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Monitoring of rehabilitation of a raised bog in Ireland using a machine learning model

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Peatlands cover ~3% of the global land area and are under threat from a land-use change such as drainage for peat extraction, and conversion to agriculture and commercial forestry. Historically, peatlands in Ireland have been used for industrial peat extraction and domestic turf cutting. One such example is Cavemount bog, County Offaly, Ireland a former raised bog where peat extraction started in the 1970s and ceased in 2015. After 2015, a programme of rehabilitation commenced by rewetting the site to raise water levels and to promote the establishment of wetland habitats. Some of the key species associated with the vegetation communities that have been developing across the site include *Betula pubescens*, *Calluna vulgaris*, *Eriophorum angustifolium*, *Typha latifolia* and *Phragmites australis*.

To monitor the progress of the colonisation of natural vegetation as part of the rehabilitation plan, reliable habitat maps are required. Google Earth Engine (GEE) is a cloud computing platform where satellite images can be processed to obtain cloud-free composite images. GEE was used to develop an automated approach to map the habitats at Cavemount using multispectral satellite imagery (Sentinel-2) and a machine-learning model i.e. random forest classifier. In this study 9 habitat classes were used which included bare peat, coniferous trees, heather, heather and scrub, open water, pioneer open cutaway habitats, scrub pioneer open cutaway habitats, wetland and mosaic of wetland and scrub. Cloud-free composites for the growing season (May to September) using satellite imagery from 2018-2021 were used to get spectral indices such as NDVI (normalised difference vegetation index), NDWI (normalised difference water index), mNDWI (modified normalised difference water index), red-edge vegetation index, EVI (enhanced vegetation index) and BSI (bare soil index). To extract open water, a seasonal composite of mNDWI was used which could differentiate water from bare peat. The seasonal composite of mNDWI was also used to monitor flooding over winter periods due to increased rainfall and was compared with summer conditions. These indices along with 10 spectral bands (10-20 m resolution) were used as an input to a random forest model, and a yearly habitat map from 2018 to 2021 was developed. The overall accuracy for the testing data from 2018, 2019, 2020 and 2021 was 87.42%, 86.81%, 87.16% and 87.50% and kappa coefficient was 0.81, 0.80, 0.81 and 0.81 respectively. Over time, the former peat extraction area showed a transformation from bare peat to a mosaic of wetland vegetation. This methodology will provide a useful tool for the long-term monitoring of the habitats at this site and to evaluate the effect of rehabilitation on the ecological composition of the site. The final habitat map will also be integrated with the eddy covariance data from the site to provide further

insight into the carbon and greenhouse gas dynamics of each habitat in the future.