

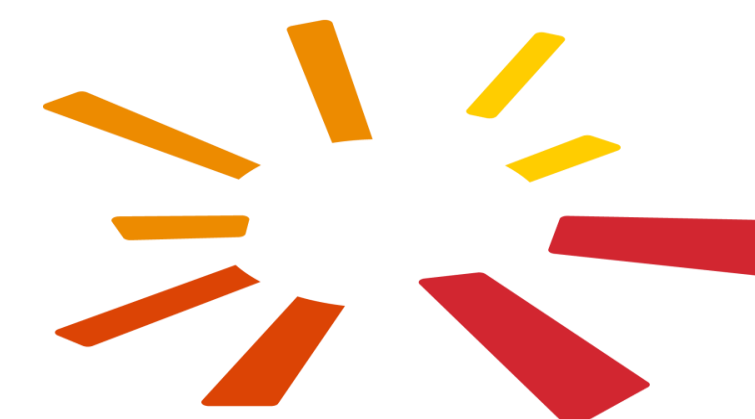
## sustainable management of water services in the Lunan Water?

<sup>1</sup> The James Hutton Institute, Craigiebuckler, Aberdeen AB15 8QH Email: <sup>2</sup> ENGEEs, Strasbourg, France, <sup>3</sup> Centre for Ecology and Hydrology, <sup>4</sup> Scottish Natural Heritage, <sup>5</sup> Angus Council. Contact: andy.vinten@hutton.ac.uk

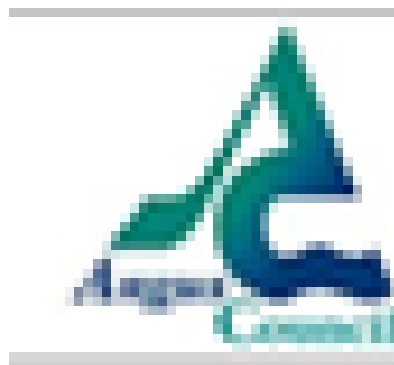


# SEFARI

LEADING IDEAS  
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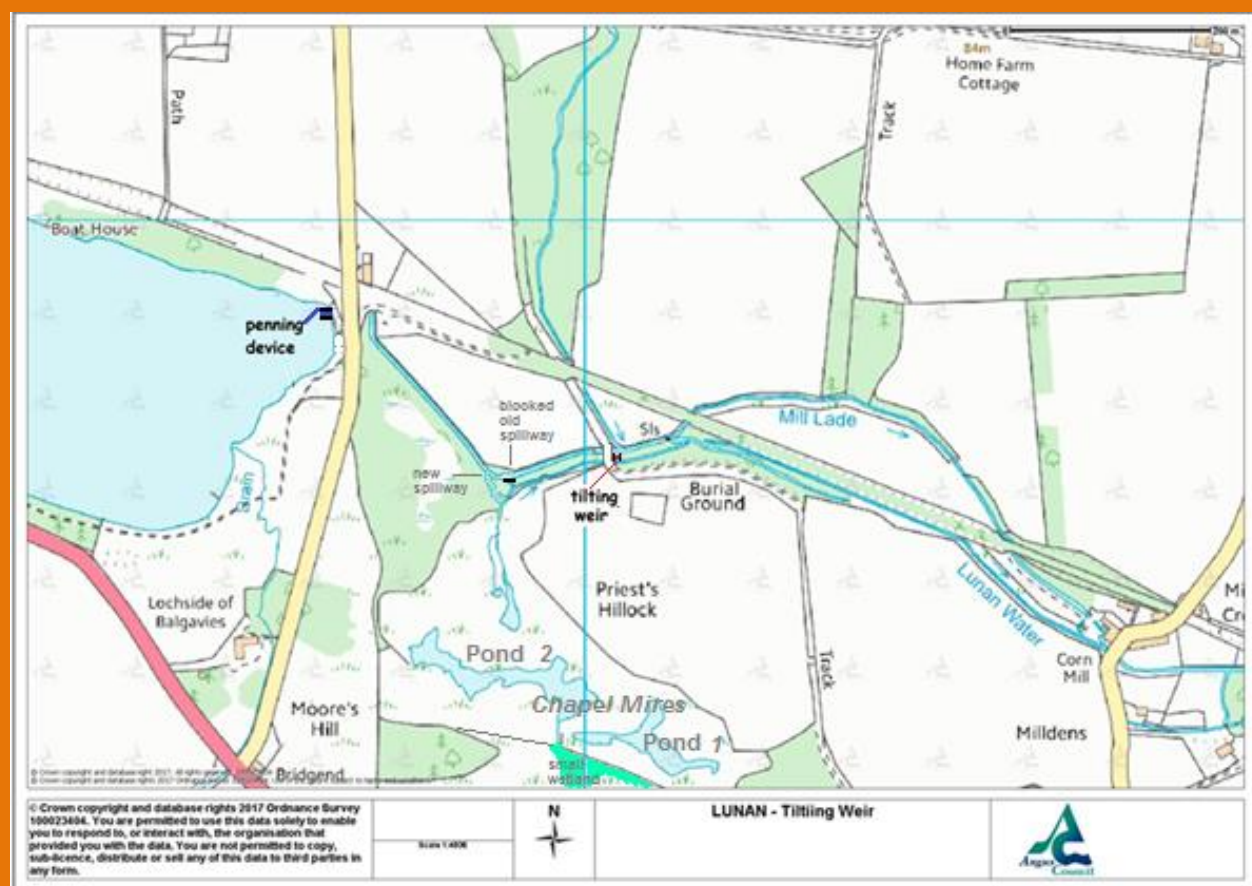
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NATURAL ENVIRONMENT RESEARCH COUNCIL

