

Quantification of Birch and Bracken Encroachment on Heathland using Airborne Hyperspectral Imagery & Sentinel-2 Satellite Imagery

We believe that airborne remote sensing can improve current estimates of heather coverage and fragmentation.

Background

- British heathlands are valuable habitats for rare and vulnerable ground nesting birds.
- In Bedfordshire, forestry and agriculture led to the decline of heathland in the 1800s but the RSPB has been working on restoring dry heathlands at the Sandy Lodge Reserve since 2005.
- Extensive birch and bracken encroachment on heather makes restoration work difficult and fragments the landscape.
- Heather coverage and fragmentation degree are estimated in the field and heathland condition is reported to Natural England on an annual basis.

Objectives

- To classify heather, birch and bracken using spectral information.
- To quantify the respective coverage of each class.
- To carry out classification independently for both hyperspectral airborne data and multispectral satellite imagery and compare the outputs.

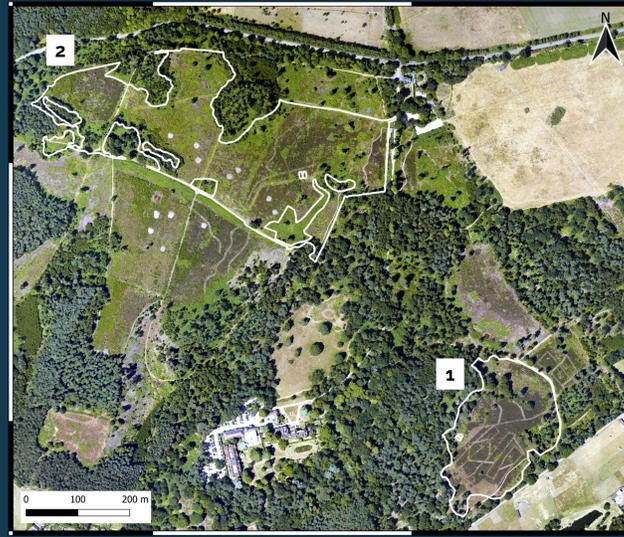


Figure 1. Overview of the RSPB Sandy Reserve with the two heathlands of interest.

Data

- Airborne imagery (Hyspex VNIR 1800 & Phase One iXA 180) from 26th June 2018.
- Sentinel-2 L2A satellite imagery from 26th June 2018.
- Phase 1 Habitat Map manually updated from the RGB true-colour airborne Phase One imagery.

Methods and Results

- Heathlands delineated by photography and two areas selected for analysis: heathland 1 was heather-dominated with little fragmentation, while heathland 2 was more diverse (Fig. 1).
- Sentinel-2 classification conducted on a pixel-basis and classified using NDVI thresholds for 3 classes (Fig. 2).
- Hyperspectral airborne data classification in 3 steps: (i) segmentation and masking, (ii) pixel classification and (iii) object classification (Fig. 2). This resulted in 7 classes (Fig. 3).
- Final classification maps were validated and class metrics were calculated (Fig.5).

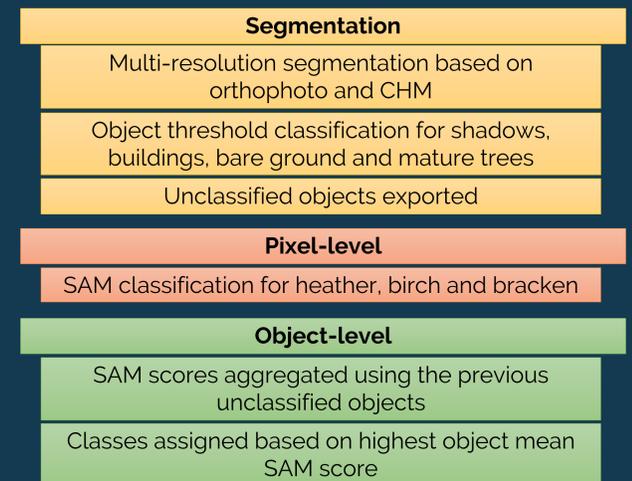


Figure 2. Methodology for classifying airborne hyperspectral data.

