Monitoring the environmental impacts of the Rural Environmental Protection Scheme: a scoping study

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MAIN MESSAGES

1. There is increasing policy pressure to demonstrate the environmental effectiveness of agri-environment schemes. This is necessary to satisfy EU agri-environment legislation, to demonstrate value-for-money to taxpayers, and to avoid accusations of trade distortion. This study aimed to support decision-making about the appropriate design and implementation of an environmental monitoring programme for the REPS.

2. To date, Ireland has not implemented a national-scale, comprehensive monitoring programme to measure the environmental impacts of REPS. As a consequence, the scheme is likely to get insufficient credit for its successes, and is restricted in identifying underperformance and taking corrective action. This scoping study outlines the nature and costs of measuring the environmental impact of REPS.

3. The majority of REPS payments are directed toward measures, supplementary measures and options with biodiversity objectives and these should be highest priority for monitoring.

4. Overall, the environmental monitoring of selected REPS measures, supplementary measures, biodiversity options and Measure A is estimated to cost about €3.4 million over a 4 year period.

5. The average annual budget for the monitoring programme (~€0.86m) would be less than 0.25% of the recent annual expenditure on REPS (>€360m in 2009).

6. There is a high degree of overlap of measures between REPS and the new Agri-Environment Options Scheme (AEOS) and NATURA 2000 Scheme. Thus, monitoring of selected measures and options in REPS 4 can be used to anticipate the environmental effectiveness of the new schemes. This would provide necessary information to confirm environmental benefits of effective measures, and to implement any required improvements to other measures.

7. The cost of measuring the environmental performance of agri-environment schemes should be viewed as an investment in securing the future of such schemes.

EXECUTIVE SUMMARY

This study aimed to support decision-making about the appropriate design and implementation of an environmental monitoring programme for the REPS. There is insufficient monitoring and measurement of the environmental effectiveness of agri-environment schemes. As a consequence, such schemes get insufficient credit for their successes, and are restricted in identifying underperformance and taking corrective action.

The objectives of this scoping study were to:
1. Outline the currently available evidence on environmental performance of the REPS
2. Clarify the operational issues confronting an environmental assessment
3. Present an outline of a monitoring programme for the REPS

An overview of available publications confirmed the absence of a comprehensive, national-scale study of the environmental impacts of REPS. Because of this, there is insufficient evidence with which to judge the environmental impact of the REPS as a whole. For selected measures/options, some evidence exists on their likely effectiveness.

Measurement of the environmental impacts of REPS is very different in purpose and consequence to compliance inspections. Monitoring of environmental impacts is intended to assess and learn to improve the scheme with no penalties or negative consequences for the individuals whose farms are sampled. Monitoring will require collection of farm-scale data for different basic measures, supplementary measure and options. In general, measurement of the impacts will require measurement of the environmental state over time.

The majority (about 80%) of the REPS basic payment is dedicated toward biodiversity objectives; in addition, supplementary measures and options are dominated by biodiversity issues. Thus, measurement of the effectiveness of biodiversity measures and options should be a priority for environmental monitoring.

In general, measures and options associated with highest participation were selected as priorities for environmental monitoring. Aims for the sampling of each of the measures and options are suggested. Because of the very different spatial distribution of different REPS measures, supplementary measures and options, privileged access to the Department of Agriculture, Fisheries and Food (DAFF) REPS database and e-REPS would be necessary for selection of farms and provision of relevant information. The effectiveness and cost-efficiency of the monitoring programme would be very dependent on such privileged access.

Overall, the monitoring of selected REPS measures, supplementary measures, biodiversity options and Measure A is estimated to cost about €3.4 million over a 4 year period. The budget estimates are based on Teagasc research cost conventions. The monitoring programme would need to recruit 18 different staff (eight of which would be part-time). The cost of measuring the environmental performance of REPS should be viewed as an investment in securing the future of agri-environment schemes in Ireland.

A new agri-environment scheme will take effect in 2010, and most of the proposed measures have been previously available as basic measures, supplementary measures or options in REPS 4. Thus, monitoring of the environmental impacts of REPS 4 can be used to more quickly assess the environmental effectiveness of the new Agri-Environment Options Scheme, AEOS and Natura 2000 Scheme (and any future schemes with the same measures). This would provide necessary information to confirm the environmental benefits of effective measures, and to identify any required improvements to other measures.

Summary of recommendations

Long-term co-ordination of research efforts should ensure that the results and details of individual research projects can be used to facilitate re-surveys.

The environmental objectives and target levels of an agri-environment scheme should be as specific as possible.

The relative priority of different environmental objectives within an agri-environment scheme should be clear.

Interactions with stakeholders should emphasise that measurement of the environmental impacts of REPS is very different in purpose and consequence to compliance inspections. The former is intended to assess the scheme and learn how to improve it, with no penalties or negative consequences for the individuals whose farms are sampled.

Monitoring effort should be preferentially directed at the measures that address the higher priority objectives.

Monitoring effort should be preferentially directed at the measures that involve greatest expenditure.

The majority of scheme payments are directed toward measures, supplementary measures and options with biodiversity objectives, and these should be highest priority for monitoring.

Different elements of the REPS scheme differ substantially in their patterns of spatial distribution and this will need to be incorporated in the strategy for site selection and sampling.

Privileged access to the REPS database will be necessary for the design and implementation of an effective and cost-efficient monitoring programme.

The results of the monitoring programme should be reported as peer-reviewed journal articles. Sufficient project resources should be allocated to ensure this.

Measurement of the environmental impacts of selected measures and options in REPS 3 and REPS 4 can be used to assess the environmental effectiveness of elements of the new Agri-Environment Options Scheme, AEOS and Natura 2000 Scheme.

As a matter of priority, new measures that may be implemented in future should have relevant baseline surveys conducted at a representative sample of sites.

INTRODUCTION

Objectives

All EU Member States are obliged to monitor and evaluate the environmental, agricultural and socio-economic impacts of their agri-environment programmes (Article 16, EC Regulation No. 746/96). Most of the recent evaluations of AESs have strongly criticised the over-reliance on data on levels of uptake and expenditure as measures of scheme performance (Court of Auditors 2000). Thus, the environmental performance of many schemes is not clearly known.

Looking to the near future, a number of different forces are aligning that will likely result in various pressures on agri-environment schemes. These include an increase in the number of EU Member States that will receive funding from the Common Agricultural Policy and Rural Development Programme, increased pressure on EU budgets, and increased pressure on the ability of individual member States to provide co-financing. In addition, the EU Court of Auditors is due to report in 2010 on its audit of the effectiveness of agri-environment schemes. Previous reports from the Court of Auditors on cross-compliance and the verifiability of agri-environment schemes have been critical and resulted in changes. The World Trade Organisation (WTO) also requires that the environmental benefits of agri-payments are clearly demonstrated, to prove that such payments are not disguised trade subsidies. One of best ways to address these various pressures is to be able to demonstrate the environmental benefits of agri-environment schemes, which highlights the need for measurement of their environmental impact.

The Rural Environmental Protection Scheme (REPS) pays farmers for the provision of environmental services. Since its inception in 1994, there has been an explicit recognition by policymakers of the need to improve the environmental impact of REPS. A variety of research projects have been undertaken that investigate the environmental effectiveness of REPS through an examination of either specific environmental measures or specific geographical areas (See Table 1). However, there has not yet been a measurement of the environmental impact of REPS at a national scale, which would help identify the environmental benefits of REPS, the specific elements of REPS that are not performing adequately, and those that are in need of improvement. Similarly, the lack of a national scale monitoring programme has hindered confirmation of the environmental benefits accruing from other elements of REPS.

The goal of this study was to support decision-making about the appropriate design and implementation of a national-scale monitoring programme for the REPS.

The objectives of this scoping study were to:
1. Outline the currently available evidence on environmental performance of the REPS
2. Clarify the operational issues confronting an environmental assessment
3. Present an outline of a monitoring programme for the REPS

Agri-environment schemes – EU perspective

Agri-environment schemes (AESs) in the EU offer payments to farmers in return for undertaking management practices (measures) that are intended to maintain, enhance or restore the rural environment (EC 2005). Between 1992 and 2003, about €23 billion was spent on AE schemes in EU-15 countries. Achieving and evaluating the environmental effectiveness of agri-environmental policy is becoming increasingly important in order to satisfy EU agri-environmental legislation, to demonstrate value-for-money to taxpayers, and to avoid accusations of trade distortion.

Summary reports on agri-environment policy evaluation have concluded that there has been insufficient measurement of the precise environmental outcomes from agri-environment schemes (European Commission 1998, DG Agriculture 2004). In practice, previous

evaluation systems have concentrated on administrative issues such as: statements of the aims of the policy programme, the levels of farmer participation, budgetary considerations, administrative structures, the extent of geographical targeting, obligations of participation and the levels of provision and support from extension services. Measures of participation levels, such as the number and area of participating farmers and land, have been widely used to document the degree of progress made towards the achievement of particular policy objectives. However, participation in AESs *per se* does not guarantee the actual delivery of environmental protection or improvement, and only the monitoring of actual performance and environmental outcomes can demonstrate the true value and environmental impacts of agri-environment schemes (Lee and Bradshaw, 1998).

Some research studies have shown that AESs are leading to the adoption of management practices that are expected to be beneficial to the environment (Primdahl et al., 2003). However, many schemes have been designed and implemented with little supporting evidence to allow prediction of expected environmental outcomes (Primdahl et al. in press), and there has been inadequate assessment of environmental impacts after implementation (Kleijn & Sutherland 2003). Studies are available on the impacts of AESs on natural resources and landscape (Tahvanainen et al. 2002, Rygnestad et al. 2002, Primdahl et al. 2003, Granlund et al. 2005) but the limited number of ecological studies of AESs have produced mixed results about the effectiveness of AESs in relation to biodiversity (Carey 2001, 2002, 2003, Kleijn et al. 2001, 2006, Potts et al. 2006, Wilson et al. 2007, Finn et al. 2008a, 2009).

For example, in a comprehensive review of studies that have attempted to assess the impact of European AESs on biodiversity, Kleijn and Sutherland (2003) identified a total of 62 such studies which were confined to only five of the 25 current EU states and to Switzerland. With the possible exceptions of the UK and the Netherlands, the authors concluded that 'there is a lack of research examining whether agri-environment schemes are effective' and observed that 'in the majority of studies, the research design was inadequate to assess reliably the effectiveness of schemes'. In another study, Primdahl et al. (2003) conducted interviews with 789 farmers participating in AESs across 22 case-study areas in nine EU Member States and Switzerland and with 211 non-participating farmers. Using 12 agricultural indicators, their study showed that participant farmers undertook more agri-environmental activities expected to maintain or improve environmental quality than non-participants. The study of Primdahl et al. (2003) relied mainly on nominal and ordinal scaled data, and so its authors found it difficult to quantitatively interpret the exact magnitudes of environmental effects. Nevertheless, that study identified indicators that were being commonly used across a variety of schemes and demonstrated clear and convincing evidence that agri-environmental policies had influenced the management practices of farmers in ways that would clearly be expected to have positive environmental impacts.

As evidence of its commitment to improving the environmental (and other) evaluation of Rural Development Policy measures, the European Commission has recently introduced the Common Monitoring and Evaluation Framework (European Commission, 2006). It provides a single framework for monitoring and evaluation of all rural development interventions for the programming period 2007-2013. The CMEF establishes means for improving programme performance, ensuring the accountability of programmes and allowing an assessment of the achievement of established objectives. In addition to the more generic evaluation of EU-level criteria required by the CMEF, Member States are also expected to conduct more specific evaluations that better address their particular conditions.

The Irish perspective - REPS

The Rural Environment Protection Scheme (REPS) is the agri-environment scheme implemented by the Irish Government. The stated objectives of REPS 4 are to:

- establish farming practices and production methods, which reflect the increasing concern for conservation, landscape protection and wider environmental problems;
- protect wildlife habitats and endangered species of flora and fauna, and;
- produce quality food in an extensive and environmentally friendly manner.

