INVENTORY OF MODERATE AND INTENSIVE TIMBER CLEARINGS DETECTED VIA REMOTE SENSING IN NEW HAMPSHIRE BETWEEN 2000 AND 2018





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Inventory of moderate and intensive timber clearings detected via remote sensing in New Hampshire between 2000 and 2018 Published February 18, 2020 Version 1.0 Forest Ecosystem Monitoring Cooperative

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Background

New Hampshire is about 83% forested. Of this, about 72% of the forestland is privately owned, with the remain

completed, a large (>1000 ac) clearcut in the state caused public outcry (NH DRED, 1996). In anticipation of updating the NH Forest Action Plan, the NH Division of Forest and Lands solicited an updated inventory of statewide timber clearing from the Forest Ecosystem Monitoring Cooperative (FEMC). Here, we inventoried the amount, extent, timing, and trajectory of moderate and intensive timber clearings in NH between 2000 and 2018 detected via remote sensing by utilizing available spatial datasets and ancillary information on the location of known timber clearings.

Methodology

Identification of forest change

We utilized the Global Forest Change spatial dataset produced by Hansen et al. (2013; Version 1.6) that identified locations of forest loss and gain between 2000 and 2018. Briefly, this dataset was created from time-series analysis of Landsat satellite imagery to characterize forest extent, loss, and gain at a 30 m (0.22 ac timber clearing inventory to evaluate for accuracy. For each of these polygons, we used Google Earth Pro

last year of the analysis (2018) and another 20% occurred in 2017 (Figure 2). This suggests that the imagery we used to assess the accuracy of the timber clearing inventory were not as recent as those used to create the Gobal Forest Change dataset. As new images are made available, we can re-assess these commission errors for 2017 and 2018. Overall, most of the misclassifications occurred on smaller polygons; the mean size of misclassified polygons was 8 ac compared to 11 ac for those that were correctly identified. Commission errors varied by county, ranging from no commission error ror in Belknap, Hillsborough, Rockingham, and Strafford Counties to a 6.0% commission error rate in Grafton County (Figure 3).

While this inventory did well at detecting some level of timber clearing, of the 1,514 polygons that correctly identified a clearing based on the historical imagery, slightly more than half (55%) were determined to be intensive timber clearings (i.e., residual basal area of <20 ft²/ ac; Figure 4). The other half (44%) were determined to be moderate clearings (i.e., >20 ft²/ ac residual basal area). We were unable to classify timber clearing intensity using remote sensing; as these results were based on a subset of timber clearing polygons, caution should be used when interpreting the amount of possible clearcutting. Further, the ratio of intensive to moderate clearings detected varied by county and year (Figure 2, Figure 3).

Using the results of our accuracy assessment, the values presented here are unlikely to overestimate the amount of timber clearing overall (<2% commission error rate by area), but these results do include both moderate and intensive timber clearings. We estimate that slightly more than half of the values presented here represent intensive timber clearings. Further, this inventory could not detect low-intensity timber clearings, like single tree or small group selection. While those types of clearing may have detected by the original dataset (Hansen et al. 2013), discontinuous pixels and clearings <3.0 ac in size were removed from further analysis (see Methods section). At the same time, the results presented here may underestimate cleared area (9% omission rate by area). These error rates were used to define the upper (omission rate) and lower (commission rate) bounds of the values presented here.

Spatiotemporal patterns of timber clearing inventory

Spatial patterns

The timber clearing inventory detected 203,832 ac of clearing representing 3.9% of the between 2000 and 2018 across 19,090 polygons (Table 3, Figure 4). Based on our accuracy assessment, this equated to 111,553 ac of intensive timber clearing (<20ft²/ ac residual basal area) and 88,876 ac of moderate timber clearing (>20ft²/ ac residual basal area). However, as the ratio of intensive to moderate clearings were assessed on a subset of polygons (1,514), these

was performed using aerial imagery and therefore may be subjective. Annually, this equated to 11,324

classified as moderate timber clearing. Using the harvest report data from the NH Department of

Figure 4. Locations of moderate and intensive timber clearings (blue polygons, enhanced for visibility) detected in New Hampshire between 2000 and 2018 using the Global Forest Disturbance dataset (Hansen et al. 2013). The inset maps on the left show examples of the range of clearings detected, with different outline colors denoting different years of detection: (top) a large, multi-year timber clearing, (middle) a



Figure 5. Histogram of the number of moderate and intensive timber clearing polygons detected per size class range (ac). The proportion of the total number of clearings depicted statewide is shown per size class range. Note that a clearing that occurred over multiple years were considered distinct clearings.

Patterns by landownership

Most of the moderate and intensive timber clearings (80.2%) occurred on private, nonconserved lands, such as private woodlots, farms, or residential areas (Table 4). The average size of clearings among owner types did vary more than it did by county: municipal/county lands had the smallest sized cuts, while land owned by other public/ quasi-public entities had the largest average size. This latter grouping, designated by the data source, included entities like water and sewer districts and school forests. That said, the range in average clearing size across these disparate ownerships is still quite small. Note that we did not evaluate whether the cut occurred when the land was under the current ownership (ownership data from 2017). For example, a forest parcel could have been harvested in 2001 and subsequently sold to a different type of owner; since our landownership data was from 2017, the area would be classified as occurring on land under the new owner. We also found that private, non-conserved lands experienced clearing at a higher rate than other landowner types: 4.9% of forestland on private, non-conserved lands was cleared compare to 0.9% of forestland on Federal lands. Table 4. Results of statewide moderate and intensive timber clearing inventory reported by land ownership entity. Land ownership data from the Society for the Protection of NH Forests (2017).

Entity	Total area (ac)	Percent of	Percent of
		statewide	for estland cut
		total	

years. Therefore, we think that there is a high degree of accuracy within 2 years of the year detected.



Figure 6. Statewide moderate and intensive timber clearing inventory identified through remote sensing displayed by the year detected and total acreage (left axis) and as the average (±SE) cut size (right axis). Upper and lower error bars for the total area are derived from the omission and commission error rates, respectively. There is a significant positive linear trend in the total area cleared over time, but not in the average cut size.



Figure 7. V clearcuts and detection year for the timber clearing inventory. The mean difference in year (\pm SE) was 0.49 \pm 0.6 years.



Future directions and areas for improvement

This analysis demonstrates the utility of the Gobal Forest Change dataset (Hansen et al. 2013) for detecting moderate and intensive timber clearings. However, it comes with limitations. The timber clearing inventory presented here missed a number of known silvicultural clearcuts (9% by area) and we are unsure why, but it was likely the result of satellite image inputs. The biggest limitation in remote sensing analyses is the temporal resolution of composite satellite images. Satellite images over New England often contain clouds and as a result, multiple years of images are needed to create a cloud-free, statewide land cover image. The authors of the Gobal Forest Change dataset that we utilized for this assessment caution that some of the underlying Landsat imagery has not been fully validated (Hansen et al. 2013). While we found that the dataset did not overestimate the amount of moderate and intensive timber clearing statewide, we were unable to effectively distinguish between these two levels of clearing intensity. Nearly half of the clearing

the amount of residual basal area qualified these polygons to be officially defined as an intensive

New Hampshire Department of Resources and Economic Development (NH DRED), Division of Forests and Lands. 1996. New Hampshire Forest Resources Plan. Available at: