A modelling approach to identify peat depth and its use within habitat management plans.

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Introduction

Peat bogs are a valued feature across many upland areas of Wales. These upland areas also provide a good wind resource, which has lead to many wind farms being located in these areas. Consent conditions of any wind farm developments require restoration of peatland disturbed by wind farm construction, often through the implementation of a Habitat Management Plan (HMP).

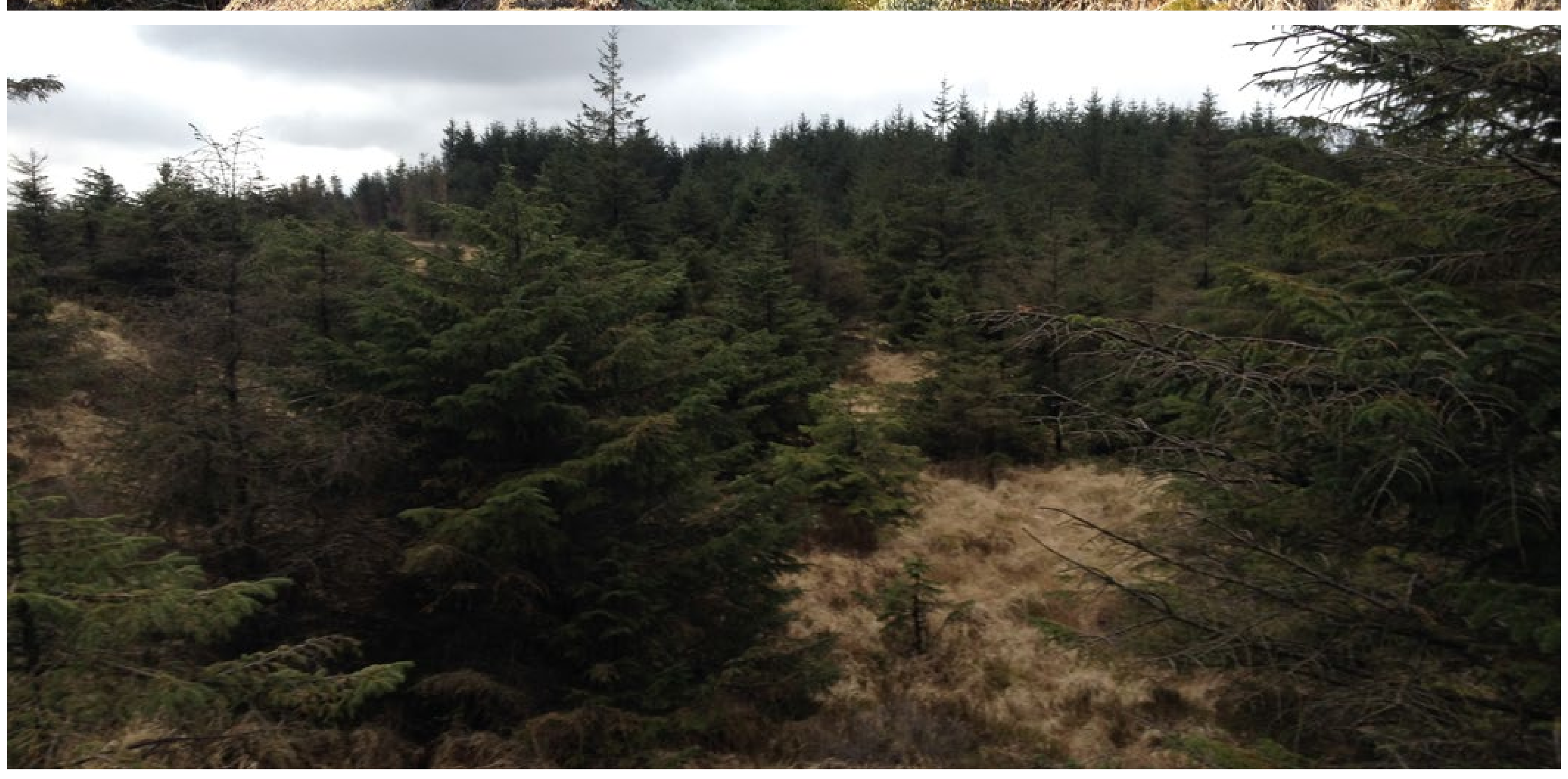
To identify peat-dependent habitats present within the Habitat Management Area (HMA), peat depth information is required. Peat depth data are usually collected manually by probing at regular grid intervals, which is a both time and labour intensive. Peat depths are interpolated within surveyed areas but are limited in that interpolations cannot be extrapolated to new areas. Here we demonstrate how survey effort can be reduced by using machine learning models to predict the distribution of deep peat (>0.5 m) and map areas to be covered by the HMP.

Study area

- Pen y Cymoedd Wind Farm, South Wales
- 76 turbines
- HMA Area of 1441 ha
- Several broad peat covered upland plateaus, bounded by steep sided valleys used primarily for coniferous plantation

Methods

- Boosted regression trees (BRTs) were used to build predictive models of the presence of deep peat given three topographic predictors: slope; elevation; and topographic wetness index (TWI) at 50 m resolution.
- Peat depth data (n = 24,563) were divided into a training dataset (n = 10,000), used to build the models, and a testing data set (n = 14,563), used to evaluate model predictive performance.
- Multiple BRT models were built on the training dataset while tree complexity and learning rate systematically altered to maximise kappa (the Proportion of Correctly Classified observations [PCC] after accounting for probability of chance agreement).
- The bag fraction was kept at a constant 75% to maintain a level of stochasticity, which is important for increasing predictive success.
- Models were then tested against the test dataset and evaluated using percentage deviance explained (% dev), area under the receiver operation curve (AUC) and correlation with observed values (high being better).



Results

- The top model found that slope (39%) and elevation (36%) were the most influential predictors. TWI contributed 25% to the model.
- Generally once the slope exceeds 10° at a site deep peat is much less likely to be present; deep peat is more likely to be at elevations between 300-340 m a.s.l.; and sites with high TWI (values above 14) are more likely to contain deep peat (Fig. 1).
- When predicted over the wind farm development area, deep peat was predicted to be present in an area of 20.4 km2 (See maps below).
- Models were validated through comparison with peat distribution resulting from peat depth interpolation (Map 1) and with existing mapped soils layers (Map 2) and showed a high degree of congruence with each.

