Water level management for ecosystem services in the Lunan Water, Angus

– should we give nature a little help?

Andy Vinten

Orla Shortall

Laure Kuhfuss

Ina Pohle

The James Hutton Institute

The Scottish Government
Riaghaltas na h-Alba

RESAS funded research and knowledge exchange (2006-2016)

- Lunan Diffuse Pollution Monitored catchment was set up to assess the effects of compliance with diffuse pollution regulations and identify cost:effective methods of pollution mitigation at a range of scales

Lunan Water A=134 km²

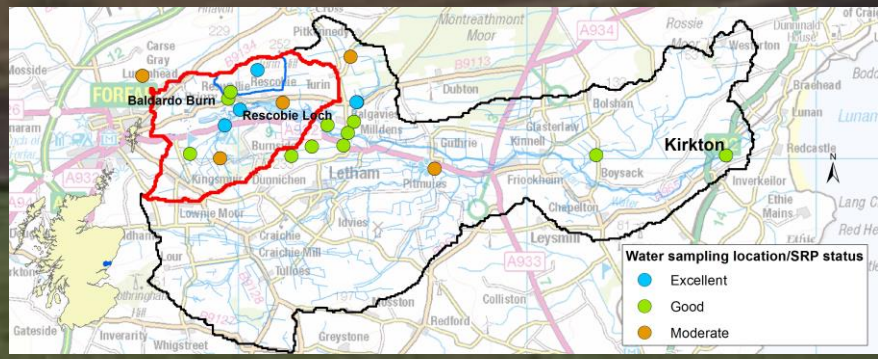
Rescobie Loch A= 22 km²

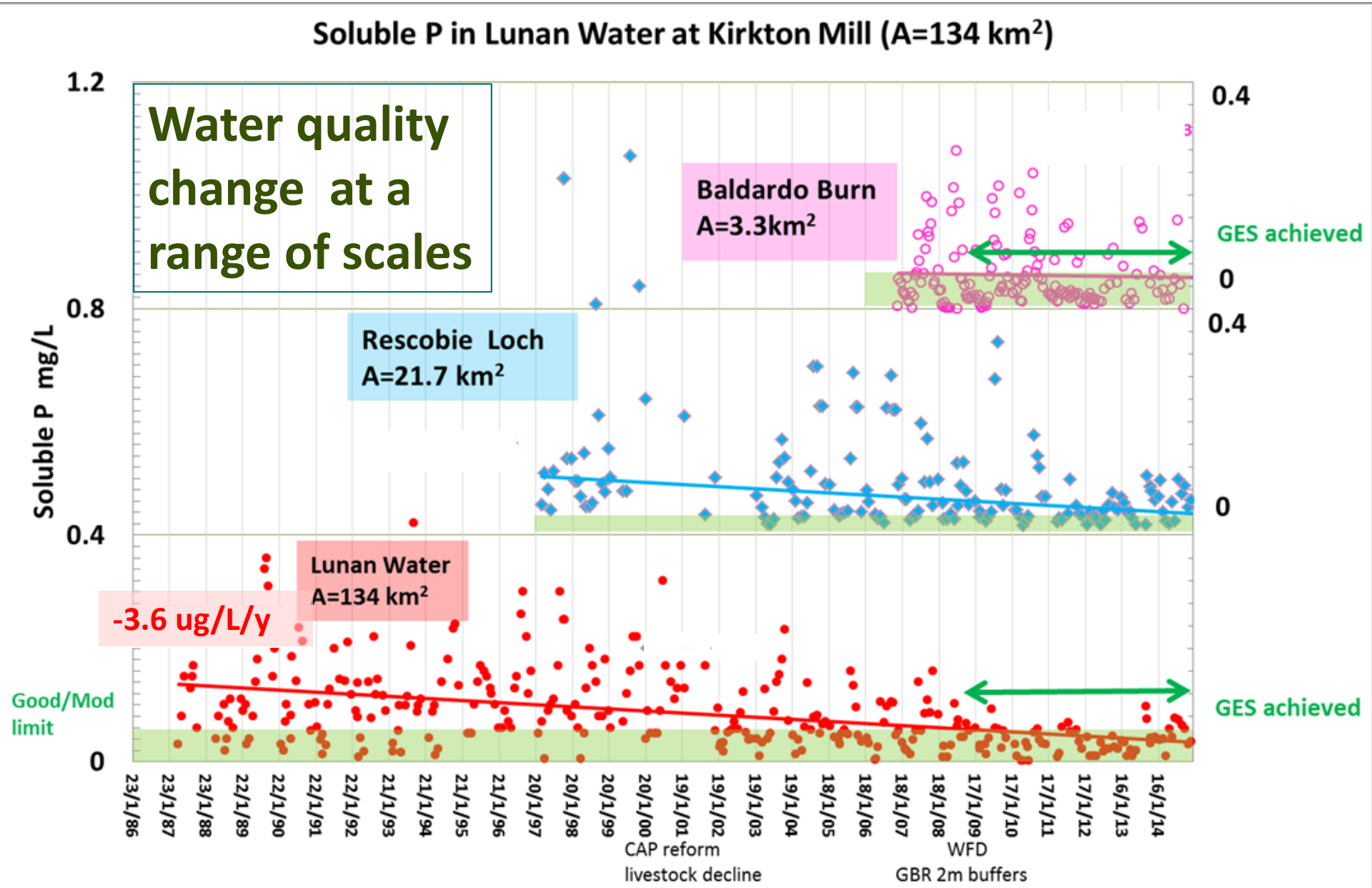
Baldardo Burn A=3 km²

Now extending this to consider multiple benefits

(eg flooding and drought mitigation)

and wider ecosystem services





NVZ Action Programme

Letham STW upgrade

PESLES*

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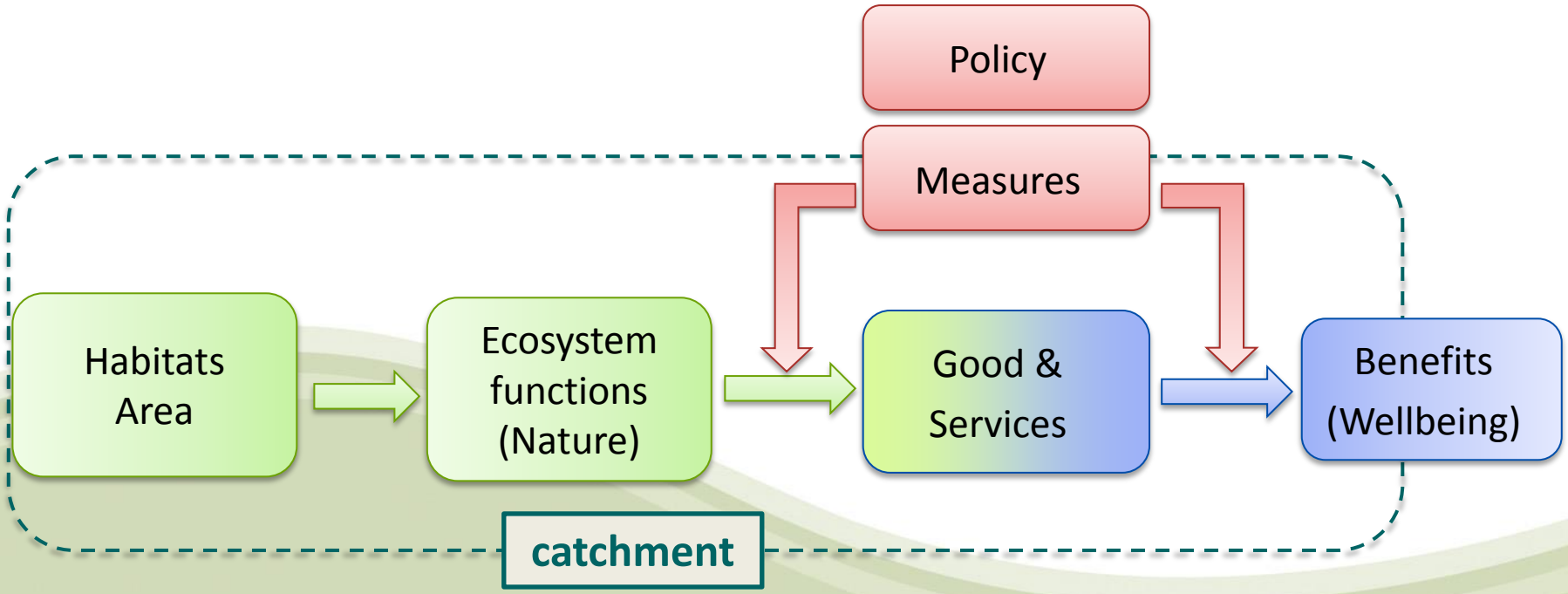
*Payment for Ecosystem Services – Lessons

The Ecosystem Service Approach

- The Ecosystem Service Approach is an ***understanding of the linkages between nature and human wellbeing***, central to which is the notion of ***ecosystem services*** (benefits to humans) and their valuation
- The key elements of an Ecosystem Service Approach are:



PES definitions

- “incentives offered to farmers or landowners in exchange for managing their land [and water] to provide some sort of ecological service”.

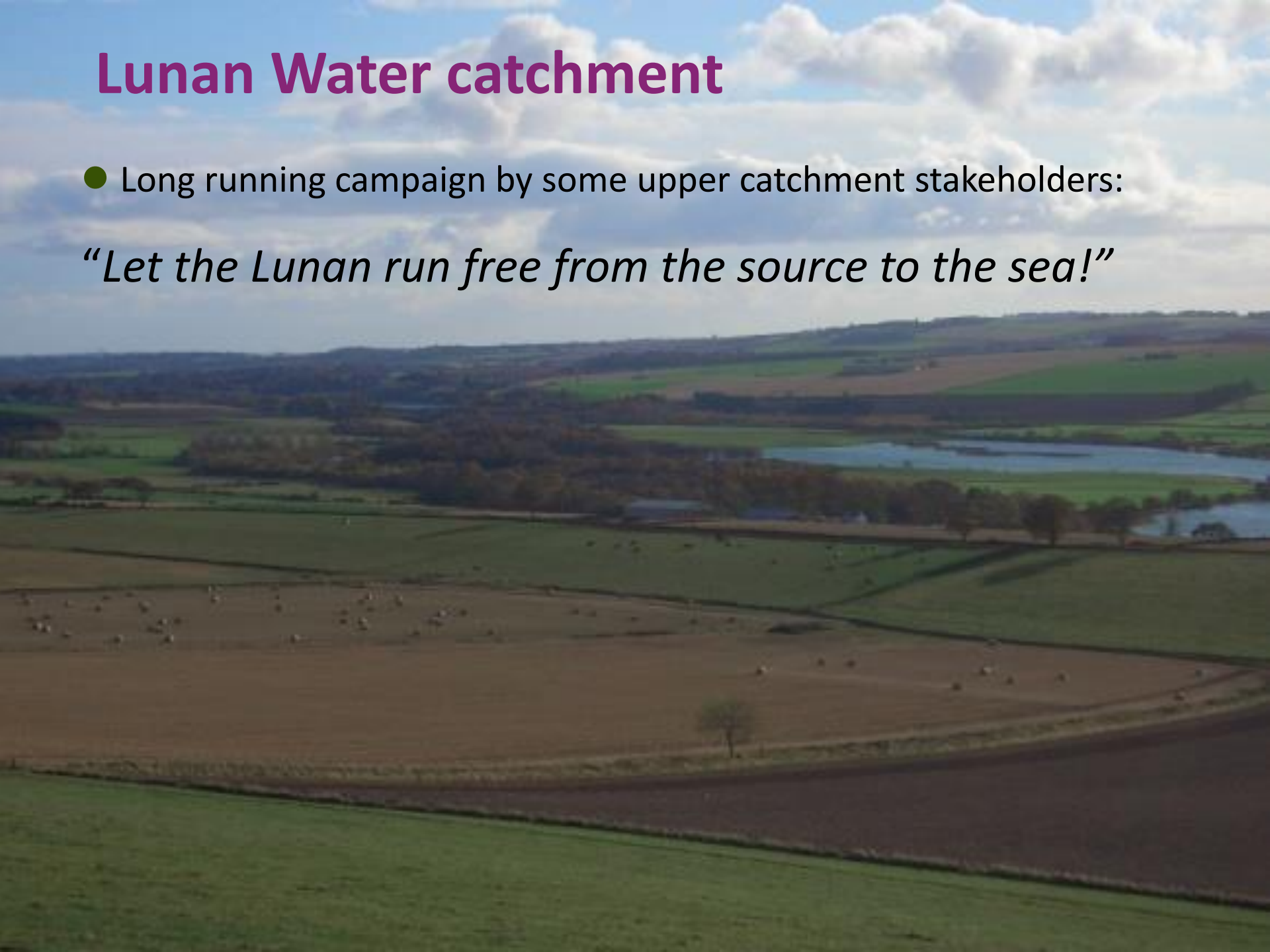
- “a transparent system for the additional provision of environmental services through conditional payments to voluntary providers.“

Tacconi, L. (2012). Redefining payments for environmental services. Ecological Economics, 73(1): 29-36

Lunan Water catchment

- Long running campaign by some upper catchment stakeholders:

"Let the Lunan run free from the source to the sea!"



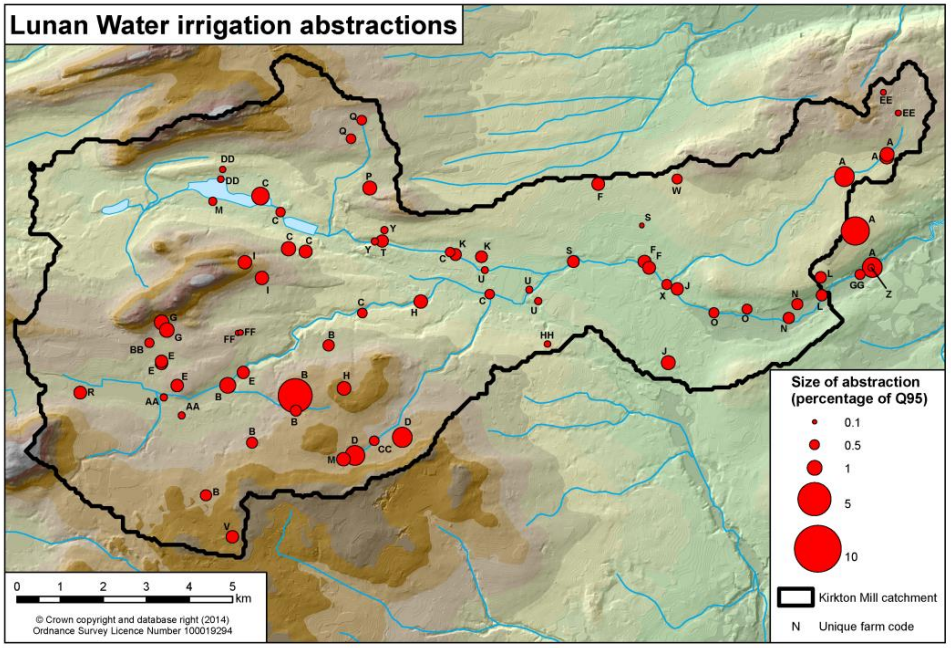
PES ideas for the Lunan Water

- Water for all

- Fishing for farmers

- Less erosion - less dredging

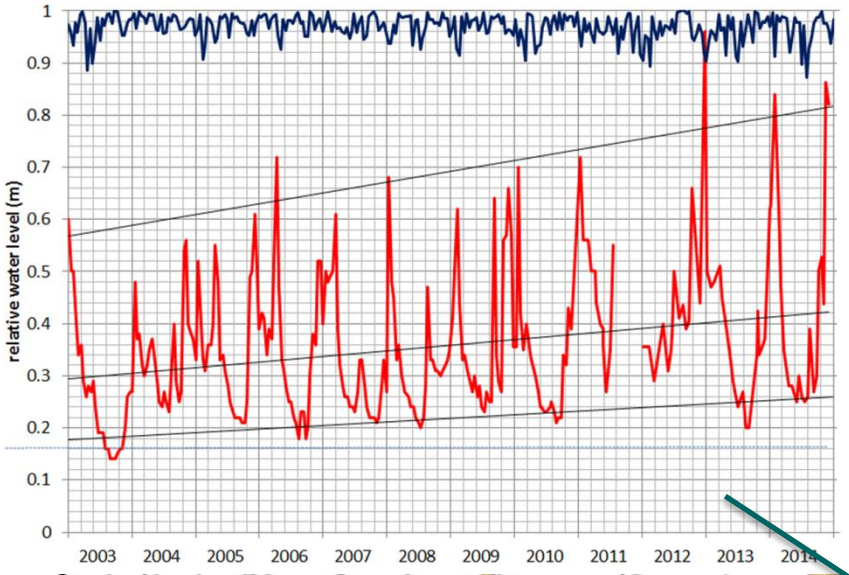
Water for all issues

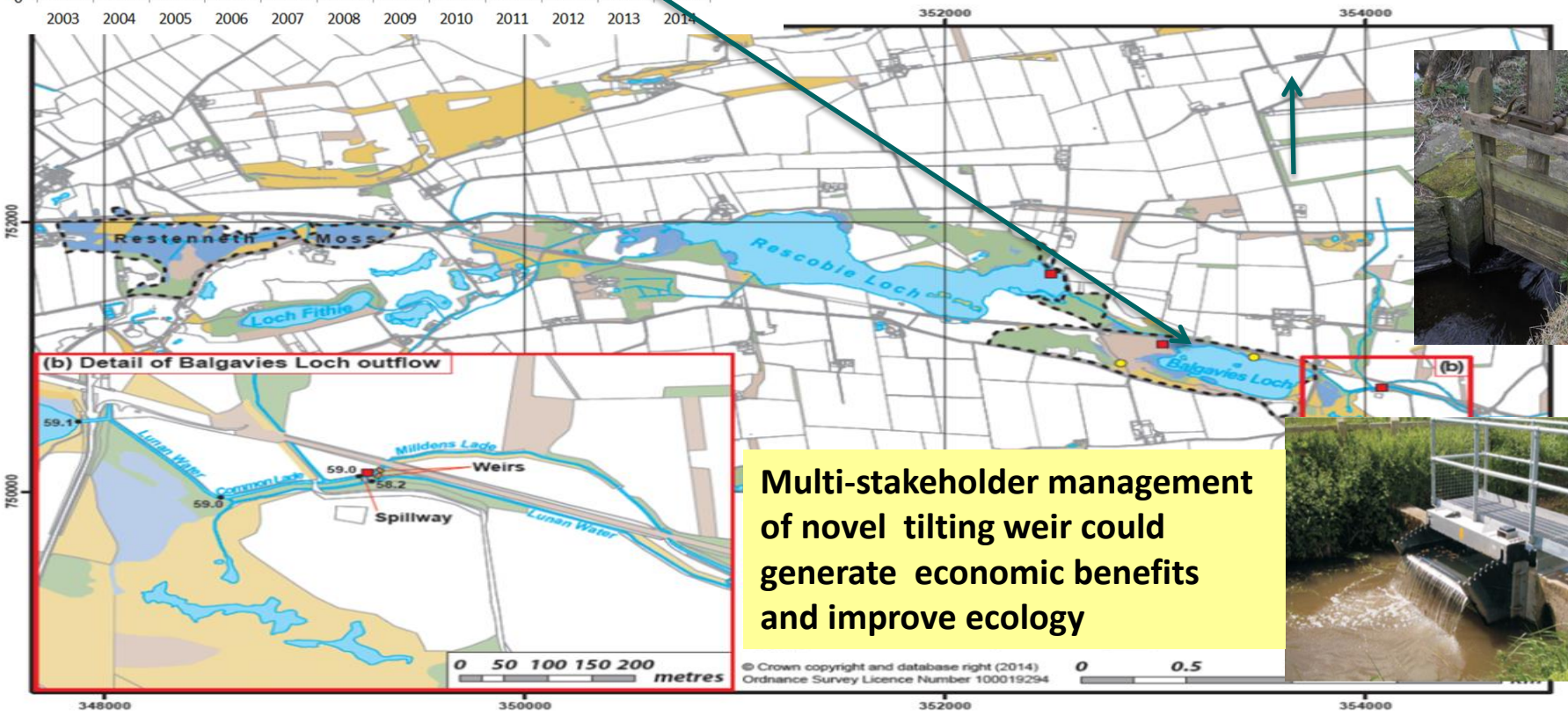


Water levels in Balgavies Loch

Maxima:
slope= 8mm/y per year, p=0.046

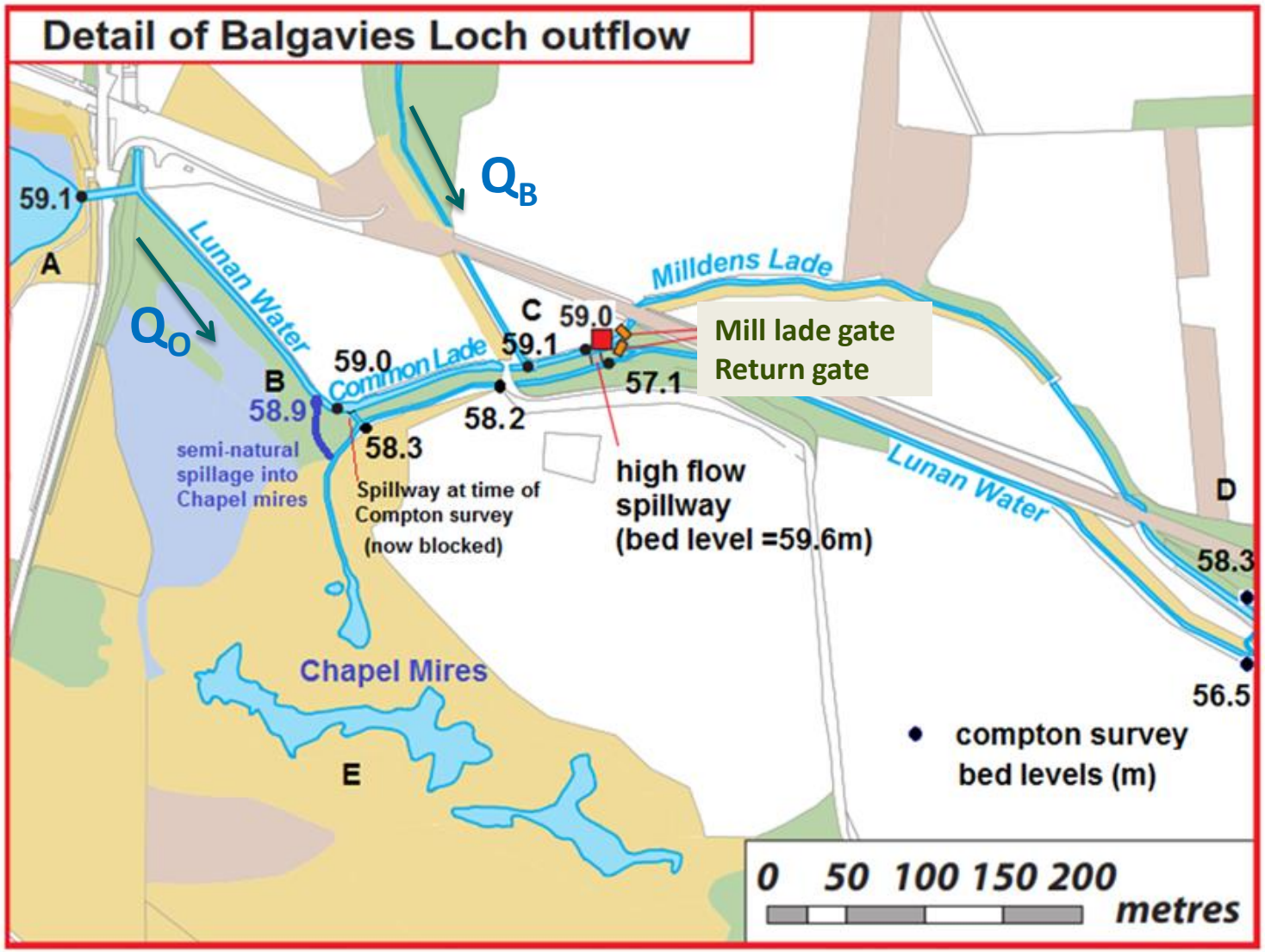
Minima:
slope= 6mm/y per year, p=0.011



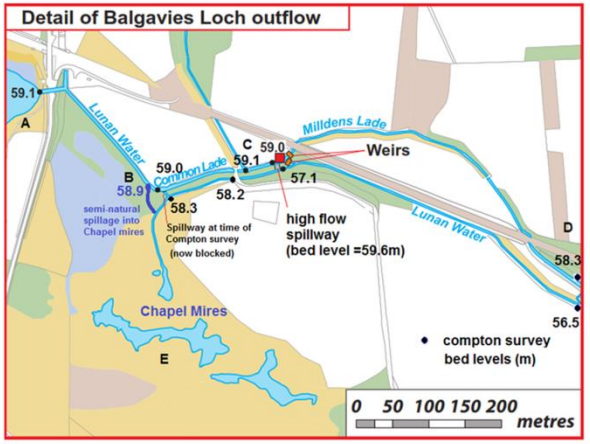


Multi-stakeholder management of novel tilting weir could generate economic benefits and improve ecology

Hydraulics downstream of Balgavies Loch



Water levels in Balgavies Loch and at Milldens weir



Water for all

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Public and private local demand for reduction in flood risk and increased water use at low flows; need to conserve wetland ecology.

Water licensing for irrigation is done by SEPA, but WFD status downgraded due to low flows based on weak information on actual useage.

Current flow barriers at Guthrie/Milldens are not historic, so modification/removal may not be eligible for Water Environment Fund

Community interest company (CIC) raises local finance for licensing, installation and management of upgrade to hydraulic control systems at current "pinch points". Upgrade could be programmable tilting weirs, low head hydro, thermal energy recovery (see River Tay)

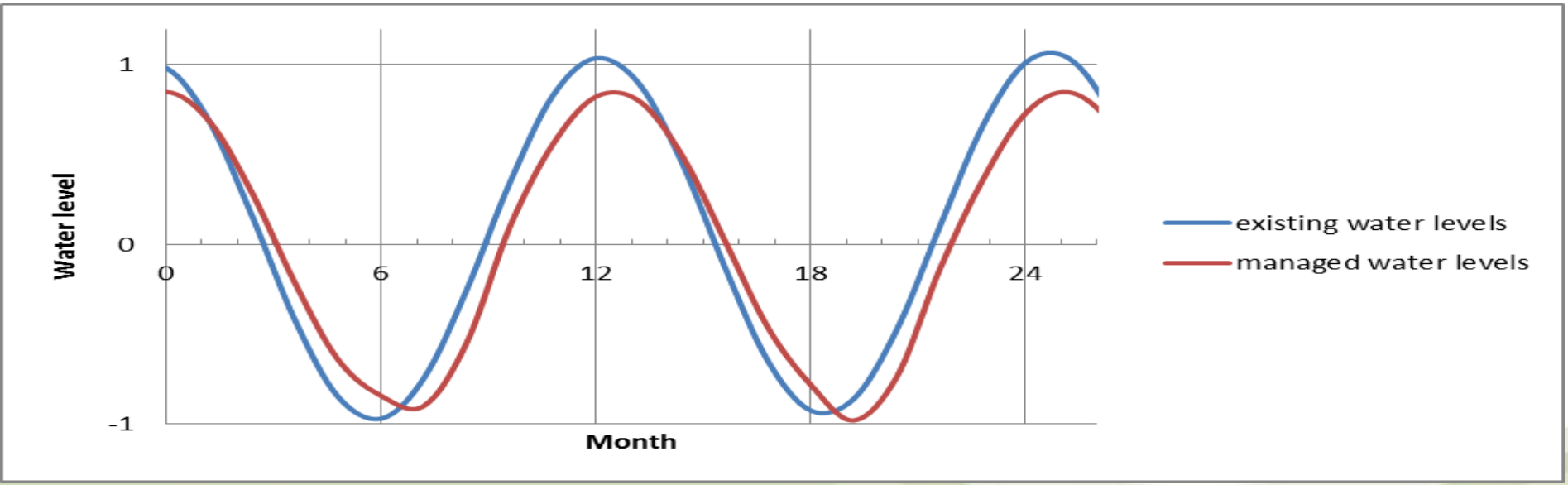
Flexible management regime designed and implemented by consultant /energy company recruited by CIC with local participation

Technical, socio-economic and governance challenges

Economic (eg Natural Capital Accounting) assessment of benefits/costs; Appraisal of implementation process

Technical challenges: What are we aiming at?

- Counteract upward trend in maximum levels on lochs
- Maintain/increase water levels for u/s ecology in early summer
- Availability of water for release to sustain low flows during irrigation demand period in July/August
- Protection of d/s wetland ecology from nutrient rich waters



Could this be achieved with existing hydraulic structures at Milldens?

Simple water balance model for predicting loch levels:

$$Q_O = (Q_B A_{LC}/A_{BC}) - A_L \frac{dH_L}{dt}$$

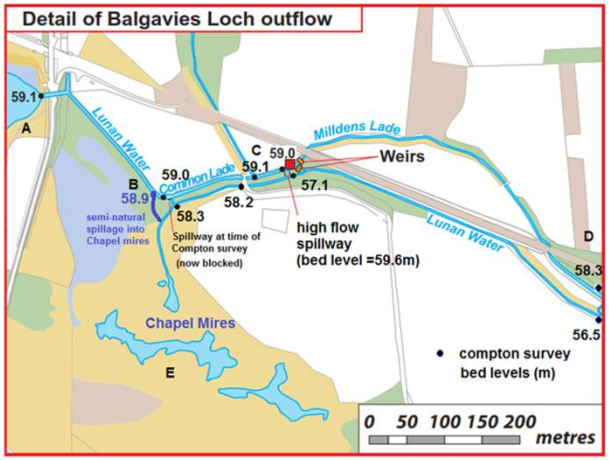
H_L=Water level in lochs and wetlands which responds to stream and direct rainfall inputs and discharge from Balgavies Loch (m above ordinance datum).

A_L=Contributing area of open water and wetlands which show water level change (ha).

