Crops
Environment
& Land Use
Programme

Farmland Conservation with 2020 Vision

Teagasc Biodiversity Conference 2015

Killeshin Hotel, Portlaoise, Co. Laois | 21st & 22nd October 2015

Teagasc
Agriculture and Food Development Authority

Farmland Conservation with 2020 Vision

IT Sligo
An Institiúid Teicneolaíochta, Sligeach

Farmland Conservation with 2020 Vision

Teagasc Biodiversity Conference 2015

ISBN: 978-1-84170-620-7

Compiled and edited by:

Daire Ó hUallacháin and John Finn, Teagasc, Johnstown Castle Environment Research Centre, Wexford

The correct form of reference for this publication, which is based on a conference organised and hosted by Teagasc is:

Ó hUallacháin, D. and Finn, J.A. (eds.) 2015, Farmland Conservation with 2020 Vision, Teagasc, Wexford, pp xx-xx. ISBN 978-1-84170-620-7

A chara,

On behalf of the Conference Committee, I would like to extend a warm welcome to everyone attending this Teagasc Biodiversity Conference: *Farmland Conservation with 2020 Vision*. This conference aims to build on the successful conference that Teagasc held in Wexford in 2011 on *Conserving Farmland Biodiversity: lessons learned and future prospects.*

Since 2011 there have been significant developments with regards to agricultural, environmental and ecological policy. The *Food Harvest 2020* and the *Food Wise 2025* strategies came in to being, with the aim of significantly increasing agricultural output, but also being cognisant of the need to develop effective methods for biodiversity conservation, as part of the development of sustainable production systems. The reform of the Common Agricultural Policy in 2013 also proposed to promote a more sustainable agriculture through a new 'Green Payment' in Pillar 1.

Having failed to halt biodiversity loss by 2010, the EU strengthened its ecological policy, with the introduction of the *EU Biodiversity Strategy to 2020* and the aim of halting the decline of biodiversity and the degradation of ecosystem services by 2020. Evaluation of the conservation status of the habitats and species designated under Natura2000 would, however, indicate that there is a need for additional investment of resources if the decline in the conservation status of many of our designated habitats and species is to be halted.

A key aim of this conference is to address how the agriculture sector has responded to these and other policy objectives, and how prepared the sector is for similar policy objectives post 2020.

This conference aims to present the latest evidence and research on current and emerging practices and policies that affect farmland biodiversity in particular:

- Current and forthcoming policies on biodiversity and agriculture
- Identification and management of High Nature Value farmland
- Ecosystem products and services
- Socio-economics of biodiversity conservation on farmland.
- Promoting biodiversity in the wider countryside.

Tá súil againn go mbaineann sibh sult as an dá lá, and we hope that the conference contributes to progressing efforts toward addressing pertinent questions in relation to agri-ecological research.

D Ó hUallacháin

Dr Daire Ó hUallacháin

On behalf of the Conference Committee:

Dr Daire Ó hUallacháin

Dr John Finn

Ms Catherine Keena

Mr Pat Murphy

CONFERENCE PROGRAMME

Day 1: Wednesday 21st October

09.00 Conference Registration and Coffee
10.00 Introduction and opening of Conference - *Professor Gerry Boyle, Teagasc Director*

Session 1: Agricultural and Biodiversity Policies
Chair: Dr Micheál Ó Cinneide, Environmental Protection Agency

10.10 Could European agricultural policy do more to promote biodiversity?
Prof Alan Matthews (Trinity College Dublin)
10.50 Overview of Biodiversity and Agricultural Policy in Ireland
Mr Jerome Walsh (Department of Agriculture, Food and the Marine)
11.10 The role of DAHG in the identification and targeting of biodiversity priorities in the Green Low-carbon Agri-environment Scheme (GLAS) under the Irish Rural Development Programme
Dr Andy Bleasdale (National Parks and Wildlife Service)
11.30 The Catchment Services Concept – A Means of Connecting and Progressing Water Framework Directive and Biodiversity Requirements in the Context of Sustainable Intensification of Agriculture
Dr Donal Daly (Environmental Protection Agency)

11.50 Discussion
12.10 Lunch

Session 2: Locally-led Agri-Environment Schemes
Chair: Bill Callanan, Department of Agriculture, Food and the Marine

13.00 Starting from scratch - the story of one Locally-Led Scheme
Dr Brendan Dunford (Burren Life Programme)
13.40 The KerryLIFE project
Dr Paul Phelan (KerryLIFE Programme)
13.55 Investigating the composition and Management of Calcareous Grasslands on the Aran Islands
Dr Amanda Browne (AranLIFE Programme)
14.10 Farmers are stakeholders too! A bottom up approach to Catchment Management in a predominantly agricultural catchment in Duhallow, North Cork.
Dr Fran Igoe (Duhallow LIFE Programme)
14.25 Developing Result Based Agri-environmental Pilot Schemes (RBAPS) to deliver species and habitats in Ireland and Spain
Dr Caitriona Maher (European Forum on Nature Conservation and Pastoralism)

14.40 Coffee and Posters

Session 3: High Nature Value Farmland
Chair: Dr James Moran, Institute of Technology, Sligo

15.00 High Nature Value farming declines: who cares?
Prof Davy McCracken (Scotland's Rural College)
15.40 Characterising (indicator based) HNV farmland distribution in Ireland- a GIS approach
Dr Shafique Matin (Teagasc)
15.55 The types of High Nature Value (HNV) in Ireland
Dr Caroline Sullivan (Institute of Technology, Sligo)
16.10 Implications of socio-economic change for the production of High Nature Value Farmland: A case study of Ireland 2000 and 2011
Dr David Meredith (Teagasc)
16.25 Typology of a High Nature Value farmland region in an Atlantic pastoral area
Ms Pamela Boyle (Institute of Technology, Sligo)
16.40 Panel Discussion and Wrap Up Session

17.20 End of Day 1
19.30 Conference Meal

Day 2: Thursday 22nd October

Session 4: Ecosystem Products and Services
Chair: Mr Pat Murphy, Teagasc

09.00 Can ecosystem services guide us towards sustainable agriculture?
Mr Alistair McVittie (Scotland's Rural College)
09.40 Support measures and incentives for native woodland and hedgerow management on farms: the role of non-governmental organisations in advancing the native woodland and hedgerow sectors
Dr Declan Little (Woodlands of Ireland)
10.00 Agri-environment measures for Chough
Dr Barry O Donoghue (National Parks and Wildlife Service)
10.20 The conservation of farmland biodiversity and the role of the All-Ireland Pollinator Plan 2015-2020
Dr Una Fitzpatrick (National Biodiversity Data Centre)

10.40 Discussion
11.00 Coffee and Posters

11.20 West of Ireland farmers hold the key to the conservation of the lesser horseshoe bat
Dr Kate McAney (The Vincent Wildlife Trust)
11.40 Evaluation of agri-environment measures for the conservation of grassland on Irish farmland
Dr Daire Ó hUallacháin (Teagasc)
12.00 ***Reduced-Length Oral Presentations***

12.40 Discussion
13.00 Lunch

Session 5: Promoting Biodiversity in the Wider Countryside
Chair: Mr Padraig Brennan, Bord Bia

13.40 A Credit Point System for assessing and enhancing biodiversity at the farm scale - and beyond
Dr Judith Zwelleger-Fischer (Swiss Ornithological Institute)
14.20 Developing methodology for habitat assessment on Irish grassland farms
Ms Hannah Denniston (Teagasc/ University College Dublin)
14.40 The relationship between biodiversity and soil organic matter in the context of ecosystem services in Irish grasslands
Dr Jim Martin (Botanical Environmental & Conservation Consultants Ltd.)
15.00 Restoring species richness to hay-meadows on the River Shannon Callows
Mr James Owens (National University of Ireland, Galway)

15.20 Panel Discussion/ Wrap Up

16.00 Close of Conference

PROGRAMME OF SPEAKERS

Day 1: Wednesday 21st October

Session 1: Agricultural and Biodiversity Policies
Chair: Dr Micheál Ó Cinneide, Environmental Protection Agency

Session 2: Locally-led Agri-Environment Schemes
Chair: Mr Bill Callanan, Department of Agriculture, Food and the Marine

Session 3: High Nature Value Farmland
Chair: Dr James Moran, Institute of Technology, Sligo

PROGRAMME OF SPEAKERS

Day 2: Thursday, 22nd October

Session 4: Ecosystem Products and Services

Chair: Mr Pat Murphy, Teagasc

Session 5: Promoting Biodiversity in the wider Countryside

Chair: Mr Padraig Brennan, Bord Bia

Reduced length Oral & Poster Presentations

Session 1:
Agricultural and Biodiversity Policies

Chair: Dr Micheál Ó Cinneide
Environmental Protection Agency

Delivering Biodiversity through the Common Agricultural Policy

A. Matthews[1]
[1]Department of Economics, Trinity College Dublin.
Email: alan.matthews@tcd.ie

Introduction

Farmland biodiversity continues to decline across the European Union (EEA 2015; Langhout 2015), despite the headline target in the EU Biodiversity Strategy to halt the loss of biodiversity and the degradation of ecosystems in the EU by 2020, and restoring them as far as possible (European Commission 2011b). Nature legislation (e.g. Birds Directive, Habitats Directive) plays an important role in protecting diversity. These key pieces of EU legislation are currently undergoing a 'fitness check' to see if the existing legislation is fit for purpose (DG ENVI 2015). However, the EU's Common Agricultural Policy (CAP), through its influence on the way farmers manage their land, has potentially an even more important role in delivering biodiversity. This was recognised in Target 3A of the Biodiversity Strategy to "maximise areas […] covered by biodiversity-related measures under the CAP" The most recent CAP reform in 2013 had a strong focus on encouraging a more sustainable agriculture. However, environmental organisations and other observers have been critical of the outcome (Pe'er et al. 2014; Hauck et al. 2014). This talk describes the initiatives taken in the 2013 CAP regulations and discusses their potential to reverse the decline in biodiversity. It also looks at the prospects for further CAP reform from an environmental and ecology perspective.

Materials and Methods

The 2013 CAP reform proposes to promote a more sustainable agriculture through a new 'green payment' in Pillar 1 (which covers CAP market management and direct payment schemes) and through reinforcing agri-environment-climate schemes and promoting innovation in Pillar 2 (which covers rural development issues). The 'green payment' allocates 30% of the overall direct payments ceiling in each member state to farmers who follow specified practices 'beneficial for the environment and the climate.' Three practices are required: crop diversification, the maintenance of permanent grassland, and the establishment of ecological focus areas on arable land. The likely impact on reversing the decline in biodiversity of each of these measures is examined. Significant changes in Pillar 2 include giving greater flexibility to member states to choose measures most appropriate to them, a new instrument the European Innovation Partnership for Agricultural Productivity and Sustainability to promote innovation, and a reinvigorated approach to LEADER. There is scope here to address declining farmland biodiversity, although the slow rate of approval of the new Rural Development Programmes (RDPs) means we do not as yet have an overview of how member states have made use of these options.

Pillar 1 greening and biodiversity

This section highlights the weaknesses of the greening measures in delivering biodiversity. Key weaknesses highlighted include the relatively small area of agricultural land which will be affected, the relatively minor changes in farm practices that farmers are asked to undertake, and the relatively small impact these changes will have for biodiversity. These weaknesses arose, in part, because differing interests were at stake when the new CAP regulations were negotiated in the legislative bodies, but also because the Commission decision to pursue greening through Pillar 1 created constraints which inevitably led to second-best outcomes.

Pillar 2 measures and biodiversity

The changes in Pillar 2 have received a broader welcome as regards their potential impact on biodiversity (e.g. Dwyer 2013). Initial concerns that the possibility to 'reverse transfer' resources from Pillar 2 to Pillar 1 might drain Pillar 2 schemes of funding have not been realised, although the situation differs by member state. Because RDPs are still being approved, it is not yet possible to say whether member states and regions have made use of the new possibilities. However, some promising initiatives are described.

Future prospects for biodiversity under the CAP

The talk discusses the political economy drivers of the next reform (Matthews 2015). Among these drivers will be the economic situation for farming in the EU in the coming years, the outcome of the negotiations on the EU budget, the sense of 'reform fatigue' among member states, the Commission focus on growth and jobs rather than the 'public goods' agenda, the need for time to assess the impact of the new measures included in CAP 2013, and the unfavourable legislative timetable for a radical CAP reform. On the other hand, there is a widespread feeling that the CAP has become too complex and that the new measures are not sufficient to drive the changes needed to bring about a more sustainable agriculture. There remains a window of opportunity to underline the importance of ensuring a robust incentive regime under the CAP to halt the decline in biodiversity.

Results and Discussion

In preparing for the next revisions of the CAP regulations, those wishing to shape the CAP so that it can become more effective in reversing the decline in biodiversity face a dilemma. One option is to build on the greening measures introduced into Pillar 1 in the 2013 reform by enlarging their scope and strengthening their effectiveness. The other option is to seek to transfer the budget for the greening measures from Pillar 1 to Pillar 2 in order to greatly expand and strengthen agri-environmental schemes. In principle, the voluntary, contractual approach pursued under Pillar 2 programmes is to be preferred to the non-contractual 'cross-compliance' approach of greening Pillar 1. However, there are also well-known barriers to increasing the Pillar 2 budget, such as the co-financing requirements, the higher transactions costs of Pillar 2 measures and the greater complexity of the programming approach.

Scientists and ecologists need to be much clearer in communicating to policy-makers what is needed to reverse the decline in biodiversity. It was striking, for example, that the impact assessment of greening that accompanied the Commission's 2011 legislative proposals for the CAP could give no quantifiable evidence of the likely environmental benefits of the three greening measures – the entire focus of the impact assessment was on the potential farm income effects (European Commission 2011a). What lessons can be learned from the land-sharing versus land-sparing debate for the appropriate spatial scale at which to integrate food production and biodiversity? How can monitoring be undertaken accurately and cheaply to allow the development of more results-based agri-environment schemes? Can we improve our methods of putting an economic valuation on natural capital and biodiversity to assist in making the complex trade-offs not only between food production and biodiversity, but between different environmental objectives as well? Can we improve the design of agri-environmental schemes so as to generate larger biodiversity benefits for a given expenditure?

An area likely to gain in importance will be the relationship between climate change policy and biodiversity. Climate change is a major threat to biodiversity, and climate change policy can also affect biodiversity both positively and negatively. On the positive side, many of the actions under the Biodiversity Strategy can help agriculture to mitigate its emissions and to adapt to climate change. But there are also concerns that a climate policy that looks solely at the least-cost ways of reducing emissions could be at the expense of a range of ecosystem services provided by land.

Conclusions

The purpose of this talk is not to draw conclusions but to raise issues for discussion as member states and the European Parliament proceed with the implementation of the 2013 CAP reform and begin their preparations for the next revision of the CAP regulations in the period to 2020. What I want to underline is the important role that scientists and ecologists have in contributing to and helping to shape that debate.

References

CEC. 2011a. *Common Agricultural Policy towards 2020 Impact Assessment.* Commission Staff Working Paper SEC(2011)1153. Brussels: European Commission.

CEC. 2011b. *The EU Biodiversity Strategy to 2020.* Brussels: European Commission.

DG ENVI. 2015. "Fitness Check of EU Nature Legislation (Birds and Habitats Directives)." http://ec.europa.eu/environment/nature/legislation/fitness_check/index_en.htm.

Dwyer, Janet. 2013. "Transformation for Sustainable Agriculture: What Role for the Second Pillar of CAP?" *Bio-Based and Applied Economics* 2 (1): 29–47.

EEA. 2015. *State of Nature in the EU 2015*. Copenhagen: European Environment Agency.

Hauck, J., C. Schleyer, K. Winkler, and J. Maes. 2014. "Shades of Greening: Reviewing the Impact of the New EU Agricultural Policy on Ecosystem Services." *Change Adaptation Socioecol. Syst.* 1: 51–62.

Langhout, W. 2015. *Halfway There: Mid-Term Assessment of Progress on the EU Biodiversity Strategy*. Brussels: Birdlife International.

Matthews, A. 2015. "Reflections on the CAP Post-2014." In *The Political Economy of the 2013 CAP Reform*, edited by L. Knops and J. Swinnen. Brussels: Centre for European Policy Studies.

Pe'er, G., L. V. Dicks, P. Visconti, R. Arlettaz, A. Báldi, T. G. Benton, S. Collins, et al. 2014. "EU Agricultural Reform Fails on Biodiversity." *Science* 344 (6188): 1090–92.

Overview of Biodiversity and Agricultural Policy in Ireland

J. Walsh and B. Callanan

Nitrates, Biodiversity and Engineering Division, Department of Agriculture, Food and the Marine, Grattan Business Centre, Dublin Road, Portlaoise, Co. Laois

Email: jerome.walsh@agriculture.gov.ie

Introduction

The Convention on Biological Diversity was adopted in 1992 against a background of growing recognition of the enormous value of biodiversity and the increasing threats to species and ecosystems generated by human activities. The convention has since been ratified by over 190 parties, including Ireland, therein committing to the sustainable use of biodiversity across all sectors including agriculture. The principles enshrined in this convention are also embodied in EU and National legislation, for example the EU Biodiversity Strategy, Nature Directives, Wildlife Act etc. In parallel, since the early 1990s, the Common Agricultural Policy (CAP) has seen a gradual but increasingly progressive emphasis on environmental sustainability. Firstly through a series of broad measures under Pillar I but complemented by more targeted priorities and solutions under Pillar II. This paper outlines some key Biodiversity aims for the agricultural sector and the measures to underpin them.

National Biodiversity Plan

Ireland's National Biodiversity Plan, first prepared in 2002, was revised in 2011, and covers the period up to 2016. The Plan was prepared against a background of increasing biodiversity pressures across a range of sectors at national and international levels. It identifies strategic objectives, targets and 102 individual actions covering a number of areas that aim to protect and understand biodiversity. The main actions concerning agriculture are:

- developing measures in rural development programmes for the protection and enhancement of biodiversity, especially for designated sites
- further develop criteria to identify High Nature Value farmland and develop measures to address threats to HNV
- ensure effective implementation of cross-compliance and statutory management requirements to ensure conservation of biodiversity
- conduct a systematic evaluation process for any agri-environmental schemes delivered
- continue the Burren Farming for Conservation Programme
- strengthen measures to ensure conservation, and availability for use, of genetic diversity of crop varieties, livestock breeds and races

The biodiversity objectives set out in the National Biodiversity Plan in relation to agriculture are very clear; they must increase the contribution from agriculture, forestry and the marine to protecting and enhancing biodiversity especially in designated areas.

Environmental Impact Assessment Regulations (EIA)

The EIA (Agriculture) Regulations were introduced in September 2011. These regulations apply to three categories of activities which are important to protecting biodiversity:

1. The restructuring of rural land holdings, which includes the removal of field boundaries such as hedgerows, clay banks, stone walls or the re-contouring of land e.g. by infill.

2. Commencing to use uncultivated land or semi-natural areas for intensive agriculture, and includes works such as ploughing, significantly increasing fertiliser usage, clearing vegetation.

3. Land drainage works on lands used for agriculture, including installation of open drains, field drains (not open) opening short distance of watercourse.

Under these regulations DAFM provides a free screening service to examine if any such activities may have significant environmental impacts. Where it is deemed that activities may have a significant negative effect on the environment a full EIA will be required. Drainage of wetlands remains within the existing Local Authority planning regulatory system.

CAP - Pillar I measures

While significant legislative provisions for biodiversity are in place, these are reinforced under the CAP Pillar I cross-compliance provisions, which comprises of two components, Statutory Management Requirements (13 SMRs) and the standards for Good Agricultural and Environmental Condition of land (7 GAECs). These requirements and standards relate to the environment, climate change, public, animal and plant health, animal welfare and the good agricultural condition of land. Two of the SMRs relate directly to the conservation of biodiversity, specifically the implementation of the Birds and Habitats directives, while another SMR relates to the Nitrates Directive. There are seven GAEC standards, the first three of which are aimed at protecting water quality, which in turn aids aquatic biodiversity. A further three standards are targeted at protecting soil and carbon stocks, which again have indirect benefits to biodiversity. The final standard has more direct benefits for biodiversity, by setting minimum standards for the protection of landscape features such as: hedges, ponds, ditches, trees in line, all of which must be retained/ protected.

Greening is a new component of CAP from 2015. Farmers who participate in the Basic Payment Scheme must implement the three standard greening measures: (i) Crop diversification (ii) Permanent grassland and (iii) Ecological Focus Area (EFA). This combination of measures has benefits for soil organic matter/structure; nutrient management and improving habitats and landscape diversity.

CAP Pillar II Rural Development Measures

Whereas Pillar I sets the environmental baseline through greening and cross-compliance, Pillar II builds on it through a series of more targeted measures to meet specific priorities. Firstly, the GLAS (Green Low-carbon Agri-environment Scheme) is the key measure providing a multiple selection of actions with environmental benefits across a wide range of areas. A new feature of GLAS is that tiered entry system based on a hierarchy of established priorities, that is weighted strongly towards biodiversity actions, which themselves are spatially targeted i.e. farmland bird /habitat actions. Other biodiversity actions include: traditional hay meadow, hedgerow actions, woodland establishment, tree planting, arable margins, bird/bat boxes and solitary bee actions.

An Organic Farming Scheme is included in the RDP to support the sustainable development of the organic sector. Organic farming contributes to improving soil and water quality and to the improvement of general biodiversity. For example, by encouraging crop rotation, better use of organic fertilisers, and habitat diversity through the non-use of herbicides or synthetic fertilisers.

A targeted and locally-led output-based measure is also planned for inclusion in the RDP (currently under discussion). A number of focused thematic areas are being considered to address specific environmental challenges. For example three specific priorities, with have a strong biodiversity focus have already been identified: (i) continuation and expansion of the Burren Farming for Conservation Project (ii) a new project aimed at the conservation of the endangered freshwater pearl mussel in priority catchments. (iii) targeted supports for the conservation of the hen harrier. In addition, a competitive-based element is envisaged to support measures under the other thematic areas such as upland/peatland conservation, as well as other identified priorities. These locally-led Schemes are likely to incorporate elements of the 'result-based payments' concept for agri-environment Schemes, which is receiving increasing interest at EU level.

Summary

Conserving farmland biodiversity is a significant challenge, but one which is being addressed by the agricultural sector in a number of ways. As well as legislative provisions, such as the EIA regulations and cross compliance, CAP funding will continue to be a key support mechanism underpinning biodiversity conservation. Pillar I Schemes can deliver benefits at landscape scale, while Agri-environmental schemes under Pillar II will continue to play an important role, but with measures likely to be increasingly targeted as they evolve over time. Locally-led Schemes offer opportunities to further test and incorporate results-based payment elements to incentivise optimum biodiversity achievement.

The role of DAHG in the identification and targeting of biodiversity priorities in the Green Low-carbon Agri-environment Scheme (GLAS) under the Irish Rural Development Programme

A. Bleasdale[1] and B. O'Donoghue[1]
[1]*NPWS, Department of Arts, Heritage and the Gaeltacht, Custom House, Flood Street, Galway.*

Email: andy.bleasdale@ahg.gov.ie

Introduction

Farmland covers almost 50% of the EU territory and farmed ecosystems represent 38% of the surface area of Natura 2000 sites (ten Brink *et al*, 2011). In an Irish context, it has been estimated by the Department of Arts, Heritage and the Gaeltacht (DAHG) that the farmed component of the terrestrial Natura 2000 network is considerably higher, at 59%. This highlights the importance of farming in the appropriate management of the Natura 2000 network in Ireland. High Nature Value farmland in the wider countryside is an additional important resource for biodiversity and also requires appropriate management and support.
The Prioritised Action Framework[1] (PAF) provides a focus on realistic goals for Natura 2000 over the next programming period until 2020. This is further elaborated for biodiversity in the wider countryside in the National Biodiversity Plan (NBP) 2011-16 and at European level in the EU Biodiversity Strategy to 2020.

This process of prioritisation has allowed Ireland to plan in a strategic way to meet the main biodiversity challenges of the years ahead. An integrated and strategic approach to biodiversity through the current Rural Development Programme (RDP), as implemented by the Department of Agriculture, Food and the Marine (DAFM), should go a long way to meeting the challenges that relate to farming. The biodiversity challenges for Ireland in the current programming period are multifaceted. They include restoration goals, grazing management in commonages and uplands, addressing species declines, resolution of ECJ cases against Ireland, etc. To address these challenges, many of which are related to farming, requires Ireland to ensure better targeting of measures and monies to the current priorities.

The mid-term evaluation of the Irish RDP 2007-2013 (Indecon, 2010) concluded that "*relatively little evidence can be attributed to this scheme in relation to an increase in biodiversity in rural areas and other initiatives are required to ensure success in this area*".
A recent report (European Court of Auditors, 2011) stated that agri-environment schemes need to be more targeted and concluded that "*a rational way to implement agri-environment policy is, on the basis of clearly identified environmental problems, to determine the required targets for impacts and participation levels and on this basis to determine the necessary financial resources*".
The imperative for improved targeting is therefore very clear for the current programming period.

Materials and Methods

The idea of improved biodiversity targeting was discussed with colleagues in DAFM in 2013. They were supportive of incorporating this approach in the upcoming agri-environment scheme (which was subsequently named GLAS). DAHG collated the datasets that were available and which could assist in achieving the PAF priorities.

In total, 33 spatial datasets were rationalised into a single "biodiversity layer" and, where possible and prudent, single priorities were identified at the relevant scale. In addition, recommendations were made for key priorities/complex sites that would benefit from a "targeted outputs/locally-led" approach.

DAFM reviewed these recommendations and made decisions in relation to the measures to be advanced in GLAS. In parallel, DAHG provided detailed comments on the specific content of measures to be delivered in GLAS. Final decisions in relation to measure content are made by DAFM. The interactions between Departments have been ongoing since 2013 and it is expected that this will continue through the GLAS operating period.

Results and Discussion

Table 1 lists the ShapeFiles (i.e. the Geographic Information System spatial data files) forwarded by DAHG to DAFM. Of the 33 ShapeFiles forwarded, 29 related to the identification of geographical areas where measures could be targeted. Of these, 15 were brought forward into GLAS measures and 3 additional files were retained as resource layers by DAFM. These resource layers should inform plan preparation (e.g. GRS, see Table 1) or identify priority areas to be advanced through locally-led agri-environmental schemes (e.g the Burren and freshwater pearl mussel sites, see Table 1).

1 The PAF has its reference in Article 8 of the Habitats Directive and in 2013 member states were required to submit their national PAF to inform the delivery of the upcoming operating programmes, including the RDP

Table 1. Spatial datasets forwarded by DAHG to DAFM (* = applied in GLAS; † = resource layer)

No.	Code	Description
	AFA*	Associated Feeding Area (Geese etc)
	BAR*	Barnacle Goose
	BB1	Blanket Bog NHAs
	BFC†	Burren Farming for Conservation
	BRG*	Brent Goose
	CHO*	Chough
	COA	Coastal habitats
	COM	Commonage
	CRX*	Corncrake
	FPM†	Freshwater Pearl Mussel (priority)
	GLG*	Greylag Goose
	GRS†	Semi-natural Grassland Survey Sites
	GRZ	Previous Grazing Restriction Areas
	GWF*	Greenland White-fronted Goose
	HHR*	Hen Harrier (Natura and non Natura)
	HWL	Priority Hardwater Lakes
	LHB	Lesser Horseshoe Bat Roosts
	MAR	Marine (background theme)
	MGS*	Multiple Geese and Swans
	NJT	Natterjack Toad intervention areas
	PDX*	Grey Partridge priority areas
	RB1	Raised Bog NHA (farmed)
	RB2	Raised Bog NHA (non-farmed)
	SAC*	Special Area of Conservation
	SPA*	Special Protection Area
	TER	Terrestrial (background theme)
	TUR	Priority Turlough areas
	TWI*	Twite (priority breeding & wintering)
	UPL	Upland (150m / 200m)
	WAD*	Wader
	WAT	Water (background theme)
	WHO*	Whooper Swan
	YWH	Yellowhammer

A separate *Curlew* (CUR) dataset was transmitted to DAFM subsequently.

Conclusions

The role which agriculture plays in the national economy and the potential of the agri-food sector to deliver essential jobs and economic growth is recognised. Equally, the agri-food sector seeks to build a competitive advantage by trading on Ireland's green credentials and recognises that this must be underpinned by genuine environmental sustainability. Sustainable agriculture in an Irish context must comply with the Natura 2000 directives and contribute to achieving the national and EU biodiversity targets. The Irish RDP is an essential conduit to delivering Irish biodiversity (and other) objectives and in so doing should bolster the agriculture sector, underpin our green credentials and create sustainable employment.

The alignment of CAP priorities for biodiversity with the PAF priorities have resulted in improved targeting of biodiversity measures under the Irish RDP. This is delivered through the GLAS programme, as operated by DAFM. While this approach has placed a significant burden on both Departments, it is considered to be an improved method of delivering on biodiversity targets in the Rural Development Programme, the Prioritised Action Framework, the National Biodiversity Plan and the EU Biodiversity Strategy to 2020.

The monitoring and evaluation of GLAS will be essential in determining the efficacy of Ireland's approach to targeting, financing and implementing conservation effort under the Rural Development Programme. It will be important to align GLAS monitoring with parallel monitoring and reporting under the Birds and Habitats Directives.

The lessons learned from inter-Departmental interaction on targeting should inform future tranches of GLAS and future iterations of agri-environment schemes in Ireland beyond 2020. In addition, it is hoped that this work will support the long-term continuation of necessary funding for agri-environment schemes in Ireland to appropriately manage biodiversity at farm level.

Acknowledgments

Considerable effort was invested by Mel Conway, GIS Unit, NPWS, in rationalising spatial and other data sets from a wide variety of sources. Staff in the Scientific Unit and regional management structure of NPWS greatly improved the quality of the product that was transmitted to DAFM. The assistance of various individuals and organisations, and BirdWatch Ireland in particular, is gratefully acknowledged.

References

Indecon (2010). Mid-Term Evaluation of the Rural Development Programme Ireland (2007-2013)

National Biodiversity Plan (2011). http://www.npws.ie/legislation/national-biodiversity-plan

PAF (2014). http://www.npws.ie/news/prioritised-action-framework-launch

Special Report No 7 (2011). *Is agri-environment support well designed and managed*? European Court Of Auditors, Luxembourg.

ten Brink P., *et al* (2011). *Estimating the Overall Economic Value of the Benefits provided by the Natura 2000 Network.* Final Report to the European Commission. Institute for European Environmental Policy/ GHK/Ecologic, Brussels 2011.

The EU Biodiversity Strategy to 2020 (2011). http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure_en.pdf

The Catchment Services Concept – A Means of Connecting and Progressing Water Framework Directive and Biodiversity Requirements in the Context of Sustainable Intensification of Agriculture

D. Daly
Environmental Protection Agency, Richview, Clonskeagh, Dublin 4

Email: d.daly@epa.ie

Introduction

Achieving successful management of our water and biodiversity resources in the context of Food Harvest 2020 strategy is a major challenge for Irish society and the public servants who have responsibilities in these areas. Meeting the challenge will benefit from a holistic, integrated approach by considering related elements of water management, biodiversity management and land-use management together to their mutual benefit. Currently there is a danger that silo organisational structures founded on either disciplines, specific regulations and/or narrowly based processes and objectives with inadequate linkages and integration, could hamper progress. This paper proposes the catchment services concept as an overarching framework that includes all the services in a catchment – ecosystem, geosystem and human/ social system services – with the aim of encouraging relevant disciplines, work units and organisations to understand and take account of the linkages, and to work together to benefit both water and biodiversity, and potentially enabling sustainable agricultural practices.

The philosophy underlying this article are that: i) in the Irish landscape, farming, habitats and water are inter-related and inter connected; ii) each have requirements that, in certain circumstances, are conflicting; iii) we need a means of maintaining agricultural production, while boosting wildlife and ensuring satisfactory water quality; iv) we are unlikely to achieve this unless we adopt a holistic, integrated approach.

Catchments

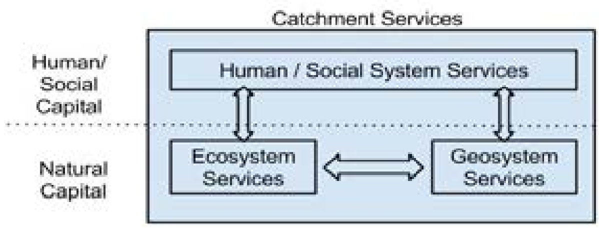
The river catchment is proposed as the land based unit for water management and for most components of aquatic and terrestrial biodiversity management. Catchments are coherent topographically-based features, defined by the natural hydrology and hydrogeology, with water in continuous connection over ground and underground from the highest areas along the topographic divide to the lowest areas alongside rivers. Therefore, catchments link aquatic biodiversity, aquatic ecology and water status. In the process, they connect the ecologically-driven Water Framework Directive (WFD) with the EU Biodiversity Strategy to 2020. Agriculture is the dominant land-use in most catchments; water links farming to the requirements of both the WFD and the Biodiversity Strategy. While it can be argued that terrestrial wildlife is not linked directly to water in catchments, several species are associated with water and all are associated with geographical areas, even if the boundaries are not defined by topography.

Integrated Catchment Management (ICM)

The ICM approach (Daly, 2013) is supported by the Department of Environment, Community & Local Government (DEHLG, 2015) as the means of ensuring the good ecological health of water in Ireland. ICM involves a series of interconnected steps: i) building partnerships; ii) creating and communicating a vision of ICM; iii) characterising the physical and ecological components; iv) identifying and evaluating possible management strategies; v) designing an implementation programme; and vi) implementing the programme and making adjustments, if necessary. It takes account of and connects all the services in the catchment – ecosystem, geosystem and human-social. It requires partnership with local communities and citizen engagement.

Catchment Services

Catchment services comprise two components of natural capital – ecosystem and geosystem services – and the social and economic services provided by people living in the catchment (see diagram below).



Ecosystem services are: the crops; livestock; terrestrial and aquatic flora and fauna; pollination; riparian zones for water purification; soil ecosystems for attenuating pollutants and increasing crop production; cultural values attached to wildlife; etc.
Geosystem services are: the landscape geomorphology; bedrock and gravel; groundwater for drinking water and geothermal energy; soils and subsoils as chemical and physical attenuating media for pollutants; hydrometeorology (rainfall, evapotranspiration, wind); geological heritage sites; minerals; oil/gas; caves; cultural values associated with landscape features; etc.
Human-social system services are: housing; farming both intensive and extensive; mining; quarrying; wind farms; water abstraction facilities; roads; landfills; industries; cultural values associated with historical

features and buildings such as ring forts, castles and holy wells; water mills; pathways along streams and canals; and other recreational facilities; etc.
There are overlaps between the three systems because natural and cultural landscapes are on a spectrum and not in separate silos.

The value of using these three subdivisions of services within the concept of catchment management is as follows:

- It helps ensure that all relevant services are considered in an integrated manner, thereby assisting in achieving sustainability.
- The conceptual framework encourages linkages between water management, biodiversity objectives, land-use planning and the ICM approach. Currently, there is a tendency to treat biodiversity and water quality objectives separately, for instance in agri-environment schemes. While many measures designed for biodiversity also assist in achieving water quality objectives (including drinking water safety) and vice versa, the cobenefits are not achieved because the measures are not usually considered collectively (e.g., planting crop cover for bird species can have dual/multiple benefits provided the crop is planted in the vicinity of a stream). This situation is exacerbated by the fact that different Departments and public bodies have separate responsibilities for biodiversity, water quality, planning, flood protection and drinking water provision.
- The catchment services concept links natural capital with human/social capital and therefore builds on the intellectual, promotional and educational opportunities provided by the natural capital concept.
- Consideration of all three types of services is necessary in preparing River Basin Management Plans as part of the implementation of the WFD.
- It may help provide additional reasons for encouraging certain types of ecological restoration, for instance, restoration of riparian zones which have the multiple benefits of increasing biodiversity, improving water quality, flood alleviation and adding to the aesthetic beauty of river flood plains.
- From the perspective of local communities, it is comprehensive and includes the complete mosaic of physical, ecological, cultural and infrastructural features and functions, thereby giving a sense of comfort that no one area is dominating and that the needs of local communities are taken into account.

EPA Catchments Approach
As part of the EPA role in WFD implementation, the EPA approach involves characterising ~600 subcatchments, which vary in size from 70-200 km^2, with the assistance of local authorities and other public bodies – the greater the assistance provided, the greater the value of the work. This scale is considered to be appropriate to the level of information available and suitable for community engagement. All the services are included and can be recorded in a subcatchment reporting template, even those not directly relevant to the WFD. Pressures on water and aquatic ecosystems are determined and, in the case of diffuse pollution sources, likely critical source areas are located. Potential management strategies and mitigation measures are evaluated. A regional assessment is enabled by aggregating the subcatchment reports into 46 water management units – these are the national hydrometric areas, e.g, Suir and Brosna catchments. These will be the basis for the national River Basin Management Plans that are due for finalisation in December 2017. This work will provide the building blocks for successful water, biodiversity and land-use management in the future and the results will be made available online to all.

Conclusions
Even with an abundance of expertise in the areas of water, biodiversity and farming, an absence of joined-up thinking can lead to poor decision making; the common platform provided by the catchment services concept would mitigate this.