The REPS is now a widely adopted scheme, and provides an important financial contribution to farm incomes in Ireland. Since 2005, the Rural Environment Protection Scheme (REPS) has paid over €305 million annually to Irish farmers.

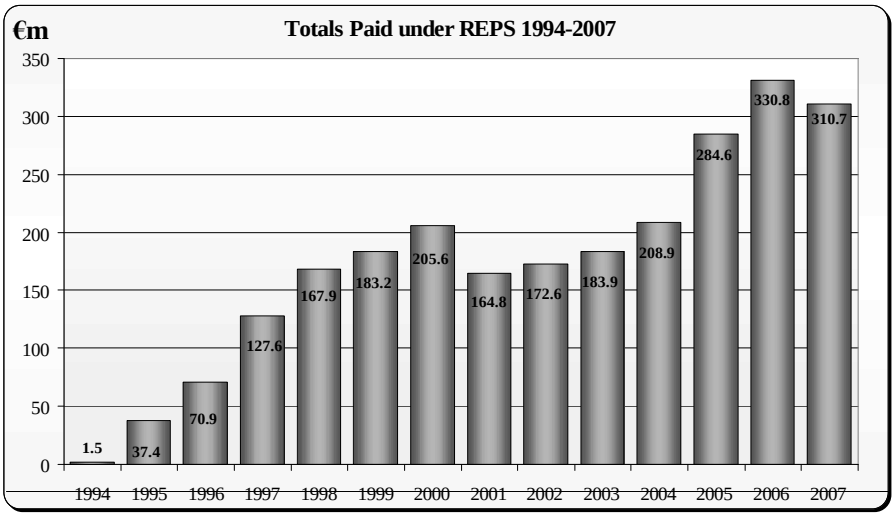


Fig. 1. REPS expenditure from 1994 to 2007 (from DAFF, 2007a).

The Teagasc National Farm Survey indicates that an estimated 48% of farms received REPS payments in 2006. The average Family Farm Income (FFI) on those farms receiving REPS at €17,713 was 13% higher than FFI of €15,744 on non-REPS farms. Over 76% of farms which participate in REPS are in the three drystock systems, 'Cattle Rearing', 'Cattle Other' and 'Mainly Sheep'. On REPS cattle farms (Cattle Rearing and Cattle Other) income was higher than on non-REPS farms with the REPS payment contributing up to 74% of the difference between FFI on REPS and Non-REPS farms in these systems. In 2006, income per farm for the Mainly Sheep system was higher on REPS farms (€15,066) than non-REPS farms (€6,647), with a difference of €8,419 (from Connolly et al., 2007).

In the first evaluation of REPS in 1999, the chapter 'Environmental impact of the REP Scheme' commented that:

> A weakness of the implementation of the REP Scheme to date has been the absence of comprehensive environmental baseline data ... this is unfortunate as it appears that the Scheme has been well designed and well promoted amongst the farming community. Instead, the evaluation has had to fall back largely on the requirements made of farmers in the individual REP Scheme plans ... there is a need for baseline data and monitoring of the Measures dealing with habitat and landscape.
>
> (DAFRD 1999, p. 52-53)

Since 1999, there have been a number of different studies of specific measures of REPS; however, there remains a strong need for national-scale monitoring to be undertaken.

A specific recommendation of the Rural Development Plan (2007-2013) is that the Department of Agriculture and Food should establish and oversee a comprehensive, integrated, environmental monitoring programme. That programme should ideally be based on a sophisticated Geographical Information System (GIS) (DAFF, 2007b). The McCarthy Report also made specific reference to REPS:

> It would be timely to conduct another in-depth value-for-money review of the scheme for the effectiveness of REPS in protecting water courses, supporting the rural environment, highlighting impacts on biodiversity particularly in sensitive regions, as well as the impact on the economy in rural areas. The outcome of the review should inform decisions on the future scope and shape of the REPS Scheme in Ireland.
>
> (McCarthy C. et al. 2009, Vol II, p. 12)

OVERVIEW OF RESEARCH STUDIES ON REPS

Table 1 lists some studies that are relevant to REPS. This list is not intended to be exhaustive, and includes published and unpublished research studies. A separate and more detailed review of evidence is underway.

Table 1. Overview of research relevant to the environmental impacts of REPS.

Relevant REPS measure	Author	Comments
Measure A farmland habitats	Dunford and Feehan 2001	Management and quality of Burren habitats
	BurrenLIFE project (unpubl.)	Management and quality of Burren habitats
	NPWS 2008	National overview of conservation status of priority habitats – most of which had 'poor' or 'bad' conservation status
	van Rensburg et al. 2009	Commonages and REPS participation (but no data on habitat quality)
	O'Rourke and Kramm 2009	Socio-economics of upland farmland and commonages in the Iveragh Peninsula, Co. Kerry.
Non-designated farmland habitats	Hickie et al. 1999, Bohnsack and Carrucan 1999, DAF, 1999, Jones et al 2003	Various reports refer to problems with habitat protection and identification.
	Aughney and Gormally 2002	Describe inadequacies in habitat identification and management.
	Gabbett and Finn 2005	Identified a desire and need for better wildlife information for REPS planners and demonstration farms.
	Copland and O'Halloran (pers. comm.)	No difference in bird diversity or density between REPS and non-REPS farms in project 'Maximising the Biodiversity Impacts of REPS'
	Egan 2007	Discussion of watercourse margins
	Hynes et al. 2008	Addressed match between the spatial distribution of REPS and land use types (but no specific data on habitat quality).
	Speight 2008	Critique of REPS 4 effects on habitats and hoverfly diversity.
Nutrient management	McEvoy 1999	Time-series comparison of investment and management characteristics of REPS and non-REPS farms.
	Hynes et al. 2008	Models based on National Farm Survey data (NFS) showed reductions in N, P and methane on REPS farms compared to non-REPS farms within NFS categories.
	Richards et al. 2007	Lower nitrate losses on REPS treatment, compared to intensive system of beef production.
Field margins	Feehan et al. 2005	No positive impact of REPS on field margin diversity
	Sheridan et al. 2008, 2009, Fritch et al. 2009	Establishment method and management have large impacts on plant and insect diversity in experimental field margins; strong negative effects of intensive grazing.
Hedgerows	Flynn 2002	Related hedgerow characteristics to birds, but limited generality due to low sample sizes.
	Copland and O'Halloran, pers. comm.	Field boundary management in REPS had little impact on bird populations
Archaeology	Sullivan 2005	Documented beneficial impacts of REPS for protection of national sites and monuments.
Assessment across multiple environmental objectives of REPS	Finn et al. 2007, 2009	Experts rated measures in REPS 2 according to different performance criteria, and estimated high variability in effectiveness of measures.
	AE-Footprint project (unpubl.)	REPS 3 farms in case study regions had higher environmental index scores than non-REPS farms (but not representative due to very low sample numbers (<50))
	Carlin et al. 2009	Experts rated supplementary measures and options in REPS 4 according to different performance criteria.
Financial effects	Connolly et al. 2005, 2007; Kinsella et al. 2007	National Farm Survey data
Others	Emerson and Egdell 1999	Comparison of scheme in Ireland and Scotland
	Emerson and Gillmor 1999	Detailed description of REPS participation
	Gorman et al. 2001	REPS and farm livelihoods
	An Taisce 2002	Detailed discussion of monitoring and evaluation
	Matthews 2002	General critique of REPS 3, with economic emphasis
	Feehan 2003	Discussion of monitoring and evaluation
	Finn 2005	General discussion of agri-environment policy and issues
	O'Connell and Harte 2006	General critique of REPS 3
	Campbell et al. 2006	Survey of public response to landscape effects of REPS
	Hynes and Hanley 2009	Economics of corncrake conservation.
	Primdahl et al. 2010	Use of impact models in selected schemes across Europe; included REPS as a case study area.
	Hynes and Garvey 2009	Factors affecting farmers participation in REPS

On the basis of these studies, a number of conclusions arise.

- There is a lack of studies conducted at a national geographical scale.
- There is a distinct lack of studies that use baseline data to compare change over time (longitudinal studies).
- There has been an emphasis on biodiversity studies, but these have had little or no co-ordination among aims, sampling methods, temporal scales or spatial scales.
- There have been surprisingly few studies on the impact of REPS on nutrient management and water quality, although available evidence is positive.
- Some evidence currently exists to guide advice/recommendations about the environmental effectiveness of selected REPS measures.

From Table 1, several research publications have been relevant to REPS, and there are some other projects from which publications are forthcoming (e.g. AgBiota, AgriBaseline and AE-Footprint). Several studies suggest problems with the identification and proper management of farmland habitats identified under Measure 4. The latter studies are generally from the earlier REPS schemes, and it is unclear if this has improved over time. In addition, it is advisable to be cautious about over-extrapolating to the national implementation of REPS from areas and surveys that are not nationally representative or have low sample sizes. Nevertheless, such studies do suggest research priorities for a larger study.

Given the absence of baseline surveys (but see McEvoy 1999, Hynes et al. 2008), the data and sites from earlier studies (Table 1) could provide a potential baseline of environmental status. By conducting future surveys in the same locations, changes in environmental status (due to REPS participation) may be assessed. Unfortunately, most studies do not contain information that allows one to identify the geographical location of the farm or the sampling site within the farm. Where possible, it is desirable in the future that agreements are reached with participant farmers in a survey that allows researchers to at least enquire about farmers' willingness to participate in a re-survey. In addition, data should be provided in a GIS format that links the spatial location of sites with data.

Recommendation

Long-term co-ordination of research efforts should ensure that the results and details of individual research projects can be used to facilitate re-surveys.

Although there seems to be relatively few Irish research projects or experiments to specifically inform the design of new agri-environment measures, there is a large body of relevant evidence available from other countries. In many (but not all) cases, this could be used to inform best practice in the design and implementation of environmentally effective measures.

Overall, there has not been a comprehensive, national-scale study of the environmental impacts of REPS in the studies conducted to date. Because of this, there is insufficient evidence with which to judge the environmental impact of the REPS as a whole. For selected measures (see Table 1), there exists sufficient information to assess individual measures, or at least learn how to improve them. For clarity, the absence of research projects and published documents does not mean that REPS has not delivered environmental benefits.

GUIDING PRINCIPLES FOR MONITORING

Ensuring the environmental effectiveness of agri-environment schemes will require a number of different approaches that include:

- using a reliable evidence base to inform the design of environmentally-effective measures and schemes (see Primdahl et al. 2010)
- design and implementation of cost-effective programmes to monitor the environmental impact of schemes on air, soil, water and biodiversity
- evaluation of environmental impacts of schemes to support decision-making and learning about what elements of AESs are effective, and which elements need to be improved.

In this section, some of the conceptual issues affecting the design and implementation of a monitoring programme are introduced.

Environmental effectiveness: terminology and concepts

The environmental effectiveness of a measure involves a judgement about whether or not the expected objectives and targets of the policy measure have been achieved (European Environment Agency 2001, Finn 2003, Lee and Bradshaw 2004). Effectiveness is therefore determined by the comparison of clearly stated objectives and quantitative targets with the magnitude of the actual effects. The difference between environmental effects and effectiveness is illustrated in Figures 2a and 2b (below). In both cases, the AE policy produces effects, but only in Fig. 2b are the effects on AES farms of sufficient magnitude to achieve the quantitative objectives and be environmentally effective. This comparison highlights how the absence of a quantitative objective makes it impossible to differentiate between an effect, and effectiveness. Note that agri-environment schemes only pay for environmental effects that exceed those associated with cross-compliance (see below).

