Environment – Land Use and Rural Stewardship
PROGRAMME 3

Enhancing Water Quality

Lunan Water
diffuse pollution monitoring catchment

– contributing an evidence base for diffuse pollution mitigation policy in Scotland

Introduction: Andy Vinten

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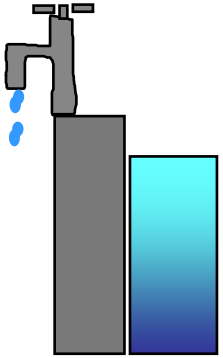
SAC

scri living technology

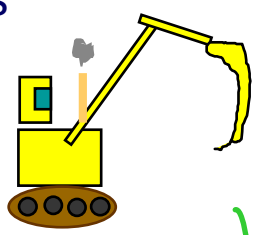
Pressures on waters in Scotland

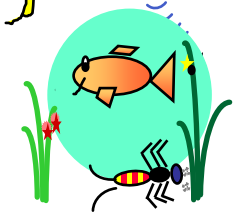
point source pollution

water flow regulation - dams



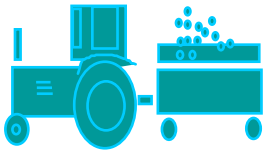
engineering works





water abstraction

diffuse source pollution



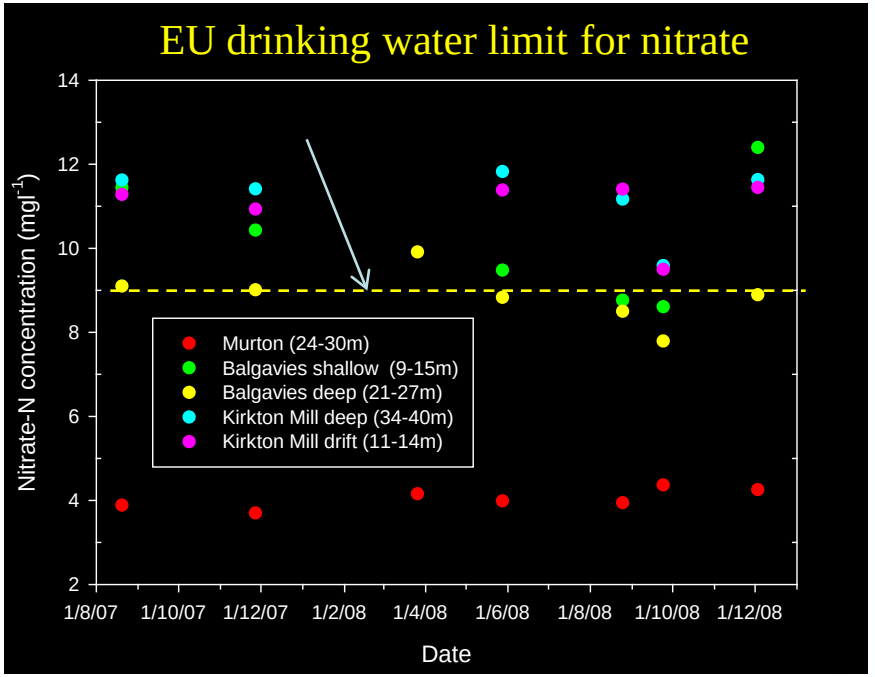
•nutrients, pesticides, faecal coliforms, sediments

Impacts in Lunan catchment

Loch eutrophication

Low salmonid and

pearl mussel numbers



High groundwater nitrate levels

Evidence for policy makers

- *Effectiveness*
- *Cost:effectiveness*
- *Benefits*
- *Relevance*
- *Uptake*

....of diffuse pollution control measures (regulatory, economic, voluntary)

Lunan project objectives

1. To assess what constitutes effective and proportionate mitigation of diffuse pollution.
2. To promote uptake of appropriate measures to control diffuse pollution through an Environmental Focus Farm, and other focus groups

Strategy for evidence of effectiveness

2006-2008 Establish monitoring and baseline characterisation

2009-10 Diffuse Pollution audits on selected sub-catchments

Chemical and ecological monitoring

2009-2011

Mitigation Measures on selected sub-catchments:

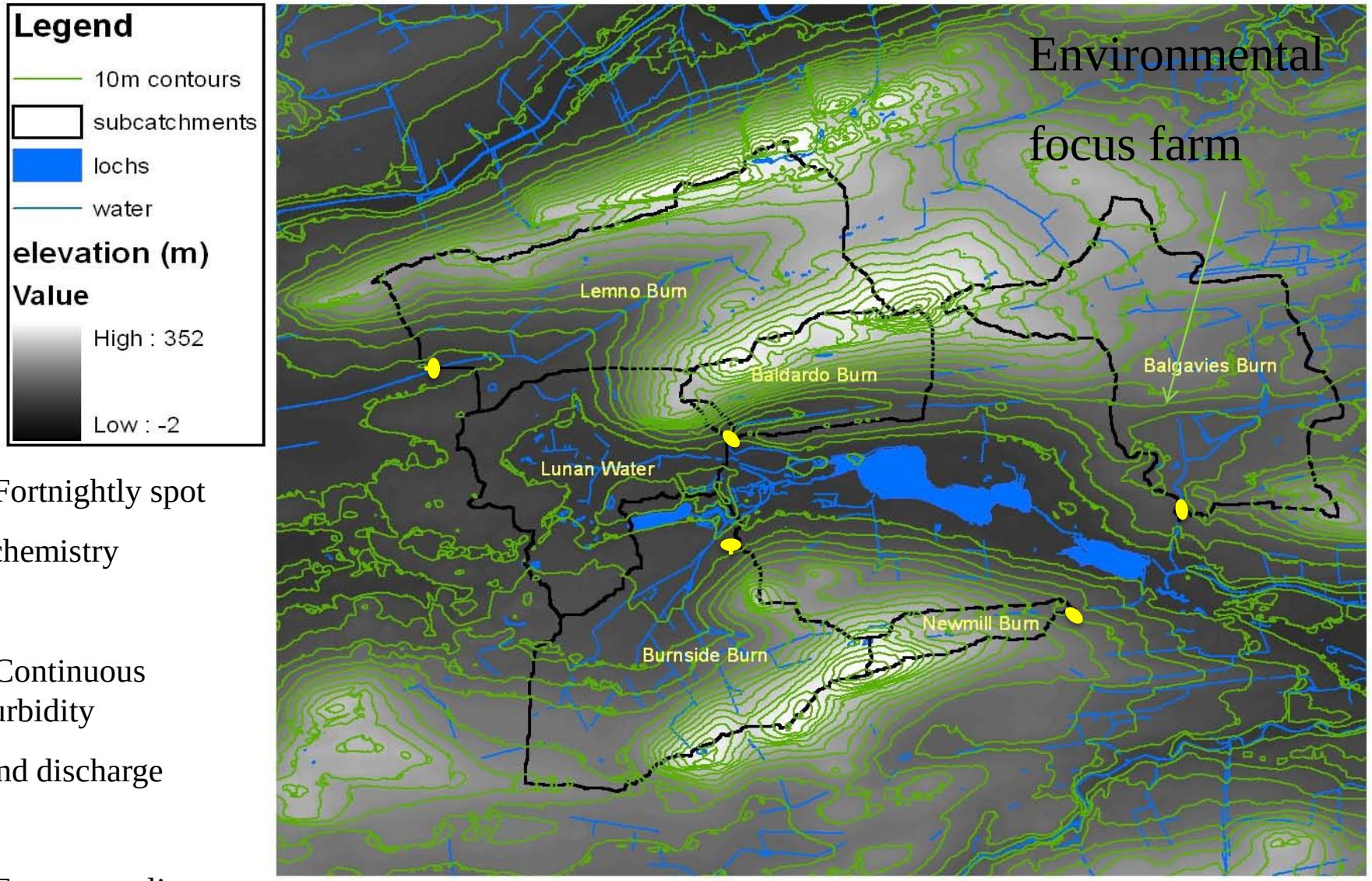
Regulatory: awareness raising (eg 2m buffers, feeder placement),