Acknowledgments
Colleagues in the WFD Integration & Coordination Unit, EPA.

References
Daly, D. 2013. A healthy catchment initiative for Ireland – Making Integrated Catchment Management Happen. *Proceedings of IAH Conf. "Groundwater and Catchment Management", Tullamore.*http://www.iah-ireland.org/current/pastevents.htm
DECLG, 2015. Significant water management issues: public consultation document. Department of Environment, Community and Local Government. http://www.environ.ie/en/Environment/Water/WaterQuality/News/MainBody,41920,en.htm

Session 2:
Locally-led Agri-Environment Schemes

Chair: Bill Callanan
Department of Agriculture, Food and the Marine

Starting from scratch – the story of one locally-led programme

B. Dunford.
Burren Life Programme, Old Schoolhouse, Carrron, Ennis, Co. Clare.

Email: Brendan@burrenlife.com

Introduction

The Burren (from the Gaelic word *Boireann*, 'place of stone') is a distinctive limestone landscape which extends over roughly 720km^2 (72,000ha) of north Co. Clare and south Co. Galway on Ireland's mid-western coast. It is a refuge for many plant and animal species which are now rare elsewhere in Ireland and Europe. The Burren boasts a fascinating archaeological record, mapping over 5,500 years of human endeavour on what is sometimes referred to as 'the fertile rock'. Though largely privately owned, the Burren and its rich and varied heritage represent a public resource of inestimable value.

Farming is integral to the character and composition of the Burren. The ancient transhumance practice of winter grazing on the rough limestone grasslands and heaths has been proven (Dunford, 2001) to be central to the health and diversity of the many species and habitats therein, making it a classic High Nature Value (HNV) farmed landscape. In a similar way, much of the Burren's landscape and rich archaeological heritage can be directly linked to the work of almost six millennia of farmers.

Today, several hundred Burren farm families continue to produce excellent livestock, often using the same ancient pastoral traditions. However these farmers, and their traditions, face a number of social and economic challenges. Recent years have seen a significant shift in the 'balance' between farming and the Burren's landscape resulting in the twin trends of intensification (richer, lowland areas) and neglect (rough, upland grasslands). This has raised significant environmental challenges – from scrub encroachment to water degradation – which have not been resolved by environmental designations or National Agri-environment schemes.

The Burren Life approach

In the late 1990's, local farmers, frustrated with the designation of their land as SAC, and with what they considered to be unfair measures of REPS, approached Teagasc to carry out some research into the relationship between farming and the Burren. This research (Dunford, 2001) later (2004) informed an application to the EU LIFE Nature fund for a €2.5m, 5-year research project with three partners: the National Parks and Wildlife Service (NPWS), Teagasc and the Burren IFA. The resultant BurrenLIFE project (2005-2010) worked closely with local farmers to design, test (on 20 Burren farms, c.2,000ha), cost and later publish a blueprint for sustainable farming in the Burren.

Between 2010 and 2015, this blueprint – which enjoyed the enthusiastic support of all partners involved, from local farmers to EU funding agencies - was rolled out across 160 farms (c.15,000ha of land) under the banner of the 'Burren Farming for Conservation Programme' (BFCP, though often still referred to as '*Burren Life*'). The BFCP was jointly funded by the Dept. of Agriculture, Food and the Marine (DAFM) who paid €5m to farmers over 5 years, and the NPWS who funded the local management team and office. The new programme built on the learnings of the research project, in particular by adopting a 'hybrid approach' which entailed paying farmers for their environmental performance as well as for actions.

Burren Life principles

Both the BurrenLIFE research project and the resultant Burren Life Programme entailed a lot of learning and adaptation for all parties involved, the following principles could be described as central to how *Burren Life* currently goes about meeting its objectives of conserving the heritage, environment and communities of the Burren:

- **Burren Life is farmer-led**. Farmers nominate and co-fund conservation actions on their own farms and are generally free to manage the land as they see fit (within the law). Burren Life minimises the bureaucratic burden (e.g. via a simple farm plan and support for securing permissions) so that farmers can concentrate on what they do best – farming!
- **Burren Life is results-based**. Simply put, Burren Life rewards those farmers who deliver the highest environmental benefits. Conservation becomes as much a product for the farmer as the livestock produced.
- **Burren Life is flexible and adaptable**. Farmers are given the freedom to deliver the required outputs using their own skills, experiences and resources, as best fits their own farms and circumstances. This flexibility means that Burren Life is capable of responding to the different needs and situations which invariably arise, from farm to farm, from year to year.
- **Burren Life is local and practical**. It focusses on works which address real needs in the Burren and which will yield real agricultural and environmental benefits.

Results and Discussion

Burren Life has pioneered a novel 'hybrid' approach to farming for conservation which sees farmers paid for both work undertaken and, most importantly, for the delivery of defined environmental objectives. Within Burren Life, farmers are helped to prepare their own simple farm plan (as short as 3 pages and very visual) each year by their trained advisor and the Burren Life team. The plan is tailored to suit the needs of the individual farm and outlines the two payment categories: (1) *Payment for Actions* and (2) *Payment for Results.*

1. Payment for Actions

The annual farm plan contains a list of actions which are nominated by the farmer with the aim of improving the site's management and conservation condition. Each job is individually costed and co-funded by the farmer, and is carried out within the year by the farmer and/or a local contractor. Payment issues only when jobs are complete and to a satisfactory standard. The farmer can 'opt-out' of a planned action if he/she so chooses, ensuring maximum flexibility for the farmer.

Most farms nominate a mixture of jobs to suit the needs of their land e.g. removing encroaching scrub from species-rich grassland, repairing internal walls, improving water supplies or enhancing access. Work completed over the first 5 years of the programme includes:

- 214ha of scrub (mainly hazel and blackthorn) removed across a wide area of the Burren
- 137km of (c.3-4m wide) stock paths opened through scrub to reconnect areas of grazing
- 89km of broken wall (gaps!) repaired and 600 new gates fitted
- 400 new watering points installed and scores of sensitive springs protected
- 45km of vehicle access tracks repaired or created, enabling improved long-term management.

2. Payment for Results

Every eligible field of species-rich Burren grassland and heath is assessed annually with a user-friendly 'habitat health' checklist. Each field receives a score between 1 and 10: all fields with a score greater than 3 (subsequently increased to 5) have received payment but higher scores receive higher payments. This gives farmers the incentive to manage their fields in ways that will improve their scores and their payment as well.

The results-based payment system allows farmers greater freedom to decide how to manage their land (with advice if needed) and also guarantees the taxpayer better value for money - no delivery, no payment! It also generates data (see Table 1) which demonstrates the positive environmental impact of *Burren Life*. This graph shows that, between 2010 and 2014, the area of Burren grassland in very good condition (scoring 8,9,10) gradually increased at the expense of the area in poorer condition (scoring 3-7), which decreased.

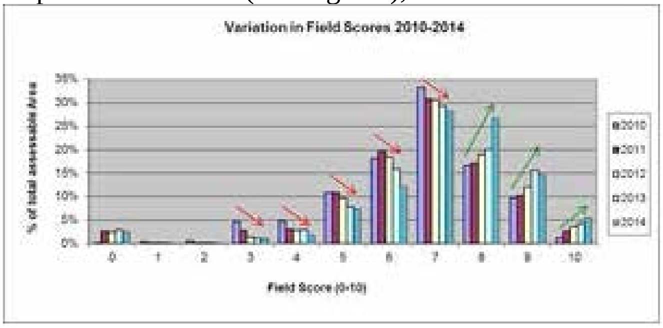


Table 1. Variation in Field scores from across 1000 fields (c.15000ha) of the Burren 2010-2015

Conclusions

Over the course of the first 5 years, Burren Life has had major environmental and socio-economic impacts in the Burren. €5m has been invested directly in the region, with an average of €6,500 per year per farmer, and the added benefit is that much of this money is recycled locally. Farmers themselves have invested an additional €1.3m in the programme through co-funding of farm works, amounting to a total spend of €6.3m. This funding has contributed to a number of spin-offs such as increased work for local contractors, more custom for local shops and manufacturers (e.g. Burren gates) and new farm-based tourism enterprises.

Burren Life has delivered a range of proven environmental benefits on c.15,000ha of prime Burren habitat. It has cemented strong partnerships between farmers and management agencies, helped to create a very positive attitude towards conservation among farmers, and has generated a far greater appreciation of the role of farmers by the wider community. Through this work, *Burren Life* has made a very meaningful and lasting contribution to the future of Ireland's most extraordinary landscape, the Burren. It is hoped that under the new RDP (2015-2020) that the Programme will be further extended across the Burren and that its core principles will help inform 'Locally Managed Schemes' elsewhere in Ireland.

Acknowledgments

Burren Life is funded by The Department of Agriculture, Food and the Marine (DAFM) and the Department of Arts, Heritage and the Gaeltacht (National Parks and Wildlife Service).

References

Dunford, B. (2001) *The Impact of Agricultural Practices on the Natural Heritage of the Burren Uplands, Co. Clare*. PhD Thesis submitted to the National University of Ireland, Dublin.

The KerryLIFE project area

P. Phelan[1], P. Cronin[1], N. McDaid[1] and R. O'Callaghan[1]

[1]*KerryLIFE project (LIFE13 NAT/IE/000144), Glencar Community Centre, Shanacashel, Co. Kerry, Ireland, V93 R963.*

Email: paul.phelan@ahg.gov.ie

Introduction

The freshwater pearl mussel *(Margaritifera margaritifera)* is a large filter-feeding freshwater bivalve that is listed as critically endangered on the IUCN red list (Moorkens, 2011). It is generally found in cool, oligotrophic, acid to neutral rivers and streams over granite or sandstone bedrocks. Freshwater pearl mussel populations have dramatically declined in the last century and the species is now of poor conservation status throughout Ireland (NPWS, 2013). Three primary pressures have been identified: (i) excessive fine sediment inputs to its habitat, (ii) excessive nutrient inputs to its habitat and (iii) changes to the habitat hydrology. KerryLIFE is an EU LIFE-funded project that aims to work with the communities and landowners to demonstrate effective conservation measures for the freshwater pearl mussel. The objective of this report is to provide an overview of the KerryLIFE project area and objectives.

Materials and Methods

The KerryLIFE project area is comprised of the Caragh and Kerry Blackwater freshwater pearl mussel population catchments (*S.I. No. 296 of* 2009) in South Kerry (Figure 1).

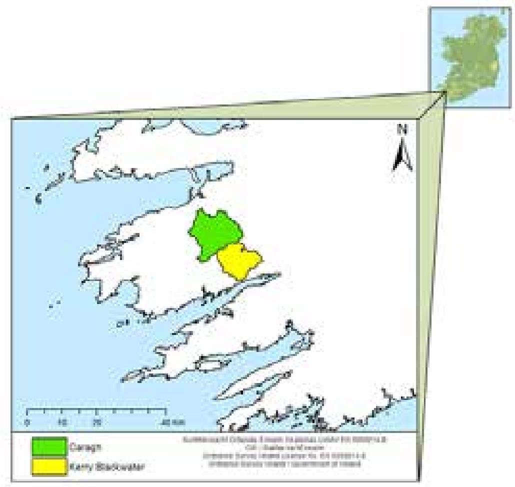


Figure 1. The KerryLIFE project area.

Land use in the project area

Data on agriculture in the project area was obtained from the Central Statistic Office's (CSO) 2010 Agricultural Census (http://census.cso.ie/agrimap/) results for Loughbrin, Caraghbeg and Lickeen (these electoral divisions overlapped with 80% of the KerryLIFE project area). Data on forestry in the project area was sourced from the second draft freshwater pearl mussel sub-basin management plans (NS 2, 2010a; 2010b) and the National Forest Inventory (Forest Service, 2012).

Freshwater pearl mussels in the project area

Data on the freshwater pearl mussel populations, and their conservation condition under *S.I. No. 296 of* 2009 in the project area were sourced from a report produced for the KerryLIFE project by E. Moorkens and associates in 2014 using NPWS monitoring guidelines.

Results and Discussion

Land use

The project area was 22,150 ha in size and the primary land use in the area was agriculture, accounting for approximately 78% of the land area.

The majority of farms in the KerryLIFE project area were mixed grazing livestock and were compared with the national average for this category in Table 1. In comparison to the national average, the farms in the project area were larger in land area and had lower stocking densities. Rough grazing was the principal land use in the project area as opposed to pasture in the national average. These differences reflect the general lower suitability of land for intensive agriculture in the project area when compared to many other parts of Ireland (Gardiner and Radford, 1980).

Table 1. Agricultural census results for mixed livestock farms from the national average and the KerryLIFE project area.

	National average	KerryLIFE project area
Grassland		
Ha/farm	32	80
Silage	22%	7%
Hay	5%	2%
Pasture	61%	30%
Rough Grazing	10%	61%
Other crops	1%	0%
Livestock density		
Cattle/farm	47	21
Sheep/farm	93	159
LU/farm	42	31
LU/ha grassland	1.20	0.38

Forest cover in the project area was similar to the national average, although there were large differences between the Caragh (7.5%) and Kerry

Blackwater (15.1%) catchments. There was a higher % of forestry over 20 years old in the project area.

Freshwater pearl mussel populations
The project area is estimated to contain two of the largest freshwater pearl mussel populations in Europe with over 2,750,000 adults estimated in each catchment. These numbers account for approximately 46 % of the total Irish population and 23% of the total European population. However, the freshwater pearl mussel populations and habitat in the project area are in unfavourable conservation condition (Table 2).

Table 2. Assessment of *M. margaritifera* conservation requirements (*S.I. No. 296 of* 2009) in the Caragh and Kerry Blackwater catchments based on monitoring results from 2014.

Criterion	Target	Caragh	Kerry Blackwater
Freshwater pearl mussel populations:			
Numbers of live adults	No recent decline	Fail	Fail
Numbers of dead shells	< 1% of population	Pass	Pass
Mussel shell length ≤ 65mm	≥ 20% of population	Fail	Fail
Mussel shell length ≤ 30mm	≥ 5% of population	Fail	Fail
Freshwater pearl mussel habitat:			
Filamentous algae	Absent or trace < 5%	Fail	Fail
Macrophytes	Absent or trace (< 5%)	Fail	Pass
Siltation	No artificially elevated levels	Fail	Fail

Certain agricultural and forestry land management practices such as intensification of land drainage, inappropriate grazing and livestock management, excessive nutrient applications, livestock access to freshwater pearl mussel habitat and inappropriate clearfelling have been identified as potential reasons for the ongoing unfavourable conservation condition in these catchments (North-South 2 project, 2010a; 2010b).

Conclusions

While the KerryLIFE project area has lower agricultural intensity than the national average, this is reflective of the land conditions in the region. The freshwater pearl mussel populations in the Caragh and Kerry Blackwater catchments are in unfavourable conservation condition and this is potentially associated with certain land-use management practices. These freshwater pearl mussel populations are extremely important to international efforts to preserve the species and the KerryLIFE project is currently working with landowners and communities to trial and demonstrate funded conservation actions such as drainage management, stabilising riverbanks through broadleaf tree planting, livestock management and restructuring of commercial forests as well as increasing awareness of freshwater pearl mussel conservation through community outreach.
The results from this project can contribute positively to targets of the Convention on Biological Diversity's, the EU 2020 Biodiversity Strategy, the Natura 2000 Directive and the Water Framework Directive primarily through improved understanding of sustainable agriculture and forestry requirements for effective freshwater pearl mussel conservation among local, research and statutory stakeholders.

Acknowledgments

The communities of the Caragh and Kerry Blackwater freshwater pearl mussel population catchments. This project is co-funded by the European Union, Department of Arts, Heritage and the Gaeltacht, Department of Agriculture Food and the Marine, the Forest Service, Coillte, Teagasc, the South Kerry Development Partnership and Pobal.

References

Gardiner, M. J. and Radford, T. (1980). Soil associations of Ireland and their land use potential. An Foras Talúntais, 19 Sandymount Avenue, Dublin 4.
Moorkens, E. A. (2011). *Margaritifera margaritifera*. The IUCN Red List of Threatened Species. Version 2015.2. www.iucnredlist.org
NPWS (2013). The Status of EU Protected Habitats and Species in Ireland. Species Assessments Volume 3. Version 1.0. NPWS, DAHG, Dublin, Ireland.
NS 2 (2010a). *Freshwater pearl mussel second draft Caragh sub-basin management plan.* NPWS, DEHLG, 7 Ely Place, Dublin 2.
NS 2 (2010b). *Freshwater pearl mussel second draft Kerry Blackwater sub-basin management plan.* NPWS, DEHLG, 7 Ely Place, Dublin 2.
Forest Service (2012). *The Second National Forest Inventory - Republic of Ireland - Results.* DAFM, Johnstown Castle Estate, Co. Wexford.

Investigating the composition and management of calcareous grasslands of the Aran Islands

A. Browne[1], P. McGurn[1], G. Ní Chonghaile[1] and L. Duignan[1]
[1]*AranLIFE, Teach Ceann Tuí 2, Inis Oírr, Oileáin Árann, Co. na Gaillimhe.*

Email: aranlifeproject@gmail.com

The AranLIFE project is an EU LIFE Nature demonstration programme seeking to develop and demonstrate the best conservation and management practises within the SAC (75% of the total land area) on Inis Mór, Inis Meáin, and Inis Oírr. Part of the programme includes determining what constitutes the best examples of priority Annex I habitats (orchid-rich calcareous grasslands, machair and limestone pavement) on the islands, and by working with the farming community identify the main drivers influencing habitat quality and conservation status. It is widely accepted that the management of such habitats is dependent on some form of agricultural management and unsuitable grazing regimes are detrimental to their overall condition (Smith *et al*. 2010; McGurn & Moran 2011; O'Neill *et al*., 2013). This paper sets out to show the floristic variety within calcareous grassland on the 68 project farms and to propose some explanations for vegetation variation. The data presented here forms part of the monitoring program of the AranLIFE project and provides an initial analysis of the plant communities within calcareous grasslands of the Aran Islands. Further work will investigate how management practices and environmental variables influence plant communities. This will identify the optimum management practises required to achieve favourable conservation status.

Materials and Methods

A botanical survey of grasslands within the SACs of the three islands was carried during the field seasons of 2014 and 2015. Using a sample of land parcels from Department of Agriculture Land Parcel Identification System (LPIS), quadrats were randomly positioned within the designated area. The relevés collected form part of the monitoring program for the AranLIFE project. A total of 99 relevés were recorded within calcareous grassland habitats. (Quadrats from machair and limestone pavement were excluded from this paper). survey methodologies for calcareous grassland, as detailed in O'Neill *et al.* (2013).

Data analysis

All relevés and species were ordinated using Detrended Correspondence Analysis (DCA) using PC-Ord (McCune & Grace 2002). Classification of the data to establish community types was carried out using two-way indicator species analysis (TWINSPAN).

Results and Discussion

Vegetation data of 133 species and 99 quadrats sampled from grassland sites across the three islands were analysed using TWINSPAN and DCA, the results of which were complimentary. By applying TWINSPAN five different groups were identified (Figure 1).

The results of the DCA ordination for all the relevés are contained in Figure 1. An eigenvalue of 0.44 and 0.33 were obtained for Axes I and II respectively.

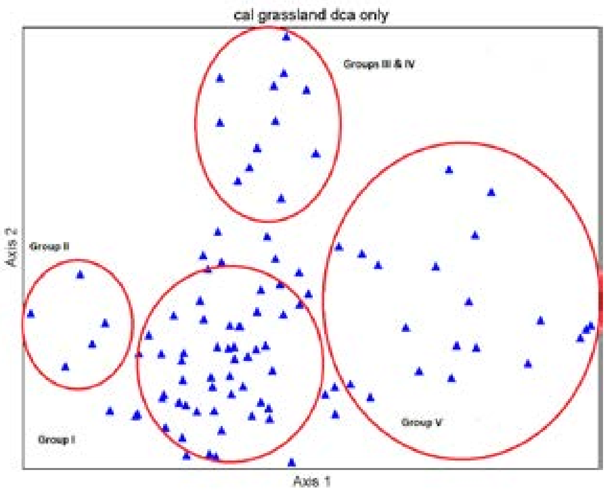


Figure 1. DCA ordination and Twinspan of the calcareous grassland relevés (blue triangles) indicating clustering of groups.

Group I.

This group is characterised by a high diversity of species, as well as a significant complement of highly positive (12) and positive indicator species (11). (Positive and negative indicator species for '*Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (6210); important orchid sites (6210*)'* are listed in O'Neill *et al.* (2013)) Eight negative indicator species occur in this group, however, the main encroaching species in the context of the Aran Islands, *Rubus fruticosus* and *Pteridium aquilinum* occur with low frequency. Species which characterise this group include *Sesleria caerulea, Asperula cynanchica, Gentianella campestris, Leontodon hispidus, Anthyllis vulneraria* and *Blackstonia perfoliata*. This group represents calcareous grassland vegetation that is in favourable conservation status.

Group II.

This group is characterised by a high cover abundance of *Molinia caerulea*, which occurs within calcareous grasslands in some parts of the winterages. This dominance of *Molinia* appears to reduce species-diversity of calcareous grassland and consequently the abundance of positive indicator species.

Group III & Group IV.

In Group III there is reduction in frequency of positive indicator species along with an increase in negative indicator species. In Group IV there is a further reduction in positive indicator species and represents a degraded version of Group III. This combined group represents a range of grasslands including former garraí (vegetable gardens) or rye plots, higher fertility pastures, land that has been 'newly made' or calcareous grasslands that are grazed in summer rather than winter and hence reducing its species diversity. Soil depth could also be influencing this group, with deeper soils being more nutrient-rich and producing a grass-dominated vegetation with a reduction in herbaceous species. Grazing levels may also be impacting on this group of relevés. Undergrazing leads to a reduction in species-diversity and a dominance of rank grasses such as *Arrhenatherum elatius* and *Dactylis glomeratum*. There is some variation in the amount of positive indicator species between group III (18) and IV (13) and may indicate that group IV has had more disturbance in terms of nutrient enrichment and/or reseeding with *Lolium perenne* (as indicated by the high frequency of this species in the group).

Group V.

This group of relevés represents calcareous grassland vegetation that is being encroached by *Rubus fruticosus* and *Pteridium aquilinum*. This group has the lowest number of positive species indicators as well as the lowest total number of species.

The variation between the groups identified indicates diversity in habitat quality. Group I with the highest species count and highest number of positive indicator species represents some of the best examples of the Annex I priority habitat '*Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (6210); important orchid sites (6210*)'* in the Aran Islands.

Groups II to IV are degraded examples of Group I due to varying environmental and management variables. Group V represents degraded calcareous grasslands where encroachment by scrub has had a negative impact on the ecological quality of these grasslands.

By using this classification as a baseline and incorporating the associated environmental and management factors, the optimum management regime to both maintain and return sites to favourable conservation status can be determined.

In a Results Based Agri-environment Programme Scheme (RBAPS), Group I would represent the highest output possible receiving the highest financial reward with Groups II to V in a reducing financial scale.

Conclusions

This paper provides an initial look at the vegetation of calcareous grasslands within designated areas on Aran Island farms that are participating in the AranLIFE project.

Working with farmers we can determine the best management practises which will aid in the design of future agri-environment schemes based on sound ecological science and practised agricultural management and answer the following question:

What are the grazing regimes and edaphic factors that support sites that are in favourable conservation status?

Acknowledgements

The AranLIFE project is 75% co-funded by the EU LIFE+ Nature Programme.

References

McCunn, B. & Grace, J. B. (2002). *Analysis of Ecological Communities*. MjM Software.

McGurn P. and Moran J. (2011). A draft high nature value programme for the Aran Islands based on the Burren Farming and Conservation Programme. The Heritage Council Ireland.

O'Neill, F.H., Martin, J.R., Devaney, F.M. and Perrin, P.M. (2013) The Irish semi-natural grasslands survey 2007-2012. Irish Wildlife Manuals, No. 78. National Parks and Wildlife Service.

Smith, G.F., Bligh, J., Delaney, E., Egan, M. O'Donavan, G., O'Donaghue, P., O'Hara, K. (2010) Case Studies on High Nature Value Farming in Ireland: Aran Islands and Connemara. The Heritage Council Ireland.

Farmers are stakeholders too! A bottom up approach to Catchment Management in a predominantly agricultural catchment in Duhallow, North Cork.

F. Igoe[1], K. Murphy, [1] PJ Phelan[2], B. Riney[3], C. Dalton[4].

[1]LIFE projects, IRD Duhallow, James O'Keeffe Institute, Newmarket, Co. Cork, [2] Phelan Advisory, Nenagh, Co. Tipperary, [3]EU Projects Office, Cork County Council, [4]Immaculate College - University of Limerick.

Email: corresponding.fran.igoe@gmail.com

Introduction

River catchments and their associated watercourses, influence and are influenced by geological features and land use activities within.

Agriculture is the predominant economic activity in rural Ireland and increasing intensification of agriculture brings increased challenges to water management. However, these challenges must not be viewed in isolation or separate to other sectors, irrespective of the relative proportion of impact that these may have. This is especially important in the context of not only stakeholder engagement but also in problem solving.

Materials and Methods

This paper outlines an Integrated Catchment Management strategy being developed by a Rural Development Company (IRD Duhallow LTD), in Duhallow, Co Cork, in an effort to address water management issues along the upper reaches of the River Blackwater, which is a Special Area of Conservation [Site code 002170]. To improve the quality of life for the local community, local environmental needs are being addressed through partnerships across the full range of stakeholders from the local to national level.

DuhallowLIFE

IRD Duhallow administer a range of voluntary and government funded social inclusion and income support schemes. It was the first Rural Development Company to successfully compete for EU LIFE funding in Ireland. The €1.9m DuhallowLIFE (LIFE09 NAT/IE/000220) project commenced in 2010 and is aimed at the conservation of the endangered Freshwater Pearl Mussel *Margaritifera margaritifera*, Otter *Lutra lutra*, Atlantic salmon *Salmo salar*, Kingfisher *Alcedo atthis* and Dipper *Cinclus cinclus.* This project includes environmental works on a large scale, including tree planting, fencing and riparian management, development and placement of nest boxes for birds and artificial Otter holts. An invasive species eradication programme was also undertaken in tandem with a comprehensive community awareness raising exercise through workshops, educational lectures, a range of publicity material, information signage, school visits and river demonstration trips. Monitoring of project actions was also carried out, often in partnership with universities.

Integrated Catchment Management (ICM)

Implementation of the DuhallowLIFE project was often less than straightforward, requiring not only sufficient farmer liaison, adequate materials and ecological information, but also the development of project innovations to meet the local conditions facing farmers and nature conservation. Additional survey work and an array of licensing and planning requirements was also involved. Significant pressures beyond the scope of the LIFE project became evident as the project evolved. To address these, IRD Duhallow formed a working partnership with the INTERREG IV funded project (TRAP) to develop an Integrated Catchment Management process for the River Allow Catchment. Stakeholders were invited to meet in April 2014 and a draft ICM Plan was prepared. Meetings are held on a six weekly basis. At each meeting the aim is to address at least one focus topic at a time. A tally is kept of progress (or lack of) and updates are presented at subsequent meetings. In addition to the advantages of having almost all sectors at a single meeting with the objective of identifying, discussing and troubleshooting on issues affecting the river, there have been some real improvements on the ground. Importantly for farmers it provides context to decisions that may affect them and allows an opportunity for their voices to be heard at the local level.

Locally Led Agri-Environment Scheme

These farmers put forward a motion that a Locally Led Agri-environment scheme should be developed for the River Allow under the 2014-2020 RDP Programme. An agricultural consultant worked in partnership with the farmers and the project partners and a draft scheme has been put together which is being presented to the Department of Agriculture Food and Marine. The scheme concentrates on nutrient loss, silt loss and livestock management.

Results and Discussion

Since the commencement of the DuhallowLIFE project the following has been achieved. The invasive species Himalayan balsam *Impatiens glandulifera* has been removed, without the use of chemicals, from over 40km of river bank. 30km of river bank has been fenced. A novel "flood friendly fencing technique" was developed for grazed floodplains. Thousands of native trees have been planted.

Over 400m of excessively eroding river bank has been addressed using a soft engineering technique developed by the project. Customised nest boxes for dipper were placed under 20 bridges, 12 nest boxes for Kingfisher in river banks and 38 artificial holts and logs piles were placed for Otters. Over 3km of trees along river banks were pruned. 120,000 newsletters were produced in addition to brochures, information signage etc. All National (n = 36) and Post Primary schools (n = 5) were visited more than twice with follow up field trips.

Table 1. River Allow ICM Initiative. Stakeholders in regular attendance at meetings. *Some stakeholders may have an interest in more than one sector*

Sector	Stakeholder (organisation)
Agriculture Practitioner:	Local farmers, Irish Farmers Association, Irish Farmers and Milk Suppliers Association, Irish Farmers with Designated Land
Agriculture advisory/policy:	Teagasc, Department of Agriculture, Food and the Marine
Environmental NGO's:	Sustainable Water Network, Coomhola Salmon Trust Ltd, Cork Nature Network, Duhallow Birdwatch Group
Forestry Practitioner:	Coillte
Forestry advisory/policy:	Forest Service
Wildlife/ Environmental regulation:	Environmental Protection Agency, Inland Fisheries Ireland, Cork Co Council Environment Section, National Parks and Wildlife Services
Planning/forward planning:	Cork Co Council Planning and Forward Planning
Road and bridge management:	Cork Co Council Engineering Section
Flood management :	Office of Public Works
Education/research:	Local school teachers (out of school term only), Mary Immaculate College
Angling:	Kanturk Trout Angling Club, Duhallow Angling Centre of Excellence
Community and voluntary:	Individuals, Kanturk Community Development Group, Tidy Towns
On the ground conservation works:	Local anglers, IRD Duhallow staff, scheme participants and LIFE project team

Through the River Allow ICM project a range of issues are being addressed. Examples include, the cessation of two major ongoing chronic pollution issues. One a municipal discharge and the other from a local industry. The former discharge was so severe that the river was lifeless for several hundred metres downstream at the time of sampling (EPA Q Value <1; 03/10/14). Subsequent to the river clean up and improvements to the management of the facility, a second sampling occasion found a dramatic improvement (EPA Q Value 4.5; 12/06/15) with juvenile salmon previous absent present in good numbers. Other benefits include movement on issues affecting farmers on the ground such as tree blockages in the river. There is an improved understanding of the difficulties that farmers endure when trying to comply with EU Designations on the one hand and Single Farm Payment requirements on the other. Other areas progressed include conflicts between management prescriptions for Hen Harrier *Circus cyaneus* and Freshwater Pearl Mussel in the upland areas of the catchment. Subsequent to the establishment of the ICM initiative, the EPA awarded funding for a study examining "bottom up" approaches to ICM in Ireland, which is being conducted in partnership with Mary Immaculate College (University Limerick). Interestingly some of the biggest obstacles to progress continue to centre around personnel who have yet to engage in the ICM process!

Conclusions

Rivers are dynamic and complex systems, presenting a range of challenges from scientific, economic, social and political arenas. The incorporation of people most affected by decisions and who ultimately will effect change on the ground is essential for any conservation strategy to work. We argue that although agriculture presents particular challenges for water and biodiversity management, the involvement of farmers at every level in both landscape and conservation planning is not only essential but can present opportunities of learning for all involved. Applying the principles of ICM, we have formed partnerships with the landowners and other stakeholders in an effort to find practical solutions to conservation issues on the ground.

Acknowledgments

The authors would like to thank the landowners and the local community for their cooperation, staff and colleagues at IRD Duhallow and all the stakeholders taking part in the River Allow ICM initiative. In addition we would like to thank Donal Daly and his colleagues at the EPA Catchments Unit for their ongoing encouragement and assistance.

References

D. Daly. (2013). Integrated catchment management (ICM) - a pathway to the future "Progress and change; change and progress" in providing foraging resources for bumblebees in intensively farmed landscapes. *Groundwater Newsletter.* 51: 2-6.

Anon (2014) River Allow Catchment Action Plan. INTERREG IV TRAP and DuhallowLIFE Projects. *56pp*.

Developing Result Based Agri-environmental Payment Schemes for the conservation of species and habitats in Ireland and Spain

C. Maher[1], V. Alzaga[2], C. Astrain[2], G. Beaufoy[1], A. Berastegi[2], A. Bleasdale[3], D. Byrne[4], V. Clavería[2], A. Donaghy[5], K. Finney[5], G. Jones[1], J. Moran[4], B. O'Donoghue[3] and J. Torres[2].

[1]European Forum on Nature Conservation and Pastoralism; [2] Gestión Ambiental de Navarra
[3] National Parks and Wildlife Service, [4] Institute of Technology Sligo and [5]BirdWatch Ireland.

Email: maher.caitriona@itsligo.ie
Website: www.rbaps.eu

Introduction

Result-based agri-environment payment schemes (RBAPS) award payments to farmers on the basis of the quality of the desired environmental outcome that is delivered. This contrasts with the standard 'prescription-based' model, where payments are awarded for complying with certain conditions, whether prohibitions or mandatory actions. For example, in a prescription-based agri-environment scheme (AES), a species-rich grassland option might specify certain grazing &/or mowing dates, livestock pressure, fertiliser and herbicide use, with the same payment made irrespective of the subsequent quality of the grassland.

With result-based schemes, the habitat condition is scored (e.g. on a scale of 1-10), with the highest payment awarded to the best quality habitat (Parr et al. 2010). Assessments are based on objective indicators, which are chosen to reflect the overall biodiversity and ecological integrity of the habitat while also responding to agricultural management practices.

Result-based schemes may involve payments awarded solely on results achieved or may be a blended model with payments for 'non-productive investments' which support the delivery of biodiversity (e.g. removal of encroaching scrub); and can be complemented by some prescriptive elements where necessary.

By linking payments to indicators RBAPS should make it financially beneficial for participating farmers to gain an understanding of the conditions needed for delivery of biodiversity. This would create a new market for biodiversity; those farmers who better deliver market requirements would be better rewarded.

Result-based schemes, though currently much less common, have the potential to be more effective in conserving biodiversity than purely prescriptive measures. In the past, traditional AES have been criticised for failing to deliver their biodiversity goals; reasons cited include poor targeting, inappropriate prescriptions and lack of farmer engagement (EU Commission, 2011).

Project objectives

An EU funded pilot project to test RBAPS measures in County Leitrim, the Shannon Callows and the Mediterranean hills of Navarra, Spain will run from January 2015 to June 2018. Its main objectives, as set out by the call for proposals, are:

- To promote the design, development and use of RBAPS to conserve and enhance biodiversity;
- To increase our understanding of factors that contribute to the success or failure of RBAPS;
- To identify opportunities for increasing the use of RBAPS in the EU and in the context of the CAP;
- To explore the potential for such schemes to be applied widely in the rural countryside and beyond grasslands, e.g. for the protection and enhancement of pollinators and soil biodiversity;
- To develop, test and apply widely appropriate monitoring protocols to verify ecological results;
- To promote awareness and better understanding of the benefits of RBAPS.

Study areas

Ireland

Within Ireland two contrasting regions, the Shannon callows (an SAC and SPA) and the largely-undesignated lowland areas of County Leitrim were chosen for trialling the result-based approach. In these areas the improved management of both habitats (species rich grassland and flood meadows) and species (marsh fritillary butterfly *Euphydryas aurinia* and breeding waders (birds including snipe *Gallinago gallinago*, curlew *Numenius arquata*, redshank *Tringa totanus* and lapwing *Vanellus vanellus*)) is being developed.

Leitrim contains a number of important sites for the marsh fritillary, now threatened by loss of habitat. Threats to semi-natural grasslands in Leitrim include intensification, abandonment and predominantly, conversion to forestry.

On the Shannon callows, breeding waders are associated with wet grasslands, mostly those that are grazed at an appropriate stocking level, have sufficient chick rearing areas and limited impact from predators. The species rich meadows on the callows face threats from both intensification (e.g. use of fertiliser and herbicides) and in recent years for some, a lack of mowing due to a combination of summer flooding and late mowing regimes (for Corncrake). As a consequence, the quality of those areas left uncut for more than one year has reduced and *Filipendula ulmaria* has spread, which in turn results in increased herbicide use on some meadows.

Spain

The upland zone of the Mediterranean region of Navarra supports a mosaic of vineyards, olive and almond groves, arable plots, rough grazing areas and high edges density which offer an important variety of ecological niches for wildlife (Iragui *et al*. 2010). Nevertheless the increase in the amount of herbicides and pesticides being used in vineyards and olive groves, a simultaneous reduction in traditional grazing pressure and a gradual extension of irrigated cultivation with intensive varieties and techniques are leading to a loss in biodiversity throughout the landscape. Traditional almond groves don't lend themselves to intensification and are now facing abandonment, with the loss of species rich ground flora and associated insects and birds (Iragui *et al*. 2010).

Table 1. Overview of species and habitats being trialled under the current result-based scheme.

Biodiversity output	Leitrim	Shannon Callows	Navarra, Spain
Species	Marsh Fritillary	Lapwing Curlew Snipe Redshank	Numerous Annex bird, reptile and mammal species
Habitat	Species rich grasslands	Species rich flood meadow	Traditional mosaic of vineyards, olive & almond groves

Our approach

The current project is geographically targeted at areas where this pilot can achieve the greatest potential. It specifically requires the input and participation of farmers; and will address both environmental and agricultural considerations.