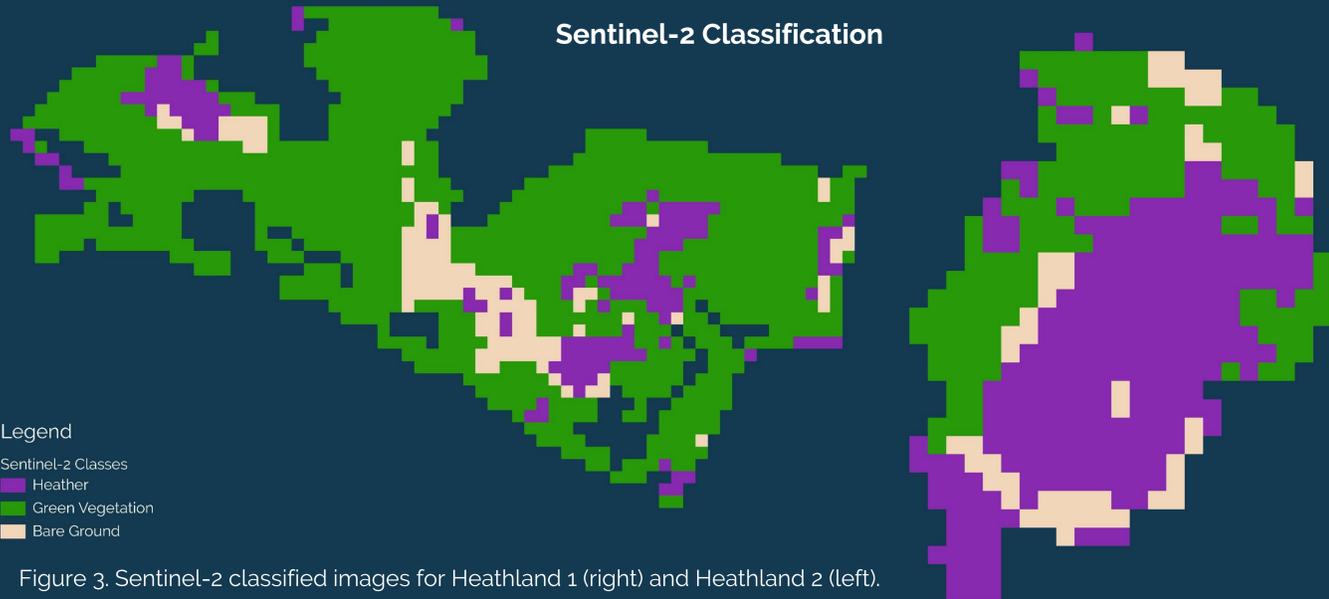


Figure 3. Sentinel-2 classified images for Heathland 1 (right) and Heathland 2 (left).