Voluntary: focus groups and 1:1 (eg bunds, filter fences)

Economic: SRDP and LMOs (eg 6m buffers, cattle housing)

Focus groups

Monitored sub-catchments

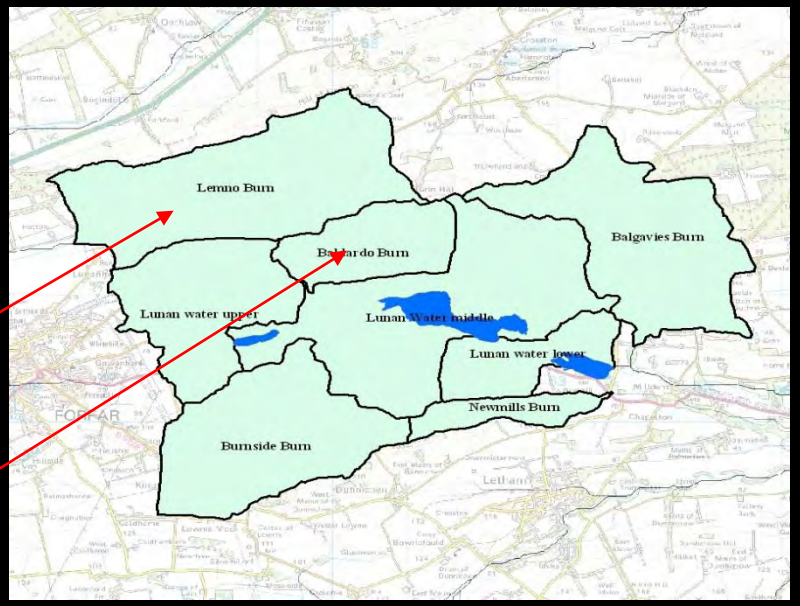


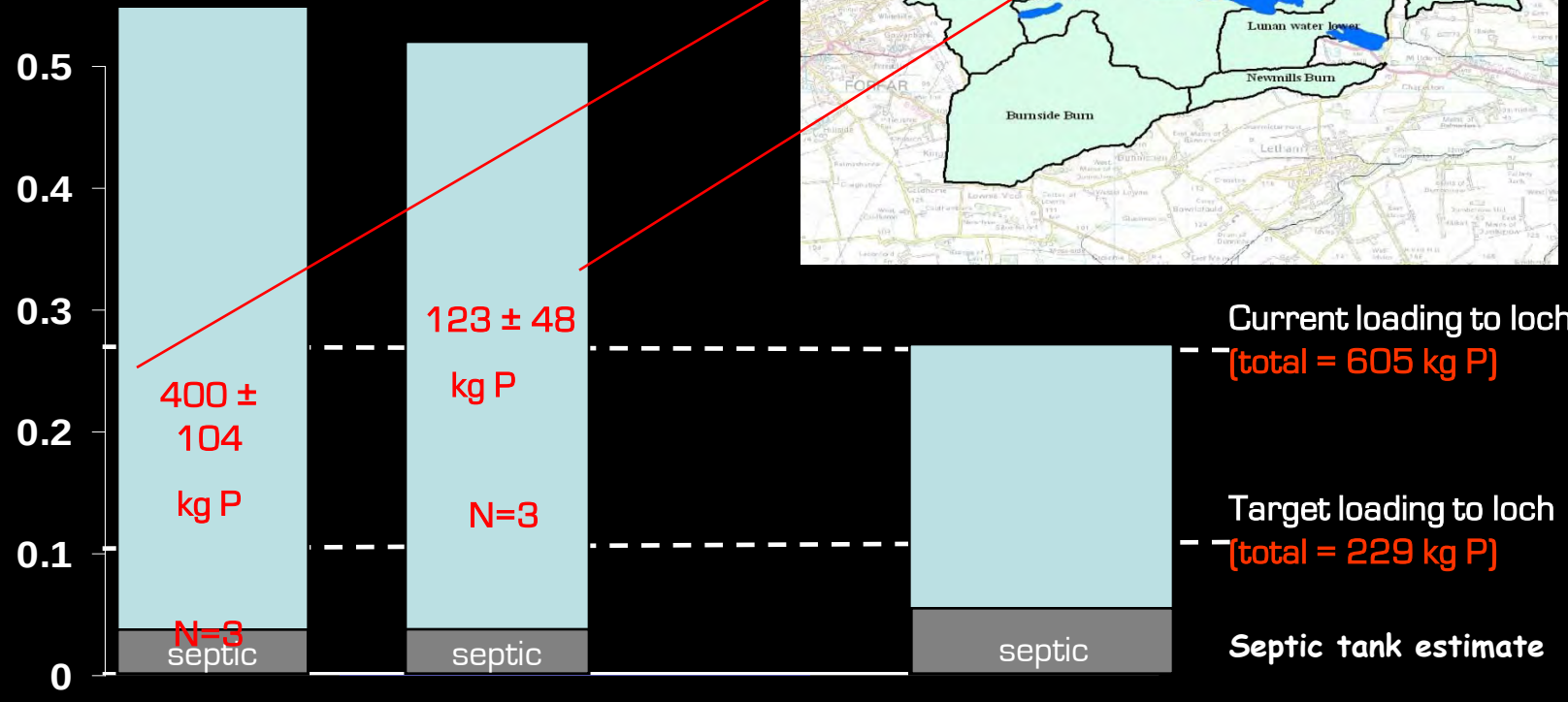
- Fortnightly spot chemistry
- Continuous turbidity and discharge
- Event sampling

P loads to Rescobie Loch

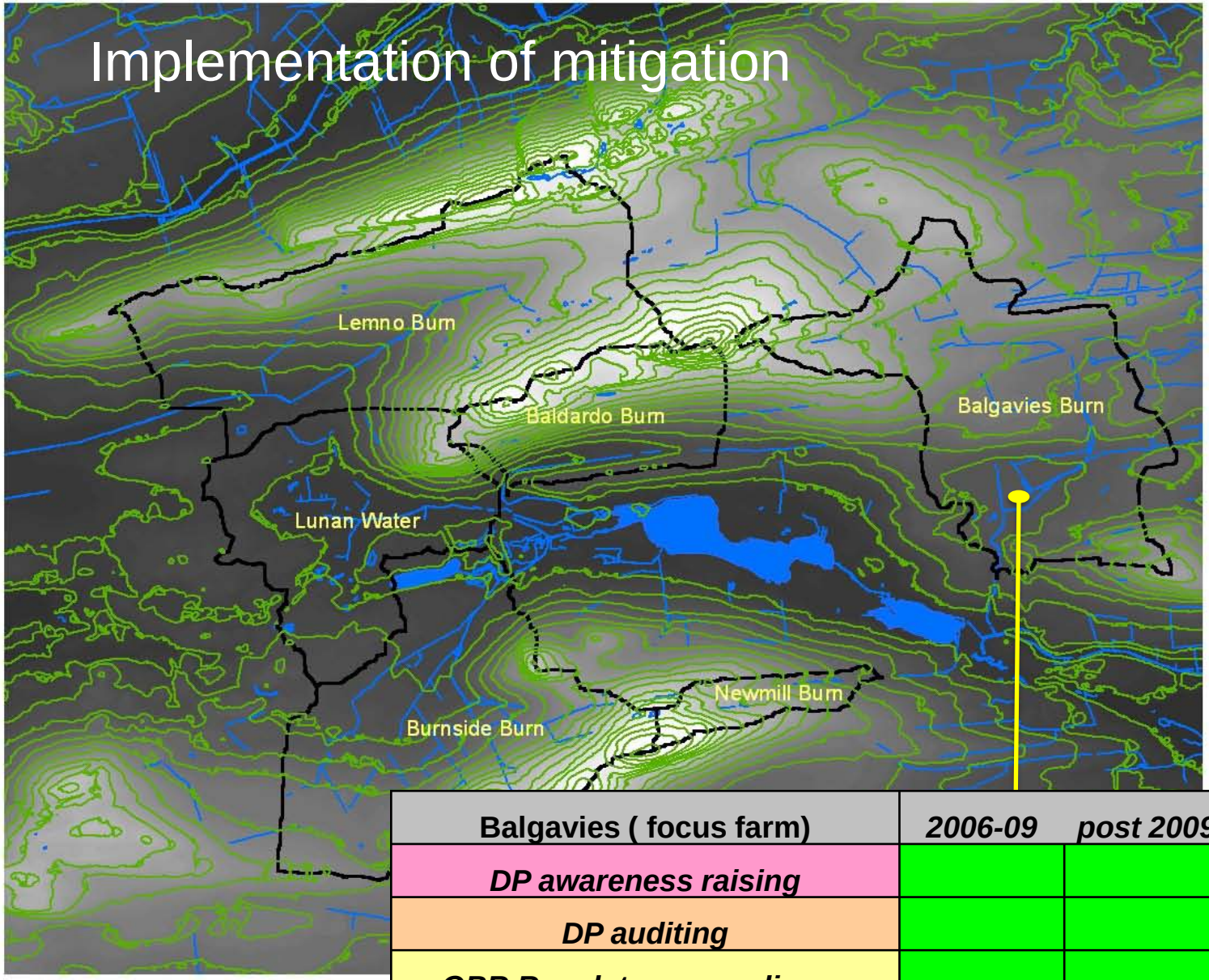
P load per catchment (kg P ha^{-1} year^{-1})

