Penny Anderson Associates Ltd
CONSULTANT ECOLOGISTS

Below we present summary statements in response to the Upland Hydrology Group's questions regarding SCaMP. We have also provided you with indicative response to the work we are doing with Grontmij for United Utilities on Lake Vyrnwy (not the RSPB scheme), together with some limited project details for Yorkshire Water schemes.

SCaMP

1. Research questions you are investigating

- Relationships between catchment scale upland land management changes and water quality, particularly colour.
- What are some of the mechanisms involved in colour generation from blanket bog catchments in response to land management changes, including extensive grip blocking, stock management, changes to burning practices and re-vegetation of bare peat;
- Impact of grip blocking and associated land management changes on the character of stream hydrographs
- Investigating the relationships between stream colour and turbidity and carbon fluxes from both intact and highly degraded blanket bog habitats
- How do air and peat temperatures; groundwater levels; and *in situ* colour generation in blanket blogs help understand carbon flux mechanisms.
- How and at what rates does POC flux respond to the remediation of heavily degraded blanket bog.
- Peat water table responses in association with the re-vegetation of damaged blanket bog.
- The intensity of pathogen generation associated with upland farm in bye management.
- The rate of change in the vegetation in response to hydrological changes, particularly in *Sphagnum* cover
- The impact of changes in grazing regimes on vegetation restoration on less severely degraded blanket bog (stock removal, stock reduction, introduction of off-wintering, stock re-introduction - largely sheep but some cattle). No direct hydrological monitoring in some of these areas.

2. The nature of monitoring activities being undertaken.

- Five years monitoring (now to be extended to 9 years) of:

Rainfall monitoring

Previously undertaken with the use of tipping bucket rain gauges. This has now been replaced with Met Office radar precipitation data supplied through United Utilities. This is 5 minute data accurate to 0.001mm per five minutes over entire North West of England.

Stream water quality monitoring

Water samples abstracted from 7 streams every day at 1700hrs (GMT). Samples analysed for colour and turbidity levels. Post processing of data converts these levels to Dissolved and Particulate organic carbon levels (DOC + POC).

Peat groundwater quality monitoring

Water samples abstracted from 3 blanket bog dipwells every day at 1700hrs (GMT). Samples analysed for colour levels. Post processing of data converts these levels to dissolved organic carbon levels (DOC).

Stream Level and Temperature data

5 rivers/streams are monitored constantly for their discharge and temperature. This data is recorded every 15 minutes.

Peat Groundwater Level and Temperature data

16 areas of blanket bog peat are monitored constantly for their water levels and temperature. This data is recorded every 15 minutes.

Manual Peat groundwater monitoring

Manual dipwells were utilised before and after the process of grip (moorland drain) blocking. This gave an idea of how the cross section of water changed through this process.

Automated gully blocking water level monitoring

In a single experiment, a line of 8 automated dipwells measuring at 15 minute intervals are showing how blanket peat responds to local gully blocking though a cross section.

Strategic catchment water colour risk monitoring and mapping

Air temperature

This data is collected every 15 minutes at each of the 3 major catchments.

Vegetation

Monitoring of vegetation (percent cover of all plant species plus additional environmental variables such as grazing, vegetation height, bare peat cover in 2mx2m quadrat – based on the NVC method and the CSM requirements) in relation to grip blocking, bare peat restoration, relationship between changing water levels in the peat and vegetation change, relationship between vegetation cover after restoration of bare peat and colour and sediment loss from the system. Changes in stock grazing and burning regimes have occurred at the same time;

Monitoring of vegetation recovery after stabilisation of peat pans (large, flattish bare peat areas with incipient rilling) with coir rolls to reduce flows and peat loss (Ashway Gap only). Similar methodology as above;

This monitoring covers catchments in the Forest of Bowland, the Goyt, and three Longdendale Estates and farms belonging to United Utilities.

3. Headline results and conclusions achieved

- Extensive catchment-wide grip blocking is associated with reductions in colour generation.
- Colour response at the catchment scale to grip blocking takes a number of years to be registered within monitoring systems (two in the case of the River Goyt).
- The generation of POC can have a rapid positive response to effective re-vegetation of bare peat (within two years) within degraded blanket bog catchments.
- Monitoring of the re-vegetation of bare peat indicates that lime, seed and fertiliser is a suitable restoration approach on bare peat areas with some remnant vegetation (typically less steep slopes), while on steeper slopes/more extensively bare peat the addition of a geotextile and heather brash further aid vegetation establishment.
- Water levels in the peat after grip blocking are higher and with much lower amplitude, thus creating a wetter and more stable environment for blanket bog vegetation to recover.
- Recovery of blanket bog vegetation in response to changes in hydrology are much slower.
- Re-colonisation by *Sphagnum* species has not yet been recorded on severely degraded bare peat restoration areas, the main recolonising moss species in these areas being *Campylopus* species and *Hypnum jutlandicum*.
- Vegetation changes after grip blocking are slow, but there are now trends towards increasing Sphagnum over time, with statistically significant increases from pre-treatment (the baseline year) to the post treatment years recorded on several monitoring sites.
- On grip blocking sites, the response of *Sphagnum* to restoration measures appears to be more rapid where there is a larger proportion of *Sphagnum* cover remaining on the site. *Sphagnum fallax* typically shows the most rapid response to restoration measures.
- Upland stream hydrographs appear to show lower peaks and extended time to peak in response to catchment scale land management changes including grip blocking.
- Farm in-bye management is a key factor in pathogen loading to upland streams.

4. Hunches about where your research might be leading you

- The scale of hydrological and ecological response, the nature of that response and the time taken for a catchment to respond to land management changes varies according to the individual environmental characteristics of the particular catchment. However, the direction of change appears to be towards a more resilient and sustainable upland resource.

Lake Vyrnwy, United Utilities work

Monitoring of Lake Vyrnwy's catchment inputs in terms of water quantity, water colour and other chemical parameters including metals and nutrients. Lake flow dynamics and the modelling of in-lake colour generation, together with the evaluation and specification of land management changes to provide a more sustainable, economically viable water supply to Lake Vyrnwy and its associated raw water treatment works

Snailsden, Eastern Peak District, Yorkshire Water work

We are monitoring the vegetation in areas associated with grip blocking to tie in with the hydrological monitoring being carried out by Jo Holden's team at Leeds Uni. 2010 is the first year, so no trends yet.

Keighley Moor, above Keighley Reservoir, West Yorkshire, Yorkshire Water work

We are monitoring the vegetation associated with gully blocking and heather cutting. 2011 is the first year of data collection, so no trends yet. Colour and hydrology being monitored by Leeds Uni.

Peter Worrall, Technical Director,

14.02.11