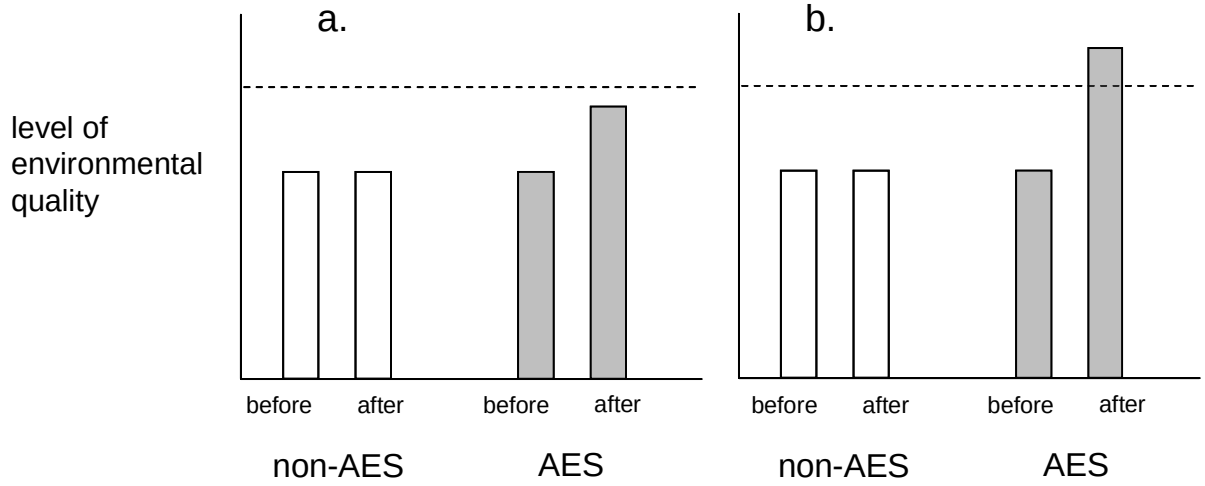


Fig. 2. Idealised comparisons of environmental quality averaged across multiple farms participating (AES) and not participating (non-AES) in an agri-environment scheme. Temporal changes within each group of farms are presented for environmental quality before and after the implementation of an agri-environment scheme. The dashed line indicates the target level of environmental quality to be achieved by the scheme objectives, and is required to justify payments (from Finn et al. 2008a).

With this definition of environmental effectiveness, any assessment of the degree of progress is seriously confounded by the absence of clarity about what is to be achieved (programme goals, environmental objectives and targets) and the absence of measurement of actual effects (environmental monitoring). Inadequate information on the relative priority of programme goals and of environmental objectives also limits the ability to collate information across multiple environmental objectives and to assess the extent to which resources are directed toward high or low priorities (Finn et al. 2009).

To this end, programme goals need to be clearly stated; note that sufficient specificity to guide the design of appropriate measures may only be apparent at the level of sub-programme goals. It is only with measurable and time-bound goals that one can assess whether the job is being done right by an agri-environment scheme. Given a variety of different goals, prioritisation of these goals (where appropriate) is necessary to ensure that money and efforts are allocated toward higher priority issues. This is especially important when resources are scarce. Such judgements about whether the right job is being done are one of the most important subjects of evaluation (see Discussion). The relative priority of environmental objectives and sub-objectives need to be clearly articulated and justified at the stage of scheme design. Geographical targeting is becoming increasingly important as a design feature of schemes, and implies spatial variation in the relative priority of environmental objectives across a region or Member State.

Recommendation

The environmental objectives and target levels of an agri-environment scheme should be as specific as possible.

Recommendation

The relative priority of different environmental objectives within an agri-environment scheme should be clear.

Monitoring aims to collect evidence and data with which to measure the environmental performance of AESs. Ultimately, evaluation aims to assess evidence (including that from monitoring) and provide judgement on the extent to which the schemes meet their environmental objectives, and are economically efficient. Currently, agri-environment schemes are officially evaluated as a measure in the Rural Development Programme, and are subject to *ex ante* evaluation, mid-term review and *ex post* evaluation.

Note that in this framework, monitoring is not the same as compliance inspection. Inspections of whether REPS farms comply with REPS regulations (which results in penalties for not doing so) are conducted by the Dept. of Agriculture, Fisheries and Food.

Recommendation

Interactions with stakeholders should emphasise that measurement of the environmental impacts of REPS is very different in purpose and consequence to compliance inspections. The former is intended to assess the scheme and learn how to improve it, with no penalties or negative consequences for the individuals whose farms are sampled.

The environmental evaluation of REPS will require a significant co-ordination and implementation of key activities.

1. Clarification of the specific environmental objectives and relevant measurable indicators for the measures to be evaluated.
2. Design of a monitoring methodology with which to record appropriate data.
3. Implementation of the monitoring methodology and recording of data.
4. Analysis of data.
5. Scientific interpretation of results.
6. Official evaluation of REPS according to formal EU evaluation procedures.

Of these six steps, Teagasc is eligible to conduct the first five. The final step, the official evaluation of REPS, must be conducted in a manner that is independent of the Dept. of Agriculture, which excludes Teagasc from doing so. In recent years, the official evaluation has been conducted by a consultancy (AFCon Management Consultants with Jim Dorgan Associates). Nevertheless, the information and results from the first five steps will be crucial for informing any official evaluation. Thus, in the same way that Teagasc can provide advice to inform policy (but does not make policy), Teagasc can also provide the results and analyses that could inform the official environmental evaluation of REPS, without Teagasc itself conducting the evaluation.

Monitoring requires farm-scale data collection

Participation in agri-environment schemes is voluntary and enrolment typically occurs at the scale of an individual farm. This is an important design feature that has strong implications for evaluation. AESs only work *via* the decisions of participating farmers to adopt (or maintain) farm management practices that are appropriate to achieve the stated environmental objectives of the scheme (Primdahl et al. 2003, 2010).

To reflect this farm-level focus of AESs, environmental monitoring needs to include farm-scale indicators and monitoring. This creates specific challenges. Although a lot of environmental data is available (e.g. water quality data at catchment scales), such data generally relate to larger spatial scales and afford insufficient resolution to attribute changes in environmental state to changes in farm-scale operations that derive from a farmer's participation in an AES.

Existing data gathering programmes, for example the Farm Accountancy Data Network in the EU, collect data that is more directed toward the financial and agricultural management of farm enterprises. However, such records are usually inadequate for anything more than a very crude measure of agri-environmental performance. Supplementing such data collection with environmental recording could improve the provision of data for agri-environmental indicators that would allow time series of the environmental performance of large samples of farms (Osterburg, 2005).

Measurements need to be repeated over time

A farmer who participates in an agri-environment scheme typically signs a contract in which all or part of their farmland is expected to either protect an existing level of medium-high environmental quality, or improve the level of environmental quality to some level that exceeds cross-compliance requirements. Where the environmental objective involves protection, then the environmental state needs to be measured at the beginning to confirm that it attains the expected medium-high level of quality, and needs to be measured over time to confirm that this level of quality does not decline (Fig. 3, top panel). Where the environmental objective involves improvement, then the environmental state needs to be measured at the beginning (to confirm the original state, and need for improvement), and over time to confirm that improvement has occurred (Fig. 3, bottom panel; see also Fig. 2 above).

Although measurements need to be repeated over time, sampling that is too frequent will waste resources if the effects are not yet apparent, whereas sampling that is too infrequent will not deliver information on the effectiveness of successful measures (or the need to modify ineffective measures). The recommended duration between successive sampling events will depend on a number of factors, but should be guided by available scientific understanding. Ideally, the justification of measures in *ex ante* evaluation would indicate the likely timescales (and lag times) over which a measurable improvement should be expected.

For some agri-environment measures, relevant changes from low to high environmental status may occur in a short duration, and persist for a long time subsequently e.g. farmyard modifications to improve storage of farmyard manure, slurry, silage runoff etc. Other measures may take a few years for the environmental benefits to be apparent e.g. establishment of hedgerows, LINNET plots, creation of new habitat, and nature corridors. Other agri-environment measures may take longer still, such as biodiversity benefits of tree planting, changes in surface- and ground-water quality, or increases in populations of rare animal and plant species.

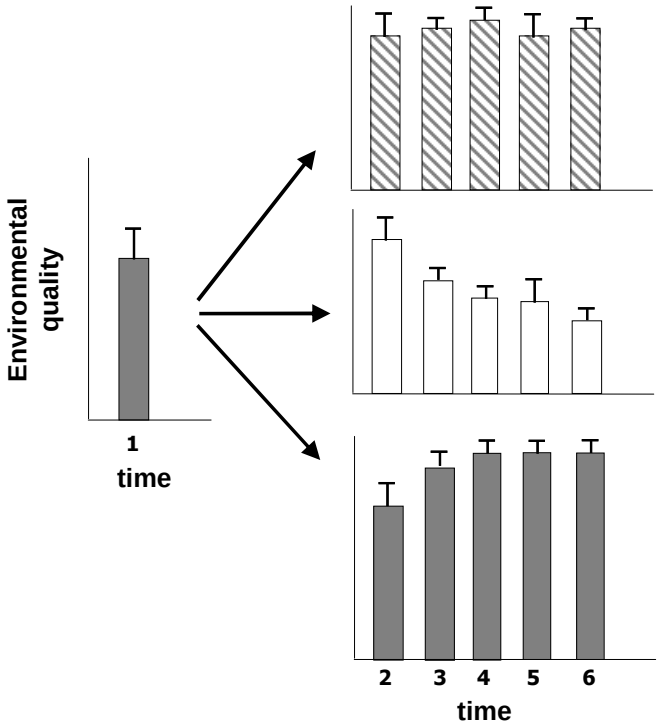


Fig. 3. Illustrated example of a large number of farms in a specified farming system that are surveyed (at time = 1, left hand side) and which may change in environmental quality over time (cf. three examples on right hand side).

Isolating the specific effects of agri-environment policy

Agri-environment schemes pay farmers for undertaking certain actions, or for making changes to their farming practices, which in turn are intended to deliver environmental benefits. This payment is predicated on the additionality of the measure i.e. the environmental benefit would not have been gained in the absence of the agri-environment scheme (the counterfactual situation). Traditionally, studies have attempted to demonstrate the additionality of scheme benefits by use of time-series comparison of similar paired sites, in which one of the pair participates in an agri-environment scheme while the other does not. This can generate the range of comparisons presented in Fig. 2. The approach is thoroughly discussed as the BACI (Before After Control Impact) method by Bro et al (2004) and Kleijn et al (2006). Such approaches are especially critical when experimentally investigating the effectiveness of a new agri-environment measure.

The use of a paired site approach is generally desirable, but may not always be necessary or appropriate. For example, when the objective is to achieve a particular environmental state that involves a change in land use (e.g. planting woodland), it seems unnecessary to confirm that a paired site does not change to woodland. What is important, however, is that there is a clear expectation about what specific biodiversity benefits will accrue from planting a small area of woodland, and that some data confirm the delivery of these benefits.

Factors affecting monitoring effort across different measures

The REPS has a multitude of different basic measures, supplementary measures and options. Here, some options are discussed that may allow measures to be prioritised for monitoring.

Relative priority of multiple objectives
Most agri-environment schemes have several simultaneous environmental objectives that can usually be categorised as natural resources (water, soil, air), biodiversity or landscape (Purvis et al. 2009), and REPS is no different. This adds to the logistical demands of

monitoring, as these different environmental objectives require different sampling methods and strategies. In addition, large differences in the relative priority of different objectives would expect to be reflected in a monitoring programme, with more monitoring effort devoted to higher priority objectives.

Recommendation

Monitoring effort should be preferentially directed at the measures that address the higher priority objectives.

Cost-expenditure

Another important factor that affects choices about the distribution of monitoring effort is cost-expenditure. All else being equal, it is preferable that more costly measures are more effective than less costly measures, especially in terms of justifying future expenditure.

Recommendation

Monitoring effort should be preferentially directed at the measures that involve greatest expenditure

Environmental impacts: confined to scheme objectives or not?

A strict interpretation of evaluation is that a policy is judged solely on the basis of whether it successfully delivers the stated environmental objectives or not. Agri-environment measures, however, can contribute environmental side-effects (known or unknown) that may have positive or negative environmental effects. Under the above strict interpretation, the occurrence of negative environmental impacts may be unrecorded (and remain unknown) or dismissed as not relevant (if known).

An alternative view, however, would consider the wider environmental consequences of delivering the policy objective. The known occurrence of positive environmental side-effects of a measure provides added-value, whereas the known occurrence of negative side-effects would diminish its value (see Fig. 4). These issues can influence decision-making about the final selection of a range of optional measures that are equivalent in their delivery of the stated objective – all else being equal, measures with greater added-value should be preferred by policymakers (from Finn et al. 2008b).

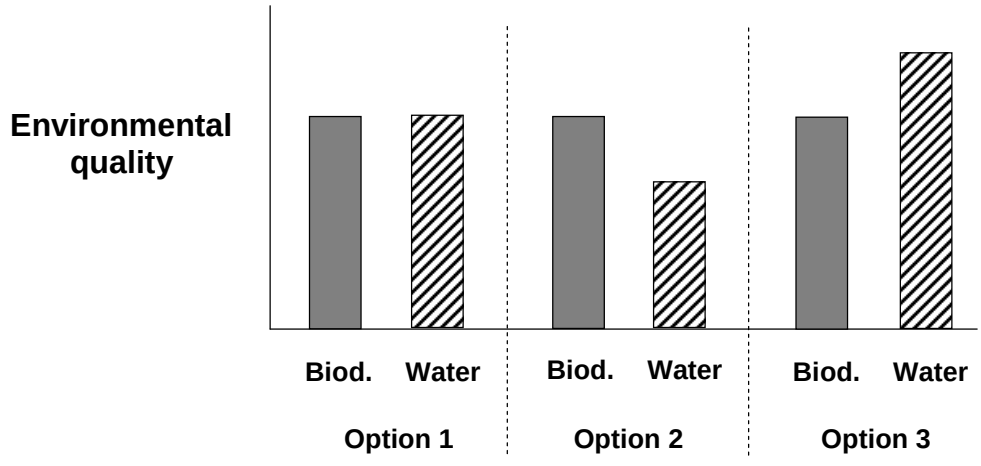


Fig. 2. Unintended effects can influence decision-making about the choice of agri-environmental measures. Consider three options for an agri-environmental measure that addresses a sole policy objective for biodiversity. (Assume that each option is of equal cost). In option 1, the required level of biodiversity is delivered, and water quality is unaffected, as indicated by the level of environmental quality. In option 2, the biodiversity measure has a negative effect on water quality. In option 3, it has a positive effect on water quality (from Finn et al., 2008b).

Selection of farms: representative samples and random selection

The environmental impacts of agri-environment schemes can be estimated from a subsample of the total number of farms. When subsampling, the question always arises: how many farms should be sampled? This will depend on the variability among farms, and the effect size to be detected at a specified level of statistical significance.

Sufficient farms need to be included so that they are representative of the national situation. Random selection of farms will be a necessary requirement. Some stratification may also be possible. For example, farm samples may be stratified to reflect the proportional breakdown of farms across different farming systems, or across different counties.

The spatial implementation of measures will also have a strong effect on the selection of farms. Mandatory measures for all (or the majority of) participating farms will probably be adequately represented by a random sample of participating farms e.g. hedgerow maintenance. However, measures that are only applicable to or eligible for some farms may not be adequately represented by a random sample of the approximately 60,000 participating farms in REPS e.g. maintenance of stone walls, national monuments. Supplementary measures and optional measures will not be adequately represented by a random sample of all participating farms e.g. biodiversity options available in REPS 4. (The exception may be some options that are very widely chosen.) Finally, some supplementary measures and optional measures may be targeted via selection criteria or geographical location e.g. species-rich grasslands, Measure A habitats, corncrake measure. Again, these will not be adequately represented by a random sample from all participating farms.

Learning to improve is not confined to learning from monitoring

A strong component of evaluation is 'learning to improve'. However, it is possible to monitor a scheme in different ways, some of which facilitate more learning than others. Monitoring of the environmental state alone may not reveal other important underlying causes of success or failure. For example, knowing that a species-rich grassland has declined from 20 species m^{-2} to 10 species m^{-2} is important, but does not reveal why the decline has occurred, which may be due to several factors that include:

- the prescribed management actions are inappropriate for species-rich grassland
- the prescribed management actions are appropriate, but have not been complied with (perhaps due to low environmental interest, and/or inadequate training)
- external factors are affecting the grassland (severe weather events, weed invasion).

The lesson here is that pinpointing the precise cause of a failure may require collection of other relevant information. For example, expert panels may be used to assist with collection of non-environmental data that may reveal other underlying causes of failure, which may be associated with institutional implementation (see Finn et al. 2007, 2009). Other such data could include attitudinal surveys of farmers to investigate whether their environmental attitudes have changed due to participation in an agri-environment scheme (Stobbelaar et al. 2009).

Agri-environment schemes are generally implemented in 5-year policy cycles, and a reliance on monitoring and *ex post* evaluation to modify and improve AESs necessarily involves a period of at least 5 years. For an ineffective scheme, this represents a significant delay before applying an effective remedy. Thus, it is very important that agri-environment schemes are well-designed before implementation, which usually requires that measures are based on scientific evidence. In a survey of agri-environment measures, more than half were based on impact models for which there was no supporting evidence available in scheme documentation (Primdahl et al. 2010). There is little doubt about the need for improved two-way communication between specialist environmental disciplines and agri-environmental decision-makers to ensure that schemes are designed in a way that reflects best scientific understanding.

Overall, learning to improve is a fundamental objective of evaluation. Learning to improve, however, requires a commitment to accepting that detection of any existing flaws is better

than allowing such flaws to persist (Redford and Taber 2000). With this approach, detection and remediation of ineffective or inefficient elements of a scheme should be an improvement that is welcomed. Across Europe, the political acceptability of improvement of schemes should be encouraged so that agri-environment schemes can evolve to learn from the past as they meet new objectives and strive for greater effectiveness and economic efficiency.

OPERATIONAL CHALLENGES AND CHOICES FOR MEASURING THE ENVIRONMENTAL BENEFITS OF REPS

Having established a number of principles that should guide the design of monitoring programmes for agri-environment schemes, this section addresses the specific application of these principles to the REPS.

The first part of this section outlines the distribution of payments across the different measures, supplementary measures and options within the REPS. The second part proposes a list of priority REPS measures and options for environmental monitoring, and indicates the broad aim of the sampling to be undertaken.

Expenditure on REPS measures and options

In the official REPS documentation there is no indication that any of the environmental objectives are more important than the other. Thus, here we explore the distribution of expenditure across different measures and environmental objectives to inform the distribution of monitoring effort across different measures and environmental objectives.

Here, the payments for individual measures (Table 2), supplementary measures (Table 2 and 3) and the main options (Table 4) are outlined. The proportion of the REPS payment that is dedicated to biodiversity is then estimated.

Table 2. Description of REPS measures and associated costs as provided in the Rural Development Plan for Ireland. Costs (per ha per annum) are based on those applicable grassland farms only (some differences in costs apply to arable farms) (DAFF, 2007b).

Measure	Cost (ha^{-1})	Measure name and description
M 1	€25	**Nutrient management planning** Protection of water resources *via* storage and application of organic and inorganic nutrients, liming, and the management of agricultural effluents and wastes.
M 2	€10.2	**Grassland management plan** Sustainable grassland management *via* control of stocking density, location and duration.
M 3	€29.3	**Protection and maintenance of watercourses, (water bodies) and wells** Protection of water resources and riparian habitats *via* 2.5 metre margins.
M 4	€21.5	**Retention of wildlife habitats** To conserve diverse habitats and their flora and fauna, any present habitats are to be conserved
M 5	€30.2	**Maintenance of farm and field boundaries** By prescribing the restoration and maintenance of old stone walls, hedges and other features, this measures also aims at preserving wildlife habitats and the visual attractiveness of the landscape.
M 6	€10	**Restricted use of pesticides and fertilisers** Watercourses and wildlife habitats are to be protected by the cessation of pesticide and fertiliser applications within 1.5m to 2m
M 7	€8	**The protection of features of historical and archaeological interest**
M 8	€0	**The maintenance and improvement of the visual appearance of farm and farmyard** Appearance of farm and farmyard in harmony with surrounding landscape.
M 9	€38.2	**Production of tillage crops (arable farmers only)** Encourages less intensive tillage production; bans burning of straw-stubble, management of animals outwintering on stubble and establishment of 3m field margin.
M 10	€4.4	**Training in environmentally friendly farming practices** Requires farmers to attend courses and open days to learn about the requirements, necessary skills and environmental benefits of REPS
M 11	€16.5	**Maintenance of farm and environmental records**
MA	€282	**The conservation and regeneration of target areas** (encompasses SACs, SPAs, NHAs, and commonage).

At an institutional level, (DAFF, Teagasc and planners) a considerable proportion of REPS activity has been allocated to nutrient management, grazing management, soil and water quality. However, the Rural Development Plan (DAFF, 2007b) clearly indicates that most of these environmental activities simply attain, or only slightly exceed, levels associated with cross compliance. For example, Measure 1 (Nutrient Management Plan) is a very prominent

measure, yet the payment of €25 (Table 2) per hectare only relates to the costs of the field-scale soil sampling and analysis, and complying with the subsequent advice from the REPS planner. The resulting restrictions on nutrient application are considered to not warrant a REPS payment for income forgone, because such restrictions are incorporated in cross-compliance.

Measure 2 (Grassland Management Plan) is another prominent activity in REPS, and is largely concerned with preventing poaching, overgrazing, soil erosion and run-off. It is associated with a payment of €10.2 per hectare (Table 2). This payment rate is justified by the provision of a core wintering period by the REPS planner, and the "additional work input by [the] farmer in managing low stock numbers over a large area" due to reduced winter stocking rates. Note that both Measures 1 and 2 have indirect biodiversity benefits, because nutrient and grassland management must be consistent with the protection of farmland habitats and aquatic biodiversity. To reiterate the main point here, Measures 1 and 2 are associated with a significant amount of activity and effort, but they generally aim to achieve cross-compliance levels and only generate a small proportion of the REPS payment.

Measures 3, 4, 5, 6 and 7 in REPS are associated with terrestrial and aquatic wildlife habitats, and a substantial payment (totalling €99 per hectare across these five measures, Table 2) is based on active management of farmland areas with the aim of protecting or actively enhancing farmland wildlife. The payment for Measure 7 (€8 per hectare) is justified in the Irish Rural Development Plan by the provision of a 20m buffer strip around historic features that retains and maintains adjacent biodiversity and is managed "in the interests of biodiversity and landscape". At least part of Measures 2, 10 and 11 have direct biodiversity commitments, so two-thirds of the payment rate for each of Measure 2 (€6.73), Measure 10 (€2.90) and Measure 11 (€10.89) is estimated to contribute to biodiversity issues.

Thus, of the total cost of €155.10 for the basic measures of REPS for grassland farmers, €119.53 is justified through measures directly aimed at farmland wildlife (M3, M4, M5, M6 and M7, and part of each of M2, M10 and M11). Including a mandatory biodiversity measure (€17/ha), and an additional payment of €30/ha (for first 20 ha) for implementation of biodiversity options results in a total payment rate of €202/ha (for first 20 ha). Thus, the biodiversity objectives in REPS directly account for at least €166.53 of the €202 flat rate payment (at least 82%). Note that there are also indirect biodiversity objectives associated with Measures 1 and 2 that are not included in the estimated value of €166.53. (For completeness, an additional payment for transaction costs brings the total payment for the basic REPS measures to €234/ha.) In summary, although different approaches might result in different specific values, the overall conclusion clearly indicates that the majority of REPS payments are associated with biodiversity objectives.