Annual means, 2008-10

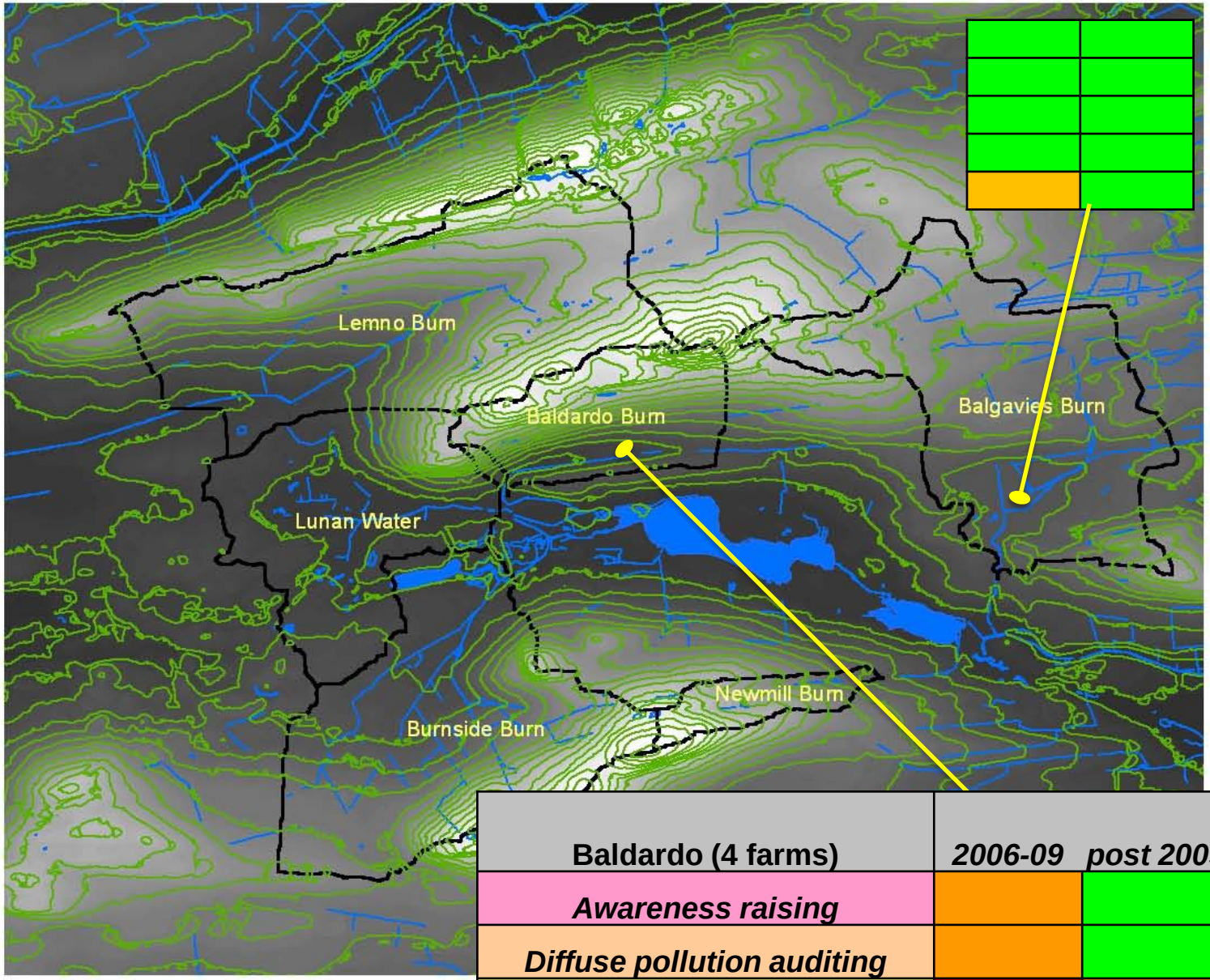




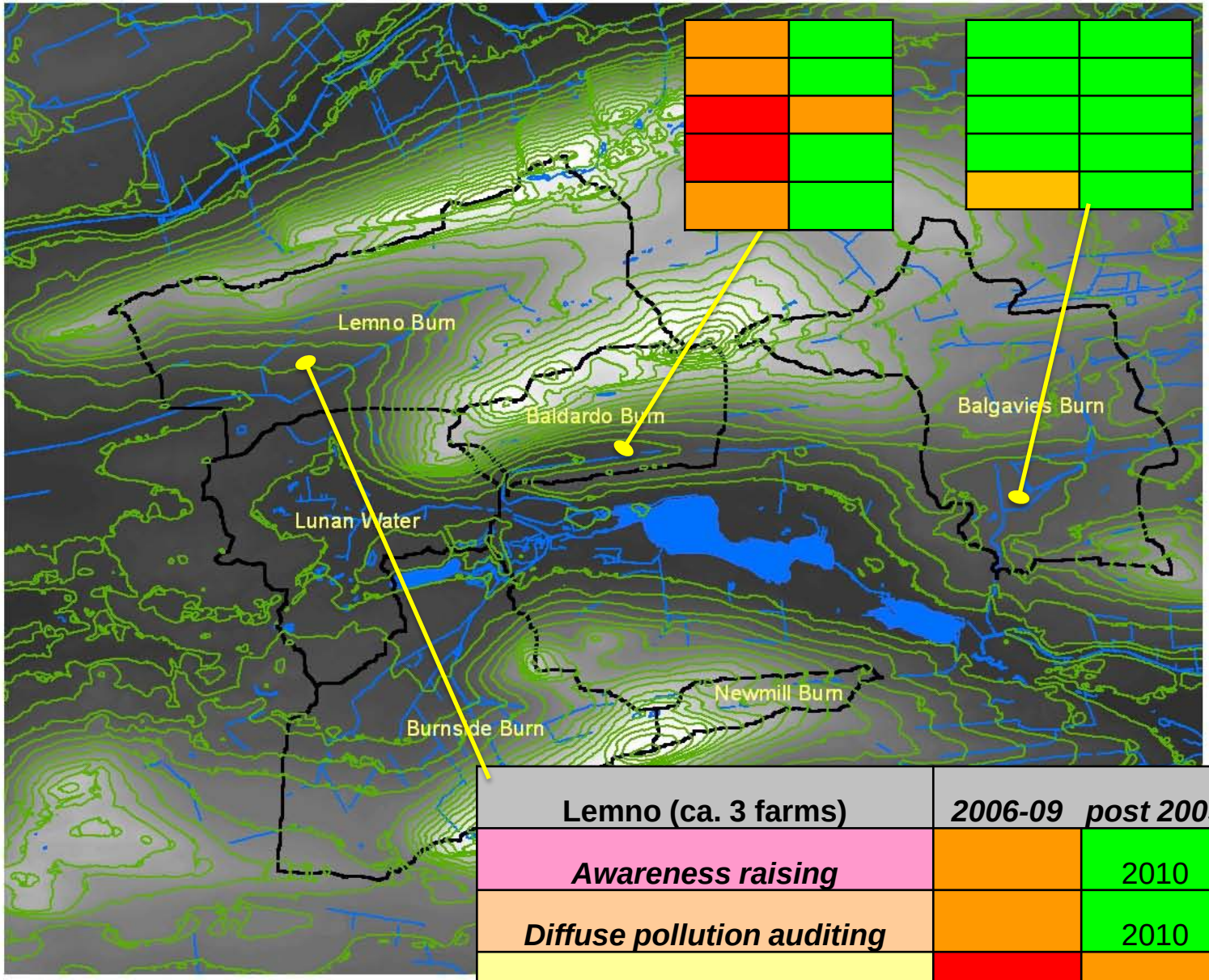
Implementation of mitigation



Balgavies (focus farm)	*2006-09*	*post 2009*
DP awareness raising		
DP auditing		
GBR Regulatory compliance		
Voluntary measures		
Economic measures		



Baldardo (4 farms)	*2006-09*	*post 2009*
Awareness raising		
Diffuse pollution auditing		
GBR Regulatory compliance		
Voluntary measures		2009
Economic measures		2010



Lemno (ca. 3 farms)	*2006-09*	*post 2009*
Awareness raising		2010
Diffuse pollution auditing		2010
GBR Regulatory compliance		2011?
Voluntary measures		2010
Economic measures		

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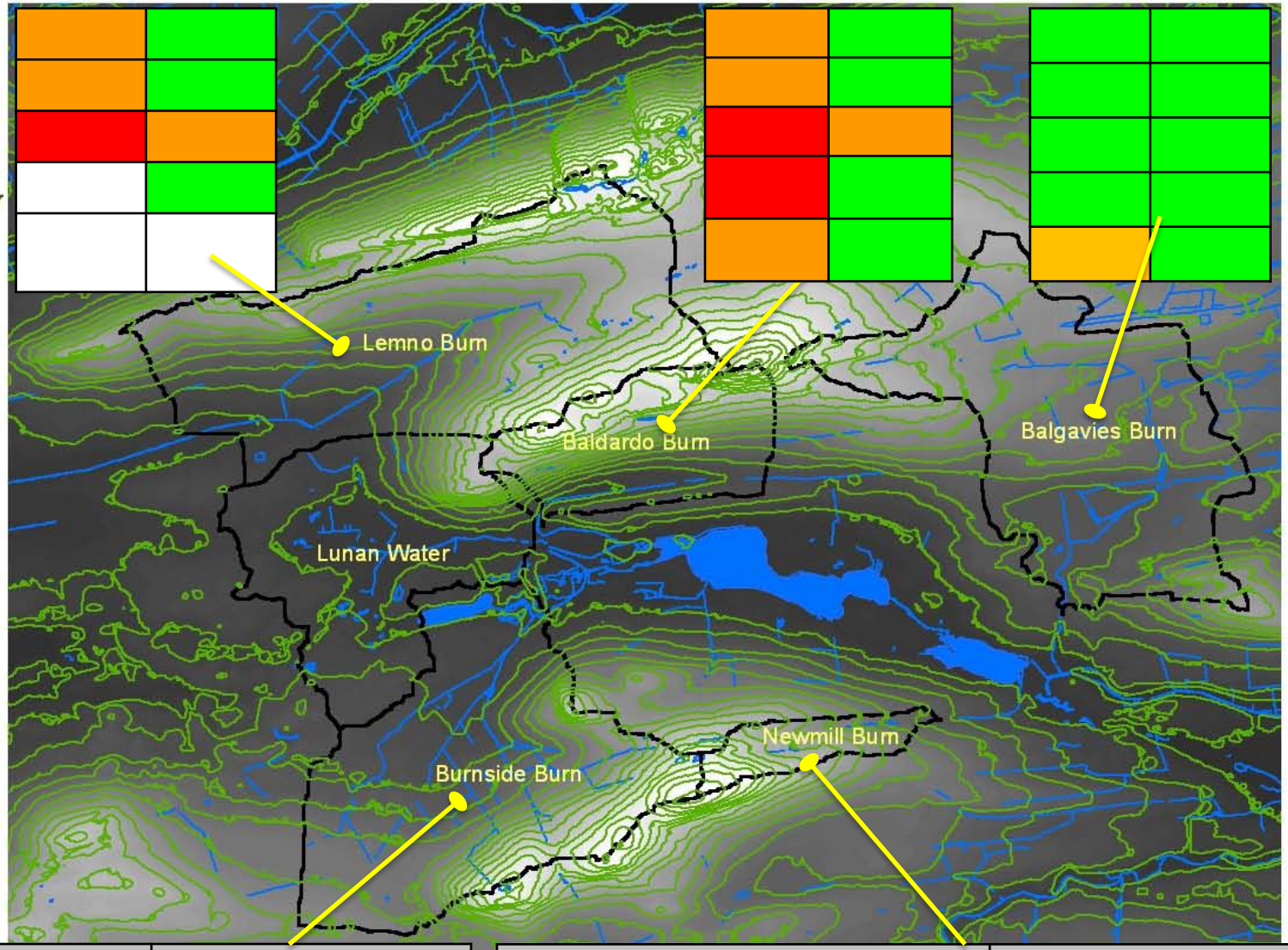
Monitoring by

SEPA Scottish Environment Protection Agency



Burnside (ca. 15 farms)	2006-09	post 2009
Awareness raising		2011
Diffuse pollution auditing		
GBR Regulatory compliance		2011
Voluntary measures		
Economic measures		STW

Newmill (2 farms)	2006-09	post 2009
Awareness raising		
Diffuse pollution auditing		
GBR Regulatory compliance		
Voluntary measures		
Economic measures		

Aims of today

- Update on assessment of measures to regulate and mitigate of diffuse pollution
- Discuss pressures and impacts on aquatic ecology of the catchment and other approaches to mitigation
- Debate direction of future policy relevant science in the area

Today's timetable

- Session 1: Diffuse pollution mitigation strategy (national and local)

- Session 2: Practical mitigation approaches (diffuse pollution and ecology)

- Session 3: obtaining the evidence for effectiveness (hard and soft)

- Session 4: towards effective policy - evidence, interpretation and participation

Questions

1. *How do you think the condition of the catchment has changed in recent years? What evidence do you have for this?*

2. *How should we gather evidence in future?*

3. *How would you like to see the Lunan project develop?*

Session 1. 10:30-11:30

Pollution mitigation- national and local strategies

The Rural Diffuse Pollution Plan for Scotland

Jannette Macdonald/Susan Arnott (SEPA)

Environmental Focus Farms

Carole Christian (SAC)

Is pollution mitigation cost-effective?

Andy Vinten (MLURI)

Is P pollution mitigation cost-effective?

