Land Cover

Land cover represents the actual or physical presence of vegetation (or other materials where vegetation is nonexistent) on the land surface. Land cover is also often described as what can be seen on land viewed from above. It is one means to describe landscape patterns and characteristics that are critical in understanding aspects of the environment, including the availability of and changes in habitat, the potential for dispersion of chemicals and other pollutants, and potential contributors to climate change, such as reflectivity of the land.

A group of federal agencies, known as the Multi-Resolution Land Characteristics (MRLC) Consortium, coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications (MRLC Consortium, 2020b). The MRLC Consortium develops and publishes the National Land Cover Database (NLCD), which provides nationwide data on land cover and land cover change. NLCD 2016 includes land cover data for years 2001, 2004, 2006, 2008, 2011, 2013, and 2016.

The land cover indicator provides summary-level land cover information from the 2016 NLCD, including land cover change data. The NLCD 2016 Land Cover change index provides a visualization of land cover change from all seven dates for the contiguous U.S. and Alaska; data products for Hawaii and Puerto Rico have not been updated for 2016 and therefore are not included in this indicator.

The 2016 NLCD provides a nationwide classification of land cover into 20 classes based on a modified Anderson Land Cover Classification System at a spatial resolution of 30 meters. For this indicator, the 20 land cover classes were aggregated into nine major land cover types: forest, grassland, shrubland, developed, agriculture, wetlands, ice/snow, barren areas, and dwarf scrub/sedge/moss. See the definitions page for a description of each land cover type. Open water is shown on the land cover map (Exhibit 1) but is otherwise not discussed as a land cover type in this indicator. See the Water theme area for more information on trends related to water. More information about forests can be found in the Forest Extent and Type indicator, and wetland acreage is discussed in greater detail in the Wetlands indicator.

What the Data Show

The 2016 NLCD for the contiguous 48 states and Alaska shows about 570 million acres of forest cover, 532 million acres of shrub, 450 million acres of agriculture, 284 million acres of grass, 143 million acres of wetland, 106 million acres of developed land, 96 million acres of dwarf scrub/sedge/moss, and 69 million acres of ice/snow and barren land combined (Exhibits 1 and 2).

A comparison of NLCD 2001 and 2016 data shows that 94.65 percent of pixels (each pixel representing an area of about 30 meters square) remained unchanged across the two databases (MRLC Consortium, 2019). Exhibits 3 and 5 reflect the 5.35 percent of pixels that did change: with pixels converted to acres. Exhibit 3 shows net changes between 2001 and 2016 by acreage for each land cover type. For the contiguous U.S. and Alaska, grassland, shrubland, and developed land showed the largest increases in acreage, while forest cover had the largest loss of acreage during this period (MRLC Consortium, 2019). Exhibit 5 provides additional detail by displaying the source of the land cover gains and losses from 2001 to 2016. For example, Exhibit 5 shows that almost 30 million acres of forest land lost primarily became shrubland, grassland, or developed land, while forest gains were from land that previously had been agricultural.

NLCD 2016 data show variation in land cover types by EPA Region for the contiguous U.S. and Alaska (Exhibit 4). Forest dominates Regions 1, 2, 3, and 4. Regions 5 and 7 contain the most agriculture acreage, with 99 million acres and 100 million acres, respectively. Shrubland and grassland account for more than half of the land cover in Regions 6 and 8, while shrubland dominates Region 9. Forest and shrubland together cover more than half of Region 10.

