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Defining the United States Land Base

A Technical Document Supporting the USDA Forest Service 2020 RPA Assessment

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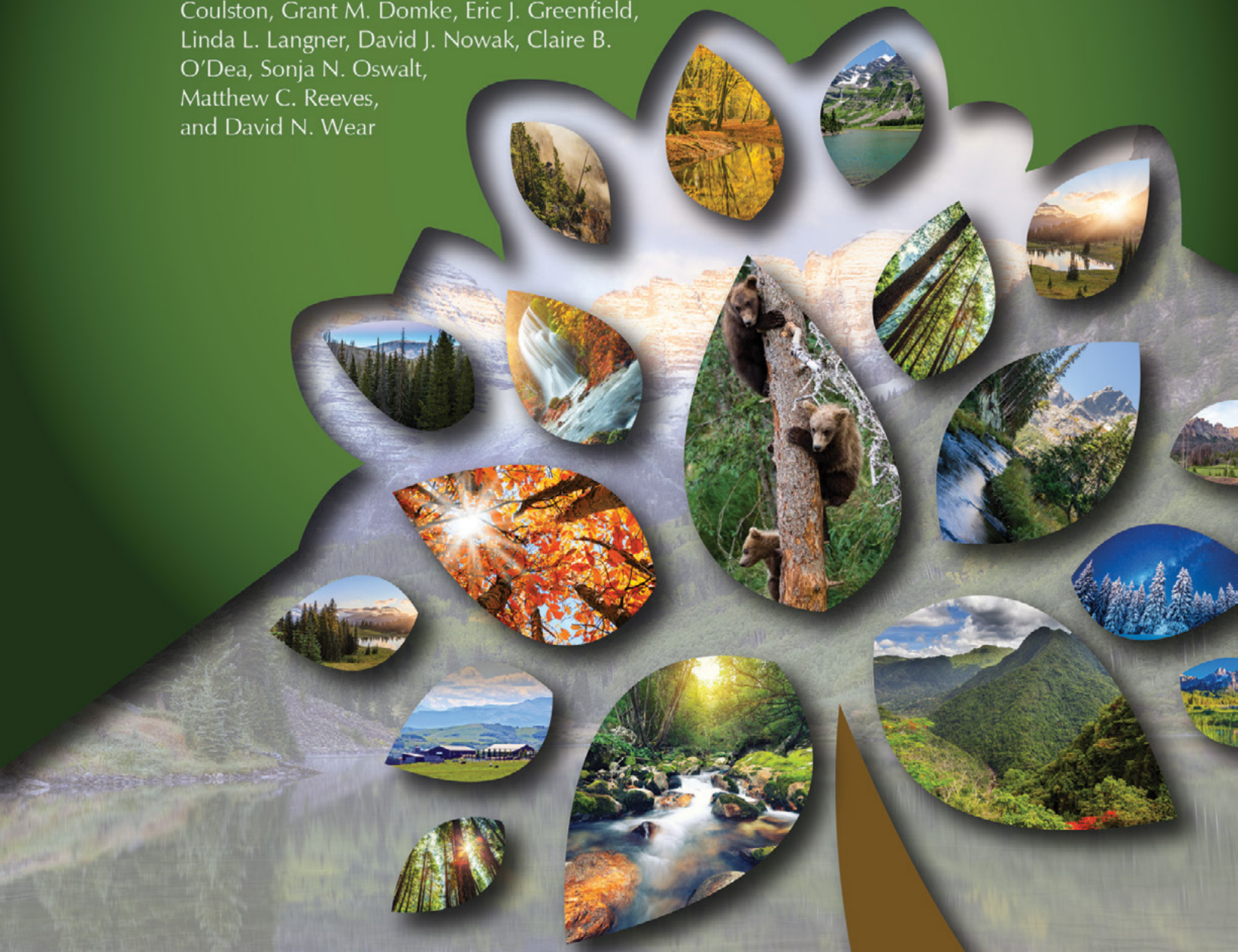

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Abstract

The Resources Planning Act (RPA) Assessment uses a combination of land use and land cover data to evaluate trends in the United States land base and project future changes. This publication describes how the RPA Assessment uses the National Resources Inventory, National Land Cover Database, and Forest Inventory and Analysis to support analyses of forest trends. The authors compare and contrast differences in definitions and approaches of these three major data sources and document the recent status and trends of land use and land cover area according to these sources. While the general definitions of land uses and land covers are superficially similar among these sources, understanding the conceptual and technical differences between them is necessary to evaluate and compare trends in the U.S. land base. Some differences can be rationalized based on the sensitivity of the different databases to the underlying drivers of landscape change over time. However, the major difference is the perception of the land base in terms of its intended human use versus its current biophysical cover. The RPA Assessment will continue to use both land use and land cover data separately and in combination because each source offers both unique and complementary perspectives on land base trends.

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SUMMARY

The Resources Planning Act (RPA) Assessment incorporates social, economic, and biophysical dimensions into an assessment of renewable natural resources across the United States. The classification and representation of the land base of the United States in the RPA Assessment are fundamental to understanding how resource conditions, trends, and future projections are estimated and interpreted. Land use and land cover perspectives are both important and need to be described. Land use describes the social and economic intent for which land is used, while land cover describes the vegetation, exposed land surfaces, water, and artificial structures covering the land surface at a given time. The choice of one land classification system over another depends on several factors, including the specific resource question being addressed, the data available to answer the question, the time frame of the analysis, and the spatial extent of the study area.

Four primary sources of information are used for land base analyses in the RPA Assessment: the National Resources Inventory (NRI), the National Land Cover Database (NLCD), the Forest Inventory and Analysis (FIA) program, and the United States Census Bureau. The two primary sources of data used to define land use and land cover of the conterminous United States (CONUS) are the NRI and the NLCD. Each offers different perspectives of changes in the U.S. land base. Land use projections are parameterized using the NRI data because it offers the longest time trend for the non-Federal CONUS and provides information for both land use and cover; NRI does not inventory Federal lands. The NLCD provides wall-to-wall maps of the land base and is, therefore, the data source for landscape pattern analyses, including landscape mosaic and fragmentation patterns.

In the RPA Assessment, FIA data are used to determine trends in forest land across all ownerships in the United States, providing information based on a land use perspective of forest land. U.S. Census Bureau definitions and data are used for analyses of urban forests and urban trends. Unlike NRI or NLCD definitions, Census Bureau definitions are not based on land use or cover, but instead measure human population density, which is subsequently combined with land use and land cover data to assess treed environments in proximity to human populations.

Trends in NRI and NLCD data on non-Federal ownerships are compared over a similar time span (approximately the decade of the 2000s) to explore how land perspectives differ. Changes in agricultural lands and developed land were broadly similar. In contrast, the forest land use and land cover

definitions resulted in markedly different outcomes for NRI and NLCD, respectively, during this time period. These differences are partially attributable to transient changes in forest cover to shrub, grass, and barren land as a result of tree canopy disturbance, which is not necessarily indicative of a permanent change in forest land use.

Because FIA samples forest land on all ownerships, it is possible to consider and compare trends in NLCD forest cover with trends in FIA forest use. However, NLCD and FIA use different definitions to delineate forest land, which results in differences in the area estimates. In contrast, unlike forest lands, where FIA conducts comprehensive statistically based sampling, rangelands do not have a national sampling program that permits statistical inference about rangeland extent. The NRI provides the most statistically rigorous data for determining trends in non-Federal rangeland area.

While the United States lacks a comprehensive inventory of the protected status of all public and private lands, the Protected Areas Database of the United States (PAD-US) includes detailed maps of the known protected areas (held in fee simple ownership) for all 50 states, along with the status of each protected area according to guidelines developed by the International Union for the Conservation of Nature (IUCN).

Compared to the update to the 2010 RPA Assessment (USDA Forest Service 2016), the improvement in labeling some individual protected areas in PAD-US resulted in noticeable differences in some IUCN categories in estimates for some RPA regions. The addition of a higher spatial and temporal resolution forest cover map reduced the estimated total area of protected forest cover. The newer estimate better approximates the total area of protected forest land use as derived from FIA data. Estimates of protected forest area depend on the definition of forest, but neither the percentage of total forest area that is protected nor the relative distribution of protected forest area among protection categories varied much among the three forest definitions based on land use or land cover.

The FIA data are the basis for national reporting on forest lands that contribute to the U.S. National Inventory Report (NIR) of greenhouse gas (GHG) emissions and sinks. The forest land category offsets more than 10 percent of economy-wide greenhouse gas emissions each year and accounts for an estimated 95 percent of all GHG removals in the land sector. In recent years, methods and models have been developed across NIR and RPA reporting teams to improve the consistency between reports. RPA Assessment carbon projections now rely on the same FIA data used in the NIR to compile baseline estimates. This has improved alignment of contemporary estimates between the reports and provides a consistent transition from the baseline reporting period compiled for the NIR to projections of forest land and woodland area compiled for the RPA Assessment.

INTRODUCTION

The Resources Planning Act (RPA) Assessment reports on the status and trends of the Nation's renewable resources on all forest and rangelands, as required by the Forest and Rangeland Renewable Resources Planning Act of 1974 (P.L. 93-378, 88 Stat 475, as amended; 16 U.S.C. 1601(a), Section 3a). The USDA Forest Service has conducted natural resource analyses for over a century; however the legislation established a 10-year reporting requirement and broadened the coverage to all renewable resources on U.S. forests and rangelands. The legislation was amended in 1990 to additionally require an analysis of the potential effects of global climate change on the condition of renewable resources. The RPA legislation recognizes the importance of our forests and rangelands in contributing to the American public's well-being and quality of life. Maintaining productive forests and rangelands requires continual monitoring and analysis of the effects of changing social expectations and a changing climate on these resources.

The RPA Assessment focuses on analyzing historical trends of forest and rangeland resources and examining the influences of multiple drivers of change on forest and rangeland resources 50 years into the future. The analyses in the RPA Assessment respond to the mandated national focus and include renewable natural resources and related economic sectors for which the Forest Service has management responsibilities: forests, rangelands, wildlife and fish, outdoor recreation, and water, and the effects of climate change on those resources. RPA Assessment results are often presented for both the entire United States and for the four RPA Assessment regions and subregions (Fig. 1), with analyses conducted to reflect the geographic extent of the resource. Some results are also reported for the East, which includes the North and South RPA regions, and the West, which includes the Rocky Mountain and Pacific Coast RPA regions.

The first RPA Assessment was produced in 1977, and since that time the USDA Forest Service has produced either an RPA Assessment or an interim update on an approximate 5-year cycle (USDA Forest Service 1977, 1980, 1984, 1989, 1994, 2000, 2007, 2012, 2016).

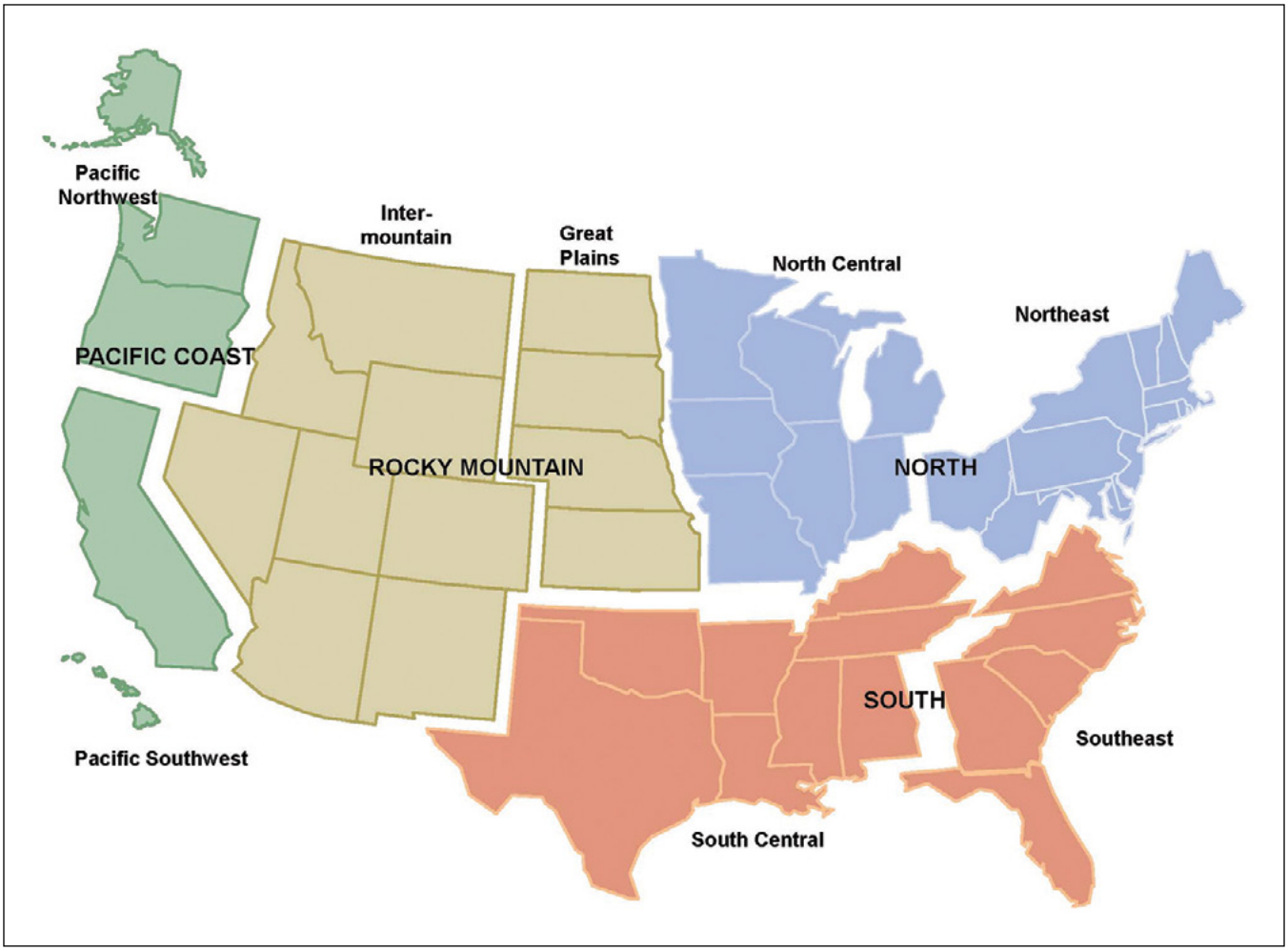

Figure 1.—Resource Planning Act (RPA) Assessment regions and subregions. Collectively, the North and South RPA regions are referred to as the "East" and the Rocky Mountain and Pacific Coast RPA regions are referred to as the "West."

UNITED STATES LAND BASE

Land Use and Land Cover Classifications

Numerous land classification systems exist for the United States, but this report focuses on land use and land cover classifications that define the U.S. land base for the RPA Assessment. Land use describes the social and economic intent for which land is used (Coulston et al. 2014, Lund 2002), while land cover describes the vegetation, exposed land surfaces, water, and artificial structures covering the land surface at a given time (Burley 1961, Osborne 1942). While a nonvegetated surface may have a clear land cover (e.g., barren), the land use of that surface cannot be inferred consistently from land cover. In contrast, some surfaces clearly exhibit both land use and land cover (e.g., agricultural row crops). These definitional and operational nuances must be accounted for when comparing statistics drawn from land use and land cover data.

Tracking the spatial and temporal distributions of land use and land cover is essential for monitoring renewable resource conditions and trends. The choice of one land classification system over another depends on several factors, including the specific resource question being addressed, the data available to answer the question, the time frame of the analysis, and the spatial extent of the study area. For example, a land cover classification that defines forest cover by forest types and successional stages can be used to assess status and trends in forest biodiversity. In contrast, a land use classification that defines forest land use by natural or planted stand origin would be chosen to assess status and trends in the amount of land available for timber production. A statistical sample from an in situ forest inventory system is cost effective for producing unbiased estimates of land area available for forest uses such as timber production, while a wall-to-wall map from remote sensing is better suited for monitoring metrics of landscape pattern to examine, for example, forest fragmentation (Riitters et al. 2002) and water quantity (Martin et al. 2017). Similarly, urban land area is relatively easy to estimate from statistical point samples, but total impervious surface area including rural roads is more easily quantified by developing predictive models from remotely sensed information.

Because the RPA Assessment is a multi-resource assessment where social, economic, and biological dimensions are all relevant, land use and land cover perspectives are both important and need to be described. Ultimately, the land base of each resource area is estimated using land use or land cover classifications, based on data availability and the assessment questions being posed.

Land use classification systems (e.g., USDA 2015) focus on how owners intend the land to be used. For example, a forested area may be used for timber production, recreation, provision of clean water, conservation of biological diversity, or a combination of these uses. Similarly, rangeland as a land use category generally implies management for and use by domestic ungulates. Rangeland defined by a land cover classification system, however, does not require herbivory but is instead defined by its actual cover, the historical climax plant community which "…is predominantly grasses, grasslike plants, forbs, or shrubs," including "…natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows" (Butler et al. 2003). Land uses are land owner choices that relate to economic (e.g., cattle grazing, timber production) and social (e.g., conservation) objectives. Because land use is based on long-term intent, fluctuations in land cover over time do not necessarily indicate the intended land use has changed (Bechtold and Patterson 2005). Cultivated land uses provide a key example of cover fluctuations. Over the course of a year, cultivated land can be plowed (bare ground), planted (crop cover), harvested (bare ground), and snow covered. Furthermore, rotating crops from year to year or the decision to leave a field fallow affect the seasonal vegetation cover during any given year. Even though the biological cover has changed over time, the management intent has not, so the area remains classified as a cultivated land use. A similar situation exists for managed forest, where the cycle from seedlings to tree-cover to harvest to seedlings extends over a longer time frame of multiple decades. Implementing a land use classification requires determining intent. Intent is best identified by direct observation via a field survey, which is often augmented by high-resolution aerial imagery. It is problematic to infer some land uses by using data from optical sensors with only moderate (Landsat 30m) to coarse (AVHRR 1000m) spatial resolution (Anderson et al. 1976), which are better suited for classifying land cover.

Land cover classification systems focus on what is actually covering the land at a single point in time, such as vegetation, water, nonvegetated surfaces, and human structures. For example, a forest cover designation requires a specified amount of tree cover, while grassland is "land on which the vegetation is dominated by grasses, grass-like plants, and/or forbs" (Butler et al. 2003). Land use choices typically are influenced by the presence of existing land cover, such as timber production in locations of existing tree cover, or grazed rangeland use in areas of natural grassland cover. In some cases land cover is a result of the land use, such as new grassland cover being the result of tree clearing to establish pasture land use, or conversely, the development of forest cover in previous grassland areas to establish forest land use, as can occur with the Conservation Reserve Program (CRP). In other situations, a land cover classification may differ from a land use classification. For example, an area classified as both forest land use and forest land cover may be reclassified as grassland land cover following tree harvest, even though the forest land use classification remains; with

sufficient tree regeneration, this area will again be considered to have forest land cover. Furthermore, the same land use classes require the absence of other uses. Forest land use, for example, is assigned when tree cover is present over sufficiently sized areas and other primary human uses are absent, for example, intensive grazing or mowing of turf grass in urban parks. While most land cover classifications are based on remote sensing data (e.g., Landsat, MODIS, aerial imagery), direct ground surveys can also be used to classify land cover. Therefore, it would be an oversimplification to characterize inventory data from ground surveys (e.g., FIA field plots) as exclusively for land use classifications and satellite image-based products as exclusively for land cover classifications (Nelson and Reams 2017).

Despite a strong desire for clear distinctions between land use and land cover classifications, each classification may contain elements of both cover and use (Comber 2008). For example, forest land use definitions typically include a requirement that the intended long-term use of land is for forestry purposes and that the land supports a minimal amount of tree cover, or has the capacity to obtain the minimal cover if such cover is not currently present. Conversely, developed land cover is an unequivocal signal of an intensive land use. Because of the integration of both cover and use components in some classification systems, it is tempting to consider land cover and land use as interchangeable. However, conflation of the two concepts is problematic for both environmental modeling and policy decision making (Comber 2008).

When monitoring the forests and rangelands of the United States, the decision to use a land cover classification, a land use classification, or both, in the RPA Assessment can influence the results. For example, contemporary estimates of forest use extent and forest cover extent are correlated but different (Coulston et al. 2014). Drivers of the divergence include forest management practices, frequency and timing of forest disturbance and regeneration, and understory land uses (e.g., intensively grazed areas beneath sufficient tree canopy cover). The relationship between change in forest land cover and change in forest land use partially depends on how much forest management and forest disturbance has occurred. This is particularly relevant over short time frames (e.g., 5-10 years) but less important over longer time frames (20-50 years), varying with the relative time in a successional stage of regeneration. Accounting for changes in either land use or land cover requires the careful consideration of all gains and losses. Gross loss and gross gain may partially or completely offset each other, with any differences reported as net change. Underestimating gross gain causes overestimates of net loss. This results in net change estimates that report more net loss than is actually occurring (Reams et al. 2010). For example, the complete loss of forest cover can be reliably detected in almost real time from satellite images, whereas the detection of the more subtle forest recovery process takes more time. In this case, a relatively long time series of satellite data (e.g., several decades or more) would be required to detect a trend in regional forest cover area. Even

then, optical image sensors are limited by canopy saturation and can result in underestimation of further growth in biomass, volume, and understory vegetation once canopy closure has occurred. This can affect estimates of forest ecosystem services, which are not defined solely by the two-dimensional surface of tree canopy cover, but also by the three dimensional "growth" of forest structure. Ultimately, each individual question was evaluated to determine whether land use or land cover classifications provide the best answer, recognizing that the answer will be primarily cast in either use or cover terminology, depending on the data source.

In the RPA Assessment, the two primary sources of data used to define land use and land cover of the conterminous United States are the NRI and NLCD. Figure 2 illustrates the use of the two sources in defining the current land base and how those sources are used as inputs to other RPA Assessment analyses.

National Resources Inventory (NRI)

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) produces the National Resources Inventory (NRI). The NRI is a long-term, multi-resource monitoring program (Nusser and Goebel 1997) that collects data and produces an array of information related to land use, land cover, soil conditions, conservation practices, and other attributes on non-Federal lands, which include privately owned,

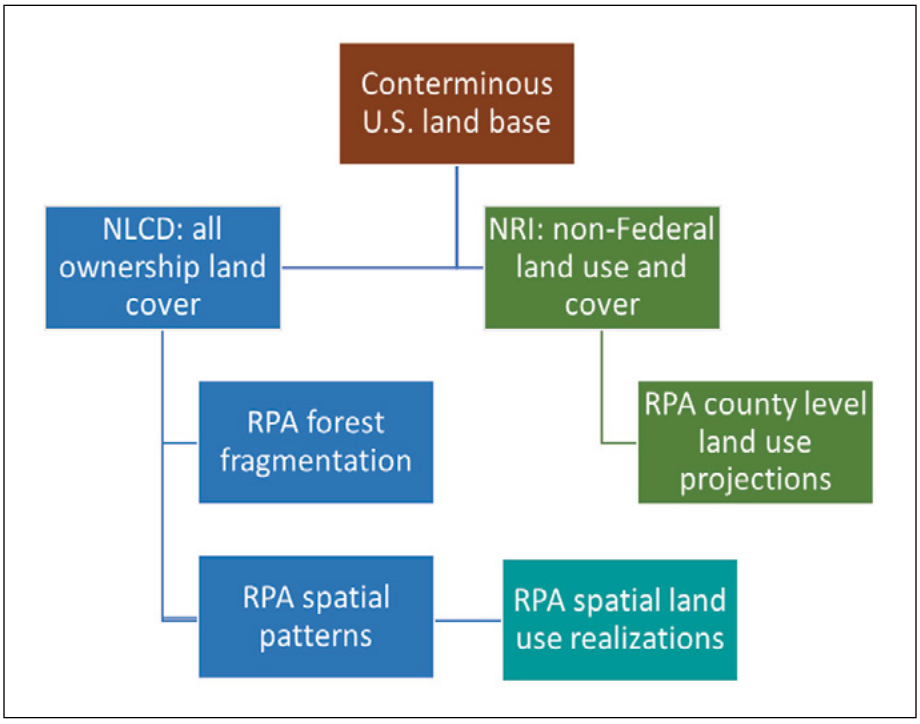

Figure 2.—Relationship between conterminous U.S. land base data sources and associated Resource Planning Act Assessment analyses. NLCD = National Land Cover Database; NRI = National Resources Inventory; RPA = Resources Planning Act.

tribal, trust, state, and local government lands. For a complete listing of data elements, see Schnepf and Flanagan (2016). The NRI is a sample-based inventory that historically (1977-1997) employed a longitudinal statistical design on a 5-year periodic cycle. Starting in 2001, the NRI shifted from a periodic design to an annual design in which a portion of the sample is observed each year. During the 1980s, most NRI data were collected during field visits (in situ) to sample plot locations. The NRI is now designed to obtain the preponderance of data through remote sensing, specifically, interpretation of aerial photographs. During recent inventories, field visits to sample sites occur only under special circumstances. With respect to the RPA Assessment, NRI data offer a long time series of land observations that are used to parameterize land use projection models (e.g., Wear 2011). The projection models are based on the broadest NRI land classifications defined in Table 1 (USDA 2015). For land use projection models, the broad NRI land classes are considered as land uses because they suggest a social or economic intent as evident by the potential for land management practices (e.g., planting of crops [trees or agricultural], fertilization, harvesting, enhancing wildlife habitat) and the presence of buildings and other social infrastructures (e.g., ownership, transportation, enrollment in specific government programs). This report examines the status and change of NRI non-Federal CONUS land classification from 1982 to 2012.

National Land Cover Database (NLCD)

The U.S. Geological Survey (USGS) produces consistent land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. As of February 2018, the USGS National Land Cover Database (NLCD; previously referred to as the National Land Cover Dataset in 1992) mapped the CONUS (1992, 2001, 2006, 2011), Hawaii (2001), Alaska (2001, 2011), and Puerto Rico (2001). Since 2000, the NLCD data have been used in RPA Assessments to portray land cover and to assess tree cover, landscape patterns, and wildlife habitat. This report examines the status and change of NLCD CONUS land cover from 2001 to 2011.[1]

Complete descriptions of the NLCD land cover maps are available from the USGS Earth Resources Observation and Science (EROS) Center (https://www.usgs.gov/centers/eros). The maps are derived primarily from Landsat satellite images (Loveland and Dwyer 2012) supplemented by ancillary geographic data. Maps are produced at a spatial resolution of 0.22 ac per pixel (each pixel is 30 m x 30 m), with a thematic resolution of 16 land cover classes (Table 2). When the NLCD 2011 CONUS map was produced (Homer

[1] The 1992 CONUS map is not included in this report because it is not strictly comparable to later NLCD maps. Alaska is not included because there was relatively little land cover change from 2001 to 2011, and seasonal differences decreased the reliability of change analyses. The NLCD 2016 CONUS map was not available at the time of this report but will be included in the 2020 RPA Assessment.

Table 1.—Broad land classifications used in the National Resources Inventory (NRI)

Land classification	Definition
Cropland	A land cover/use category that includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and noncultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland, for example, hayland or pastureland that is in a rotation with row or close-grown crops. Noncultivated cropland includes permanent hayland and horticultural cropland.
Conservation Reserve Program (CRP)	A Federal program established under the Food Security Act of 1985 to assist private landowners to convert highly erodible cropland to vegetative cover for 10 years. For NRI, only acres that have been enrolled in CRP general sign-up are included in the CRP land cover/use category. It does not include acres enrolled under CRP continuous sign-up.
Pastureland	A land cover/use category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture, or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding or renovation, and control of grazing. For the NRI, includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether or not it is being grazed by livestock.
Rangeland	A land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grasslike plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.
Forest land	A land cover/use category that is at least 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cut over forest or abandoned farmland) and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction, equates to an areal canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification as forest land is 1 acre, and the area must be at least 100 feet wide.
Other rural land	A land cover/use category that includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
Developed land	A combination of land cover/use categories, large urban and built-up areas, small built-up areas, and rural transportation land.
Water areas	A land cover/use category comprising water bodies and streams that are permanent water.
Federal land	A land ownership category designating land that is owned by the Federal Government. It does not include, for example, trust lands administered by the Bureau of Indian Affairs or Tennessee Valley Authority (TVA) land. No data are collected for any year that land is in this ownership.

Sources: NRCS 2015, USDA 2015.

Table 2.—National Land Cover Database (NLCD) land cover classes, class descriptions, and aggregated class used for the Resources Planning Act (RPA) Assessment

NLCD class[a]	NLCD class description	Aggregated class used in this report
Open water	Areas of open water, generally with less than 25 percent cover of vegetation or soil.	Other
Perennial ice/snow	Areas characterized by a perennial cover of ice and/or snow, generally greater than 25 percent of total cover.	Other
Developed, open space	Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.	Developed
Developed, low intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20–49 percent of total cover. These areas most commonly include single-family housing units.	Developed
Developed, medium intensity	Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50–79 percent of the total cover. These areas most commonly include single-family housing units.	Developed
Developed, high intensity	Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80–100 percent of the total cover.	Developed
Barren land (rock/sand/clay)	Areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover.	Other
Deciduous forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.	Forest
Evergreen forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	Forest
Mixed forest	Areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.	Forest
Shrub/scrub	Areas dominated by shrubs less than 5 meters tall, with shrub canopy typically greater than 20 percent of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.	Shrub
Grassland/herbaceous	Areas dominated by gramanoid or herbaceous vegetation, and generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.	Grass

(continued on next page)

Table 2. (continued)—National Land Cover Database (NLCD) land cover classes, class descriptions, and aggregated class used for the Resources Planning Act (RPA) Assessment

NLCD class[a]	NLCD class description	Aggregated class used in this report
Pasture/hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	Pasture
Cultivated crops	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops, such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.	Crop
Woody wetlands	Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover, and the soil or substrate is periodically saturated with or covered with water.	Forest
Emergent herbaceous wetlands	Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover, and the soil or substrate is periodically saturated with or covered with water.	Other

[a] The NLCD maps of Alaska identify four additional shrubland and herbaceous classes that are not listed here.
Source: NLCD (U.S. Geological Survey 2014b).

et al. 2015, U.S. Geological Survey 2014b), the 2001 NLCD CONUS map (Homer et al. 2007, U.S. Geological Survey 2014a) was also updated to improve the comparability between the 2001 and 2011 maps. The overall classification accuracy of the 16-class 2011 NLCD CONUS map was 65.8 ± 0.7 percent (= one standard error of the estimate) for primary reference classes (Wickham et al. 2017); classification accuracies were higher when considering alternate reference labels from similar classes. Overall accuracy provides a statistical estimate of the percent of reference observations correctly classified across all classes within a map. User's accuracy (capturing commission error) and producer's accuracy (capturing omission error) were estimated for each map class.

Data from the NLCD were used to describe CONUS land cover changes from 2001 to 2011. To improve the comparability of the NLCD data with NRI land use statistics presented elsewhere in this report, the 16 NLCD land cover classes were aggregated to the following 7 classes (Table 2): forest, grass, shrub, crop, pasture, developed, and other. Map accuracies for these seven classes were estimated for the 2011 classification by aggregating data from the full error matrix of Wickham et al. (2017), resulting in 73 percent overall accuracy, class-specific producer's accuracies ranging from 48 percent (pasture) to 84 percent (forest), and class-specific user's accuracies ranging from 53 percent (grass) to 87 percent (forest) (Table 3).

