CREW
centre of expertise for waters

Report on workshop on strategies to assess effectiveness of diffuse pollution mitigation policy in Scotland.

Final Report

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The James Hutton Institute

UNIVERSITY OF STIRLING

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Centre of Expertise for Waters (CREW)

CREW is a hub which ensures that water research and expertise is available and accessible to the Scottish Government and its agencies. This is designed to ensure that existing and new research and expertise can feed into the development of water related policy in Scotland in a timely and effective manner.

CREW Management

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Executive Summary

Project reference:
Diffuse Pollution Management, December 2011

Project contractors:
Andy Vinten, JHI
David Oliver, University of Stirling

Summary:

There is a need for ongoing review and advice on the technical effectiveness of measures to mitigate diffuse pollution and the effectiveness of the policy to deliver them. The Scottish Government needs support on understanding how to better spend across these measures, to get the most value. The aims of the day were to update on available data on effectiveness of existing measures, to review strategies for assessing effectiveness and uptake of measures and to identify potential measures that could be supported in the future. In the **morning session (see Section 4)**, there were five presentations by key stakeholders (SEPA, NFUS, RSPB) and catchment researchers (JHI, Univ. Stirling) followed by discussion. In the afternoon, two parallel workshops were held. **Workshop A** (**see section 5**) aimed to identify impact indicators for measures that affect water quality, with a focus on those funded by the Scottish Government Rural Priorities fund. **Workshop B (see section 5)** aimed to develop effective approaches to achieving compliance with diffuse pollution regulations, with a focus on the General Binding Rules. A **field visit** to the Lunan Diffuse Pollution Monitoring Catchment (DPMC) was arranged for the following day to familiarize stakeholders with a variety of regulatory, funded and voluntary measures going on in this catchment.

Key points from the morning session included:

1. In priority catchments over 5000 non compliances with the general binding rules element of the Controlled Activities regulations (2008) were found over 5000 km of riparian zone surveys. Feedback on this, and on good practice observed, has been given to farmers.
2. Multiple benefits of land management including food security and sustaining economic growth need to be balanced with environmental issues.
3. The current SRDP spend for agri-environment measures is not particularly well targeted to water quality, but better targeted towards biodiversity benefits.

Key points from the afternoon session included:

1. Impact indicators need to consider biophysical processes and include metrics on uptake; the WFD- or farm- to catchment-scale is most appropriate; they should be used to attribute change in WQ to measures, quantitatively if possible.
2. Measures most regarded as cost-effective for improving water quality are: water margins for diffuse pollution, retention of winter stubbles, livestock tracks and gates and management of wetlands.
3. Proposing practical ways for assessing the impacts of measures on improving the phosphorus status of rivers and lochs was found to be difficult. Effectiveness depends on local conditions and scale. Proposals for assessing impacts relied heavily on monitoring. Accounting for the level of uptake of the measures was considered useful.
4. There was very positive discussion about the role of demonstration farms in cementing ideas about compliance and win-win messages. Their advantages with regard to the multiplier effect of endorsement by a group community were also highlighted and are very important for providing weight to management options and strategies being seen as legitimate in the eyes of the farming community.
5. Regarding CAP reform and farm payments, farmers can be 'penalized' financially for what they have already done if multiple benefits are sought as later opportunities reap no financial reward. This highlighted a clear mindset that it was often more beneficial to farming communities to wait a while and apply for future benefits rather than achieve multiple benefits in a single transaction.
6. An individual exercise to provide a cognitive map of their understanding/beliefs/perceptions surrounding farmer compliance with GBRs showed that the concept-group 'policy' has its main influences or impacts on the groups *farm economy management* and *attitude and knowledge*; only a little on *natural resources* group and none what so ever on *practical farming* concept group.

List of attendees and workshop timetable

Sarah Hutcheon	SNH
Alison Reeves	University of Dundee
Joyce Carr	Scottish Government
Linda May	CEH Edinburgh
Brian McCreadie	SEPA
Amy Corrigan	RSPB
Fiona Napier	SEPA
Stephen Field	SEPA
Jannette MacDonald	SEPA
Ben Bickle	Scottish Water
Lisa Webb	RSPB
Jonathan Bowes	SEPA
Andrew Bauer	NFUS
Bill Crooks	SAC
Willie Campbell	Low Holehouse farm, Ayrshire
Ben Christen	Univ Aarhus, Denmark
Kit Macleod	JHI
Sarah Dunn	JHI
Marc Stutter	JHI
Julia Martin Ortega	JHI
James Sample	JHI
Julian Dawson	JHI
Leah Jackson Blake	JHI
David Oliver	University of Stirling (co-organiser)
Andy Vinten	JHI (co-organiser)

11:00-13:00 Morning Plenary session (the main points are summarised in Table 1).

11:00 Introduction (Andy Vinten/Kit Macleod, James Hutton Institute)

11:10 The Rural Diffuse Pollution Plan for Scotland (Jannette Macdonald, SEPA)

11:30 Assessing effectiveness of measures in the Scottish diffuse pollution monitored catchments (Andy Vinten, JHI)

11:50 Prioritisation and siting of measures: engaging farmers (David Oliver, University of Stirling)

12:10 NFUS perspectives on the diffuse pollution plan (Andrew Bauer, NFUS).

12:30 The likely environmental impacts of SRDP (Amy Corrigan, RSPB).

12:50 Discussion

14:00 – 15:45 Afternoon Workshops

Workshop A. Aim: To identify impact indicators for measures that affect water quality, with a focus on those funded by the Scottish Government Rural Priorities fund (facilitated by Andy Vinten, Leah Jackson-Blake and Julia Martin Ortega).

Workshop B. Aim: To develop effective approaches to achieving compliance with diffuse pollution regulations, with a focus on the General Binding Rules (facilitated by David Oliver and Ben Kristen, Univ. Aarhus).

15:45 -16:30 Afternoon Plenary session

Workshop group reporting, round up discussion and conclusions.