Building on the Burren model (Parr et al. 2010), biodiversity results must be easily measurable using a simple ecosystem assessment in which the result indicators reflect both the quality of the biodiversity output and the agricultural management of the site. For example, when assessing the quality of species-rich grassland, the amount of bare soil may reflect both damage to grassland habitat and inappropriate stocking density. This project will strive to identify robust surrogates for biodiversity which are easily understood and measured by farmers, advisors, civil servants etc. and on-going work will involve testing the validity of these surrogates and assessing the merits of the RBAPS approach against a range of criteria.

Our current Irish grassland indicators (for use in the Irish pilot areas) include easily identifiable positive indicator plant species as well as indicators of good management and ecological integrity. Where the habitat is appropriate for marsh fritillary (i.e. suitable availability of its food plant, *Succisa pratensis*), the grassland assessment will be adjusted to reward appropriate management for the species. Indicators for breeding waders have been developed over the past number of years, including indicators for vegetation structure, condition of chick rearing areas and extent of predator habitat. Indicators to be tested in Navarra relate to the extent, diversity and period of herbaceous cover, evidence of traditional grazing practices and quality of traditional boundaries, rough grazing areas and structures valuable for wildlife.

Conclusions

Directly linking payments to indicators of results on the ground has been shown, in the Burren, to ensure both good delivery of biodiversity objectives and the engagement of farmers. The current project provides a valuable opportunity to test and demonstrate at local, national and European level the versatility, efficacy and value of result-based approaches to conservation through agriculture in a range of other natural, agronomic and regulatory conditions.

Acknowledgments

We acknowledge the European Commission for providing financial support to the project; and Teagasc, The Heritage Council, National Parks and Wildlife Service, Institute of Technology Sligo and the Department of Agriculture Food and the Marine for providing support to the Irish part of the project and Gestión Ambiental de Navarra to the Spanish part.

References

EU Commission (2011) Is agri-environmental support well designed and managed? *European Court of Auditors Special Report No. 7/2011*.

Iragui *et al.* (2010) Sistemas agrarios y forestales de alto valor natural en Navarra. Informe inédito. Gobierno de Navarra.

Parr *et al*. (2010) Farming for Conservation in the Burren. *Conservation Land Management*; Autumn 2010.

Session 3:

High Nature Value Farmland

Chair: Dr. James Moran
Institute of Technology, Sligo

This session was sponsored by IdealHNV, a collaborative research project involving Teagasc and the Institute of Technology, Sligo and funded by the Department of Agriculture, Fisheries and the Marine under the Stimulus Research Funding Programme.

Characterising indicator based HNV farmland distribution in Ireland- a GIS approach

S. Matin[1], S. Green[1], J.A. Finn[2], J. Moran[3], and C. Sullivan[3]
[1]*REDP, Teagasc, Ashtown, Dublin*
[2]*ERC, Teagasc, Johnstown Castle, Wexford*
[3]*Centre for Environmental Research Innovation and Sustainability, IT Sligo*

Email: shafique.matin@teagasc.ie

Introduction

High nature value (HNV) farmland is categorized by low-intensity farming, which supports high biodiversity and a range of wildlife habitats. Precisely, HNV farmland involves farming styles that are positively linked to biodiversity (Andersen et al., 2003). Restoration of biodiversity associated with farmland is one of the proposed priorities under the Rural Development Plan for 2014–2020 (DAFM, 2014). This would require appropriate identification of the HNV farmlands. Baldock et al. (1993) described the general characteristics of low-input farming systems in terms of biodiversity and management practices and introduced the term HNV farmland. Characterizing the HNV farmland distribution thus ties the idea of preservation of the biological diversity of farmlands to the need for safeguarding the continuation of farming in areas where such diversity is higher.

Direct identification of HNV farmland is difficult and relies on different surrogates of agro-biodiversity. Defining the minimum set of indicators is essential and depends primarily on the scale of mapping and data availability. The reasoning behind this is that the indicators need to be developed using Pan-European data to make them applicable across EU member states and perhaps beyond. The aim of this study is to establish a methodology to qualitatively identify the extent of HNV farmlands in Ireland using geographical information system (GIS) and also suggest the possible set of indicators for HNV identification.

Materials and Methods

Indicators for HNV identification

Five variables (Table 1) as surrogates for agro-biodiversity were utilized to identify potential HNV areas at tetrad scale (2km x 2km grid). A selection of the final set of indicators is based on multi-level analysis using different sets and combinations of indicators. Values were calculated for each tetrad for all five indicators and scaled between 0-1. For example, Level 3 of Corine 2012 land use and land cover map was initially coded with 1-5 for each class and scaled between 0-1. Similarly, LPIS data with average stocking density was used to calculate the presence of livestock units in each tetrad with negative weighting on HNV potential indication. Hedgerow cover map of 1 m^2 pixel was utilized to calculate the percent cover for each tetrad. Ordnance Survey of Ireland (www.osi.ie) provided line shapefile data for river and stream distribution in Ireland. Based on the fact that higher levels of semi-natural habitat cover are indicated by presence of river and stream running along it (Sullivan et al. 2011), we calculated the length of line feature for each grid. Finally, soil type data, at association level, was utilised to calculate soil diversity for each tetrad. As all the variables may not have equal influence in the HNV area identification (Boyle et al. 2015), differential weights have been assigned to the input layers in the model (Table 1).

Table 1. List of indicators with percent weight for model input

Data	Indicator	Weight
Corine 2012	Semi-natural land use classes	40 %
LPIS	Stocking density	30 %
Hedgerow cover	% hedgerow cover	10 %
OSI river-stream map	Length of river and stream	10 %
Soil association map	Soil diversity	10 %

GIS modelling

A 2km x 2km grid with 18849 grid boxes, covering the entire Republic of Ireland was created. All the input files were converted into the same projection (TM65 Irish Grid) and datum (D-TM65) for an exact grid to grid match and null values were removed prior to running the final model. All the input layers were intersected with the grid cells and values extracted for each tetrad. Finally, each tetrad was assigned with the average value of the feature, except for the input 'length of river and stream', where a total sum of the features was assigned to the tetrad instead of average. To keep the data in a similar format and range, all the input values were rescaled using a linear stretching algorithm. The stretch operation re-distributed values of the input map over a desired scale of 0-1. Input values are specified by the 'stretch from' values; the lower and upper 'stretch from' boundary values are included in the stretching. Output values are specified by the output domain and the value range and precision of this domain.

Linear stretching algorithm uses the following formula:

$$\text{OUTVAL} = (\text{INVAL} - \text{INLO}) * ((\text{OUTUP}-\text{OUTLO})/(\text{INUP}-\text{INLO})) + \text{OUTLO}$$

Where, OUTVAL: Value of pixel in output map, INVAL: Value of pixel in input map, INLO: Lower value of 'stretch from' range, INUP: Upper value of 'stretch from' range, OUTLO: Lower value of 'stretch to' range, OUTUP: Upper value of 'stretch to' range.

The Weighted Sum Model (WSM), which provides the ability to assign a distinct weight to the input layers and combines multiple inputs to create an integrated output, was used for final compilation of indicator layers. Using this model, complemented by other spatial analyst tools, an additive overlay analysis was carried out. The input layers maintained the attribute resolution of the values entered in the model. Weighted sum assumes that more favourable factors result in the higher values in the final output, therefore, identifies these locations as being the best to locate areas with higher HNV probability. Finally, the modelled output HNV map with 18849 grid cells was masked with the 1 km pixel farmland map of Ireland to extract out only the farmland areas.

Results and Discussion

The HNV potential map (Fig. 1), with values between 0-5, indicates the probability of HNV farmland in each tetrad. Cells with value 0 correspond to least probability of HNV farmland present in the cell, while 5 indicates the highest probability. WSM modelling resulted in 18309 grid cells with HNV potential, with 540 non-farmland grid cells. Upland areas showed a higher HNV potential than the lowlands. It was also evident that areas with commonage practices are less prone to intensification and hence showed higher HNV potential. Counties like Kerry, Clare, Western Galway, Leitrim, Donegal and Cavan exhibiting more HNV potential, while Dublin, Meath and Kilkenny were the counties with least HNV potential.

Of three types of HNV farmlands (farmland dominated by semi-natural vegetation; farms with mosaic of arable and/or permanent crops and semi-natural features; and farmland which supports species of conservation concern; Andersen et al., 2003), results from the current map (Figure 1) can be related to the first and second type of farmlands but not to the third type. In general, 'Type 3' HNV is relatively easy to identify, as it mostly coincides with designated sites (e.g. Natura2000 sites)

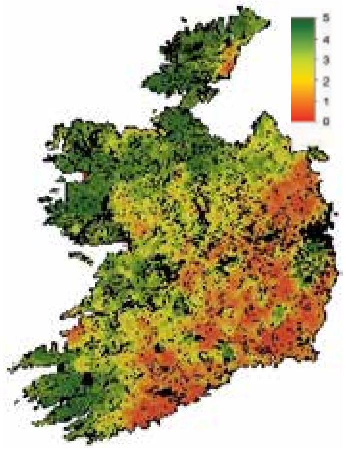


Figure 1. HNV potential map using 5 indicators. Output is a spectrum with 5 as very probably HNV and 0 as very unlikely (black is NA).

Accuracy assessment

The accuracy of the HNV farmland map accessed with 2049 known points corresponds to semi-natural grassland category (GS1-GS4) of Fossitt 2000 classification which resulted in 1717 grids (83.8%) matching with the current HNV farmland map.

Conclusions

The quality of detection of HNV farmland depends largely on the availability of suitable input data. In this paper, we provided a minimum set of indicators with distinctive weights to characterize the HNV farmland distribution in Ireland. This is an indicator based map and the values only represent the probability of HNV farmland in each tetrad. Such potential maps are good for planning and management practices but not for area estimation. A similar methodology can be used for other regions with regional specific inputs for better results.

Acknowledgements

This study is a part of IDEAL-HNV project and we thankfully acknowledge DAFM for the funding.

References

Andersen, E. et al., (2003). Developing a high nature value farming area indicator. *Final Report. EEP, Copenhagen.*

Baldock, D. et al., (1993). Nature Conservation and New Directions in the Common Agricultural Policy. *IEEP, London.*

Boyle P., (2015). Development of a nature value index for pastoral farmland—A rapid farm-level assessment. *Ecol. Indic. 56, 31–40.*

Sullivan, C.A., et al., (2011). Modelling semi-natural habitat area on lowland farms in western Ireland. *Biol. Conserv. 144, 1089–1099.*

The types of High Nature Value (HNV) farmland in Ireland

C. Sullivan[1], J.A. Finn[2], S. Green [2], S.Matin[2], D. O hUallachain[2], D. Meredith[2] and J. Moran[1]
[1]*Centre for Environmental Research Innovation and Sustainability, Dept of Environmental Science, Institute of Technology Sligo, Ash Lane, Sligo*
[2]*Environment Research Centre, Teagasc, Johnstown Castle, Wexford*
Email: caroline.sullivan1@gmail.com

Introduction

Almost half of the European Union's (EU) territory is dominated by agriculture and so it plays an important role in the conservation of the EU's environmental resources (1). This farming ranges from very intensive production systems on fertile land with high inputs, to very extensive production on marginal land with low inputs (2). Biodiversity is usually higher on farmland that is managed at a low intensity. At this end of the farming scale, the farmland itself supports a range of wildlife species, especially when it includes a high proportion of semi-natural habitats such as pasture or peatland. This farmland is called High Nature Value farmland (HNVf) and produces important environmental public goods such as clean air, clean water, stable climate and aesthetic landscapes (3). Identification, monitoring and support of these areas has been a policy requirement for EU countries since 2003 (4). This research is part of a project which identified the areas of Ireland where HNVf is most likely to occur and this paper describes the types of HNVf found in Ireland.

Materials and Methods

A map of the distribution of potential HNVf was produced as part of the IDEAL-HNV project (Figure 1). The map was based on three variables that are common European HNVf indicators; stocking density (per townland), reclassed Corine Land Cover map (into semi-natural and non-semi-natural), and hedgerow density. This map was then used to direct farm-level survey work locations around the country. Based on the map, eight sites with high potential for HNVf were selected for detailed farm surveys. This was supplemented with two more sites not indicated on the map (based on expert knowledge of these areas and their HNVf potential), i.e. islands and farms with floodplain land. Ten farms were surveyed at each site except for the islands where four farms were surveyed on each of three islands off the west coast, giving a total of 102 farms (see Figure 1 for site locations). Data gathered during fieldwork was subsequently digitised and variables relating to farm management, landscape and farmland biodiversity were calculated.

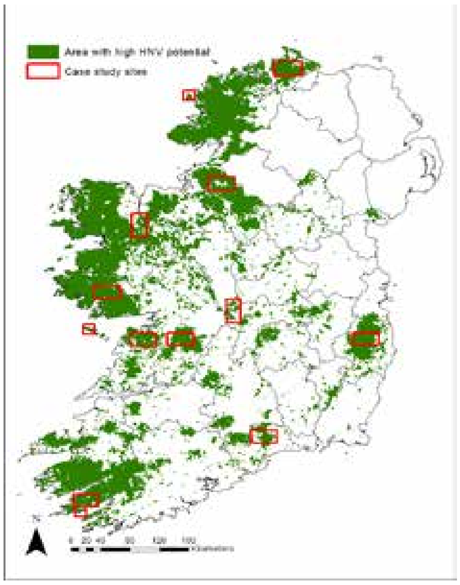


Figure 1. Map of areas in Ireland with high HNV potential shown in green. Locations of fieldwork sites highlighted with red boxes.

Habitats were digitised and areas calculated using ArcGIS 10.2. Where commonage comprised some of the farm, the proportion of the commonage claimed for Single Farm Payment (SFP) only was included in the area calculations. Principal Components Analysis (PCA) was carried out on 98 of the 102 farms. PCA linearly combines a number of variables into one single component. A correlation cross-products matrix was selected (Zuur et al., 2007) and results were displayed as a distance biplot. The significant axes were assessed by examining the eigenvalues and selecting only those with values higher than the broken-stick eigenvalues (5). Cluster analysis (CA), a hierarchical analytic method, was performed in PC-Ord using the principal components scores for the significant axes of the PCA analyses. CA creates groups of farms based on their homogeneity. Euclidean distance measure and Wards linkage method were used (6). This was done to identify groups of similar farms to produce a typology. Groupings from 15 to 2 were considered and the number of final clusters selected was based on expert knowledge and interpretability of the data.

Results and Discussion

Using the broken-stick eigenvalues, the first three PC axes are significant with PC1, PC2 and PC3 accounting for 26.06%, 17.26 and 15.28% of the variance respectively (Zuur et al., 2007). PC1 relates to land management intensity, PC2 relates to farm complexity and PC3 relates to elevation and farm size.

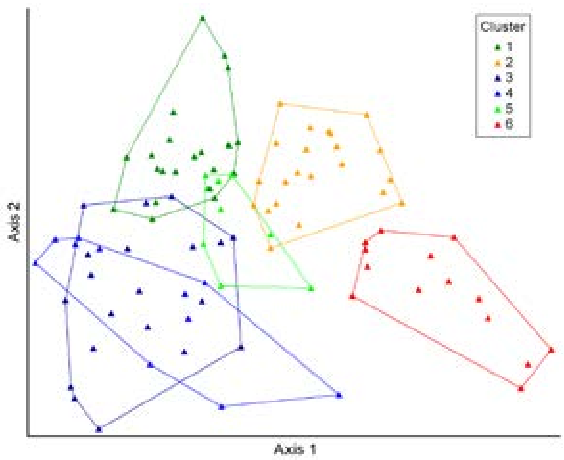


Figure 2. PCA results showing cluster overlays. Partial HNV groups are in red and orange. Whole HNV groups are in blue and green.

The average value for a subset of the variables analysed are presented in Table 1.

Table 1. Average values per cluster for a subset of the analysed variables

Cluster	1	3	5	4	2	6
Number of farms	10	15	26	9	21	17
Farm size (ha)	160 (± 69)	208 (± 85)	44 (± 30)	208 (±86)	55 (±34)	59 (±31)
Commonage (%)	0 (± 0)	45 (± 33)	44 (± 28)	62(24)	8 (± 12)	4 (±12)
Stocking density (LU/ha)	0.58 (± 0.27)	0.32 (± 0.21)	0.50 (± 0.32)	0.69 (± 0.44)	0.69 (± 0.29)	1.48 (±0.48)
Semi-natural habitat (%)	75 (± 13)	91 (± 8)	81 (± 12)	68 (± 22)	55 (± 16)	28 (±19)
Nature Value Score	6.9 (± 0.75)	7.7 (± 0.5)	7.5 (± 0.8)	6.2 (1.6)	6.6 (± 0.7)	4.2 (±1.13)
Field boundary density	93.1 (±27.2)	92.6 (±65.6)	273.1 (±128.6)	185.2 (±60.3)	216.4 (±71.5)	231.9 (±78.2)

Discussion

Keenleyside (7) categorised HNVf in Europe into two broad types; whole HNVf and partial HNVf. Clusters 1, 3, 4 and 5 correspond to whole HNVf. Cluster 1 represents large farms with no shares in commonage. Farms in this group occurred in the Burren and the Donegal coast. Cluster 3 represents large farms, many of which have shares in commonage. Farms in this group occurred in Connemara and Wicklow. Cluster 5 represents smaller farms, many with shares in commonage. Farms in this group included all the island farms. Cluster 4 represents polarised farms with high proportions of upland and commonage. These farms occurred in Waterford and Wicklow where the lowland areas can be more intensively farmed. Clusters 2 and 6 correspond to partial HNV farms. Cluster 2 represents farms with areas that can be more intensively farmed and so the semi-natural habitat cover, while high, is less than that of whole HNV farmland. Cluster 6 represents farms with lower semi-natural habitat cover but this is often a smaller part of an important landscape biodiversity feature such as the Shannon Callows or the Comeragh mountains (see Figure 2)

Describing the types of HNV farmland that occurs in Ireland makes it possible to better target supports for these areas. Knowing the different categories that exist will be valuable for designing these supports. This information will also allow comparisons of HNV farmland types among other European countries.

Conclusions

HNV farmland in Ireland falls into two types; whole HNV and partial HNV. According to this research there are six sub-types of HNV farmland in Ireland. This information will make monitoring and directing supports towards this type of farmland easier.

Acknowledgments

This research was funded by the Department of Agriculture, Food and the Marine Stimulus Research Funding Programme, grant award no. 11/S/108

References

CEC. Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy 2006.

Beaufoy G. HNV Farming-Explaining the concept and interpreting EU and national policy commitments. 2008.

Lefebvre M, Espinosa M, Gomez y Paloma S. The influence of the Common Agricultural Policy on agricultural landscapes. Luxembourg: Joint Research Centre of the European Commission, 2012.

Beaufoy G, Goemann H, Kaufmann P, Koorberg P, Michalek J, Moran D, et al. WORKING PAPER ON Approaches for assessing the impacts of the Rural Development Programmes in the context of multiple intervening factors. Brussels: The European Evaluation Network for Rural Development, 2010.

Zuur AF, Ieno EN, Smith GM. Analysing ecological data. New York ; London: Springer; 2007. xxvi, 672 p. p.

McCune B, Grace JB. Analysis of ecological communities. Oregon: MjM Software Design; 2002. 300 p. p.

Keenleyside C, Beaufoy G, Tucker G, Jones G. The High Nature Value farming concept throughout EU 27 and its maturity for financial support under the CAP London2014.

Implications of socio-economic change for the production of High Nature Value Farmland: A case study of Ireland 2000 and 2011.

D. Meredith[1], C. Crowley[4], G. Jones, S. Green[1], S. Matin[1], J. Moran[2], C. O'Sullivan[2], D.O'Huallachain[3], and J. Finn[3].

[1]REDP, Teagasc, Ashtown, Dublin 15, [2]Institute of Technology, Sligo, Ash Lane, Sligo, [3]Teagasc, Johnstown Castle Research Centre, Co. Wexford, [4]Identities Cluster, University College Cork.

Email: david.meredith@teagasc.ie

Introduction

Renwick et al. (1) evaluate the potential impacts of land use change arising from changes to the Common Agricultural Policy and conclude that removal of Pillar 1 support payments and further trade liberalisation will particularly impact on, livestock grazing farms situated in the more marginal areas of Europe. These spaces are commonly associated with higher levels of semi-natural habitat, rich bio-diversity and culturally important landscapes (2). The term High Nature Value Farmland (HNVf) is increasingly used to describe such spaces (3). Substantial research has been undertaken exploring the role of farm management practices and policy supports for multifunctional agriculture which support the production and maintenance of these landscapes (4). In recent years, concerns associated with the socio-economic resilience of HNVf have gained prominence within the literature (5). This reflects a recognition that sustaining HNVf landscapes, and the production of associated public goods, depends on continuation of multifunctional pastoral farming, i.e. on-going interaction between nature and farming cultures (3, 6).

The role of EU and national level agri-environmental policies in sustaining HNVf is the focus of a number of studies and the activities of NGOs, e.g. the European Forum on Nature Conservation and Pastoralism. These contributions, in general, emphasise the need for continuation and enhancement of payments to farmers working farms that contain HNVf in order to maintain biodiversity (4, 7). Within much of this research there is a recognition that farm management practices are not only influenced by agricultural policies and production technologies but are also shaped by farmers' decision making processes which are themselves influenced by a variety of personal, professional and locally contingent social and economic factors that are subject to change. Despite this, relatively little research has linked the production, via multifunctional agriculture, and management of HNVf or its sustainability to wider processes of rural restructuring, and hence, agricultural restructuring. This is particularly important given that local variation in environmental, social, cultural and economic conditions can and do give rise to spatially variable outcomes to common or generic policy initiatives (8).

This paper provides a review of selected literature concerned with rural restructuring and agricultural restructuring in marginal farming areas. Using Ireland as a case study we profile farm households, enterprises and structures in areas with high levels of HNVf and how these changed between 2000 and 2011. We then broaden the analysis to consider the evolution of the wider rural economy associated with the population living or working in these areas. We deepen the analysis to evaluate whether we are seeing increasing differentiation between HNVf areas before considering the implications of the findings for the continued maintenance of HNVf.

Materials and Methods

The data used in this study are drawn from a number of sources including the Ideal High Nature Value farmland project, which explores the extent and distribution of HNVf in Ireland, the Census of Agriculture and the Census of Population. The Census of Agriculture, last taken in 2010, reported results for 2,828 EDs, describes the size, structure and characteristics of farming within each ED. The Census of Population, last taken in 2011, provides a profile of the demographic, social and economic characteristics of the population living in each ED and also their place of work.

Geo-statistical analysis was undertaken by Matin and Green (unpublished) classified farmland into one of five groups, based on the probability of having high or low levels of HNVf. The classification was applied to two Km^2 grid cells of farmland; i.e. forested and urban areas were excluded from the analysis. As this spatial scale is incompatible with available socio-economic data, which are only published at the scale of the Electoral Division, additional analysis was undertaking associating grid cells to their corresponding EDs. Statistical analysis was subsequently undertaken to classify EDs according to their probability of recording high or low levels of HNVf. For this paper, only those EDs that recorded High (4) or Very High (5) probability of HNVf are included in the analysis.

Results and Discussion

The results of the analysis highlight similarities and differences in the structure of agriculture and socio-economic composition of the population in areas with HNVf. In general, farmers working land in areas of HNVf are older, operate specialist drystock farms, and record lower levels of farm income. Areas with higher probabilities of HNVf are characterised by higher levels of unemployment and out migration of younger people. There are some differences between HNVf areas. These are associated with proximity to larger (urban) labour markets which provide off-farm employment opportunities for more members of the farm household.

Discussion

Farming communities make important, often vital, environmental, social and economic contributions in upland areas, frequently because there are few or insufficient alternative economic opportunities and because they produce a landscape that is critical to other sectors, e.g. the tourist industry. Yet, in the face of declining policy support payments, introduction of new or changes to existing land use designations, volatile market income and changes in the structure of the broader rural economy which lead to fewer off-farm employment opportunities in some areas, the future of hill farming is uncertain (7). A substantial dimension of uncertainty relates to the paradox that whilst it is difficult to envisage the uplands delivering the desired ecosystem services and other public goods without the 'land management and livestock husbandry skills of farmers and the culture of their communities' Condliffe (9) the socio-economic system underpinning the production and reproduction of these skills is constantly evolving. As a consequence the availability of these skills, or at the very least the capacity to implement them, is perceived to be in decline. Some of these declines are associated with the reduced number of farmers (of particular age groups) whilst others are associated with a shift to alternative, labour or cost saving farming systems (6). This reflects changes to the wider social and geographic context within which farmers and farm households are situated. The challenge for policy, from the point of view of maintaining HNVf, remains one of ensuring that there are sufficient numbers of farmers with the appropriate knowledge and skills that are actively engaged in the management of upland areas. This is not simply a case of providing supports, the feasibility of which is questionable given the trend in policy initiatives towards reduced supports, over a number of decades, but rather ensuring viable livelihoods for farm households.

Conclusions

If farm enterprises in areas with HNVf are to be maintained an integrated development approach is required that facilitates the development of the economy of these areas and the engagement of the farm household the wider rural economy. Targeted measures are required in areas that are not accessible to labour markets associated with larger urban centres. Consideration should be given to exploring the feasibility of using local tourist taxes to reimburse farm enterprises for the production of HNVf.

Acknowledgments

This research was funded by the Department of Agriculture, Food and the Marine 'Stimulus Research Funding Programme', grant award no. 11/S/108

References

1. Renwick A, Jansson T, Verburg PH, Revoredo-Giha C, Britz W, Gocht A, et al. Policy reform and agricultural land abandonment in the EU. Land Use Policy. 2013;30(1):446-57.
2. Lefebvre M, Espinosa M, Gomez y Paloma S. The influence of the Common Agricultural Policy on agricultural landscapes. Luxembourg: European Commission Joint Research Centre, Institute for Prospective Technological Studies2012.
3. Oppermann R, Beaufoy G, Jones G, editors. High nature value farming in Europe – 35 European countries, experiences and perspectives. Ubstadt-Weiher, Germany: Verlag Regionalkultur; 2012.
4. Beaufoy G. HNV Farming-Explaining the concept and interpreting EU and national policy commitments. Lampeter: European Forum on Nature Conservation & Pastoralism2008.
5. Plieninger T, Bieling C. Resilience-based perspectives to guiding high-nature-value farmland through socioeconomic change. Ecology and Society 2013;18(4):20.
6. O'Rourke E, Kramm N, Chisholm N. The influence of farming styles on the management of the Iveragh uplands, southwest Ireland. Land Use Policy. 2012;29(4):805-16.
7. Morgan-Davies C, Waterhouse T, Wilson R. Characterisation of farmers' responses to policy reforms in Scottish hill farming areas. Small Ruminant Research. 2012;102(2–3):96-107.
8. Lobley M, Potter C. Agricultural change and restructuring: recent evidence from a survey of agricultural households in England. Journal of Rural Studies. 2004;20(4):499-510.
9. Condliffe I. Policy change in the uplands. In: Bonn A, Allott T, Hubacek K, Steward J, editors. rivers of Environmental Change in Uplands. London: Routledge; 2009. p. pp. 59–90.

Typology of a High Nature Value farmland region in an Atlantic pastoral area

P. Boyle[a], M. Gormally[b], C. Sullivan[a], M. Hayes[b], J. Moran[a]

[a] *CERIS, Department of Environmental Science, School of Science, Institute of Technology, Sligo, Ash Lane, Sligo, Ireland*
[b]*Applied Ecology Unit, School of Natural Sciences, National University of Ireland Galway, Galway, Ireland*

Email: pamgcboyle@gmail.com

Introduction

In an effort to address the loss of farmland biodiversity across Europe, agricultural policies have recently become increasingly focused on 'green measures' which support the production of public goods including biodiversity protection and enhancement, within a multifunctional model of agriculture. This shift in policy focus necessitates the identification of farm types that are capable of producing a wide range of environmental services such as clean air and water, carbon sequestration and maintaining the genetic diversity of flora and fauna (O'Rourke and Kramm, 2012). As a result, it has become increasingly important to develop farm typologies that reflect environmental factors such as management intensity and the presence of extensive farmland habitats (Andersen et al., 2007). This facilitates the recognition of gaps in economic and environmental supports; emphasises the links between farm management and environmental condition; and simplifies complex systems for communicating the factual condition of agriculture to non-specialist policy makers.

Low intensity farms in Europe have been described as High Nature Value (HNV) farmland areas which support high species and/or habitat diversity. Characterising HNV farmland aids the development of policies targeted at less productive, less economically viable farms, which contribute significantly to the protection of farmland biodiversity.

The aim of this paper is to develop a farm typology using a combination of land cover, farm management and landscape structure variables in a High Nature Value pastoral landscape in a northern Atlantic biogeographic region. This typology is based on the environmental setting of farms rather than economic production values. This approach can be used to inform future policy and agri-environmental scheme developments by describing the types of HNV farms and quantifying the degree of variability between farm types to determine where more targeted supports are required to maintain their biodiversity levels into the future.

Materials and Methods

Study area

The research was conducted in counties Mayo, Sligo and Leitrim, in the north-west of Ireland (**Error! Reference source not found.**). The most frequent landcover types are pasture and heterogeneous agricultural areas. Average farm size in the region is 24.6 ha UAA compared to the national average of 32.7 ha UAA.

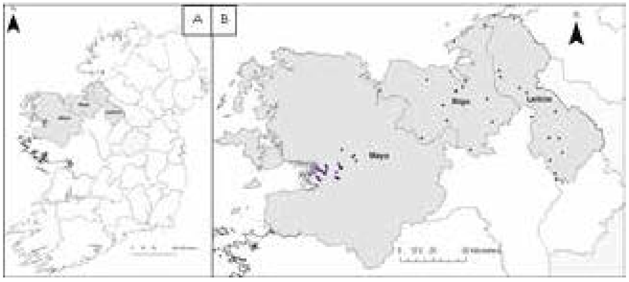


Figure 1. (A) Location of study area within Ireland. (B) Location of study farms within areas indicated

Farm management and biodiversity surveys

Fifty-eight farms were surveyed with the requirement for inclusion in the study being that the farm was actively farmed and contained less than 20% cover of conifer plantation. Farm questionnaires gathered data relating to farm management. All land within the farm boundary was walked and all habitats were identified. All vascular plants encountered during a structured 'W' walk across each field were recorded and abundance was assigned.

Data analysis

Principal Components Analysis (PCA) was carried out on farms and eighteen variables using a correlation cross-product matrix and displayed as a distance-based biplot. Cluster analysis, a hierarchical analytic method, was performed using the principle components scores for the first four axes identified from PCA to identify groups used to create a typology of the sample farms.

Results

Results of farm typology

PCA yielded four principal components (PCs) explaining 68.2 % of the original variance (Figure 2.) PC1 appears to relate to farm structure, PC2 appears to relate to farm biodiversity**.** PC3 appears to relate to farm management intensity and PC4 appears to relate to farm fragmentation.

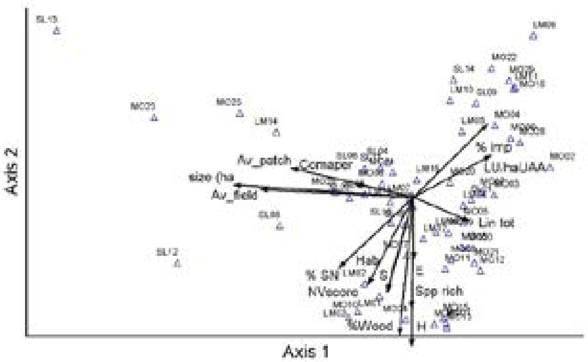


Figure 2: Principal Components Analysis ordination with variables overlay (MO –Mayo, SL – Sligo, LM – Leitrim)

Farm typology

Results show a differentiation largely based on semi-natural habitat cover, livestock units, species richness and cover of linear habitats.

Group 1 represents extensively managed farms. These farms have a low mean stocking rate (0.7 LU/ha UAA) and high cover of semi-natural habitat (82.9%). This group also has the highest nature value score (8.06), highest proportion of designated land (14% of farm area) and highest mean species richness per field (23.6).

Group 2 has a high cover of semi-natural habitat (67.8%) but has a higher mean stocking density than Group 1 (1.03 LU/ha UAA). This group has a nature value score of (7.27) and a mean plant species richness per field of (11).

Group 3 relates to relatively intensively managed farmland for this landscape. Mean livestock density is high (1.98 LU ha/UAA) and mean semi-natural habitat cover of the group is low (35.9%). This group also has the lowest number of habitat types per farm (5) and lowest nature value score (4.45).

Group 4 relates to farms which use extensive areas of commonage (mean value of 44.8% of commonage on farm). Mean livestock density is 0.58 LU/ha UAA and semi-natural habitat cover is 89.3%. The mean nature value score for this group is 7.68.

Conclusions

The results from this study have identified four farming types present in a HNV region based on habitat and management factors. Obvious differentiations between land use intensity which impacted on farmland diversity were identified. Threats to farmland biodiversity including abandonment and polarisation of farm management are shown in the typology. The application of Keenlyeside et al (2014) description of whole, partial and remnant HNV groups has shown that concerns for extensive farmland at an EU level (i.e. intensification, abandonment and afforestation) are very real at an Irish regional scale.

The typology described in this study reflects a diverse landscape which supports a diversity of farming types. This provides greater understanding of the challenges which face farmers in these areas. This information can be used to inform the development of measures and policies which may be implemented at regional level, which has been found to be desirable for the protection and enhancement of farmland biodiversity (Signorotti et al, 2013).

Acknowledgments

We would like to thank the farmers that participated in this study and their agricultural advisors for their help in sourcing sample farms. This project was funded by Irish Research Council and Presidents Bursary, IT Sligo.

References

Andersen, E., Elbersen, B., Godeschalk, F., Verhoog, D., 2007. Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. Journal of Environmental Manangement, 82, 353–362.

Keenleyside, C., Beaufoy, G., Tucker, G., Jones, G., 2014. High Nature Value farming throughout EU-27 and its financial support under the CAP. Report Prepared for DG Environment, Contract No ENV B.1/ETU/2012/0035, Institute for European Environmental Policy, London.

O'Rourke, E., Kramm, N., 2012. High Nature Value (HNV) Farming And The Management Of Upland Diversity. A Review. European Countryside Journal, 2, 116–133.

Signorotti, C.,Marconi, V.,Raggi, M., Viaggi,D. 2013. How Do Agri-Environmental Schemes (AES's) Contribute to High Nature Value (HNV) Farmland: a Case Study in Emilia Romagna. 2nd AIEAA Conference Parma 6-7 June 2013

Session 4:

Ecosystem Products and Services

Chair: Mr Pat Murphy
Teagasc

Can ecosystem services guide us toward sustainable agriculture?

A. McVittie[1]
[1]*SRUC, West Mains Road, Edinburgh, UK*
Email: alistair.mcvittie@sruc.ac.uk

Introduction

The choice of the term 'sustainable agriculture' in the title of this paper is potentially risky. It is a term likely to have as many definitions as opinions as to how it might be achieved. However, the United States Congress considered the issue in its 1990 Farm Bill and came up with a reasonable and comprehensive definition.

The term sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long term:

- *satisfy human food and fibre needs;*
- *enhance environmental quality and the natural resource base upon which the agricultural economy depends;*
- *make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;*
- *sustain the economic viability of farm operations; and*
- *enhance the quality of life for farmers and society as a whole.*[1]

In this paper I don't seek to test or develop this definition. Instead, within the context of recent developments in UK and EU agricultural policy and scientific understanding, I hope to explore whether we are closer to achieving sustainable agriculture. In particular whether the adoption of ecosystem services within policy and scientific discourse is facilitating the move towards sustainability.

Evolution of environmental concerns in agricultural policy

European agricultural policy in the latter half of the 20th century was initially concerned with ensuring the supply of food with little regard paid to the consequences for biodiversity and wider environmental concerns. This included supporting the active removal of traditional features, such as hedgerows, within agricultural landscapes that had over time allowed the coevolution of agricultural systems and their associated biodiversity. By the late 1980's the particular success of production oriented policy was becoming increasing apparent through large surpluses in agricultural commodities and increasing recognition of its environmental consequences whether in terms of diffuse pollution, overgrazing, or loss of habitats and biodiversity.

This coincided with the culmination of a long journal towards wider environmental awareness in society from Silent Spring (Carson, 1962), Limits to Growth (1972) and the Bruntland Report on sustainable development in (WCED, 1987). In the UK, the Government's response to this included the white paper Our Common Inheritance; this also recognised the role of environmental economic analysis in environmental policy assessment.

In the agricultural sphere, policy responses to the agendas of over production and environmental damage were comprised of the combination of carrots and sticks. For example, diffuse pollution was initially addressed through Nitrate Sensitive Areas[2] with restrictions on nutrient inputs. The first agri-environment schemes were typically 'narrow and deep' targeting areas that were arguably already offering benefits in terms of landscapes and by, possibly, association biodiversity. This switch of some support from production to environment also prompted the use of environmental valuation in policy appraisal, the motivation was to allay finance ministry concerns about what they were now paying farmers for (they understood food production even if it was wasted surpluses). See Garrod and Willis (1999) or IERM and SAC (1999) for some examples of these studies. The process of valuation through surveys is also of note as it introduced a form of direct public consultation that identified preferences for the non-production aspects of agriculture.