Table 3.—Error matrix, overall accuracy, producer's accuracies, and user's accuracies for 7-class aggregation of National Land Cover Database (NLCD) 2011 land cover classes

	Reference							
Map	**Forest**	**Shrub**	**Grass**	**Pasture**	**Crop**	**Developed**	**Other**	**User's accuracy**
Forest[a]	25.659	2.070	0.393	0.097	0.230	0.613	0.268	87.49
Shrub	2.047	15.497	3.198	0.295	0.085	0.378	0.192	71.45
Grass	0.676	3.589	7.960	1.703	0.606	0.384	0.201	52.65
Pasture	0.598	0.159	0.304	3.893	1.344	0.486	0.012	56.36
Crop	0.469	0.154	0.298	1.617	12.905	0.514	0.163	80.06
Developed	0.554	0.132	0.176	0.359	0.346	4.204	0.048	72.27
Other	0.438	0.036	0.365	0.075	0.033	0.088	2.950	68.54
Producer's accuracy	84.29	70.58	62.70	48.43	83.00	63.07	74.80	Overall accuracy 73.07

[a] Aggregated land cover classes are defined in Table 2.
Source: Based on table 4 in Wickham et al. (2017).

Comparability with NRI statistics was also improved by identifying the ownership (i.e., Federal or non-Federal) of each land cover pixel. Ownership was determined by a geographic overlay of the PAD-US protected area database (Conservation Biology Institute 2016) and was assumed to be the same in 2001 and 2011 because changes in Federal ownership tend to be quite small over time. The District of Columbia was excluded because the PAD-US map does not show ownership for that area. A detailed map of county boundaries (ESRI 2005) was used to exclude ocean water and the Great Lakes from the analysis.

Land Base Trends

Trends in NRI data

NRI data from 1982 to 2012 were examined because this is the longest time trend available for the non-Federal CONUS NRI data and because we parameterize our land use projections on the NRI data. In 1982, cropland had the largest single share of the land base (Table 4, Fig. 3), and cropland combined with rangeland and forest land accounted for 64.3 percent of the land base. The Conservation Reserve Program had not yet been established in 1982, and there were 71.5 million acres (1 acre = 0.4 hectares) of developed land. Between 1982 and 2012, there were net losses of cropland, pastureland, and rangeland and net gains in forest land, developed land, and CRP land. Because of these changes, forest land had the largest single share of the land base in 2012.

Table 4.—National Resources Inventory (NRI) land use trends and transitions for the conterminous United States, 1982 to 2012

	2012 Land use									
1982 Land use[a]	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	Water	Federal land	CRP	1982 total
	Thousand acres									
Crop	328,197	34,936	6,166	10,180	4,189	11,688	1,007	1,451	22,086.7	419,901
Pasture	20,783	74,268	4,572	19,582	2,361	6,769	651	455	1,025.1	130,464
Rangeland	8,170	3,822	387,565	3,422	2,719	5,746	652	5,132	901.7	418,130
Forest	2,418	5,743	2,507	372,420	2,678	17,615	1,159	3,487	115.6	408,142
Other rural	1,705	1,381	1,122	3,682	32,808	1,172	92	201	82.9	42,247
Developed land	332	183	183	477	43	70,246	3	4	1.8	71,472
Water	322	183	294	365	28	24	48,456	7	6.1	49,683
Federal land	476	166	2,171	890	98	13	11	393,846	2.1	397,673
CRP	0	0	0	0	0	0	0	0	0.0	0
2012 total	362,403	120,681	404,580	411,018	44,923	113,272	52,032	404,583	24,222.0	1,937,713
Net change	-57,499	-9,784	-13,550	2,876	2,675	41,800	2,348	6,910	24,222	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Source: NRI (USDA 2015).

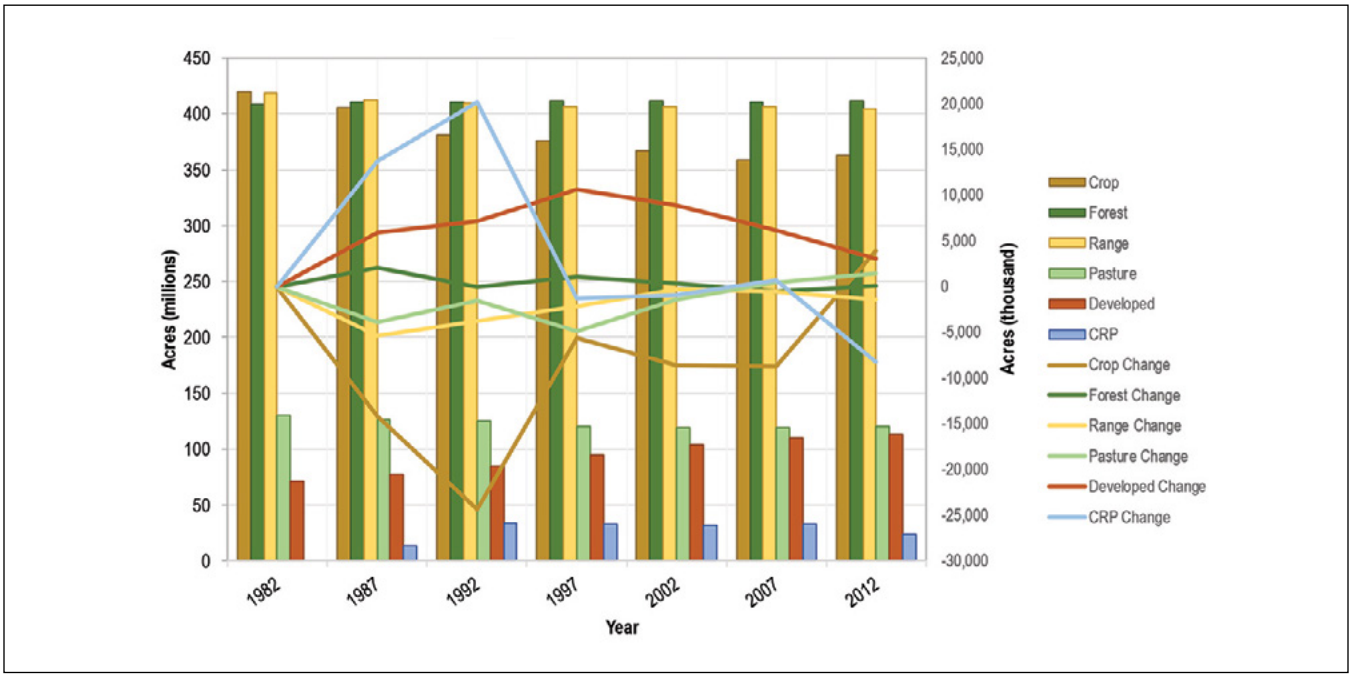

Figure 3.—NRI area trends in land use classes (bars) and net change in land use classes (lines) in the conterminous United States for land classes that are projected in the RPA Assessment and Conservation Reserve Program (CRP) trends, 1982 to 2012. Land classes are defined in Table 1, but names have been shortened for formatting purposes. Source: USDA 2015.

Net changes, however, mask many land use dynamics (Fig. 3). The gross changes presented in Table 4 identify the gains and losses among land use categories. For example, the loss of rangeland from 1982 to 2012 was predominately caused by conversions to cropland, pastureland, and developed uses. However, these losses were partially offset by conversion to rangeland from cropland, pastureland, and forest land. Forest land gains between 1982 and 2012 were driven by conversion of cropland, pastureland, and other rural land to forest land. These gains were moderated by forest land shifts to developed land and pastureland over the time period. The amount of developed lands increased the most from 1982 to 2012, with the increase dominated by the transition of forest land to developed land, cropland to developed land, pastureland to developed land, and rangeland to developed land.

The national NRI trends presented in Figure 3 can be disaggregated to provide a regional context, and in many cases the observed patterns of land use change are regionally distinct. Between 1982 and 2012, the North Region was dominated by net gains in developed land and forest land, with net losses in cropland and pastureland (Table 5). Most of the gains in forest land were a result of conversion from pastureland, while most loss of forest land was conversion to developed land over the same time period. Gains in developed land were also a result of transitions from cropland and pastureland.

Table 5.—National Resources Inventory (NRI) land use trends and transitions for the North Region, 1982 to 2012

	2012 Land use									
1982 Land use[a]	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	Water	Federal land	CRP	1982 total
	Thousand acres									
Crop	129,904	10,293	1	2,508	1,715	4,954	263	237	3,938.8	153,813
Pasture	10,196	23,259	1	8,867	954	2,016	122	82	562.6	46,058
Rangeland	43	15	45	20	1	0	0	0	0.0	124
Forest	902	1,713	0	141,590	1,058	6,150	265	695	53.5	152,425
Other rural	872	669	0	1,962	9,985	399	9	14	39.7	13,949
Developed land	167	64	0	187	14	29,040	2	0	0.5	29,475
Water	111	33	0	136	6	5	15,005	0	0.0	15,297
Federal land	59	23	0	172	4	3	11	15,098	1.8	15,371
CRP	0	0	0	0	0	0	0	0	0.0	0
2012 total	142,253	36,068	47	155,441	13,737	42,567	15,676	16,125	4,596.9	426,511
Net change	-11,560	-9,990	-77	3,016	-212	13,093	379	754	4,597	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Source: NRI (USDA 2015).

In the Pacific Coast Region there were net losses of cropland, pastureland, rangeland, and forest land with increases in other land uses (except water) between 1982 and 2012 (Table 6). Approximately 50 percent of the cropland losses were croplands that entered the CRP land use. Forest land losses were predominated by a shift from forest to rangeland and developed land. Shifts from rangeland and other land use classes to forest only partially offset these forest land losses. Gains in developed land came evenly from cropland, rangeland, and forest land.

The Rocky Mountain Region had net losses in cropland, rangeland, and forest land, with increases in other classes from 1982 to 2012 (Table 7). Over this same time period, increases in developed land and pastureland were observed. Most of the loss of cropland was a result of croplands moving into the CRP, followed by pasture and rangeland. Rangeland losses were primarily because of transitions to cropland, Federal land, and developed land. There were also gains in rangeland due to transitions from cropland, Federal land, and forest land. The largest loss of forest land was because of transitions to rangeland. Most of the increase in developed land was from rangeland and cropland.

The South Region is characterized by substantial net losses in cropland, pastureland, and rangeland with net gains in all other land use classes (Table 8). Most of the cropland loss was because of cropland transitions to pastureland, forest land, and developed land. Pastureland losses were because of transitions to forest land, cropland, and developed land. However, there were additions to pastureland from croplands, forest land, and rangelands. Rangeland losses were driven by transitions to pastureland, developed land, cropland, and forest land. There were also gains to rangeland primarily from cropland and pastureland, but these gains did not offset the losses. The gains

Table 6.—National Resources Inventory (NRI) land use trends and transitions for the Pacific Coast Region, 1982 to 2012

	2012 Land use									
1982 Land use[a]	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	Water	Federal land	CRP	1982 total
					Thousand acres					
Crop	16,869	1,250	739	55	479	901	33	270	1,853.9	22,450
Pasture	731	2,577	424	244	161	366	25	36	16.6	4,580
Rangeland	668	233	31,287	732	283	1,201	101	1,510	17.5	36,032
Forest	35	66	859	37,439	111	1,079	71	552	0.0	40,211
Other rural	66	49	152	92	2,892	112	7	66	1.9	3,438
Developed land	20	11	26	46	6	6,561	0	0	0.0	6,669
Water	20	13	129	21	1	3	4,019	2	0.0	4,208
Federal land	53	11	229	165	55	1	0	89,604	0.0	90,119
CRP	0	0	0	0	0	0	0	0	0.0	0
2012 total	18,462	4,209	33,845	38,794	3,987	10,225	4,256	92,039	1,889.9	207,707
Net change	-3,989	-371	-2,187	-1,417	548	3,556	48	1,920	1,890	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Source: NRI (USDA 2015).

to forest land primarily came from pastureland and cropland. However, conversion of forest land to developed land was nearly as large. Most of the land converted to developed uses came from forest land, cropland, and pasture land, while most rangeland loss was from conversion to developed land and cropland.

Table 7.—National Resources Inventory (NRI) land use trends and transitions for the Rocky Mountain Region, 1982 to 2012

	2012 Land use									
1982 Land use[a]	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	Water	Federal land	CRP	1982 total
					Thousand acres					
Crop	112,020	7,743	3,063	72	916	901	230	533	10,774.7	136,992
Pasture	3,865	8,447	1,802	162	166	346	30	141	205.8	15,164
Rangeland	5,768	1,376	251,300	1,376	1,586	2,471	214	3,407	702.6	268,201
Forest	84	66	1,340	28,278	116	473	22	854	0.0	31,232
Other rural	468	134	736	366	10,047	139	52	91	25.4	12,059
Developed land	74	16	110	16	7	9,773	0	0	1.3	9,997
Water	65	10	93	7	4	1	7,362	0	0.0	7,542
Federal land	333	85	1,937	341	39	7	0	265,565	0.2	268,307
CRP	0	0	0	0	0	0	0	0	0.0	0
2012 total	122,676	17,877	260,381	30,618	12,882	14,850	7,910	270,591	11,710.0	749,494
Net change	-14,316	2,712	-7,820	-614	823	4,853	368	2,284	11,710	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Source: NRI (USDA 2015).

Table 8.—National Resources Inventory (NRI) land use trends and transitions for the South Region, 1982 to 2012

	2012 Land use									
1982 Land use[a]	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	Water	Federal land	CRP	1982 total
					Thousand acres					
Crop	69,405	15,649	2,363	7,545	1,079	4,193	481	412	5,519.3	106,646
Pasture	5,990	39,985	2,345	10,310	1,080	4,042	474	197	240.1	64,662
Rangeland	1,692	2,199	104,934	1,293	848	2,074	337	215	181.6	113,774
Forest	1,398	3,898	308	165,114	1,393	9,913	802	1,387	62.1	184,274
Other rural	298	530	235	1,262	9,884	522	25	30	15.9	12,801
Developed land	71	93	47	229	17	24,871	0	4	0.0	25,332
Water	126	127	72	201	16	14	22,070	5	6.1	22,636
Federal land	32	47	4	212	0	2	0	23,580	0.1	23,876
CRP	0	0	0	0	0	0	0	0	0.0	0
2012 total	79,012	62,527	110,307	186,165	14,318	45,630	24,189	25,829	6,025.2	554,002
Net change	-27,634	-2,135	-3,467	1,891	1,517	20,298	1,553	1,952	6,025	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Source: NRI (USDA 2015).

Trends in NLCD data

Data from the NLCD were used to determine land cover changes from 2001 to 2011 for the CONUS. The map of CONUS land cover in 2011 (Fig. 4) shows the familiar pattern of natural vegetation as driven primarily by large-scale biophysical constraints: forest in the East, grassland in the Midwest, and shrub/grassland except for wetter forested locations in the West. Agricultural and developed lands were common nearly everywhere, with agricultural lands largely replacing natural vegetation in some areas and developed lands forming a connected network linking large urban areas across backdrops of either natural or agricultural land covers. Those broad-scale, visual impressions were mirrored in quantitative summaries of land cover types by RPA regions (Fig. 5). Figure 5 also emphasizes that almost all agricultural land cover is in non-Federal ownership. There is a noticeable share of developed land cover in Federal ownership because roads are considered to be developed land cover in the NLCD.