Friday 4th November. Field visit to Lunan Diffuse Pollution monitoring catchment

Speaker	Title	Key points	Questions
Jannette Macdonald (SEPA)	**The Rural Diffuse Pollution Plan for Scotland http://www.sepa.org.uk/water/river_basin_planning/diffuse_pollution_mag.aspx**	A package of guidance (codes of practice, PLANET nutrient management tool, demo. farms ,voluntary initiative) as well as SRDP funded and regulatory measures(especially the general binding rules for diffuse pollution control) are available. These are being implemented through a combined national and priority catchment approach based on sound science In priority catchments >5000 GBR non compliances found over 5000km of riparian zone surveys. Feedback on these and on good practice examples have been given to farmers.	Should delay in ecological response affect cost effectiveness analysis? No, as a first step and we do not fully understand delays. In second cycle we may want to explore this if current measures are not delivering improvements, Do we need to include assessments of multiple benefits? Yes.
Andy Vinten (JHI)	**Assessing effectiveness of measures in the Scottish diffuse pollution monitored catchments**	Can use catchment and measure scale monitoring and modelling to assess effectiveness. Highlighted the detailed steps that may be required to assess effectiveness of one or more measures/GBRs.	Need to look at water bodies in addition to land management example of adding Roach altered food web
David Oliver (University of Stirling)	**Prioritisation and siting of measures: engaging farmers**	Understanding obstacles to farmer so they reduce the transfer of hazards to water is key. Spatial assessment of problem areas. Need to integrate participatory and analytical processes. Need to be aware of the different perceptions on the impact of land based management on water bodies.	The transaction costs for this type of research are very high. The information farmers give you can alter based on their level of trust of you.
Andrew Bauer NFUS	**NFUS perspectives on the diffuse pollution plan**	Multiple benefits of land management including food security and sustaining economic growth need to be balanced with environmental issues. The apparent gap between science and farmer experience needs to be addressed. Approach needs to be spatially aware.	Discussion on the relative regulatory burden on farmers compared to similar sized enterprises. Paperwork is challenging from a farmers perspective on top of long hours. Simple but effective solutions e.g. GBRs are seen as being very effective and make convincing farmers of their use easier.
Amy Corrigan RSPB	**The likely environmental impacts of SRDP**	Valuable study of what has been spent where, combined with interviews. 2008-2010: £400mspent over 5500 cases Highest spend options are Restructuring agri-business, Woodland creation – native woodland, Hedgerows – 3 yrs biodiversity benefit, Open grazed grassland for wildlife, Diversification out with agriculture . Spend targeted at DP is low. Need to improve	

		and remove funding from applications process as RP arms race occurs. Strong differences in spends between regions (More in NE)	
General discussion	• Paperwork is complex, is there a way to simplify it? • What can we learn from Nitrate Vulnerable Zones? • How to optimize what farmers do for multiple benefits? • Farmers do see themselves as stewards of the countryside but challenge is the multiple demands on them. • Land use strategy may help. • From a research perspective need to understand what is important, and appropriateness of current approaches, especially when an approach has been developed for one particular spatial scale e.g. national. • Pressure to set up what we know works and the longer term science.		

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Introduction

CREW

Scottish Government (SG) is funding the development of a **Centre for Expertise for Waters (CREW).** This initiative is led by the James Hutton Institute (JHI) which, in collaboration with Higher Education Institutions (HEIs) will take forward a series of knowledge exchange projects agreed with SG and designed to support specific policy objectives. Topics of projects funded include: Natural Flood Management; River Functioning and Resilience; Diffuse Pollution Management; Coastal Flooding, Mapping of Climate Change on Water Demand-Supply Deficits in Scotland; Integrated Catchment Management Planning; and Water, Health and Well-being. More information on CREW can be found on the website: http://www.crew.ac.uk/

CREW-DP

The SG has legislated through the Controlled Activities Regulations (CAR) 2008 to mitigate diffuse pollution (e.g. by establishing a set of General Binding Rules), and requirements for Good Agricultural and Environmental Conditions (GAEC) for single farm payments; it has also promoted voluntary codes of good farming practice such as Prevention of Pollution from Agricultural Activity (PEPFAA), the Four point plan, and the Voluntary Initiative; it also provides financial support through the SRDP and Land Management Options for measures that enhance biodiversity, and some measures that help to control diffuse pollution. There is a need expressed by the SG policy unit, for ongoing review and advice with respect to these measures, and the development of new measures and policy instruments to deliver them. The Rural Diffuse Pollution Plan for Scotland describes Scotland's first national approach to improving water quality by reducing diffuse pollution. A statutory stakeholder group, the Diffuse Pollution Management Advisory Group (DPMAG) has been established to deliver this plan.

The CREW-DP project has been funded to support:

(1) Awareness raising with SG, SEPA, DEFRA and other stakeholders, about existing monitoring and diffuse pollution control efforts (on Diffuse Pollution Monitoring Catchments and elsewhere) through appropriate field visits,
(2) **Engagement** with SEPA's Diffuse Pollution Management Advisory Group (DPMAG) re. approaches to assessment of effectiveness in the priority catchments.

As part of this delivery the James Hutton Institute, assisted by the division of Biological and Environmental Sciences, University of Stirling, hosted a workshop on strategies to assess effectiveness of diffuse pollution mitigation policy in Scotland.

Report on Workshop A:

Assessing impact of existing procedures on water quality

Aim of the workshop: To identify impact indicators for measures that affect water quality, with a focus on those funded by the Scottish Government Rural Priorities fund.

Background

The EU common monitoring and evaluation framework (CMEF) is designed to report on financial execution, outputs, results and impacts of rural development programmes. Impact indicators are used to measure longer term socio-economic and environmental effects for rural development policy established at programme level. The indicators relevant to agri-environment are: reversal in biodiversity decline, trends in farmland bird populations, maintenance of high nature value farmland and forestry and improvement in water quality. It has been noted that environmental benefits of agri-environment payments are unclear, that little targeting occurs, and the evidence base is weak. In the context of water quality in Scotland, there is a need to develop post-hoc evidence based impact indicators for relevant agri-environment payments funded from 2006-2013, to assess whether these payments are well designed. This will also mean that when revision of the Scotland Rural Development Plan takes place for post 2013, the measures funded have improved potential to enhance water quality, in line with the requirements of the Water Framework Directive, as set out in Scottish national and regional River Basin Plans.

Workshop A was organized into 4 activities. **Activity 1** consisted on a feedback session about general approaches to devising impact indicators (based on the morning presentations) and was done at the individual level. **Activity 2,** also individual, was focusing on prioritizing measures according to cost-effectiveness criteria for improving the phosphorus status of rivers and lochs**. Activity 3** was based on break out groups and was aimed at identifying practical ways of measuring impact. The breakout group was followed by a general group discussion. **Activity 4** consisted on a group brainstorm on potential new measures for improving water quality.

Attendees: 11 participants attended Workshop A. Affiliations were dominated by The James Hutton Institute (5 participants) and SEPA (4 participants). There was one member from CEH and one member from the RSPB. Therefore, half of the attendees were researchers, which has influenced the outcomes of the workshop (see further discussion).