“Water for all” has explored the potential for innovative water level management in the Lunan Water, an agricultural catchment in eastern Scotland. The aim was to enhance water ecosystem services across a range of beneficiaries.

One proposal is flexible hydraulic control using a tilting weir and a penning device to mitigate flood risk, protect high-nature value lowland wetlands from eutrophication and deliver water to downstream users at low flows (see Fig 1).



**Figure 1. Details of water bodies downstream of Balgavies Loch**

The potential impacts of “Water for all “ scheme include:

- **Flooding:** In association with dredging of the mill lade, the scheme could help to reduce risk of flooding in the upper catchment. This would be done by increasing flow out of the locks giving increased storage to cope with forecasted rain

- **Wetland conservation:** The scheme could help to reduce over-enrichment of Chapel Mires wetland by diverting water flowing from Balgavies Loch away from them at critical times and so help conserve biodiverse sedge-dominated habitats
- **Water scarcity:** There is a significant downstream demand for abstraction 3 years in 10. This may cause low flows which affect the ecology of the river. Managed storage and release from Balgavies Loch in summer, using a penning structure, may help to ensure abstraction of water doesn't need to be restricted, while protecting and improving river ecological status (Vinten et al., 2017).

- A Lunan catchment management group, chaired by Angus Council
- A survey of residents/land users re. governance structure and willingness to pay
- Interviews with selected stakeholders and survey respondents

## 2. Hydrological and hydraulic (HECRAS 5.0.1) modelling of flows and water levels

- Stage-discharge relationships for Balgavies Loch estimated for different settings of existing and proposed lateral weir gates, with/without dredging
- Hydrological model of catchment, together with the stage-discharge relationships, generate daily simulations of water levels in Balgavies Loch and flow of water into Chapel Mires wetland