Measure A pays €282/ha for Natural Heritage Areas and commonages (including Natura 2000 sites, Special Areas for Conservation and Special Protection Areas). In 2007 alone, a total of €56 million was paid for about 337,000 ha that was eligible for Measure A payments (Table 3). The inclusion of payments for Measure A and other supplementary measures would further increase the proportion of total REPS expenditure that is allocated to biodiversity objectives.

Table 3. Area and expenditure associated with Measure A in 2007.

	REPS	Measure A	% in Measure A
Participants	54,674	15,954	29%
Area (million ha)	1.981	0.337	17%
Total paid to Measure A participants (€million)	€141.3[a]	€56.3[b]	40%

[a] includes basic REPS payment and Measure A payment for participants in Measure A
[b] payment under Measure A only
Source: DAFF (2007a).

Table 4. Uptake of supplementary measures in REPS 3 (DAFF, 2007a) and REPS 4 (2007+2008, DAFF, pers. comm.).

Code	Supplementary measure	REPS 3	REPS 4
SM1	Wild Bird Habitats	47	3
SM2	Traditional Irish Orchard	251	420
SM3	Conservation of Animal Genetic Resources	560	239
SM4	Riparian zones - Salmon/Crayfish	260	20
SM4	Riparian Habitat for Pearl Mussel	-	8
SM5	LINNET habitats	1378	147
SM6 2007	Organic Farming	773	-
SM6	Low Input Cereals	-	6
SM7	Minimum-Tillage	-	14
SM8	Traditional Sustainable Grazing	-	162
SM9	Incorporation of clover into grassland swards	-	253
SM10	Mixed Grazing	-	808
SM11	Reduced Organic N	-	1
SM11	Traditional Hay Meadows	-	1
SM11	Species Rich Grassland	-	1
SM11	Water Margin	-	0
SM11	Buffer Zones	-	0
SM11	Drink Points	-	0
SM12	Heritage Buildings	-	0

Table 5. Uptake of biodiversity options in REPS 3 (DAFF, 2007a) and REPS 4 (2007+2008, DAFF, pers. comm.).

Biodiversity option	Description*	Uptake REPS 3	Uptake REPS 4
2A	Traditional Hay Meadows	3555	447
2B	Species Rich Grassland	4388	775
2C	Use of Clover in Grassland Swards	-	3218
2D	Use of Trailing Shoe Technology	-	36
2E	Control of Invasive Species	-	35
3A	Increased Watercourse Margin	1651	131
3B	Exclude bovine access to watercourses	6361	1030
3C	Use of Planted Buffer Zones	-	0
4A	Creation of a New Habitat	14913	1694
4B	Broad Leaved Tree Planting	7568	5054
4C	Nature Corridors	17300	5022
4D	Farm Woodland Establishment	-	28
5A	Hedgerow Coppicing	13258	1244
5B	Hedgerow Laying		408
5C	New Hedgerow Establishment	15392	2594
5D	Additional Stonewall Maintenance	6178	1247
7A	Increase in Archaeological Buffer Margins	5564	1131
8A	Traditional Irish Orchards	-	52
8B	Bird and Bat Boxes	-	2956
9A	Green Cover Establishment	50+40	24
9B	Environmental Management of Setaside	455	7
9C	Increased Arable Margins	81+124	14
9D	Low Input Spring Cereals	-	2
9E	Minimum-tillage	-	24

*The names and codes are as in REPS 4, and may differ slightly to those in REPS 3.

In addition to the basic REPS measures, a number of supplementary measures and options are available, and primarily address biodiversity objectives. See Appendix 1 for payment rates associated with these measures and options. A number of other supplementary measures were available in REPS 3, and several other supplementary measures were included in REPS 4 (Table 4).

Recommendation

The majority of scheme payments are directed toward measures, supplementary measures and options with biodiversity objectives, and these should be highest priority for monitoring.

To summarise this section, although environmental objectives related to water (*via* nutrient management) and soil dominate the popular perception of REPS, these now (in REPS 4) tend to contribute little to scheme payments as they are largely consistent with cross compliance levels. The majority of the scheme payments (for basic Measures, Measure A, supplementary measures and options) are now directed toward biodiversity objectives.

Priorities for environmental monitoring

On the basis of information in Tables 2, 3, 4 and 5, the following measures and options are proposed as priorities for monitoring of the environmental impacts of REPS. For a funded monitoring programme, note that the final selection of measures and options would also require consultation with DAFF and the agency that would fund the monitoring programme (if not DAFF).

In general (but not always, see below), measures and options associated with highest participation were selected, as these generally involve greatest expenditure. Several of the measures or options are not included because they have too few participants to implement any meaningful survey of environmental impact.

There are suggested aims for the sampling of each of the measures and options. With the exception of SM5, the sampling aims in Table 6 focus on vegetation sampling. Some of the measures and options (e.g. measures 3, 4 and 5 as well as options 2A, 2B, 4A, 4B and 4C) imply benefits for fauna (invertebrates and or vertebrates). The sampling of fauna is not included here, to reduce the costs; however, demonstration of the benefits of REPS for fauna would be preferable.

Some of the measures and options warrant further comment.

Although participation in SM8 Traditional Sustainable Grazing (n=162) and SM10 Mixed Grazing (n=808) is not very high, these supplementary measures are new to REPS 4. If shown to be effective, they represent significant potential for a future agri-environment scheme to achieve biodiversity objectives in High Nature Value farmland. Similarly, there has not been high uptake of options Measure 2E Control of invasive species (n=35), Measure 9B Environmental management of setaside (n=462) and Measure 4D Farm Woodland establishment (n=28). These new options, however, also represent significant potential for a future agri-environment scheme to protect or enhance biodiversity in different types of farmland, and were included for this reason.

In the short comments in the second column of Table 6, there are a number of consistent issues that are elaborated here.

A general approach to the monitoring of measures aimed at habitats is to assess the conservation status or habitat quality of the vegetation. This could be based on either a visual assessment of the area and dominant vegetation type. For more detailed and specific assessment, quadrat sampling of the vegetation would be conducted to record the plant species and their relative abundance in the vegetation.

A habitat that currently has high conservation value may be faced with imminent threats. For example, there may be a threat from overgrazing, undergrazing, scrub encroachment or

spread of invasive species. Recording of the extent and intensity of such threats would also be important, as would be a record of the appropriateness of the management (in terms of poor management causing the threat in the first place, or good management that should ameliorate a threat).

In general, resampling after a period of implementing REPS is necessary to confirm any change in environmental status. For new measures and new entrants, there is little choice but to resample after a period of several years. However, for measures and options that have been in place in successive REPS schemes (e.g. field margins, fenced watercourses, LINNET plots) it may be possible to select farms that have implemented a measure for different time periods. Thus by selecting farmers that have participated in long-term riparian zones for 2, 5, and 10 years, one can estimate the change over time that is likely to occur to riparian zones managed according to this measure. In this way, the need (and costs) of future re-surveying of sites may be reduced. (Note that this approach does not require a baseline survey, although the availability of such data would be best.)

Note that Measure A is addressed in more detail in a following section.

Table 6. Proposed priorities for monitoring of the environmental impacts of REPS.

Measure/option	Purpose of monitoring
BASIC MEASURES	
Measure 3 Protection and maintenance of watercourses, (water bodies) and wells	It is very difficult to isolate the specific effects of REPS on inputs of nutrients and pesticides to watercourses, and this work is more suited to field experiments rather than a monitoring programme. Impacts on the riparian zone may be assessed as follows: - Assess the vegetation condition of riparian zones. Very important to establish a baseline with new/recent entrants - Can include temporal sampling of entrants to estimate temporal effects of management prescriptions
Measure 4 Farmland habitats	If possible, use sites where habitat survey work has been conducted. - Whole-farm inventory of types and spatial distribution of farmland habitats, described by visual assessment as a broad habitat type (no quadrat sampling) - Check inclusion of habitats in REPS plan - Assess appropriateness of management - Resampling over time can indicate change in habitat quality.
Measure 5 Farm and field boundaries	See options 5A/5B/5C below.
Measure 6 Restricted use of pesticides and fertilizers along watercourses	It is very difficult to isolate the specific effects of REPS on inputs of nutrients and pesticides to watercourses, and this work is more suited to field experiments rather than a monitoring programme. See Measure 3 for surveying of riparian zones. For unfenced field margins (also relevant to Measure 5), new monitoring is probably unnecessary, with sufficient research to show need for modification of prescriptions. Research on field margins has eby Teagasc Walsh Fellows (Feehan et al., 2002; Sheridan et al 2008, 2009; Fritch et al. 2009).
Measure A Conservation and regeneration of target areas	– Assessment of conservation status based on vegetation surveys – If possible, use sites with prior survey work (e.g. by NPWS) for temporal comparison. – Assess appropriateness of management – Resampling over time can indicate change in vegetation.
SUPPLEMENTARY MEASURES	
SM1 Wild Bird Habitats	Monitoring of corncrake is currently undertaken by Birdwatch Ireland. For this reason only, it does not require new monitoring.
SM2 Traditional Irish Orchards	- Conduct desk study (based on REPS database) to describe the uptake and distribution of a diversity of different apple varieties.
SM5 LINNET	*Aims to increase wild bird populations* - Measure abundance and diversity of farmland birds in LINNET plots over winter (when food is limiting) - Compare with adjacent area to confirm preferential feeding in LINNET plots
SM8 Traditional Sustainable Grazing	*Aims to maintain farming on specific habitats (Measure 4 grassland habitats) in danger of abandonment* Important to establish a baseline with new/recent entrants - Identify existing conservation value of grassland habitat *via* quadrat sampling. - Resampling over time can indicate change in plant diversity.
SM9 Clover swards	*Aims to protect water quality (via reduced need for inorganic N) and improve biodiversity* - measure clover establishment in the sward - confirm reduction in application of inorganic nitrogen - resample clover content in sward in third year after establishment

SM10	
Mixed Grazing	*Aims to maintain and increase biodiversity on grassland via mixed grazing.* - Important to establish a baseline with new/recent entrants - Identify habitat type *via* quadrat sampling of grassland. - Resampling can confirm change in biodiversity.
BIODIVERSITY OPTIONS	
2A	
Traditional hay meadows	- Identify existing conservation value of grassland habitat *via* quadrat sampling. - Assess appropriateness of management - Resampling can indicate change in plant diversity.
2B	
Species rich grassland	- Identify existing conservation value of grassland habitat *via* quadrat sampling. - Assess appropriateness of management - Resampling over time can indicate change in plant diversity.
2E	
Control of invasive species	- Identify existing conservation value of grassland habitat *via* quadrat sampling. - Identify existing level of threat by invasive species *via* quadrat sampling. - Assess appropriateness of management - Resampling can indicate change in plant diversity.
3B	
Exclude bovine access to watercourses	- Important to establish a baseline with new entrants, with assessments of water quality, bank stability and riparian vegetation.
4A	
Creation of new habitat	*Aims to create new habitat area for wildlife to flourish* - Identify composition of vegetation in selected area *via* quadrat sampling. Resampling can indicate change in plant diversity. - Identify management practices and assess appropriateness - Can include temporal sampling of entrants since 2005
4B	
Broad Leaved Tree planting	- Identify composition of vegetation in selected area for planting *via* quadrat sampling, to confirm that planting is not on habitat of conservation value
4C	
Nature corridor	*Aims to protect field margins for plant diversity and dispersal by wildlife.* - Identify composition of vegetation in selected area *via* quadrat sampling. Resampling can indicate change in plant diversity. - Appropriateness of management - measure improved dispersal by wildlife - Can include temporal sampling of entrants since 2005 i.e. a survey of the current status of the treatment area would be conducted on each of a random sample of farm areas that first participated in this measure in 2005, 2007 and 2009 (see above)
4D	
Farm Woodland establishment	- Identify composition of vegetation in selected area for planting *via* quadrat sampling, to confirm that planting is not on habitat of conservation value
5C/5A/5B	Of the hedgerow options, new planting and coppicing have very high participation levels.
Plant new hedgerows, coppicing and laying.	- Important to establish a baseline with new/recent entrants - Measure tree establishment, tree diversity, associated biodiversity
5D	
Additional stone wall maintenance	- Record moss, lichen and plant diversity of stone walls - Could compare with plant diversity on stone walls in disrepair
9B	
Environmental management of setaside	- Identify composition of vegetation in selected area *via* quadrat sampling. - Assess appropriateness of management - Resampling can indicate change in plant diversity.