The following round of CAP reform in 2003 took this further and included concepts of multi-functional agriculture. Work that we undertook for the Scottish Government (McVittie et al, 2010) sought to determine public preferences for the productive, social and environmental outcomes from farming. The results indicated that the public wanted a bit of everything and could also understand the inherent trade-offs between production and environment. This new CAP also saw a shift in agri-environmental support to include 'broad and shallow' measures available to all farmers alongside the continuation of more targeted 'narrow and deep' schemes. Arguably, the decoupling of direct support from production also relieved the environmental pressures from agriculture in some instances particularly with respect to over

1 http://afsic.nal.usda.gov/sustainable-agriculture-definitions-and-terms-1

2 NSAs were introduced as a response to the Drinking Water Directive; the later Nitrates Directive resulted in Nitrate Vulnerable Zones which superseded NSAs.

stocking of livestock.

At the same time as this round of CAP reform concepts of ecosystem services were emerging in the wider environmental discourse particularly with the Millennium Ecosystem Assessment (MEA, 2006). Arguably there is nothing new in the ecosystem services concept, but its benefit is that it formalised different environmental issues into a common framework. It also made explicit the link between ecosystem services and human well-being. Such linkages are important in making the case for environmental protection beyond simply the intrinsic value of nature or the valuation of preference that people hold. This has allowed the ecosystem services concept to become ingrained in policy circles.

Where are we now?

In recent years agricultural policy and management has become hugely concerned with climate change mitigation and adaptation. Land management is also now required to address the objectives of a wider range of policy drivers including the Water Framework Directive, Bathing Waters Directive, Floods Directive, Habitats and Birds Directives. These can be addressed through Rural Development measures (Pillar II) in addition to increasingly stringent 'greening' and cross-compliance requirements in Pillar I. There are also likely to be a variety of policies at member state level (e.g. landscapes, cultural heritage, waste, renewable energy) as well as international initiatives (e.g. CBD Aichi targets).

The ecosystem services concept is advantageous in that it allows interlinkages between objectives and associated ecosystem services to become apparent whether these are trade-offs or synergies. Recent policy discourse and research agendas on land management have emphasised the potential to achieve multiple benefits, i.e. identifying and encouraging agricultural practices that can simultaneously deliver both food production and the range of environmental benefits (or minimised negative impacts) associated with the growing list of policy drivers. This may be a restatement of multifunctional agriculture, but with the adoption of ecosystem services frameworks there is arguably now the opportunity for more explicit integration of multiple objectives.

For example, with respect to GHG mitigation there is an interest in the potential for agricultural soils to act as carbon sinks. Soil carbon concentrations in many European arable soils have been observed as diminishing over time (due to intensive production). There is an interest in identifying and encouraging production measures that can reverse this decline and result in a net increase in soil carbon stocks. Possible measures include reduced or zero tillage, cover crops, incorporating crop residues, green and animal manures and improved crop rotation particularly including legumes. In addition to increase carbon stocks these measures can address other policy objectives:

- Improved water quality through reduced sedimentation and reduced nutrient loss;
- Moderation of surface water flows;
- Increased groundwater recharge;
- Reduce soil erosion risk; and
- Enhance surface and sub-surface biodiversity

The improvement in soil structure enhances the quality of the soil natural capital asset and makes it more resilient to disturbance such as extreme events. From an agricultural perspective there are benefits to farmers in terms of potential yield improvements, reduced input requirements (nutrients and fuel), and better workability including more days where soil is accessible for machinery.

The demonstration of private benefits to farmers may not be sufficient to encourage uptake; whereas some management responses may offer less obvious private benefits to farmers (beyond regulatory compliance or agri-environment payments). So there is a need to demonstrate to both farmers and policymakers the multiple benefits of different management interventions.

How can we integrate ecosystem services in our analysis?

In many instances the evidence base for assessing multiple ecosystem service benefits is limited. Studies of interventions have often focussed on single or small sets of objectives. Where evidence does exist for a wide range of ecosystem service outcomes this is likely to be from multiple studies each relating to specific contexts. Consequently it is difficult to undertake an integrated analysis particularly in a quantitative way.

One of the reasons why integrated analysis can be problematic is due to the variety of scales over which ecosystem processes and services occur. This is often reflected in the different scales from field plots to farms to catchments. It may be insufficient for management changes enacted on individual fields or farms to influence the delivery of landscape scale ecosystem services. Further our models of the relevant process and services may not be able to bridge the gaps in scale.

One potential solution that we considered in the context of evaluating the impacts of farm land management on water quality and flood risk was the use of Bayesian Belief Networks (McVittie et al, 2015). We wouldn't claim that such approaches can produce accurate models of complex ecosystem process and service interactions; conversely it was their relative simplicity and ability to integrate multiple types of data that we found to be their most attractive feature.

Bayesian Networks also have the potential to involve a wider variety of expertise as well as stakeholder interests in the construction and parameterisation of the model. In our case we involved expertise from terrestrial and aquatic ecologists, soil scientists and economists in the development of the models structure and parameterisation as well information from different strands of the scientific literature. The process of model construction provided the opportunity to gain insights into different disciplines that is often lacking even in explicitly interdisciplinary research. Although the process did raise many unresolved questions, particularly with respect to how economic valuation can be fully integrated into Bayesian Networks.

Who and how are ecosystem services paid for?

The preceding discussion has indicated that much of the ecosystem service delivery from agriculture is associated with different aspects of the CAP and Rural Development Programmes. Traditionally these have been the sources for support payments and can arguably they be considered as forms of Payments for Ecosystem Services (PES) schemes. However, the increasing recognition of the benefits of ecosystem services to a broader range of stakeholders, beyond being purely public goods, has increased interest for additional PES. There remains a great deal of suspicion surrounding the use of PES, particularly amongst environmental NGOs. This in part reflects the views of their membership who can be fairly conservative in their view of how conservation should operate and are sceptical about ecosystem services concepts and 'commodification' of nature that they fear PES represents. However, some eNGOs are more progressive then others. One prospect may be for eNGOs to provide 'PES in kind' through advice and support for land-managers. This could improve the effectiveness of support under traditional (publically funded) agri-environment schemes; particularly where the evidence of effectiveness is poor or quite often lacking (see Austin et al, 2015).

The other new players in PES markets are companies that rely on ecosystem services to provide resources. For example South West Water in the southwest of England has set up a number of PES like pilot schemes within its area that are innovative in a UK context. These are included in 'Upstream Thinking'[3] which aims to better manage water resources including flood risk through changes in land management in upper catchments. This has included grassland management and peatland restoration. A Peatland Code is also being established in the UK to develop peat as a carbon resource with a broader market. One area of potential future research is the extent to which cross-compliance requirements such as CAP greening and RDP agri-environment-climate measures could effectively be crowding out more innovative PES schemes, i.e. would farmers be reluctant to enter into yet more contracts on top of CAP obligations and familiar RDP schemes?

Conclusions

This paper has traced the evolution of environmental concerns both within agriculture and beyond over the recent decades. From an ecosystem services perspective this reflects earlier policy focused on narrow provisioning good outcomes. The first agri-environment schemes were themselves relatively restricted in that they were limited in their area of application and focussed largely on cultural ecosystem services. It has been policy priorities from outside agriculture including climate change, water quality, flooding and biodiversity that have been responsible for bringing regulating and supporting services into agricultural measures.

Although the ecosystem services concept cannot in itself be credited with this broadening of the policy demands for benefits from agriculture. The concept has arguably been very useful in drawing focussing our analysis and policy responses to identify those measures and management options that can deliver across these objectives. From a research perspective the concept explicitly requires inputs across multiple disciplines, although fully interdisciplinary science remains a challenge. Therefore, although ecosystem services do not in themselves deliver sustainable agriculture their recognition can provide scientific and policy responses that can at least better enable it.

Acknowledgments

The research discussed in this paper was supported by funding from the Scottish Government, the Valuing Nature Network (Natural Environment Research Council), SmartSOIL (EU FP7) and Natural Water Retention Measures (EU DG ENV).

References

Austin Z, McVittie A, McCracken D, Moxey A, Moran

3 http://www.southwestwater.co.uk/index.cfm?articleid=8329

D and White PL (2015) Integrating quantitative and qualitative data in assessing the cost-effectiveness of biodiversity conservation programmes, *Biodiversity and Conservation*, DOI10.1007/s10531-015-0861-4.

Carson, R. (1962) *Silent Spring*. New York: Houghton Mifflin Company.

Garrod, G. and Willis, K.G. (1999). *Economic Valuation of the Environment: Methods and Case Studies*. Edward Elgar, Cheltenham, UK.

IERM and SAC (1999). Estimating the value of environmental features, Stage 1. Final report to MAFF, Institute of Ecology and Resource Management (University of Edinburgh) and the Scottish Agricultural College.
http://webarchive.nationalarchives.gov.uk/20070206032844/http://statistics.defra.gov.uk/esg/reports/envfeat/finalrep1.pdf

McVittie A, Moran D and Elston D (2010) Public Preferences for Rural Policy Reform: Evidence from Scottish Surveys, *Regional Studies*, 44(5): 609-626.

McVittie A, Norton L, Martin-Ortega J, Siameti I, Glenk K and Aalders I (2015) Operationalizing an ecosystem services-based approach using Bayesian Belief Networks: An application to riparian buffer strips, *Ecological Economics*, 110, 15-27.

Meadows, D.H., Meadows, G., Randers, J. and Behrens, W.W. (1972) *The Limits to Growth*. New York, Universe Books.

Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Biodiversity Synthesis*, World Resources Institute, Washington DC.

World Commission on Environment and Development (1987).*Our Common Future*. Oxford: Oxford University Press.

Support measures and incentives for native woodland and hedgerow management on farms: the role of non-governmental agencies in advancing the native woodland and hedgerow sectors

D. Little[1] and N. Foulkes[2]
[1]Woodlands of Ireland, Seismograph House, Rathfarnham Castle, Rathfarnham, Dublin 14, [2]Hedge Laying Association of Ireland, Miskaun, Ballinamore, Co. Leitrim

Email: woodsofireland@iol.ie

Introduction

The new Forestry Programme 2014-2020 and the GLAS Programme, part of the Rural Development Programme (RDP) 2014-2020 - both operated by the Department of Agriculture, Food and the Marine (DAFM) - provide incentives and measures for farmers to manage and expand native woodlands and hedgerows in Ireland. The Native Woodland Scheme (NWS) is the principle measure available to private landowners and farmers to manage native woodlands. Native woodland and hedgerow management enhances woodland biodiversity, protects water quality, contributes to ecosystem connectivity at a landscape level, prevents soil erosion and provides a range of other ecosystem services. An assessment of a range of habitats, especially when enhanced via management, indicated that hedgerows and woodlands scored highest with respect to the ecosystem services provided (DEFRA, 2009). In order to maximise the uptake of these measures, promotion, training and technical support are pre-requisites given the specialised and skilled traditional management techniques involved. Aside from governmental departments and agencies such as Teagasc, non-governmental organisations can, and do, play a key role in developing and promoting these measures.

Main Body

Woodlands of Ireland (WoI)

WoI an environmental non-governmental organisation (ENGO) established in 1998 *'to develop projects and sustainable management strategies aimed at ensuring the future viability of native woodlands'* has been central to the development and implementation of the Forest Service NWS. WoI utilises expertise from across the woodland and non-woodland sectors to advance projects and provide technical support for native woodlands. Under the NWS, it provides native woodland training in partnership with the Forest Service. Also, WoI publishes technical bulletins on native woodlands which deal with the operational aspects of the NWS (Little et al., 2009). Since the NWS was introduced in 2001, over 4,000 hectares of native woodland have been established and managed and ca. 850 people have participated in NWS training courses. WoI also provides feedback from NWS practitioners and landowners to the Forest Service during the schemes revision, which occurs periodically.

Hedge Laying Association of Ireland (HLAI)

The HLAI, also an ENGO, was established in 2004, with the principle objective of *'to encourage and facilitate the conservation, protection and appropriate management of hedgerows'*. It comprises many individuals with considerable hedgerow management skills and experience. The HLAI was actively involved in supporting both the REPS and AEOS schemes through the provision of information, demonstrations and hands-on training (including City & Guilds accredited programmes) in hedgerow management techniques to participating farmers, most notably in the skilled, traditional craft of hedge laying. It has produced a technical DVD entitled *Hands-On Hedges* which contains six practical sections: *Understanding Hedgerows & Assessment of Hedgerow Condition; How to Lay & Coppice Hedgerows; How to Plant a New Hedge; Collecting Seed & Propagating Native Hedgerow Plants & Aftercare of Newly Planted and Rejuvenated Hedgerows*.

Joint initiatives

In 2013, WoI and the HLAI published a '*Hedgerow Appraisal System*' which provides current best practise guidance on hedgerow surveying, data collation and appraisal (Foulkes et al., 2013). It is especially targeted at hedgerow surveyors and helps to inform those involved in hedgerow management. This guidance complements the new National Hedgerow Database - also compiled by WoI and HLAI - which comprises all county hedgerow surveys conducted to date in a single software format which is maintained at the National Biodiversity Data Centre.

Discussion

This paper outlines the crucial roles ENGOs provide with minimal resources. Examples of promotion, technical support, training and guidance regarding native woodland and hedgerow management are provided. Promotion of the NWS until 2020 will occur via a five year Native Woodland Strategy, compiled by WoI after detailed consultation with native woodland stakeholders, including government departments (Little, in press). With regard to the NWS, its implementation to date could not have been achieved effectively without ongoing engagement, consultation and the partnership approach adopted by the Forest Service. With regard to hedgerow management it is also important that scheme planners, administrators and inspectors are conversant with the technical aspects of hedgerow management operations, where qualitative implementation impacts on the schemes objectives. The HLAI is suitably qualified and experienced to provide this support. Though lobbying is an important role for many ENGOs there is also a role for technical support, training and promotion from ENGOs established with these goals in mind, as demonstrated by the work of WoI and the HLAI. Such initiatives serve to promote and underpin the measures and incentives provided under the RDP.

Figure 1: Participants at the WoI/Forest Service NWS native woodland establishment training course held at Delphi, Leenane, Co. Mayo, July 2013.

Conclusions

In a recent report commissioned by WoI (Bullock & Hawe, 2014), it is estimated that the total natural capital value of the numerous ecosystem services provided by native woodlands in Ireland, is worth up to €140 million annually. Many of these values are invisible yet crucial to the wellbeing of society. Some key values include biodiversity utility value, which is worth €40 million/yr; amenity use, valued at €35 million/yr; woodland-related domestic and international tourism expenditure brings in €50 million/yr, and carbon sequestration at €8 million annually. Hedgerows provide similar ecosystem services and should also be managed sustainably to optimise ecosystem functions and values, particularly regulatory and cultural services (DEFRA, 2009). Key relevant regulatory services include water quality improvement, flood risk reduction, soil loss reduction (erosion control), crop water availability, crop pest reduction, crop pollination improvement, shelter provision (crops and livestock) and climate change mitigation.

The NWS and GLAS woodland and hedgerow measures are currently the only incentives landowners have to maintain and expand these resources. It is critical that that these measures are designed and implemented as effectively as possible which will result in a notable improvement in environmental quality and maximum value for money to the taxpayer.

It is recommended that governmental departments such as the DAFM harness more fully the considerable potential of technical ENGOs such as WoI and HLAI. In particular, the promotion and implementation of schemes such as the GLAS woodland and hedgerow measures can be achieved through increased consultation and technical input before and during the implementation of the schemes and through direct support and partnership, using the model currently applied by the Forest Service with respect to the NWS. This should short circuit problems as they arise and strengthen the relationship between end-users (farmers), practitioners and the service providers (DAFM). It would also help to ensure greater uptake and application of the measures concerned, particularly at a time when staffing levels in the Public Service are at an all time low due to the recent recession and embargo on recruitment. The result should be more efficient use of tax payer's money, the achievement of targets established for the measures concerned, which in turn will help meet national, international and EU policy goals.

Acknowledgments

We would like to acknowledge the ongoing support of all native woodland and hedgerow stakeholders, including government departments and agencies. WoI is funded by the Forest Service, DAFM, National Parks & Wildlife Service of the Department of Arts, Heritage and the Gaeltacht, and the Heritage Council.

References

Bullock, C. and Hawe, J. (2014). The Natural Capital Values of Ireland's Native Woodlands. Pdf. Woodlands of Ireland. Dublin.

DEFRA. (2009). Provision of Ecosystem Services through the Environmental Stewardship Scheme. Land Use Consultants in association with GHK Consulting Ltd. March 2009. DEFRA

Foulkes, N., Fuller, J., Little, D.J., McCourt, S. and Murphy, P. (2013). Hedgerow Appraisal System - Best Practise Guidance on Hedgerow Survey, Data Collation and Appraisal. Unpublished. pdf. Woodlands of Ireland, Dublin.

Little, D.J., Curran, E., Horgan, T., Cross, J., Doyle, M. and Hawe, J. (2009). Establishment, Design and Stocking Densities of New Native Woodlands. Native Woodland Scheme Information Note No. 5. Woodlands of Ireland. Dublin.

Little, D.J. A Strategy for Ireland's Native Woodlands 2015 – 2020 (In Press). Woodlands of Ireland. Dublin.

Agri-environment measures for Chough

B. O'Donoghue[1], D. O'Keeffe[1], A. Bleasdale[1], O. O'Driscoll[2] and M. Trewby[3]
[1]*National Parks & Wildlife Service, Custom House, Flood Street, Galway.* [2]*Bridge Street, Skibbereen.* [3]*BirdWatch Ireland, Kilcoole, Co. Wicklow.*

Email: Barry.O'Donoghue@ahg.gov.ie

Introduction

The Chough (*Pyrrhocorax pyrrhocorax*) is a member of the crow family; jet black in colour with a bright red bill and legs that bestow a Latin name meaning 'fire raven'. Chough are largely coastal in distribution in Ireland, with the maritime influence helping to maintain short swards which are optimal for access to their invertebrate prey in the soil. The Irish Chough population makes up about 60% of a geographically distinct and isolated NW European population of approximately 1,500 pairs. Chough are classed as Annex 1 species, meriting designation of Special Protection Areas under the EU Bird's Directive. Chough populations are classified as vulnerable in a changing agricultural landscape (intensification/ abandonment/crop changes and pesticides), so agri-environmental measures aimed at providing suitable Chough habitat are particularly important. This paper reviews a trial farm plan project for Chough under the National Parks & Wildlife Service Farm Plan (NPWS) Scheme between 2008 and 2015. The efficacy of the scheme and lessons learned are discussed.

Materials and Methods

The NPWS Farm Plan Scheme had the purpose of promoting a focussed, targeted and innovative approach to farming for habitats and species of conservation concern in some of Ireland's most important biodiversity areas. Bespoke five year farm plans were developed to enhance the environment for particular species including Chough. The Seven Heads SPA in County Cork was the main test bed for the NPWS Chough Farm Plan Scheme. This SPA had a total of nine NPWS Chough Farm plans, covering a total of 164ha. These plans operated between 2008 and 2015. The habitats targeted included dry acid grasslands, earth/ stone banks, maritime turf and coastal heath. The farm plan prescription involved the following:

- A sward height of 2-3cm to be maintained over 40% of the farm within SPA target areas.
- Avoidance of Ivermectins and Glyphosate.
- Avoidance of agricultural intensification on maritime turf.
- Retention and enhancement of earth banks.
- Creation and maintenance of open areas of short sward within heath.

The NPWS farm planner decided on the grazing levels required, coupled with hay and silage management regimes and any capital works required (e.g. scrub control). Cognisance was taken of other conservation interests that could be affected through management for Chough. Payments were made at a rate of €250 per hectare, as costed by an independent agricultural consultant. When the five year farm plans drew to a close, nine farmers were interviewed using standard questions about their views on the NPWS Farm Plan Scheme and what advice they would impart for future schemes for helping Chough.

In 2008, at the outset of the first Chough farm plans, a survey of the Seven Heads Special Protection Area (SPA) was undertaken by NPWS and BirdWatch Ireland (Trewby *et al.*, 2010). This survey was repeated in 2012 and again in 2014. The objectives of the surveys were to record breeding numbers, locations and productivity.

Results and Discussion

The breeding productivity (young reared per attempt) of Chough in the SPA increased over the period of the Farm Plan Scheme (Table 1), though poor weather in 2008 may have hampered productivity. Chough were regularly seen using fields that were included in the NPWS farm plans.

Table 1. Average breeding productivity (± st dev) of Chough within the Seven Heads SPA.

	2008	2012	2014
Breeding Productivity	1.08 (±0.24)	2.15 (±0.25)	2.50 (±0.34)

While the initial attraction to the plan for both the planner and farmers was economic, there was a lot of goodwill towards the objectives of the scheme and the Chough itself. Answers given to the anonymous questionnaires show that over the period of the scheme, the production of quality habitat became a more highly motivating factor for all nine farmers. Overall, compliance with the farm plan prescription was high. Some teething problems were encountered at the outset and communication between NPWS, the planner and the farmers was found to be central to delivering the desired effects in terms of habitat management. The questionnaires showed that the planner and individual farmers communicated on average 3.0 times per year, with individual farm visits occurring on average 1.5 times per year. Both the planner and farmers agreed this interface was crucial to delivering the desired effect. Prior to the scheme, farmers were unaware of the rarity of this bird, or even what it was called. By the end of the five years, farmers had a greater understanding of the Chough's requirements. The entire process was one of enlightenment for NPWS, the planner and farmers. While the farmers were given a farm plan prescription, in a number of cases, it was only when this prescription was fully discussed and interpreted that progress began to be made. Some farmers showed great initiative in considering how the desired result would be achieved – for example one farmer who never before dealt with sheep, bought in ewes to deliver a tight sward. Farmers were able to inform NPWS of specific practicalities with regard to abiding by the prescription. Many farmers, particularly the older farmers, knew of the ecological requirements of the Chough from direct observations and were able to suggest additional measures beyond the farm plan prescription to benefit Chough. The planner and all farmers felt the payment rates fairly reflected the effort the farmers put into delivering the farm plan prescription and that overall the scheme was of benefit to their enterprise. All parties considered that the amount of paperwork included in the Farm Plan was excessive.

Six out of nine farmers had concerns about the SPA designation when it was first announced. Four farmers were concerned it would interfere with their farming practice and two farmers were concerned about the impacts it might have on planning permission. Two of the farmers continued to have concerns about the SPA, while 7 of the 9 farmers now believe the SPA is fully compatible with their existing activities. The planner rated the farm plan scheme as 4.5 out of 5. The farmers rated the farm plan scheme as 4.55 on average. In terms of suggested improvements for the future, the planner advocated a hybrid approach whereby a base payment would be given for basic land management for Chough and an optional top-up for certain actions to achieve greater income and habitat value.

All nine farmers agreed a results (non-prescriptive) approach, whereby the farmer was given freedom to deliver the habitat and paid according to habitat quality was a good idea, though it was also noted that grass can be a particularly difficult crop to manage due to fluctuations in growth rates. Seven out of nine farmers suggested improvements that could deliver greater benefit for Chough. These included the use of sheep to deliver tighter swards, the use of a finishing mower to deliver quality swards, dumping of earth/FYM to provide microhabitats for invertebrates, the limited and rotational use of sprays to tackle scrub encroachment, and out-wintering of animals (to provide grubs under dung in frosty weather, lessen the need for cattle dosing and keep scrub in check). Farmer suggestions also included a capital works budget (e.g. to provide for fencing to manage grazing units more efficiently and to create new earth/stone banks which Chough like to feed on) and to establish discussion groups focussing on delivering Chough habitat and receiving feedback on how their efforts were delivering for the bird.

Conclusions

Administrators, farmers and planners can all learn from one another. The NPWS Farm Plan Scheme for Chough was a success in highlighting what could be done for Chough in terms of habitat management and how practical this was for farmers. The review of the farm plan scheme provided much food for thought and consideration for future projects. A consensus emerged that pointed towards a desire for farmers to contribute to habitat delivery in a more expressive, non-prescriptive way, but with the need for guidance from an expert adviser to ensure effective and safe delivery. Agri-environmental plans have the capacity to promote nature designations such as SPAs and SACs in a more positive light, provided the landowners feel they are appreciated and supported in delivering the biodiversity that made their locality so important in the first place. It is intended to re-survey the Seven Heads SPA in 2016, as a baseline at the outset of GLAS plans targeted at Chough conservation. It is recommended that a more scientific approach is taken to documenting the use made of specific fields within the target area in order to adjudicate on the efficacy of the measures applied. From an initial review of the NPWS Chough farm plans, it would appear that management for Chough has had some beneficial impact on this otherwise threatened species, though further research would bolster this view.

Acknowledgments

The landowners who manage and maintain habitat for Ireland's Chough. The staff of NPWS and of BirdWatch Ireland who have helped formulate Chough conservation strategies in Ireland.

References

Trewby, M., Carroll, D., Mugan, N. O'Keeffe, D. & Newton, S. (2010). *The seasonal distribution and foraging behaviour of Red-billed Choughs Pyrrhocorax pyrrhocorax in Counties Waterford and Cork, February 2008 to January 2009.* Unpublished BirdWatch Ireland Report to National Parks & Wildlife Service, Kilcoole, Wicklow.

The conservation of farmland biodiversity and the role of the All-Ireland Pollinator Plan 2015-2020

Ú. FitzPatrick[1], J. C. Stout[2] & M. Quinn[3]
[1]*National Biodiversity Data Centre, Carriganore, Waterford*
[2]*School of Natural Sciences, Trinity College Dublin, Dublin 2*
[3]*Northern Ireland Environment Agency, Klondyke Building, Gasworks Business Park, Belfast*

Email: ufitzpatrick@biodiversityireland.ie

Introduction

Irish pollinators are in decline. The problem is serious and requires immediate attention to ensure the sustainability of our food, avoid additional economic impact on the agricultural sector, and protect the health of the environment. The annual value of pollinators for human food crops has been estimated at €153 billion world-wide, and at least €53 million in the Republic of Ireland (Bullock et. al., 2008). Regional estimates of the value of pollinators to individual crops have also been made, with values of over £7 million per annum for apples in Northern Ireland and €3.9 million for oilseed rape in the Republic of Ireland. Pollinators play an important role in maintaining healthy farm ecosystems which are a prerequisite for sustainable agricultural production. In taking action to support pollinators in the farm system, it future-proofs how the land can be used for generations to come. It is important to accept that if wild pollinator species were to be lost from the Irish landscape, they could not be replaced, regardless of monetary input. Three-quarters of our wild plants also require insect pollinators, meaning that without them our landscape would be a very different place. Their value from a tourism and branding perspective is of particular relevance in Ireland, but this has never been assessed in a monetary sense.

Ireland has 98 native bee species, of which one third are threatened with extinction (FitzPatrick et. al., 2006). Research shows that to maintain pollination service you need healthy honeybee colonies in combination with high abundance and species richness in wild bees and other wild pollinators like hoverflies. Pollinator declines are attributed to five main factors: habitat loss, general declines in wildflowers, disease, pesticide use, and our changing climate. Experts commonly agree that the loss of floral resources in the agricultural landscape has been a key driver. Declines in wildflowers are largely due to changing farming practice, particularly the movement from hay to silage production. Increases in the amount of fertiliser applied to arable fields has resulted in increased crop yields, but has led to a strong decline in species diversity and flower richness within managed fields (Kleijn et. al., 2009) and in semi-natural habitats adjacent to fertilised fields. Our tendency to tidy up the landscape rather than allowing wildflowers to grow along roadsides, field margins, and in parks and gardens is also playing a role in fewer of these resources being available.

Materials and Methods

To address the problem, the All-Ireland Pollinator Plan was initiated by Ú. FitzPatrick and J. C. Stout and then developed by a 15 member steering group, representative of key stakeholders, including the Department of Agriculture and Teagasc.

At its core, the Plan is about providing food and shelter across all types of land so that Irish pollinators can survive and thrive. It is a shared plan of action. It is about coming together to work strategically and cohesively over the period 2015-2020, so that collectively we can take steps to reverse pollinator losses and help restore populations to healthy levels. The Plan proposes taking action across five areas:

1. Making Ireland pollinator friendly (farmland, public land & private land)
2. Raising awareness of pollinators and how to protect them
3. Managed pollinators – supporting beekeepers and growers
4. Expanding our knowledge on pollinators and pollination service
5. Collecting evidence to track change and measure success

Within each area, targets have been set and actions have been identified to help achieve that target. The Plan identifies 24 targets and 81 actions in total. These range from creating pollinator highways along our transport routes, to supporting pollinators through agri-environment schemes and encouraging the public to see their gardens as potential pit-stops for bees. The Plan is also about raising awareness on pollinators and how to protect them. With the support of organisations like An Taisce Green Schools it aims to ensure that everyone from schools, to farmers, to local authorities, to gardeners and businesses know what pollinators need and what simple cost-effective actions they can take to help. Sixty-eight organisations have agreed to support the Plan, many of whom have accepted responsibility for specific actions. These organisations range from Local Authorities, to Local Development Companies, to State Agencies and NGOs.

Pollinators and farmland

Target 1.1 is aimed at making Irish farmland more pollinator friendly. In comparison to other countries, Ireland does not currently grow large numbers of crops that are pollinator dependent. However, globally the market share of pollinated crops is rising and in Ireland within the last ten years the value of Irish soft fruit, field vegetable, and apple production has increased by 17, 21 and 24% respectively. Pollinators have a key role to play in maximising yields from our current crops and those that will be important in the future. Within Target 1.1, twelve individual actions have been identified.

Farmland targets for 2015-2020

1.1.1 Increase the area of farmland that is farmed in a pollinator friendly way (4 actions)
1.1.2 Create a network of meadows and other flower-rich habitats to serve as pollinator havens (1 action)
1.1.3 Encourage the sustainable use of agricultural pesticides (1 action)
1.1.4 Provide clearer information on pollinators to the farming community (5 actions).

As part of Target 1.1.4, clear guidelines will be produced and disseminated in an appropriate way to the farming community. These will outline general actions that can be taken to make farms more pollinator friendly (e.g., maintaining good quality hedgerows, planting native trees and shrubs, allowing wild flowers to grow along laneways, and providing long grass or bare ground as nesting habitat). Information on additional specific actions that can be taken on different farm types will also be prepared for: dairy, beef, tillage, sheep, horse, soft-fruit growers, and orchards.

Farmers, more than any other group, are in an ideal position to help improve the quality and amount of diverse and flower-rich habitat for pollinators. It is hoped that, through engagement with the farming community, the Pollinator Plan will begin to make the agricultural landscape a place where pollinators can survive and thrive.

Results and Discussion

The Pollinator Plan is due to launch in September 2015. Guidelines for each sector will be available in spring 2016.

A publicly available online management system will be used to track progress in the 81 actions within the Plan. Those organisations with responsibility for actions will be requested to submit short annual progress reports into the system. In parallel, a publicly available online mapping system will be developed where all those who have taken pollinator friendly actions (farmers, schools, land managers, individuals) can log their location and the action(s) taken, and progress in the creation of pollinator friendly habitat across Ireland can be tracked. Ultimately the success of the Plan will be measured in increases in the abundance and diversity of pollinators within the Irish landscape.

Conclusions

It is intended that the All-Ireland Pollinator Plan be integrated within future policy mechanisms where relevant. The Plan is not just about protecting bees. It's about protecting the farmers who depend on their free pollination service for their livelihood. It's about protecting our landscape and the wild plants that need insect pollinators. It's about the birds and mammals that depend on the seeds and fruits of those plants. It's about protecting our own healthy balanced diet and our ability to buy Irish grown fruit and vegetables at an affordable price. It is hoped that the Pollinator Plan will provide a structured framework to support the conservation of farmland biodiversity. More specifically, it is hoped that it will begin to create an Ireland with healthy, sustainable populations of pollinators to protect how future generations of farmers can use the land.

Acknowledgments

Acknowledgements are extended to the 15 member All-Ireland Pollinator Plan steering group who developed the Plan. Thanks are also extended to the 68 organisations who have agreed to support the Plan and work together on its implementation.

References

Bullock, C., Kretch, C. & Candon, E. (2008). The Economic and Social Aspects of Biodiversity: Benefits and Costs of Biodiversity in Ireland. In: Department of the Environment Heritage and Local Government (ed.). Dublin: Government of Ireland.

FitzPatrick Ú., Murray T.E., Byrne A., Paxton R.J., Brown M.J.F. (2006). Regional Red List of Irish Bees, Publ. Rep. to National Parks and Wildlife Service (Ireland) and Environment and Heritage Service (N. Ireland).

Kleijn D. et al. (2009) On the relationship between farmland biodiversity and land-use intensity in Europe. *Proc. Royal Soc. London* B, 276: 903–909.

http://www.biodiversityireland.ie/pollinator-plan

West of Ireland farmers hold the key to the conservation of the lesser horseshoe bat

K. McAney
The Vincent Wildlife Trust, Donaghpatrick, Headford, County Galway.

Email: katemcaney@vwt.org.uk

Introduction

The Vincent Wildlife Trust, a non-governmental organisation and registered charity in Ireland, has been actively researching and conserving the lesser horseshoe bat (*Rhinolophus hipposideros)* in Ireland since the early 1990s.

The lesser horseshoe bat is the only Irish bat species listed under Annex II of the EU Habitats Directive, due to the dramatic decline in its distribution throughout Europe in the last century because of habitat loss, habitat fragmentation, loss of suitable roosting sites and a reduction in insect prey arising from long-term and wide-scale use of agricultural pesticides. It is one of Ireland's smallest bats, weighing just 4-9g and is easily identified by a horseshoe-shaped flap of skin around its nose and at rest it hangs upside, often with its wings wrapped around its body. Its summer roosts are usually in old, undisturbed buildings, with slated, thatched or iron sheeted roofs. In winter it hibernates underground in caves, cellars, tunnels, souterrains, mines and ice houses, although due to the normally mild winters in the west of Ireland, it is active for short periods during this time. It is the only Irish bat with a restricted distribution, occurring in just six western counties and occupying a core area of 6,000km^2.

The VWT is a leading authority on the lesser horseshoe bat and owns or manages 13 roosts of this animal in Ireland, which held 3,136 bats in 2014, approximately 23% of the national population. Figure 1 shows the long-term trends in the number of lesser horseshoe bats at all VWT-managed sites up to 2011, following site-specific conservation measures.

Between the years 2010-2013 the Trust contributed to the long-term conservation of the lesser horseshoe bat in the upper Usk Valley in Wales with a project that provided landowners with practical support and guidance for improving roosting and feeding habitats for this species. (Sedgeley-Strachan *et al*., in prep.). Eight roosts were enhanced or purpose-built, five of which have been adopted by the bats. 11,800 trees were planted at six sites, including 2.75ha of wet woodland and 2.9km of hedgerows.

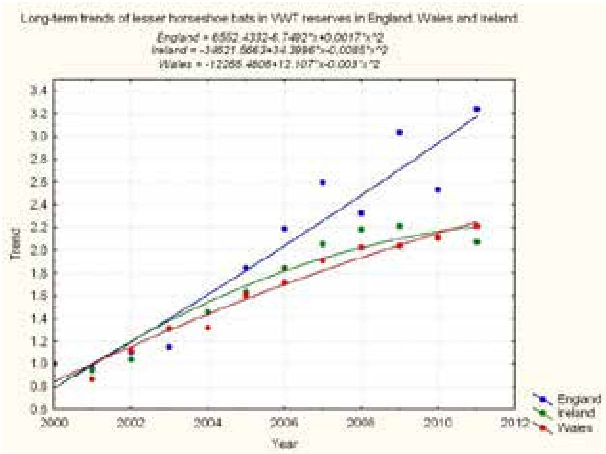


Figure 1 Long-term trends of lesser horseshoe bats at VWT sites

This paper outlines eight measures that would address the challenges facing this species (Table 1) if a compensatory mechanism for farmers could be accessed in Ireland. These measures are easily monitored and to date have proven to be successful, both in Ireland and in the UK.

Table 1 Suite of conservation measures for the lesser horseshoe bat

Action	Result
Opening up existing structures as roosts	Provide the bats with more summer roosts
Reducing draughts & Installing hot-boxes	Increase the reproductive capabilities of the bats by raising roost temperature
Re-roofing small derelict outbuildings	Create a suitable summer roost
Planting vegetation near buildings	Provide bats with shelter entering and leaving the roosts
Building an artificial summer roost	Provide the bats with ideal breeding conditions
Building an artificial winter roost	Provide the bats with ideal hibernation conditions
Providing night roosts	Create connectivity for bats to move between known sites and regions
Linking field margins and other traditional landscape features	Create connectivity for bats to move between known sites and regions

Opening up existing structures

Hundreds of roosts are needed by this species throughout the west of Ireland. Unlike other Irish bats, the horseshoe cannot land and crawl into a structure, but like a swallow needs an opening through which it can fly. This opening must be in the region of 500mm x 500mm so that it can fly directly into a structure. Lesser horseshoe bats cannot get into bat boxes, which is why this agri-environment (GLAS) option does not benefit them.

Most small farms in the west of Ireland have derelict or little-used buildings that could function as lesser horseshoe bat roosts following minor modifications.