Limitations

- A new generation of NLCD products was released in 2016 to provide consistent, robust methodologies for production of a multi-temporal land cover and land cover change database from 2001 to 2016 (Yang et al., 2018; Jin et al., 2019). The new database design produces more accurate land cover information by correcting legacy errors inherited from older NLCD products (i.e., NLCD 2011 and earlier); therefore, NLCD 2016 is not directly comparable to previous NLCD versions.
- The NLCD 2016 land cover product was validated using existing reference data from the legacy NLCD 2011 accuracy assessment, applied to the 2011 epoch of the NLCD 2016 product line. The legacy and new NLCD 2011 overall accuracies demonstrated a small but significant increase in overall accuracy (Homer et al., 2020; Wickham et al., 2021).
- While the nominal date of an NLCD database implies that data were collected during that year, in fact the data for each database were collected from satellite imagery captured during the nominal year and, to some extent, the preceding and succeeding years.
- Alaska NLCD classification derivations are affected by short "leaf on" growing seasons, persistent cloud cover, and increasing terrain shadow and sun angle problems outside the growing season. These are challenges that Alaska faces and the contiguous U.S. does not, and they mean that more years of compiled, acceptable imagery are needed to satisfy established criteria for reasonable change detection; thus, they tend to increase the time between NLCD updates for Alaska (MRLC Consortium, 2019).
- For the 2016 Alaska NLCD update, the Google Earth engine was employed to create a composite imagery mosaic that uses much smaller pieces of Landsat imagery to develop a complete snapshot. This snapshot was used for change detection between 2011 and 2016. This composite technique is not as scientifically rigorous as using direct Landsat imagery (MRLC Consortium, 2019).
- National estimates of land cover vary, depending on the survey approach, data sources, classification, timing, and data processing steps, among other factors. The interaction of these variables will result in different estimates of the extent of any given land cover type depending on the data set used. Techniques relying on satellite data to generate land cover estimates classify what is visible from above, meaning they may underestimate developed cover in heavily treed urban areas and underestimate forest cover where trees have been harvested.
- Definitions, coverage, and methodologies used for land cover classification vary among federal agencies (USDA Economic Research Service, 2022).
- The NLCD has traditionally been updated every 5 years, though this frequency has been increasing with advances in data availability and computer technology. The data from each NLCD update are organized and analyzed for release about 1 or 2 years after the update (Homer et al., 2020).
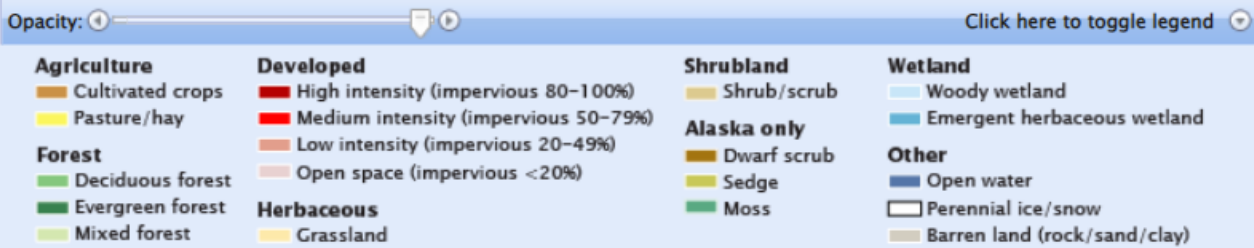
Data Sources

- NLCD 2016 land cover data for the contiguous 48 states and Alaska were obtained from the MRLC Consortium (2019) where they are available for download. Users can also view and explore the data through the MRLC NLCD viewer (MRLC Consortium, 2020a). The NLCD 2016 source data are versioned by date of publication, and the analysis was performed on the version of the data dated "20190424."

References

Homer, C., J. Dewitz, J. Suming, G. Xian, C. Costello, P. Danielson, L. Gass, M. Funk, J. Wickham, S. Stehman, R. Auch, and K. Riitters. 2020. Conterminous United States land cover change patterns 2001–2016 from the 2016 National Land Cover Database. ISPRS J. Photogramm. Remote Sens. 162:184-199.

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MRLC Consortium. 2020b. About. Accessed January 17, 2020. https://www.mrlc.gov/about.

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Wickham, J., S. Stehman, D. Sorenson, L. Gass, and J. Dewitz. 2021. Thematic accuracy assessment of the NLCD 2016 land cover for the conterminous United States. Remote Sens. Environ. 257:112357.

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G. Liknes, M. Rigge, and G. Xian. 2018. A new generation of the United States National Land Cover Database: Requirements, research priorities, design, and implementation strategies. ISPRS J. Photogramm. Remote Sens. 146:108-123.

Exhibit 1. Land cover of the contiguous U.S. and Alaska, based on 2016 NLCD

Opacity: ◀——————————▢▶ ⊙   **Click here to toggle legend** ⊙

Agriculture
■ Cultivated crops
■ Pasture/hay

Forest
■ Deciduous forest
■ Evergreen forest
■ Mixed forest

Developed
■ High intensity (impervious 80–100%)
■ Medium intensity (impervious 50–79%)
■ Low intensity (impervious 20–49%)
■ Open space (impervious <20%)

Herbaceous
■ Grassland

Shrubland
■ Shrub/scrub

Alaska only
■ Dwarf scrub
■ Sedge
■ Moss

Wetland
■ Woody wetland
■ Emergent herbaceous wetland

Other
■ Open water
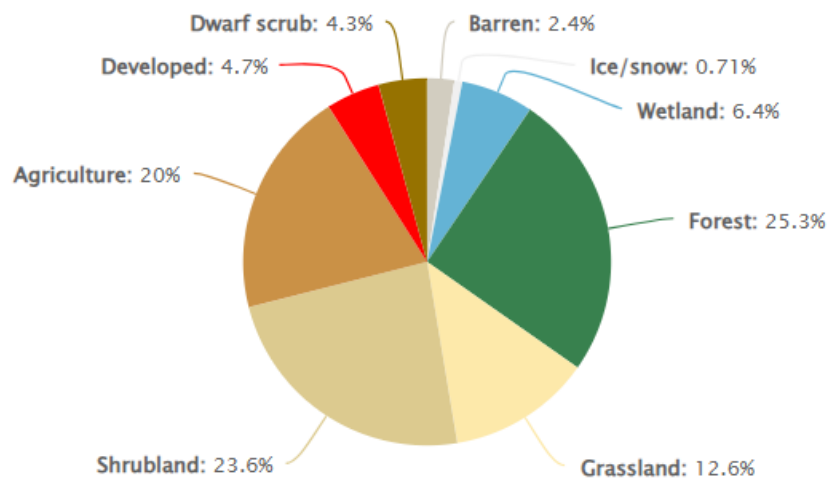□ Perennial ice/snow
■ Barren land (rock/sand/clay)