Spatial considerations in selection of sites for monitoring

The REPS consists of a mixture of measures and options that differ in their method of spatial implementation. These include:

- mandatory measures for all (or the majority of) participating farms e.g. Measures 1, 2, 5, 8, 10 and 11
- measures that are only applicable to farms with relevant features e.g. Measures 3 and 6 (watercourses, wells and habitats), Measure 4 (wildlife habitats), Measure 7 (archaeological sites and monuments) and Measure 9 (tillage).
- a range of supplementary measures and optional measures from which REPS participants must choose some for implementation e.g. clover mixtures, SM3 (Genetic diversity of farm animals) and SM6 (Organic farming), LINNET. In principle, these are available to all farms but in practice any one farm would only implement a small subset of these.
- supplementary measures and optional measures that are targeted *via* selection criteria or geographical location e.g. species-rich grasslands, Measure A (designated habitats), corncrake option, SM4 (Long term set-aside by salmonid rivers) sensitive lakes and catchments.

The main point here is that the spatial distribution of measures in REPS varies considerably across the different measures and options. The rapid and effective identification of a random subsample of farms with the measure or option of interest becomes increasingly difficult for measures with either low participation rates, or spatial targeting. This will have significant impacts on the selection of sites and design of a sampling strategy. As one proceeds from the mandatory measures to the highly targeted measures and options, there is a decreasing probability of their inclusion in a random subsampling of all REPS farms (as discussed above). This is a logistical issue which can be resolved *via* automated selection procedures (see next paragraph, and text associated with Table 7).

Recommendation

Different elements of the REPS scheme differ substantially in their patterns of spatial distribution and this will need to be incorporated in the strategy for site selection and sampling.

Privileged access to the REPS database

The REPS scheme is comprised of a number of different measures, supplementary measures and option that vary widely in their patterns of spatial distribution. Thus, there is a significant increase in logistical and planning effort to design and implement corresponding monitoring programmes that differ in their method of site selection and sampling strategy. To date, research that requires selection of REPS farms has usually depended on contacting a REPS planner to forward a request for participation to their REPS clients. Even for small sample numbers (<40 farms), this method is time-consuming and cumbersome for researchers and planners, and is susceptible to selection biases. In addition, this approach is only feasible for monitoring the basic REPS measures. As one attempts to monitor REPS options or supplementary measures that are more spatially distributed, it becomes increasingly challenging (and time-consuming) to rely on personal contact with planners to determine the location of farms with specific options or measures.

An alternative is to use existing information on the DAFF database of REPS participants, and e-REPS. Presumably, this has a list of measures, options and supplementary measures that are undertaken by each REPS farm, as well as administrative details on farm location, the REPS plan, and contact details. The most effective and efficient method for selecting farms would be to use this database to assist the design and selection of farms. Using the LINNET supplementary measure as an example, the database and e-REPS could be used to:

- identify all REPS farms that have LINNET plots
- randomly select a sub-sample of 50 LINNET plots
- provide electronic access to the farm map and REPS farm plan
- to identify the specific location of the LINNET plot on the REPS farm map

- indicate the year of sowing of the LINNET plots
- provide the geographical location and address of the farm
- provide contact details to arrange a visit to the farm.

Similar information could be accessed for a range of other REPS measures and options. The use of such data would require privileged access to the REPS database, and would have to comply with the strict confidentiality that normally applies to its use. Any reporting of the research would need to guarantee anonymity for the participant farmers. Nevertheless, some form of privileged access to the REPS database would be a prerequisite for ensuring farm selection of farms that implement the chosen measures and options, incorporating any necessary stratification and randomizing the selection of farms.

Recommendation

Privileged access to the REPS database will be necessary for the design and implementation of an effective and cost-efficient monitoring programme.

PROJECT MANAGEMENT AND COST ESTIMATES

This section outlines some of the logistical and management characteristics of a monitoring programme for REPS. It provides a separate assessment of the costs of monitoring Measure A. The section concludes with a provisional estimate of the costs of a monitoring programme.

Monitoring of basic REPS measures, supplementary measures and biodiversity options

A number of priorities for environmental monitoring are indicated in Table 6.

Note that several of the measures presented as priorities in Table 6 are not included in Table 7. In most cases, this is because there is sufficient information available with which to assess performance of the current management prescription (e.g. field margins), or other studies are addressing the measure (e.g. SM1 Wild Bird Habitats). Note that some measures that aim to address water quality are not included here i.e. M3, M6 and most notably, Measure 3B (Exclude bovine access to watercourses). These issues, especially the exclusion of bovine access, are likely to be extremely important objectives in future agri-environment schemes. To address them properly will require more detailed investigation as part of field experiments (e.g. Richards et al. 2007), and they are unlikely to be adequately addressed as part of a general monitoring programme.

Based on the number of farms to be sampled, the number of people per sampling visit and the time per sampling visit, a provisional estimate is made of the person-effort required to achieve this monitoring programme (Table 7). The estimated number of 'Days per farm' is based on local travel to a farm i.e. sampling of farms in a county would require the data collectors to stay in that county for a period of weeks as they move from farm to farm. In general, two people visit a farm, which is consistent with best practice in Health and Safety.

Note that these estimates assume independent visits to farms for each measure or option. A single farm, however, may often contain two or three of the measures or options to be monitored. Every advantage should be taken of such overlap in sampling, and should be easily detected from access to the REPS plan for a farm, or a relevant query to the REPS database. Such overlap would offer some savings in time, travel and subsistence allowances. However, these might well be offset by delays due to bad weather or some underestimates in workload (particularly for fieldwork involving quadrat sampling and habitat assessments).

The indicative workload in Table 7 is based on the assumption of privileged access to the REPS database being granted. If this is not the case, then the time required to select and locate farms will escalate considerably, and very significantly increase the costs.

As mentioned earlier, the sampling aims in Table 6 focus on vegetation sampling, although some of the measures and options imply benefits for fauna (invertebrates and or vertebrates). The inclusion of relevant sampling for faunal groups is certainly possible, but would be associated with a significant increase in effort and costs. Any final decision on the design of an environmental monitoring programme would need to clarify whether measurement of fauna is required for specific measures or options.

These estimates are only for time spent conducting fieldwork, which will require just over 13 person–years (Table 7). With this level of effort, it is quite clear that a research team comprised of several people will be necessary to successfully implement a monitoring programme.

There will be many other additional and essential time commitments for the research team e.g. project planning, training, stakeholder interaction, project management, farmer liaison, data entry and analysis, financial reporting, scientific reporting, publication and dissemination.

Table 7. Indicative workload (no. of farm visits) and time requirements [no. of days per farm*number of staff per day] for fieldwork associated with sampling of selected REPS measures and options. Estimates are for environmental sampling only and assume independent visits to farms for each measure or option (which could be reduced, see text for details).

Measure/option[1]	REPS	non-REPS	Days per farm	Person-days	Person-years
Measure 3: Watercourses and wells	90	30	1	240	1.1
Measure 4: Farmland habitats	240	60	1.25	750	3.3
SM2 Traditional Irish orchards[2]	-	-	-	8	0.0
SM5 LINNET	50[3]	0	1.5	75	0.3
SM8 Traditional grazing systems	70	40	1	220	1.0
SM9 Clover swards	100	0	0.5	50	0.2
SM10 Mixed grazing	100	25	1	250	1.1
2A Traditional hay meadow	50	20	1	140	0.6
2B Species-rich grassland	100[3]	0	0.75	150	0.7
2E Control of invasive species	35	25	0.75	90	0.4
4A Creation of new habitat	70[3]	0	1	140	0.6
4B Broadleaved tree planting	80	0	0.75	60	0.3
4C Nature corridor	70[3]	0	1	140	0.6
4D Farm Woodland establishment	28	0	1	56	0.3
5C/5A New hedgerow establishment	70	40	1	220	1.0
5D Stone wall maintenance	60	35	1	190	0.8
9B Environmental management of setaside	60	30	1	180	0.8
Total	**1274**	**305**		**2959**	**13.2**

[1]Note that some REPS options and supplementary measures have the same title and activity.
[2]The counterfactual will be an area adjacent to and representative of the vegetation type prior to conversion to the REPS option or measure.
[3]Desk study

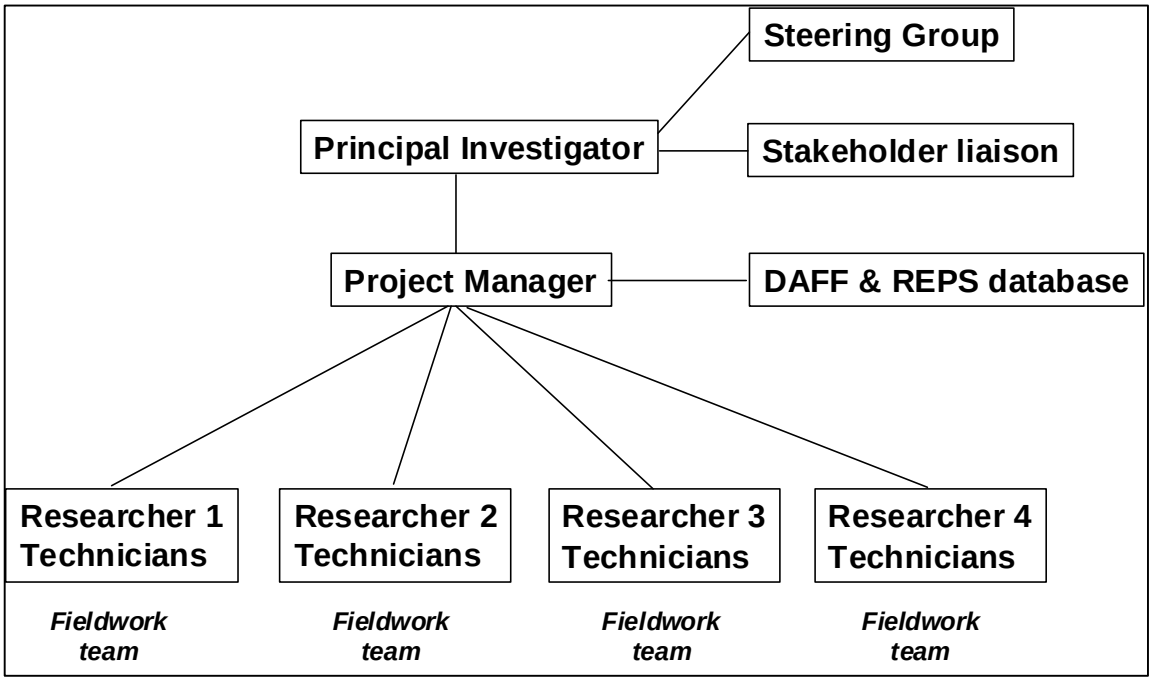
An estimate of the staff requirement is provided in Table 8. The fieldwork will be mostly conducted by the four researchers and eight technicians. Fieldwork will be largely confined to a sampling period between April and October. To minimise costs, six of the eight technician posts will be part-time, each for a duration of 7 months over years 2 and 3. Although it is desirable that the same individuals would be employed for the part-time posts in both years, it is not necessary. The technician positions will primarily require skills related to vegetation sampling and assessment. The four researchers and two of the technicians should be full-time positions to ensure that their expertise can be maintained over the different sampling seasons and for the duration of the project. In addition to having skills related to vegetation sampling and assessment, the researchers will be expected to lead each of four different sampling teams (each consisting of a researcher and technicians). The duration of two of the researcher positions will be longer (3.25 years), to assist with the project planning, logistics and training before the fieldwork begins, and to assist the data analysis and publication toward the end of the project.