Figure 2: Repaired farm building

Reducing draughts & installing hot boxes

Many unoccupied buildings are too cold to function as breeding roosts for the lesser horseshoe bat. In some cases, simply fitting timber sheeting at openings can prevent the flow of cold air and allow warm air to build up. However, a better solution is to provide a timber ‘hot-box’ within the roof space, with a small hatch to allow the bats access.

Re-roofing small derelict outbuildings

Many small structures on farms would make suitable roosts for the horseshoe bat if minor repairs were carried out. The Trust has leased a building from a farmer and paid for slates to be replaced, a ceiling fitted and openings partially closed off. Over 200 horseshoe bats are now using this shed as a maternity roost in summer while the farmer gained a secure storage area in winter.

Planting vegetation near buildings

Planting hedgerow plants and small trees in the vicinity of buildings enables horseshoe bats to emerge earlier in the evenings to feed on insects, because they have protection from avian predators.

Building an artificial summer roost

In the past the lesser horseshoe bat had access to large old buildings, some of which have been designated as cSACs. However, it is inevitable that some of these will be lost through dereliction. Nevertheless, it is possible to provide an artificial horseshoe bat roost for relatively small sums of money, providing a suitable location is selected within 2-3 km of a suitable feeding habitat and in an area known to be used by the species.

Building an artificial winter roost

In general, horseshoe bats need underground sites during winter. The absence of these can be a limiting factor in their distribution. The National Parks and Wildlife Service has successfully built a number of artificial sites using pre-cast road culverts that are set into trenches in the ground, which are then covered by earth.

Providing night roosts

Gaps in the distribution of the horseshoe bat are opening up in certain areas so steps need to be taken to link up existing roosts. This can be done by erecting simple timber shelters on farms in which the bats can hang up in during the night so that animals of different colonies can intermix.

Linking field margins and other traditional landscape features

A co-operative approach by neighbouring farmers and other rural landowners to retain or provide features within a radius of 2-3km of a lesser horseshoe roost, such as hedgerows, stone walls, ditches, banks and treelines, would enable the lesser horseshoe bat to move more freely and safely within the countryside.

Conclusions

The lesser horseshoe bat has been part of Ireland’s biodiversity for at least 6,000 years. Although considered a woodland specialist, it has survived the loss of 99% of the broadleaf woodland that once covered the island. The reason it has survived is due primarily to the previous actions of Ireland’s farmers who provided hedgerows and stone walls along which the bats fly and feed, built structures that the bats adopted for use in summer and retained underground sites, such as caves and souterrains, which the bats use in winter.

Many of the actions described here could be undertaken directly by the farmer or landowner, while others would involve outside contractors, such as the creation of a hibernation site. While these actions are aimed at benefiting the lesser horseshoe bat, some will also confer benefits to other plant and animal species, as well as enhancing the rural landscape for local communities. These actions will enable landowners without designated sites on their lands to play a role in conserving a protected species, yet where actions link with the suite of Natura 2000 areas, an added benefit would accrue to the latter.

References

Sedgeley-Strachan, J., Macmillan, H. & Jermyn, D. (in prep.) *Our Beacons for Bat Project 2010-2013.* The Vincent Wildlife Trust, Herefordshire, UK

Evaluation of agri-environment measures for the conservation of grassland on Irish farmland

D. Ó hUallacháin[1], H. Sheridan[2], B. Keogh[1,2] and J.A. Finn[1]

[1] Teagasc, Environment Research Centre, Johnstown Castle, Wexford, Ireland;
[2] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, Ireland

Email: daire.ohuallachain@teagasc.ie

Introduction

The recent widespread decline in global biodiversity, including the well-documented reduction in farmland biodiversity, represents a major global conservation challenge.

One of the priority environmental goals of the Common Agricultural Policy is to contribute to the EU goal to 'halt biodiversity loss and the degradation of ecosystem services by 2020'. In addition to achieving favourable conservation status in designated habitats (e.g. Natura 2000 sites), there is also increased emphasis on biodiversity conservation in the wider countryside (as in stated objectives in the 2010-2015 National Biodiversity Plan, and EU policies). These objectives are also contained in the Food Harvest 2020 report, and protection of biodiversity is one of its more challenging environmental goals.

Within Ireland, approximately 65% of the national land area is dedicated to agricultural production of which over 90% is pasture-based. Semi-natural grassland habitats have however undergone a significant decline in Ireland, mimicking the trend that has been witnessed throughout Europe.

Given the prominence of grasslands in Ireland, and the 'bad' conservation status of the majority of grassland habitats, it is not surprising that measures to address the conservation of grassland habitats have been included in all of Ireland's agri-environment schemes (Rural Environment Protection Scheme; Agri-Environment Options Scheme; Green Low-Carbon Agri-environment Scheme).

Grassland conservation options within the Agri-Environment Options Scheme consist of the 'Traditional Hay Meadow' (THM), and the 'Species Rich Grassland' (SRG) options. Participation in these measures has typically been high, with the SRG and THM being the two most popular options in AEOS in 2013. Payments to farmers for these options were €314 ha^{-1} on a maximum of 10 ha, thus, a farmer could potentially obtain the vast majority of their AEOS maximum payment of €4000 (€5000 in 2010) through selection of either of these options. Farmers with SRG or THM which has been designated as part of Natura 2000 can avail of the same level of payment on an unrestricted area of land, up to €4000.

Agri-environment schemes have an important role in delivering environmental public goods. The provision of public goods is a prominent justification for the allocation of public funds to the agriculture sector, and is a major feature of the European model of agriculture. However appropriate evaluation is necessary to satisfy EU agri-environment legislation, to demonstrate value-for-money to taxpayers, and to avoid accusations of trade distortion. To date, there has been no assessment of the effect of these grassland conservation measures on botanical diversity.

The aim of this study was to provide a baseline study and comparison of the botanical composition of the various grassland types currently supported through the Agri Environment Options Scheme.

Materials and Methods

Grassland surveys were undertaken on pastoral drystock farms predominantly in the midlands of Ireland. Farm selection was based on participation in any of the following AEOS grassland options:

- Species Rich Grassland;
- Traditional Hay Meadow, or;
- Species Rich Grassland in Natura 2000

Twenty sites for each of the grassland options were selected, resulting in a total of 60 sites.

Field work was undertaken between early May and August 2013 and 2014.

One field per grassland type was surveyed per farm; where a farm had more than one field of any one grassland type then the largest field was selected. Botanical diversity of the grasslands was surveyed using 1m x 1m quadrat sampling. Twenty quadrats were randomly located in each surveyed field. Species were identified according to Stace (1997), and abundance values were assigned to all vascular plants rooted within each quadrat according to the Braun-Blanquet Scale.

Generalised linear modelling (GLIMMIX, SAS 9.3.1) was used to investigate the species richness of the different types of grasslands. Ordination analysis was used (Canoco 4) to investigate the relationship between plant species composition and grassland type.

All of the surveyed sites complied with the entry criteria for the relevant AEOS measure.

Results and Discussion

Natura Grassland had a significantly greater species richness than Species Rich Grassland, which in turn had significantly more species than Traditional Hay Meadows. This pattern was also true for the abundance and diversity of herbs within these sites (Figure 1).

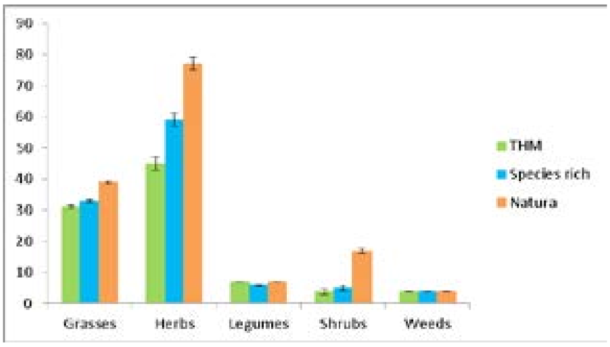


Figure 1. Species composition of Traditional Hay Meadow, Species Rich Grassland and Natura 2000 grassland.

The PCA ordination biplot (Figure 2) shows the principle separation of grassland types along axis 1. It shows an association between species composition and grassland type. There is a close association between a number of grass species and THM and a number of herb species with Natura grassland. Species Rich Grassland sites were on a gradient between THM and Natura grassland, but were more closely associated with THM.

The results indicate that even though the THM grasslands had a botanical range from species poor to relatively species rich, the species most closely associated with this grassland category were those which are generally considered indicative of improved pasture e.g., *Lolium perenne*, *Agrostis spp*., *Poa trivialis*, *Rumex obtusifolius*, *Ranunculus repens*, with grasses being a dominant feature of the vegetation.

The majority of Natura 2000 sites were found to have a botanically diverse sward. The species associated with these sites tended to be indicative of semi-natural habitats e.g. *Senecio aquaticus*, *Succisa pratensis*, *Mentha aquatica*, *Carex spp*. *Caltha palustris*, *Parnassia palustris*. Here, grasses were found to be less dominant than herbs in the vegetation. Where Natura 2000 sites were found with a reduced botanical diversity, anecdotal evidence suggested that there was a fear amongst landowners that they might accidently undertake management that may be in violation of Irish or European law, therefore they tended to adopt a 'less is more' policy whereby they did not actively manage the grasslands. This in turn was leading to grasslands becoming rank and losing botanical diversity.

The vegetation of the Species Rich Grassland option was associated with a combination of both grasses and herbs. The vegetation has some grasses that are not associated with high levels of fertiliser inputs e.g. *Anthoxanthum odoratum*, *Cynosurus criststus*, *Festuca spp*. as well as herbs such as *Cerastium fontanum*, *Plantago lanceolata*, *Potentilla erecta*. However, none of these species are characteristic of vegetation that is associated with high nature value.

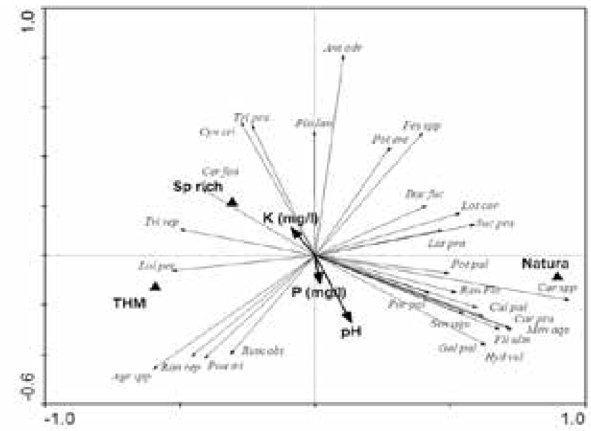


Figure 2. PCA biplots of grassland composition with projection of grassland variables and soil P, K and pH; nominal variables are represented as centroids. Grassland types: Sp rich - Species rich grassland; THM - Traditional Hay Meadow; Natura, Natura 2000 grassland.

Conclusions

This study found considerable variation in the biodiversity benefits across three different options within an agri-environment scheme. This suggests opportunity for improved design and targeting of the Traditional Hay Meadows and Species Rich Grassland options or a modification so that the payments better reflect the outcomes. For example, the full payment would be paid for vegetation with higher nature value, and lower quality vegetation would receive lower payment rates. This would be in line with approaches developed in the Burren Farming for Conservation Programme, and would incentivise improvement in the nature value of vegetation of low and medium nature value.

Acknowledgments

This project was funded by the Teagasc Walsh Fellowship Programme. We would like to thank participating farmers for facilitating the surveys in this study.

References

Stace, C.A. 1997. New flora of the British Isles, Cambridge University Press, Cambridge

Session 5:

Promoting Biodiversity in the wider Countryside

Chair: Mr Padraig Brennan
Bord Bia

A Credit Point System for assessing and enhancing biodiversity at the farm scale – and beyond

J. Zellweger-Fischer[1], S. Birrer[1], M. Jenny[1], S. Stoeckli[2], and L. Pfiffner[2]

[1]Swiss Ornithological Institute, Seerose 1, 6204 Sempach, Switzerland. [2]Research Institute of Organic Agriculture (FiBL), Ackerstrasse 113, P.O. 219, 5070 Frick, Switzerland.

Email: judith.zellweger@vogelwarte.ch

Introduction

Over the past decades, farmland biodiversity has decreased drastically in many European countries, and Switzerland is no exception. There have been attempts to halt and reverse this decline for over 20 years. The Swiss government spends 2.8 bn Swiss Francs annually on subsidy payments for agriculture. Ca. 8% is expended on ecological compensation areas (ECAs), the official options of the Swiss agri-environmental scheme (AES). Despite these efforts, no general increase of biodiversity has been observed at the national level.

On-farm experience shows that many farmers are interested in promoting biodiversity on their farms. However, a lack of knowledge transfer on ecology and agri-environmental issues seems to hinder farmers from managing their land in a more wildlife-friendly manner.

Enhancing farmland biodiversity has often been initiated at the plot level, although the principle unit of decision making in agriculture is the farm, and decisions on promoting biodiversity are also taken at that level.

We thus focused on the farm level and developed a tool which assesses on-farm biodiversity as a whole. With this tool, farmers are rewarded credit points for their efforts for biodiversity.

Materials and Methods

The Credit Point System

The Credit Point System (CPS) helps farmers with the assessment of biodiversity-promoting measures on their land. The CPS combines quantity and ecological quality of over 30 options known to enhance farmland biodiversity. Farmers can score points by applying some of these measures. Most of the listed options are official ECAs from the Swiss AES. Further, a number of arable and grassland options also yield points (for details see Birrer et al. 2014). The CPS weights the options according to their known benefit for biodiversity, i.e. a larger-sized meadow will yield more points than smaller ones and meadows with a high ecological quality (according to the Swiss ‘quality scheme’) yield more points than those without. The weighting is based on results of studies addressing, amongst others, farming intensity, landscape and habitat heterogeneity, conservation measures for target species etc., and is complemented with expert knowledge. The CPS returns one total biodiversity score for each farm (CPS score).

Evaluation of the Credit Point System

We tested whether the CPS score correlated with biodiversity using four organism groups: vascular plants, butterflies, grasshoppers and breeding birds. These biodiversity indicators and the CPS scores were assessed on 133 farms in the Swiss lowland. 42 farms were certified organic, 80 were integrated farms (integrated production according to the farming organisation IP-SUISSE) and 11 were conventional holdings.

For each of the four organism groups, species richness and density were examined, both for all species found and for a subset of species mainly occurring or depending on farmland (henceforth “farmland-specialist species”).

Correlations between biodiversity measures (e.g. plant species richness, farmland butterfly density etc.) and the CPS score were analysed with generalised linear mixed models. A range of environmental variables which are likely to influence biodiversity, but cannot be ‘changed’ by farmers, were added (e.g. farm area, proportions of arable land and adjacent woodland etc.) to test the CPS score in a realistic context.

Results and Discussion

Species richness and density of plants, grasshoppers, butterflies and birds significantly increased with CPS score. Correlations with farmland-specialist species were also significantly positive (see for instance farmland plant species richness, Figure 1). The CPS was thus shown to reflect biodiversity and to be a suitable proxy of biodiversity at the farm scale.

The most readily available proxy for biodiversity efforts at the farm scale would be the proportions of ECAs, as these are already assessed and officially registered. In our evaluation, however, the CPS score performed better than mere proportions of ECAs. The weighting of quantity and ecological quality in the CPS helps to better predict farm-scale biodiversity. Moreover, the CPS can be used as a self-evaluation tool with which farmers can assess their current biodiversity CPS score and also run scenarios on how to further promote biodiversity on their land. This in turn increases their motivation and self-initiative, a prerequisite for sustainable conservation of farmland biodiversity.

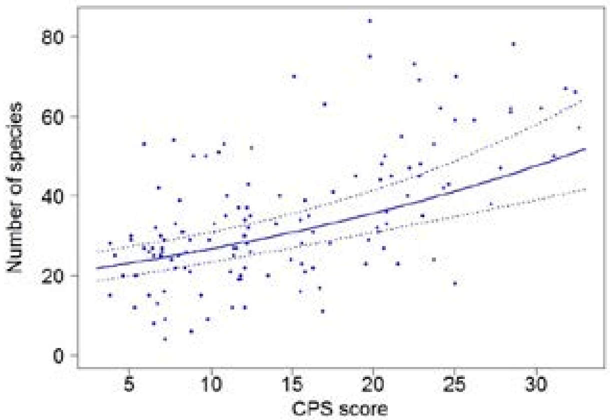


Figure 1. Relationship between the CPS score and species richness of farmland-specialist plants. Shown is regression line incl. 95% credibility intervals (dotted lines). The raw data is plotted as dots. N = 133 farms.

In 2010, a farming organisation for sustainable and wildlife-friendly foods, IP-SUISSE (integrated production; www.ip-suisse.ch), set up a mandatory guideline for the enhancement of biodiversity on their producers' farms. Since then, it has become mandatory for those ca. 9000 farms to apply the CPS and reach a minimal CPS score in order to remain in the label programme. Meanwhile, CPS scores on those farms have markedly increased (Figure 2).

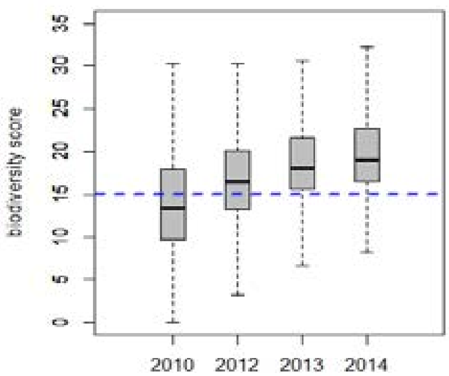


Figure 2. Increase of CPS scores (biodiversity score) of IP-SUISSE label producers (N varying annually; 2010: 5860, 2014: 8633 farms). By 2014, 88% reached the required minimal biodiversity CPS score (hatched line).

Already between 2010 and 2012 farmers implemented additional habitats (mostly ECAs) for biodiversity to reach the mandatory minimal CPS score. Not only the quantity but especially the ecological quality of those habitats was higher in 2012 than at the outset in 2010 (Table 1). In total, the area of high-quality options was increased by ca. 43% to nearly 88 km^2.

Table 1: Implemented high-quality CPS options and their area (km2) before (2010) and after the introduction of the CPS by IP-SUISSE in 2012 (n = 4852 farms with data from 2010 and 2012).

CPS options	Area (km2) 2010	Area (km2) 2012
High-quality meadows	51.4	75.6
Wildflower areas	7.1	7.6
High-quality hedgerows	1.9	3.1
Other	1.2	1.6
Total high-quality area	61.6	87.9

For IP-SUISSE, it was a challenging goal to raise the awareness of their producers for biodiversity. A few hundred farms dropped out of the programme, but the majority has increased its biodiversity efforts. This process has taken time, and advisory support was claimed by many farmers to make the necessary adjustments on their farms.

Ca. 15% of Swiss farms produce foods according to IP-SUISSE guidelines. They manage 25% of the Swiss farmland (2600 km^2). Improved biodiversity efforts on these farms therefore contribute to the ecological improvement of a substantial part of the Swiss farmland.

Conclusions

The Credit Point System is a suitable tool to assess biodiversity at the farm scale. The resulting CPS score reflects biodiversity efforts made by farmers on their land.

The CPS as an assessment tool and the uptake of biodiversity directives in a label programme for sustainable and wildlife-friendly foods have opened up new perspectives towards promoting farmland biodiversity at a large scale.

Acknowledgments

This project was financially supported by the Swiss Federal Offices for Agriculture and for the Environment as well as a number of private foundations. We thank all participating farmers and field assistants.

References

Birrer, S., Zellweger-Fischer, J., Stoeckli, S., Korner-Nievergelt, F., Balmer, O., Jenny, M. and Pfiffner, L. (2014). *Biodiversity at the farm scale: A novel credit point system.* Agriculture, Ecosystems and Environment 197: 195-203.

Developing methodology for habitat assessment on Irish grassland farms

H. Denniston[1], H.Sheridan[2], and J.A. Finn[1]
[1]*Teagasc, Environment Research Centre, Johnstown Castle, Wexford* [2]*School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4*
Email: Hannah.denniston@teagasc.ie

Introduction

The challenge of assessing the biodiversity of agricultural systems is becoming increasingly important for Irish food production. The Common Agricultural Policy (CAP) reform and the Food Wise 2025 initiative are directing changes in agriculture towards sustainable intensification. Along with the drive to promote Ireland's reputation for sustainable food production, there is a need for methodology to underpin the verification and accreditation of such claims. Protecting biodiversity is an integral part of the environmental sustainability of agriculture, along with energy, water, nutrient use efficiency and GHG emissions. The inherent complexity of biodiversity creates challenges for the measuring, monitoring and mitigation of farmland biodiversity. There are few existing examples where a comprehensive assessment of farmland biodiversity has been incorporated into an accredited initiative for sustainable food production.

To date, studies of Irish agriculture and habitats show that Ireland can have a greater percentage of semi-natural habitats on farms (up to 15%, Sheridan et al., 2011) when compared with other European countries (e.g. Swiss lowland farms dedicate a minimum of 7% for ecological conservation, Jeanneret et al., 2003). To include farmland habitats in sustainability assessments, it is necessary to increase knowledge of habitats on Irish farms and to develop practical survey methodology that can be implemented at a national scale. In Ireland 80% of agricultural land is devoted to grass-based feeding systems. By focusing on more intensive grassland farms in Ireland, this study aimed to address some of these challenges by providing benchmark habitat data. This study also aimed to implement methodology for biodiversity assessment and mitigation in a way that might be suitable for incorporation of farmland biodiversity into accreditation schemes for environmental sustainability.

Materials and Methods

This work was conducted as part of the wider E-Ruminant project, and we report preliminary results here. Habitat surveys were carried out on 24 grassland dairy farms. Farms were distributed across the south of the country. Aerial orthophotographs from 2011 (ESRI, Digitalglobe) were used to conduct a preliminary desk-based assessment of potential wildlife habitats on farms. In advance of travelling to the farms, the orthophotographs (along with Single Farm Payment maps) were used to guide the survey of habitats on each farm. All habitats were mapped and categorised primarily according to Fossitt (2000). Grassland was further divided according to level of improvement (Sheridan et al. 2011). Further categories were created for smaller-scale wildlife habitats and features. All habitats for each farm were digitally mapped and habitat proportions were calculated using ArcGIS software (Fig. 1.). Preliminary summary statistics were calculated.

Table 1. Habitat classification showing source definition or description.

Habitat	Code	Reference / description
Intensively managed grassland	GA1	Sheridan *et al.* 2011
Wet grassland – *Juncus*	GS4	Sheridan *et al.* 2011
Improved grassland	GA1	Sheridan *et al.* 2011
Arable land	BC1	Fossitt 2000
Built land	BL3	Fossitt 2000
Conifer plantation	WD4	Fossitt 2000
Constructed wetland	-	Artificially constructed
Depositing lowland river	FW2	Fossitt 2000
Immature woodland	WS2	Fossitt 2000
Mixed broadleaf / conifer woodland	WD2	Fossitt 2000
Transitional grassland / scrub	-	Sheridan *et al.* 2011
Greenways	-	Double boundary with central grass laneway
Ponds	FL8	Fossitt 2000
Scrub	WS1	Fossitt 2000
Broadleaf woodland	WD1	Fossitt 2000
Field boundaries	WL	Fossitt 2000

Figure 1. Example farm map showing detail of orthophotograph and digitised habitat map.

Results and Discussion

The average farm size was 51 ha (n= 24). Across the sample of farms, intensively managed grassland was the dominant habitat covering an average of 80.8% of total farm area (Fig. 2). The average proportion of wildlife habitat was 7.6% (s.d. ±4.9), ranging widely across farms from 28.3% to 3.3% (Fig. 3).

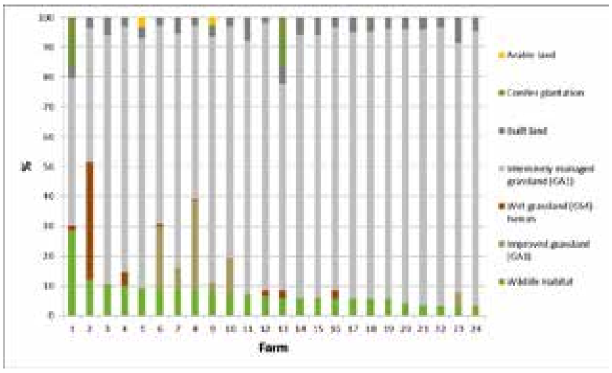


Figure 2. Percentage cover of intensively-managed agriculturally land, built land and non-cropped wildlife habitat. Note the dominance of intensively-managed grassland.

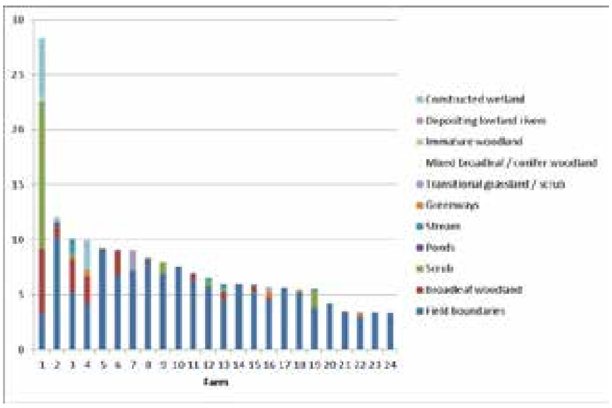


Figure 3. Percentage cover of non-cropped wildlife habitats on 24 farms. Note the dominance of hedgerows (blue bar).

Only five of the twenty-four farms had wildlife habitat cover of less than 5%. The importance of field boundaries as a habitat on more intensive grassland farms is clearly evident (Fig. 3) and field boundaries were the only wildlife habitat on eight of the twenty-four farms (Fig.3). There was only one farm where hedgerows were not the dominant wildlife habitat. This farm had a high proportion of scrub habitat (13.1%).

Conclusions

The use of orthophotography helped to target potential habitats in advance of the farm survey, and make the visits to farms more effective and efficient. The preliminary results of this survey of intensively managed grassland farms indicate that there can be a wide variety of wildlife habitat area across farms, and most farms had >5% of habitat area.

Such surveys and habitat management will become increasingly important as part of formal verification and accreditation of agricultural sustainability.

Acknowledgment

This work was funded as part of the E-Ruminant project funded by the Research Stimulus Fund through the Department of Agriculture and Marine.

References

Fossitt, J.A. (2000). *A Guide to Habitats in Ireland*. Heritage Council, Kilkenny.

Jeanneret, D.U. Baumgartner, R. Freiermuth, Knuchel, G. Gaillard (2008). A new LCIA method for assessing impacts of agricultural activities on biodiversity (SALCA-Biodiversity). Proc. of the 6th Int. Conf. on LCA in the Agri-Food Sector, Zurich, November 12–14, 2008.

Sheridan, H., B. J. McMahon, T. Carnus, J. A. Finn, A. Anderson, A. J. Helden, A. Kinsella, and G. Purvis. (2011). Pastoral farmland habitat diversity in south-east Ireland. *Agriculture, Ecosystems & Environment* 144:130-135.

The relationship between biodiversity and soil organic matter in the context of ecosystem services in Irish grasslands

J.R. Martin, F.H. O'Neill, and P.M. Perrin
BEC Consultants, 43 Herbert Lane, Dublin 2

Email: jmartin@botanicalenvironmental.com

Introduction.
Within Ireland, grasslands are fundamental in providing ecosystem services (ESS) from the three categories defined by CICES (2011): provisioning, regulating and maintenance, and cultural. Production of Soil Organic Matter (SOM) plays a key role in ecological functions which provide several of these ESS, for example, water holding capacity, nutrient retention and carbon storage (Graves *et al*., 2011).

The objective of our study was to investigate the relationship between plant biodiversity, as measured by species richness (SR), and SOM in semi-natural grasslands.

Materials and methods
Data were collected between April 2008 and September 2011, from Cork and Waterford (CW region), and Leitrim, Mayo and Sligo (LMS region). The CW region is one of the most intensively farmed areas in the State and both counties have a mean farm standard output higher than the average for the State. The LMS region is one of the most extensively farmed areas with the three lowest mean farm standard output figures for counties in the State (CSO, 2012).

Across a network of sites spread throughout the two regions, 1141 lowland semi-natural grassland plots (2 m x 2 m) were recorded (CW region, n = 543; LMS region, n = 598). Plots were classified into two broad groups based on soil type: well-drained mineral soils (WDM) and gleyed soils (Gley). Vascular plant species data and soil samples were collected as detailed in O'Neill *et al.* (2013). SOM was measured using the loss-on-ignition method.

SR (number of species) and SOM (%) data were $\log_{10}$ transformed to achieve normality. Data analysis was conducted using R version 3.1.2.

Results
For all plots combined (n = 1141), the Pearson's product-moment correlation between SR and SOM was positive and significant ($R^2 = 0.006$, $p = 0.011$). Gley plots alone (n = 673) had a non-significant correlation ($R^2 = 0.001$, $p = 0.514$), but the result for WDM plots alone (n = 468) was significant ($R^2 = 0.021$, $p = 0.002$). WDM plots in the LMS region (n = 220) demonstrated a significant correlation between SR and SOM ($R^2 = 0.048$, $p = 0.001$) but those in the CW region (n = 248) did not ($R^2 = 0.011$, $p = 0.102$).

Mean vascular plant SR differed significantly between the two soil groups and between the two regions (Tables 1 and 2). The interaction between the regions and groups was not significant.

Mean SOM was not significantly different between the two soil groups (Gley = 17.99%, WDM = 17.28%), or between regions (CW = 17.37%, LMS = 17.99%) (Table 1). The interaction between the regions and groups was also not significant.

Table 1: Two-way ANOVA for the SR data and SOM data across the two agricultural regions of Cork/ Waterford and Leitrim/ Mayo/Sligo and the two groups of well-drained mineral soils and gleyed soils.

	Df	*p* SR	*p* SOM
Region	1	<0.001	0.321
Group	1	<0.001	0.256
Region × Group	1	0.373	0.690

Table 2: Mean vascular plant SR by region and group.

	Gleys	WDM	Overall
CW	12.06	12.86	12.42
LMS	18.31	20.38	19.05
Total	15.25	15.97	15.54

Discussion
Across all 1141 plots within the study and across the 468 plots within the dry grasslands WDM group there were significant positive, but weak, relationships between vascular plant SR and SOM. This relationship was strongest and most significant for the WDM group within the LMS region, but even then was still weak, indicating that other important factors also influence this relationship.

The significant positive relationship observed between SR and SOM within the LMS region WDM group is similar to the results presented by Cong *et al.* (2014), who proposed that a positive effect of SR on SOM could be caused by enhanced production relative to SOM decomposition, with root biomass and root exudates the main contributors of organic carbon to the soil. This positive correlation between SR and SOM was not observed for the wetter Gley group, with no significant correlation observed between the two factors. It may be speculated that in grasslands on gley soils waterlogging stress provides an additional interaction with SR and SOM that is not present in WDM soils. This may manifest as impeded growth and slower overall decomposition in these wetter systems. A complex relationship between ESS has been previously reported (Hector & Loreau, 2005) and further analyses may show that the relationships between SR and SOM, and between SOM and the ESS it provides, are non-linear.

Vascular plant SR within the semi-natural grasslands studied was significantly lower in the CW region, with agricultural intensification (e.g. re-sowing) the likely main driver for this. Furthermore, increased grazing results in higher levels of trampling and increased nutrient inputs from manure, which both can contribute to a decrease in plant SR. While it could be hypothesised that intensification also reduces SOM, SOM was not significantly different between regions. The probable reason for this is that, with the more intensive agricultural practices in the CW region, there is increased grassland fertilisation, either through manuring or the application of chemical fertiliser. This results in the maintenance of SOM, through a combination of direct application and possible increased productivity in below-ground biomass.

This study within semi-natural grasslands has suggested that the more intensive farming practices and greater emphasis on provisioning services, such as milk and beef production, in the CW region have had a negative impact on vascular plant SR, a component of total biodiversity. However, there is no evidence that this is the case for SOM, with factors such as higher stocking densities and higher fertilisation levels and manure inputs contributing to the maintenance of SOM. Further studies on agriculturally improved grasslands, such as species-poor *Lolium* swards, would assist in understanding the relationships between intensification and ESS.

In conclusion, this study has shown that the relationships between SR and the parameters driving ESS can be complex. This complexity needs to be defined, understood, and communicated to policy-makers to ensure that ESS are assessed and managed correctly.

References

CICES (2011). Common International Classification of Ecosystem Services (CICES): 2011 update. Paper prepared for discussion at the expert meeting on ecosystem accounts organised by the United Nations Statistical Division, the European Environment Agency and the World Bank, London, December 2011.

CSO (2012). *Census of agriculture 2010 – Final results*. The Stationery Office, Dublin.

Cong, W., van Ruijven, J., Mommer, L., De Deyn, G.B., Berendse, F. and Hoffland, E. (2014). Plant SR promotes soil carbon and nitrogen stocks in grasslands without legumes. *Journal of Ecology*. 102: 1163–1170.

Graves, A., Morris, J., Deeks, L., Rickson, J., Kibblewhite, M., Harris, J. and Fairwell, T. (2011). The total costs of soils degradation in England and Wales. Research project final report to Defra, UK.

Hector, A. and Loreau, M. (2005). Relationships between biodiversity and production in grasslands at local and regional scales. In *Grassland: a global resource*, D.A. McGilloway Ed., Wageningen Academic Publishers, Wageningen, Netherlands: 295-304.

O'Neill, F.H., Martin, J.R., Devaney, F.M. and Perrin, P.M. (2013). The Irish Semi-natural Grasslands Survey 2007-2012. *Irish Wildlife Manuals.* No. 78. National Parks and Wildlife Service, Dublin.

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

J. Owens[1], N. Gourlaouen[2], C. Maher [3] and M. Sheehy Skeffington[1]

[1]*Plant Ecology Research Unit, School of Natural Sciences, NUI Galway,* [2]*, L'école Nationale Supérieure Agronomique de Toulouse, Toulouse, France,* [3] *European Forum on Nature Conservation and Pastoralism, IT Sligo*

Email: jimowens84@yahoo.co.uk

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 km^2 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 (4m^2) 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. 2.). 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.

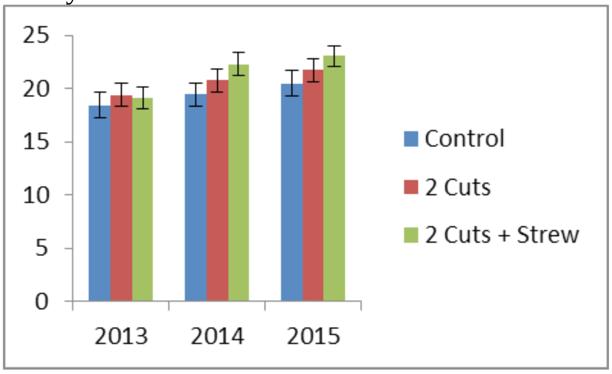


Figure 1. Changes in mean species richness over three years between the three treatments.

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.

Acknowledgments

The authors would like to thank the NPWS for all their support and we also offer very special thanks to the callows farmers. We gratefully acknowledge Louis Collin, Quentin Petitjean, Cian Ó Ceallaigh and Piaras Ó Giobúin for their help on fieldwork

References

Grevilliot, F., and Muller, S. (2002). Grassland ecotypes of the upper Meuse as references for habitats and biodiversity restoration: A synthesis. *Landscape Ecology*. 17(1): 19-33

Heery, S. (1993). *The Shannon Floodlands: a natural history of the Shannon Callows*. Tír Eolas, Kinvara.

Maher, C. (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, National University of Ireland Galway, Galway

Maher, C., Sheehy Skeffington, M. and Gormally, M. (2015). Hydroperiod and Traditional Farming Practices Drive Plant Community Composition on Unregulated Atlantic Floodplain Meadows. *Wetlands*. 35:263-279

Pavlu, L., Pavlu, V., Gaisler, J., Hejcman, M. and Mikulka, J. (2011). Effect of long-term cutting versus abandonment on the vegetation of a mountain hay meadow (Polygono-Trisetion) in Central Europe. *Flora*. 206: 1020-1029.

Reduced Length Oral & Poster Presentations

Experimental cutting regimes to restore *Arctostaphylos*-heath plant communities in the Burren, County Clare

S. Hanrahan*, M. Sheehy Skeffington.
Plant Ecology Research Unit, Botany & Plant Science, School of Natural Sciences, NUI Galway.
*Email: sarahann.o@gmail.com

Summary
Alpine heath is a rare habitat in the Burren and in some areas its low-growing vegetation has been encroached upon by mature *Calluna vulgaris.* Cutting trials are under way to restore the species composition of this habitat and investigate whether time of year is a factor in regrowth patterns. Results are inconclusive to date; however, data collection was repeated in August 2015. It is thought that *Arctostaphylos uva-ursi* will show recovery within this time frame.