Andy Vinten, Bedru Balana, Nikki Baggaley, Marie Castellazzi, Marc Stutter, Manuel Lago (MLURI)

Is pollution mitigation cost effective?

- Rescobie Loch - ecological standards for Phosphorus
- Apportioning sources of P across the catchment
- Assessment of buffer strip costs and effectiveness on a field-by-field basis across catchment
- Costs and effectiveness of other approaches

(filter fences, Phoslock, sewage treatment, bunds).

- Overall cost effectiveness of P mitigation for Rescobie

Restoration targets for Rescobie Loch

Loch total P concentration (annual geomean, 2003-2006)	71	µg P/L
Good Status mean total P concentration (Ian Fozzard)	27	µg P/L
Total load reduction needed	376	kg TP/year

How can this reduction in loading be achieved?

What will it cost?

Sources of P in Rescobie catchment

Farm sources include:

- Soil erosion
- Field drains
- Feeders
- Livestock grazing
- Livestock housing
- Farm tracks

Non-farm sources include:

- Fish stocking
- Septic tanks
- Sewage treatment works
- Release from loch sediment
- Birds

Estimation of P export from land

P export from land (kg/ha)

Slope Risk Class		1	2	3
	average field slope (degrees)	<4	4-13	>13
	slope descriptor	low	medium	high
Crop Risk Class				
1	*very low*	0.01	0.02	0.03
2	*low*	0.06	0.10	0.14
3	*moderate*	0.3	0.5	0.7
4	*high*	0.7	1.1	1.5
5	*very high*	1.3	2.2	3.1

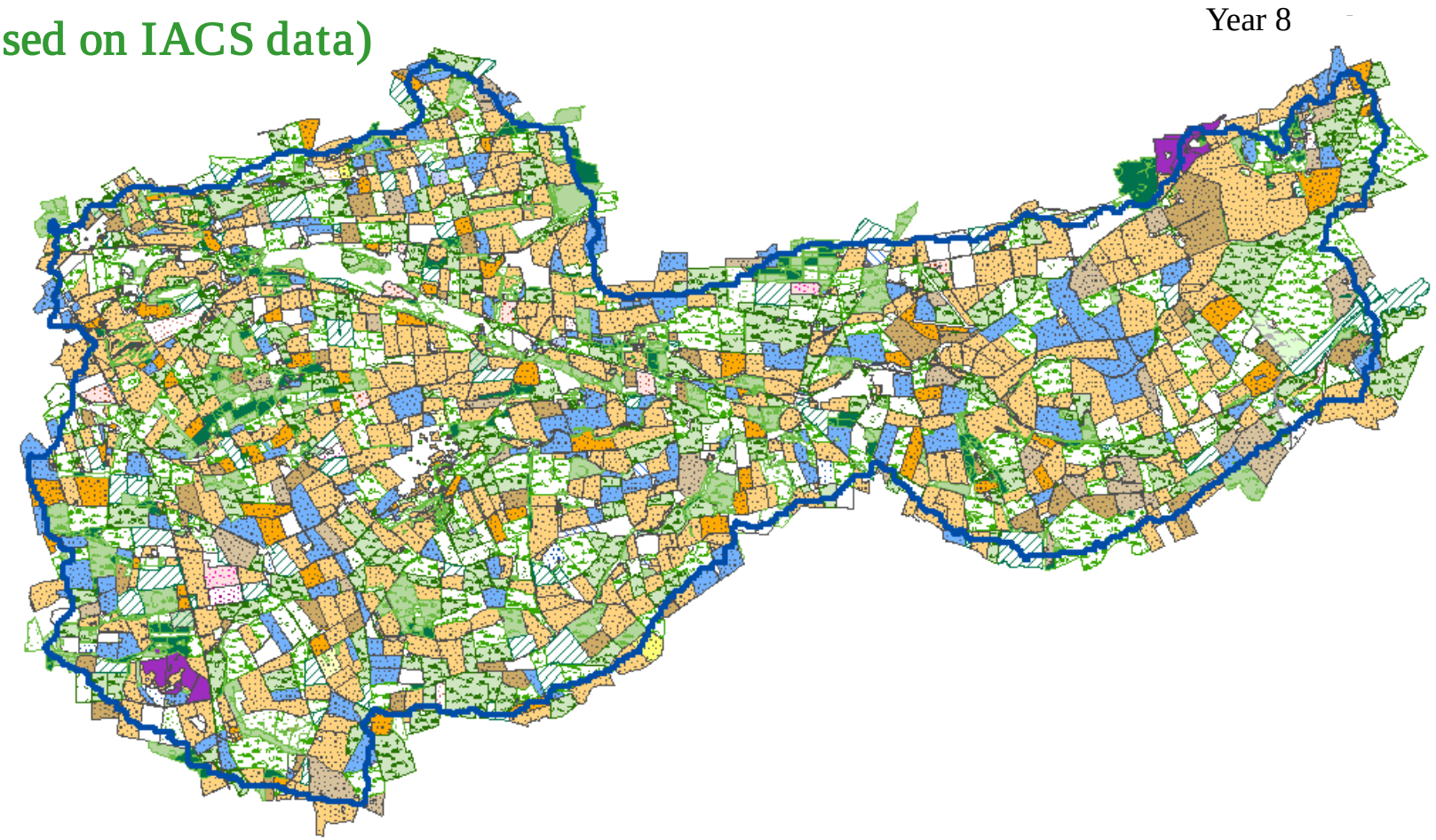
Crop risk class

Crop risk class	eg. crop types
1	rough grazing
2	grass > 5 years
3	spring cereals, grass under 5 years
4	Winter cereals, fodder roots
5	potatoes, vegetables

Modelling catchment P loss

LandSFACTS simulation of crop rotation in Lunan Catchment

(based on IACS data)



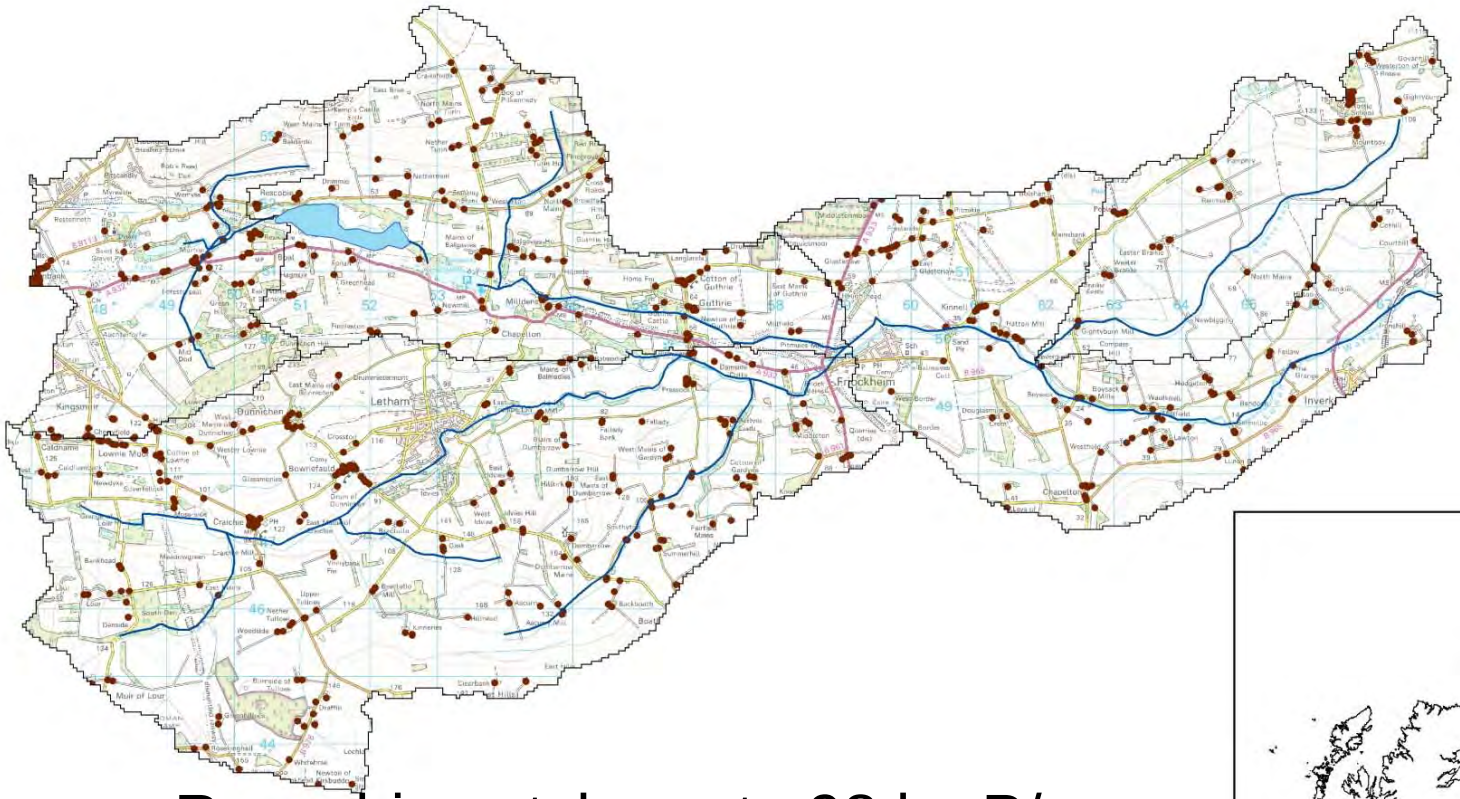
We ran P export model for 10 years -> maximum, minimum and median P loss