Recommendation

The results of the monitoring programme should be reported as peer-reviewed journal articles. Sufficient project resources should be allocated to ensure this.

Table 8. Indicative staff requirement (person-years) for fieldwork only, as part of a monitoring programme for priority REPS measures and options.

	Year 1 year	Year 2 year	Year 3 year	Year 4 year
Principal Investigator (SRO)	0.5	1	1	1
Project Manager (RO)	0.25	1	1	1
Researcher (RO)	0.25	1	1	1
Researcher (RO)	0.25	1	1	1
Researcher (RO)	-	1	1	0.5
Researcher (RO)	-	1	1	0.5
Technician	-	1	1	0.5
Technician	-	1	1	-
Technician	-	0.6	0.6	-
Technician	-	0.6	0.6	-
Technician	-	0.6	0.6	-
Technician	-	0.6	0.6	-
Technician	-	0.6	0.6	-
Technician	-	0.6	0.6	-



The Principal Investigator will be in charge of the strategic direction and scientific co-ordination of the project, and will report to the funding agency. They will liaise with a Steering Group and stakeholders. The Principal Investigator will be responsible for the recruitment of staff, and for developing the selection criteria and sampling protocols. The Principal Investigator will be responsible for ensuring consistent practice in sampling practice, data acquisition and data storage across the four fieldwork teams. The Principal Investigator will be responsible for financial and scientific reporting, and for ensuring the publication of results in peer-reviewed journals.

The Project Manager will be primarily responsible for facilitating fieldwork by the four fieldwork teams. This will require co-operation with managers of REPS database to ensure selection of farms with the appropriate characteristics for the monitoring programme. On a day-to-day basis, the Project Manager will be an important contact point for the fieldwork

teams. The Project Manager will be responsible for liaison with farmers in advance of visits, and making requests for permission to conduct fieldwork on farms. The Project Manager will be responsible for providing the fieldwork teams with sampling locations, details of sampling objectives, and ensuring that relevant information is available (e.g. farm maps, REPS plan, contact details, etc.).

Table 9. Indicative staff costs for a monitoring programme for priority REPS measures and options, based on personnel requirements in Table 8.

	Year 1 €	Year 2 €	Year 3 €	Year 4 €	Total €
Principal Investigator (SRO)	45086	91073	93805	96619	326582
Project Manager (RO)	14488	58531	60286	62095	195400
Researcher (RO)	14488	58531	60286	62095	195400
Researcher (RO)	14488	58531	60286	62095	195400
Researcher (RO)		57951	58531	30143	146625
Researcher (RO)		57951	58531	30143	146625
Technician		39331	39724	20458	99513
Technician		39331	39724	20458	99513
Technician		23599	23835	0	47433
Technician		23599	23835	0	47433
Technician		23599	23835	0	47433
Technician		23599	23835	0	47433
Technician		23599	23835	0	47433
Technician		23599	23835	0	47433
Total	88549	602820	614181	384107	**1689656**

Costs are based on 2009 Teagasc cost conventions for Research Stimulus Fund proposals, include 11.1% superannuation, and increase by 1% per annum in years 1 and 2, and 3% per annum in years 3 and 4. Note that these costs are liable to change.

Based on a number of assumptions and estimated costs, Table 10 provides an indicative budget for achieving the monitoring outlined in Table 7.

The personnel costs are derived from Tables 8 and 9. A fixed cost of €10k per annum has been allocated to Consumables, as well as an extra 1.5k per annum for tax and insurance each vehicle (see below). This will be required for items such as software, fuel, and mobile internet connection. A modest travel budget is included for Steering Group meetings as well as conference and other travel in Years 1 and 4. A modest budget is included for any necessary training. This may be required for e.g. use of palmtops for data collection, vegetation assessment, use of GPS units and use of GIS software.

Estimates of subsistence costs in years 2 and 3 are based on a total of 2959 fieldwork person-days (from Table 7). It is assumed that for a project based in Teagasc, Johnstown Castle (where the relevant research experience in Teagasc is located), 30% of fieldwork visits will be charged at the 10-hour rate of €33.61. The remaining 70% of fieldwork visits will require overnight stays (because the majority of REPS farms are located along the west of Ireland) at €107.69 per night. Subsistence costs are mostly associated with fieldwork. Some additional subsistence costs are included for Steering Group meetings as well as conference travel in Years 1 and 4.

To reduce costs associated with mileage rates for personal vehicles, four vehicles will be purchased for use by the four fieldwork teams, at an approximate cost of €15k each. Other equipment will include fieldwork and sampling equipment, weatherproof palmtop/laptop computers for automating data collection and transfer, GPS units, and SatNav units.

Based on the above assumptions and estimates, the total estimated cost for this monitoring programme of selected REPS basic measures, supplementary measures and biodiversity options, over four years, is €2.77 million (Table 10).

Table 10. Indicative costs for a monitoring programme for priority REPS measures and options.

	Year 1 €	Year 2 €	Year 3 €	Year 4 €	Total €
Personnel†	88549	602820	614181	384107	1689656
Travel	4000	3000	3000	10000	20000
Consumables	16000	16000	16000	16000	64000
Training	10000	3000	2000	0	15000
Statistical support	5000	2500	2500	10000	20000
Subsistence	3000	126447	126447	10000	265894
Overheads*	37965	226130	229238	129032	622365
Equipment: Transport	60000	0	0	0	60000
Equipment: Other	12000	3000	3000	0	18000
Total	236513	982897	996367	559139	**2774916**

†From Table 9.
* 30% on non-equipment costs.
Note that personnel and subsistence costs are liable to change.

Monitoring of Measure A habitats

Measure A is an extremely important policy instrument for achieving the biodiversity objectives associated with the Habitats Directive, and is associated with significant payments for the management of important areas for biodiversity. REPS payments for this measure alone totaled about €57 million in 2007.

The primary purpose of monitoring Measure A habitats is to track the conservation status of the habitats over time i.e. to assess whether the conservation status is declining, staying the same, or improving. This will indicate the degree to which the management prescriptions (or their implementation) are appropriate, and assist in identifying any need for corrective action. Monitoring and reporting on such priority habitats has been the responsibility of National Parks and Wildlife Service in the Department of Environment, Heritage and Local Government (for a recent report, see NPWS 2008). The last decade has seen a substantial increase in the monitoring of Irish grasslands and habitats by NPWS, in order to complete site assessments as required for reporting commitments under the Habitats Directive (e.g. see Tubridy et al. 2006, Martin et al. 2007, NPWS 2008).

As a priority, every effort should be made to resurvey Measure A habitats for which relevés and vegetation assessments have already been made (but the resurvey should occur at least 5 years after the original survey). In this way, the original survey would serve a baseline against which to measure change in conservation status over time. This would require some co-ordination between this monitoring programme and those conducted by NPWS.

Here, a sample size of 250 REPS farms is assumed for Measure A habitats.

An indicative budget is provided in Table 13. The personnel costs are derived from Tables 11 and 12. The Consumables budget is for items such as tax, insurance, software, fuel, and mobile internet connection. A modest travel budget is included for project meetings as well as conference and other travel. A modest budget is included for any necessary training. This may be required for e.g. use of palmtops for data collection, vegetation assessment, use of GPS units and use of GIS software.

Estimates of subsistence costs are based on a total of 625 fieldwork person-days (250 farms *1.25 days per farm *2 people per farm visit). It is assumed that for a project requiring a lot of fieldwork in the west of Ireland, 30% of fieldwork visits will be charged at the +10-hour rate of €33.61. The remaining 70% of fieldwork visits will require overnight stays at €107.69 per night. This gives a total subsistence budget of 53,416 (rounded up to €54,000 in Table 13). Subsistence costs are mostly associated with fieldwork.

To reduce costs associated with mileage rates for personal vehicles, two vehicles will be purchased for use by the two fieldwork teams, at an approximate cost of €15k each. Other equipment will include fieldwork and sampling equipment, weatherproof palmtop/laptop computers for automating data collection and transfer, GPS units, and SatNav units.

Based on the above assumptions and estimates, the total estimated cost for this monitoring programme of REPS Measure A is €663k (Table 13). Fieldwork will be largely confined to a sampling period between April and October. To reduce costs, the two technician posts will be part-time for a duration of 7 months in each of years 1 and 2. The technician positions will require high-level skills related to vegetation sampling and assessment. The two researchers should be full-time positions to ensure that their expertise can be maintained over the different sampling seasons and for the duration of the project. In addition to having skills related to vegetation sampling and assessment, the researchers will be expected to lead each of two different sampling teams (each consisting of a research and technician). The researchers will be responsible for project planning, logistics and training before the fieldwork begins, and to lead the data analysis and publication toward the end of the project.

It is important to note that this element of the project could not be conducted as an independent project at this cost. The task of sampling of Measure A habitats is very dependent on the skills and management and of the wider project, especially that of the Principal Investigator and Project Manager.

Table 11. Indicative staff requirement (person-years) for a monitoring programme for REPS Measure A.

	Year 1 year	Year 2 year	Year 3 year
Researcher (RO)	1	1	0.5
Researcher (RO)	1	1	0.5
Technician	0.6	0.6	-
Technician	0.6	0.6	-

Table 12. Indicative staff costs for a monitoring programme for REPS Measure A, based on personnel requirements in Table 11.

	Year 1 €	Year 2 €	Year 3 €	Total €
Researcher (RO)	57951	58531	30143	146625
Researcher (RO)	57951	58531	30143	146625
Technician	23599	23835	-	47433
Technician	23599	23835	-	47433
Total	163099	164730	60286	**388116**

Costs are based on Teagasc cost conventions for Research Stimulus Fund proposals, include 11.1% superannuation, and increase by 1% per annum in years 1 and 2, and 3% per annum in year 3. Note that these costs are liable to change.

Table 13. Indicative costs for a monitoring programme for REPS Measure A.

	Year 1 €	Year 2 €	Year 3 €	Total €
Personnel†	163099	164730	60286	388116
Travel	2500	1000	3500	7000
Consumables	8000	8000	8000	24000
Training	2500	1500	0	4000
Statistical support	2000		2000	4000
Subsistence	25000	25000	4000	54000
Overheads*	60930	60069	23336	144335
Equipment: Transport	30000			30000
Equipment: Other	4000	1000	3000	8000
Total	298029	261299	104122	**663451**

†From Table 12.
* 30% on non-equipment costs.
Note that these costs are liable to change.

Overview of estimated budget for monitoring

Overall, the monitoring of selected REPS measures, supplementary measures, biodiversity options and Measure A is estimated to cost about €3.44 million over a four-year period (sum of costs in Table 10 and Table 13), and involve the recruitment of 18 staff (eight of which would be part-time). The budget estimates are based on Teagasc cost conventions for Research Stimulus Fund projects. (This is for example purposes only, and does not assume that Research Stimulus Fund would necessarily be the source of funding.)

The number of person-days allocated per farm are conservative, and the estimates of person-days may slightly over-estimate the time required. However, this is not unreasonable, given the likelihood of additional time being needed for liaising with farmers, coping with inclement weather conditions and working in difficult and isolated terrain.

Of course, increasing or decreasing the number of measures to be monitored will increase or decrease the overall cost, as would increasing or decreasing the number of farms to be sampled.

There are a number of cost-savings that may be achieved in both monitoring studies (Tables 10 and 13). One of the biggest potential cost-savings relates to the subsistence costs. Rather than paying overnight subsistence rates, it may be possible to undertake short-term rental of houses or apartments in a particular region until all farms in that region have been sampled. This could result in a substantial reduction in costs for *per diem* subsistence payments.