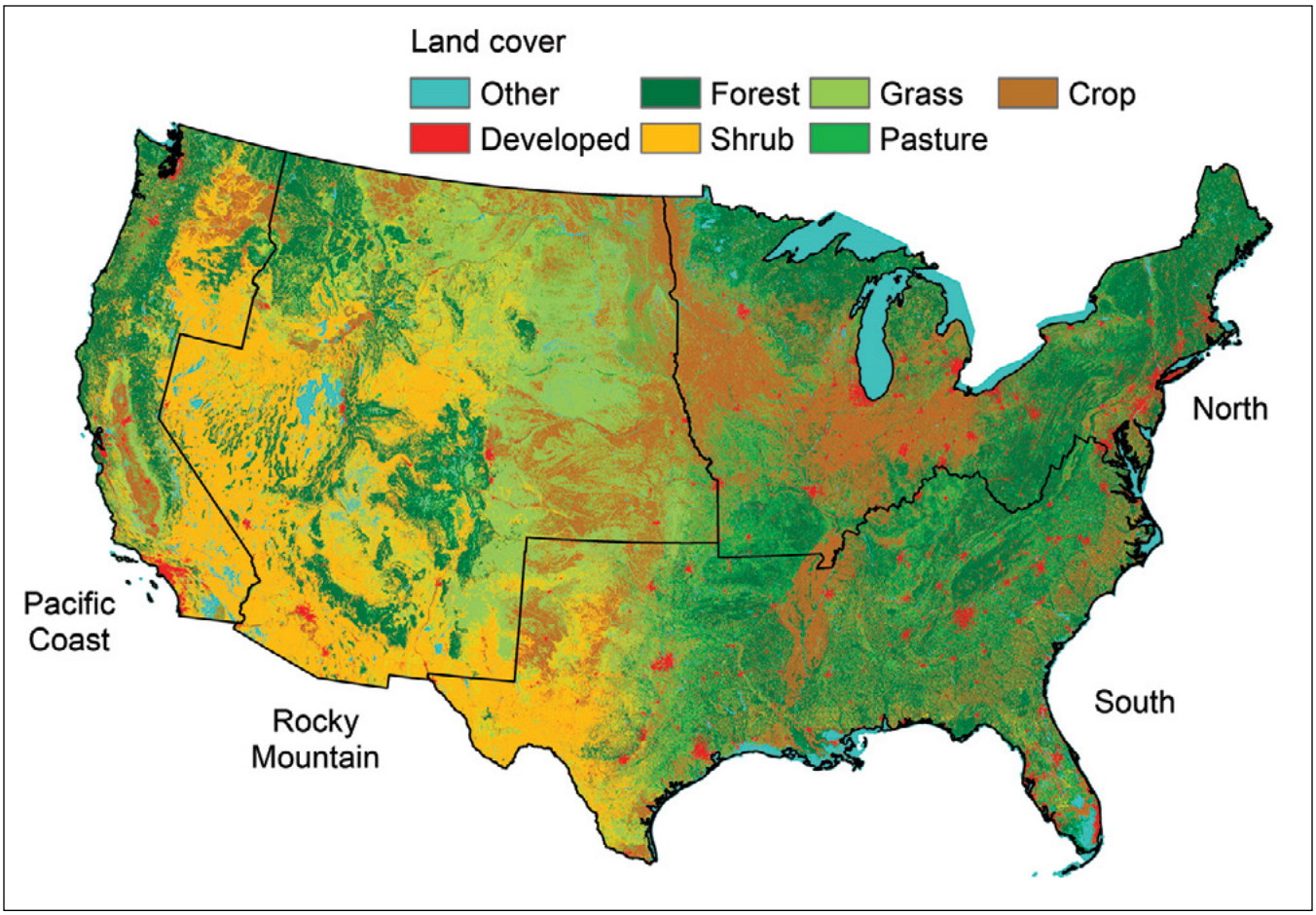

Figure 4.—NLCD-based land cover with RPA regions indicated in the conterminous United States, 2011.

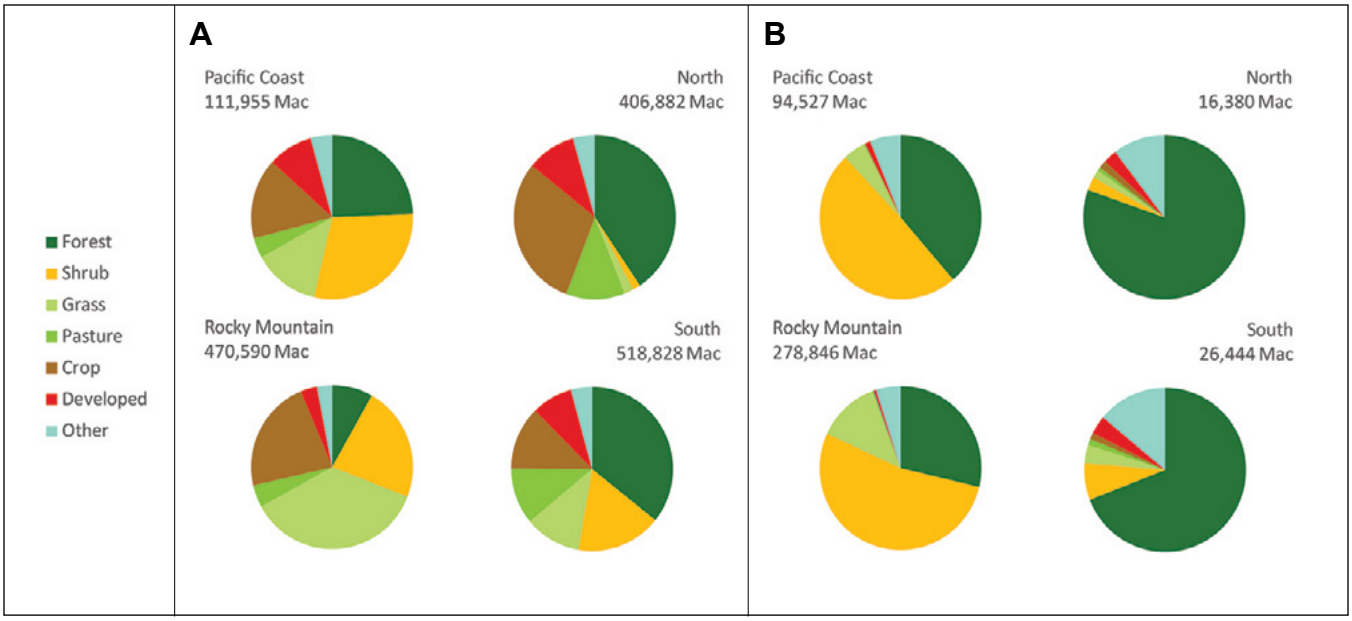

Figure 5.—NLCD-based land cover by owner and RPA region for (A) non-Federal owners, and (B) Federal owners in the conterminous United States, 2011. The total area of each pie chart is indicated (Mac = thousand acres). Note: Pacific Coast Region excludes Alaska and Hawaii; North Region excludes District of Columbia. Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Most of the net change of land cover from 2001 to 2011 occurred in non-Federal ownerships (Table 9). This result is to be expected because most of the total land area was in non-Federal ownership, and the cover of non-Federal land tends to be more dynamic than the cover of Federal land. The county-level status and trends of non-Federal land cover are illustrated in Figure 6. While the percentage of non-Federal area with developed land cover was typically small in 2011 (Fig. 6A), that percentage reflected an increase since 2001 in all counties. Many counties, primarily the ones encompassing large urban areas, experienced substantial increases (Fig. 6E). In contrast, agricultural land cover area was relatively stable in the predominantly agricultural counties (Figs. 6B and 6F), with relatively large percentage losses in the southeast and mid-Atlantic regions and in counties encompassing large urban areas. The relatively large percentage changes in agricultural land cover in many western counties (Fig. 6F) were attributable to the relatively small amount of agricultural land in those counties (Fig. 6B). While there was some evidence of conversion to agricultural land in the Midwest, the largest percentage losses of semi-natural land cover (forest, shrub, grass) occurred in or near urban or urbanizing counties (Figs. 6C and 6G). There was not much evidence of substantial increases in semi-natural land cover (Fig. 6G), except in the mid South, where the increases were likely associated with the loss of agricultural land cover (Fig. 6F). The other land cover types did not typically make up a large share of non-Federal ownership area (Fig. 6D), such that even small absolute changes were translated to large percentage changes (Fig. 6H).

Table 9.—National Land Cover Database (NLCD) land cover class status and change of land cover by owner in the conterminous United States (CONUS), 2001 to 2011

RPA region	Land cover[a]	All owners			Non-Federal owners			Federal owners		
		2001	2011	Net change	2001	2011	Net change	2001	2011	Net change
		Thousand acres		*Percent*	*Thousand acres*		*Percent*	*Thousand acres*		*Percent*
North[b]										
	Crop	122,859	122,278	-0.47	122,603	122,032	-0.47	256	246	-3.97
	Pasture	48,712	48,210	-1.03	48,580	48,080	-1.03	132	130	-1.56
	Shrub	6,030	6,624	9.85	5,611	6,183	10.19	419	441	5.26
	Grass	7,358	7,822	6.30	7,147	7,573	5.96	211	248	17.81
	Forest	180,451	178,360	-1.16	167,202	165,189	-1.20	13,249	13,171	-0.59
	Developed	38,979	40,489	3.88	38,536	40,039	3.90	442	450	1.61
	Other	18,873	19,479	3.21	17,203	17,785	3.38	1,670	1,694	1.43
	All	423,262	423,262		406,882	406,882		16,380	16,380	
Pacific Coast[c]										
	Crop	17,860	17,850	-0.05	17,732	17,722	-0.06	128	128	0.53
	Pasture	4,655	4,605	-1.07	4,512	4,470	-0.94	142	135	-4.90
	Shrub	77,563	79,363	2.32	31,269	32,730	4.67	46,294	46,633	0.73
	Grass	18,495	19,093	3.23	14,433	14,851	2.89	4,062	4,242	4.44
	Forest	66,639	63,894	-4.12	29,448	27,292	-7.32	37,191	36,601	-1.58
	Developed	10,773	11,102	3.05	9,779	10,103	3.30	994	999	0.57
	Other	10,498	10,575	0.74	4,780	4,788	0.16	5,718	5,788	1.22
	All	206,482	206,482		111,955	111,955		94,527	94,527	
Rocky Mountain										
	Crop	104,443	104,931	0.47	104,078	104,560	0.46	365	372	1.87
	Pasture	21,707	21,547	-0.74	21,053	20,890	-0.77	654	656	0.37
	Shrub	253,683	255,330	0.65	106,779	107,072	0.28	146,904	148,258	0.92
	Grass	203,956	204,522	0.28	170,323	169,813	-0.30	33,632	34,709	3.20
	Forest	121,921	118,465	-2.83	39,360	38,403	-2.43	82,561	80,062	-3.03
	Developed	16,110	16,793	4.24	14,986	15,644	4.39	1,124	1,149	2.25
	Other	27,616	27,847	0.84	14,011	14,208	1.41	13,606	13,639	0.25
	All	749,435	749,435		470,590	470,590		278,846	278,846	

(continued on next page)

Table 9 (continued).—National Land Cover Database (NLCD) land cover class status and change of land cover by owner in the conterminous United States (CONUS), 2001 to 2011

RPA region	Land cover[a]	All owners			Non-Federal owners			Federal owners		
		2001	2011	Net change	2001	2011	Net change	2001	2011	Net change
		Thousand acres		*Percent*	*Thousand acres*		*Percent*	*Thousand acres*		*Percent*
South										
	Crop	64,850	64,553	-0.46	64,521	64,231	-0.45	329	322	-2.14
	Pasture	60,144	58,456	-2.81	59,796	58,121	-2.80	348	335	-3.73
	Shrub	86,524	90,182	4.23	84,777	88,259	4.11	1,747	1,923	10.08
	Grass	55,461	59,189	6.72	54,560	58,248	6.76	901	942	4.49
	Forest	212,493	203,571	-4.20	193,977	185,307	-4.47	18,516	18,264	-1.36
	Developed	41,260	43,740	6.01	40,314	42,768	6.09	946	972	2.73
	Other	24,540	25,581	4.24	20,884	21,895	4.84	3,656	3,685	0.82
	All	545,272	545,272		518,828	518,828		26,444	26,444	
CONUS										
	Crop	310,012	309,613	-0.13	308,934	308,545	-0.13	1,078	1,068	-0.90
	Pasture	135,217	132,818	-1.77	133,941	131,562	-1.78	1,276	1,257	-1.54
	Shrub	423,800	431,499	1.82	228,436	234,244	2.54	195,364	197,256	0.97
	Grass	285,270	290,625	1.88	246,464	250,484	1.63	38,806	40,141	3.44
	Forest	581,504	564,290	-2.96	429,987	416,192	-3.21	151,517	148,098	-2.26
	Developed	107,121	112,124	4.67	103,615	108,554	4.77	3,506	3,570	1.82
	Other	81,527	83,482	2.40	56,878	58,676	3.16	24,649	24,807	0.64
	All	1,924,452	1,924,452		1,508,255	1,508,255		416,197	416,197	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
[b] Excludes District of Columbia.
[c] Excludes Alaska and Hawaii.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

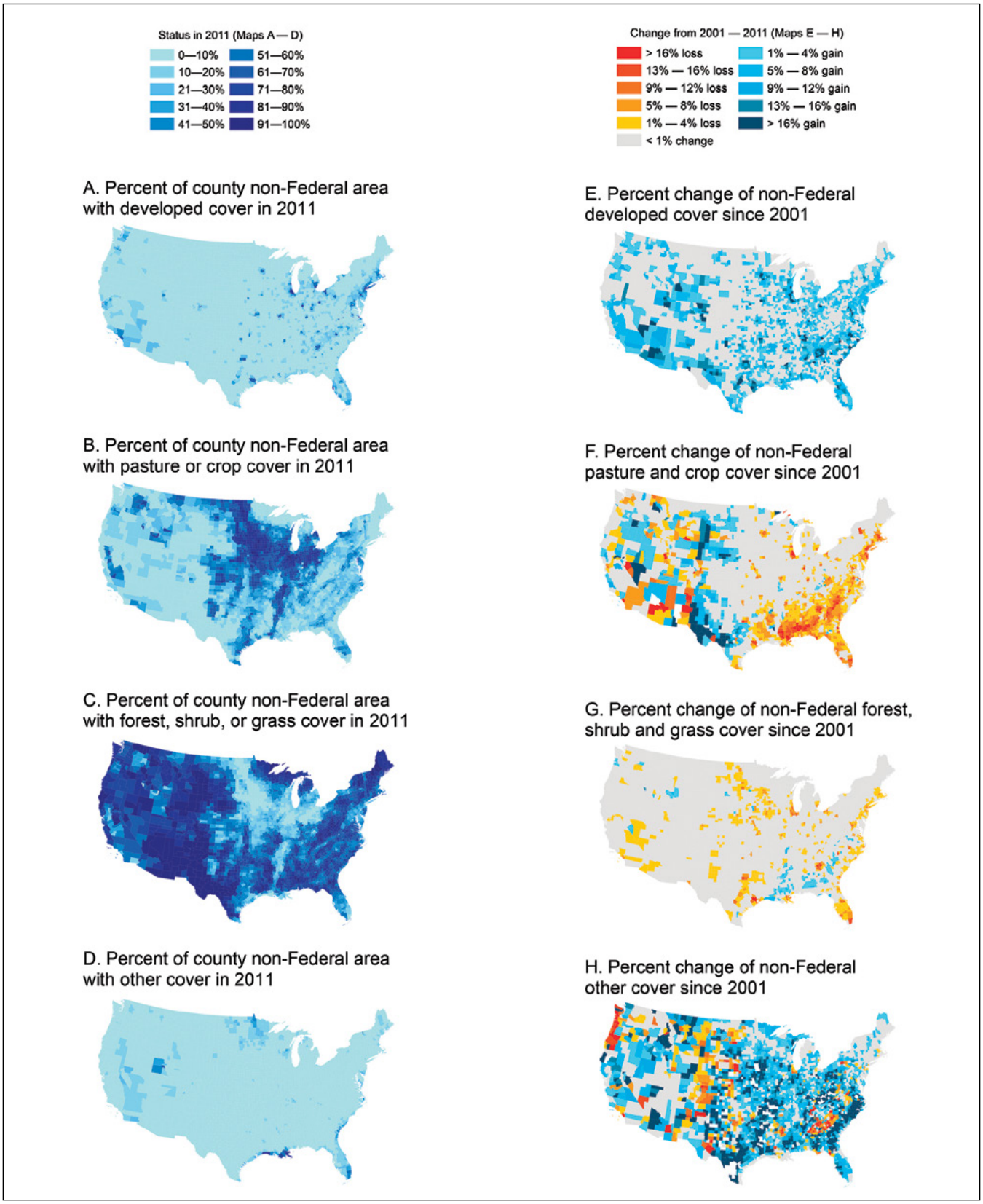

Figure 6.—NLCD-based share of total county (excluding the District of Columbia) non-Federal area with the indicated land cover in 2011 (left) and the percent change of that land cover area from 2001 to 2011 (right). Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