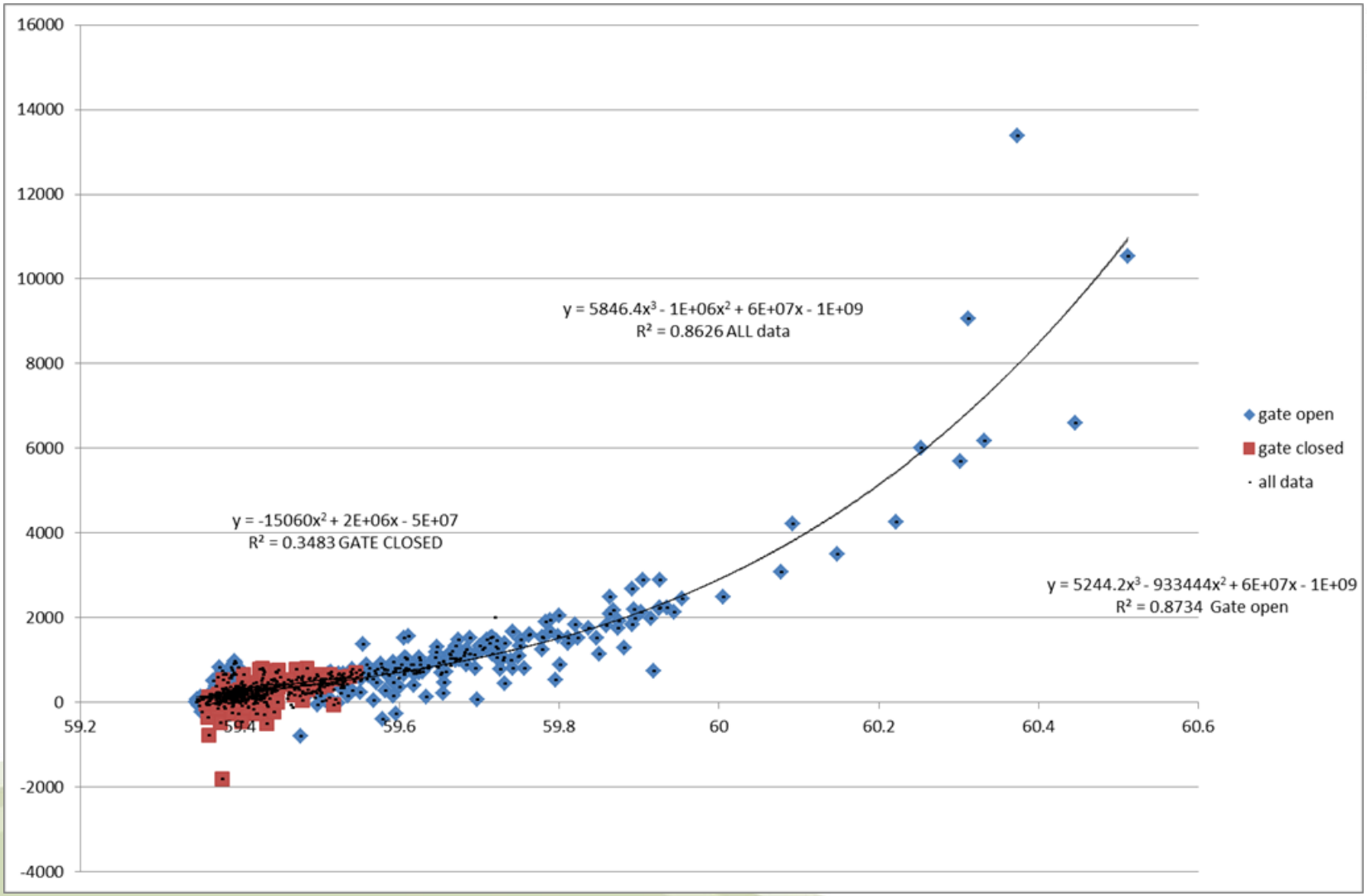
A_{LC}=total catchment area of Balgavies Loch outlet (ca.2933 ha)

Q_B= daily discharge of Balgavies Burn (m^3/d), with catchment area

A_{BC} = catchment area of Balgavies Burn (ca 440 ha)



Qo (L/s) vs Balgavies Loch Level (H_L)



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Observed and modelled Balgavies Loch water levels

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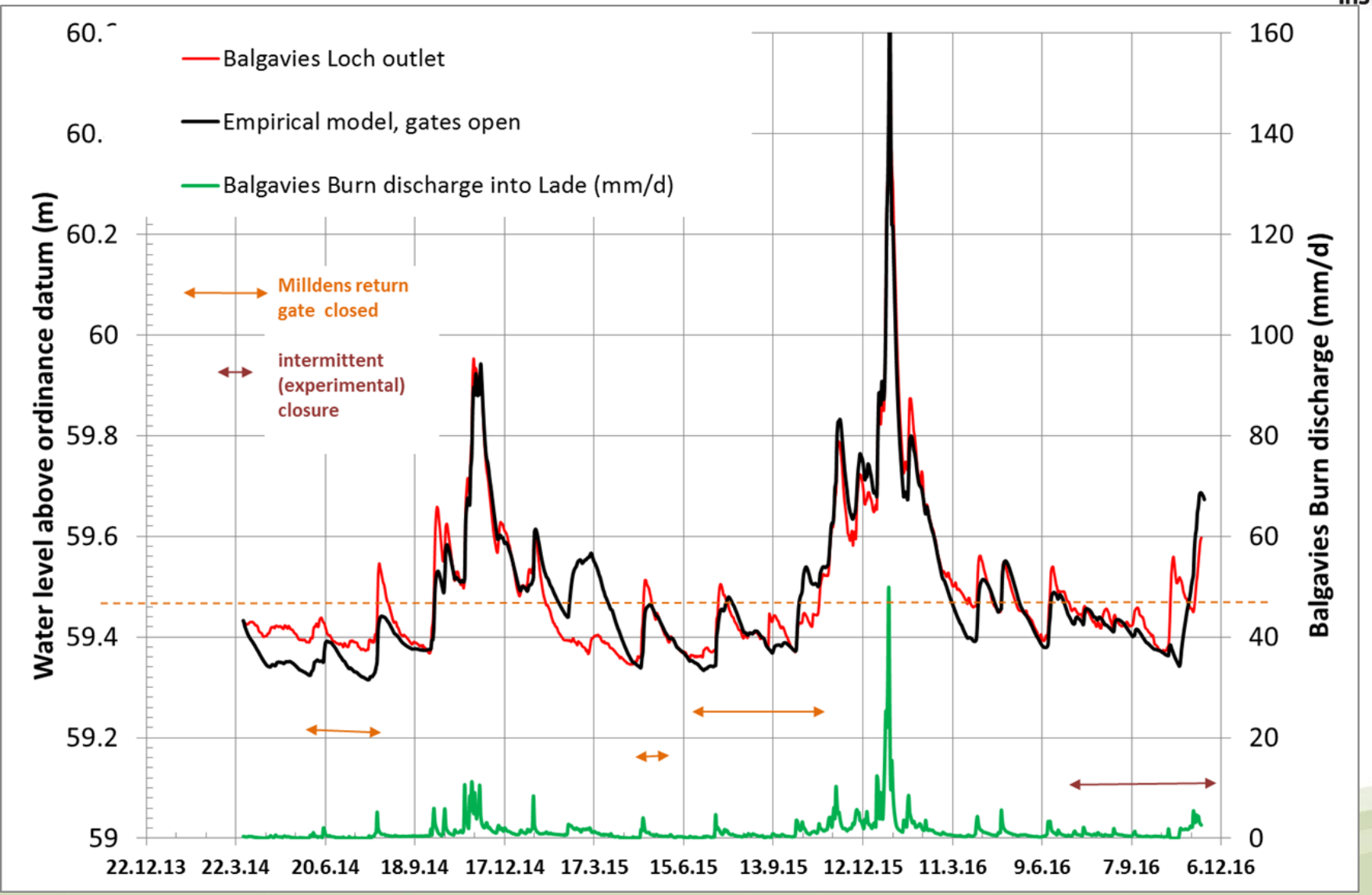

Empirical approach to assess response of loch levels and outflow to gate position