### 3. Surveying of Chapel Mires wetland biodiversity and hydrology (Fig 2)

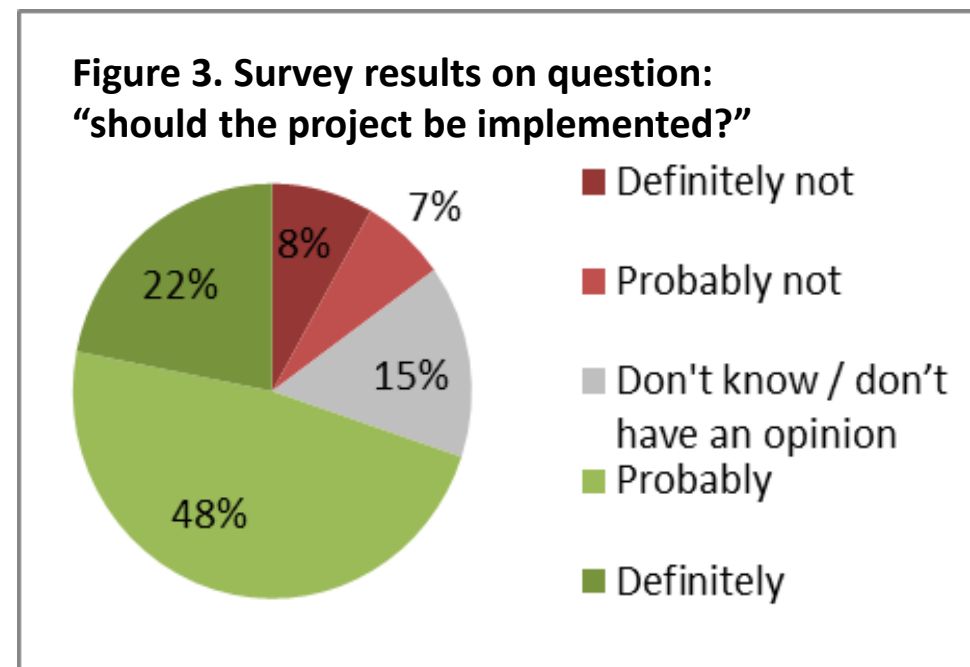
- National Vegetation Classification(NVC) of mires and ponds in Chapel Mires
- Water level/water quality survey to identify sources of water in Chapel Mires



**Figure 2**  
**Chapel Mires from south**  
**when Balgavies Loch**  
**Level (Hbal) is 60.0 m**  
**(10/3/18)**

The willingness to pay survey (n=75) showed:

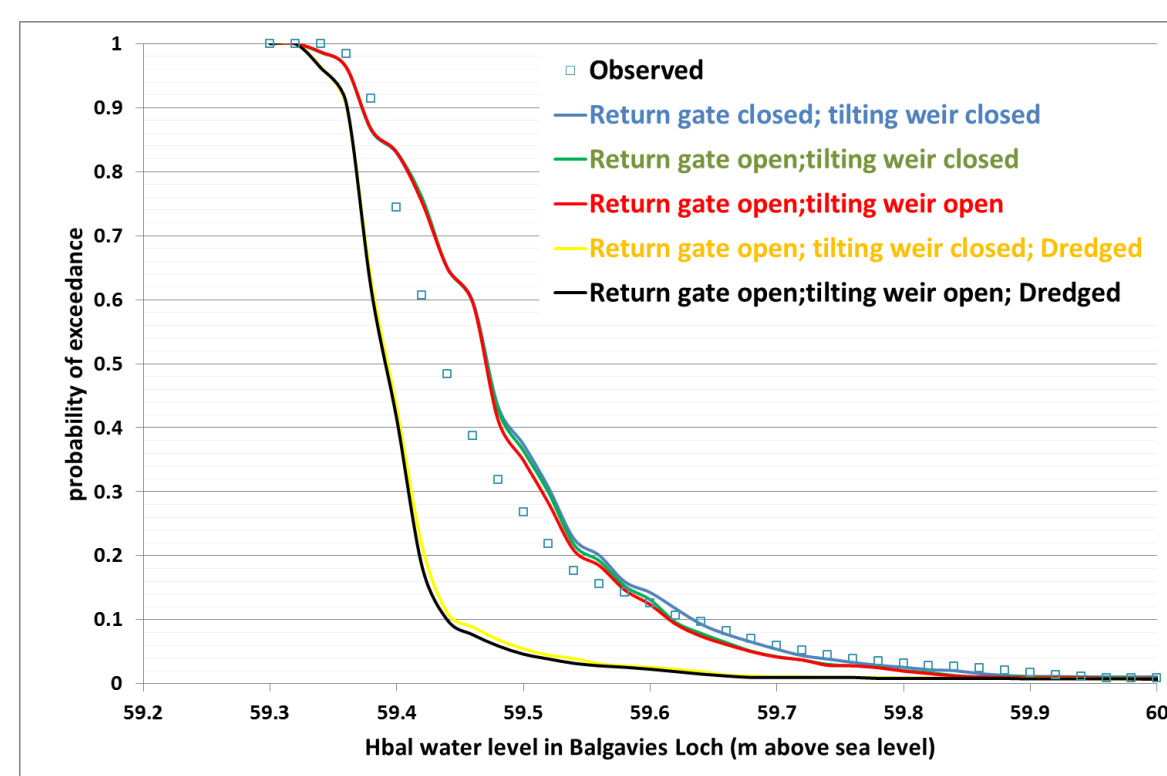
- Local opinion in favour of the scheme (Fig 3) but farmers were divided
- the preferred governance scenario was local government, rather charity or business



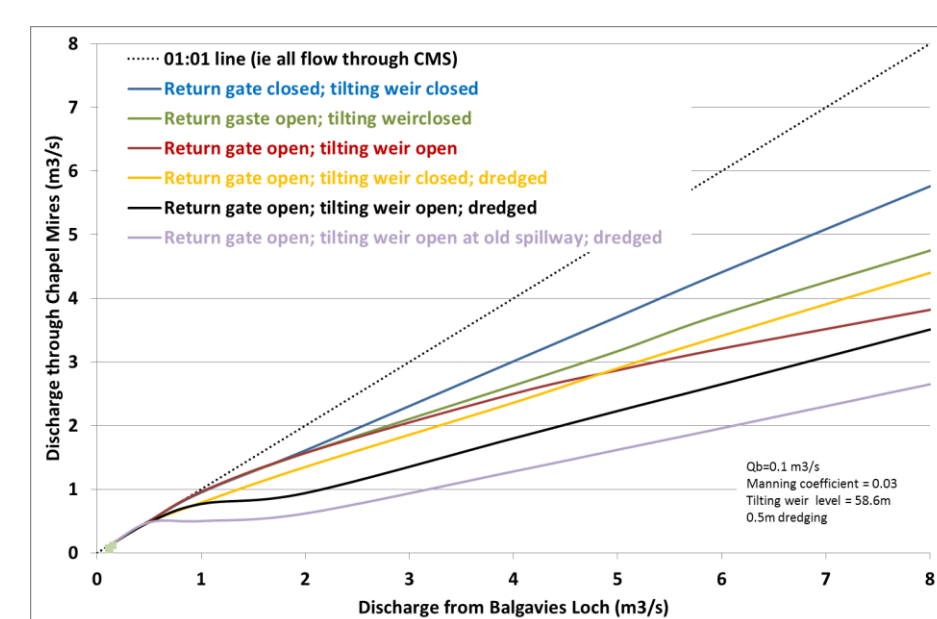
Emerging themes from 17 interviews include:

- The potential benefits and dis-benefits
- The feasibility of managing such a scheme
- Gaps in the governance of water management in the catchment and more widely
- The types of evidence that are necessary for approval of the scheme by stakeholders and regulators, and how this evidence is communicated
- Farmer and land owners' rights and responsibilities as stewards of the land
- The merits of engineering solutions vs natural flood management

- HECRAS model of Balgavies Loch-mill lade with optional lateral weir structures shows dredging the lade is more critical to Loch levels than weir gate management (Fig 4)
- But weir gate changes help maintain benefits of dredging by preventing sediment accumulation in the lade