Introduction
The karst limestone landscape of the Burren is a landscape that has been influenced and transformed by farmers since Neolithic times (Dunford, 2002). As such it is a cultural landscape and its management is integral to the conservation of its biodiversity and archaeology. The region includes several Special Areas of Conservation (SACs). The Burren LIFE Project (BLP) caters for 160 farmers across the Burren region with a resultant marked improvement in the quality of Annex I habitats, in particular the Orchid-rich Calcareous grasslands. Limestone heath is another important Annex I Burren habitat especially when composed of the arctic-alpine species *Arctostaphylos uva-ursi* and/or *Empetrum nigrum* together with *Dryas octopetala,* corresponding with Alpine and Boreal heaths (EU habitat code: 4060). These habitats have been described by Parr et al. (2009), however little or no work has addressed the management requirements of these habitats in Ireland. In a number a sites where these plant communities occur there has been encroachment of mature *Calluna vulgaris* on the prostrate mats of *A. uva-ursi*, *E. nigrum* and *D. octopetala.* Given this encroachment, it would seem that some form of management is required. *Arctostaphylos*-heaths occur as a mosaic with limestone pavement and calcareous grasslands and thus it is largely grazed as part of the winterage grazing regime (Oct-Apr). Where there has been regular grazing this appears to be sufficient to maintain the growth of *C. vulgaris*, but in sites where grazing has perhaps ceased for a number of years or even decades – *C. vulgaris* enters its mature phase after 15 years (Gimingham, 1972) - it would appear that restorative measures are required. In many areas of Europe, burning is a well-established management practise for heathlands, and palynological studies in the Burren uplands found charcoal deposits suggesting that burning of vegetation was practised from the Iron Age until approximately the late 16th Century (Feeser & O'Connell, 2010). However in recent times burning has not been widely undertaken and is not recommended due to the Burren soils being so thin (Parr et al., 2009). Furthermore, as most of the Burren region is designated as SACs, burning is a notifiable action requiring National Parks and Wildlife Service (NPWS) approval. In addition, burning must not take place within the bird nesting season (1 March – 31 August). Therefore, this study focuses on different cutting regimes as a management tool for these *Arctostaphylos*-heaths.

Methods and Materials
The study area is in the uplands adjacent to the Caher valley in County Clare (Figure 1). Three sites were selected based on the encroachment of over-mature *Calluna vulgaris* on *Arctostaphylos uva-ursi* and other low-growing alpine heath species. At each site, fifteen permanent 4m x 4m plots were marked out in clusters of three; each plot was placed at least 2m apart and each cluster was more than 5m apart. All plots were located 160-280m a.s.l. Each cluster contained one of each of three treatments, randomly assigned: Autumn cut, Spring cut and the uncut Control. 2m x 2m quadrats were placed in the centre of each of the 45 plots and these were sampled in August/September 2013 (Yr 0), prior to cutting.

Figure 1. Study area indicating plots per site. Inset: Galway Bay with box indicating study area.

Percentage cover of vascular and bryophyte species, soil depth and vegetation height were recorded, as well as slope, aspect, bare ground, exposed rock, leaf litter and total cover of plant groups ie. graminoids, forbs, shrubs, ferns, bryophytes; soil samples were also collected. Autumn and spring plots were cut in October 2013 and February 2014, respectively, outside of bird-nesting season. All vegetation was cut with a hedge-cutter to a maximum of 5 cm above the ground and cut material was removed from the plots. All plots were re-surveyed in August/September 2014 (Yr 1) and 2015 (Yr 2). Data were analysed using ANOVA in R for differences in soils, original plant species composition in terms of percent cover of dwarf shrubs (*C. vulgaris, Erica cinerea, D. octopetala, A. uva-ursi* and *E. nigrum*) and for the effects of site and treatments. Percentage cover data were arcsine square root transformed.

Preliminary Results

Preliminary results are based on data from Yr 0 (pre-treatment, 2013) and Yr 1 (following treatment, 2014). Yr 2 (2015) data were collected at time of writing but not yet analysed. The ANOVA showed a significant difference between sites in the original percentage cover of *C. vulgaris* and *E. cinerea* ($p < 0.001$). There was no significant difference in the percent cover of *A. uva-ursi*, *D. octopetala* or *E. nigrum* before and after treatment or between spring and autumn cuts. As expected, the cover of *E. cinerea* and *C. vulgaris* decreased from Yr 0 to Yr 1 in cut plots, however there is no significant difference between spring and autumn treatments.

In both spring and autumn treatments the percentage cover of *C. vulgaris* decreased from Yr 0 to Yr 1 as we expected (Figure 2), but *A. uva-ursi* has also decreased in percentage cover.

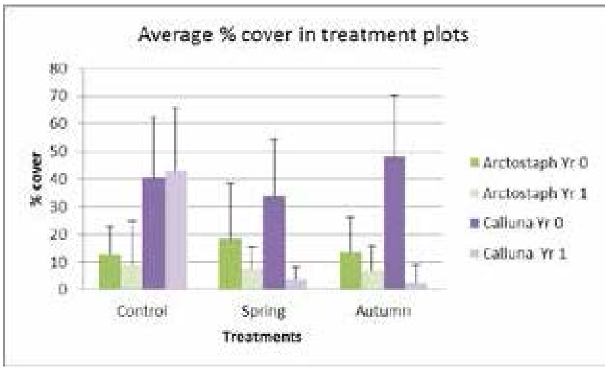


Figure. 2. Mean percentage cover of *A. uva-ursi* and *C. vulgaris* for each treatment (n = 45) before cutting (Yr 0) and after cutting (Yr 1).

Discussion

The decrease in cover of *A. uva-ursi* following cutting may be partially due to it having unavoidably been cut with treatment, but may also be in response to increased exposure following the removal of tall *C. vulgaris* which was providing some shelter. Several plants were visibly discoloured in treatment plots, possibly due to exposure. To date results indicate that growth response of the target species is slow and require a few years to show recovery to conservation status. Any significant differences between cutting at different times of the year, will also require more time to quantify. Research in North Spain has shown that cutting and burning are both favourable to the vegetative re-growth of *A. uva-ursi* and that its recovery is rapid, achieving 70% recovery in 30 months following treatment (del Barrio et al., 1999). Therefore, one might expect more significant recovery of *A. uva-ursi* in experimental plots by Aug/Sep 2015: 23 months after autumn and 20 months after spring treatment. *C. vulgaris* is also likely to show regrowth although this is expected to be quite slow where the *Calluna* is over 20 years old (Calvo et al., 2005).

Acknowledgments

Thanks to the Irish Research Council EMBARK initiative for funding. Thanks to the BurrenLIFE Project staff for their collaboration, in particular Sharon Parr for site selection, and to the landowners on whose land this research took place. Thanks to Louis Collin, Quentin Petitjean and Hannah Mulcahy for assistance with fieldwork, and thanks to Leonor Calvo and Nicolas Gourlaouen for help with statistics.

References

Calvo, L., Alonso, I. Fernandez, A.J. and De Luis, E. (2005) Short-term study of effects of fertilisation and cutting treatments on the vegetation dynamics of mountain heathlands in Spain. *Plant Ecology.* 179, 181-191.

del Barrio, J., Luis-Calabuig, E. and Tárrega, R. (1999) Vegetative response of Arctostaphylos uva-ursi to experimental cutting and burning. *Plant Ecology*. 145: 191-195.

Dunford, B. 2002. Farming and the Burren. Teagasc Publications.

Feeser, I. and O'Connell, M. (2010) Late Holocene land-use and vegetation dynamics in an upland karst region based on pollen and coprophilous fungal spore analyses: an example from the Burren, western Ireland. *Vegetation History and Archaeobotany*. 19: 409-426.

Gimingham, C. H. 1972. The Ecology of Heathlands. Chapham and Hall.

Parr, S., O'Donovan, G., Ward, S. and Finn, J.A. (2009) Vegetation analysis of upland Burren grasslands of conservation interest. *Biology and Environment: Proceedings of the Royal Irish Academy.* 109 B: 11-33.

Resistance of four grassland plant species to experimental drought conditions

E. Haughey[1, 2], J.C. McElwain[2], J. A. Finn[1]
[1] *Teagasc, Environment Research Centre, Johnstown Castle, Wexford, Ireland;*
[2] *School of Biology & Environment Science, University College Dublin, Belfield, Dublin 4, Ireland*

Email: eamon.haughey@teagasc.ie

Introduction

Increased variability in precipitation patterns is predicted to be a major component of climate change (IPCC 2013). Maintaining agricultural forage production in a sustainable manner in the face of these changes will require new practices in grassland agriculture. We investigate if small increases in the plant diversity of agricultural grasslands can provide increased resistance and resilience against these changes.

There is growing agreement that the use of increased plant diversity in crop systems may be important for the long term stability and sustainability of agro-ecosystems. Major studies have found a positive relationship between plant species diversity and aboveground biomass productivity (Hector et al., 1999), others have found that that increased species richness in grassland communities led to higher temporal stability of those communities (Tilman et al., 2006, Hector et al., 2010).

More recently, a pan-European experiment found that modest increases in plant diversity; from one to four species, has the potential to increase productivity in grassland swards (Finn et al., 2013). In this project we examine if grassland mixtures with one to four species may also provide increased resistance to drought events.

It is hypothesised that deep-rooting plant species will have an advantage over shallow rooting species under drought conditions; and the inclusion of such species in diverse mixtures may help improve grassland drought resistance. We investigated the drought resistance of four grassland plant species with different functional traits and hypothesized that deep rooting species would be more resistant to drought due to water up-take from deeper soil layers.

Figure 1. Rain-out shelters in place on the field site, in July 2013 at Johnstown Castle, Co. Wexford.

Materials and Methods

The experiment was established in May 2012 in Johnstown Castle, Co. Wexford. Field plots (3 m x 5 m) were sown with the species: *Lolium perenne* (shallow-rooting grass), *Cichorium intybus* (deep-rooting forb), *Trifolium repens* (shallow-rooting legume) and *Trifolium pratense* (deep-rooting legume). Plots were fertilised at a rate of 130 kg ha^{-1} yr^{-1} of nitrogen and aboveground biomass was removed five times annually at a height of 5 cm.

In July 2013 an experimental drought was applied using 'rain-out' shelters, for a duration of 10 weeks. Shelters were designed to minimise changes to the micro-climate of plots underneath them while still excluding rainfall. Soil moisture content was measured on a weekly basis between April and December. Biomass was harvested: mid-way through and at the end of the drought treatment. Drought resistance (kg ha^{-1} DM) was calculated as the difference in biomass between drought and control plots.

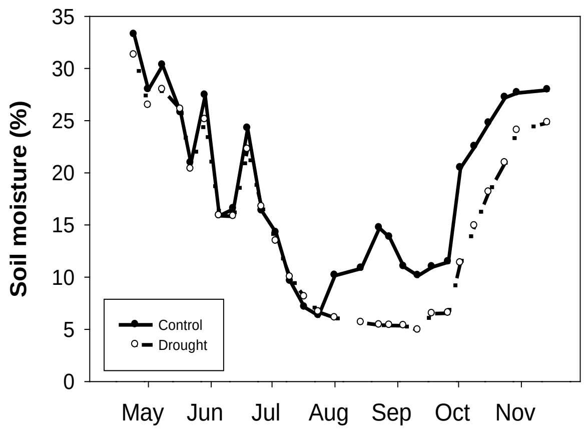


Figure 2. Mean soil moisture content of the field-site at 10 cm deep from April to December 2013.

Results and Discussion

The imposed rain-exclusion led to a reduction in soil moisture (Fig. 2); however, due to a very dry summer, control plot soil moisture was lower than expected. Rain-out shelters were effective at; excluding rainfall, minimising changes to air temperature and humidity but they did negatively affect photosynthetically active radiation transmission (approx. -25.0%).

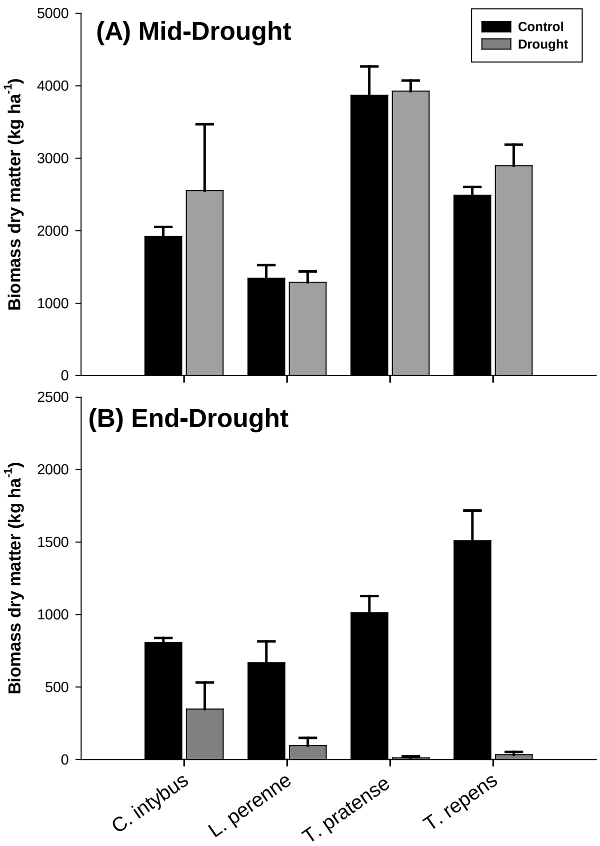


Figure 3. Mean biomass (± S.E.) produced at (A) mid-drought and (B) end-drought stages. Note the difference between y-axis scales.

At the mid-drought harvest, effects on biomass production were very small (Fig. 3A). *T. pratense* was the most productive at this stage, producing over twice as much biomass as *L. perenne*. *C. intybus* and *T. repens* actually produced more biomass under the drought treatment than the control at this stage. At the end-of-drought harvest, there was a strong negative effect on all species (Fig. 3B). *T. pratense* and *T. repens* had the lowest resistance to drought (-1001.5 and -1476.0 kg ha^{-1} DM respectively) while *C. intybus* had the highest (-460.1 kg ha^{-1} DM).

Conclusions

The higher resistance of deep-rooting *C. intybus* supported our hypothesis that deep-rooting plant species have an advantage over shallow rooting species under drought conditions, but the low resistance of the other deep-rooting species, *T. pratense* did not. These results highlight the complexity of individual species responses to drought stress, and the significance of drought duration and intensity on those responses. The inclusion of deep rooted species in grassland mixtures may provide some increased resistance to drought events. This work is on-going.

Acknowledgments

The research leading to these results was conducted as part of the AnimalChange project (grant agreement 266018) which received funding from the European Community's Seventh Framework Programme (FP7/2007-2013). Many thanks go to Alan Cuddihy for help with establishing and running this experiment. Thanks also to Rioch Fox, the farm staff at Johnstown Castle and numerous summer students for their assistance with field-work.

References

Finn JA, Kirwan L, Connolly J, Sebastià MT, Helgadottir A, Baadshaug OH, Bélanger G, Black A, Brophy C, Collins RP (2013). Ecosystem function enhanced by combining four functional types of plant species in intensively managed grassland mixtures: A 3-year continental-scale field experiment. *Journal of Applied Ecology* 50:365-375.

Hector A, Hautier Y, Saner P, Wacker L, Bagchi R, Joshi J, Scherer-Lorenzen M, Spehn E, Bazeley-White E Weilenmann M (2010). General stabilizing effects of plant diversity on grassland productivity through population asynchrony and overyielding. *Ecology* 91:2213-2220.

Hector A, Schmid B, Beierkuhnlein C, Caldeira M, Diemer M, Dimitrakopoulos P, Finn J, Freitas H, Giller P, Good J (1999). Plant diversity and productivity experiments in European grasslands. *Science* 286:1123-1127.

IPCC (2013). Climate change 2013: The physical science basis. Intergovernmental Panel on Climate Change, Working Group I Contribution to the IPCC Fifth Assessment Report (AR5). Cambridge Univ. Press, New York.

Tilman D, Reich PB, Knops JMH (2006). Biodiversity and ecosystem stability in a decade-long grassland experiment. *Nature* 441:629-632.

COSAINT - Cattle Exclusion from Watercourses: Environmental and socio-economic implications

P. O'Callaghan[1], K.Daly[1], O. Fenton[1], S. Green[1], E. Jennings[2], M. Kelly-Quinn[3], S. Linnane[2], F.Regan[4], M. Ryan[1], M. Shore[1], G. Shortle[1] and D. Ó hUallacháin[1]
[1]Environment Research Centre, Teagasc, Johnstown Castle,[2]National Centre for Freshwater Studies, Dept. of Applied Sciences, Dundalk Institute of Technology, [3] School of Biology and Environmental Science, Science Centre West, University College Dublin, [4]School of Chemical Sciences, Dublin City University.

Email: paul.ocallaghan@teagasc.ie

Introduction

The Water Framework Directive (WFD) 2000/60/EC (Council of the European Union (2000)) requires all surface water bodies in member states to achieve or maintain at least 'good' ecological and chemical status by 2015. The Food Harvest 2020 report aims to significantly expand the Irish agri-food sector. This expansion and intensification could potentially put significant pressure on waterbodies draining agricultural systems.

Agri-Environment Schemes (AES) have often been employed to address the challenge of sustainable agricultural expansion. Irish AES such as the Rural Environment Protection Scheme (REPS) and the Green Low carbon Agri-environment Scheme (GLAS) include provisions aimed at limiting cattle access to streams in order to improve water quality. Studies suggest that unrestricted cattle access to watercourses can have detrimental impacts on water quality with elevated faecal coliform counts, increased nutrient and sediment inputs, and higher temperatures among others reported in the literature (Belsky et al. (1999), Line (2002), Agouridis et al. (2005)). However, several studies report only insignificant trends or no impact (Samson et al. (1988), Ranganath et al. (2009)). Furthermore the majority of the existing literature originates from North America and Australasia, where climatic conditions and agricultural practices differ significantly from those in Ireland. There is therefore a dearth of local research on the subject, with the few existing studies showing divergent results.

This project aims to address gaps in knowledge by examining the geochemical, physicochemical and ecological effects of cattle access to (and exclusion from) streams. Additionally, the study will assess the socioeconomic implications of cattle exclusion measures including farmer's attitudes and willingness to adopt mitigation measures.

Figure1: Cattle access point eligible under REPS and AEOS

Materials and Methods

Study sites will be short-listed based on a suite of selection criteria which will be determined based on the available literature and expert opinion. These sites will be studied during the course of two parallel PhD projects, one based in Dundalk Institute of Technology which will examine geochemical, physical and bacteriological parameters and one in University College Dublin which will investigate ecological parameters.

Geochemical and Bacteriological

During this PhD project the impact of cattle access points, cattle in-stream activity and proposed cattle exclusion measures on freshwater geochemical parameters, faecal indicator bacteria and sediment export and dynamics will be assessed. This PhD will utilise low resolution field sampling in conjunction with targeted high resolution data. Additionally, controlled laboratory experiments will be undertaken to:

1) examine the role of stream sediments at access points as sources of water-borne pollutants

2) model the estimated nutrient loading from cattle access in the context of the total catchment load

3) inform the management of nutrient and microbial contaminants originating from cattle access

Ecological

This PhD will examine the impact of the aforementioned pressures on freshwater benthic ecology and its recovery over time. The study will also assess the effects of cattle access on hyporheic (the zone under and adjacent to the stream bed influenced by both stream and ground water) chemistry and ecology. This will involve the sampling of benthic invertebrates and diatoms at a spatial scale above and below cattle access points across several years to assess aspects of both spatial and temporal impacts and recovery.

The hyporheos will be examined at sites representing zero, moderate and high cattle trampling using methods established by Kibichii et al. (2009) with concurrent sampling of associated physicochemical and hydrochemical variables.

Figure 2: Kick-sampling for aquatic invertebrates

Socio-economic

No map currently exists showing individual Irish farm boundaries. Such a map will be created and used in conjunction with the OSI water body maps to calculate a suite of statistics on farm waterbodies.

Using this information, along with a comprehensive review of the literature and engagement with farmers and other stakeholders, the cost-effectiveness of fencing and alternative water provision mechanisms as measures to improve water quality will be evaluated. The willingness of farmers to adopt such measures will also be assessed as will the level of incentives required to ensure adequate participation.

Discussion

This study will identify the impacts of certain agricultural stressors, resulting from cattle access points, on stream biotic and abiotic parameters. It will also evaluate the cost-effectiveness of proposed mitigation measures. This knowledge will facilitate policy-makers to identify the most economically viable measures to help surface waters achieve WFD targets. Information from the study will justify the prioritisation and targeting of cattle exclusion measures in future revisions of the Rural Development Programme.

Understanding of farmer attitudes to the environment, their perception of estimated costs associated with cattle exclusion measures and their likelihood of adopting specific existing and potential measures to prevent cattle access or novel water provision mechanisms, will aid the revision of existing mitigation measures and the development of new potential cost-effective measures. Cattle exclusion measures (and associated water provision mechanisms) will thus be appropriately designed and costed for Irish conditions, taking into account differing farming enterprises and intensities.

The study will contribute to environmental policy and to improved management of agricultural and surface water landscapes in Ireland in the context of the sustainable intensification objectives of food Harvest 2020.

Acknowledgments

Funding for this project is provided by EPA Research.

References

Agouridis, C. T., et al. (2005). “Livesock grazing management impacts on stream water quality: A review.” JAWRA Journal of the American Water Resources Association **41**(3): 591-606.

Belsky, A. J., et al. (1999). “Survey of livestock influences on stream and riparian ecosystems in the western United States.” Journal of Soil and Water Conservation **54**(1): 419-431.

Council of the European Union (2000). Water Framework Directive 2000/60/EC establishing a framework for community action in the field of water policy. L 327/1. C. 2000.

Kibichii, S., et al. (2009). “Optimising sample volume and replicates using the Bou-Rouch method for the rapid assessment of hyporheic fauna.” Marine and Freshwater Research **60**(1): 83-96.

Line, D. E. (2002). “Changes in a stream’s physical and biological conditions following livestock exclusion.” Transactions of the American Society of Agricultural Engineers **46**(2): 287-293.

Ranganath, S. C., et al. (2009). “Livestock exclusion influences on riparian vegetation, channel morphology, and benthic macroinvertebrate assemblages.” Journal of Soil and Water Conservation **64**(1): 33-42.

Samson, F. B., et al. (1988). “Small mammal response to the introduction of cattle into a cottonwood floodplain.”

http://www.teagasc.ie/environment/cosaint/

Overlap of afforestation and birds of conservation concern on farmland habitat

I. Corkery[1], U. Keating[1], J.Lusby[2], S.Irwin[1], J. Quinn[1], J. O'Halloran[1]
[1]*School of Biological Earth and Environmental Sciences, University College Cork*
[2]*Birdwatch Ireland, Bullford Business Campus, Kilcoole, County Wicklow*

Email: ilse.corkery@ucc.ie

Introduction

At the beginning of the twentieth century, forest cover was <1% in Ireland (Mitchell 2000). By 2012 the national forest estate was 731,650ha, which represents 10.5% of the land surface area, and the aim is to further increase this to 18% land cover by 2046 (DAFM, 2014). This large land-use change has serious implications for biodiversity, including bird species. For example, afforestation is known to cause direct habitat losses for farmland and open habitat species and to give rise to increased predation on ground nesting birds even though it may provide opportunities for other species associated with these forests (O'Connell et al. 2012). Similar to the rest of Europe, there have already been extensive declines in many farmland birds in Ireland over the past 40 years (Balmer et al., 2013). Our goal was to evaluate the extent to which recent afforestation has overlapped with the distributions of birds of conservation concern associated with farmland habitats.

Materials and Methods

Threatened birds associated with farmland habitats were identified from the Action Plan for Lowland Farmland Birds (BWI, 2011) and from the most recent assessment of birds in Ireland (Colhoun & Cummins, 2013). The list included all Annex 1 species, as well as those on the Red and Amber list of "Birds of Conservation Concern in Ireland" (BoCCI). The Bird Atlas (2007-2011) provided data on the distributions of these bird species (Balmer et al., 2013), recorded in 10 × 10 km squares throughout Ireland (using Irish Transverse Mercator (ITM) coordinates). There were 25 bird species of conservation concern associated with farmland habitats which were recorded in a minimum of 10 grid cells (10 x 10km) in the current atlas (Balmer et al., 2013) and which formed the basis for data analysis.

Data on the distribution of the current extent of forests in Ireland were obtained through the Forest Inventory Planting (FIPs) in November 2014. The extent of recent afforestation (2008-2012), expressed as a percentage of land cover in each grid cell (10 × 10 km ITM square) was calculated to align it with the bird atlas data. Grid cells with 100 hectares of recent planted forest was considered to be a high planting level as this equated to an additional 1% coverage of new forest.

The level of overlap of newly planted forests with the current distributions of the selected species was assessed using ArcGIS-ArcMap® 10.2 (Figure 1).

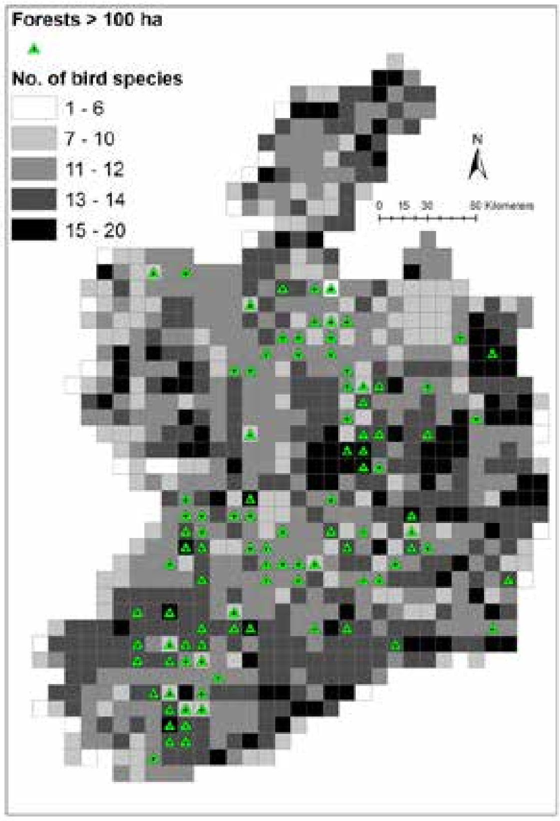


Figure 1. Overlap of BoCCI associated with farmland habitat and cells with at least 100 hectares of recently planted forest (2008-2012).

Results and Discussion

Recent forest planting has overlapped with 78% of the 10 x 10km squares occupied by birds of conservation concern, with 11% of these squares being planted with 100ha or more. Overlaps of recent forest planting with individual species range from an 8% overlap (Twite) up to 93% overlap (Barn owl). Despite the abundance and wide distribution of lowland farmland birds, observed and predicted rates of pasture conversion in Ireland (Pithon et al. 2005) suggests that afforestation may represent a threat at a regional and national scales to some of these bird species in the near future. At least for the already threatened species, which depend on grassland areas for foraging, plantation forests may already be having a negative impact.

Table 1. Number of 10 x 10km atlas squares occupied by BoCCI species with the percentage overlap between those squares and recent afforestation (2008-2012)

Species	No. occupied cells	% overlap with forestry	% overlap >10ha
Barn Owl	249	93	15
Stock Dove	252	91	12
Grey Wagtail	649	88	13
Yellowhammer	309	88	9
Mistle Thrush	752	87	13
Curlew	64	84	16
Greenfinch	790	83	12
Red Kite	12	83	0
Snipe	306	81	13
Kestrel	768	81	12
Tree Sparrow	141	81	5
Robin	841	80	12
Starling	842	80	12
Linnet	804	80	12
Swallow	855	79	11
Whinchat	34	79	6
Meadow Pipit	831	78	12
Skylark	737	76	11
Stonechat	655	76	11
Lapwing	206	75	9
Redshank	68	72	13
Corncrake	43	51	2
Chough	167	46	4
Golden Plover	27	33	0
Twite	18	6	0

Conclusions

All forest planting is now effectively undertaken by private individuals or companies, unlike previous planting which was largely undertaken by State bodies, therefore future planting areas will be relatively small, scattered patches on mostly marginal land (Pithon et al., 2005). This scenario potentially carries the greatest risk for open habitat birds. Particularly as the total area affected by a forest plantation is larger than the surface actually planted with trees and the extent of habitat reductions may further increase with the proportion of the landscape converted into forest. Thus, lowland farmland bird population declines may be accelerated with increasing habitat fragmentation. The time to prevent future problems is now because we are still in the early stages of addressing a new conservation issue that will affect many species and countries (e.g. forest cover expansion is included as a source of carbon dioxide emission reduction under the Kyoto Protocol). Determining the extent to which afforestation can be tolerated by vulnerable species is critical. Maintaining open habitats above the threshold point may be the most effective measure to preserve birds of conservation concern. Finding the best locations for future planting from an avian perspective requires all future afforestation management to carefully consider habitat selection, as well as forest patch size and shape.

Acknowledgments

Bird Atlas 2007–2011 is a joint project of the British Trust for Ornithology, BirdWatch Ireland and the Scottish Ornithologists' Club. We thank all of the dedicated observers who have taken part in these surveys, which provided the data on which these analyses are based. We also thank the Forest Service for providing the planting data. This work was part of a larger study (ADAPT: Avian Diversity and Afforestation Planning Tools) funded by the Department of Agriculture, Food and the Marine.

References

Balmer, D., Gillings, S., Caffrey, B., Swann, B., Downie, I., & Fuller, R. (2013). *Bird Atlas 2007-11. The breeding and wintering birds of Britain and Ireland*. British Trust for Ornithology.

BirdWatch Ireland (2011) Action Plan for Lowland Farmland Birds in Ireland 2011-2020. BirdWatch Ireland's. Group Action Plans for Irish Birds.

Buscardo, E., Smith, G. F., Kelly, D. L., Freitas, H., Iremonger, S., Mitchell, F. J. G., McKee, A. M. (2008). The early effects of afforestation on biodiversity of grasslands in Ireland. *Biodiversity and Conservation*. 17(5): 1057–1072.

Colhoun, K., & Cummins, S. (2013). Birds of Conservation Concern in Ireland 2014 – 2019. *Irish Birds*. 9: 523–544.

Department of Agriculture, food and the M. (2014). *Forests, products and people. Ireland's forest policy- a renewed vision*. Dublin.

Mitchell, F. (2000). The development of Ireland's tree cover over the millennia. *Irish Forestry*. 57: 38–46.

O'Connell, S., Irwin S., Wilson M., McD. Sweeney O., Kelly T.C. & O'Halloran J. (2012) How can forest management benefit bird communities? Evidence from eight years of research in Ireland. *Irish Forestry*. 69: 44-57.

Pithon, J., Moles, R., & O'Halloran, J. (2005). The influence of coniferous afforestation on lowland farmland bird communities in Ireland: different seasons and landscape contexts. *Landscape and Urban Planning*. 71: 91–103.

Sustainable land use management for the conservation of the Freshwater Pearl Mussel: sediment flux and provenance

K.A. O'Neill[1,2], J.S. Rowan[2], J.A. Finn[1] and D. Ó hUallacháin[1]

[1] *Teagasc, Environment Research Centre, Johnstown Castle, Wexford, Ireland;*

[2]*School of the Environment, University of Dundee, Dundee, DD1 4HN, Scotland, UK*

Email: K. A. O'Neill (karen.oneill@teagasc.ie)

Introduction

The Freshwater Pearl Mussel (*Margaritifera margaritifera*) is an aquatic invertebrate with a lifespan of over 150 years. It thrives in coarse sand or fine gravel substrates in clean, fast-flowing and well-oxygenated waters. This species has undergone a dramatic decline throughout its geographical range and is now listed as Critically Endangered in the IUCN Red Data Book. Irish populations, while representing 46% of the EU's total numbers, have low recruitment levels and are considered to be in unfavourable conservation status. The principal pressures impacting on Freshwater Pearl Mussel (FPM) populations are believed to be diffuse sediment and nutrient losses associated with agriculture and forestry.

Figure 1: The Freshwater Pearl Mussel requires clean, well-oxygenated gravels, excessive sedimentation results in high mortality of juveniles.

The contribution of anthropogenic activity to river sediment load is of increasing global concern (Duerdoth *et al*., 2015). Excessive sedimentation of watercourses can reduce habitat quality, in part due to the limitation of exchange between the hyporheic zone (the porous substrate adjacent to flowing water) and the water column. This effect is of crucial importance to the FPM which inhabits the hyporheic zone at critical stages in its life cycle. Other impacts associated with excessive transport of sediment, include changes in turbidity, disruption of primary productivity, and alteration of substrate and channel morphology.

The primary aim of this study is to assess sediment sources, pathways and sinks in two internationally important FPM catchments: the Caragh and the Kerry Blackwater catchments in SW Ireland. Each catchment contains populations of over 2,750,000 mussels. However, despite the large populations, recruitment levels are insufficient to ensure the survival of the species. Fieldwork for this project will commence in 2016. The project will integrate with the wider KerryLIFE scheme, which has been established to demonstrate sustainable land management practices in catchments of high ecological importance.

Materials and methods

Sediment flux

This study will evaluate sediment transfer in two catchments using a turbidity method, with the aim of delivering a cost-effective approach to relating turbidity to suspended sediment flux. This approach will employ linear and multiple-linear regression; analysis will provide metrics for sediment concentration and areal flux, as well as magnitude-frequency curves, allowing for comparison of the catchments.

Water samples will be obtained by grab samples and automatic sampling, and suspended sediment by depth-integrated sampling. Suspended sediment will be calculated using the ash-free dry weight method. Dissolved organic matter will be measured using the absorbance coefficient at 254nm. Passive time-integrated samplers will collect periodic bulk samples for particle-size analysis and to provide samples for provenance studies. Particles will also be characterized fully in the laboratory (by size, organic content and physico-chemical properties).

A combination of sediment samples from the passive time-integrated samplers and automatic samplers will be used, in conjunction with samples from pit trays (in-stream passive samplers) and depth-integrated samplers, to characterise vertical as well as horizontal sediment flow in river channels; this will provide high spatial-resolution results.

Sediment provenance

Each catchment will be surveyed to identify critical sources areas and areas of sediment storage. Source samples will be categorized both by land-use (e.g. grassland, peatland and forestry) and by surface and subsurface areas (e.g. channel banks). The physico-chemical signatures and associated variability will be established by further analysis, and Digital Elevation Models will help identify potential sediment pathways. Transported SS will be obtained using passive time-integrated samplers and retrievable basket-samplers. The resulting data will be used to investigate the rates of deposition and residence time of fine-sediment.

To determine non-point sources of sediment, sediment analysis will be undertaken to ascertain the most appropriate properties (e.g. trace and heavy metals, organic content) for sediment fingerprinting. Unmixing models will be employed to analyse the properties of source and sink sediment, building on the work of Sherriff *et al*., (2014). Controlled mixture experiments will be used to validate the models, while also assessing the extent to which catchment scale affects model performance. The combination of fingerprinting with multivariate ‘unmixing models’ will allow for discrimination between sources, as well as the evaluation of relative contribution of sediment from each source.

Figure 2: Overgrazing resulting in erosion is a potential pressure in the Caragh Catchment.

Assessment of habitat quality

The Freshwater Pearl Mussel has specific habitat requirements and therefore in-depth analysis of the streambed parameters is essential such that conservation efforts can be appropriately designed and targeted. A range of techniques will be employed to assess habitat quality and sediment penetration, these techniques include pebble counts, vane sheer tests, texture analysis and freeze-coring. The distribution of dissolved oxygen (DO) in the substratum will also be investigated, with particular focus on the relationship between DO and redox potential in relation to sediment ingress.

Assessment of mitigation success

This study will investigate the effectiveness of a subset of implemented mitigation measures through the recognition of key sources areas, the modelling of overland flow and extensive field data. This will help to assess the practicality and cost-effectiveness of measures such as buffer strips.

Discussion

We will deliver new information regarding insight into selective erosion and preferential deposition in river channels and a provenance methodology across land-use gradients in an Irish context. The study will deliver tested methods for calibrating turbidity data against suspended sediment, with emphasis on constraining factors and determining high-resolution, synchronous discharge and turbidity methods. Sediment flux analysis will provide information on concentration, flux and magnitude-frequency analysis of high-resolution turbidity and suspended sediment data. The quality control of high-resolution data will also be highly relevant to future studies. Furthermore, relevant data will be provided to the KerryLIFE project, with the intention of enhancing the implementation of erosion and sediment control measures, and safe-guarding rivers for the conservation of the Freshwater Pearl Mussel.
Overall, the study aims to contribute to the development of ecosystem-based adaptation measures that both aid the restoration of endangered species and provide broader sustainable land management benefits.

Acknowledgments

This project is funded by the Teagasc Walsh Fellowship Programme. The research will be carried out in close collaboration with the KerryLIFE+ project team.

References

Duerdoth, C. P., A. Arnold, J. F. Murphy, P. S. Naden, P. Scarlett, A. L. Collins, D. A. Sear, and Jones., J. I. 2015. “Assessment of a Rapid Method for Quantitative Reach-Scale Estimates of Deposited Fine Sediment in Rivers.” *Geomorphology* 230: 37-50.

Sherriff, S., Rowan, J.S., Franks, S.M., Walden, J., Melland, A., Jordan, P., Fenton, O. and Ó hUallacháin, D. 2014. Tracer selection in sediment fingerprinting: methodologies for corrupt tracer identification. *Journal of Soils and Sediment*. In press.