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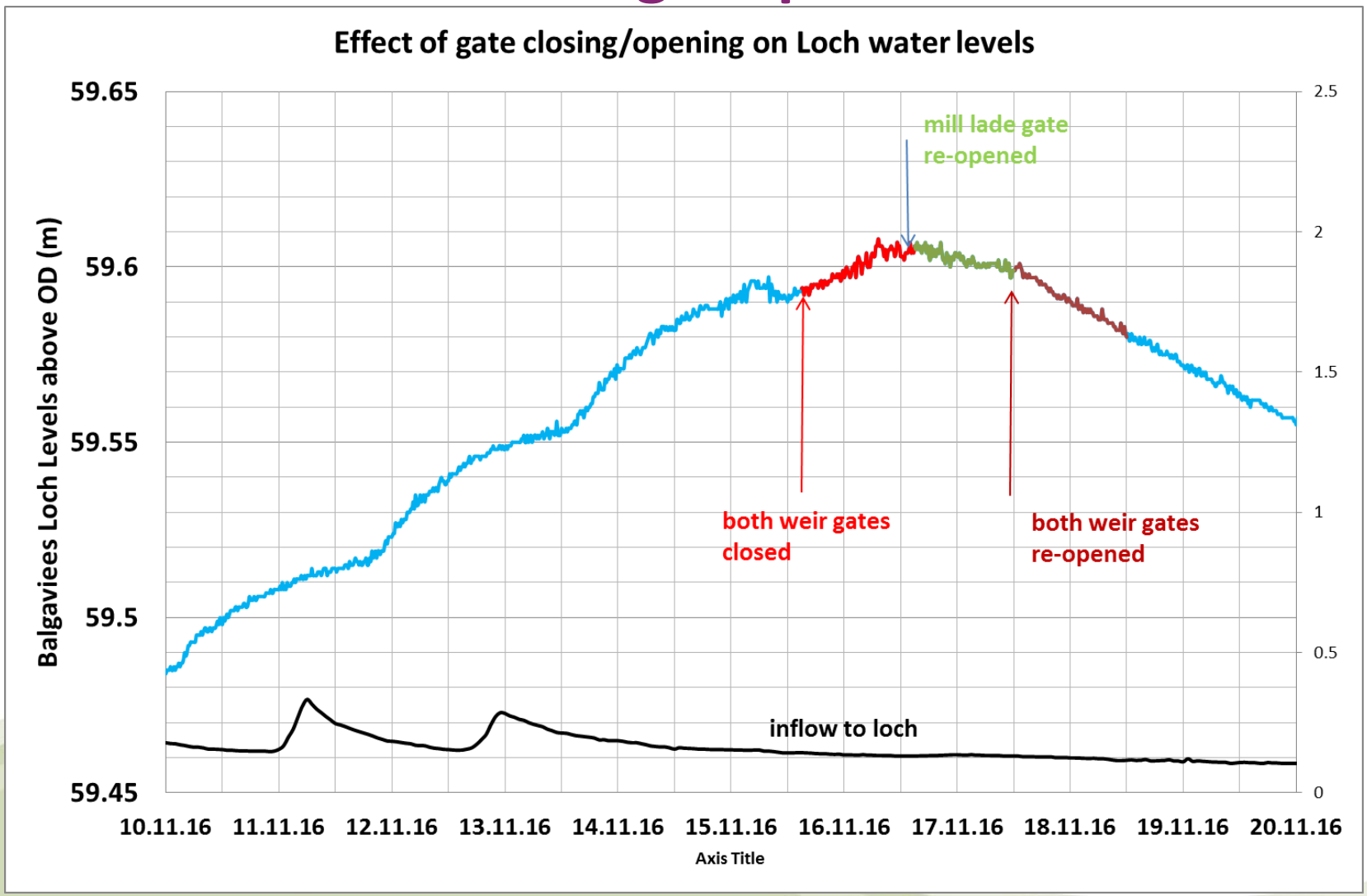
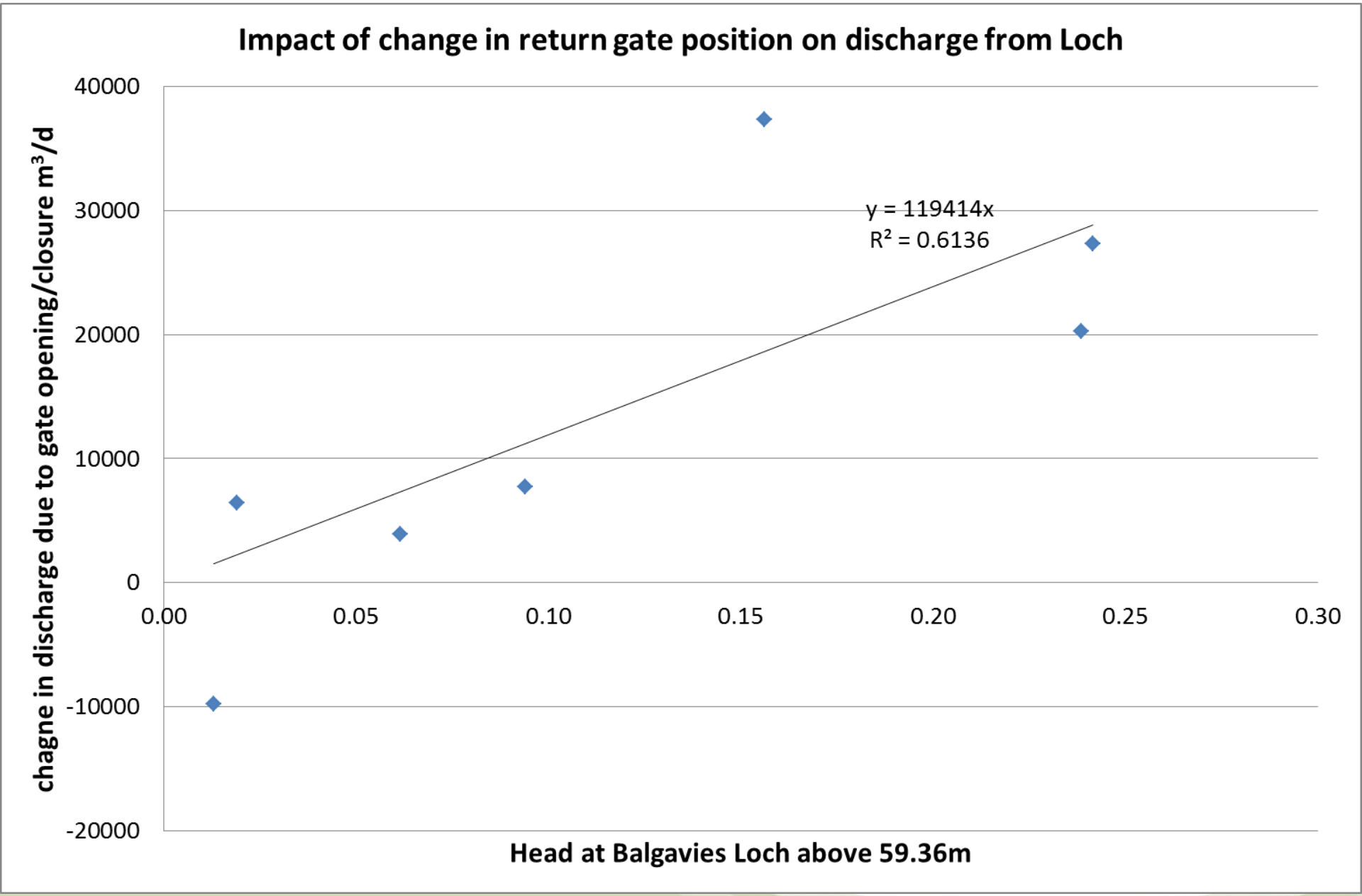
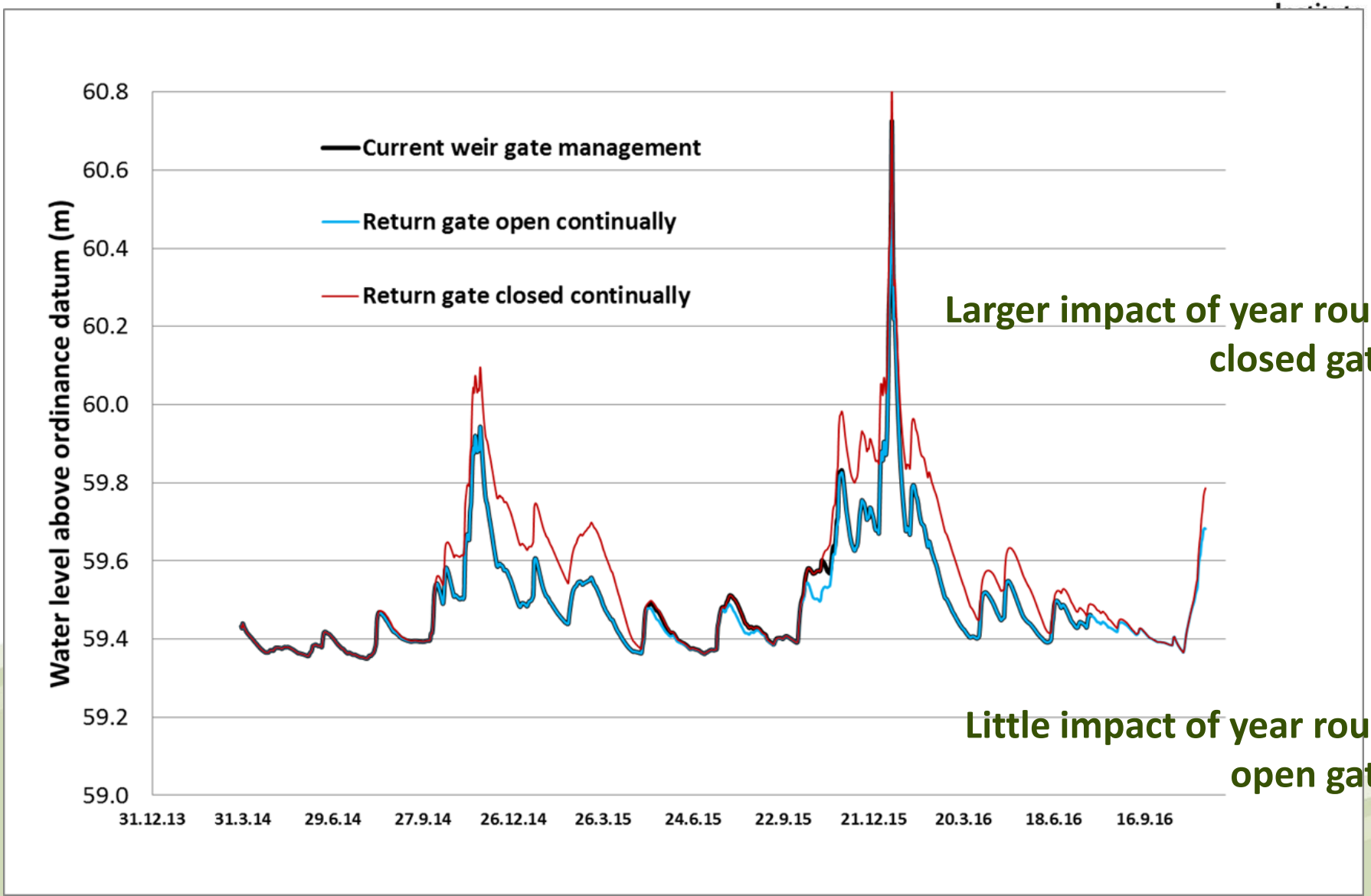



Impact of change in return gate position on discharge from Loch
chagne in discharge due to gate opening/closure m³/d
40000
30000
20000
10000
0
-10000
-20000
0.00
0.05
0.10
0.15
0.20
0.25
0.30
y = 119414x
R² = 0.6136
Head at Balgavies Loch above 59.36m

Impact of changing management of current gate on water levels



Ecosystem service benefits to be derived from water level management with additional tilting weir

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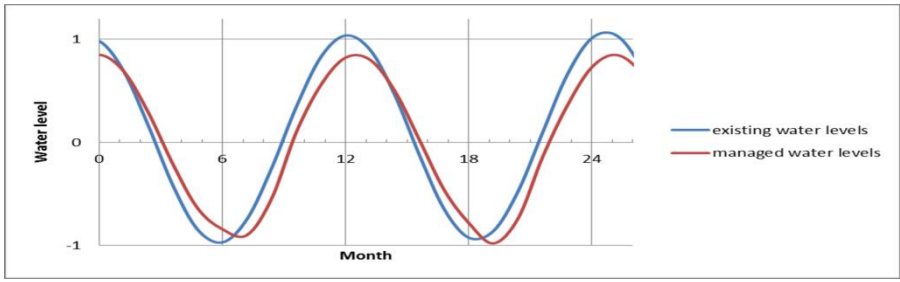
- Irrigation availability at low flows
- Mitigation of upstream flooding
- Mitigation of downstream flooding
- Enhancement of wetland ecology



- Add in **1.5m wide variable level weir with H minimum= 58.9m**
- Fully open from Sept to Jan
- Fully closed from Feb to June
- Variable base 4cm below water level at weir during July and August

Bazin's formula to estimate the flow over an additional weir

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$$Q_W = 0.66 \times cB \times (2g)^{0.66} \times H_W^{1.5}$$

where;