Facilitators: Andy Vinten, Julia Martin-Ortega, Leah Jackson-Blake (The James Hutton Institute)

Activity 1: *Feedback session on general approaches to devising impact indicators*

part I. Participants were asked to write their answers to the following four questions on post-it notes.

1) What is an impact indicator?

The understanding of what constitutes an impact indicator for the effectiveness of measures may vary between stakeholders. Therefore we felt it was valuable to have an initial activity which explored what were the requirements for a good impact indicator. It was agreed amongst the group that, in general, an impact indicator provides some indication of the effectiveness of a measure implemented to reduce the harmful effects of diffuse pollution on water bodies.

Summary of individual participant responses:

i) Biophysical impact indicators – quantify the effect of a measure on water chemistry and/or ecology. Indicators should focus on the change (not absolute values, e.g. step-change analysis) in:
   - Chemical concentrations and loads
   - Rates of flow

- Biodiversity (e.g. focus/target species, farm bird monitoring)
- Ecological response (e.g. algae/chl-a, zooplankton, fish, aquatic plants)
- WFD classification
- Bathing Waters compliance
- Water body morphology

ii) However effective a measure is theoretically, it won't make a difference unless it is used in practice. Some measures of this might be:
    - SRDP applications and emplacement
    - Farmer level of compliance, acceptance, satisfaction
    - For some measures, reduction in fertiliser sales/application
    - Farmer attendance at awareness raising events

Some general points about choosing indicators:
- Look at the literature on what makes a good indicator
- The effectiveness of a combination of measures does not equal the sum of its parts, i.e. there is a need to quantify both the effectiveness of single measures, and to understand how measures interact.

2) What level of detail should an impact indicator have?

A number of participants highlighted that the level of detail required depends on the spatial scale the impact indicator is to be used at. A range of detail levels may then be needed, depending on the scale of interest, e.g. when looking at water body biophysical attributes:

- National/international scale: annual averages
- Regional scale: annual or seasonal averages
- Catchment scale: seasonal or monthly averages
- Farm to sub-catchment scale: Daily to monthly averages

Several people believed the WFD water body or sub-catchment scale was the most appropriate spatial scale at which effectiveness of measures should be measured, whilst others believed the farm to sub-catchment scale was most appropriate, as most measures are implemented at this scale. Some suggested indicators should include some spatial information, i.e. is the impact of the measure the same everywhere? This spatial information could be regional or site/topographic related.

Some more general responses/suggestions:
- Indicator needs to be understandable to a wide range of users, i.e. not too complex. Traffic light system thought by one person to be a good, clear system for communicating the effectiveness of a measure, but it needs to be well linked to more detail
- Impact indicators could be grouped either by specific measure, or to benefit by sector (e.g. livestock farming, sewage treatment)
- Ideally, impact indicators should be accessible from public sector statistics without the need for modelling
- The level of detail needed depends on the water body attribute of interest; ideally one impact indicator should represent a range of different water body attributes (i.e. a metric summarising chemistry, ecology, biodiversity, morphology). E.g. WFD class. This might be through a set of very simplistic indicators relating a measure to a certain water quality attribute, which together provide more detail as to the effectiveness of the measure.
- May also need to include some information about timescales of effectiveness (e.g. if interested in the groundwater or ecological response)
- One participant felt there was a need to combine local scales with being able to fit into modelling applications which are often at larger (e.g. sub-catchment) scales
- It was also felt by several participants that value attached to non-WFD/water improvements should be factored in, e.g. indicators should include a financial element,

- Overall, the level of detail should be proportionate to the complexity of the system and the amount of data available, i.e. "enough detail, but not too much!" as one person put it.

3) How should these indicators of effectiveness of measures be used?

The fundamental point of an effectiveness indicator is to:

i) Measure a change in water quality
ii) Attribute this change to 'measures' put in place, preferably in a quantitative way.

Use this to then:

- Clarify/define the scope or applicability of different measures in different situations, and thereby target measures more effectively
- Prioritise/rank measures, through a combination of information on effectiveness and cost of the measure. i.e. support decision making at a) the farm scale, e.g. siting of measures, b) the catchment scale (operational) or c) national scale (e.g. national targets)
- Justify economic support for measures. E.g. Inform the Scottish Government on what payments to make to the relevant sectors which are responsible for measure implementation
- Help link across policy areas to ensure linked decision making
- Report on the state of the environment/quality of water
- Show improved (hopefully) WFD compliance – backing for 'enforcement' if needed
- Provide an integrated understanding of effects of measures (maybe through a weight of evidence approach?)
- Help to develop simple, practical guidelines that will demonstrably improve water quality. E.g. develop a diffuse pollution "toolkit", a list of measures and their impact indicators (for a given spatial scale), which can then be applied to specific problems.

Ultimately, the aim is to:

- Reduce water treatment costs
- Reduce losses of pollutants and nutrients from farms
- Improve the downstream environment (environmental and social)

4) What are the main limitations of the approach presented in the morning session (see Table 1)?

This question invited participants to comment on Andy Vinten's presentation in the morning session, where he described a relatively simple approach to cost-effectiveness analysis, using back-of-the envelope calculations, in the Lunan catchment. The main response of the participants can be summarised as:

i) Worries as to whether the underlying scientific assumptions are sound:
   - Issues with the Volleinder equation
   - Uncertainty of elements in the mass balance
   - Lack of source apportionment
   - Too many assumptions – more detailed input data needed

   Several participants believed uncertainty estimation is an essential part of the approach that is missing at the moment.

ii) Comments on the approach being too simplistic, with the following not being taken into account:
   - Spatial variability (different areas will respond to measures in different ways depending on biological/physical/chemical setting), i.e. assuming a constant effect of a measure is too simplistic
   - Timescales for effect of measures to be seen in the environment
   - The interactions between measures in terms of effectiveness
   - A link between loss estimates and increases in water quality (as the two may not be linearly related)

Other general comments:

- Can the approach be applied with multiple pollutants? And multiple benefits? To be useful, it really should include all of these. i.e. diffuse pollution needs to be integrated with other ecosystem services and the balance between them for food, energy and water security
- Potentially a costly approach at larger scales, but a useful learning exercise at the sub-catchment scale
- The approach needs to be made completely transparent so each step/assumption can be assessed by users

It can be concluded that impact indicators need to consider biophysical process and include metrics on uptake; WFD or farm to catchment scale is most appropriate; they should be used to attribute change in WQ to measures, quantitatively if possible; diffuse pollution needs to be integrated with other ecosystem services and the balance between them for food, energy and water security

Activity 2: ***Cost-effectiveness of Rural Priorities for water quality improvement: individual work***.

