APPENDIX M

Fact Sheet Template

OSMRE National Technology Transfer Team (NTTT), **Applied Science Fact Sheet***
U.S. Department of the Interior, OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT

Improved characterization of reclamation outcomes through the synergistic combination of no-cost satellite data and 3D point clouds

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Project Description and Objectives:

Many surface mines are revegetated as part of their postmining land use. However, there is not good information for the Appalachian coal field region for the composition of surface mine land cover on a large scale. Additionally, the invasive shrub *Elaeagnus umbellata* (autumn olive) has become a prolific nuisance on former mining sites, incurring high removal costs.

The goal of this study was to develop a new method for interpreting open source remote sensing data to better characterize vegetative cover and type on reclaimed surface coal mines in the Appalachian coalfield region. Using this new dataset we sought to answer questions concerning the:

- Composition of surface mines in Virginia and Tennessee within seven land cover classes.
- Total area estimate of autumn olive on mines.
- Progression of land cover over time on mines.
- Transferability of the classification methodology to unseen areas and years.

Applicability to Mining and Reclamation:

The results document the vegetative outcomes of reclamation practices across the Appalachian coal fields of Virginia and Tennessee. This classification methodology could be extended for other Appalachian states to document annual progression of mine reclamation.

Methodology:

To develop a land cover classification of Appalachian surface mines in the study region (Figure 1), we integrated multi-source remotely sensed data, including Sentinel-2 and Landsat satellite imagery as well as USGS 3D Elevation Program (3DEP) LiDAR to identify seven land cover classes, with an emphasis on invasive autumn olive. Training data consisted of 1,284 photo-interpreted sample points interpreted from high-resolution aerial imagery across Southwestern Virginia. Predictor layers included seasonal spectral composites, harmonic and trend metrics from time series models, and structural attributes from LiDAR. We identified land cover using a one-vs-rest trained random forest classifier for three years (2018 to 2021) and two regions (Virginia and Tennessee). Land cover prediction maps were validated with post-classification stratified samples to obtain unbiased area-weighted measures of accuracy and area estimates with confidence intervals. We summarized post-mining land cover proportions, trends, and their relationship to site age. We also summarized the effectiveness of the spatial and temporal extension of the classification model for regions and years not included in the training data.

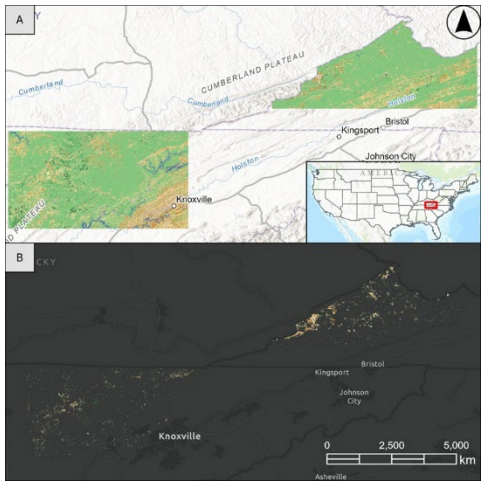


Figure 1: *Predicted land cover for the year 2021. A: Full extent of land cover in Virginia and Tennessee. B: Land cover within mining extent identified by the Skytruth MTM dataset in Virginia and Tennessee.*

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Highlights:

Important conclusions of the study include the following:

1. The classification methodology performs well when predicting land cover in new areas and prior years with overall accuracy ranging between 74.3% and 76.8%.
2. Surface mines appear to be successfully revegetating within about 11 years.
3. Autumn olive covers 3,788 ± 1,041 ha or 9.8% of all mined area in Virginia for the year 2021

Results and Findings:

The classification model showed stable accuracy (74–77%) across years, but performance was worse in new locations, especially for autumn olive, which was much harder to identify in Tennessee than in Virginia (Table 1).

Autumn olive makes up almost 10% of mined land in Virginia, but is relatively rare in Tennessee, which is predominantly composed of herbaceous and coniferous forest cover (Figure 2).

Over time, mined land in Virginia shifts from herbaceous or barren to predominately forest cover types, with autumn olive most prevalent 14 to 16 years after disturbance and then declining as forests became established (Figure 3) .

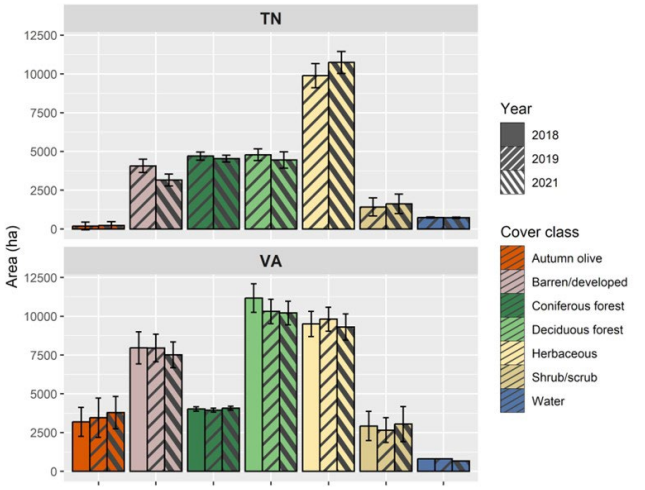


Figure 2: *Per-class estimates with error bars indicating the 95% confidence interval for each region and year evaluated.*

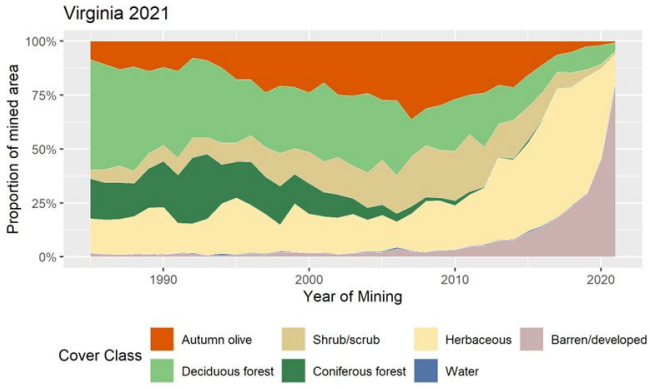


Figure 3: *Chronosequence of land cover proportions by year of mining for mines in Virginia as of 2021.*

Table 1 *Class-specific accuracy scores (F1 score) for the year 2021 in Virginia (VA) and Tennessee (TN)*

Region	Barren/developed	Deciduous forest	Coniferous forest	Herbaceous	Shrub/scrub	Autumn olive	Water
VA	0.78	0.84	0.64	0.80	0.48	0.68	0.50
TN	0.65	0.77	0.86	0.86	0.31	0.17	0.81

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