Observing the efficacy of sampling methods for potential Invertebrate Bioindicators (Diptera: Sciomyzidae) in High Nature Value Wet Grassland

J. Carey[1], M. LeRoy[2], C. Williams[3], M. Gormally[1]
[1]*Applied Ecology Unit, School of Natural Sciences, NUI Galway*
[2]*UFR Sciences et Techniques, Universite de Bretagne Occidentale, Brest, France*
[3]*Behavioural Ecology and Biocontrol, Department of Biology, NUI Maynooth*

Email: jgjcarey@gmail.com

Introduction

The recognition of High Nature Value (HNV) farming is a pressing conservation issue within both the EU and at national levels. Much of the conservation of lowland wet grasslands is driven by botanical or ornithological interest and considerably less is known about their associated invertebrate assemblages. Sciomyzidae (Diptera) are wetland habitat specialists with sedentary adults which permit their use as both qualitative and quantitative bioindicators of wetlands. Sciomyzidae have also recently been shown to be both ubiquitous and diverse in wet grassland habitats with assemblages responding to hydrological and management changes (Maher et al., 2014). Such ecological patterns could yield important information on the future management of HNV wet grasslands which harbour small-scale wetland features important for wetland insect communities. Nevertheless, Williams et al. (2009) suggest the possibility that the determination of sciomyzid communities captured by the most widely used method (sweep netting) may be influenced by certain variables, particularly vegetation length. In addition, Vala (1984) has demonstrated improved sciomyzid catches at sunrise and sunset using a sweep-net. Using the most widely employed capture techniques (Malaise trap, emergence trap and sweep-net), we compared the species composition of each method in a wet grassland dominated by *Juncus* species and a *Carexs* dominated wet grassland. We also examined the difference between sweep-net catch returns at crepuscular times compared to catches made during the middle of the day.

Materials and Methods

Sampling was undertaken in June and July (2014) at two adjacent (~100 m apart) wet grassland sites in Menlo, north-east of Galway City in the west of Ireland (53°17057.39″N; 9°4035.35″W). Site 1 was situated in a habitat with tall vegetation (mean: 66.85 cm ± 37.35 SD; n = 50) dominated by the rush species *Juncus conglomeratus* (L.) and *Juncus acutiflorus* (Ehrh. Ex Hoffm.). Site 2 was characterised by a relatively homogenous sward of shorter vegetation (mean: 32.12 cm ± 21.94 SD; n = 50) dominated by *Carex nigra* (L.) Reichard and occasionally interspersed with some taller plants. A standard Townes Malaise trap (MT) and emergence trap (ET) (165 x 115 x 110 cm) were positioned 3 m apart in homogenous vegetation within each site and protected from livestock by a portable electric fence. Traps were placed a minimum distance of 10 m from linear or man-made features, e.g. ditches, hedgerows. Samples were collected weekly for 5 weeks between June 12th and July 16th (2014). Sweep-netting (SN) was undertaken weekly at dawn (05:30 h), mid-morning (09:30 h), solar noon (13:30 h), mid-afternoon (17:50 h) and dusk (20:00 h). Five sweep-net sample paths (10 m long) were defined in the immediate vicinity (~7.5 m) of the Malaise/emergence enclosures. Each sweep path was separated by approximately 1.0–1.5 m. Weather conditions were comparable every time sampling was undertaken and specimens were dispatched in a kill jar with ethyl acetate, stored in 70% alcohol and subsequently determined in the laboratory.

Results and Discussion

A total of 43 individual sciomyzids comprising 14 different species were captured during the 5 week period. Thirty-one individuals (13 species) were captured at Site 1 with 16 (eight species), 12 (seven species) and 3 (three species) individuals trapped using the sweep-net, Malaise trap and emergence trap respectively. Six species at Site 1 were unique to the sweep-net catches and three were unique to the Malaise trap with no unique species being caught using emergence traps. In contrast, only 12 individuals (six species) were captured at Site 2 with no sciomyzids caught using sweep-nets compared to 10 (four unique species) and two (two unique species) individuals caught using the Malaise trap and emergence trap respectively. Nevertheless, Site 2 produced similar numbers of individual captures in the Malaise trap as Site 1 (Table 1). It is interesting to note that had sweep-netting been the only sampling method employed, just 61% of species captured using all sampling methods would have been recorded at Site 1 and 0% at Site 2. Similarly, if sampling were restricted to Malaise traps, just 54% of species captured using all sampling methods would have been recorded at Site 1 and 67% at Site 2. While no additional species were captured using emergence traps at Site 1, one-third (albeit with small numbers) of species would have been missed had emergence traps not been employed at Site 2.

Sweep-netting appears as a standard collection method in many articles related to the qualitative collection of sciomyzid adults for faunistic accounts and ecological investigations (Williams et al. 2009;

Maher et al. 2014). Within Site 1 a distinct difference in sciomyzid species composition was observed dependent on the capture method (Figure 1).

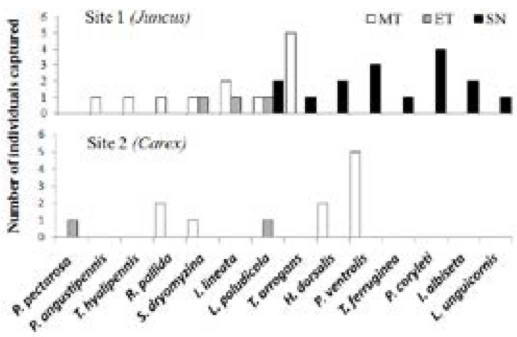


Figure 1. Sciomyzidae species distributions in Juncus and Carex dominated wet grasslands (MT: Malaise Trap, ET: Emergence Trap, SN: Sweep Net).

Six species were exclusively captured at Site 1 using the sweep net and five species were exclusively captured using the combination of Malaise and emergence traps. Site 2 produced no sciomyzid captures using the sweep-net – most likely due to the overall shorter vegetation at the site. Of the 16 individuals captured using a sweep-net at Site 1, ten of these were captured during the crepuscular time periods (four unique species) and six during the period between mid-morning and mid-afternoon (one unique species).

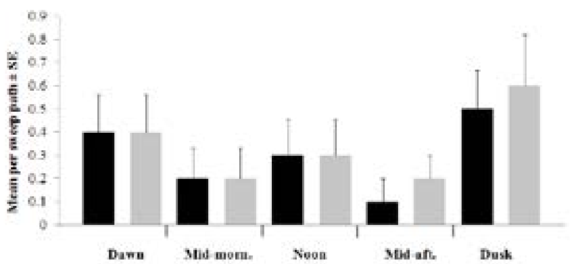


Figure 2. Sciomyzidae mean individual capture (± SE) by sweep netting during different times of the day. Dawn (05:30 h), Mid-morn. (09:30 h), Noon (13:30 h), Mid-aft. (17:50 h) and dusk (20:00 h).Carey et al. (2015)

Vala (1984) showed a marked variation between temperature/time of day and the number of Sciomyzidae individuals captured in a Mediterranean forest biotope. A similar trend was illustrated in our findings with an increase in capture rates during the crepuscular periods (Mann-Whitney U test Dawn/Dusk abundance vs. Other times ($U=3$, $P=0.04$, $n=5$) (Fig. 2).

Conclusion

The results of this study illustrate that sciomyzid sampling can be markedly different in wet grasslands dependent on vegetation type and sampling methodology. It also verifies a previously observed trend for increased captures during low temperature and low light conditions. Future investigations of sciomyzid assemblages, as well as other invertebrate studies of in HNV wet grasslands, should acknowledge the potential caveats of specific collection methods. While the use of invertebrates as bioindicators of HNV farmland remains challenging, the extensive data derived from invertebrate groups may yield information on other features that support biodiversity in low intensity grassland habitats. Habitats such as *Juncus* grasslands which are traditionally considered as species-poor for birds, plants and butterflies (typical bioindicators), can potentially harbour rich numbers of less iconic groups of invertebrates; such as in this study. These observations may have future implications on the designation of HNV wet grasslands for atypical indicator groups. For full information see Carey et al. (2015)

Acknowledgements

Thanks to the Irish Research Council for funding.

References

Carey JGJ, LeRoy M, Williams CD, Gormally MJ (2015) Observations concerning the sampling of Sciomyzidae (Diptera) in High Nature Value wet grassland habitats: caveats to consider. *Insect Conserv. Diver.*, Online May 2015

Maher, C., Gormally, M.J., Williams, C.D. & Sheehy-Skeffington, M. (2014) Atlantic floodplain meadows: influence of hydrological gradients and management on sciomyzid (Diptera) assemblages. *J. Insect Conserv.*, 18, 267–282

Vala, J.-C. (1984) Phenology of Diptera Sciomyzidae in a Mediterranean forestry biotope. *Entomologica Basiliensis*, 9, 432–440.

Williams, C.D., Moran, J., Doherty, O., Mc Donnell, R.J., Gormally, M.J., Knutson, L.V. & Vala, J.-C. (2009) Factors affecting Sciomyzidae (Diptera) across a transect at Skealoghan Turlough (Co. Mayo, Ireland). *Aquat. Ecol.*, 43,117–133.

Ecological Focus Areas on Intensively Managed Farmland

J. Larkin[a,b], H. Sheridan[b], J.A. Finn[a], M. Ryan[c] and D. Ó hUallacháin[a]
[a]Environment and Land-use Programme, Teagasc, Johnstown Castle, Wexford, [b]School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4, [c]Rural Economy and Development Programme, Teagasc Mellows Campus, Athenry, Co. Galway.
Email: Julie.larkin@teagasc.ie

Introduction

The recent reform of the Common Agricultural Policy (CAP) has seen the introduction of three "Greening" measures aimed at improving agricultural sustainability. Greening measures now account for 30% of Basic Payment Scheme subsidies - these measures are; crop diversification; the maintenance of permanent grassland and the establishment of Ecological Focus Areas (EFAs). EFAs are landscape features and practices that are ecologically beneficial, having a positive effect on biodiversity and the environment. CAP stipulations require farmers with over 15 hectares of arable land to declare at least 5% of this land as Ecological Focus Area. Although these stipulations will have an impact on farmland biodiversity, they could also have a significant impact on farmers, as viable agricultural land may have to be taken out of production to create EFAs potentially resulting in a loss of income. Furthermore, the current 5% requirement is likely to rise to 7% in 2017.

Benefits of Ecological Focus Areas

Ecological Focus Areas have many potential benefits for the environment and biodiversity and also for farmers - they can provide shelter and feeding sites for many species including birds, mammals and insects, some of which are crop pest predators. They can also help improve soil physical qualities and guard against flooding and water pollution. In addition to environmental and farmer related benefits, EFAs can also be advantageous for tourism and can have valuable, positive social aspects. The maintenance of aesthetically pleasing landscape features such as hedgerows and woodlands will enhance Ireland's clean, green image as well as slowing climate change via carbon sequestration.

Current EFAs

EU legislation lists a number of different measures and features that are eligible to Member States to qualify as EFAs within their respective countries, outlined in Table 1. Cross Compliance landscape features vary from country to country, for example, Northern Ireland has included earth banks; Denmark has included ancient monuments while Germany has included wetlands. In Ireland, current eligible EFAs include hedgerows, drains, riparian buffer strips and areas of nitrogen fixing crops (Table 1).

Hedgerows

Hedgerows are man-made structures created as field boundaries for retaining livestock. They are a very common landscape feature in the Irish countryside providing an important habitat for wildlife. They are significant food, nesting and refuge sources for many species of birds, mammal and invertebrate. Further to this, they are used as commuting corridors by birds, bats and other mammals to travel between foraging and refuge sites.

As Ireland has a distinct lack of native woodland, hedgerows also provide an important habitat for many open woodland wildflower species such as tutsan (*Hypericum androsaemum*), primrose (*Primula vulgaris*) and bluebell (*Hyacinthoides non-scripta*). These wildflowers, along with others found in hedges are important food sources for pollinators such as bees, hoverflies and butterflies. Hedgerows can also be important habitats for many other invertebrate species including those that are crop pest predators, the most notable of which are the ground dwelling beetles. In addition, hedgerows play a number of other important roles such as providing shelter for livestock, preventing the spread of diseases such as bovine TB and they can act as a carbon sink.

Drainage ditches

Drainage ditches are man-made structures created to help alleviate waterlogging on flood-prone land and they are usually associated with hedgerows. These ditches can provide a unique habitat within a landscape containing many water-loving botanical species such as rushes, water-cress (*Nasturtium officinale*) and brooklime (*Veronica beccabunga*). Drains can also be favourable habitats for Ireland's three native amphibian species – the common frog (*Rana temporaria*), Natterjack toad (*Epidalea calamita*) and the smooth newt (*Lissotriton vulgaris*).

Buffer Strips

Buffer strips are bands of permanent vegetation adjacent to watercourses that are excluded from intensive farming practices. Buffer strips can help improve and maintain water quality by intercepting overland runoff which may contain sediment and pesticide or fertiliser residue. Additionally, they can ensure bank stability, reducing erosion and decreasing sediment infiltration into watercourses. Buffer strips also provide habitat for species including small mammals, birds and invertebrates and can act as wildlife corridors.

The enhancement and maintenance of landscape diversity via EFAs will have an important, positive

Table 1: Ecological Focus Areas eligible under EU legislation and those chosen by 10 EU countries.

Ecological Focus Area	IE	GB-NI	GB-WLS	GB-ENG	GB-SCO	DE	IT	FR	SE	DK
Fallow land	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Terraces						✓	✓	✓		
Landscape features										
Cross Compliance features		✓				✓	✓			✓
Hedges/wooded strips	✓	✓	✓	✓		✓	✓	✓		
Isolated trees						✓	✓	✓		
Trees in a line	✓					✓	✓	✓		
Copse	✓					✓	✓	✓		
Field margins					✓	✓	✓	✓	✓	
Ponds							✓	✓		
Ditches	✓	✓					✓	✓		
Traditional stone walls		✓	✓			✓	✓	✓		
Buffer strips	✓			✓	✓	✓	✓	✓		✓
SPS afforested areas	✓	✓	✓				✓	✓		
Agro-forestry		✓				✓	✓	✓		
Bands along forest edges						✓	✓	✓		
Short rotation coppice	✓	✓	✓			✓	✓	✓	✓	✓
Catch crops and green cover	✓			✓	✓	✓		✓	✓	✓
Nitrogen fixing crops	✓	✓	✓	✓	✓	✓	✓	✓	✓	

impact on the overall biodiversity within a system. An increase in landscape diversity generally leads to the augmentation of the genetic diversity within species supplementary to an increase in species diversity. This enhances the stability of populations present which strengthens the resilience of an ecosystem from disturbances (Schippers *et al*. 2015).

In addition, EFAs will assist in halting farmland biodiversity loss which will contribute towards achieving sustainability and environmental targets (e.g. Biodiversity Strategy 2020, Water Framework Directive). These targets aim to strengthen the ecosystem services provided by biodiversity, such as food, fresh water, pollination, flood protection, clean air.

Materials and Methods

It is unclear what percentage of Irish arable farmland currently qualifies as EFA. This study involves a habitat survey which will be carried out on a number of intensively-managed farms throughout Ireland. This approach will help determine the proportion of farm area currently under semi-natural habitat cover. Semi-natural habitat will include 1) areas currently classified as EFA under Irish prescriptions 2) areas that are not currently allowed under Irish prescriptions but are allowed under EU regulations (e.g. isolated trees, earthbanks) 3) semi-natural habitats that are not allowed under EU legislation. Additionally, as hedgerows are likely to be the dominant EFA on Irish farms a subset of hedgerows from each farm will be surveyed in greater detail.

To supplement the ecological data collected a farmer attitudinal survey on farmers' perception of the environment and the cost of agri-environment options will be completed. This should provide an insight into

the attitude of intensive farmers towards the environment and their likelihood of adopting specific biodiversity measures. A review of the cost-effectiveness of potential measures aimed at creating or enhancing EFAs shall also be carried out.

Outcomes

This study will provide a baseline data-set of semi-natural habitats (EFA and non-EFA) on intensive farms in Ireland in addition to an insight into the attitude of intensive farmers towards the environment. The study will combine biodiversity, attitudinal and cost-effectiveness data in a single database supporting the evaluation of the applicability and environmental impact of these measures on intensively managed systems. Our research will provide information to policy-makers regarding the targeting of appropriate management prescriptions aimed at the conservation of species and habitats on intensively managed agri-systems.

Acknowledgments

This project is funded by the Walsh Fellowship Programme, Teagasc.

References

Schippers, P. *et al*. (2015) Landscape diversity enhances the resilience of populations, ecosystems and local economy in rural areas. *Landscape Ecol*, 30: 193-202

The impact of hydrochemical disturbances on stream ecology

S. J. Davis[1, 2], M. Kelly-Quinn[2] M. Shore[3], P-E, Mellander[3] and D. Ó hUallacháin[1]

[1] *Teagasc, Environment Research Centre, Johnstown Castle, Wexford, Ireland;*
[2] *School of Environmental and Biological Sciences, University College Dublin, Dublin 4,*
[3] *Agricultural Catchments Programme, Teagasc, Johnstown Castle, Wexford, Co. Wexford, Ireland*
Email: stephen.davis@teagasc.ie

Introduction

Achieving and maintaining high ecological status in waterbodies are key aims of the Water Framework Directive. In Ireland, the two main threats to water quality are nutrient transfers from municipal (point) and agricultural (diffuse) sources, contributing to eutrophication. Diffuse nutrient losses from agriculture are closely linked with storm (i.e. acute) events, whereas municipal point sources pose a chronic pressure, particularly during summer baseflows, when dilution effects are minimal.

Figure 1: intensively farmed grassland catchment

The loss of nitrogen (N) and phosphorus (P) from grassland systems to water has been highlighted as one of the main threats to water quality in Ireland (Lucey, 2007). The impact of elevated nutrients on stream ecology has received much attention to date, less attention has been focused on the impact of acute/episodic inputs versus chronic/sustained inputs on stream ecology, and how taxa respond to and recover from episodic events.

Jordan *et al.* (2007) found that storm events could account for up to 92% of the total P load. This disproportionate effect highlights the need to understand how these acute events affect stream ecology. However, questions remain as to what short and long term impact these episodes of high nutrient and sediment concentrations have on ecological community structure and functioning, and how these impacts compare with the longer duration exposure of stream ecology to low flow conditions (i.e. chronic conditions).

The overall aim of this study is to investigate the effect of chronic and acute sources of nutrients on the ecological status of headwater streams. This paper looks at one element of the study i.e. the analysis of existing datasets to identify relationships between physico-chemical and ecological parameters.

Materials and Methods

Physico-chemical data have been collected, at sub-hourly intervals, at the outlets of five agricultural catchments since 2009. Parameters measured include two phosphorus fractions (total phosphorus (TP) and total reactive P (TRP)), nitrate-N (as total oxidised N), turbidity and conductivity. In addition to this continuous monitoring, monthly "snapshot" samples were also taken near the outlets. Snapshot samples were measured for metals, total P, total dissolved P, reactive P, dissolved molybdate reactive P, total N, nitrate-N, nitrite-N, ammonium N, total oxidised N, pH and conductivity.

Since 2009, diatom and macroinvertebrate samples have been collected biannually, from the five catchments, in May and September.

Data Analysis

Data were analysed by regression analysis (using SAS) to identify relationships between chemical parameters and responses in ecological communities. Chemical parameters included in the analysis were: total phosphorus, total dissolved phosphorus, reactive phosphorus, dissolved molybdate reactive phosphorus, nitrate-N, nitrite-N, ammonium-N, total nitrogen, and conductivity. Spring chemistry parameters constituted an average of February, March and April data, whilst summer data were an average of June, July and August.

Ecological data from spring (May) and summer (September) were compared to the chemical data highlighted above. Ecological parameters analysed for this paper included Q-value, total macroinvertebrate abundance and total richness.

Results

Preliminary results on comparisons between macroinvertebrate richness and abundance between catchments, seasons and years are in Table 1.

Regression analysis showed that macroinvertebrate richness differed significantly between catchments ($P < 0.001$); years ($P < 0.05$); and seasons ($P < 0.001$) with a higher taxon richness observed in spring as opposed to summer.

Macroinvertebrate abundance also differed significantly between catchments ($P < 0.001$) and years ($P < 0.001$) but not between seasons.

Q-value was significantly positively correlated with macroinvertebrate richness ($P < 0.001$) but there was no correlation with abundance.

Preliminary results in relation to the influence of chemical parameters on ecological responses (Table 2) suggest that conductivity ($P < 0.001$) and total N ($P < 0.001$) both had a significant influence on taxon richness. Where there was higher conductivity, there was lower taxon richness. The analysis also found a positive correlation between total N and taxon richness, this result is likely to change when data are analysed on spatial scale.

Conductivity ($P < 0.001$) and nitrate-N ($P < 0.05$) had a significant influence on macroinvertebrate abundance, once again where there was a high conductivity or a high nitrate N, macroinvertebrate abundance was reduced.

Relationships between chemical variables and Q-value were also investigated. Regression analysis found that conductivity ($P < 0.001$), ammonium-N ($P < 0.05$), reactive P ($P < 0.01$) and total P ($P < 0.05$) all significantly influenced macroinvertebrate Q-value, with an inverse correlation between these chemical parameters and the Q-value.

Table 1. Regression analysis (using PROC MIXED) of macroinvertebrate diversity and abundance with catchment, season and year. P values < 0.05 are significant, (indicated by *)

Parameter	Diversity	Abundance
Catchment	$P < 0.001$*	$P < 0.001$*
Season	$P < 0.001$*	$P = 0.628$
Year	$P < 0.05$*	$P < 0.001$*

Table 2. Regression analysis using (PROC REG), forward stepwise selection, of macroinvertebrate diversity and abundance with conductivity, total N and nitrate N. P values < 0.05 are significant (*).

Parameter	Diversity	Abundance
Conductivity	$P < 0.001$*	$P < 0.001$*
Total N	$P < 0.001$*	$P > 0.05$
Nitrate N	$P > 0.05$	$P < 0.05$*

Discussion

It is well known that macroinvertebrate communities naturally change between seasons (Callanan *et al.*, 2008). It was therefore unsurprising that that our preliminary results found that there was a significant difference in macroinvertebrate diversity between seasons. However, this project is investigating the hypothesis that changes observed may not be fully explained by natural variation alone and that chronic inputs of nutrients and sediment might also be adversely affecting macroinvertebrate diversity.

It was also not surprising that there was no significant difference in macroinvertebrate abundance between seasons. This was expected as other species proliferate to fill the niche left by species which have disappeared, thus explaining why macroinvertebrate abundance is a poor indicator of habitat quality.

The significant differences observed in macroinvertebrate richness and abundance between catchments were also to be expected. All five catchments differ greatly in their land use, drainage, typology, hydrological regimes and nutrient loss risk. Results suggest that conductivity had a significant influence on macroinvertebrate taxon richness and abundance, and on Q-value. It is likely that conductivity is following seasonal trends and is acting as an indicator for other parameters not included in this preliminary analysis. This highlights the need for additional research to investigate the impact of physico-chemical parameters on ecological communities

Conclusions

Preliminary analyses present some unexpected results which will require additional work to fully understand. More site specific analysis is required to identify how phosphorus and nitrogen are affecting aquatic macroinvertebrate communities, and what role conductivity is playing in influencing ecological communities.

Further research is also needed over the summer months to identify when exactly changes in aquatic macroinvertebrate communities are occurring.

Acknowledgments

This project is funded by the Walsh Fellowship Programme, Teagasc. We acknowledge the Teagasc Agricultural Catchments Programme, and the farmers and landowners of the study catchments. We also acknowledge the Aquatic Services Unit, UCC who collected the data.

References

Callanan, M., Baars, J-R., and Kelly-Quinn, M. (2008) Critical influence of seasonal sampling on the ecological quality assessment of small headwater streams. Hydrobiologia 610, 245-255.

Jordan, P., Arnscheidt, A., McGrogan, H. and McCormick, S. (2007) Characterising phosphorus transfers in rural catchments using a continuous bank-side analyser. Hydrology & Earth System Sciences 11(1).

Lucey, J. (2007) Water quality in Ireland 2006: Key indicators of the aquatic Environment. Wexford, Environmental Protection Agency.

Targeting agri-environment scheme payments for terrestrial ecosystem services to conserve priority freshwater aquatic ecology

M. Gonbour[1], D. Doody[2], D. Ó hUallacháin[3], H. Sheridan[1] and D. Burgess[2]

[1]University College Dublin (UCD), [2]Agri-Food and Biosciences Institute (AFBI) and [3]Teagasc

Email: mohamed.gonbour@ucdconnect.ie

Introduction

Agricultural practices can result in the transfer of sediment and nutrients (nitrogen and phosphorus (P)) through hydrological pathways, potentially causing deterioration in the ecological status of water bodies. Sediment and nutrients are the key drivers affecting catchments, therefore by controlling sources and delivery pathways, freshwater status can potentially be improved or maintained. Under certain circumstances it has been demonstrated that Agri-Environmental Schemes (AES) may mitigate the impact of agriculture on freshwater habitats and species if they are implemented correctly (Kleijn *et al*., 2006; Princé *et al*., 2012; Poole *et al.*, 2013; Horrocks *et al.*, 2014). The need for spatial targeting of mitigation measures is well documented, however, few AES schemes to date take hydrological connectivity into account, which impacts on the likelihood of improving or maintaining the ecological status of freshwater bodies. In addition, a lack of monitoring and evaluation data in relation to the effectiveness of AES (Finn & Ó hUallachain, 2012) make it difficult to demonstrate the effectiveness of AES schemes.

The aim of this study is to target AES payments primarily to critical source areas (i.e. hydrological connected areas that overlap with a source pressure), and consider the risks of hydrological connectivity to the delivery of phosphorus using the Lough Melvin catchment as case study. Furthermore, this study proposes to examine the distribution of AES payments, e.g. paying farmers for certain actions but basing these payments on the value to society of the ecosystem services (ES) delivered. This is opposed to the AES payments under the EU CAP (Common Agricultural Policy), which evaluates the costs of implementing the measures and compensates farmers for income forgone.

Materials and Methods

The Lough Melvin catchment is a designated Special Area of Conservation (SAC). The most significant threat to the ecological status of Lough Melvin has been an increase in P loadings from agriculture within the surrounding catchment (estimated to be a 40% increase over 10 years). In 1990, Lough Melvin was classified as a mildly mesotrophic lake (i.e. in the middle of the trophic range) with P concentration of 19.1 µg L^{-1} (reference condition). This concentration is considered to be it's natural and historic status (Campbell *et al*., 2008). In 2002, the concentration increased to 29.5 µg L^{-1} and in 2007 this was 27 µg L^{-1}. In order to maintain the ecological, social and economic values that Lough Melvin supports, the concentration of P in the lake must be maintained at a sustainable level and the current level need to be reduced by 30% (the compliance gap). The current P loadings resulting from agricultural practices are approximately 13 tonnes per year. A P concentration of 19 µg L^{-1} equates to an average nutrient loading of less than 10 tonnes per annum. Therefore, a reduction in loads of approximately 3 tonnes (23%) would be required to reduce the concentration in Lough Melvin to baseline levels. Doody *et al.* (2012) reported that over-application of slurry to many silage fields had resulted in a significant build up of soil P above agronomic optimum level, which now pose a significant risk to water quality in the catchment. By identifying the terrestrial ecosystem services related to land-use activities (i.e. that have the potential to impact on the delivery of water related ecosystem services e.g. grazing, slurry application), a link to manage these practices and to measure their impact on the state of the required ecosystem services is facilitated. The SCIMAP approach provides a framework to identify the high risk fields based on land-use and hydrological connectivity (Doody *et al.*, 2012). The objective is to link the critical source areas identified through the application of SCIMAP, with the delivery of required freshwater ES, to identify the spatial distribution of economic ES values throughout the catchment.

Ecosystem services classification

In the Lough Melvin case study the focus was on the terrestrial regulation & maintenance ES relation to P (CICES classification, 2013): the maintenance of the chemical conditions (i.e. soil buffering resulting in a change of the chemical conditions of freshwater). Proposed payments are targeted based on the economic value of the delivered provisioning ES. This required the scoping of ecological impacts, by assessing the environments potential and actual provision of ecosystem services, followed by identification of how a change in the ecosystem can affect human welfare and estimating the economic value of the ecosystem services. When applying Campbell et al., (2008) valuation approach to salmon in the Lough Melvin catchment, the value for each salmon was estimated at €26.28.

SCIMAP & GIS analysis

A GIS analysis was conducted and a total of 3200 land-parcels were digitised in the Roogagh sub catchment of Lough Melvin, using aerial orthoimagery in ArcGIS 10.2. The 5-meter DEM (digital elevation model) for Northern Ireland was processed and used in SCIMAP. The DEM was first corrected by cutting the obstacles caused by roads and bridges, using CUTDEM processing in FORTRAN. The corrected DEM was then used as an input in ArcGIS 10.2, to apply the Arc Hydro toolbox for terrain pre-processing. SCIMAP provided output grids of slope, catchment area, stream network and the network index. The Network Index was then overlain with Google Earth mapped farmyards with the highest likelihood of slurry application, to explore the proximity of slurry spreading fields to the hydrological connected source areas. McGuckin et al. (1999) P export coefficient ranges were applied to the different land-uses as the Network Index was only based on slope. This layer was then multiplied with the Network Index in ArcGIS 10.2 to identify the CSA's (critical source areas) (Fig. 1). Finally allowing for the calculation of the highest risk values for each parcel using Zonal Statistics in ArcGIS 10.2. This resulted in a connectivity risk per field map.

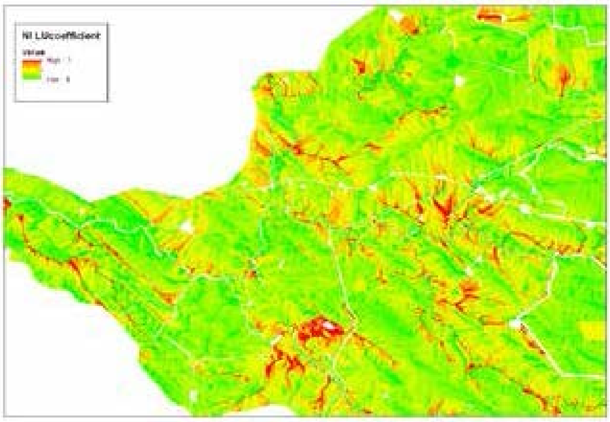


Figure 1: The identified CSA's (critical source areas)

Bayesian Belief Networks

The next step was to create a Bayesian Belief Network (BBN) using the *BNlearn* package in R studio, to determine the probable impact of the distribution of the identified critical source areas on the Salmon spawning grounds (Fig. 2). The BBN is used to integrate the biophysical assessments (SCIMAP) and the economic values of ES. We can then include the probability of the change of the delivery of required ES under the different water quality scenarios. By linking the BBN to GIS data layers we can develop a map depicting the scattered ES quantities throughout the catchment. Finally these quantities are converted into financial units.

Results and Discussion

A map was developed to identify the "P hotspots" and where AES payments to reduce P losses to water systems and to conserve priority freshwater ecology should be targeted (Fig. 2). The objective is to distribute the payments to maximise the cost-effectiveness. From this map it can be concluded that a large portion of the parcels where AES measures could potentially be implemented, are not hydrological connected and thus it would seem that scheme participation in these areas would not provide any significant environmental benefits (i.e. to priority freshwater ecology).

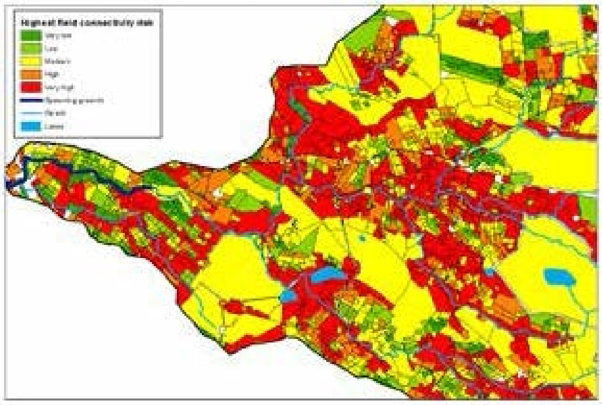


Figure 2: The proximity of CSA's to spawning grounds

Conclusions

Overall, this approach has shown that it is possible to map the hotspots and these maps may provide the basis for greater targeting of resources. Furthermore, cost-effectiveness of AES schemes could be maximised by targeting payments to advisory services in the identified CSA's and to stimulate co-financing by farmers for the implementation of AES measures.

References

Campbell, E., Foy, B., Barry, C., Bryne, P., Campbell, D., Cockerill, C., … Quinn, M. (2008). Lough Melvin: catchment management plan. *Lough Melvin Nutrient Reduction Programme*, (June).

Doody, D. G., Foy, R. H., & Barry, C. D. (2012). Accounting for the role of uncertainty in declining water quality in an extensively farmed grassland catchment. *Environmental Science & Policy*, *24*, 15–23.

Finn, J. A., & Ó'hUallachain, D. (2012). A review of evidence on the environmental impact of Ireland's rural environement protection scheme (REPS). *Biology & Environment: Proceedings of the Royal Irish Academy*, *112B*, 1–24.

McGuckin, S. O., Jordan, C., & Smith, R. V. (1999). Deriving phosphorus export coefficients for corine land cover types. *Water Science and Technology*, *39*(12), 47–53.

The forage quality of semi-natural calcareous

grasslands of the Aran Islands

L. Duignan[12], D. Ó hUallacháin[2], J.A. Finn[2], J. Moran[1]
[1] *Centre for Environmental Research Innovation and Sustainability, Department of Environmental Science, Institute of Technology Sligo, Sligo*
[2] *Teagasc, Johnstown Castle, Wexford*
Email: louise.duignan@mail.itsligo.ie

Introduction

Traditional grazing regimes are likely to be the most effective and sustainable way to maintain, and in some instances restore, the biodiversity of semi-natural grasslands within priority farmland habitat on the Aran Islands (Smith *et al.* 2010). AranLIFE (an EU LIFE co-funded project, 2014-present) is working with farmers to demonstrate best management practices for the conservation of priority EU-protected habitats that are dependent on a continued farming system. This requires the development of optimal grazing and supplementary feeding regimes that ensure both nature conservation and animal nutrition objectives are met. However, there is a lack of data that adequately characterizes the forage quality of semi-natural grasslands of high nature value. This shortcoming makes devising optimal grazing regimes, which meet the nutritional requirements of grazers, difficult. The aim of this study was threefold: (1) to identify the principal grassland communities within a representative sample of semi-natural farmland habitats across AranLIFE monitor farms, (2) determine the nutritional status of the forage resource within these vegetation types across sampling dates, and (3) to relate concentrations observed to livestock requirements.

Materials and Methods

Fifty sampling sites (two land parcels from each of 25 farms across Inis Mór, Inis Meáin, and Inis Oírr) were randomly selected from a total of 68 farms participating in AranLIFE. Sites were visited, and a homogeneous vegetation type that best represented the land parcel was selected for forage sampling. Representative forage samples were collected during mid-March and early-June 2015. Forage samples were analysed for oven dry matter (DM), crude protein (CP), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF) at the Agri-Food and Biosciences Institute, Northern Ireland. Botanical surveys of sample sites were carried out during September 2015 to determine vegetation community types. Plant community nomenclature followed O'Neill *et al.* (2014). A two-way analysis of variance analysed the effects of sampling period and vegetation community type on forage quality variables. Pairwise comparisons are based on estimated marginal means (α level = 0.05). Data analysis was carried out using R statistical programme.

Results and Discussion

The main management activity within grassland habitats was grazing, with a spring-calving suckler cow/drystock herd being the most prevalent farming system on sample farms. Sites were classified into four different grassland vegetation communities using a grassland key that resulted from a national survey of the semi-natural grasslands of Ireland (O'Neill *et al.*, 2014). The most abundant vegetation type was 3a *Briza media- Thymus polytrichus* (n=17), which approximates to EU Annex I habitat: Dry calcareous grassland 6210 (O'Neill *et al.*, 2014). The least abundant community types were *Sesleria sub community* (n=8) and 3f *Coastal sub community* (n=8).

There was a significant correlation (r_s, $p<0.01$, 2-tailed) between all nutrient quality parameters, i.e. DM, CP, ash, ADF and NDF. As CP increases, DM, ADF and NDF values decrease and ash increases. Overall, CP was lowest during March in *Sesleria sub community* and highest in *Lowland pasture/meadows*, also during March. ADF is at its highest during March and its lowest during June in *Coastal sub community*. With the exception of *Lowland pasture/meadows*, vegetation types showed an increase in CP in June compared to March (Table 1). When associations between plant classification systems are taken into account, forage quality patterns between vegetation communities over time found in this study are in line with results observed by Moran *et al.* (2008) in a similar study carried out in the Burren, Co. Clare.

Table 1: Mean (± SE) of forage quality variables of grassland vegetation communities during March and June 2015. (Number of sites in parentheses).