-> median P export year (**420 kg TP**) was assumed for catchment P mass balance

→ Section 6

Identifying P sources : Septic tanks

Potential septic tank sites in Lunan Water catchment



Rescobie catchment: 98 kg P/year

assuming 0.3 kg TP/person/day,

4 persons per septic tank

82 septic tanks

draft mass balance for Loch

				Notes
Rescobie Loch				
	Loch [TP] μg/L		71	A
	implied total P load to Loch (kg)		605	B
non-land based inputs				
	septic tanks	98		C
	sewage treatment works (Forrester seat)	20		D
	fish stocking	7		E
	birds	16		F
	Internal load	30		G
	total non-land based inputs		172	H
land-based inputs				
export model, no buffers	from riparian fields (export model)	420		I
	input from non-riparian zone (by difference)	12		J
	total land based inputs		432	K

Notes

A. mean of 2003-2006 annual geomeans

B. Using OECD (1982)

C. assuming 0.3 kg TP/person/day, 4 persons per septic tank and 82 septic tanks

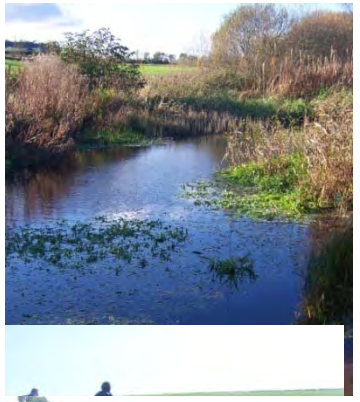
D. assume 90 pe sewage treatment works, operating 50% of year, 0.44 kg TP/person/day

E. Using mean stocking and catch rates for Loch (2000-2009), assuming P content of 0.23%

F. Assuming deposition rates per unit area the same as for Loch Leven (Bailey-Watts and Kirika, 1997).

G. Assuming 5% of total load per year

Mitigation measures for P



Mitigation of P sources

Farm sources

- Soil erosion
- Field drains
- Feeders
- Livestock grazing
- Housing
- Farm tracks

Mitigation by (eg):

Buffer strips

Reduced cultivation

Ponds and wetlands

Soil bunds/ filter fences

Non-farm sources

- Fish stocking
- Septic tanks
- Sewage treatment works
- Release from loch sediment
- Birds

Mitigation by (eg):

Reduced fish stocking

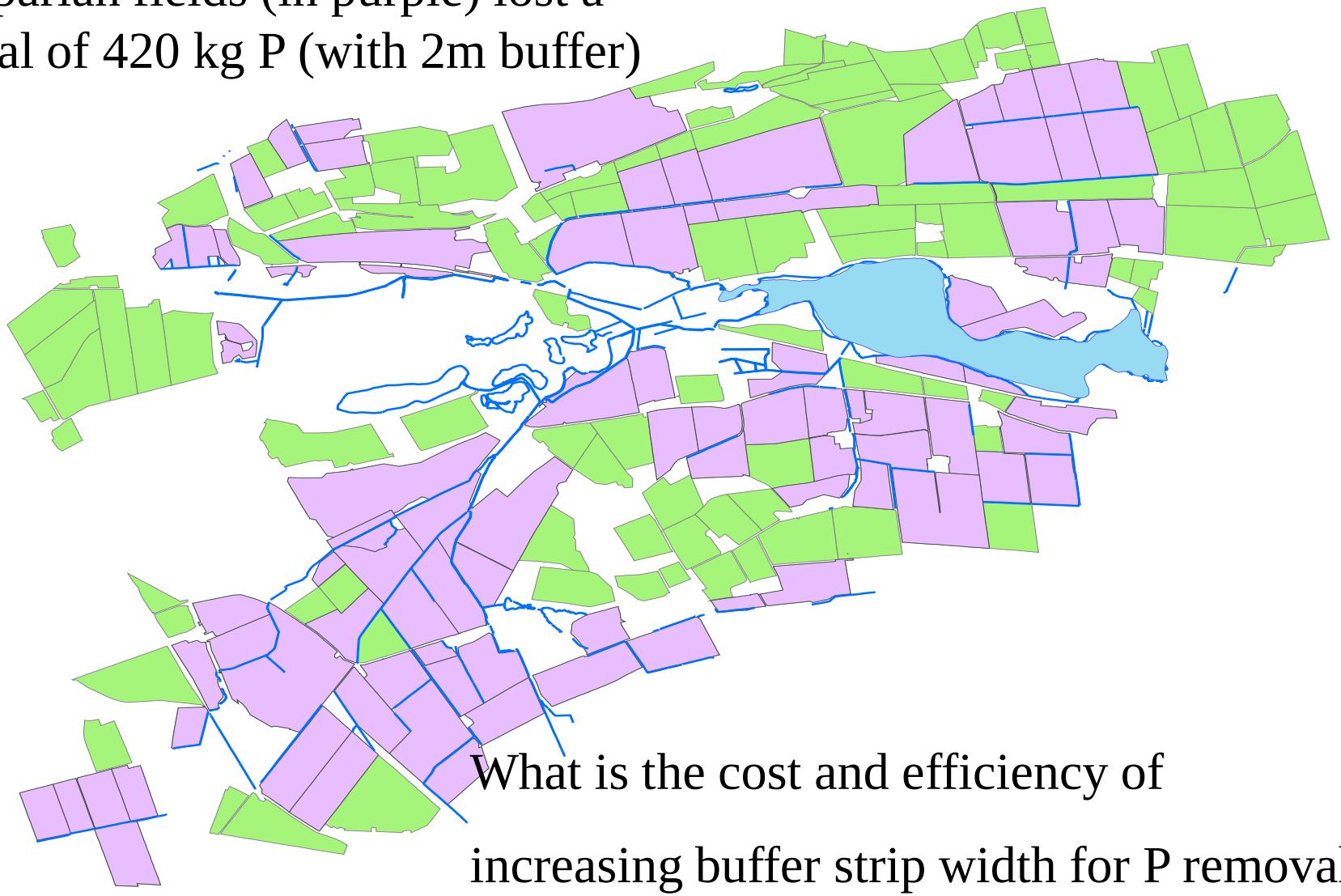
P stripping from septic sources

Loch treatment- Phoslock

Control of birds

Landscape based model of buffer strip cost-effectiveness

Riparian fields (in purple) lost a total of 420 kg P (with 2m buffer)



What is the cost and efficiency of increasing buffer strip width for P removal ?

