Quantifying the relative importance of extrinsic and intrinsic drivers of individual behaviour and habitat use of hefted sheep on a biodiverse but fragile upland ecosystem (Ref IAP2-18-25)

Durham University In partnership with Newcastle University and CASE partner: Natural England

**Overview**

The unenclosed upland areas of the UK are internationally important for wildlife, of high nature conservation value being recognised for their unique vegetation assemblages and of economic importance (1, 2). However, these fragile habitats are subject to various threats including; the impacts of climate change (3), atmospheric pollution deposition, acid rain and grazing pressures (2). A primary tool for sustainable management of these landscapes is implementing grazing regimes that allow maintenance or recovery of habitats and which support ecosystem services (1). However, remarkably little is known about the behaviour of the major grazer of UK uplands; domestic hill sheep (1), and their impact on vegetation mosaics. It is recognised that there is a need to fill this gap in knowledge (1,2) and this project aims to provide empirical understanding of the extrinsic and intrinsic drivers of individual sheep behaviour, particularly with respect to factors determining habitat selection and activity within upland vegetation mosaics.

**Background & Aims:** The Upper Teesdale National Nature Reserve is part of a larger protected landscape of Upper Teesdale SSSI and is designated a Special Area of Conservation for upland habitats and Special Protection Area for upland breeding birds under the European Habitat Regulations and Birds Directive and is within the North Pennines Area of Outstanding Natural Beauty. Its upland habitats host unique Arctic-Alpine plant assemblages associated with limestone grassland and base-rich flush habitats (2). It is also Britain’s leading site for research into the effects of changing climate on the natural environment because many species within this “Teesdale Assemblage” exist in climatically marginal locations and are therefore potentially highly vulnerable to climate driven changes in local conditions (2). Recent observations suggest that vegetation structure and composition in this assemblage is already undergoing changes, but the extent to which this is climate driven or due to grazing regimes or interactions between these processes is unknown.

Sawdale ewe on Upper Teesdale NNR. This project will discover where these sheep spend their time, what they do and why. Grazing animals are a primary management tool for habitats of conservation importance, although inappropriate management of grazing animals can cause under-or over-grazing (4,5). Choosing
appropriate management regimes, including suitable stocking rates, is challenging and likely to be dependent upon fine scale local conditions (1,2), including extrinsic drivers such as soil and vegetation patterns, weather and its interaction with microtopography, and intrinsic factors such a sheep age, experience (hefted sheep possess knowledge of where optimal grazing and shelter can be found throughout the year) and size. Such factors are likely to influence diet selection by sheep (6) and therefore impact upon vegetation structure and diversity. In the complex vegetation mosaics of Upper Teesdale NNR there is limited information on the patterns of habitat utilisation by sheep, and even fewer data on the behaviours performed by sheep in different habitats (e.g. forage vs rest) and the drivers of those behaviours (1). This project aims to understand the extrinsic and intrinsic drivers of hill sheep behaviour at Upper Teesdale NNR in order to provide insights into the fine scale spatial and temporal variability of grazing pressures and facilitate the resolution of concerns regarding grazing-related damage to habitats of conservation importance. 

**Significance:** Although previous studies have implicated habitat preferences by hill sheep with access to a mosaic of upland habitats (4) such studies base preference on time allocation to different habitat types. However, it remains unclear what the sheep are doing in these habitats. Therefore, there is a need for a more detailed, individual based behavioural study, linked to data on time and space use by the sheep to determine the fine scale impacts of grazing, and other sheep behaviours.

Current, human-induced changes in climate are likely to impact on long-term persistence of rare vegetation communities at upland sites such and Upper Teesdale NNR. Manipulating grazing impact is a primary and critical management tool in these habitats, and so understanding the extrinsic and intrinsic drivers of sheep behaviour *in situ* will provide a vital evidence base for Natural England to refine their systematic management of sheep numbers, distributions and activity. Furthermore, this study will provide valuable information on how these different factors interact with the spatial distribution of vegetation types and allow a consideration of practical management techniques that can be used to influence the spatial distribution and feeding choices of sheep.

**Methodology**

Fieldwork will encompass 3 successive spring to early autumn seasons focusing on recording sheep behaviour and distribution on Widdybank Fell, part of the NNR that contains some of the most biodiverse habitat, and for which pre-existing fine scale habitat maps exist. Sheep behaviour will be monitored at the level of the individual. Behaviour will be recorded using a combination of *in situ* visual observation, supplemented by video recordings, and by using GPS telemetry together with accelerometers on a subset of focal individuals.