	Sampling Period	DM g kg^{-1}	Ash g kg^{-1} DM	CP g kg^{-1} DM	ADF g kg^{-1} DM	NDF g kg^{-1} DM
3a *Sesleria caerulea sub community* (8)	Mar 2015	607.1 ±17.9	43.1 ±5.5	65.3 ±3.3	377.8 ±6.8	707.3 ±10
	Jun 2015	329.4 ±18.5	54.5 ±4.2	100.7 ±5.5	294.3 ±10.5	549.6 ±21.9
3f *Coastal Sub community* (8)	Mar 2015	612.1 ±38.6	46.07 ±3.8	77.1 ±8.1	381.7 ±6.7	703.1 ±8.1
	Jun 2015	283.3 ±3.4	72.6 ±3.1	125.8 ±7.9	246.1 ±10.4	432.6 ±16.8
3a *Briza media- Thymus polytrichus* (17)	Mar 2015	487.0 ±52.5	48.9 ±4.4	85.3 ±12	355.8 ±11.6	674.6 ±16.3
	Jun 2015	307.2 ±20.5	62.7 ±3.2	116.5 ±5.7	261.3 ±13.7	455.5 ±37.4
3c & 3d *Lowland pasture/ meadows* (15)	Mar 2015	330.1 ±22.8	72.4 ±5.8	144.6 ±8	307.4 ±8.7	610.1 ±12.3
	Jun 2015	259.8 ±9.4	70.2 ±2.4	125.0 ±7.1	275.1 ±6.2	517.9 ±14.5

Both community type and sampling date had a significant main effect on both CP and ADF. However, the interaction effect between vegetation community type and sampling date was also significant for both CP, $F_{3,54} = 7.1$, $p < 0.05$, and ADF, $F_{3,54} = 6.1$, $p < 0.05$. Simple effects analysis revealed significant differences in CP and ADF between sampling dates in *Briza media-Thymus polytrichus, Sesleria sub community*, and *Coastal sub community*. In contrast, *Lowland pasture/meadows* had the smallest difference in means between sampling dates for both CP and ADF (Table 1 & Figure 1). CP and ADF varied significantly between *Lowland pasture/meadows* and all other vegetation types during March; higher CP-ADF ratios in *Lowland pasture/meadows* are likely reflecting the relatively higher rates of spring grass growth in this vegetation type.

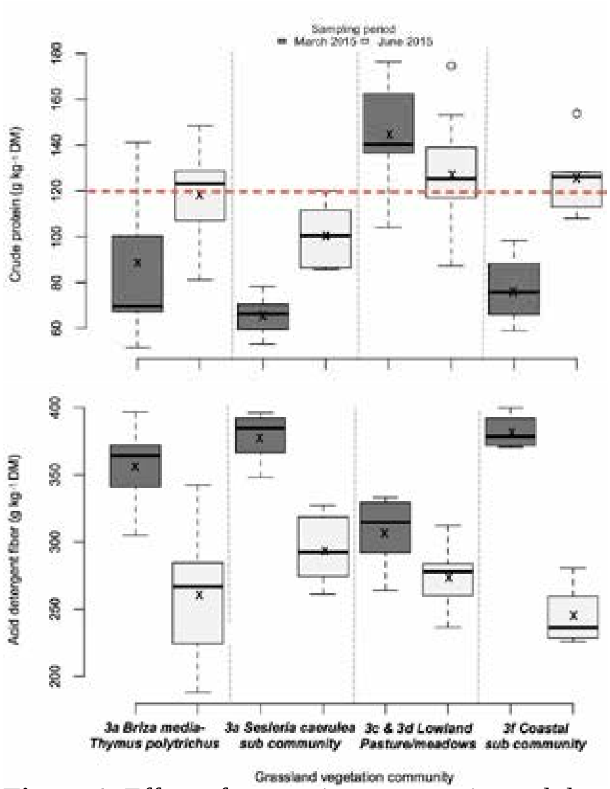


Figure 1. Effect of vegetation community and date (dark-gray= March; light-gray = June 2015) on CP (top) and ADF (bottom) levels (g km^{-1} DM). X = group mean. Red broken line = recommended dietary CP level.

By June, only CP concentrations in the *Sesleria sub community* remained significantly different from *Lowland pasture/meadows*. Significant differences in ADF between *Sesleria sub community* and both *Briza media-Thymus polytrichus* and *Coastal sub community* remained in June. Phenological patterns within and between plant communities are likely reflected in the observed variation in forage nutritive value between vegetation types and between sampling dates; as the forage resource matures, ADF (lignified fibre portion that is resistant to digestion) increases with a corresponding decrease in CP. This results in an overall reduction in nutrient availability. A spring-calving suckler beef production system is employed so that farmers can make full use of the relatively higher rates of plant growth during spring and summer when suckler cows are lactating. The current recommended levels of CP supply for beef production is 120 g kg $^{-1}$ DM (Rogers, 2003). *Briza media-Thymus polytrichus*, *Sesleria caerulea* and the *coastal sub community* vegetation communities fall below the recommended CP levels during March. The average CP level in *Sesleria sub community* is suboptimal in June (Figure 1).

Conclusions

This ongoing study found that the vegetation community types identified exhibit community-dependent temporal variation in forage quality. Farmers on the Aran Islands match forage supply to their herds' requirements during the year, while also preserving a sufficient forage resource potential for the winter grazing period. Data pertaining to both annual grazing patterns and variations in forage quality will provide a more comprehensive view of the relationship between nutrient availability and livestock requirements.

Acknowledgements

EU LIFE+ Nature Programme, Teagasc, DAHG, DAFM, FAILTE Ireland, The Heritage Council and Galway County Council. The AranLIFE project team and participating farmers.

References

Moran, J., Parr, S., Dunford B, O' Conchúir, R. (2008) Species-rich limestone grasslands of the Burren, Ireland: feed value and sustainable grazing systems. *Grassland Sciences in Europe*.13:150-152

O'Neill, F.H., Martin, J.R., Devaney, F.M. & Perrin, P.M. (2014) *A key to the identification of semi- natural grassland communities in Ireland.* BEC Consultants Ltd. Dublin.

Rogers, P. (2003, July 22). Optimal Mineral Nutrition of Cattle and Sheep on Irish Farms. Retrieved September 15, 2015, from http://homepage.eircom.net/~progers/bov_ov_min_nutr.htm

Smith, G.F., et al. (2010) *Case Studies on High Nature Value Farming in Ireland: Aran Islands and Connemara.* A report to the Heritage Council Ireland.

Creating new Woodlands: the potential for biodiversity and carbon sequestration

D.E. Burgess[1]
[1]*Agricultural and Food Economics, The Agri-Food and Biosciences Institute (AFBI) Newforge Lane Belfast BT9 5PX*
Email: Diane.Burgess@AFBINI.gov.uk

Introduction

New woodland has the potential of delivering biodiversity both in terms of the habitat itself and the species it supports. These deliver economic benefits such as (1) direct use (wildlife interaction), indirect use (support for off-site biodiversity) and non-use values (existence of wildlife). However, these are frequently not captured by decision makers as there is no market price. Only a few of the potential economic benefits deriving from the creation of new woodlands have a tangible financial value.

Given the financial support available for new woodlands, it is pertinent to consider the value of the ecosystem services. This project explored the benefits of the carbon sequestration resulting from the creating of 50,000 hectares of new woodlands in Northern Ireland through the conversion of agricultural land through the Forestry Grant Scheme (FGS).

Materials and Methods

To obtain the monetary value of the carbon sequestered by the new woodland, a two-stage process was undertaken:

1. Estimating of the amount of carbon potentially sequestered by the new FGS woodland;

2. The value of the amount of carbon sequester using the price of a tonne of non-traded carbon dioxide which was £62 in 2014 (DECC 2010).

A number of methods of estimating the carbon sequestration potential of woodland exist, including:

1. Annual average rates of sequestration which incorporate the carbon lost from the soil when the trees are planted. These were developed to create carbon inventories based on the entire woodland stock under international treaties. Rates range from 5.2 t CO_2 ha in the UK (Dyson et al., 2009) and between 4 and 8 t CO_2 per ha for the Republic of Ireland (Black and Farrell, 2006);

2. Sequestration rates for a range of trees under different management regimes have been developed by the Forestry Commission of Great Britain (soil carbon lost is calculated separately)

The latter approach recognises that rate of carbon sequestration depends on the tree species, age of the tree, the previous land use and the management regime adopted. Importantly, the scheme recognises and quantifies the amount of carbon released from soil when the new trees are planted. Therefore, this approach enables differences in management regimes on carbon sequestration to be assessed.

Management options

Within this project, the following were assessed:

(1) Timing of planting:
- a. 50,000 ha planted immediately;
- b. 10,000 ha planted every 10 years;
- c. 1,000 ha planted annually;

(2) Tree species planted:
- a. Broadleaf (sycamore, ash and beech (SAB));
- b. Conifer (Japanese larch);

(3) The method used to prepare the land (loss of soil carbon):
- a. Ploughing: 40% loss;
- b. Forestry ploughing: 10-20% loss
- c. Hand turfing and mounding: 5% loss;
- d. Hand Screefing: no loss

(4) Previous land use (which affected the carbon content of the soil):
- a. Land under semi-natural management (697t CO2/ha);
- b. Arable land (477t CO2/ha);
- c. Pasture land (367 t CO2/ha);

Results and Discussion

Based on the average carbon sequestration rates of woodlands (4-8 t CO2/ha/yr), the amount of carbon sequestered by the FGS would range between 5 and 20 million tonnes of carbon dioxide, worth between £373 and £1,327 million. Benefits increased the earlier the trees were planted.

In contrast, using the Forestry Commission rates, this project showed that the amount of carbon sequestered by the scheme was dependent on:

Time of planting: if all the additional 50,000 hectares are planted at the start of the scheme the total amount of carbon sequestered (25 million tonnes from broadleaf trees) will exceed the amount sequestered if only an additional 1,000 hectares are planted each year (12 million tonnes from broadleaf trees)

Type of trees: Broadleaf trees (SAB) sequester more than conifers (Japanese Larch), 25 million tonnes compared to 17 million tonnes (if all trees planted immediately).

If the 50,000 hectares of new broadleaf woodland was planted at the start of the scheme, 25 million tonnes of carbon would potentially be sequestered, delivering benefits of £1,600 million. However, this is dependent on no soil carbon being released when the land is prepared for tree planting.

Method of planting and previous land use: if the trees are planted at a rate of 1,000 ha per annum, and carbon rich soil is ploughed prior to planting, rather than carbon being sequestered; between 2 and 6 million tonnes of carbon dioxide can be emitted. This is particularly the case if:

1) A damaging method of land preparation i.e. ploughing is used on carbon rich soil (land previously under semi-natural management):
2) A management regime with low carbon sequestration rates is employed, i.e. conifers planted at a rate of 1,000 hectares a year.

If all the new woodland was planted on semi-natural land which was ploughed prior to coniferous trees being planted at a rate of 1,000 hectares per annum; the scheme would result in the net emission of 6 million tonnes of carbon dioxide with an associated cost of £317 million.

Table 1. Amount of carbon sequestered from 50,000 ha of new woodland on land under semi- natural management (all figures are in millions)

	50,000 ha planted in year 0		1,000 ha planted each year	
	tCO_2	**£**	**tCO_2**	**£**
4 t CO_2/ha/yr	10	£663	5	£373
8 t CO_2/ha/yr	20	£1,327	11	£747
Broadleaf (0% Soil carbon loss):				
	25	£1,651	12	£864
Broadleaf (40% Soil carbon loss):				
	11	£789	-2	-£42
Conifers (0% Soil carbon loss):				
	17	£1,124	8	£588
Conifers (40% Soil carbon loss):				
	3	£262	-6	-£317

Conclusions

This project assessed the economic value of the carbon sequestration delivered by the additional 50,000 hectares of woodland planted over the next 50 years supported by the Forestry Grant Scheme of the Forest Service in Northern Ireland. The study estimated that this scheme could sequester up to 25 tonnes of carbon, an economic value of £1,600 million (2014 values).

The use of the specific carbon sequestration rates rather than using average annualised sequestration rates enabled the identification that the amount of carbon sequestered through the FGS was dependent on:

(1) When the new woodlands were planted (earlier the better);
(2) Which trees were planted (broadleaf trees sequester more carbon than conifers);
(3) Method of preparing the ground for planting;
(4) Carbon content of soil particularly if a damaging method of preparation was used.

One key finding of the study was that rather than sequestering carbon and contributing to Northern Ireland meeting its obligations under the Kyoto Protocol, the method of preparing the agricultural land for planting (combined with the type of land) can result in the FGS resulting in a net loss of soil carbon. Using an intensive preparation method such as ploughing on a carbon rich soil could release nearly 14 million tonnes of carbon. Over the 50 years of the scheme, this will result in the net emission of 6 million tonnes of carbon dioxide at a cost of £317 million (depending on the trees planted and the carbon content of the soil prior to planting). Therefore to maximise the carbon dioxide sequestered within the new woodland, the study identified that care should be taken to minimise the loss of carbon from soil in the preparation of the land prior to planting the trees.

A second key finding was the importance of selecting a species of tree with a high sequestration rate. The use of broadleaf trees (sycamore, ash and beech (SAB), as well as sequestering higher levels of carbon will contribute to biodiversity within Northern Ireland. Mixed ash woodlands, for example are a priority habitats and support priority species such as red squirrel, bats, small cow wheat and wood cranesbill.

Acknowledgments

Funding from DARD was provided through the Evidence & Innovation call of 2012/13

References

Black, K. G. & Farrell, E. P. (2006). Carbon sequestration and Irish forest ecosystems. Dublin: COFORD.

DECC (2010) Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, Department of Energy and Climate Change, London.

Dyson, et al. (2009) Inventory and projections of UK emissions by sources and removals by sinks due to land use, land use change and forestry. Annual report, CEH, Edinburgh.

Valuing Ireland's mountains and upland areas and respecting their custodians

R. Ó Conchúir[1], H. Lawless[1]
Mountaineering Ireland[1] Sports HQ, National Sports Campus Blanchardstown, Dublin 15, Ireland
Email: ruairi@mountaineering.ie

Introduction

Mountaineering Ireland, as the recognised representative body for walkers in Ireland, has a particular interest in Ireland's upland environment - hills, mountains, forests, bogland, sea cliffs and associated areas. Mountaineering Ireland has been involved in ongoing work with various bodies to build a shared vision for the sustainable future of Ireland's upland areas. This work has been undertaken in a spirit of partnership building for the uplands. During 2012 and 2013, Mountaineering Ireland coordinated the National Uplands Working Group and a wider Consultation Group, to develop a suite of measures to be incorporated into a combined and unified Rural Development Programme (RDP) submission from 31 different organisations, including all three main farming representative bodies. The submission was strengthened by the input of a range of stakeholders, including farming and environmental organisations, local development groups and government bodies involved in agriculture and nature conservation in upland areas. Mountaineering Ireland co-ordinated this work with the objective of securing the sustainable management of large areas of Ireland's uplands through a targeted upland agri-environment measure under the RDP 2014-2020.

Valuing Ireland's Uplands

While limited in their extent, the Irish uplands are very significant elements in the landscape, providing defining geographic features, some of Ireland's most beautiful scenery and our largest areas of relatively wild yet actively farmed land. Mountaineering Ireland's mission is to represent and support walkers in Ireland and equally importantly to be a voice for the sustainable use of Ireland's upland areas. As the recognised National Governing Body for the sport of mountaineering, by both the Irish Sports Council and Sport Northern Ireland, Mountaineering Ireland has worked closely with farmers, landowners and land managers for over 20 years. Having a membership base of 11,550 members, comprising 174 clubs and approximately 1,400 individual members, Mountaineering Ireland is uniquely placed at the juxtaposition between the recreational user and the needs and aspirations of upland farmers to make a living from the land and act as custodians of Ireland's uplands for current and future generations. A great many Mountaineering Ireland clubs draw heavily on the goodwill of local farmers to access upland areas, and with the continued growth in the popularity of hillwalking farm families are increasingly becoming members in local Mountaineering Ireland clubs throughout Ireland.

Targeted Upland Agri-Environment Scheme

The RDP submission made by the National Uplands Working Group was concentrated on targeted agri-environment measures relevant to the uplands. It was underpinned by the principles of farming for conservation, to be user-friendly with minimal 'red tape' and was designed to foster respect for the cultural and built heritage of the Irish uplands. It also focused on the need to raise awareness of the importance of hill-farming amongst the general public. It noted the need to avoid unnecessary intervention in the mountain environment and the need to avoid fencing of previously unfenced mountain lands in order to retain the 'wild' character of much of Ireland's upland landscape.

Roll-out of RDP

With the current roll-out of GLAS and GLAS+ and the expected roll-out of local led agri-environmental schemes in the 3rd and 4th quarter of 2015, the need for a coordinated approach to the sustainable management of the Irish uplands is as great as ever. Mountaineering Ireland believes a national scheme is needed which would target upland farmers actively managing land with a high percentage of semi-natural vegetation, or farmers willing to recommence farming on abandoned semi-natural land. The key habitat types would include dry and wet heath, blanket bog, semi-natural grasslands and other upland habitats. Mountaineering Ireland is seeking a national voluntary scheme which would focus on the maintenance, and where required the re-introduction, of traditional sustainable farming practices. The aim of such a scheme would be to restore, preserve and enhance ecosystems dependent on agriculture. Payments occur for work undertaken and the delivery of outputs. A key issue from Mountaineering Ireland's perspective, is that of dealing with path erosion in upland areas. Path repair and maintenance and the restoration of degraded upland habitats could be considered within such a scheme, but critically only with specialised training and specification.

How to Apply – Who to Apply

From Mountaineering Ireland's perspective there should be a national upland agri-environmental scheme which should apply to upland areas (hill farms), including commonages, on both designated and non-designated lands. It would work to actively address land abandonment in the uplands. Most critically the levels of payment, unlike those available currently under GLAS and GLAS+, would be financially attractive to encourage younger farmers to take over hill-farms. A national scheme, locally administered, would actively involve farmers in the preparation of their own farm plans and would incorporate enhancement measures to meet programme objectives (i.e. specific measures to enhance habitat condition).

At a farm level, such a scheme would be based on a whole farm planning approach, with a simple user friendly farm plan. Similar to the model deployed by the BurrenLIFE Farming for Conservation Programme, to identify work required to improve habitat condition (e.g. targeted grazing, scrub removal, bracken or other invasive plant species, burning etc.). The national scheme would also include a capital works programme to finance necessary work (repair of boundary walls, provision of access and water, and possible path repair works). In areas of high recreational activity, farm plans should consider opportunities for further recreational activity and related economic opportunity on farm / off-farm.

Conclusions

By 2020, Mountaineering Ireland would envisage a significant premium being in place reflecting the environmental and ecological value of upland habitats (on designated & non-designated land). As an organisation with an increasing membership base which values the conservation and protection of upland areas, Mountaineering Ireland will work to ensure that payments are linked directly to the delivery of outputs as specified within simple user-friendly farm plans. Mountaineering Ireland members like to engage with, acknowledge and give respect to the landowners who facilitate access to upland areas. Due consideration should be given to the inclusion of non-commercial pedestrian recreational activities on land that is managed under the scheme, provided that participants act responsibly. As such a national scheme should ensure that participants are actively farming. Finally, the need for appropriate agricultural advice, combined with technical support and a two-way sharing of skills and knowledge transfer should form a central component of a future vision for the Irish Uplands. This should be provided to and by participating farmers, with plans developed by and in conjunction with farmers and environmental advisers. This two-way skills transfer should be done at a local level in as far as possible. It should acknowledge the wider common good of upland areas and the desire by many to use such areas for recreational purposes while respecting that they are working farms. Local upland partnerships and fora can provide the platform for all to promote biodiversity in the wider countryside.

Acknowledgments

Mountaineering Ireland acknowledges all parties who inputted into the work of the National Uplands Working Group and the wider consultation group, which included: Irish Farmers Association; Irish Cattle and Sheep Farmers' Association; Irish Creamery Milk Suppliers Association; Department of Arts, Heritage and the Gaeltacht (National Parks and Wildlife Service); Department of Environment, Community and Local Government; Teagasc; The Heritage Council; European Forum on Nature Conservation and Pastoralism; Burren Farming for Conservation Programme; BirdWatch Ireland; Irish Peatland Conservation Council; Irish Uplands Forum; Wicklow Uplands Council; Golden Eagle Trust; National Association of Regional Game Councils; Wicklow Cheviot Sheep Owners Association; Irish Landowners Organisation; Institute of Technology Sligo (Department of Environmental Science); Vincent Wildlife Trust and South Kerry Development Partnership. This paper is a reflection on the work of the NUWG but the comments expressed are those of Mountaineering Ireland alone.

References

Irish Mountain Log, Issue 104, Winter 2012, Report on the Helping the Hills, online: http://www.mountaineering.ie/accessandenvironment/HelpingTheHills/default.aspx

Ó Conchúir, R. (2013) Proposals to Support Farming in Ireland's Uplands, Teagasc National Agrienvironment Conference 7th Nov. 2013, online:

Fáilte Ireland (2014) *Fáilte Ireland Market Research 2013*, published by Fáilte Ireland, Dublin.

Corncrake conservation

B. O'Donoghue[1] and A. Bleasdale[1]
[1]*National Parks & Wildlife Service, Custom House, Flood Street, Galway.*
Email: Barry.O'Donoghue@ahg.gov.ie

Introduction

When it comes to modern agriculture and its relationship with nature, the Corncrake (*Crex crex*) has long featured as a species of concern. The Irish Corncrake population, as in various other countries, declined remarkably with the modernisation of agriculture, particularly the advent of silage cutting with early harvest dates. Conservation efforts in Ireland stem back to at least 1990 and have primarily revolved around paying farmers with Corncrake on their lands to delay harvests until the birds have reared their young. Action plans have been published, setting out goals and objectives in terms of stabilising and increasing the availability of suitable habitat and subsequently the breeding population itself. This paper provides an overview of the Corncrake population in Ireland and the strategies to save this species from further loss.

Materials and Methods

Early estimates of Corncrake populations (Sharrock, 1976; O'Meara 1979) were derived by volunteers reporting Corncrake records to survey co-ordinators. Systematic annual national surveying began in 1993. The population trend since then can be seen in Figure 1. This surveying entailed both (a) seeking reports from the public which would then be verified and (b) dedicated surveyors searching for Corncrakes. Surveying was carried out primarily by listening for Corncrakes, using standard methodology described by Stowe and Hudson (1988). To minimise the risk of over counting, only males heard calling from the same location for a minimum of five nights were considered breeding, and thus counted in the census. Since 1993, data has been collated according to four main regions (Donegal, West Connacht and Shannon Callows and the Moy Catchment). In more recent years, precise geo-referenced data has been collated as to where birds have been recorded. The Corncrake census is one of the longest running studies for any species in Ireland.

The All Ireland Species Action Plan for Corncrake (NPWS and EHS, 2005) was developed by relevant experts, using available information and knowledge of conservation issues. In 2014, a Corncrake Conservation Strategy to 2021 was published by the National Parks & Wildlife Service of the Department of Arts, Heritage & the Gaeltacht, with specific targets for regional and national population estimates and habitat availability (NPWS, 2014).

Corncrake conservation measures for the most part concentrated on delayed mowing and "inside-out" cutting, to avoid and minimise risks posed by silage harvesting. In more recent years, these measures have been supplemented by the creation of Early and Late Cover to provide refuge for the birds before and after meadow cover is available. Predator control has also featured in recent years, with Foxes (*Vulpes vulpes*), Mink (*Neovison vison*) and Crows (Corvidae) being targeted. The NPWS Corncrake Grant Scheme and the NPWS Farm Plan Scheme (designed by various parties including NPWS and BirdWatch Ireland) have been the primary sources of financial support for landowners to deliver conservation measures for the Corncrake. These schemes have served as useful pilots to inform the Green-Low Carbon Agri-environment Scheme (GLAS), which has a dedicated measure for Corncrake. A total area of 9,774ha has been designated in nine Special Protection Areas in accordance with the EU Bird's Directive.

Results and Discussion

While the Corncrake is known to have been very common and widespread across Ireland up to the latter half of the 20^{th} century, it was not until the Atlas of Breeding birds in Britain and Ireland (Sharrock, 1976) that a national population estimate of 4000 pairs of Corncrakes was produced. A survey by the Irish Wildbird Conservancy (IWC) in 1978 produced an estimate of 1200-1500 pairs (O'Meara, 1979). When systematic annual national survey effort began in 1993, it was clear that the Corncrake population has declined massively, with just 189 calling males recorded in the Republic of Ireland. The population at this stage was confined to four geographical regions – Donegal, West Connacht, the Shannon Callows and the Moy catchment.

Since 1993, the Corncrake populations of both the Moy Catchment (1999) and the Shannon Callows (2015) have become extinct. A dedicated agri-environment scheme in the Shannon Callows was unsuccessful in saving a population that had essentially been confined to floodplains that experienced relatively frequent summer flooding in the past decade. The Moy population was lost with increasing intensification of agriculture. The loss of these two regions has had obvious ramifications in terms of the national range and population of Corncrakes in Ireland.

However, populations in Donegal and West Connacht have experienced greater fortunes since 1993, with both having more calling males in 2014 than at any other time in that period (and consequently a 21-year high national population in 2014).

The Corncrake designations, coupled with the voluntary Corncrake Grant Scheme and the National

Parks & Wildlife Service Farm Plan Scheme have resulted in significant areas of meadows being retained until the Corncrake's breeding season has completed. In addition, the areas of Early and Late Cover created in recent years are beginning to pay dividends. For example, a 3ha area of nettles was created as ELC in Mayo held 6 calling males in 2014.

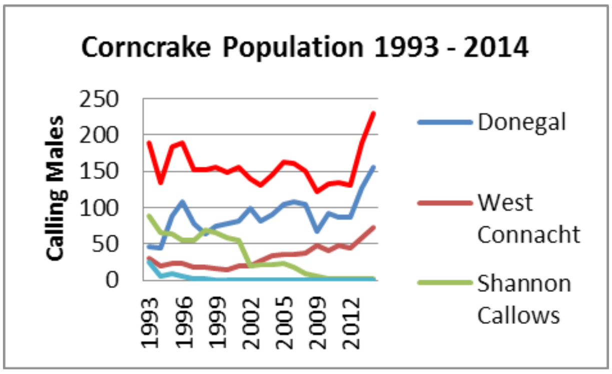


Figure 1. Corncrake Population in Ireland 1993 – 2014

Donegal is of particular note, as the population here increased more than three-fold between 1993 and 2014. The increase in Donegal has been particularly prevalent on certain offshore islands, where farming has declined. Grazing in particular has declined on a number of these islands and this has offered a greater area of cover for Corncrakes.

Conclusions

The Corncrake has long been a focal species when it comes to modern agriculture and the environment. Dedicated research and annual surveys since the early 1990s have enhanced knowledge of the species range, population and requirements, while applied conservation effort has accordingly evolved over this period.

The population in 2014 was higher than in 1993, but worryingly the population is now restricted to, essentially just two geographical regions in the West and Donegal.

While a decline in farming on certain Donegal islands appears to have been of initial benefit, there is a significant risk that a lack of management through grazing and/or mowing will result in a loss of habitat for Corncrakes when the vegetation becomes too rank and difficult to move through. This has been identified as a key issue for future conservation planning. As with many farmland species, Corncrakes require a happy medium between intensive agriculture and abandonment. While this may initially be an issue for islands, given the projected viability of many marginal farms (Hanrahan, 2014), it could also become an issue for many mainland areas that currently host Corncrakes.

The Corncrake Conservation Strategy cannot afford to stand as a once-off publication and must continually evolve as new and future issues and requirements come to light.

Acknowledgments

The landowners who manage and maintain habitat for Ireland's Corncrakes. The Corncrake fieldworkers who have surveyed and helped Corncrakes in too many ways to mention. The staff of NPWS and of BirdWatch Ireland who have campaigned for and helped formulate Corncrake conservation strategies in Ireland. Numerous members of the public who have assisted in reporting Corncrake records and who have supported conservation efforts.

References

National Parks and Wildlife Service (NPWS) and Environment and Heritage Service(EHS) (2005). All Ireland Species Action Plans.

National Parks and Wildlife Service (NPWS) (2014). A Framework for Corncrake Conservation to 2021. Dublin.

Pywell, R.F., Warman, E.A., Hulmes, L., Hulmes, S., Nuttall, P., Sparks, T.H., Critchley, C.N.R. and Sherwood, A. (2006). Effectiveness of new agri-environment schemes in providing foraging resources for bumblebees in intensively farmed landscapes. *Biol. Cons.* 129: 192-206.

Stowe, T.J., & Hudson, A.V., (1988) Corncrake studies in the. Western Isles. RSPB Conservation. Review 2: RSPB, Sandy, Beds.

Hanrahan, K., Hennessy, T., Kinsella, A., Moran, B., and Thorne, F. (2014). Farm Viability – A Teagasc National Farm Survey Analysis. http://www.teagasc.ie/publications/2014/3305/Farm_Viability_Analysis.pdf

Plant species of conservation concern have very variable coincidence with designated areas

A. Walsh[1, 3], J.A. Finn[1], M. Jebb[2], S. Waldren[3] and C. Sullivan[4]

[1]Environment Research Centre, Teagasc, Johnstown Castle, Wexford, [2]National Botanic Gardens of Ireland, Glasnevin, Dublin 9, [3]Department of Botany, Trinity College Dublin, College Green, Dublin 2, [4]Department of Environmental Science, Institute of Technology Sligo, Ash Lane, Sligo

Email: john.finn@teagasc.ie

Introduction

Global biodiversity continues to decline and of the estimated 350,000 plant species in the world, 20% are estimated to be threatened with extinction. In response, the Global Strategy for Plant Conservation has an overall objective of halting the loss of plant diversity. The principal strategy for the conservation of biodiversity to date has been to designate areas to shield biodiversity features from threatening processes. Although important, protected areas alone are not sufficient to guarantee the persistence of biodiversity, and sites outside of designated areas also contain important components of biodiversity.

We collated a number of Irish national-scale datasets of records of vascular plant distribution and used them to investigate the following questions:

- what is the coverage provided by distribution records for all recorded vascular plant species on the island of Ireland?
- to what extent does the distribution of vascular plant species of conservation concern overlap with the Irish network of designated areas?

Materials and Methods

This study examined the distribution of vascular plant species of conservation concern (including protected species) that are relevant to the island of Ireland, as well as specific categories for plants of high conservation value in the Republic of Ireland and Northern Ireland. The plant species of conservation concern were defined as those named in:

- the Flora Protection Order of Ireland
- The Northern Ireland priority species list
- The Irish Red Data Book of Vascular Plants

Records of species of conservation concern were extracted from: tetrad-scale data supplied by the Botanical Society of Britain and Ireland (BSBI); and supplemented by records of species of conservation concern extracted from rare plant inventories for the Republic of Ireland from the National Parks and Wildlife Service of Ireland (NPWS) and for Northern Ireland from the Northern Ireland Environment Agency (NIEA).

We created a geospatial data layer to map records of vascular plant species of conservation concern at the tetrad (2km x 2km) scale. We investigated the overlap of tetrads containing records of species of plants of conservation concern with designated areas. Designated areas consisted of Natura 2000 and Natural Heritage Areas boundaries for the Republic of Ireland, and Natura 2000 and Areas of Special Scientific Interest for Northern Ireland.

Results and Discussion

The plant distribution database contained 518,388 records distributed across 6773 (30%) of the 22,449 tetrads that encompass the terrestrial area of the island of Ireland (Fig. 1). These results show that the cover provided by the vascular plant data at the national scale is quite incomplete and locations of species of conservation concern may be unrecorded at the tetrad scale.

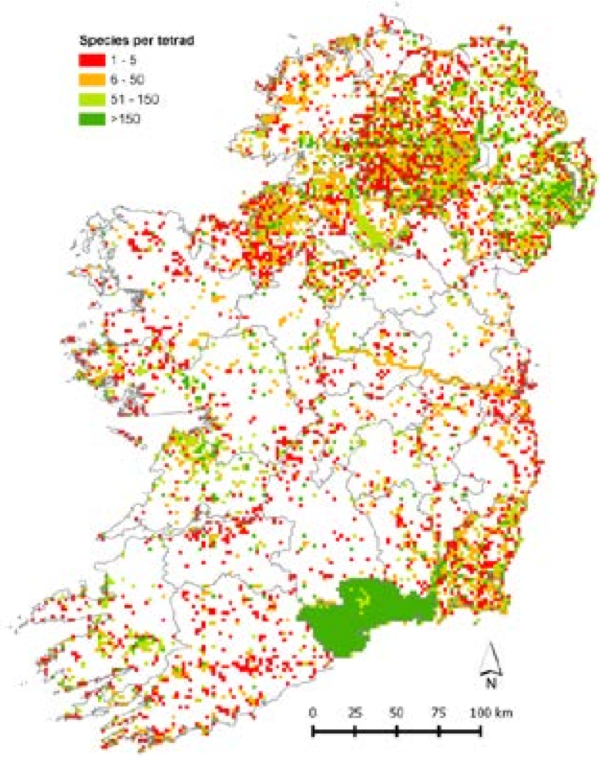


Figure. 1. The distribution of all available plant records at the tetrad scale for the island of Ireland.

On the island of Ireland, 20.6% (1394) of the tetrads with plant data contained records of Red Data Book plant species. Of those, 32.4% (452) were completely outside of the Natura 2000 designated network (Fig. 2). When national designations (Areas of Special Scientific Interest and Natural Heritage Areas) were included with the EU designations, the percentage of tetrads with Red Data Book plant species that were outside designated areas was 28.0%.

In the Republic of Ireland, 14.5% (657) of tetrads had records of Flora Protection Order plant species and 23.0% (151) of these tetrads were completely outside of Natura 2000. Tetrads containing Wildlife Protection Order and/or Priority List species in Northern Ireland accounted for 16.7% (398) of the tetrads with plant records in that region. Of these 49.5% (197) were located completely outside of the Natura 2000 network. The percentage of target tetrads outside the designated areas was reduced with the inclusion of Areas of Special Scientific Interest and Natural Heritage Areas in the analysis (see Walsh *et al*. 2015 for details).

There was considerable variation across species, both in the number of tetrads with records, and in their coincidence with designated areas (see supplementary material in Walsh *et al*. 2015).

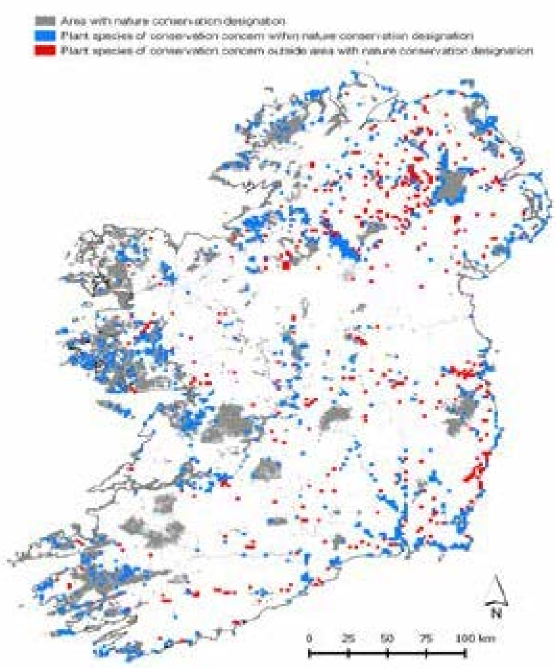


Figure 2. The distribution of tetrads that contain plant species of conservation concern in Ireland. The red tetrads illustrate locations that are conclusively outside of designated areas (and contain records of plant species of conservation concern) and the blue tetrads represent locations that coincide with designated areas.

Conclusions

A conservative estimate suggests that many tetrads with plant species of conservation concern do not overlap with designated areas (in the range of 22–40% for available records). The coincidence of records of individual species with designated areas ranged from 0% to 100% (mean = 79%). This work indicates the importance of both designated areas and the (non-designated) wider countryside for biodiversity conservation. In particular, the presence of species of conservation concern in non-designated areas highlights the need for conservation measures outside of designated areas.

Acknowledgments

We thank the National Biodiversity Data Centre of Ireland, the Botanical Society of Britain and Ireland (BSBI), the National Parks and Wildlife Service of Ireland, and the Northern Ireland Environment Agency for providing the vascular plant distribution data. In particular we thank the volunteer recorders of the BSBI and Paul Green, the vice-county recorder for Co. Waterford. This work was funded by Teagasc as part of the Walsh Fellowship Scheme.

References

Walsh, A., Finn, J.A., Jebb, M., Waldren, S. and Sullivan, C. (2015). The distribution of vascular plant species of conservation concern in Ireland, and their coincidence with designated areas. *J. Nat. Cons.* 24: 56-62.

Acknowledgement

We gratefully acknowledge financial support for this conference from Teagasc and from the IdealHNV project. IdealHNV is a collaborative research project involving Teagasc and the Institute of Technology, Sligo. The research is funded by the Department of Agriculture, Food and the Marine under the 'Stimulus Research Funding Programme' (grant award no. 11/S/108).

We are especially grateful to Sarah Lacey for all her administrative support in the weeks and months in advance of the conference. We are also grateful to Aileen Cardiff for her support in helping organise the conference. Alison Maloney provided great assistance with preparation of conference proceedings, the conference flier, and with additional website and media dissemination

We thank our keynote speakers, contributors of oral and poster presentation, and our chairpersons for sharing their knowledge and insights on the broad spectrum of topics.

Finally, we thank you, the attendees, for your engagement and contribution throughout the conference.

Contact Details:

Teagasc Crops, Environment & Land-Use Research Centre
Johnstown Castle, Co. Wexford
Tel: +353 (0) 53 9171200
Fax: +353 (0) 53 9142213
Email: daire.ohuallachain@teagasc.ie

www.teagasc.ie

Teagasc
Agriculture and Food Development Authority

Farmland Conservation with 2020 Vision

IT Sligo
An Institiúid Teicneolaíochta, Sligeach