Participants were provided with a list of SRDP funded agri-environment options thought to impact on WQ. These were in 5 categories and participants were asked to choose the most cost-effective for improving the phosphorus status of lochs and rivers, in each category (see **Appendix 1**).

From the **LAND CONVERSION** category, the measure considered to be most cost-effective is the ***creation, restoration and management of wetlands***, chose by 7 respondents. This is followed by the ***reversion of arable land to grassland*** (mentioned by 3 respondents). The ***conversion to organic faming*** and the ***creation and management of species-rich grassland*** were not chosen by any respondent.

The reasons for the selection of the creation and management of wetlands are diverse, but their potential for producing multiple benefits was often mentioned. It is also seen as relatively inexpensive or not too difficult to implement.

There was more diversity of responses in the category of **WOODLAND AND HEDGES**. Two respondents considered the ***implementation of hedgerows for 2 years for landscape benefits*** most cost effective. Also two people chose the ***extension of existing hedgerows***. Nobody chose ***hedgerows for 3 years***. A total of 8 people chose ***woodland creation related measures***, but there none of the specific woodland creation types dominates over the others (all of them where selected by one person, and ***native woodland planting*** was selected by two people***). Extension of hedges*** was seen as relatively cheap and easy to implement. Low maintenance and multiple benefits are mentioned as reasons for selecting woodland related measures.

There was an obvious consensus over the fact that the most cost-effective measure regarding **LIVESTOCK MANAGEMENT**, is ***livestock tracks, gates and river crossings***, having been chose by 8 participants. ***Manure and slurry storage*** was chosen twice, while ***manure and slurry treatment*** was not selected by any respondents. One person considered ***fencing as a way of reducing bacterial contamination in water*** as the most cost-effective measure. Popularity of ***livestock tracks and gates*** is due to the fact that is a hotspot, easy to locate P source and that implementation is seen as relatively inexpensive.

There was also a consensus regarding the ***retention of winter stubbles*** as the most cost-effective **LAND MANAGEMENT MEASURE** (chosen by 9 respondents). The key for winter stubbles effectiveness seems to be related to the ability to tackle key P sources at high risk periods. Multiple benefits and simplicity are also important features of this measure. ***Open grazed or wet grassland for wildlife*** and ***natural regeneration after cereals*** were chosen on one occasion each.

Water margins for reducing diffuse pollution were unanimously chosen by all respondents as the most cost-effective measure regarding **FIELD AND WATER MARGINS.** The reasons are: it is seen as a low cost measure, well targeted and producing multiple benefits.

Regarding **PLANNING MEASURES**, ***soil and water management plans*** and ***nutrient management plans*** are seen as equally cost-effective (supported by 5 and 6 respondents respectively) and as relatively cheap and easy to implement measures.

It can be concluded that the measures most regarded as cost-effective for improving water quality are (in this order): water margins for diffuse pollution, retention of winter stubbles, livestock tracks and gates and management of wetlands.
The capacity of the measures to provide multiple benefits is a key argument for their consideration. Applying to hotspots at high risk times is also seen as a key feature of cost-effectiveness. Low investments and easy implementation are also seen as important features (not always linked with high effectiveness).

Respondents found it difficult at times to respond to the question. Some of them argued that they did not know enough about each of the measures. A recurrent argument is that the effectiveness of the measures depends heavily on location and land use, and therefore it is difficult to answer in general. It was interesting to note how most of the scientists provided technical explanations on how the measure acts over the loading of P, not always referring to cost-effectiveness arguments.

Activity 3: *Cost-effectiveness of Rural Priorities for water quality improvement: Break out groups*

Based on the individual work, break out groups were asked to arrive at a consensus on the selection of the 3 most cost-effective measures (from all categories) for improving the phosphorus status of lochs and rivers and to propose practical ways of assessing the impacts of those measures. The break-out groups were followed by a general discussion of the whole group.

Three groups were formed, including the following members profile:

- Group 1: 2 SEPA representatives, 2 researchers
- Group 2: 1 SEPA representative, 2 researchers, 1 RSPA representative
- Group 3: 1 SEPA representative, 2 researchers

The measure most often selected by the groups was the establishment of water margins for preventing diffuse pollution, also very highly rated in the individual work. This measure was chosen by all groups. The reasons relate to the potential for providing multiple benefits. Also because it is seen as relatively cheap and easy, although its effectiveness in the long run was questioned by one group.

Nutrient management was selected by three groups, which is considered to be cheap and having a direct effect on P loads. A set of measures were selected by one group. These were: ***soil and management programming plan, creation and management of wetlands, livestock tracks and gates, retention of winter stubbles and arable reversion to grassland***.

The measure considered to be the most cost-effective is the establishment of water margins for preventing diffuse pollution, due to its potential for providing multiple benefits.

Participants had difficulties[1] with the question of proposing practical ways of assessing impacts. On the one hand, it was not clear to all participants what was to be considered a way of assessing impacts (this relates to the discussion on Activity 1). On the other hand, it was stated that effectiveness is scale and context dependent (on location, local conditions and land use) and that more information on the measures was needed. It should be noted that all groups failed to provide a proposal for at least one of their selected measures.

In the case of water margins to prevent diffuse pollution, maps (at the field scale) were proposed as useful tools (knowing the actual length of the water course), although problems with confidentially issues were recognized. Input/output monitoring, including loss coefficients, was proposed. It was signalled that there is already a lot of literature on the effects of buffer strips. Making use of that literature (meta-analysis) was considered more relevant than new monitoring research (that would require too much time). A practical idea of monitoring one representative small scale catchment and comparing the results with the literature was proposed. The difficulties of isolating effectiveness of water margins only were discussed (i.e. there might be other reasons for the change in P status).

In relation to livestock tracks, gates and river crossings, it was proposed to monitor in-stream loads of suspended solids and P, and to identify number of points to be addressed and to produce area estimates. Loss coefficients would be required. A more practical solution would be to monitor specific points (e.g. specific gates, tracks), because they are small and well located. Monitoring or estimating the movement of cattle was suggested by one participant, but it was contested. It was considered that since it is cheap and easy to implement the measure, measuring effectiveness might not be necessary.

Looking at fertilizing savings as a way of monitoring effectiveness of nutrient management plans was suggested.