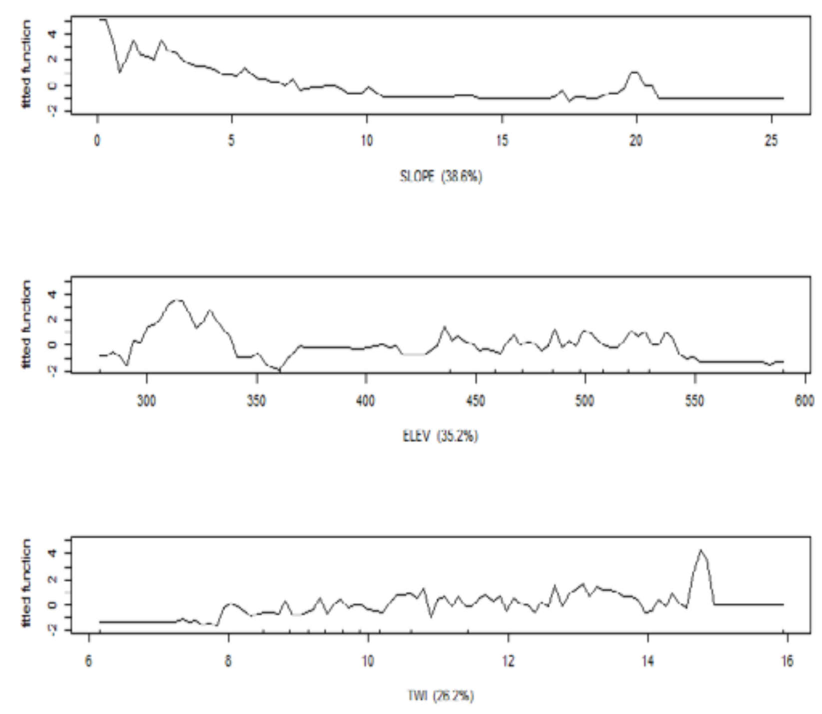
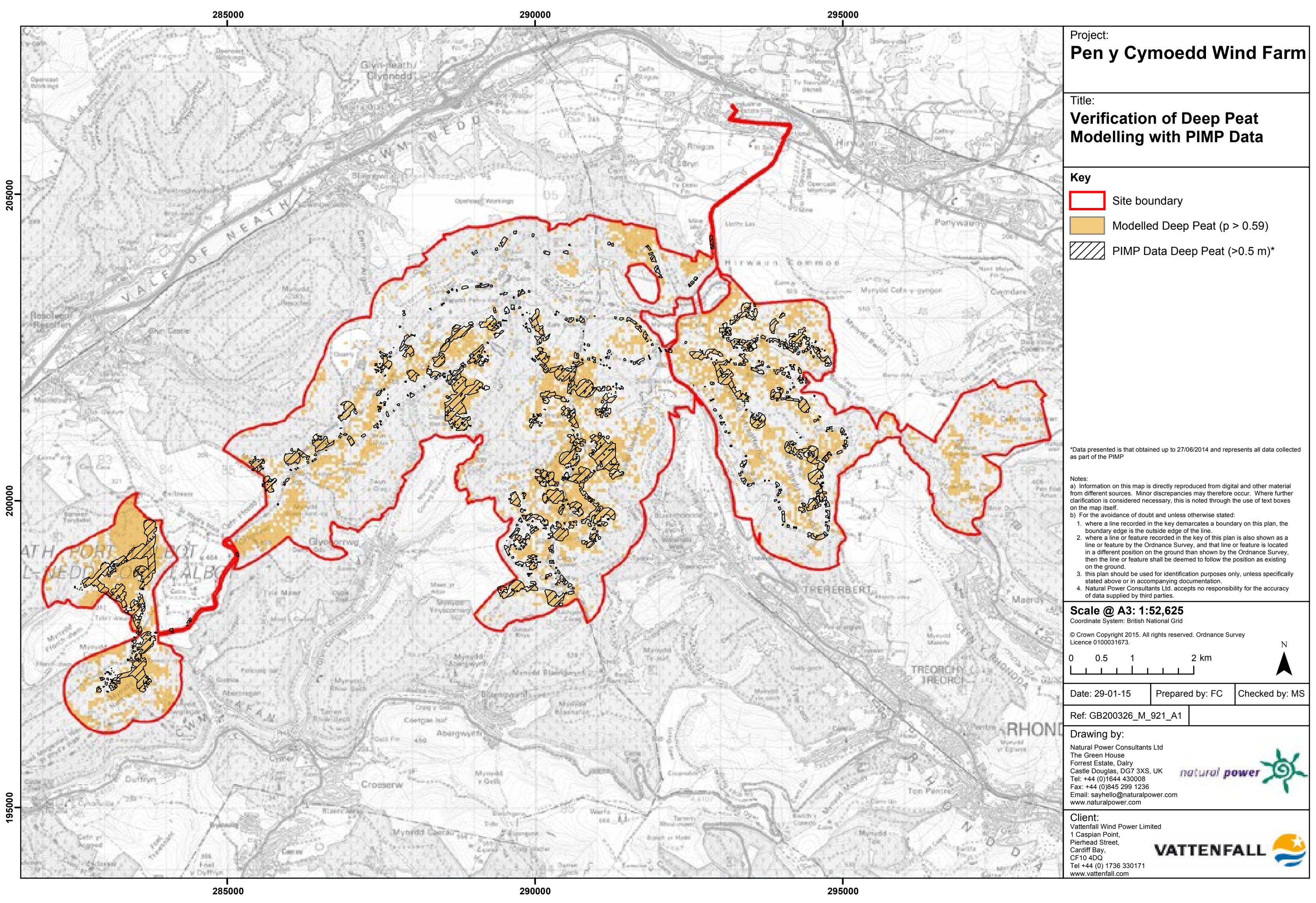
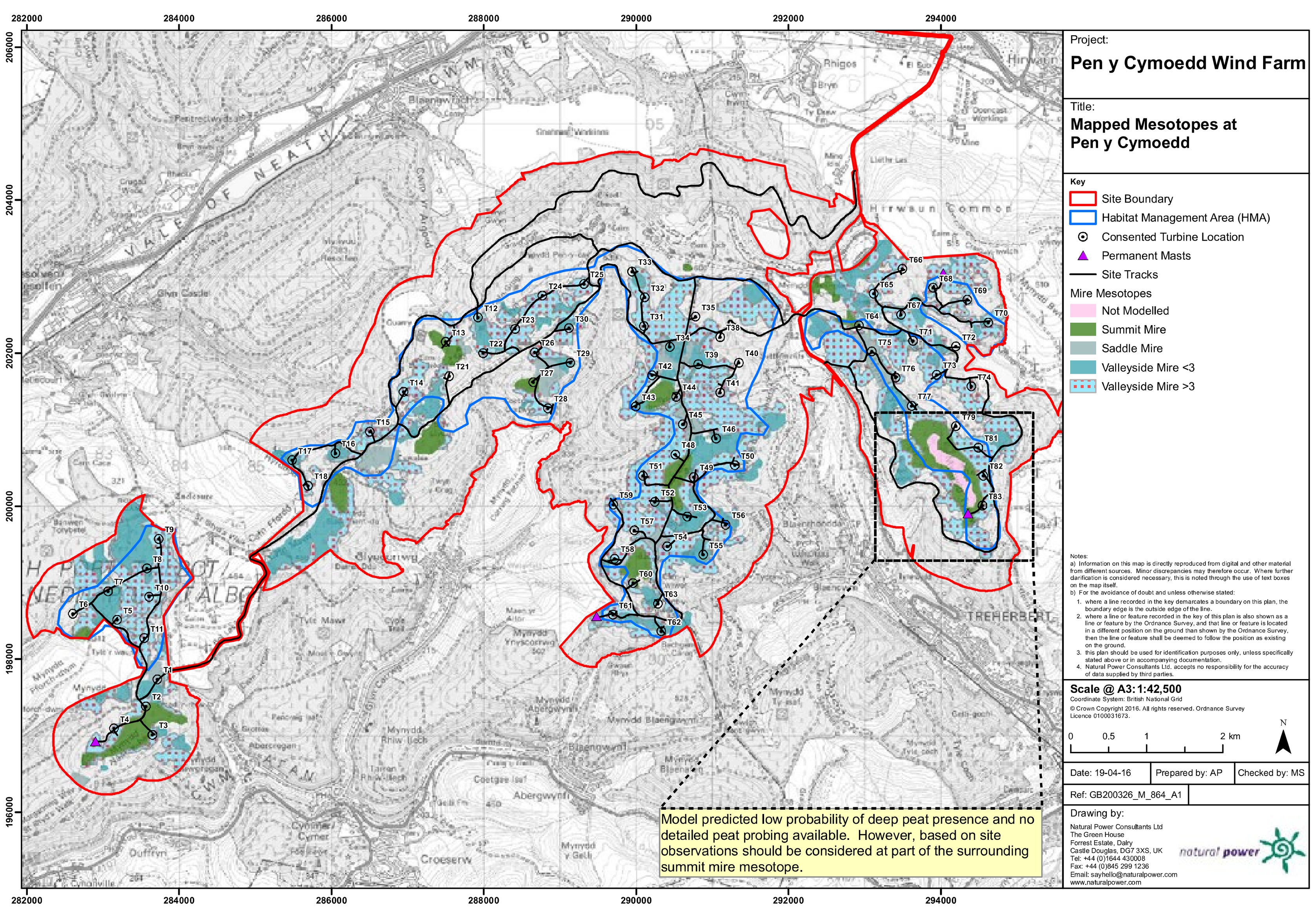


Figure 1: Peat depth interpolation



Map 1: Peat depth interpolation



Map 2: Existing mapped soil layers

Conclusion

This model provides a valuable resource for rapidly assessing and understanding the distribution of peat habitats within a site, which can then be used to inform management prescriptions within habitat management plans. The model requires testing for generality at other sites, but should it prove successful it would considerably reduce the effort required to map sensitive peat habitats.

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