These statistics are good for summarizing the relative net changes in the area of different land cover types; however, it is also informative to examine the gross gains and losses in terms of the specific land cover transitions that occur in different regions. Land cover changes for non-Federal lands by RPA region (Tables 10 through 13) can be compared to NRI regional land use data (Tables 5 through 8). In all regions, the developed land cover type acted as a "sink" in the sense that its gross gains from all other land cover types far exceeded its gross losses to all other types. Forest cover changes not associated with conversion to developed land cover were observed in all regions. Most of the gross forest cover loss represented conversion to grass, shrub, and other (i.e., barren) land cover, while most of the gross forest cover gains came at the expense of those same three land cover types. In other words, the transition table suggests that over the long term, forest that is not permanently lost to developed land cover will be lost temporarily to transitional land cover types that will eventually become forest again. This pattern of gains and losses is consistent with temporary forest losses associated with harvesting, fire, and other natural disturbances. Future forest gains and losses associated with agricultural conversion and abandonment are more likely to be driven by future comparative economic returns to forest and agricultural land uses and on incentive programs (e.g., Conservation Reserve Program), such that transition statistics from 2001 to 2011 are not necessarily indicative of future transitions.

Table 10.—National Land Cover Database (NLCD) non-Federal land cover changes and transitions for the North Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	**Crop**	**Pasture**	**Shrub**	**Grass**	**Forest**	**Developed**	**Other**	**2001 total**
				Thousand acres				
Crop	121,540	103	22	30	38	594	276	122,603
Pasture	297	47,869	10	21	27	290	66	48,580
Shrub	11	7	4,778	40	730	31	13	5,611
Grass	71	12	223	6,651	75	71	45	7,147
Forest	90	81	1,137	796	164,247	462	389	167,202
Developed	<1	<1	<1	<1	<1	38,534	1	38,536
Other	24	9	13	34	72	57	16,994	17,203
2011 total	122,032	48,080	6,183	7,573	165,189	40,039	17,785	406,882
Net change	-570	-500	572	426	-2,013	1,503	582	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 11.—National Land Cover Database (NLCD) non-Federal land cover changes and transitions for the Pacific Coast Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				Thousand acres				
Crop	17,509	10	43	46	2	91	31	17,732
Pasture	6	4,419	20	9	2	42	14	4,512
Shrub	108	20	30,624	123	274	51	69	31,269
Grass	74	8	502	13,675	29	88	56	14,433
Forest	6	3	1,292	968	26,954	30	196	29,448
Developed	<1	<1	<1	<1	<1	9,779	<1	9,779
Other	20	9	249	28	32	21	4,421	4,780
2011 total	17,722	4,470	32,730	14,851	27,292	10,103	4,788	111,955
Net change	-10	-43	1,461	417	-2,156	323	8	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes Alaska and Hawaii.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 12.—National Land Cover Database (NLCD) non-Federal land cover changes and transitions for the Rocky Mountain Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				Thousand acres				
Crop	103,303	37	108	220	31	207	173	104,078
Pasture	86	20,532	98	152	42	66	77	21,053
Shrub	142	132	105,674	304	173	217	136	106,779
Grass	890	121	236	168,585	103	111	277	170,323
Forest	39	25	902	309	37,993	26	66	39,360
Developed	<1	<1	<1	<1	<1	14,986	<1	14,986
Other	99	43	53	243	62	31	13,479	14,011
2011 total	104,560	20,890	107,072	169,813	38,403	15,644	14,208	470,590
Net change	481	-162	294	-511	-957	658	197	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 13.—National Land Cover Database (NLCD) non-Federal land cover changes and transitions for the South Region, 2001 to 2011

2001 Land cover	2011 Land cover[a]							2001 total
	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	
	Thousand acres							
Crop	63,303	58	257	107	365	299	134	64,521
Pasture	199	57,633	409	182	733	511	128	59,796
Shrub	176	127	78,155	1,794	4,099	226	200	84,777
Grass	285	37	1,593	50,463	1,654	328	199	54,560
Forest	171	248	7,741	5,571	177,948	1,000	1,298	193,977
Developed	<1	<1	1	2	1	40,309	1	40,314
Other	97	19	103	129	507	96	19,935	20,884
2011 total	64,231	58,121	88,259	58,248	185,307	42,768	21,895	518,828
Net change	-290	-1,675	3,482	3,688	-8,670	2,454	1,011	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Comparing land base trends

The NRI and NCLD offer different perspectives of changes in the U.S. land base. However, the longer time trend (1982-2012) for the NRI and its depiction of land use change (Tables 4 through 8) has made the NRI the source of data for RPA Assessment land use trends and projections. Examining more recent NRI data from 2002-2012 provides a more direct comparison with NLCD changes from 2001 to 2011 (Tables 14 and 15), and several key points about the non-Federal CONUS land base are evident within this time frame. NRI cropland showed a slight decline between 2002 and 2012 (Table 14), but that trend does not reflect the greater loss of cropland through 2007, which was then reversed as lands in the CRP were returned to cropland use between 2007 and 2012 (data not shown here). Over the entire period, changes in total acreage of pasture, rangeland, and forest were small, and developed land continued to increase at the expense of the other land use classes (USDA 2015). For further comparisons, regional changes in the land base are tabulated for NRI data in Appendix 1 and NLCD data in Appendix 2.

Table 14.—National Resources Inventory (NRI)-based non-Federal land use changes for the conterminous United States, 2002 to 2012

	2012 Land use[a]							
2002 Land use	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	CRP	2002 Non-federal
	Thousand acres							
Crop	345,593	12,594	851	885	1,246	2,173	3,321	366,661
Pasture	8,391	102,069	1,114	4,281	793	1,539	388	118,573
Rangeland	1,108	335	401,036	676	1,001	1,623	14	405,794
Forest	379	1,450	432	403,089	1,051	4,102	3	410,505
Other rural	298	388	337	743	40,742	314	2	42,824
Developed land	146	87	55	287	35	103,480	0	104,089
CRP	6,354	3,686	386	776	40	24	20,493	31,759
2012 total	362,403	120,609	404,210	410,736	44,907	113,254	24,221	1,480,206
Net change	-4,393	2,036	-1,584	231	2,083	9,166	-7,538	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Note: Transitions with water and federal land classes are not shown in this table. Totals may not match exactly due to rounding.
Source: NRI (USDA 2015).

Table 15.—National Land Cover Database (NLCD)-based non-Federal land cover changes for the conterminous United States, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
	Thousand acres							
Crop	305,654	208	429	403	435	1,191	613	308,934
Pasture	589	130,453	537	364	804	908	285	133,941
Shrub	438	286	219,231	2,262	5,276	525	418	228,436
Grass	1,321	178	2,554	239,374	1,861	598	578	246,464
Forest	304	357	11,072	7,645	407,142	1,517	1,950	429,987
Developed	<1	<1	2	2	1	103,608	2	103,615
Other	239	80	418	435	673	205	54,829	56,878
2011 total	308,545	131,562	234,244	250,484	416,192	108,554	58,676	1,508,255
Net change	-389	-2,379	5,808	4,020	-13,796	4,938	1,798	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

In comparison, the NLCD data for non-Federal ownerships from 2001 to 2011 showed a modest increase (4 percent) in agricultural land cover (crop plus pasture), which is consistent with the reported NRI increase after 2007. The changes in developed land cover were also broadly similar to changes in developed land use from NRI: both increased at least somewhat in nearly every location, and differences in absolute amounts of change were easily explained by differences in the definition used for developed land. For agriculture, the difference between a land use and a land cover was minor. In contrast, the forest land use and land cover definitions resulted in markedly different results for NLCD versus NRI data during this time period, with the NLCD exhibiting a substantial net loss of forest land cover while NRI showed a slight gain in forest land use (Fig. 7). As previously mentioned, the land cover transitions indicated that the large majority of forest cover loss and gain was associated with conversion to or from shrub, grass, and barren land cover (Fig. 8), which indicates that most change in forest cover is not necessarily indicative of a permanent change in forest land use. The NLCD did exhibit a net loss of forest to developed land cover on non-Federal lands (Table 15), which is strong evidence of a change of land use consistent with NRI (Fig. 8). Since that loss represented less than 1 percent of the forest cover in 2001, this finding is consistent with the NRI (Table 14). Some of the discrepancy could also be the result of the loss of forest cover from semi-developed treed areas (e.g., expanding suburban neighborhoods), data that the NRI would not consider to be a forest land use during the initial time period.

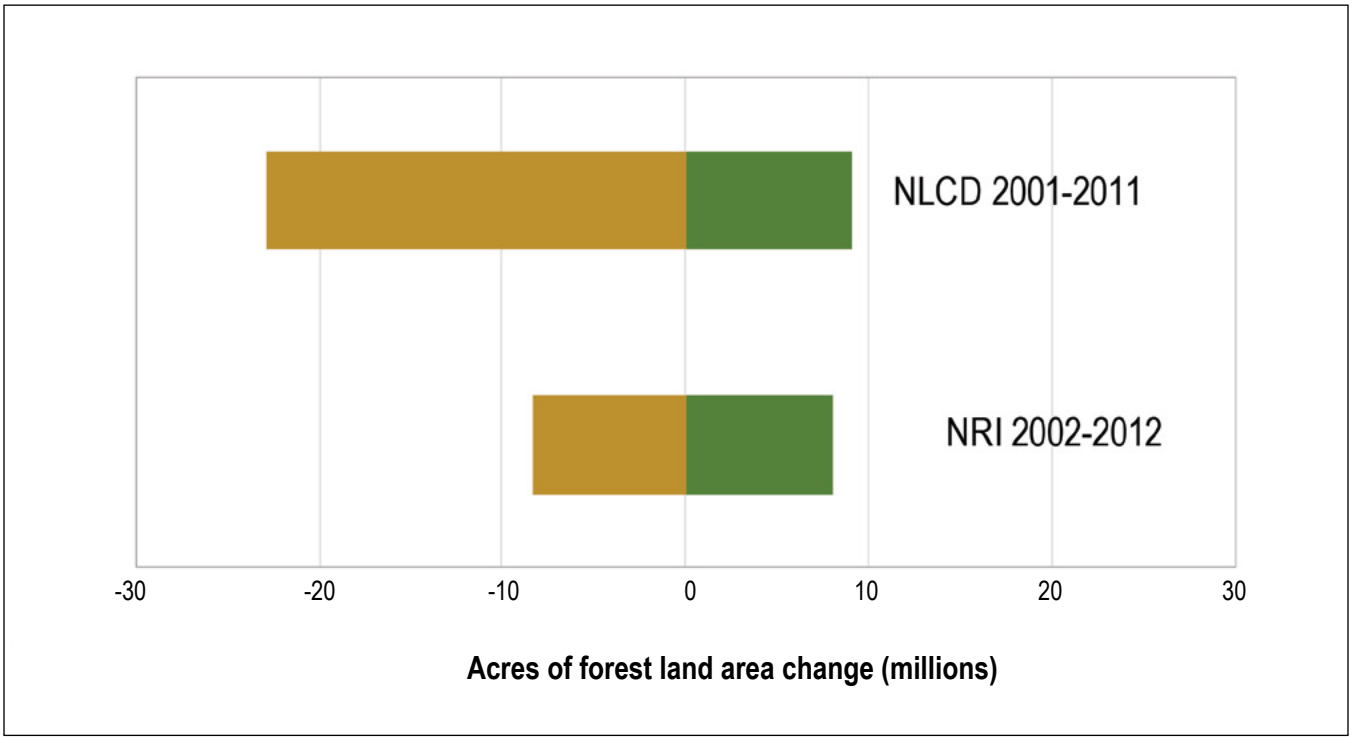

Figure 7.—Forest loss and gain on non-Federal land in the conterminous United States, NLCD 2001-2011 and NRI 2002-2012.

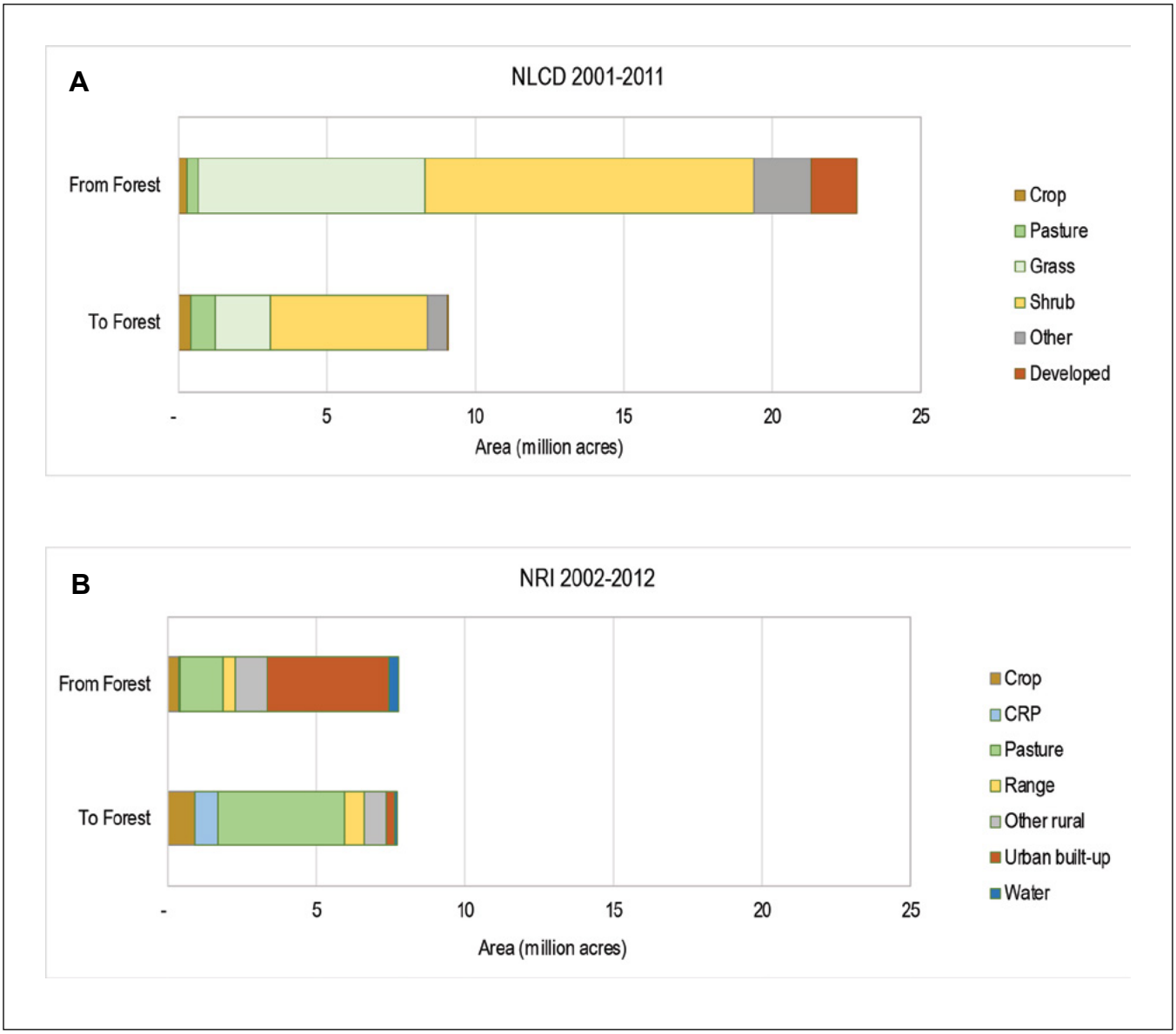

Figure 8.—Land base change from forest and to forest on non-Federal land in the conterminous United States for (A) NLCD-based land cover change, 2001 to 2011, and (B) NRI-based land use change, 2002 to 2012.