Checking for changes in turbidity was proposed for the reversion of arable to grassland and woodland related measures. Once again, monitoring was suggested. There seemed to be a consensus over the need to establish targeting to very specific areas.

In relation to retention of winter stubbles, it was suggested that the % change in land use from bare soil would help to estimate reduction in erosion. Relating the amount of phosphorus in stubble to estimate the phosphorus retained was proposed, along with erosion risk modelling.

In general, it was considered useful to monitor the level of uptake of the measures. A nationwide approach is required, since monitoring all catchments is unrealistic.

Proposing practical ways for assessing the impacts of measures on improving the phosphorus status of rivers and lochs was found to be very difficult. Effectiveness depends on local conditions and scale. Proposals for assessing impacts rely heavily on monitoring (a scientific approach seems to dominate). Accounting for the level of uptake of the measures was considered useful.

Activity 4: *new measures for improving water quality*

A brainstorm at the group level resulted in the following proposals:

[1] The introduction to this activity was hampered by the lack of availability of a projector to recap examples of an impact indicator from the morning session (see appendix 2)

- Flow deflection
- Wetlands for water quality
- Soft drainage
- Runoff management
- Septic tanks, separating toilets
- Low P feed
- Network and transport of nutrients
- In-stream rafts of vegetation, hydroponic solutions
- Demand management (e.g. vegetarianism)

Report on Workshop B

Evaluating engagement mechanisms and barriers to uptake

Aim of the workshop: To develop effective approaches to achieving compliance with diffuse pollution regulations, with a focus on the general binding rules.

Background

The theme of the second workshop was organised following dialogue with the Scottish Government (Ian Speirs). The main aim was to evaluate current approaches to farmer engagement and undertake an appraisal of a range/combination of engagement tools. SEPA have a process in place to raise awareness and engage with farmers as part of their rural diffuse pollution plan for Scotland. This forum provided an opportunity to undertake an appraisal of various components of this approach in addition to other potential channels of engagement. This allowed the group to debate issues that could maximise compliance opportunities and communication of win-win messages to the farming communities given that breaches of GBRs have been frequently observed (see Table 1). In particular the workshop focussed on trying to identify awareness raising options/engagement methods that would target the 'hard-to-reach' farming communities who were less receptive to previous awareness raising campaigns. This idea had been raised in the morning presentations by DO. The workshop was divided into two elements: (i) an open floor appraisal of a range of different approaches to engagement for promoting compliance with GBRs, principally GBR 19 and 20; (ii) the application and trialling of a novel cognitive mapping approach to assess barriers to compliance and opportunities to promote uptake with regard to GBRs.

Contributors to Workshop B`: David Oliver (University of Stirling), Ben Christen (University of Aarhus), Bill Crooks (SAC), Stephen Field (SEPA), Joyce Carr (SG), Sarah Hutcheon (SNH), Marc Stutter (JHI), Willie Campbell (Farmer) and Andrew Bauer (NFUS).

Breakdown per GBR

Catchment	18	19	20	21	22	23	24	DP GBRs	Distance Walked (km)
South Esk	10	254	234	6	0	0	0	504	400
Ugie	**3**	**189**	**38**	**2**	**0**	**0**	**1**	**233**	**278**
Buchan	3	238	4	3	0	1	0	249	324
Deveron	11	270	63	2	0	0	0	346	846
Dee	4	261	20	2	0	0	0	287	457
Galloway	2	498	52	35	0	0	0	587	629
Stewartry	1	382	16	5	0	0	0	404	286
Tay	1	489	298	10	0	0	0	798	950
Eye	**1**	**263**	**18**	**4**	**0**	**0**	**0**	**286**	**130**
Ayr	**32**	**383**	**35**	**0**	**0**	**0**	**0**	**450**	**350**
Doon	3	70	11	1	0	0	0	85	140
N. Ayrshire	1	59	5	0	0	1	0	66	65
Irvine	13	399	9	4	0	0	0	425	525
Garnock	4	263	18	4	0	0	0	289	252
							TOTAL	**5015**	**5666**

Table 2: Breakdown of GBR breaches per catchment provided courtesy of SEPA.

Part I. We ran part 1 of the workshop as a single group discussion (9 people) rather than splitting the participants into different groups. This ensured a fluent debate surrounding the appraisal of engagement approaches. This phase of the workshop was concerned with an evaluation, undertaken by various stakeholder communities, of how we can enhance the win-win message to farmers via different channels of communication. To stimulate debate and discussion a series of current and proposed engagement procedures were listed as shown below:

- One-to-one advice (SEPA)
- One-to-one advice (independent farm advice service)
- Focus groups
- Citizens jury based approaches
- Demonstration farms/Champion farmers
- Guidance documentation (do's & don'ts)
- Provision of training

It was important to consider the approaches with regard to their ability to accommodate 'Inclusiveness' (that individuals have a legitimate right to engage in a process that has a direct bearing on them); 'Acceptability' (that greater trust and legitimacy can be built into compliance to achieve particular ends); and 'Effectiveness' (that outcomes are realised more effectively - for example active engagement with farmers provides a source of practical know-how that can help reinforce the win-win message).

The above list of engagement approaches was not intended to be exhaustive and the workshop opened up the list to scrutiny from the participants – were any key methods of engagement or awareness-raising missing? Were any considered to be inappropriate for serving as an effective method?

The group collectively agreed that there are a range of approaches available for communicating win-win compliance messages to the farming community but to underpin their success and application there would always need to be an ***enabling mechanism*** (presumably in the form of resources, appropriate staffing). The group were consistent in stressing that engagement should not be about rehashing advice but rather identifying 'we have a problem, but we can solve it'. Approaches to secure buy-in of farmers would be more successful if they allowed for a ***step-by-step approach to promote engagement***.

The engagement approaches were considered and suggestions of 'Governance Structures', 'Catchment Management Partnerships' and 'Advisory Activity Funding' were raised as additional engagement procedures not currently recognised in the list.

The group considered Focus Groups and Demo farm approaches to be the same mechanism highlighting the value of undertaking focus group meetings on-farm, and these events were considered to represent training too, thus highlighting some overlap in the original list of mechanisms.

There was very positive discussion about the role of demo farms in cementing ideas about compliance and win-win messages. Their advantages with regard to the multiplier effect of endorsement by a group community were also highlighted and are very important for providing weight to management options and strategies being seen as legitimate in the eyes of the farming community.