Q_W = water flow rate, m^3/sec

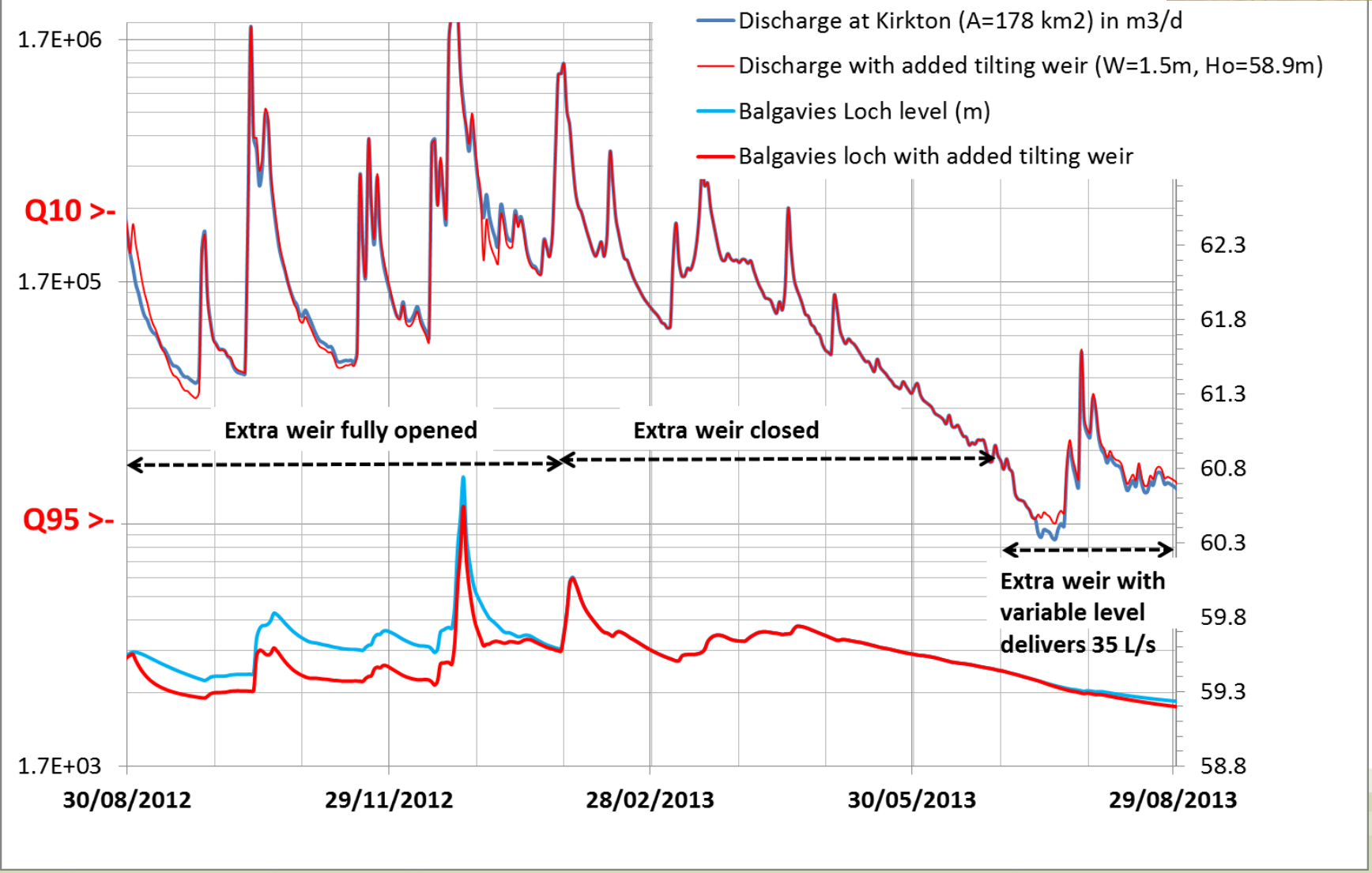
B = width of the weir, metres*

c = discharge coefficient, average 0.62

g = gravitational constant, 9.81

H_W = Height of the water over the weir, measured behind the weir edge, m

Impact of added tilting weir on Balgavies Loch levels and water availability for irrigation at low flows



Impact of added variable level weir on flood risk

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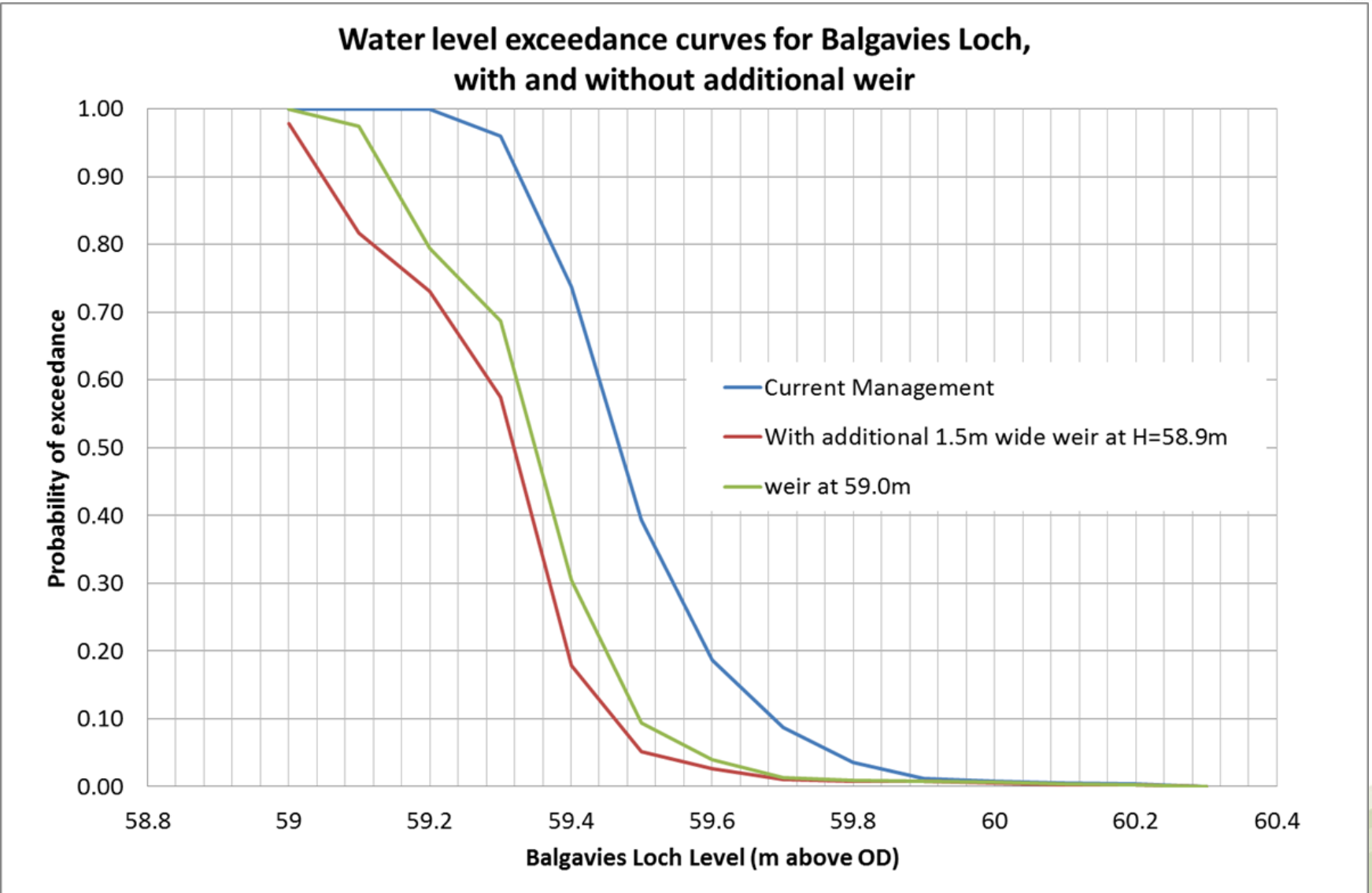
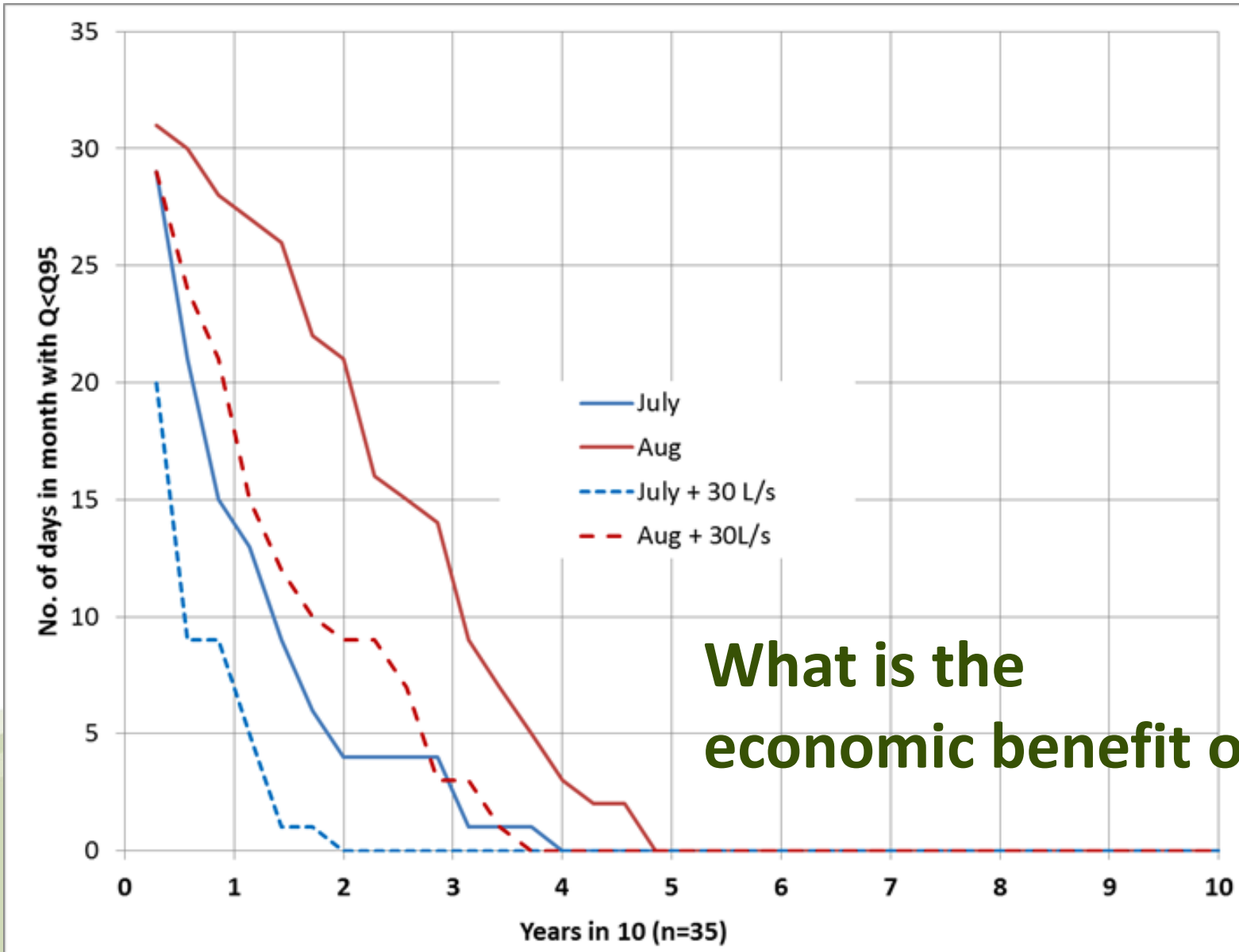


Risk of Q<Q95 at Kirkton Mill



What is the economic benefit of this?