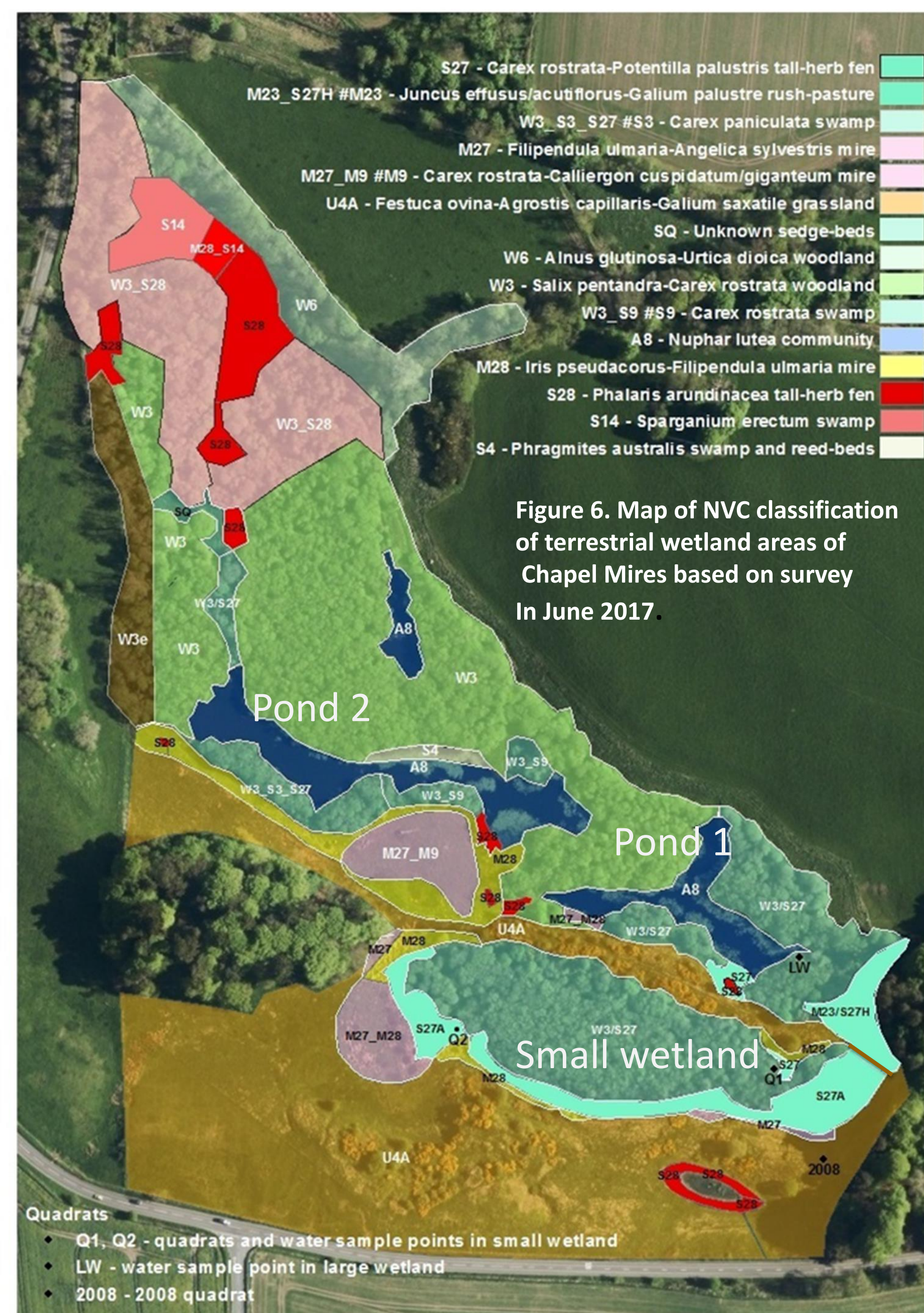
**Figure 4. Water level exceedance curves for Balgavies Loch.**