See text for definitions of land 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: MRLC Consortium, 2019

Exhibit 2. Land cover types in the U.S., based on 2016 NLCD

Dwarf scrub: 4.3%
Barren: 2.4%
Developed: 4.7%
Ice/snow: 0.71%
Wetland: 6.4%
Agriculture: 20%
Forest: 25.3%
Shrubland: 23.6%
Grassland: 12.6%

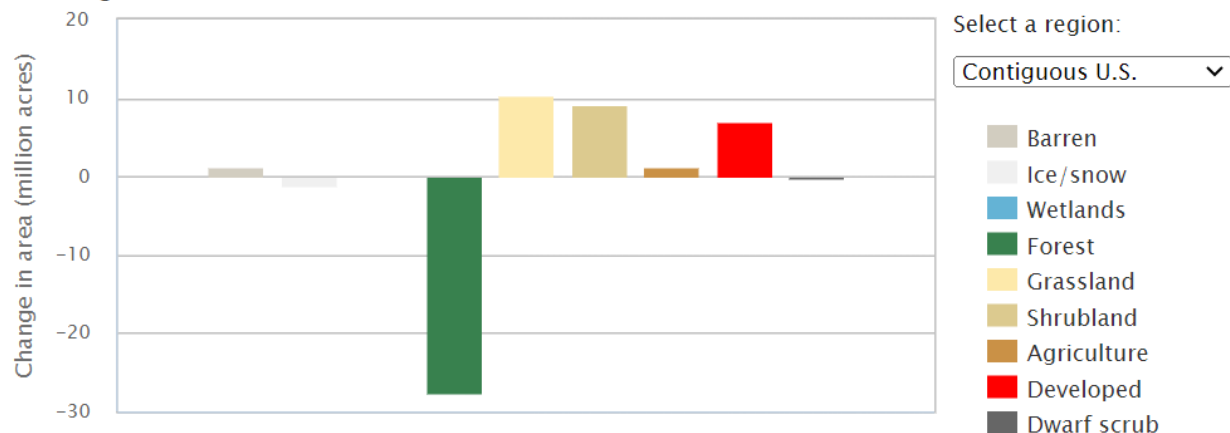**Coverage:** Contiguous 48 states, Alaska, and the District of Columbia, excluding area classified as "open water."

See text for definitions of land cover types. The "Dwarf scrub" land cover type shown in this figure also includes the sedge and moss land cover types.

See Exhibit 3 for changes between NLCD 2001 and NLCD 2016.

Data source: MRLC Consortium, 2019

Exhibit 3. Changes in land cover in the U.S., 2001–2016

Contiguous U.S.

Select a region:

Contiguous U.S. ⌄

- Barren
- Ice/snow
- Wetlands
- Forest
- Grassland
- Shrubland
- Agriculture
- Developed
- Dwarf scrub