Effectiveness and costs of buffer strips

Buffer strip efficiency factor

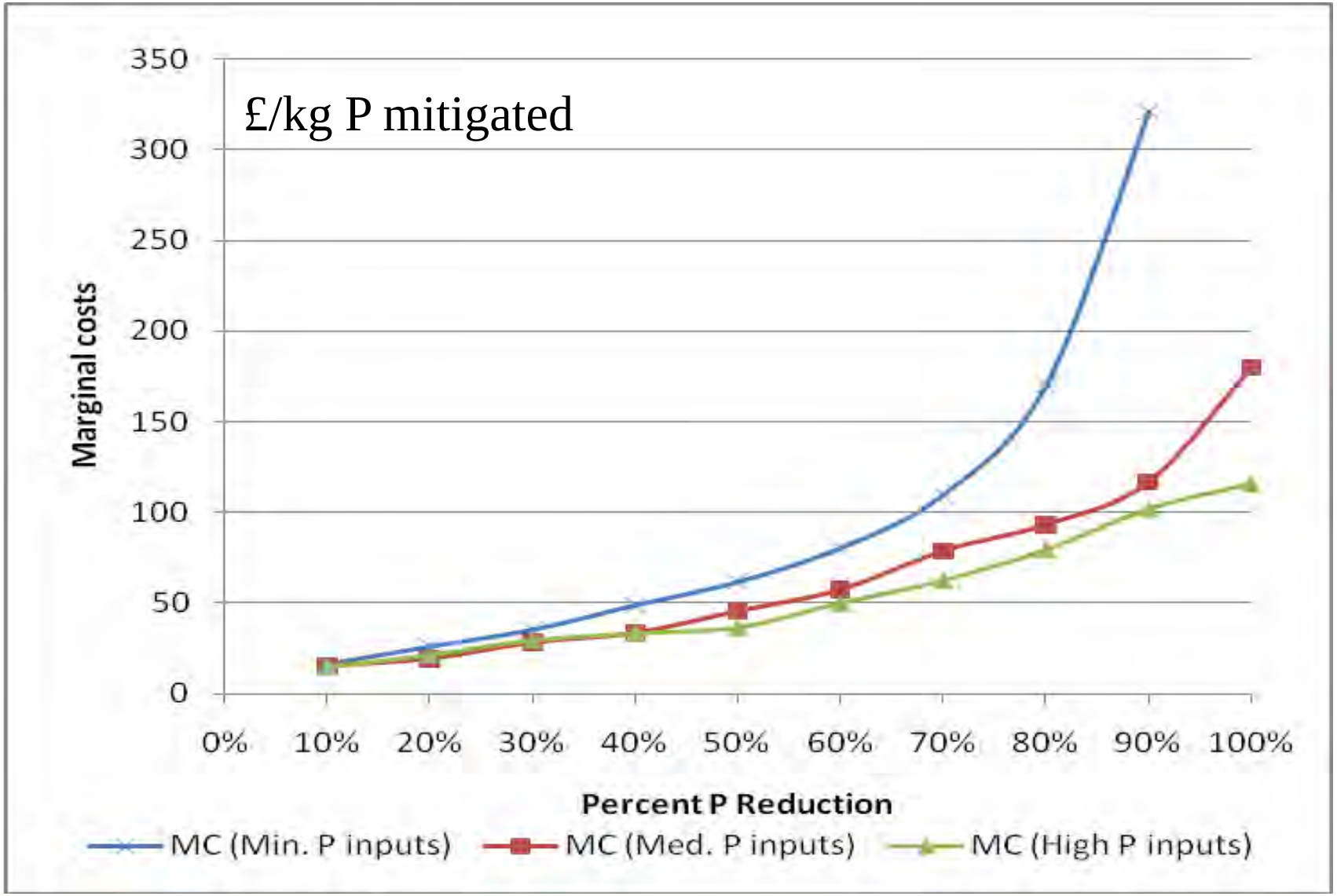
Slope Risk Class	1	2	3
2m (GBRs)[a]	0.5	0.3	0.1
6m +2m (LMOs +GBRs)[b]	0.9	0.75	0.5
20m	1	0.97	0.94

Using data set of >40 papers from Collins et al.(2009)

Gross margin losses from buffer strip

GM class	£/ha	example crop
1	0	rough grazing
2	50	grass> 5years
3	200	grass<5 years, spring cereals
4	300	peas/beans
5	500	spring cereals
6	700	winter cereals
7	1500	potatoes, vegetables

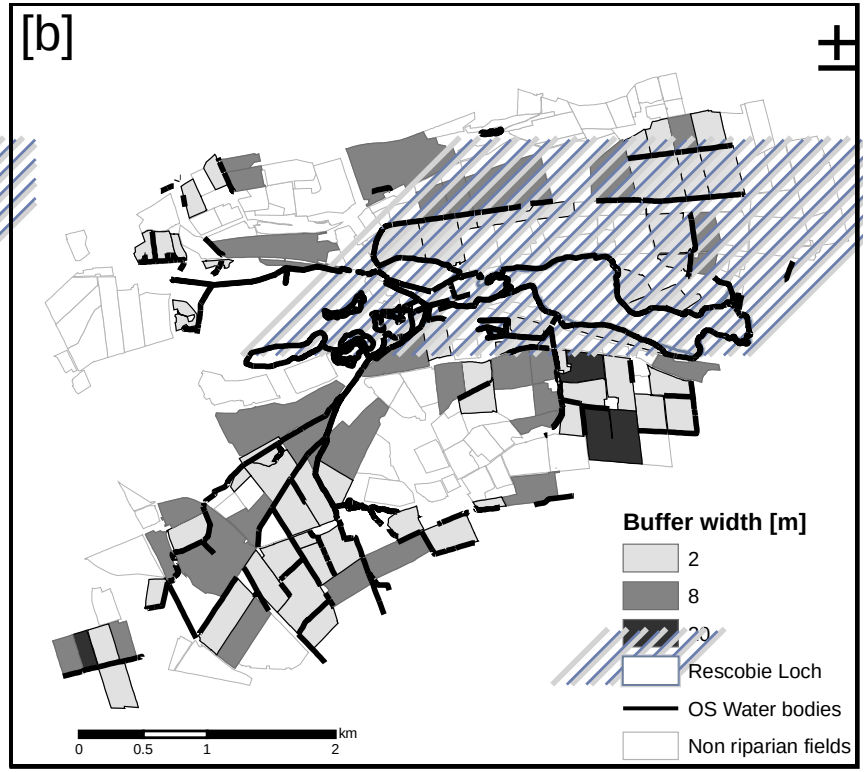
Marginal P mitigation costs using buffer strips



Distribution of buffering to achieve good status in Loch

[a]

[b]