- Operation of tilting weir reduces flow through Chapel Mires
- This would benefit wetland ecology by reducing loading of nutrients/sediment, eg to the best conserved, small wetland on the southernmost edge (Fig 5)

**Figure 5. impact of dredging and weir gate management on flow through Chapel Mires**

- A map of the National Vegetation Classification (NVC) codes for the Chapel Mires was drawn in ARC-GIS using site survey data collected in June 2017 in collaboration with SNH (see Fig. 6)
- There is a gradient from competitive, nutrient and sediment tolerant species (S28/S14/S4) such as Reed Canary grass (*Phalaris arundinacea*), Branched Burr reed (*Sparganium erectum*) and Common reed (*Phragmites australis*), in the north of Chapel Mires to more biodiverse *Carex*-rich southern areas of the wetland (W3/S27a).
- These contain locally rare species such tufted Loosestrife (*Lysimachia thyrsiflora*) and cowbane (*Cicuta virosa*).
- However, it should also be noted (O'Hare, pers. comm) that the competitive species are a normal part of the assemblage in mesotrophic systems and may not be progressing in their extent
- The small areas of *P. arundinacea* in the central part of the area have been accurately mapped with the RTK-GPS system, so we can return in future to assess whether these areas are extending.
- The open water ponds were also surveyed in Sept 2017 by CEH. These were found to contain species such as Bladderwort (*Utricularia vulgaris* agg) and Rigid Hornwort (*Ceratophyllum demersum*).



**Figure 6. Map of NVC classification of terrestrial wetland areas of Chapel Mires based on survey In June 2017.**

Water chemistry samples showed a clear north-south gradient in alkalinity across the wetlands, and some evidence of undesirable transfer of river water at high flows to the best conserved, southernmost wetlands (Fig. 7).

- The proposed “Water for all” scheme to install a tilting lateral weir on the mill lade could improve conservation of valuable floodplain wetlands at Chapel Mires by reducing input of nutrient and sediment rich waters at key times
- The proposed scheme can only deliver upstream flood risk mitigation if dredging and/or vegetation control in the lade d/s of Balgavies Loch occurs first. Dredging could also aid wetland management.
- If dredging action were agreed between stakeholders, ongoing sediment management in the mill lade downstream of Balgavies Loch would also be needed. Several options could be considered in this discussion which include: (a) a management plan for repeated dredging; (b) moving the existing spillway into Chapel Mires back to the original spillway; (c) adding a manually or automatically operated lateral weir or sluice gate to help control sediment flushing and water flows; (d) “light touch” vegetation removal
- The proposed scheme would need to include a penning structure at the outlet of Balgavies Loch to deliver benefits to downstream water users at low flows.
- Options for water management other than the status quo are currently restricted by absence of viable long term governance structures.
- Opinion about the scheme among local residents is positive, but farmers are more divided
- The preferred option for governance, among those surveyed, is through local government
- Results of the project are being reported to Angus Council and Agencies through the Lunan Catchment Management Group for consideration.
- “Water for all” project work will now shift focus to consideration of water “governance gaps” on a national basis. Options for filling these gaps, such as through the development of drainage boards. eg. <http://www.parliament.scot/parliamentarybusiness/Bills/103888.aspx>).

See project webpage at <http://www.hutton.ac.uk/research/projects/payments-ecosystem-services-lessons> for further information  
Hydrological Engineering Center River Analysis Software 5.0.1 (2016) <http://www.hec.usace.army.mil/software/hec-ras/> (HECRAS)  
Vinten AJA, Wilkinson, M, Sample J, Rear L, Hoang-Cong C, Novo P, and Halliday M. (2017). Water level management in the upper L  
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<http://www.hutton.ac.uk/sites/default/files/files/Lunan%20Water%20Managementv12.pdf>

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