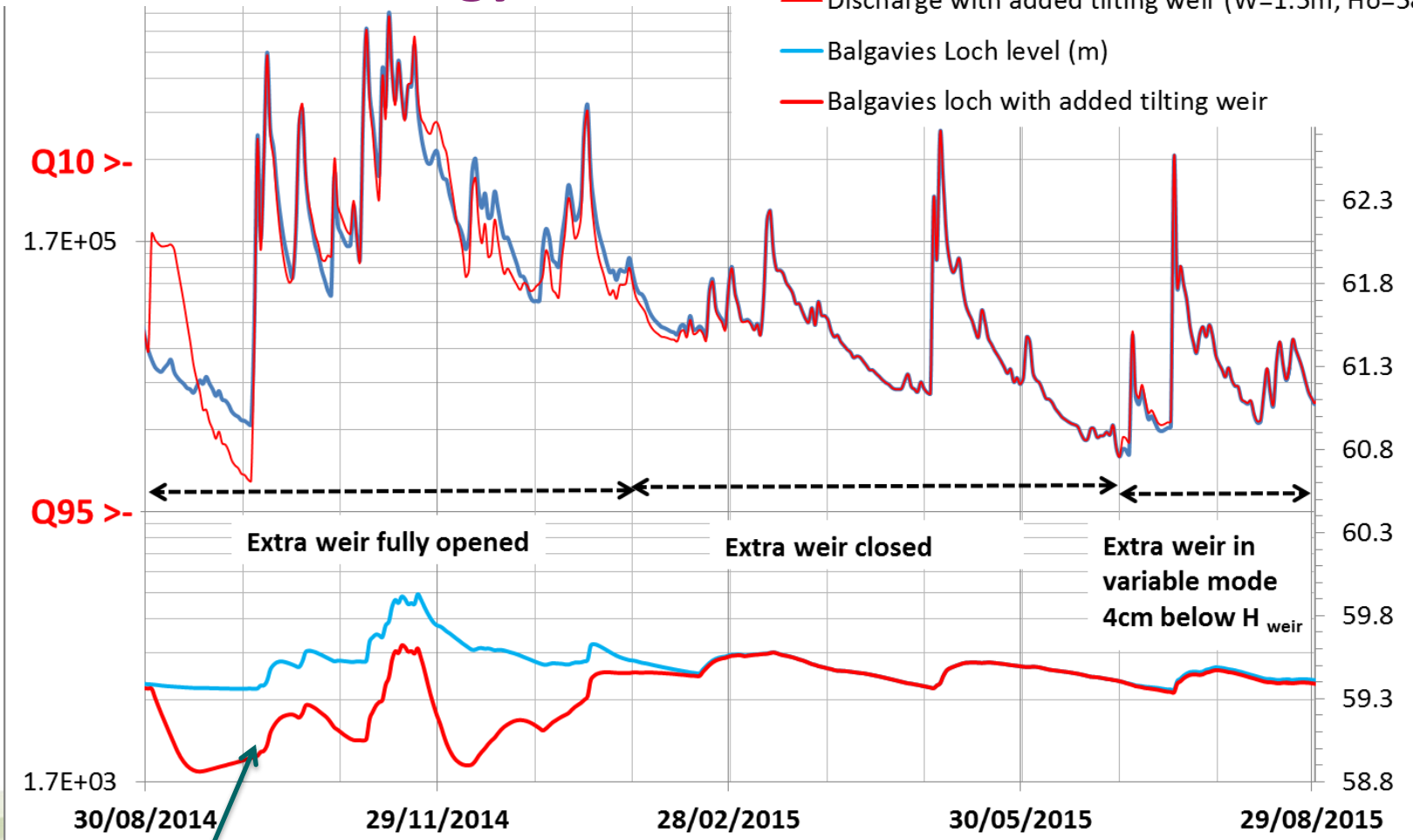
Crop(potato) water economics: Crabtree et al (2002) Report on impact of irrigation controls Tyne and West Peffer catchments (E. Scotland)*

Economic impact of restricting irrigation at low flows

- **Across 10 years modelling, mean marginal value of irrigation water of £5.2/m^3**
- Lunan: In 2013, the reduction in abstraction if restriction took place at 10% of Q_{95} would have been 19,400m^3 (≅ 2 cm water in Balgavies/Rescobie wetlands)
- The marginal value of this water for irrigation is approx. £100,000
- Lunan flow data suggest 3 years in 10 are as dry or drier than 2013
- Annualised benefit of a scheme to mitigate low flows to enable irrigation is £30,000
- Also other benefits:
  - to low flows/ecology downstream which is at < Good Status for WFD
  - To upstream wetland ecology

***wwwscotlandgovuk/library5/agri/Potato%20study%20final%20reportpdf**

Impact of added variable level weir on wetland ecology



Late summer nutrient rich loch water only enters chapel mires (oligotrophic wetland) if $H_{loch} > 58.9m$

RTK-GPS survey of water margin at Chapel Mires – May 7-11 2015

The James Hutton Institute

Master map coverage

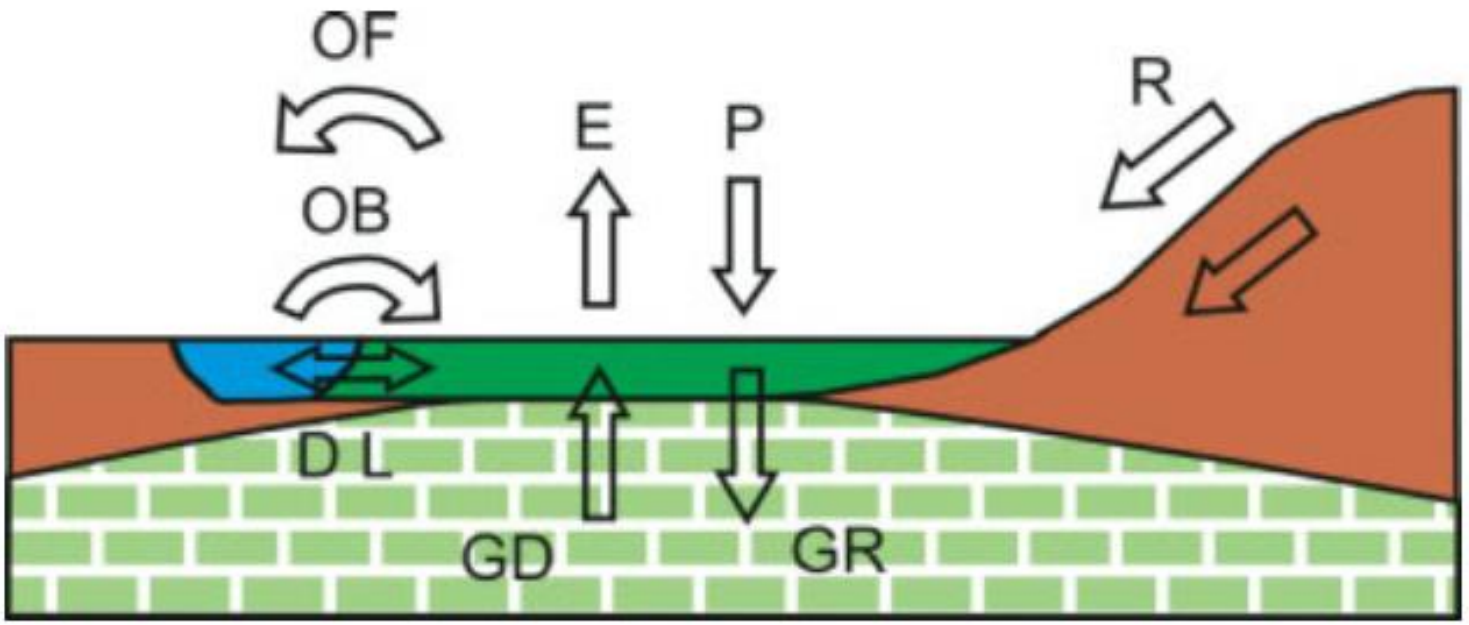


Figure 2. Conceptual cross-section diagram of a floodplain wetland (green) in direct contact with underlying aquifer (brick) and river (blue). Hydrological inputs are: precipitation (P), over-bank flow (OB), runoff (R), lateral inflow (L) and, when the water table is high, groundwater discharge (GD). Outputs are: evaporation (E), surface outflow (OF), drainage (D) and, when the water table is low, groundwater recharge (GR). After Acreman and Miller (2007).

Surface water elevation in S to N transect of Chapel Mires

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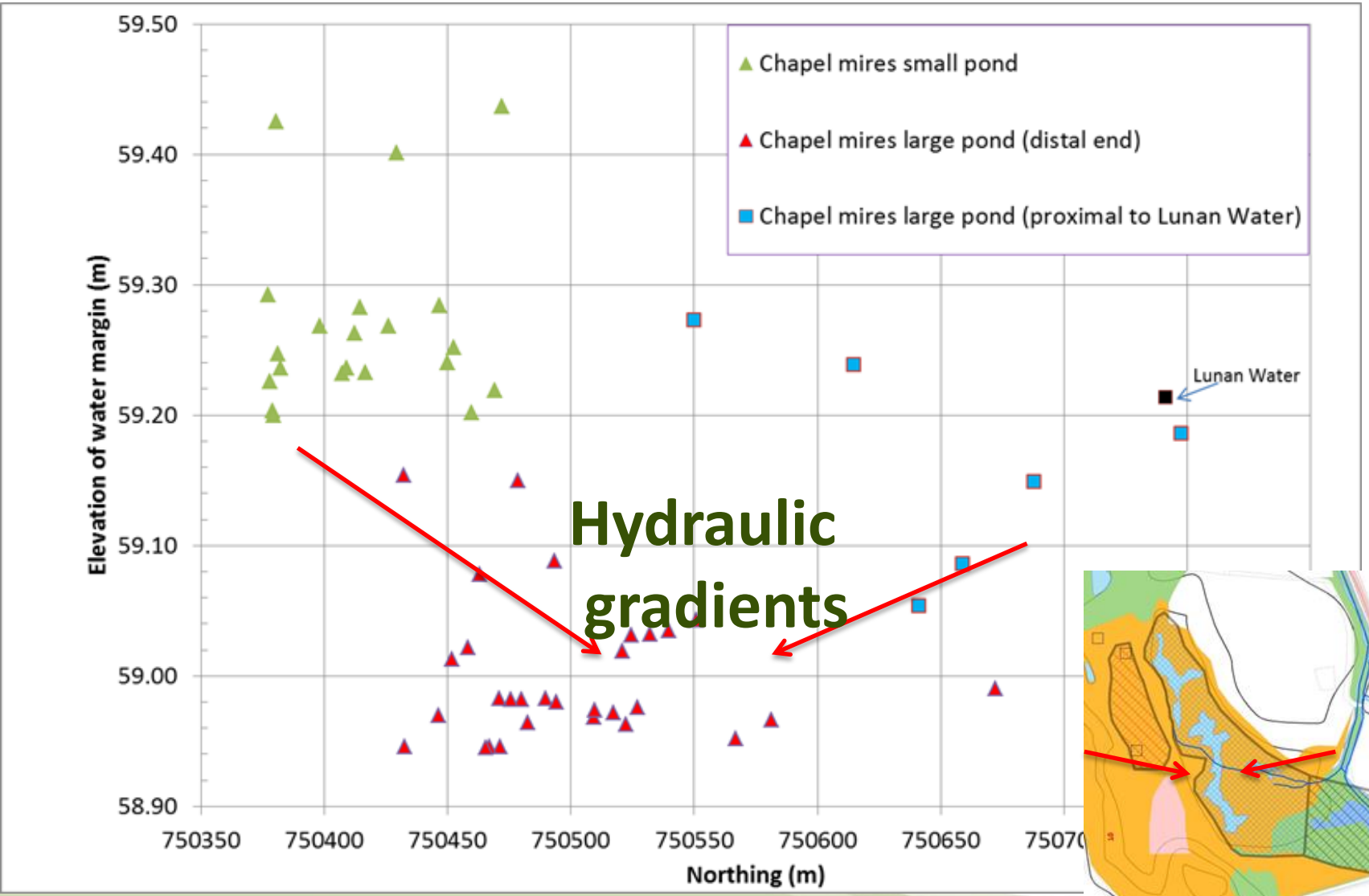