An additional and significant cost-saving may be achieved by subcontracting a proportion of the fieldwork to one or more environmental consultancies with relevant fieldwork expertise. This would have the advantage of reducing delays due to recruitment, reducing the total number of project staff to be provided with office facilities (which would be significant). It would also reduce the need for training. Subcontracted work would not be eligible for receipt of overheads (using the Research Stimulus Fund budget model), which would also reduce the total cost.

Note that a major assumption underpinning these cost estimates is the provision of privileged access to the REPS database. If this is not possible, then the costs will increase significantly.

Finally, these cost estimates are intended to be indicative only. However, the costs are clearly outlined, and the effects of changes to particular cost headings can be readily estimated.

DISCUSSION

Doing the right job *versus* doing the job right

Ultimately, it is only by their contribution to national-scale priority issues that the success of agri-environment schemes can be judged. It is important to point out that monitoring of implemented measures can only assess the extent to which measures fulfil their immediate objectives for each individual measure; it is the role of evaluation to conduct an overarching judgement of whether the initial choice of measures was appropriate to achieve the objectives of a scheme, and that the scheme objectives themselves address national priorities for e.g. biodiversity, water quality and mitigation of climate change. This is the distinction between doing the right job and doing the job right, which contrasts strategic decision-making (that informs task selection) with the proper execution of tasks.

The decision-making and prioritization process that leads to the identification of programme goals (the right job to be done) is of paramount importance. For an environmental issue such as biodiversity, such goals might be expected to reflect policy priorities for e.g. Biodiversity Action Plans, Ireland's National Biodiversity Plan (www.npws.ie), the National Strategy for Plant Conservation (www.botanicgardens.ie/gspc/inspc.htm) and the Rural Development Programme. Such policies and appropriate consultation should guide the prioritisation of different types of biodiversity that include:

- priority habitats that occur on Natura 2000 sites;
- priority habitats that occur outside of Natura 2000 sites;
- rare and threatened species that are named in e.g. Red Data Books;
- other rare and threatened species;
- species that are declining, but are not yet rare or threatened;
- common farmland habitats;
- common farmland species;
- creation of farmland habitat to support named species;
- creation of common farmland habitats.

Costs and payments

The calculation of payments for measures is based on income foregone and also includes payment for farmers' transaction costs. These private transaction costs include a farmer's time that is spent searching and processing information that informs decision-making about whether to enter a scheme or not, as well as the costs involved in getting professional advice or planning services. After participating in a scheme, there are also costs incurred in the implementation of a contract, which include the time for training, learning new practices and administration. There may also need to be investments to properly implement the contract, and of course there is income foregone due to decreased output of market products.

In addition to other factors, transaction costs can have a large impact on the decision of farmers to participate in a scheme or not. Presumably, where there is choice from a list of different options, it is likely that farmers will choose those options that maximize their profitability.

A detailed discussion of transaction costs and a methodology for estimation of farmers' private transaction costs is provided by Mettepenningen et al. (2007) and Mettepenningen et al. (2009). They describe a follow-up approach that requires farmers to record their labour, costs and revenues associated with an area of land under contract, and a comparable area that is not under contract. This method is particularly appropriate for delivering detailed and high quality information on small numbers of measures that are suspected to have a mismatch between costs and payment rates. The approach is relatively time-intensive and costly, and the project costs were estimated at about €360

per participating farmer (farmers participated on a voluntary basis), and could involve small groups of farmers (20-30). The study also included a more general survey of farmers' perceptions of transaction costs. This had the advantage of being easier to implement on a larger scale, easier to respond to, and cheaper. However, the information may be of lower quality.

Thus, it is important that the calculations of income foregone and transaction costs are accurate, so that payment rates for some measures are not perceived as being economically disadvantageous compared to other measures. Otherwise, the choice of measures is likely to be unduly influenced by perceived profitability rather than environmental merit. Looking at the distribution of participation among the measures and options (Tables 4 and 5), it is clear that some are more favoured than others. One of several possible reasons for this may be that the payment level for some measures is insufficient to cover the costs associated with both income foregone and transaction costs, although other reasons are possible.

Looking to the future

As this report was being finalised, the Minister for Agriculture announced the closure of REPS 4 to new entrants (July 2009). However, there will continue to be a significant number of REPS 4 participants (and associated expenditure) up to 2013.

A new agri-environment scheme (Agri-Environment Options Scheme, AEOS, and the Natura 2000 Scheme) will take effect in 2010. Most of proposed measures have been previously available as basic measures, supplementary measures or options in REPS 3 or 4. The new scheme will not be a whole-farm scheme. The approach described here could be easily applied to estimate the cost of monitoring the measure environmental effects of the AEOS.

There is considerable overlap between the REPS measures and options that were prioritised for monitoring by this study (Table 6), and those included in the AEOS (and Natura 2000 scheme) (Table 14). Thus, environmental assessment of the environmental impacts of REPS 3 and REPS 4 can be used to more quickly assess the environmental effectiveness of measures in the proposed new agri-environment scheme. This would provide necessary information to confirm the environmental benefits of effective measures, and to identify any required improvements to other measures. (Note that some care is required in this approach, as a specific measure that is implemented with several other measures on a whole-farm basis may appear to have a greater environmental effect than if it is implemented in isolation on part of a farm.) Monitoring of REPS 4 could investigate whether some of the existing REPS measures or options not included in the proposed new scheme may actually be very beneficial, and could be used as justification for their future inclusion in an agri-environment scheme.

Revisions of the AEOS may include new measures that have not been included in previous REPS schemes. The effectiveness of such measures should be investigated as soon as possible, and should include baseline surveys so that the environmental effects of new measures can be measured over time.

Recommendations

Measurement of the environmental impacts of selected measures and options in REPS 3 and REPS 4 can be used to assess the environmental effectiveness of elements of the new Agri-Environment Options Scheme, AEOS and Natura 2000 Scheme.

As a matter of priority, new measures that may be implemented in the proposed new agri-environment scheme should have relevant baseline surveys conducted at a representative sample of participant farms.

Table 14. List of actions available in the Agri-Environment Options Scheme (AEOS) and the Natura 2000 Scheme.

Actions	Minimum Requirement
Natura 2000 Land	All Natura land on the farm must be included even where this exceeds the maximum area for payment of €5,000.
1. Commonage land outside Natura 2000	All commonage land on the farm must be included even where this exceeds the maximum payment of €5,000.
2. Establishment and Maintenance of Habitats	2.5metre margin be delivered on a LPIS parcel boundary basis
3. Tree planting	Standard: Minimum of 10 trees to apply Whips: Minimum of 25 to apply
4. Traditional hay meadows	Undertaking to be delivered on whole LPIS parcel basis
5. Species-rich grassland	Undertaking to be delivered on whole LPIS parcel basis
6. Conservation of Animal Genetic Resources	No minimum.
7. Traditional Orchards	Limit to one orchard per farm (minimum of 10 trees).
8. Wild Bird Cover	Undertaking be delivered on whole LPIS parcel basis; minimum area 0.5 hectares
9. Planting new hedgerows	Minimum continuous length of 30 metres
10. Coppicing of hedgerows	Minimum continuous length of 30 metres
11. Laying hedgerows	Minimum continuous length of 15 metres
12. Traditional Stone wall maintenance	No minimum
13. Riparian Margins	No minimum
14. Water trough installation	No minimum
15. Arable margins	3 metre margin be delivered on a LPIS parcel boundary basis
16. Green Cover Establishment from a sown crop	Minimum of 2 hectares
17. Use of new technologies for slurry spreading	Minimum of 100m^3 slurry applied
18. Minimum Tillage	Minimum of 2 hectares

From: DAFF (2010) Terms and Conditions of the (AEOS) and the NATURA 2000 SCHEME.

Concluding remarks

Across the EU, agri-environment schemes have been criticised for not sufficiently monitoring the resulting environmental impacts, which is the first step in demonstrating the environmental benefits that occur, and learning how to improve measures that are not as effective as intended. This study aimed to support decision-making about the appropriate design and implementation of an environmental monitoring programme for the REPS. The general approach provided here may also assist the design and costing of an environmental monitoring programme for the new agri-environment scheme that is expected to begin in 2010.

This report outlines a framework for a monitoring programme for REPS, and an indicative cost of such a programme. Note that several measures and options require resampling over time to confirm either maintenance of high environmental quality, or improvement in environmental quality (see Table 6). This study only addresses the costs of the initial sampling programme; however, the costs of subsequent resampling surveys should be lower.

As indicated in this study, the design of a programme to measure the environmental effects of an agri-environment scheme will require multiple strategic choices (in addition to the logistical choices). Such choices will require clear decisions about: the relative priority of the different environmental objectives addressed by REPS; the relative financial importance of difference measures and options, and; the identity and scope of

environmental impacts intended by different measures and options. Such issues may well invoke difficult and probing discussions about the purpose and method of measures and options; however, clarity about such issues is essential for an effective programme to measure environmental performance.

Under the assumptions of this study, the costs associated with measuring the environmental impacts of REPS (~€0.86m per annum for four years) are very small (less than 0.25%) in comparison to the value of these schemes to farm and other rural livelihoods (over €360m in 2009). More than ever before, the cost of measuring the environmental performance of REPS should be viewed as an investment in securing the future of these schemes, their contribution to public goods for society and their contribution to rural livelihoods.

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APPENDIX 1

Payment rates for supplementary measures (DAFF 2007b).

Supplementary measure	Description	Payment rates
SM1	Wild Bird Habitats	€100/ha
SM2	Orchard	€300 per orchard
SM3	Rare Breeds	€234 /LU
SM4	Riparian Habitats	€ 850/ha
SM5	LINNET	€700 up to 1ha; max = €1300
SM6	Organic Farming (2007)	€ 7/ha
SM6	Low Input Cereals	€370/ha, max = €925
SM7	Minimum Tillage	€ 7/ha
SM8	Traditional Grazing	€50/ha, max = €1000
SM9	Clover	€30/ha, max = €1200
SM10	Mixed Grazing	€50/ha, max = €1000
SM11	Reduced Organic N	€80-120/ha
SM11	Traditional Hay Meadows	€ 120/ha
SM11	Species Rich Grassland	€ 120/ha
SM11	Water Margin	€ 3/100m
SM11	Buffer Zones	€ 200/0.2ha
SM11	Drink Points	€ 5/ha
SM12	Heritage Buildings	€ 7/ha

Payment rates for biodiversity options (DAFF 2007b).

Biodiversity option	Description	Payment rate
2A	Traditional Hay Meadows	€ 7/ha
2B	Species Rich Grassland	€ 7/ha
2C	Use of Clover in Grassland Swards	€23/ha
2D	Use of Trailing Shoe Technology	€10/ha
2E	Control of Invasive Species	€12/ha
3A	Increased Watercourse Margin	€8/ha
3B	Exclude bovine access to watercourses	€5/ha
3C	Use of Planted Buffer Zones	€8.5/ha
4A	Creation of a New Habitat	€23/ha
4B	Broad Leaved Tree Planting	€13/ha
4C	Nature Corridors	€9/ha
4D	Farm Woodland Establishment	€23/ha
5A	Hedgerow Coppicing	€31.5/ha
5B	Hedgerow Laying	€30/ha
5C	New Hedgerow Establishment	€32/ha
5D	Additional Stonewall Maintenance	€23/ha
7A	Increase in Archaeological Buffer Margins	€10/ha
8A	Traditional Irish Orchards	€22/ha or €11/ha
8B	Bird and Bat Boxes	€11/ha
9A	Green Cover Establishment	€25/ha
9B	Environmental Management of Setaside	€23/ha
9C	Increased Arable Margins	€23/ha
9D	Low Input Spring Cereals	€37/ha
9E	Minimum-tillage	€23/ha

The names and codes are as in REPS 4, and may differ slightly to those in REPS 3.