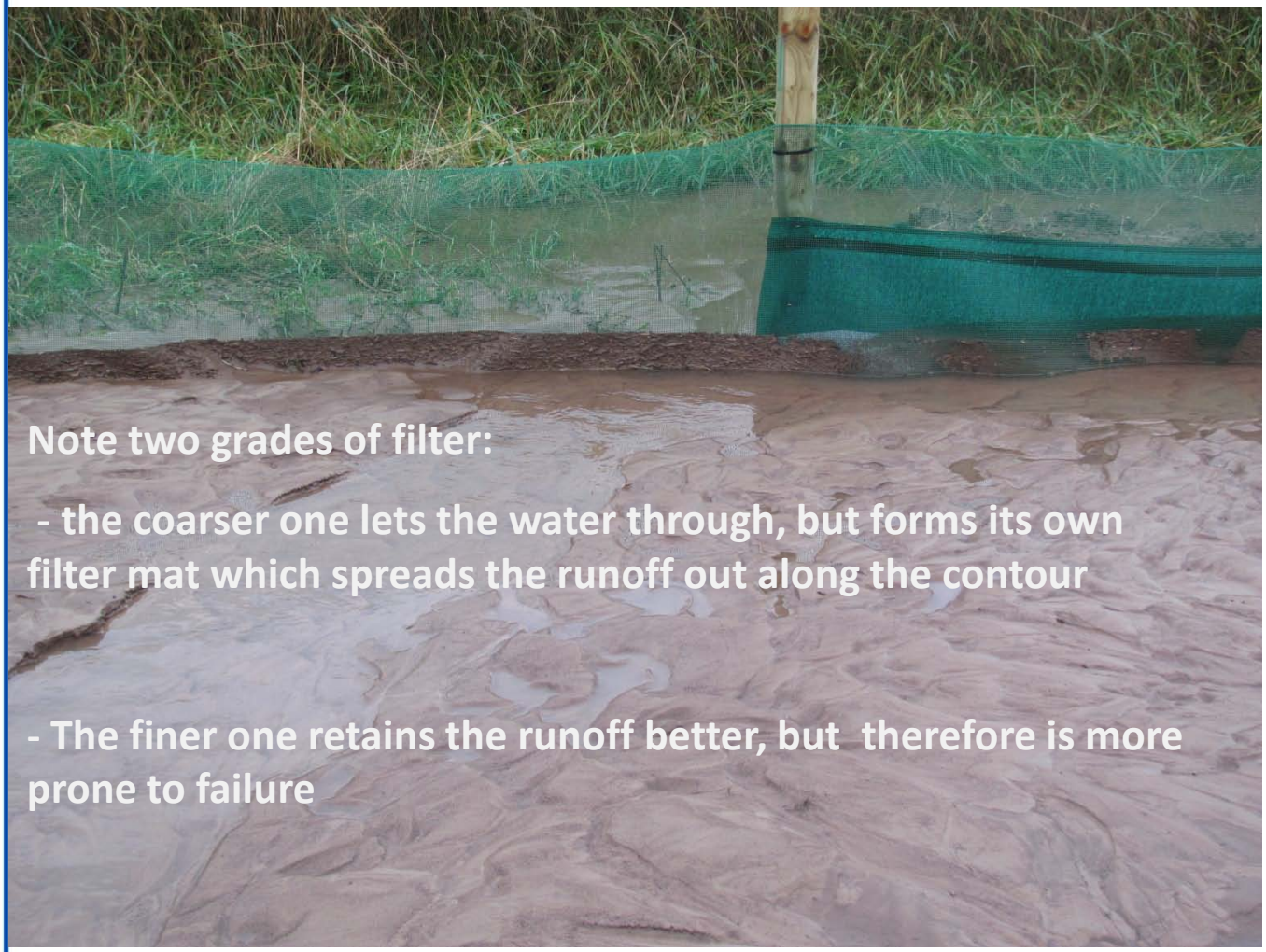
Example Low P loss year

Example High P loss year

Mitigation of non farm P losses

• Septic tanks	£35/kg P
• Small sewage treatment works	£15/kg P
• Phoslock (loch treatment)	£200/kg P

Filter fences help mitigation of erosion after potatoes

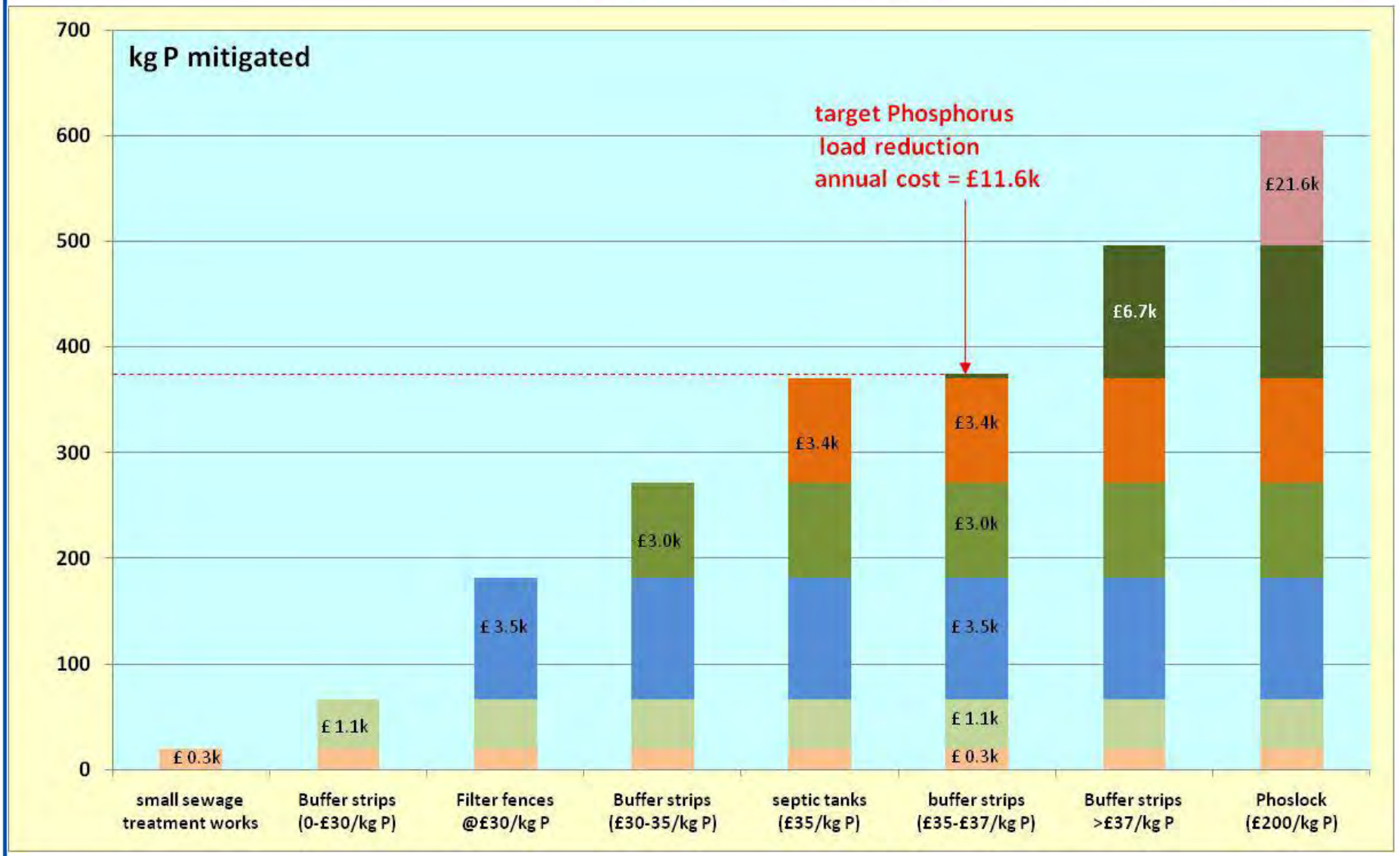


Ca. 40 tonnes of soil retained from 19ha field

(see also poster)

Estimated cost:effectiveness £30 per kg P trapped

Cost:effectiveness analysis



Is pollution mitigation cost-effective?

Yes, if measures suited to the landscape and land use are selected…

we estimate expenditure of £12k per year, targeted at soil erosion control and septic sources, would achieve target reductions

Need to get more targeted spatial data on hotspots and compliance with regulations

Costs to achieve target P reductions (ca. £200/ha of loch surface) are modest compared with estimates of value of improvements