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Flexible management regime designed and implemented by consultant /energy company recruited by CIC with local participation

Technical, socio-economic and governance challenges

Economic (eg Natural Capital Accounting) assessment of benefits/costs; Appraisal of implementation process

Stakeholders

- Riparian owners (farmers, residents)
- Wetland ecology and conservation (SWT, SNH)
- Fishermen (Rescobie Loch, Lunan Water)
- Downstream irrigators (farmers, horticulture, quarry)

- Steering Group has been formed of :
- Angus Council (chair), SNH, SEPA, ERFT, SWT, JHI, Univ. Dundee ,(NFUS)

Next steps

- Agreement with the riparian owners and Agencies to be sought for a tilting weir installation with base level minimum of 58.9m
- Proof of concept (technical /economic/governance) over next 3-4 years
- A JHI led study be initiated to assess attitudes of SEPA, SNH and d/s farmers to improved management of low and high flows, readiness to pay for management and infrastructure, and views on how this should be governed. ***Orla Shortall and Laure Kuhfuss to lead this study***
- Reinstatement or adoption by stakeholder community at end of project

Social sciences work

Orla Shortall and Laure Kuhfuss

- **Stakeholder views on Water for All scheme.** Scoping interviews with farmers who abstract water. Survey exploring willingness to pay for different ecosystems services among riparian farmers and other stakeholders – less flooding and abstraction restrictions risks and water quality benefits.

- **Stakeholder relationships and farming culture.** Qualitative interviews following from survey exploring relationships between stakeholders and how that would impact on the feasibility of the scheme. And farmer and other stakeholder views on how the scheme fits with soil and water management practices in potato farming and notions of "good farming".

Some initial stakeholder comments…..

- project is like an oil tanker once it is on the move it is very difficult to turn it around
- flooding of B9113 appear easy to resolve by repeated dredging removal of fallen trees
- all interested parties have different agendas and we will never be able to satisfy all
- if things go wrong there must therefore be someone with suitable qualifications to deal with complaints and issues and resolve them.
- Talk of forming a company. Who is going to be on it? Who is going to pay? The success of a committee is disproportionate to the number of people on it.
- The operating of a tilting weir presents all sort of problems and issues:
  - Who will be responsible for it?
  - Has this person got the power to operate it without approval ?
  - Will this person have the expertise? Who will pay for this person?
  - Will a licence be required and who will pay for it?
  - Applying for licences take time and if it takes time will we not miss the optimum time to lower or raise the weir?
  - Who is the operator responsible to?
- Who will benefit? To what degree will those further down benefit from a tilting weir? Will they be prepared to pay on top of what they might already be paying eg abstraction licences and to what extent?
- Who might have a negative response to what is proposed?

Catchment citizenship barometer

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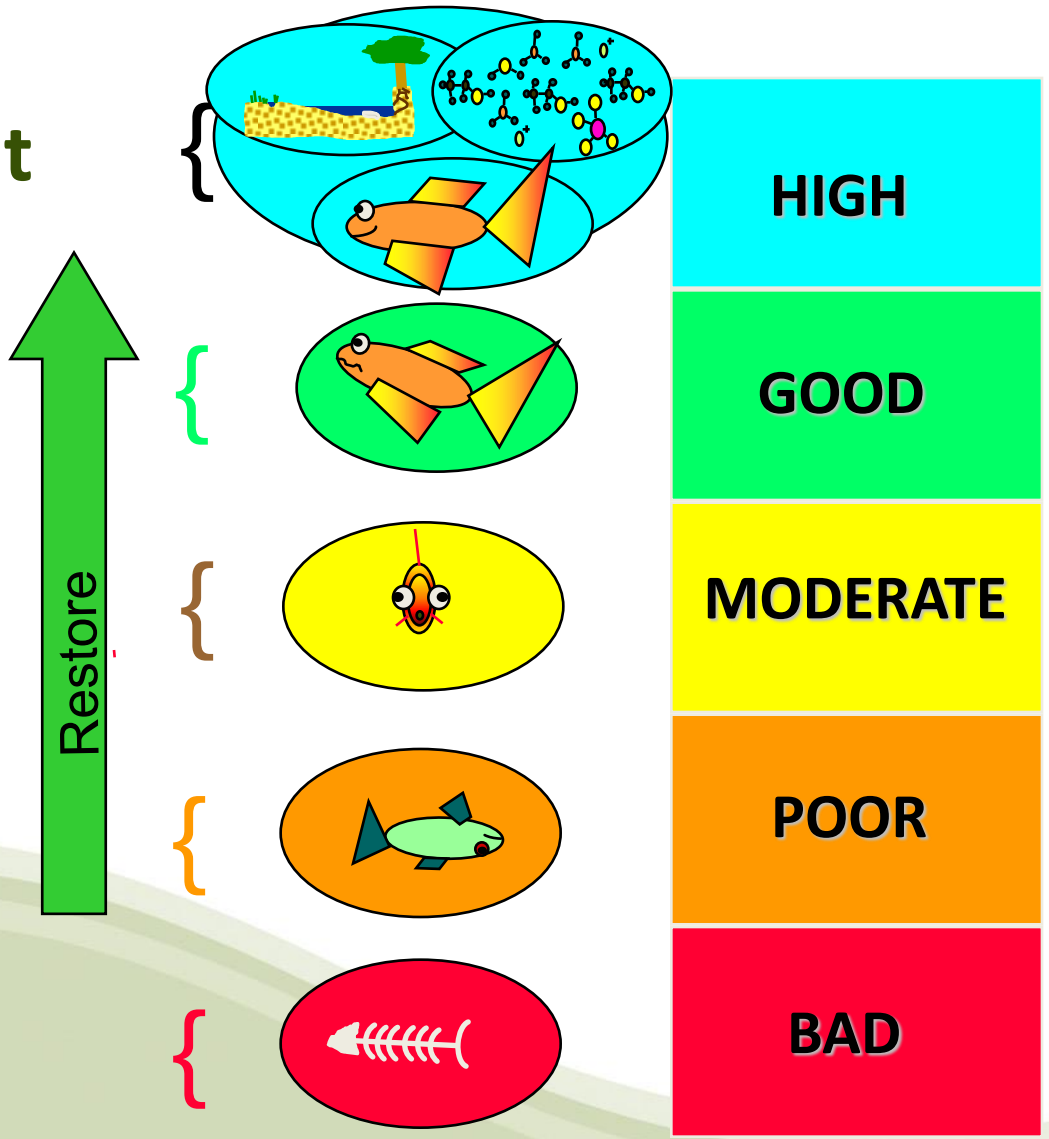
Transcendent values

Mutual benefit

Narrow self-interest



Water level management for ecosystem services in the Lunan Water, Angus

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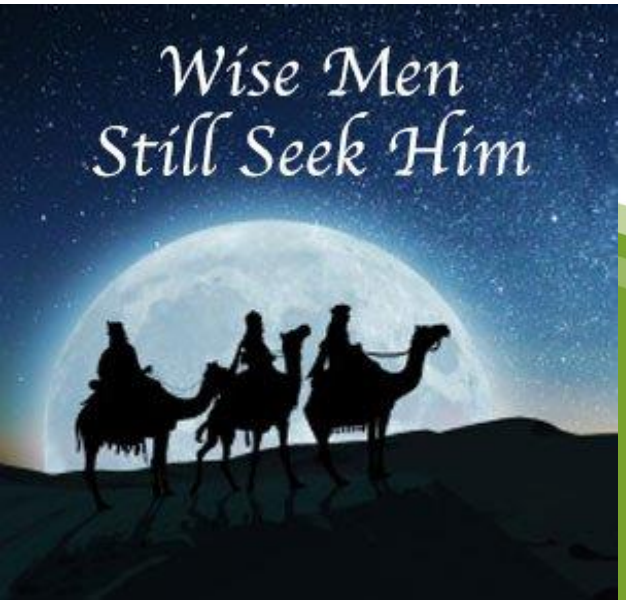

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Other PES ideas for the Lunan Water

- Fishing for farmers

- Water for all

- Less erosion

  - less dredging

Fishing for farmers

Annual agreement exists to lease fishing from riparian owners

Could riparian owners deliver more "ecosystem services", such as aquatic weed composting in exchange for this agreement?

Rescobie Loch Development Association

(fishing club)

Condition in lease?

Extra payment for sediment control?

Fishing permits?

Share of takings?

Less erosion – less dredging

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ECAF project promotes uptake of AECS sediment mitigation measures

AECS grant applications for sediment mitigation

NFUS supported plan for dredging

SEPA licensing of dredging plan linked to uptake of erosion control measures promoted by SRUC advisors and local sediment and water management consultants

Improved, ecologically acceptable approach to dredging and sediment management across catchment

Use cost-effectiveness analysis tools developed by JHI to target measures; impact assessment as part of RD 1.2.1 (fine sediment project)

- This project is funded by the Scottish Government RESAS Strategic Research Programme 2016-21. For more information about this ongoing research contact :

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Laure Kuhfuss(Laure.Kuhfuss@hutton.ac.uk)

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