U.S. FOREST AND RANGELAND BASE

The RPA Assessment looks at broad land use and land cover trends to provide context for more detailed analyses of forest and rangeland resources as directed in the RPA legislation (P.L. 93-378, 88 Stat 475, as amended; 16 U.S.C. 1601(a), Section 3a). As discussed previously, the NRI data are used to construct projections of crop, pasture, range, forest, and developed land. However, the NRI does not include Federal lands, nor is the NRI survey of forest land in situ. Therefore, data from the Forest Inventory and Analysis (FIA) program were used to provide the basis for trends in forest land across all ownerships in the United States, while projected changes of forest land use from NRI modeling were used to impose socio-economic and climate-based shifts to the RPA forest land base during projections. This report lays out FIA program forest definitions, compares FIA definitions to those used in the RPA Assessment, and compares trends in forest lands as defined by both the RPA Assessment and the NLCD.

Defining the rangeland base is more challenging. The NRI provides non-Federal rangeland trends over time, but no Federal land program consistently estimates rangeland area. The NLCD tracks land cover across all ownerships, but there are definitional issues when comparing between NRI rangelands and the NLCD land cover classes most closely associated with rangelands (i.e., shrublands and grasslands). Some of these data and compatibility issues will be discussed here, along with a discussion of how rangelands area and trends are quantified in the 2020 RPA Assessment.

Forest Inventory and Analysis (FIA) Program

The Forest Inventory and Analysis (FIA) program (https://www.fia.fs.fed.us/) of the U.S. Department of Agriculture, Forest Service (hereafter, Forest Service) provides authoritative, comprehensive data and information related to forests of the United States across all states and territories and all ownership categories including Federal lands, which are omitted from the NRI. Table 16 provides definitions of land uses included in the FIA program, as well as FIA-based forest land definitions used for the RPA Assessment. Definitions for both FIA and RPA are based predominately, but not exclusively, on land use concepts. FIA's definition of forest land is more inclusive than the RPA definition of forest land, which distinguishes woodland from forest land. The RPA Assessment definitions are consistent with international reporting requirements for the United Nations Food and Agriculture Organization (FAO). Plots where land is classified as "forest land" by FIA but the land is not productive enough to meet the FAO definition have been placed into a category termed "woodland" for the present report (Oswalt et al. 2019). Both FIA and RPA forest land definitions include a timberland subcategory, based on the FIA definition.

RPA Assessment forest trends

Forests and woodlands, as defined within the RPA Assessment, occupy 822.5 million acres of the total U.S. land base when combined. Ninety-three percent (765.5 million acres) of this land meets the international definition of forest (RPA forest land definition), with the remaining 7 percent (57 million acres) recognized as woodlands. Thus, forests make up 34 percent of the U.S. landscape, and forests combined with woodlands make up 36 percent of the landscape. There was an upward trend in forest area from 1987 to 2012, but amounts have leveled off since then (Fig. 9).

The 57 million acres of woodlands occur in 14 states and in three of the four major RPA Assessment regions. Texas accounts for more woodlands than any other state at 22 million acres, or 39 percent of total woodland acres, partly because of the large size of Texas. Taken as a percentage of total state land area, Texas has the greatest land area in woodlands at 13 percent, followed by Utah (12 percent), Arizona (11 percent), and New Mexico (10 percent). The Rocky Mountain Region contains the majority of woodland acres.

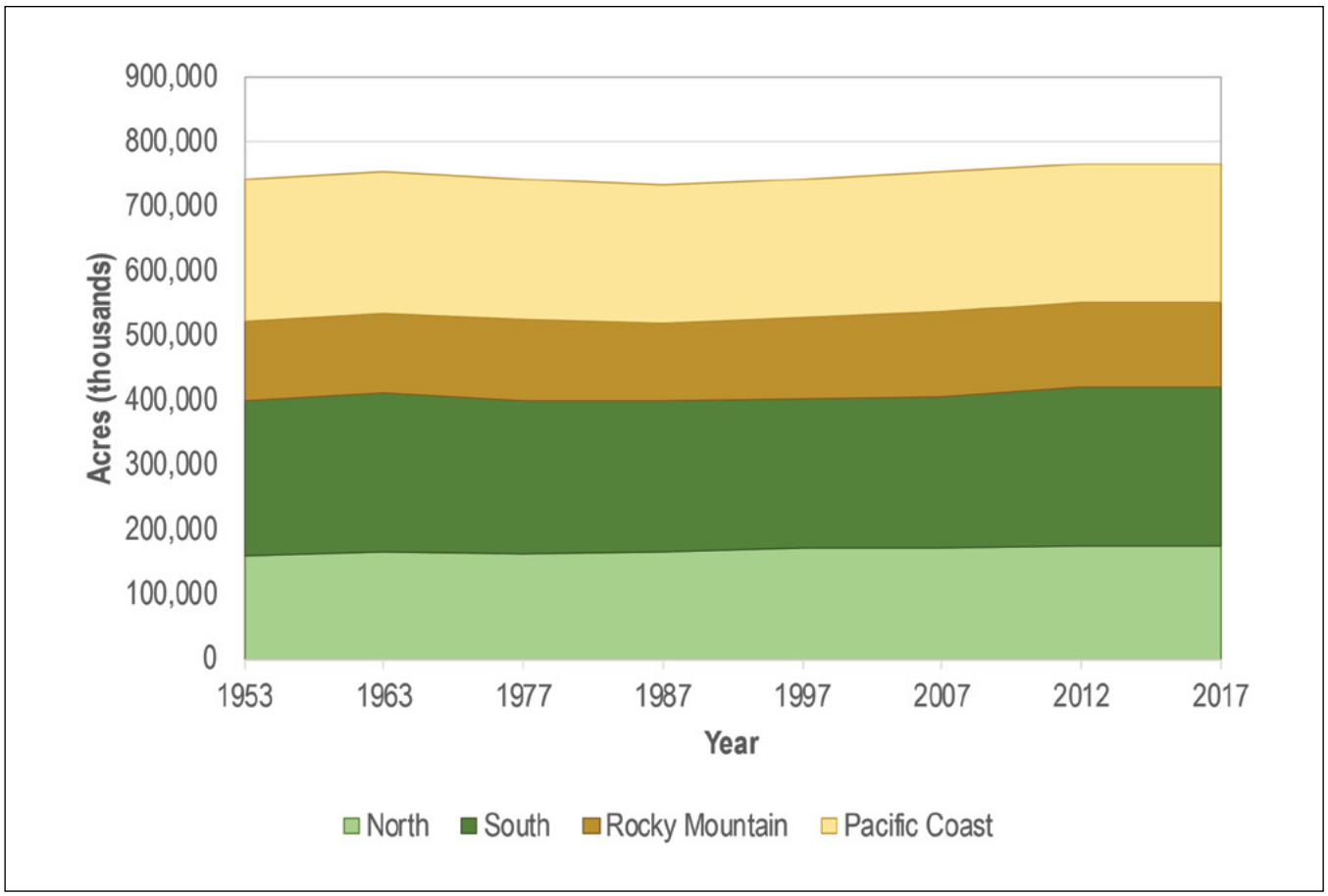

Figure 9.—Forest land area in the United States and by RPA region, 1953 to 2017.

Forest land area trends for each region show small changes through time relative to total forest area (Fig. 9). Since 1997, forest land has increased in all but one region. The largest increase has been in the South, at 6 percent. The Rocky Mountain and North each saw gains of 3 percent in forest land. The Pacific Coast lost forest land (less than 1 percent), although it is important to note that much of that change is believed to be due to changes in the inventory process in the late 1990s and early 2000s that resulted in a paucity of available trend data during those reporting periods (McRoberts et al. 2005).

Even when estimates of forest land use do not change, forest cover may be impacted by cutting or other disturbances to the canopy, such as weather, fire, insects, and disease. FIA plot-based assessments from about 2006 through 2015 were used to quantify the area of forest land that has experienced this type of canopy disturbance, regardless of whether the disturbance resulted in a change in land use class from forest land to another class. Average annual rates of canopy disturbance and cutting ranged from less than 1 percent in Rhode Island to nearly 5 percent in several states throughout the United States.

Comparing Forest Trends

The previous comparisons of NRI and NLCD data focused on non-Federal lands because of the limitation of NRI coverage. In contrast, FIA covers forest land on all ownerships, making it possible to consider and compare trends in NLCD forest cover with trends in FIA forest use. Comparisons in this report focus on trends from a similar decadal period: 2001-2011 for the NLCD and about 2002 to 2011 for FIA data from CONUS only. NLCD and FIA use different definitions to delineate forest land (see Tables 2 and 16), resulting in differences in the area estimates. Here the focus is on the interpretation of forest trends from the two sources, for example the impact of definitional differences of land use and land cover, and the interpretations on forest dynamics that underlie any differences.

Shifts between forest land and all other land cover classes between 2001 and 2011 based on the NLCD data are summarized in Figure 10. The data indicate that gross gains and losses of forest area are relatively small in comparison to total region area or total forest area. For comparisons with the eastern regions in Figure 10, Figure 11 summarizes shifts between forest land and all other land use classes between 2001 and 2011 based on the FIA data. These data also indicate that gross gain and loss of forest area comprise a relatively small share of total region area or total forest area. The NLCD data further describe the types of nonforest land cover that are involved in transitions to and from forest cover (Fig. 12a, b).The dynamics of change in forest cover were concentrated in the grass and shrub categories, as might be expected from temporary clearing (harvest, fire, insects, and disease) followed by succession. Gains from agriculture (crop and pasture) were relatively important in the South and Rocky Mountain Regions, and losses to development were relatively important in the North and South Regions.

Table 16.—Forest Inventory and Analysis (FIA) land and water definitions and Resources Planning Act (RPA) Assessment forest and woodland definitions

Land Use	Definition
FIA land use	
FIA forest land	Land that has at least 10 percent canopy cover by live tally trees of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To qualify, the area must be at least 1.0 acre (0.4 hectare) in size and 120.0 feet (36.6 meters) wide. Forest land includes transition zones, such as areas between forest and nonforest lands that meet the minimal tree canopy cover and forest areas adjacent to urban and built-up lands. Roadside, streamside, and shelterbelt strips of trees must have a width of at least 120 feet and continuous length of at least 363 feet (110.6 meters) to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if they are less than 120 feet wide or less than an acre in size. Tree-covered areas in agricultural production settings, such as fruit orchards, or tree-covered areas in urban settings, such as city parks, are not considered forest land. (Burrill et al. 2017).
FIA timberland	Forest land that is producing or capable of producing in excess of 20 cubic feet per acre per year of wood at culmination of mean annual increment (MAI), also known as average yearly volume growth. Timberland excludes reserved forest lands. (Bechtold and Patterson 2005).
FIA reserved forest	Reserved land is permanently prohibited from being managed for the production of wood products through statute or agency mandate; the prohibition cannot be changed through decision of the land manager. Logging may occur to meet protected area objectives. Examples include designated federal Wilderness areas, National Parks and Monuments, and most State Parks. Private land cannot be reserved. (Burrill et al. 2017).
FIA other forest	Forest land other than timberland and reserved forest land. It includes available and reserved low-productivity forest land, which is incapable of producing 20 cubic feet of growing stock per acre annually under natural conditions because of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, steepness, or rockiness. (Burrill et al. 2017).
FIA woodlands	Forest land having species composition and associated forest types among three softwood or six hardwood woodland types. To qualify as one of these woodland forest types the majority tree stocking must comprise one or more of the 38 FIA-defined woodland tree species. Although woodlands will typically have less crown cover than traditional forests, they must meet the minimum crown cover threshold (10 percent) to be included in FIA forest and woodland estimations. (Burrill et al. 2017).
FIA nonforest land	Land that has less than 10 percent canopy cover of tally tree species of any size and, in the case of afforested land, fewer than 150 established trees per acre; or land that has sufficient canopy cover or stems but is classified as nonforest land use. Nonforest also includes areas that have sufficient cover or live stems to meet the forest land definition, but do not meet the dimensional requirements. Nonforest land includes "other wooded land" that has at least 5 percent, but less than 10 percent canopy cover of live tally tree species of any size or has had at least 5 percent, but less than 10 percent, canopy cover of tally species in the recent past, based on the presence of stumps, snags, or other evidence. Other wooded land is recognized as a subset of nonforest land and is classified according to the same nonforest land use rules as forest land. For example, 6 percent tree canopy cover in an urban setting is not considered other wooded land, and 11 percent tree canopy cover in an urban setting is not considered forest land; urban land use disqualified both examples, even though canopy cover minimums were met. Other wooded land is therefore defined as having >=5 percent and <10 percent canopy cover at present, or evidence of such in the past. (Burrill et al. 2017).
Noncensus water	Lakes, reservoirs, ponds, and similar bodies of water 1.0 acre to 4.5 acre in size. Rivers, streams, canals, etc., 30.0 feet to 200 feet wide. This definition was used in the 1990 census and applied when the data became available. Earlier inventories defined noncensus water differently. (Burrill et al. 2017).
Census water	Lakes, reservoirs, ponds, and similar bodies of water 4.5 acre in size and larger; and rivers, streams, canals, etc., more than 200 feet wide. (Burrill et al. 2017).

(continued on next page)

Table 16. (continued)—Forest Inventory and Analysis (FIA) land and water definitions and Resources Planning Act (RPA) Assessment forest and woodland definitions

Land Use	Definition
RPA forest land	
RPA forest land	Land at least 120 feet (36.6 meters) wide and at least 1 acre (0.4 hectare) in size with at least 10 percent cover (or equivalent stocking) by live trees including land that formerly had such tree cover and that will be naturally or artificially regenerated. Trees are woody plants having a more or less erect perennial stem(s) capable of achieving at least 3 inches (7.6 cm) in diameter at breast height, or 5 inches (12.7 cm) diameter at root collar and a height of 16.4 feet (5.0 meters) at maturity in situ. In addition to RPA's minimum in-situ height requirement (above), RPA forest land also excludes: two forest type-groups (pinyon/juniper group, woodland hardwoods group), nine forest types (Rocky Mountain juniper, juniper woodland, pinyon/juniper woodland, deciduous oak woodland, evergreen oak woodland, mesquite woodland, Cercocarpus (mountain brush) woodland, intermountain maple woodland, miscellaneous woodland hardwoods), nine ecological sections (311 Great Plains steppe and shrub, 313 Colorado plateau semi-desert, 315 Southwest plateau and plains dry steppe and shrub, 321 Chihuahuan semi-desert, 322 American semi-desert and desert, 331 Great Plains-Palouse dry steppe, 332 Great Plains steppe, 341 Nevada-Utah mountains semi-desert – coniferous forest – alpine meadow, 342 Intermountain semi-desert), and site productivity class 7 (0-19 cubic feet per acre per year at culmination of mean annual increment). (Oswalt et al. 2019; USDA Forest Service 2018).
RPA woodland	Land at least 120 feet (36.6 meters) wide and at least 1 acre (0.4 hectares) in size with sparse trees capable of achieving 16.4 feet (5.0 meters) in height with a tree canopy cover of 5 to 10 percent combined with shrubs at least 6 feet (1.8 meters) in height to achieve an overall cover of greater than 10 percent woody vegetation. Trees are woody plants having a more or less erect perennial stem(s) capable of achieving at least 3 inches (7.6 cm) in diameter at breast height, or 16.4 feet (5.0 meters) at maturity in situ. (Oswalt et al. 2019).

