited for input on EU LIFE project application.

Invited submission and participation in Steering Group for NPWS Conservation Plan for River Shannon Callows

Presentation to Teagasc Conference 19th November 2015:

Restoring species richness to hay-meadows on the River Shannon Callows

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Introduction

The river Shannon floodplain, also known as the “callows”, is the most extensive area of seasonally flooded semi-natural grassland in Britain and Ireland (Heery, 1993). The floodplain grasslands are either managed as permanent pasture or permanent hay meadow. This study focuses on the hay meadows, which make up 25% of the grassland area. Changes in microtopography allow for hydroperiod heterogeneity which maintains plant diversity across the meadows (Maher *et al.* 2015). The traditional annual mowing and removal of the forage crop is essential in maintaining the nutrient budget and thus species diversity. It has been shown that farming practices are a secondary factor after flooding in determining plant species diversity (Maher *et al.* 2015).

In recent years changes in environmental and management practices have compromised the conservation status of the meadows. Over the period 2002-2012, summer flooding occurred in eight out of ten summers, resulting in farmers being unable to cut their meadows, with some meadows remaining uncut for up

to four years. Between 2007 and 2010, it was found that there was a significant increase in the abundance of *Filipendula ulmaria* (meadowsweet) and a corresponding decrease in plant species diversity (Maher, 2013). Management cessation in semi-natural grassland leads to changes in the dominance of functional groups, leading to an increase in abundance of tall forbs, sedges and competitive grasses (Pavlu *et al.* 2011). Farmers were also anxious to control *F. ulmaria* where it was over-abundant, as it greatly reduced the fodder value of hay.

To stop the increase of competitive species like *F. ulmaria*, annual mowing is essential. However the timing is also important as late summer hay making (from August on) can still result in competitive species becoming dominant (Grevilliot & Muller, 2002). This research examines the effectiveness of two cuts in one year compared with one mid-summer hay cut in reducing *F. ulmaria* abundance and restoring the species richness to the meadows. We also investigate the effectiveness of strewing local green hay as a seed source to restore species richness.

Materials and Methods

The river Shannon catchment drains >18,000 km² of Ireland's central plain. The flat topography surrounding the middle section of the river, between the lakes Lough Ree and Lough Derg, results in a low river gradient creating 5,856.48 ha of uninterrupted floodplain which floods every winter and into spring. The floodplain is in the Natura 2000 network, having dual designation of SPA and SAC.

Field Methods

Five sites were selected along a 17km stretch of river, two in Co. Roscommon and three in

Co. Offaly. An experimental block (21m x 16m) was set up at each site where three rows of four experimental plots (4m x 4m) were established with 1m guard paths between plots. Three treatments were tested; (a) Control (1 cut mid-July), (b) two cuts (mid-July & late September) and (c) two cuts (mid-July & late September) plus strewing of green hay material.

Treatments were randomly allocated to plots at each site and were applied in 2013 and 2014. Relevés (4m²) were taken from the centre of each plot where all vascular plant species were recorded and percentage cover estimated to monitor changes in species number and composition. Relevés were recorded annually between 2013 and 2015 before meadows were cut.

Strewing only took place after the first cut in 2013 with green hay material being sourced locally from a site of good conservation status. The plots were prepared to create at least 50% bare ground before green hay was spread.

Statistical Analysis

To assess the effect of treatments on species richness a general linear mixed effect model (GLM) was created using R software. The interaction between treatments, site and year were analysed.

PerMANOVA in PC-Ord 5.0 was used to measure differences in species composition taking into account site and treatment in a two-way factorial design.

Results and Discussion

Mean species richness increased over the three years across all treatments, including control (Fig. 1.). The GLM analysis showed both year and treatment had a significant

effect on species richness ($p < 0.0001$; $p < 0.001$). The analysis also revealed a significant interaction between year and treatment ($p < 0.05$). Treatment c (2 cuts + strewing) showed the greatest increase in species richness and was the only treatment to show significant results after one year.

The two-way factorial PerMANOVA was conducted on the first year (2013) and the last year (2015) where the first year, before treatments took place, showed a difference in community composition between sites ($p < 0.001$) but not between treatment plots ($p = 0.81$). In 2015, after two years of treatments, significant differences in community composition due to management became evident (Table 1) with post hoc test showing treatments b and c to be significantly different from the control. There was no significant site by treatment interaction.

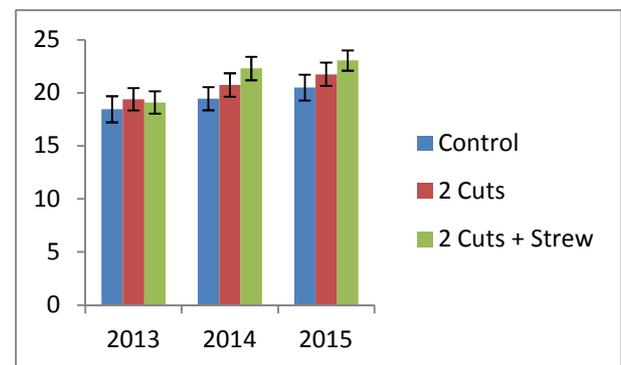


Fig. 1. Changes in mean species richness over three years between the three treatments.

All treatments increased species richness after three years but with varying levels of success. The hay strewing combined with two cuts had the most immediate effect on the number of species. This could be due to ground disturbance, necessary for strewing, in creating suitable microsites for germination of existing plants along with the actual importing of seed. Other studies have shown that reinstatement of cutting after abandonment

can restore species richness. But most of those studies involved long-term abandoned sites and usually took over 8 years to see significant results. Although the meadows in this study had been unmanaged for a very short time, the recovery of species richness was quicker than expected. The PerMANOVA analysis, which takes into account the abundance and frequency of each species along with the number of species, showed that changes in community composition were more significant for both treatments receiving two cuts compared with the control of an annual mid-summer cut.

Table 1. Results of two-factorial PerMANOVA for 2015 data

Source	df	F	P
Site	4	34.487	0.0002
Treat	2	2.665	0.0156
Interact	8	1.209	0.2210
Residual	45		
Total	59		

Conclusions

Reinstating mowing after periodic lapses in management can increase species richness within three years on the hay meadows of the Shannon callows. The most effective way of achieving an increase in plant species richness is through strewing green hay and cutting meadows twice in the same summer. However, the strewing treatment could cost

an extra €175/ha in practice compared with the two cuts only treatment. This means that the double cut treatment might be a more practical and cost effective restoration method rather than strewing green hay to restore species richness. Strewing could still be used on meadows where species may have been lost from the species pool and where cutting alone is not successful in restoring species richness.

The results from this study will help to inform suitable meadow restoration options for farmers who take part in a results based agri-environmental scheme which is currently being piloted on the Shannon Callows and in Co. Leitrim. The research could also feed into a national version of a similar scheme should it be launched.

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