Forest Fragmentation

The amount of forest land in the U.S. monitored by the U.S. Department of Agriculture (USDA) Forest Service has remained nearly constant over the past century, but the patterns of human land use have affected its distribution from one region of the U.S. to another (USDA Forest Service, 2012; Oswalt et al., 2014). Forest fragmentation involves both the extent of forest and its spatial pattern, and is the degree to which forested areas are being broken into smaller patches and pierced or interspersed with non-forest cover. Temporal trends in forest fragmentation are the result of two potentially dissimilar spatial processes imposed on the existing forest pattern – the pattern of forest gain and the pattern of forest loss – and as a result, fragmentation can change even if the absolute area of forest does not change.

Forest fragmentation is a critical aspect of the extent and distribution of ecological systems. Many forest species are adapted to either edge or interior habitats. Changes in the degree or patterns of fragmentation can affect habitat quality for the majority of mammal, reptile, bird, and amphibian species found in forest habitats (Fahrig, 2003). As forest fragmentation increases beyond the fragmentation caused by natural disturbances, edge effects become more dominant, interior-adapted species are more likely to disappear, and edge- and open-field species are likely to increase.

This indicator of forest fragmentation was developed by the USDA Forest Service. The indicator is based on the 2001, 2006, and 2011 National Land Cover Database (NLCD), which was constructed from satellite imagery showing the land area of the contiguous U.S. during different seasons (i.e., leaves-on and leaves-off) (Xian et al., 2009; Fry et al., 2011; Jin et al., 2013). The USDA Forest Service's Southern Research Station performed a re-analysis of the NLCD, aggregating the four NLCD forest cover classes (coniferous, deciduous, mixed, and wetland forest) into one forest class and the remaining land cover classes into a single non-forest class (USDA Forest Service, 2014). A model that classifies forest fragmentation based on the degree of forest land surrounding each forest pixel (a square approximately 30 meters on each edge) for various landscape sizes (known as "windows") provides a synoptic assessment of forest fragmentation for the contiguous U.S. by assessing each pixel's "forest neighborhood" within various distances.

Results are based on four degrees of forest cover: "core" if a subject pixel is surrounded by a completely forested landscape (no fragmentation), "interior" if a subject pixel is surrounded by a landscape that is 90 to 100 percent forest, "connected" if a subject pixel is surrounded by a landscape that is 60 to 90 percent forest, and "patchy" if the subject pixel is surrounded by less than 60 percent forest. The window (landscape) size used for this analysis was 13 by 13 pixels, 390 meters on each edge, or about 15.2 hectares (37.6 acres). The window is shifted one pixel at a time over the map, so the target population for the indicator is all forested pixels in the contiguous U.S. Percent forest was resampled from 30-meter pixel data and aggregated by state to develop the EPA Region-specific breakouts.

What the Data Show

As of 2011, 23.5 percent of the forested pixels in the U.S. represent "core" forest (Exhibit 1). About 20.5 percent of forest pixels in the U.S. are surrounded by a landscape that is less than 60 percent forest (i.e., forest cover is "patchy"). The most noticeable trend from 2001 to 2011 was the loss of relatively intact forest. From 2001 to 2011, while the total NLCD forest land cover area decreased by 3.0 percent, the proportion of total forest area that was considered "core" or "interior" decreased

by 3.1 percentage points and the proportion that was "connected" or "patchy" increased by 3.1 percentage points. The total extent of "core" forest cover decreased by 12.8 percent from 2001 to 2011. Thus, there is less forest cover in 2011 compared with 2001, and that which remains is more fragmented.

Forest fragmentation shows considerable regional variation (Exhibit 1). EPA Regions 1, 2, and 3 have more than 30 percent "core" forest pixels, while only about 15 percent of the forest pixels in Region 7 are "core" forest. From the opposite perspective, fewer than 10 percent of the forest pixels in Region 1 are "patchy" (surrounded by less than 60 percent forest), compared with almost 40 percent of the forest pixels in Region 7. The largest changes in forest fragmentation by region between 2001 and 2011 were losses of "core" forest cover. Region 4's "core" forest cover decreased by 22 percent during this 10-year period, which was the largest change seen between 2001 and 2011 within any region. Regions 1, 6, 8, and 10 saw decreases of more than 10 percent. Most regions also saw decreases in "interior" forest extent, most saw increases in "connected" forest, and all saw increases in "patchy" forest. Region 10 experienced the largest "patchy" increase (12.5 percent).

Limitations

- Although earlier land cover data are available as part of the 1992 NLCD, they are not directly comparable with the 2001, 2006, and 2011 NLCD due to differences in classification methodology. Efforts to derive comparable and more recent databases are ongoing.
- The apparent degree of connectivity depends on the size of the window. In a similar analysis of 1992 and 2001 NLCD data, Wickham et al. (2008) determined that the percentages for all categories (especially "core" and "connected" forest pixels) decrease rapidly as the size of the window is increased.
- The NLCD is updated approximately every 5 years. It typically takes a few years for a full set of NLCD data to be organized and analyzed for release, plus it takes additional time to conduct the supplemental analysis that supports this ROE indicator. Thus, while the data may appear to be several years old, this indicator uses the most recent analysis available.
- This indicator does not identify what causes fragmentation; it identifies only the landscape patterns of the existing forest land cover at a point in time. Additional indicators can be used to identify natural and anthropogenic fragmentation (e.g., Wade et al., 2003).
- This analysis describes observed changes in landscape patterns, but it does not identify the permanence of the changes. For example, losses of core forest area could result from deliberate conversion (e.g., clearing for development) as well as from shorter-term disturbances that happen to be detected at the time of the survey (e.g., trees damaged or killed by fire, insects, or disease).
- The data do not include Hawaii or Alaska, which account for about 1 out of every 6 acres of forest land in the U.S.

Data Sources

Earlier versions of this indicator have appeared in several national reports including USDA Forest Service (2004, 2011, 2012) and Heinz Center (2005). This indicator is based on land cover data from the 2001, 2006, and 2011 NLCD (USGS, 2014a, 2014b, 2014c). The summary statistics presented here were derived from analyses described by Riitters and Wickham (2012). The data for

this indicator were provided by state by the USDA Forest Service (2014) and EPA grouped the results by EPA Region.

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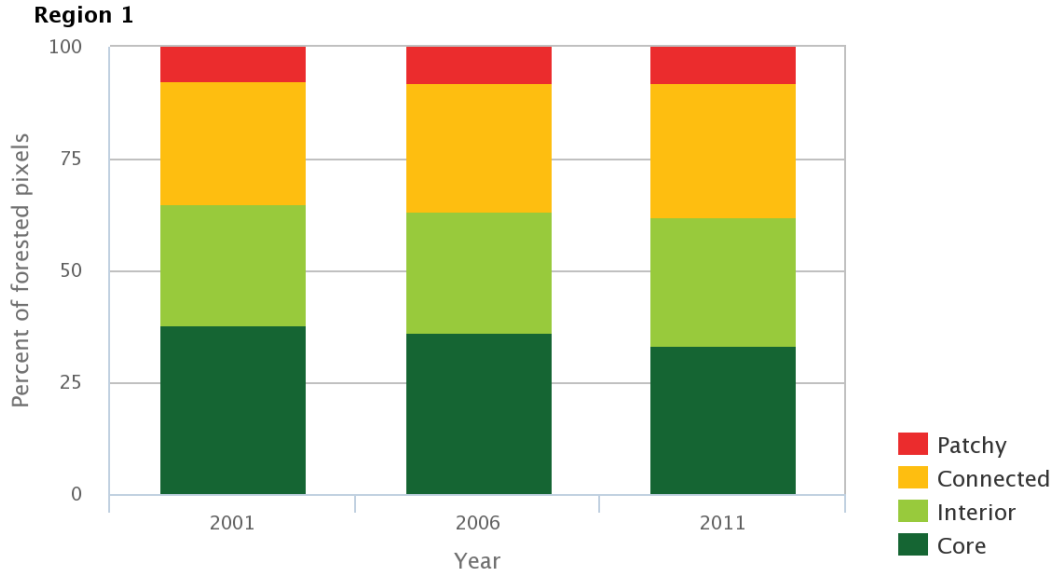
Exhibit 1. Forest fragmentation in the contiguous U.S. by EPA Region, based on 2001, 2006, and 2011 NLCD



Coverage: Areas of the contiguous 48 states classified as "forested" by the 2001, 2006, and 2011 National Land Cover Database (NLCD).

See text for definitions of forest cover categories.

Trend analysis has not been conducted because these data represent a single snapshot in time. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: USDA Forest Service, 2014

Visit http://www.epa.gov/roe to see the full exhibit.