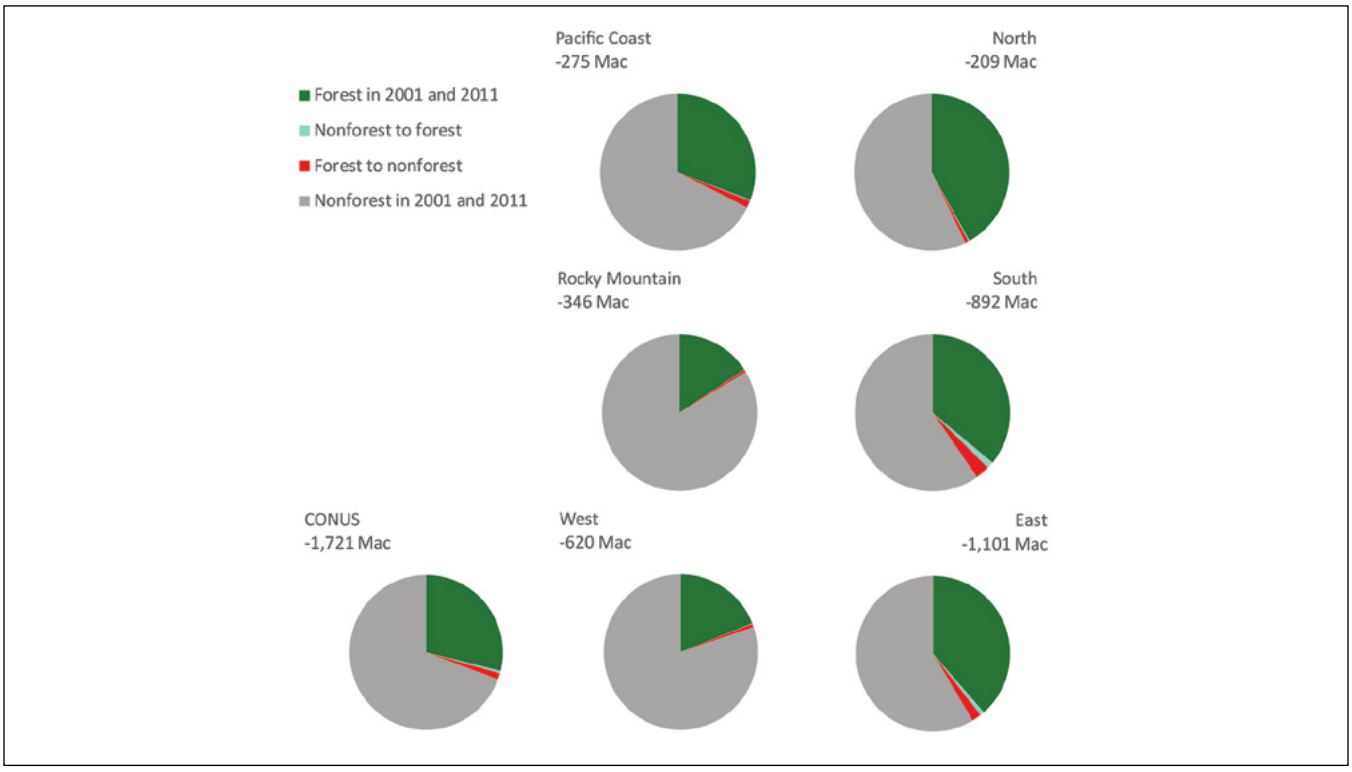

Figure 10.—NLCD-based forest and nonforest land cover changes from 2001 to 2011 for all owners, by RPA region, East (North + South regions), West (Pacific Coast + Rocky Mountain), and conterminous United States. The average annual net area change of forest cover in thousand acres (Mac) is indicated for each region. Note: Pacific Coast region excludes Alaska and Hawaii. North region excludes the District of Columbia. Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

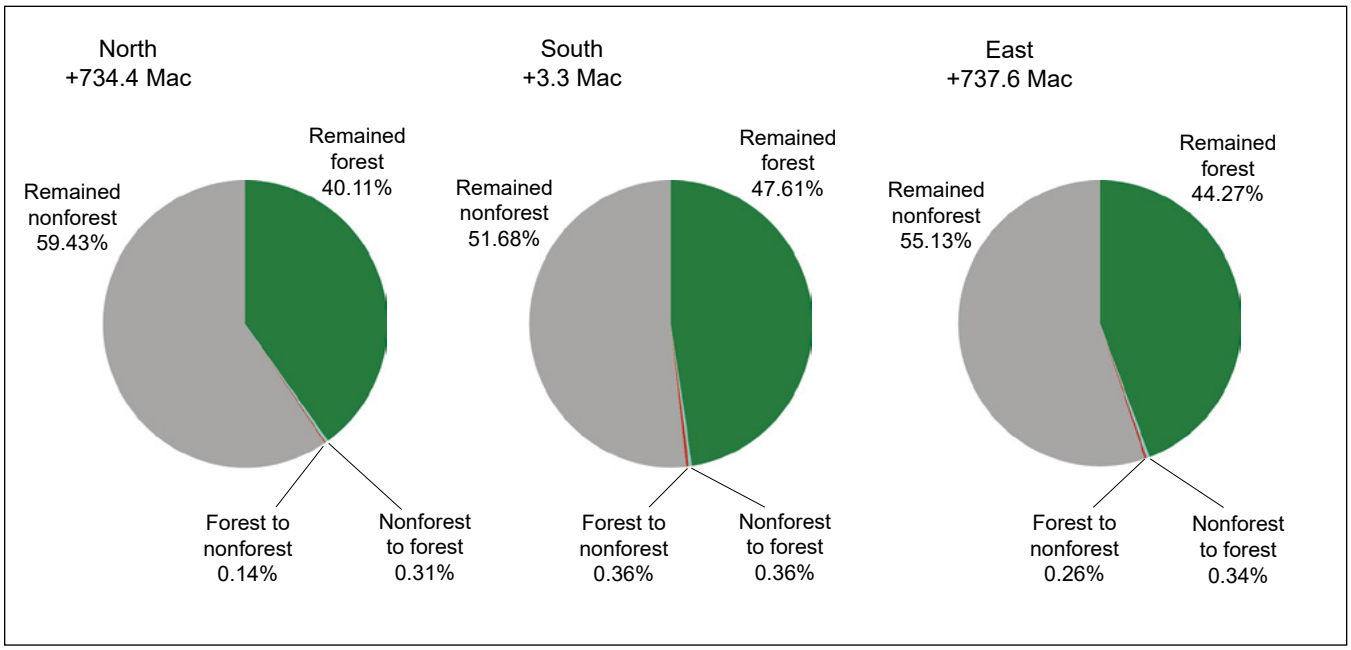

Figure 11.—FIA-based forest/nonforest land cover change from 2001 to 2011 for all owners in the eastern RPA regions. The average annual net area change of forest cover in thousand acres (Mac) is indicated for each region. Notes: All comparisons end with year 2011; number of inventory years varies by state; average annual estimates of change adjusted for numbers of years; no estimates were produced for the West due to insufficient remeasurement data; the class colors follow the legend in Figure 10. Source: USDA Forest Service 2018.

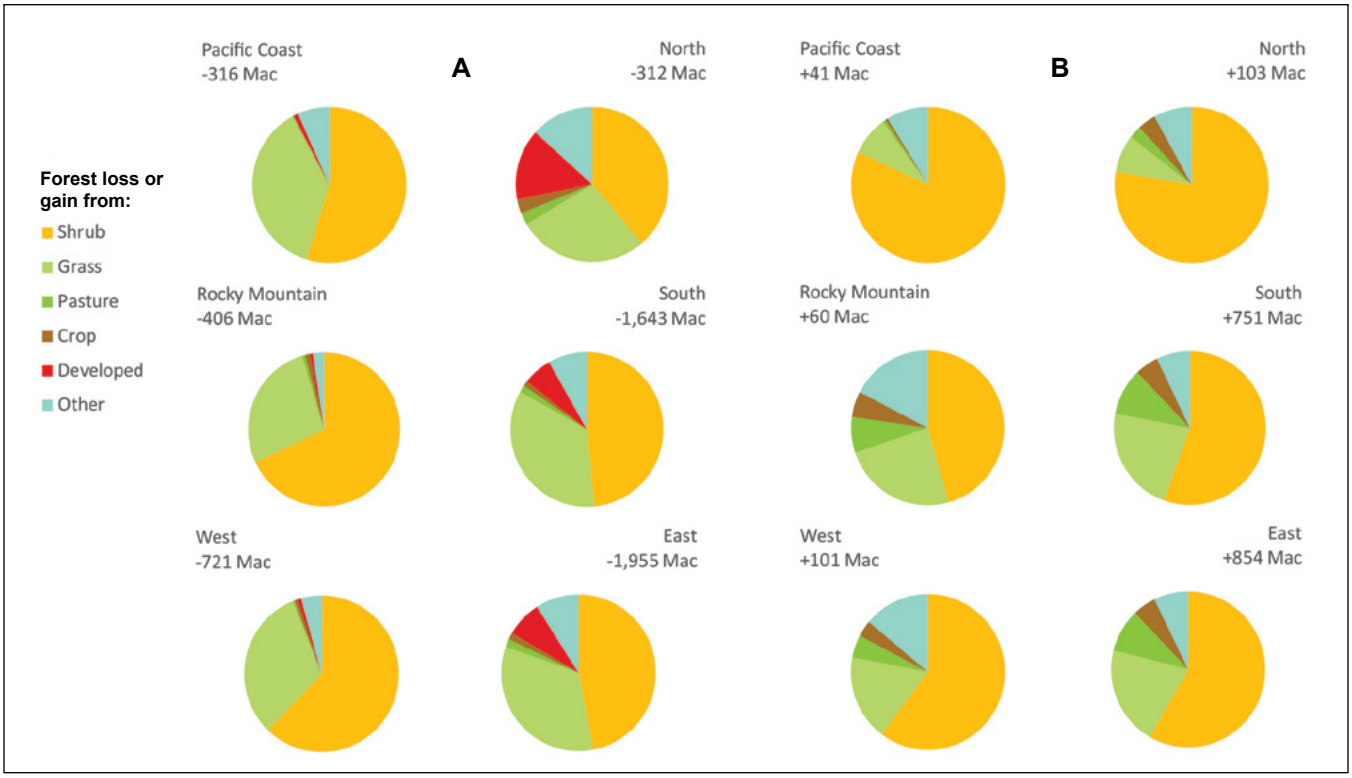

Figure 12.—NLCD-based gross forest cover loss (A), and gross forest cover gain (B) from 2001 to 2011 for all owners, by RPA region. Average annual total area of loss or gain in thousand acres (Mac) is indicated. Pacific Coast region excludes Alaska and Hawaii. North region excludes the District of Columbia. Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Rangeland Trends

Compared to forest lands, where FIA conducts comprehensive statistically based sampling, there is no national sampling program that permits statistical inference about rangeland extent on both Federal and non-Federal lands. This discrepancy makes it challenging to define the rangeland base and rangeland trends. On Federal lands, the Forest Service collects some rangeland data through FIA's All Conditions Inventory (ACI) in the Rocky Mountain region, and the Bureau of Land Management collects some data on public lands, mostly in the West, through its Assessment Inventory and Monitoring (AIM) project. These programs have limited geographic and temporal coverage, however, and are not yet suitable for determining either rangeland extent or trends on a national scale. In addition, only a portion of the AIM data points are randomly located to permit statistical inference. As a result, even though the NRI only inventories non-Federal lands, NRI data is used to describe trends in rangeland area.

The NRI provides the most statistically rigorous program for determining trends in non-Federal rangeland area. From 1982 to 2012, the NRI showed a steadily declining trend for rangelands, with a total loss of 13.5 million acres (Table 4). Of that total, only 1.9 million acres of these rangeland losses occurred between 2002 and 2012 (Table 14). Most of the changes in rangeland area on non-Federal lands were due to transitions with cropland, developed land, pastureland, and Federal land (Table 4). These types of transitions are unlikely on Federal lands, suggesting that rangeland area on Federal land is more likely to be constant over time. However, some changes also occur between rangeland and Federal lands or other rural lands (Table 14). Therefore, if most of the changes in the U.S. rangeland base occur on non-Federal land, it is reasonable to assume that most changes can be accounted for by using only the NRI data. The NRI rangeland area estimates were aggregated from the point level to counties and states, but for consistency, the NRI results are also represented by RPA region, (see Tables 5 through 8). The Rocky Mountain Region lost the greatest proportion of rangeland from 1982 to 2012, primarily as a result of conversion to cropland and pasture land, but some rangeland was also lost to developed land and other rural uses (Table 7). The total non-Federal area of U.S. rangelands in 2012 calculated using the NRI was 404.6 million acres (Table 4).

With respect to the NLCD, shrubland and grassland land cover categories were selected as the most appropriate surrogates for rangelands because there was no "rangeland" land cover in the NLCD. Pastureland is not considered rangeland because pastures are actively managed with intensive exogenous inputs (e.g., irrigation, fertilizer, seeding), and this, by definition, means they cannot be rangelands. Pastures are a good example of why it is difficult to classify rangelands using land cover alone. The NLCD showed a 13.1 million acre increase in shrublands and grasslands from 2001 to 2011 (Table 9), with 9.8 million acres (2 percent) gained on non-Federal lands and 3.2 million acres (1.4 percent) gained on Federal lands, for a total of 722.1 million acres. This is not equivalent to 722.1 million acres of rangelands, however, since many of the areas where shrubs and grasses increased in dominance

were likely early-seral situations (e.g., a forested site after a fire) that will presumably return to a forested condition and, therefore, do not represent an increase in the rangeland base. The total non-Federal area of shrublands and grasslands in 2011 calculated using the NLCD was 484.7 million acres, while 237.4 million acres of shrublands and grasslands occur in the public domain.

While it may be tempting to estimate rangeland extent by adding the estimate of non-Federal rangelands sourced from NRI with the NLCD shrub and grass area in the public domain, this methodology is not valid. Much of the NLCD shrub and grassland categories exist on sites that the NRI and FIA programs would classify as forest lands due to expected regrowth of forest vegetation. To produce an estimate of rangeland area using a consistent strategy and definition across all ownerships, Reeves and Mitchell (2011) explored the effect of disparate rangeland definitions applied to estimate vegetation structure, composition, and site potential. Specifically, Reeves and Mitchell calculated rangeland area estimates in the conterminous United States of 511 and 662 million acres, corresponding to FIA and NRI rangeland definitions, respectively. This process has the advantages of being consistent, avoiding the problem of counting secondary rangelands (e.g., shrub and grass cover on forested sites), and providing two different viewpoints of what constitutes a rangeland. Given the lack of a consistent sampling program (like FIA or NRI) in the rangeland domain, many of the analyses and trends presented in the 2020 Rangeland Assessment rely on remote sensing and modeling to fill in the data gaps. The Reeves and Mitchell (2011) work, therefore, provides a critical analysis context that aids in the determination of whether an area is a "forest" or a rangeland.