However, there is clear need to consider how practical the role of the demo-farm is for wider implementation at the national level. The key question here was 'how many would we need?'. The other useful point was to stress that it is more useful to operate demo farms as 'mucky' farms as opposed to pristine farms to ensure the most reward from focus group meetings on-farm. It was reiterated that farmer-to-farmer communication is in fact very effective and can help convince older generation farmers to consider alternative approaches if

younger farmers are advocating changes in management. Ultimately local problems need local solutions and there was collective recognition that someone is needed to kick-start the solution and act as a catalyst among the community. The group were in agreement that this is easier said than done, but there was widespread positivity that momentum would build if the right person could initiate activity among a farming collective.
The use of Demo farm systems was also seen as a platform for developing 'case studies' whereby an assessment of financial savings can be made and converted into communication of positive efficiency gains to show the business value of shifts in management related to GBR compliance.

A key question was then raised by Joyce Carr – 'so if Scottish Government had money to invest in engagement and awareness raising approaches, then where should the priority lie with regard to options available'? There was strong support for 1-to-1 advice but it was recognised that SEPA are well placed to advise on whether or not a farm is complaint or not (though it was emphasised that it was incredibly important to have the right type of person to deliver this message) but that focus farms may be more useful for delivering key advice about practices. Thus a coupled 1-to-1 service and focus farm approach was considered appropriate provided the above notes were taken on board.

The group then considered the implications for promoting compliance with GBRs beyond the priority catchments and there was a clear message to communicate better with those communities out with the priority catchments. A key requirement would be to encourage participation of farming communities beyond the priority catchment boundaries at demonstration events etc within the priority catchments.

Participants also suggested that it would be interesting to explore how we can incentivise people to do that little bit extra so that the 'pot of money' available could be stretched by looking at multiple benefits rather than diffuse pollution management or improved biodiversity as individual environmental rewards.

The multiple benefits discussion did recognise that this is of course very challenging and there was a degree of scepticism that this could actually be achieved without wider society buy-in to reflect the value of extra benefits from environmental management. In response a point was made regarding CAP reform and farm payments and that in some respects farmers can be 'penalised' financially for what they have already done if multiple benefits are sought as later opportunities reap no financial reward. This was an important point and highlighted a clear mindset that it was often more beneficial to farming communities to wait a while and apply for future benefits rather than achieve multiple benefits in a single transaction.

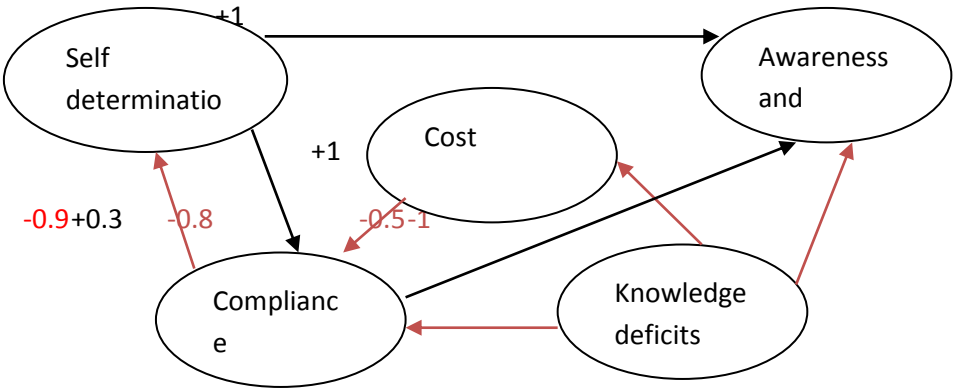
The discussion was rounded off with a clear point that we do need a backstop of enforcement. It was considered important to ensure a message of eventual enforcement to be applied for those who are repeatedly not acting. If people are aware of this eventual repercussion then we will ultimately see changes. It was emphasised that this was not an option to be taken lightly.

Part II

The fruitful discussion resulting from Part I helped to generate ideas among the participants about key aspects / factors that acted as (i) barriers to uptake and; (ii) mechanisms to promote compliance. Part 1 therefore served a secondary purpose to get the workshop participants engaged with the workshop themes before undertaking an individual exercise to provide a cognitive map of their understanding/beliefs/perceptions surrounding farmer compliance with GBRs. This phase of the workshop was facilitated by Ben Christen who provided each participant with an A3 sheet and asked the question: '*how do environmental regulations affect farmers and farming practice and what is important for compliance/non-compliance with GBRs*?'

Each participant individually noted down any number of different concepts coming to mind when thinking about the question (in this case, 7-19 different concepts per FCM), then proceeded to plot

these concepts as a map of interrelationships. On an FCM, concepts are mapped in related groups and then each connected by arrows denominating an increasing or decreasing influence on another concept. Additionally, these influences are weighted by assigning a positive (for increasing influence) or negative (for decreasing influence) value between 0.1 (very weak) and 1 (very strong). Example piece from a workshop map:



System dynamics can then be visualised using different arrow widths relating to the assigned value and different sizes for the depiction of the concepts. This is governed by a concept's 'centrality', which is the combined value of the incoming and outgoing influences. When adding up, negative numbers are treated as positive as the interest is in the combined strength of influence, irrespective of if those influences are in- or decreasing ones. Concepts can also be ranked by their 'outdegree' or 'indegree', which is the combined value of their influence on other concepts or the combined value of influence received from other concepts, respectively. Using the concept of 'compliance' in the above example, its centrality would be 3.4, its outdegree 1.9 and its indegree 1.5.

An FCM depicts how a person views the dynamics within a specific system and which parts are deemed the most important, a so called expert map that can be of interest in itself when comparing how stakeholders from different backgrounds view the same system (in this case Scottish Government, farmer, SAC, SNH, NFUS, JHI, RSPB). Expert maps can be combined into an expert network by adding up the different maps, using the assigned values. The strength of the FCM approach lies in its capability to integrate different kinds of knowledge into system analysis on an equal basis (local farmer, advisor, policy maker, scientist, etc.).

Some preliminary findings: The 7 FCMs created during the workshop contain 79 concepts, 51 of which are unique, meaning they were only mentioned by one participant. This shows the high diversity that still arises despite having agreed upon the topic of discussion. The 79 concepts could be assigned to 7 groups: policy, farm economy management, knowledge, attitude, practical farming, natural resources and environmental problems. Keeping in mind the fact that the 'expert network' only consists of seven individual maps, it is interesting to note that the concept-group 'policy' has its main influences or impacts on the groups farm economy management, attitude and knowledge; only a little on natural resources and none what so ever on practical farming. This is especially noteworthy since a part of the main question asked about the direct effect of environmental regulations (policy, in other words) on actual farming practice. The answer would appear to be 'none' so far, at least in the minds of the workshop participants.

The most central concept was ‘compliance’ with a centrality of 10.70 – not surprising when looking at how the question was framed. Interestingly though, it does not only have a very high indegree (7.30, due to a lot of concepts stating causes for compliance) but also the highest outdegree in the expert network (3.40), meaning that it also shows what *is caused by* compliance. The four most central concepts for the network after that were ‘farmer attitude’ (centrality 4.35, indg. 3.70, outdg. 0.65), ‘awareness, interest, perspective’ (centrality 4.20, indg. 3.15, outdg. 1.05), ‘costs’ (centrality 4.00, indg. 2.00, outdg. 2.00) and ‘biodiversity’ (centrality 3.65, indg. 2.05, outdg. 1.60).

Closing plenary session, conclusions and next steps

The closing plenary session involved reporting back to the whole group the results of workshops A and B.

Key messages from this feedback session are:

- More dialogue between SEPA and the scientist is needed to avoid 'reinventing the wheel' but looking for practical solutions. CREW can be a very good instrument for this.
- NFUS (Andrew Brauer) made a plea for not forgetting the negative effects of the measures on food security, taxation and employment.
- There was some level of surprise about the current allocation of money across measures (e.g. only £6k allocated to nutrient management compared with the £23 million allocated to hedgerows).
- The Scottish Government needs support on understanding how to better spend the money across those measures, to make the most value out of it.
- The workshop was considered useful for enabling dialogue between the different stakeholders and a useful exercise for the Scottish Government to help in a more efficient allocation of expenditures across the Rural Priorities measures.
-

A field visit was arranged to the Baldardo catchment, which drains into Rescobie Loch, near Forfar, on the following day. A report of this visit is given in **section 7.**

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The main conclusions of the workshop were as follows:

1. An impact indicator provides some indication of the effectiveness of a measure implemented to reduce the harmful effects of diffuse pollution on water bodies. I
2. Impact indicators need to consider biophysical process and include metrics on uptake; WFD or farm to catchment scale is most appropriate; they should be used to attribute change in WQ to measures, quantitatively if possible;
3. Measures most regarded as cost-effective for improving water quality are (in this order): water margins for diffuse pollution, retention of winter stubbles, livestock tracks and gates and management of wetlands.
4. The capacity of the measures to provide multiple benefits is a key argument for their consideration.
5. diffuse pollution needs to be integrated with other ecosystem services and the balance between them for food, energy and water security
6. In a fuzzy cognitive mapping exercise, the concept group 'policy' has its main influences or impacts on the groups farm economy management and attitude and knowledge; only a little on natural resources group and none what so ever on practical farming concept group
7. There seems to be a clear mindset that it was often more beneficial to farming communities to wait a while and apply for future benefits rather than achieve multiple benefits in a single transaction
8. Demonstration farms are very beneficial in cementing ideas about compliance, and in endorsement by a group community

The next activity on the CREW-DP agenda is a farmer focus group in the Lunan catchment. This is an opportunity for farmers to:

Hear about current work to minimise impacts of diffuse pollution in the catchment area of the Lunan Water, including filter fences for erosion management, and harvesting weed from Rescobie Loch

Recap on the Environmental Focus Farm work at Mains of Balgavies: what does Tom Sampson feel it's meant for the farm and what are the next steps?

Talk and discussion on the potential of precision agriculture for improving yields and benefiting the environment –led by Philip White, crop agronomist from JHI Dundee

Hear from Ben Christen, a Danish forester, of experience in Denmark on growing energy crops in buffer strips

Review of opportunities for environmental management under rural priorities and a look at the future funding opportunities

As part of this workshop, we will put the questionnaire used in the stakeholder workshop A (section4) to the farmers, with an additional request for information about whether they have applied for any of the measures under SRDP, whether they were successful, and whether they would be more likely to apply if it were in the LMO scheme.

We also plan a Lunan science update in Late February, at which local stakeholders will have an opportunity to feedback on SRDP measures and their uptake locally.

Report on field visit Friday 4th November

Introduction

A field visit was arranged to the Baldardo catchment, which drains into Rescobie Loch, near Forfar, on the following day. In attendance were Willie Lindsay (farmer), Duncan Robertson (farmer), Willie Lindsay (farmer), Andy Vinten (JHI, organiser), Sandy Forgan (Rescobie Loch Development Association), Jonathan Bowes (SEPA), David Oliver (University of Stirling) and Ben Christen (Uni. Aarhus). Apologies from Ian Spiers (Scottish Government), Brian Macreadie, Fiona Napier (SEPA), Andre Bauer (NFUS).

The visit was intended to familiarise stakeholders with some of the water quality issues in the upper lunan catchment and familiarise them with regulatory, funded and voluntary measures being taken to control soil erosion.

Mains of Baldardo

1. We visited the erosion control experiment at Mains of Baldardo, which was set up by Andy Vinten and Ken Loades of JHI to investigate the cost:effectiveness of filter fences to reduce loss of soil and phosphorus in the aftermath of potatoes grown on relatively steep slopes. Two filter fences had been constructed,one at the toe of the main slope in the field, with the field above this fence separated out into 9 erosion plots, receiving one of 3 cultivation treatments: control, partial grubbing (6 runs of 6 m width along the length of the slope (about 400m) and full grubbing of the whole length of the field). Each plot had ca. 10 furrow widths. The experiment had only been in about 3 weeks, but significant soil/sand had acculmulated in front of the fences. Devices to capture more of the fine silt and clay (finer mesh filters at the corners of each plot) had been effective in collecting more fine material from theplumes of soil that had formed (see Fig 1)

Figure 1. Main filter fence experiment at Mains of Baldardo, showing an erosion plume from a rill deposting in front of the filter fence, which has a pore size of approximately 2mm. . The section in the foreground is one of the corners of the plot, where finer mesh filter was use (Approx 0.25mm)

Participants' comments included queries about the cost (ca. 1k for the field), whether the fences were only collecting sand and whether the deposit would have settled anyway at the bottom of the field. However there was also some interest in trying out the measure on one of the participant's fields in the following year.

There was also a lengthy discussion about whether the water level in the loch was rising, and the causes of this. It was agreed to investigate the eeltraps between Rescobie Loch and Balgavies Loch as a potential source of the problem, on a separate occasion.

Wemyss farm

2. We visited a gently sloping field in aftermath of organic tatties and saw attempts to control soil loss through use of strips of ploughing , which were approximately on the contour. Ploughing both up- and downslope had been tried in different strips. The combination of this and the weed growth (in contrast to the bare soil in the aftermath of conventional tatties) was proving effective, but slopes were much less significant than that where the filter fence experiment was taking place.

We also discussed the implementation of 10m grass margins around this and other fields, and noted that the farmer felt that the margins should be targeted to the vulnerable edges, such as where connections to streams or roads (eg farm gates), were likely to occur. It was also felt that the occasional use of margins for turning, especially where grass was established for more than one year and therefore more resilient, should be permitted.

Figure 2. Partial contour ploughing to control soil erosion on a gently sloping field in the aftermath of organic potatoes.

Rescobie Loch

3. We visited the Rescobie Loch side and viewed the aquatic weeds (mainly elodea) which had been harvested by the Rescobie Loch Development Association to enhance the fishing. This modest amount of removal had been approved by SNH, and discussions ensued with an organic farmer about the potential for use of this material as an organic amendment. Further research was needed to explore the feasibility of this, and David Oliver agreed to prepare a case for a Master's project on this, as a follow up to the initial feasibility study done by Matthew Nelson at Stirling University the previous year.

Figure 3. Discussion about the potential of use of harvested pond weed (Elodea – see pile on right of photograph) as a nutrient source on a local organic farm.

Mains of Balgavies

In the afternoon, a visit was made to some of the SRDP funded measures implemented on the Environmental Focus farm at Mains of Balgavies, and ti view other good practice measures around the catchment. Measures included broadleaved woodland planting on steep slopes on the margin of an arable field, detention pond at the foot of a slope, and a retention basin where surface drainage runs off via a gully; and winter stubble maintenance in a gully within an arable field.

Figure 4. Broadleaved planting on a steep slope currently in arable cultivation on the Environmental Focus Farm, Mains of Balgavies Farm.

Conclusion

These visits highlighted the issues with soil erosion in the catchment, recognised some significant improvements in management and awareness about the issue, and identified a further range of opportunities to reduce the impact of soil erosion. A highlight was the building of stronger links between Loch users and farmers, leading to a potential project to recycle nutrients from the loch back to the farmland.

Appendix 1. Questionnaire used in Workshop A

Parallel session 1
Activity:
Rural Priorities and Water Quality

Individual work

Workshop on assessing impact of existing measures on water quality

3rd November 2011

NAME OF PARTICIPANT: _____

Please, take some time to think and answer these questions

Different categories of measures are presented below. From each of the categories, please tick the one that you think is most cost-effective for improving the phosphorus status of lochs and rivers? Please, select them according to cost and effectiveness criteria and explain your choice.

LAND CONVERSION 1	✓	Why did you chose this measure?
Conversion to organic farming - arable		
Arable reversion to grassland		
Create, Restore and Manage Wetland		
Creation and Management of Species Rich Grassland		

WOODLAND AND HEDGES		
Hedgerows – 3 years for biodiversity benefits		
Hedgerows – 2 years for landscape benefits		
Extended hedges		
Woodland creation – Native woodland – natural regeneration		
Woodland creation – Productive conifer – low cost		
Woodland creation – Productive broadleaf woodland		
Woodland creation – Productive conifer – high cost		
Woodland creation – Native woodland planting		
Woodland creation – Mixed conifer/broadleaved woodland		
Small scale woodland creation		

LIVESTOCK MANAGEMENT		
Livestock tracks, gates and river crossings		
Reducing bacterial contamination in water (fencing)		
Manure/slurry storage and treatment – manure storage		
Manure/slurry storage and treatment – manure treatment		

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LAND MANAGEMENT	✓	Why did you chose this measure?
Management of Wetland		
Management of Habitat Mosaics		
Open Grazed or Wet Grassland for Wildlife		
Management of Species Rich Grassland		
Retention of Winter Stubbles		
Natural regeneration after cereals		
Maintenance of organic farming – improved grassland		
Maintenance of organic farming – arable		
Maintenance of organic farming – fruit and veg		

FIELD AND WATER MARGINS		
Buffer Areas for Fens and Lowland Raised Bogs		
Water Margins - reduce diffuse pollution		
Water Margins - Enhance biodiversity		
Grass Margins and Beetlebanks - mixed arable		
Grass Margins and Beetlebanks - organic		
Management of Conservation Headlands		

PLANNING		
Soil and water management programme - plan		
Nutrient management plan		

Anything else you want to tell us? … Write it here

Let us give you feedback!

Name:

Address (or email):

Phone:

The James Hutton Institute

If you find this card, please send it to:
Julia Martin-Ortega
The James Hutton Institute
Craigiebuckler
Aberdeen AB15 8QH

Appendix 2. Example of impact indicator for GBR 19 from morning session

Estimate of potential P load to water due to non-compliance with GBR 19 in Rescobie Catchment

Stocking rate in managed grass	101	beef and dairy cattle/km2	from screening tool for Rescobie catchment
total grazing days	200	days/year	estimate
Area of managed grass	6.01	km2	IACS 2010
Area of riparian fields in managed grass	2.5	km2	IACS 2010
Riparian length in managed grass	12.27	km	IACS 2010
No of riparian fields in managed grass	52		IACS 2010
average managed grass field riparian length	0.24	km	calculation
Time spent drinking per grazing day	0.5	hours	literature estimate
P excretion rate	50	g P/day	literature estimate
No. of breaches of GBR19a/km (access to water)	1	per km	SEPA S. Esk survey
proportion of fields in breach	0.24		calculation
Potential P load due to GBR 19a breach	12	kg/year	calculation
Cost of offstream drinking supply	400	£/pasture pump	web
cost per catchment	4908	£/catchment	calculation

Appendix 3. Feedback Questionnaire

Thanks for attending this CREW –DP workshop. We would appreciate your comments on the workshop and on the report. Could you please fill them in below:

	Strongly disagree	Disagree	No comment	Agree	Strongly agree	Further comments
I understand the effectiveness of diffuse pollution measures better						
I understand stakeholder viewpoints about diffuse pollution better						
I know what is required of land users better						
I made useful new contacts						
The workshop fulfilled its aims:						
1. update on available data on effectiveness of existing measures						
2. review strategies for assessing effectiveness and uptake of measures						
3.identify potential measures that could be supported in the future						
The catering arrangements were good						
The facilities were good						
The venue was good						
I would come to another CREW-DP workshop						
The format for the day was suitable to the aims						
Key topics which were missing from the agenda of this workshop						
Suitable topics for future CREW-DP stakeholder workshops						
Suggestions for improvements						

Comments on workshop report	

Please continue with any further comments below, if necessary:

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