Coverage: Contiguous U.S. states and Alaska and the District of Columbia. Because of large variations in the way "open water" areas are measured, the open water land cover category is not included in this analysis.
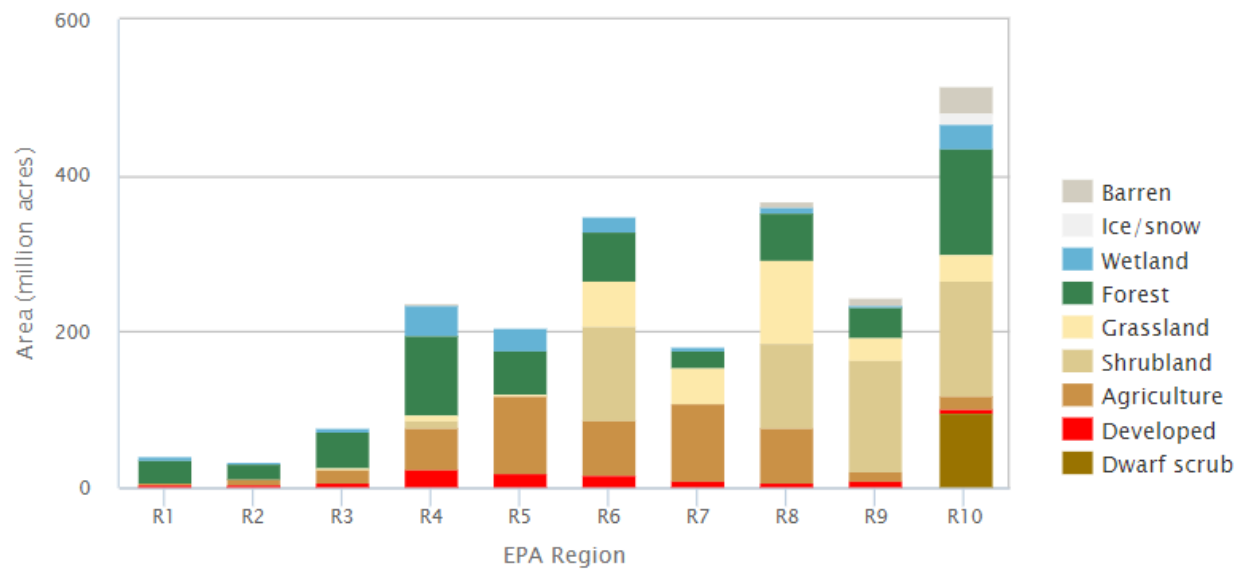
See text for definitions of land cover categories. The "Dwarf scrub" land cover type shown in this figure also includes the sedge and moss land cover types.

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

Data source: MRLC Consortium, 2019

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

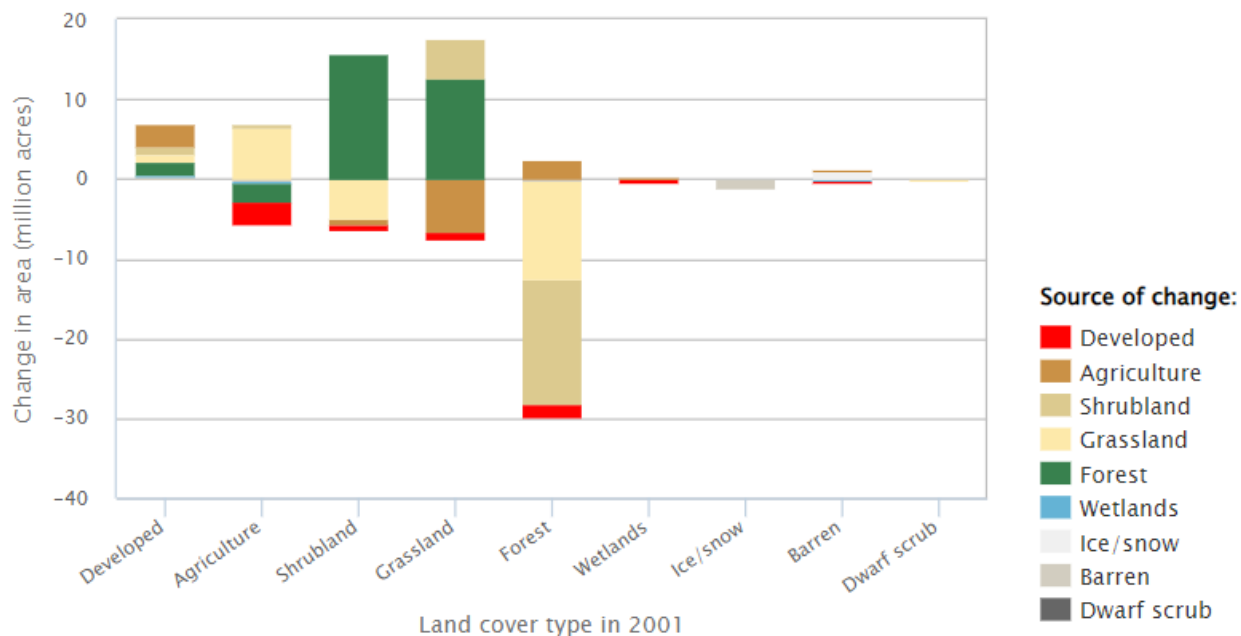# Exhibit 4. Land cover types in the U.S. by EPA Region, based on 2016 NLCD

Coverage: Contiguous 48 states, Alaska, and the District of Columbia, excluding area classified as "open water."

See text for definitions of land cover types. The "Dwarf scrub" land cover type shown in this figure also includes the sedge and moss land cover types.

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: MRLC Consortium, 2019

Exhibit 5. Sources of land cover gain and loss in the U.S., 2001–2016

Coverage:: Contiguous U.S. states and Alaska and the District of Columbia, excluding area classified as "open water."

See text for definitions of land cover categories. The "Dwarf scrub" land cover type shown in this figure also includes the sedge and moss land cover types.

Information on the statistical significance of the trends in this exhibit is not presented here. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: MRLC Consortium, 2019