Upper Teesdale NNR, a unique but fragile environment. Understanding sheep behaviour is key to managing this landscape. A combination of telemetry and in-field observations will be used to determine sheep behaviour at the level of the individual.

**Telemetry:** A subsample of sheep, spanning a range of ages and experience will be selected for the deployment of combined GPS data loggers and triaxial accelerometers. GPS telemetry will provide data on fine scale movement and location, whilst accelerometry will provide scope for developing automatic classification of behaviours with respect to time and location. The research will require the development of analytical protocols to classify raw accelerometry data into behavioural categories, including foraging. Classification of accelerometry data will be achieved through supervised classification using video footage of telemeterised sheep free roaming on the Fell, and in more controlled situations in the in-bye fields.

**In field observations:** A key component of this research will be in field behavioural observations. High resolution, 24/7 data will be obtained on a sub-sample of sheep from the telemetry, however, visual observations will be necessary to (a) determine how representative the telemeterised sheep are of the flock, and (b) to gain a larger sample of locational and activity data permitting rigorous analyses of group and individual variation in behaviour across the flock. This will be achieved through regular periods of observations during the ‘Fell’ season. Sheep will be individually identified by artificial dye marks applied before their release on to the Fell which will relate to their individual stock identifiers.

**Habitat and environmental data:** A major advantage of this study is that Widdybank Fell is a long-established research site, with detailed existing data and ongoing studies on micrometeorology, microtopography and microhabitat (2). By linking with these existing and ongoing research efforts, the current study will have the potential to examine fine
scale sheep location/distribution and activity with respect to microclimate and microtopography (elevation, slope, aspect etc.) to unravel the fine spatial and temporal extrinsic drivers of sheep behaviour and therefore foraging impact throughout Widdybank’s mosaic of habitats. Behavioural data from telemetry and in field observations will be processed and integrated with ongoing projects mapping past and current vegetation at fine spatial resolution (1:2500 maps) within a GIS to analyse the extrinsic drivers of sheep behaviour. Spatial and behavioural data will be used within the GIS to examine intrinsic drivers of sheep behaviour by examining the movement and behaviour patterns in relation to sheep age, size, group membership and social associations and experience (hefted vs non-hefted). By monitoring the same individuals over multiple years, data should be gathered on the development of behaviour and habitat use in naive sheep over successive years as they gain experience. There is scope for further extension of the study depending on time, to either incorporate an adjacent study site for comparative work, to examine biomass offtake using experimental plots, or to build in behavioural tests on sheep while contained within the ‘in-by’ to derive metrics of individual behavioural types (7) for integration with individualised patterns of habitat use.

### Timeline

**Years 1–3:** Field work, data collection and analyses.

**Years 3–3.5:** Complete data analyses, interpretation, writing, and attendance at professional meeting(s).

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*FP = Fieldwork preparation (logistics)*

### Training & Skills

The student will gain inter-disciplinary training and experience in field behavioural observation, application of biotelemetry devices, fieldwork logistics and safety, and analytical techniques including behavioural analysis, integration and analysis of movement (GPS) data within a GIS, and classification of accelerometry. Beyond these, the student will develop critical thinking, writing, and teamwork skills as part of dynamic, interdisciplinary, and supportive research groups. The student will gain experience from networking with a broad range of interested parties, including academics working at all levels of this ecosystem, conservation practitioners and local land users.

### References & Further Reading

2. Baxter R. 2017. Report on the Potential Impact of Climate Change on Vulnerable Notified Vegetation Communities and Species of Moor House-Upper Teesdale NNR.

### Further Information

This project is in competition with others for funding. Success will therefore depend on the quality of applications received, relative to those for competing projects.

For further information, or if you are interested in applying, in the first instance contact Dr. Sean Twiss.

In your email include: 1) a two-page covering letter detailing your reasons for applying and why you have selected this project, 2) your current CV with contact information for at least two references, 3) Full transcripts of previous qualifications obtained to date. Only the best applicants will be asked to submit an application to the University.

The application deadline is Fri. 18th Jan. 2019 therefore students are encouraged to contact Dr. Twiss in advance for consideration. See here for information on eligibility and requirements.