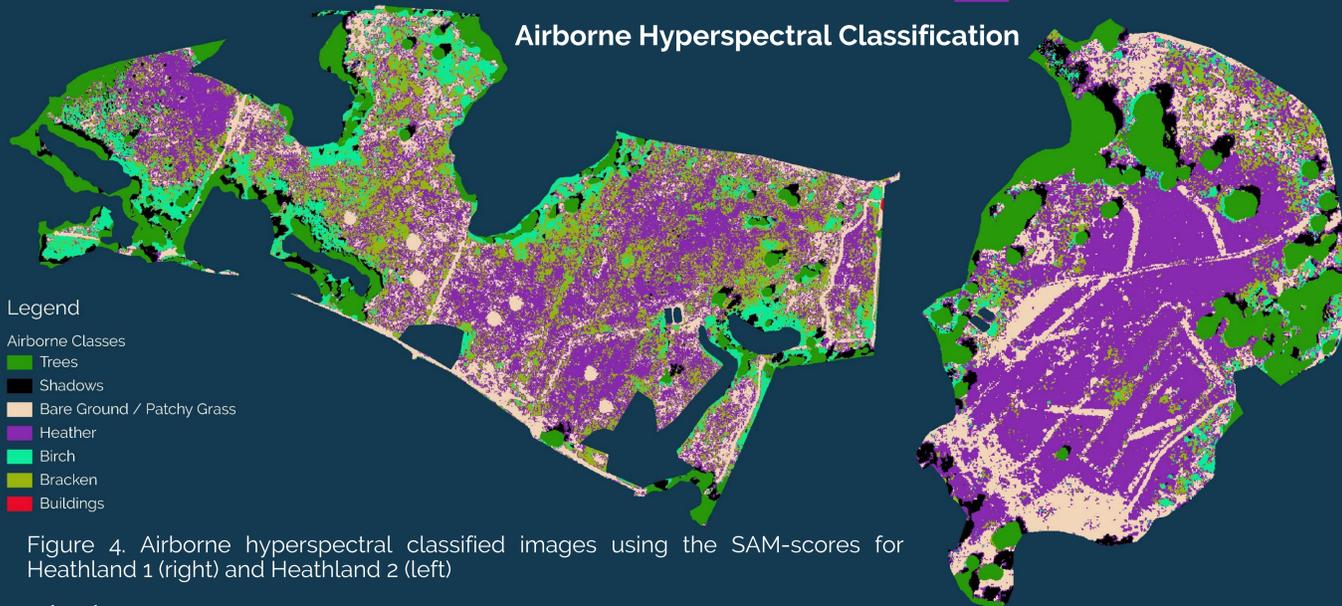


Figure 4. Airborne hyperspectral classified images using the SAM-scores for Heathland 1 (right) and Heathland 2 (left)

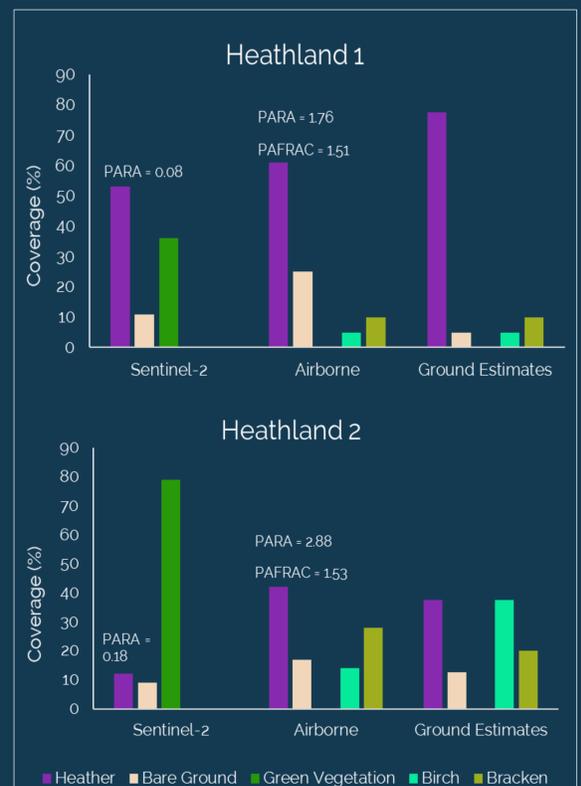


Figure 5. Bar graphs showing the relative percentage coverage of all classes for Sentinel-2, airborne and ground estimates (top: Heathland 1; bottom: Heathland 2).

Coverage percentages were calculated for all classes of interest. The outputs from the Sentinel-2 and airborne classification were compared to the RSPB ground estimates from July 2018. Heather Perimeter-Area Ratio (PARA) and Perimeter-Area Fractal Dimension (PAFRAC) were calculated to inform on the degree of fragmentation.

Conclusion

- The overall accuracy of heather classification for the airborne imagery was 95%, against 66% for Sentinel-2. For Heathland 1, analysis from Sentinel-2 data could not detect the paths and smaller bracken/birch patches. Heathland 2 had a mosaic composition and was more generally a challenge.
- Sentinel-2's spatial resolution was too low and no CHM was available to distinguish between birch, bracken and other trees. It meant that results could not be directly compared to the airborne classification as only 3 classes were obtained. Nevertheless, in the airborne imagery young birch with sparse canopy and bracken were confused (42% and 48% accuracy respectively). This was taken into account during the field collect and a wide variety of birch trees were sampled to mitigate for it. In contrast,
- As expected, heather in Heathland 1 had a lower perimeter-area ratio than Heathland 2 for both airborne and satellite imagery, indicating less fragmentation. Comparison with the RSPB 2018 also highlighted a minor confusion between difficulty in distinguishing birch from bracken.

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- Deliver bespoke remote sensing solutions.
- Specialist experience in forestry, agriculture & environment management.
- Provide cost-effective, high performance data products and services.



References

- Greife, A. and Ehlers, M. (2012) Combined Analysis of Hyperspectral and High Resolution Image Data in an Object Classification Approach.
- Modified Copernicus Sentinel data 2019/Sentinel Hub.

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