For the 2020 Rangeland Assessment, the NRI data will be used to describe trends in rangeland area, and the work by Reeves and Mitchell (2011) will be used to describe the rangeland areal extent.

SPECIAL LAND BASE TOPICS

The RPA Assessment uses a variety of sources to assess and analyze changes in the U.S. land base. The previous sections laid out the use of various sources as the basis for land use change projections and land pattern changes. In this section, the use of land base data that underpins three RPA analyses is described: defining protected areas in the United States, estimating forest carbon for greenhouse gas inventories, and analyzing trends in urban forests.

Protected Areas in the United States

Forests and rangelands of the United States in protected status help to preserve functioning natural ecosystems and maintain ecological processes, thereby providing amenities such as species refuges, water supply, and human enjoyment. While the United States lacks a comprehensive inventory of the protected status of all public and private lands, significant progress has been made in the past two decades through a collaborative effort involving Federal and state agencies as well as private conservation organizations. The resulting Protected Area Database of the United States (PAD-US) includes detailed maps of the known protected areas (held in fee simple ownership) for all 50 states, along with the status of each protected area as assigned by the collaborators according to guidelines developed by the International Union for the Conservation of Nature (IUCN) (Table 17). This section summarizes the most recent update of the Nation's protected areas by owner type and IUCN designation (Fig. 13) as documented in version 2.1 of PAD-US (Conservation Biology Institute 2016).

Along with some private lands without formal protection, public ownership in the United States usually confers de facto ("unassigned") protection from widespread conversion of natural landscapes to more developed uses, even though public ownership does not always meet the criteria to be included in an IUCN protection class in all countries. According to PAD-US, in circa 2016 the Federal Government held 669 million acres of land (28 percent of the country's total area), which is slightly higher than the Congressional Research Service (CRS) estimate of roughly 640 million acres of federal ownership, as of 2015 (CRS R42346). Based on PAD-US, most of the Federal total was administered by the Bureau of Land Management (~262 million acres), National Forest System (~199 million acres), Fish and Wildlife Service (~98 million acres), and National Park Service (~80 million acres) and included forests and rangelands that are managed according to their varying legal mandates. State governments administered a total of ~187 million acres in state parks, state forests, and other holdings. PAD-US also identified protected areas owned by Native Americans (~99 million acres) and local governments (~8 million acres), as well as ~7 million acres of privately owned conservation land and ~4 million acres in joint ownership (Conservation Biology Institute 2016).

Table 17.—Protection categories used by the International Union for Conservation of Nature (IUCN)

IUCN label and name	Description
Ia - Strict nature reserve	Protected areas that are strictly set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring.
Ib - Wilderness area	Protected areas that are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.
II - National park	Large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.
III - Natural monument or feature	Protected areas set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.
IV - Habitat/species management area	Protected areas aiming to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.
V - Protected landscape/seascape	A protected area where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.
VI - Protected area with sustainable use of natural resources	Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Note: In the PAD-US database, the “unassigned” category includes Federal and State land that has not been assigned to one of the IUCN categories. This report uses the term “de facto protection” instead of “unassigned” because the majority of such areas have protection from permanent conversion of natural land cover and confer protection to federally-listed endangered and threatened species throughout the area. Examples of such areas are state forests and the National Forest System general public lands. Source: IUCN 2020.

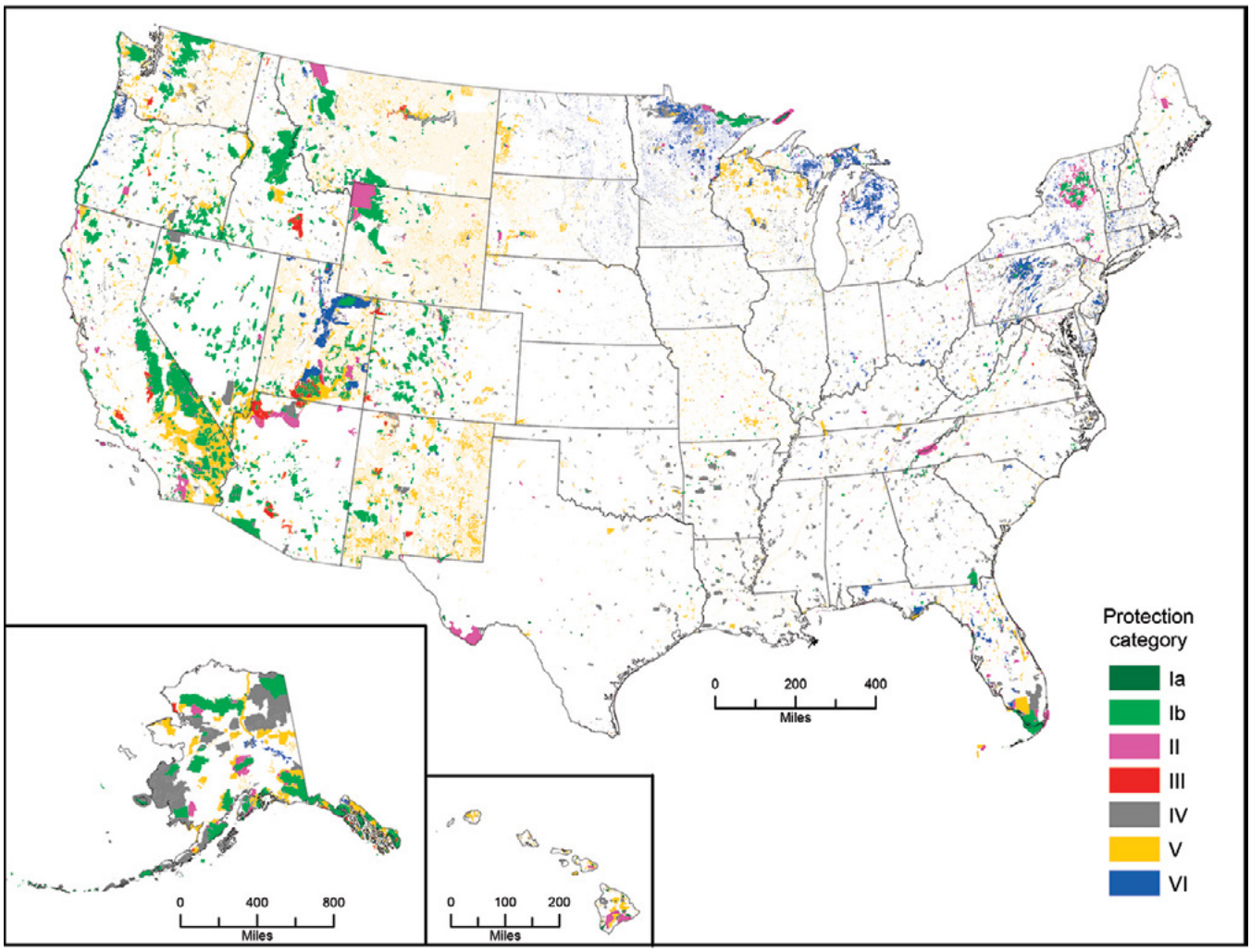

Figure 13.— International Union for the Conservation of Nature (IUCN) designated protected areas of the United States. IUCN protection categories (see Table 17 for definitions): Ia = Strict nature reserve; Ib = Wilderness area; II = National park; III = Natural monument or feature; IV = Habitat/species management area; V = Protected landscape/seascape; VI = Protected area with sustainable use of natural resources. Source: PAD-US (Conservation Biology Institute 2016).

Not all federal or state ownerships are protected, but most of the designated IUCN protection classes I through VI are in Federal or state ownership; all of the other ownership types were grouped together for this analysis. The PAD-US revealed an approximate area of 394 million acres of protected lands in the United States, or 16.2 percent of total area (Table 18). Approximately 94 percent of the protected area was either Federal (288 million acres) or state (84 million acres) land. An additional 484 million acres (20 percent of total U.S. area) were held in Federal or state ownership without a designated IUCN protection status; such lands have de facto protection only (i.e., protection conferred by public ownership alone). The area with de facto protection is shown in relation to IUCN protected area by region in Figure 14. Overall, the protected lands in the East were not as extensive as in the West, primarily reflecting the distribution of Federal ownership. For the purposes of this report, East includes the North and South RPA regions, while

West includes the Rocky Mountain and Pacific Coast RPA regions. Of the total IUCN designated area of 394 million acres, approximately 48 percent was found in Alaska, 24 percent in the Rocky Mountain region, 13 percent in the Pacific Coast region, 9 percent in the North region, and 6 percent in the South region. The statistics reported in Table 18 are similar to those reported in the Update to the 2010 RPA Assessment (USDA Forest Service 2016).

Table 18.—Protected areas identified by the Protected Areas Database of the United States (PAD-US), by owner and Resources Planning Act (RPA) region

RPA region	Owner	Designated IUCN[a] Category (excludes de facto protection area)							Row total
		Ia	Ib	II	III	IV	V	VI	
		Thousand acres							
Alaska	Federal	216	59,698	6,840	1,785	64,447	28,349	57	161,392
	State	22	520	2,502	0	3,050	3,950	2,158	12,203
	Other	2	460	542	77	12,761	856	61	14,759
	Region total	240	60,678	9,884	1,862	80,258	33,155	2,276	188,354
North[b]	Federal	15	1,868	864	12	1,215	656	208	4,838
	State	457	1,472	2,771	0	5,949	3,082	12,031	25,761
	Other	22	0	38	0	96	2,744	148	3,049
	Region total	494	3,340	3,673	12	7,260	6,482	12,387	33,648
Pacific Coast[c]	Federal	400	25,657	1,337	842	1,449	11,147	22	40,854
	State	146	3	1,021	16	1,257	5,309	784	8,537
	Other	0	177	2	5	81	119	151	535
	Region total	546	25,837	2,360	863	2,787	16,576	957	49,925
Rocky Mountain	Federal	612	35,068	6,008	4,506	5,211	12,731	5,180	69,316
	State	3	6	471	27	2,906	22,915	221	26,548
	Other	15	1	112	0	121	184	0	433
	Region total	629	35,075	6,590	4,533	8,239	35,831	5,401	96,298
South	Federal	9	2,743	2,264	140	4,527	2,088	5	11,776
	State	192	11	975	0	6,743	1,570	1,078	10,568
	Other	53	16	236	0	1,718	608	341	2,971
	Region total	254	2,769	3,474	140	12,988	4,266	1,424	25,315
National	Federal	1,252	125,033	17,313	7,285	76,850	54,971	5,473	288,176
	State	820	2,012	7,740	43	19,905	36,827	16,272	83,618
	Other	91	654	929	82	14,778	4,512	701	21,747
	National total[b]	2,163	127,698	25,982	7,410	111,533	96,310	22,445	393,540

[a] IUCN = International Union for the Conservation of Nature. Categories are described in Table 17.
[b] Excludes the District of Columbia.
[c] Alaska is not included in the Pacific coast region because it is listed separately. Hawaii is included in the Pacific Coast region.
Entries may not sum to row or column totals because of rounding.
Source: PAD-US version 2.1 (Conservation Biology Institute 2016).

Most of the differences are due to improved mapping or labeling of existing protected areas and not to the gain or loss of individual protected areas. Additional improvements may occur because PAD-US, although mostly complete for Federal and most state ownerships, is less complete for county and local ownership categories, with completion rates varying by state.

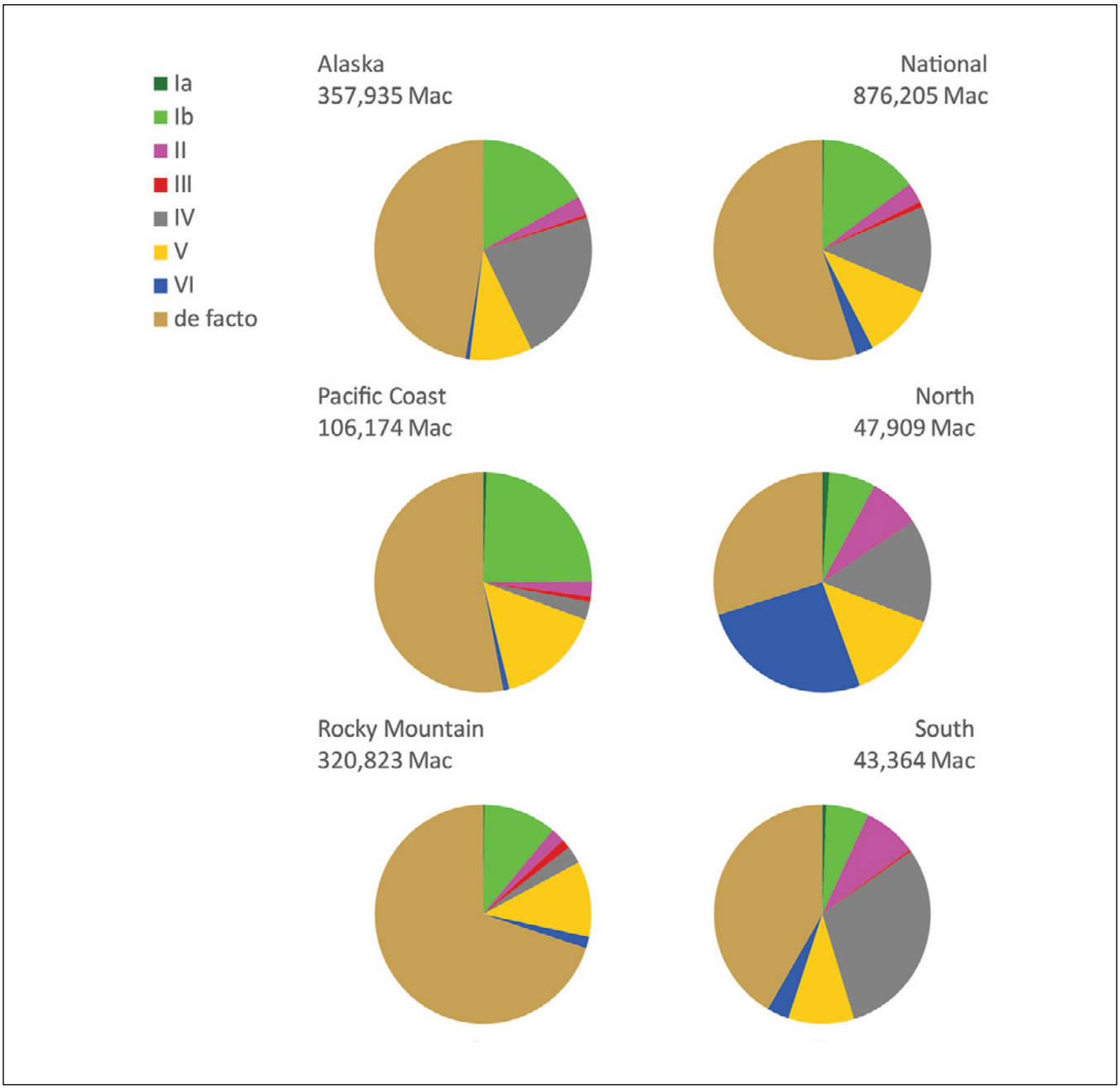

Figure 14.—Share of total IUCN designated protected area (including de facto protected area) in the United States by protection category within each Resources Planning Act (RPA) region. IUCN protection categories (see Table 17 for definitions): Ia = Strict nature reserve; Ib = Wilderness area; II = National park; III = Natural monument or feature; IV = Habitat/species management area; V = Protected landscape/seascape; VI = Protected area with sustainable use of natural resources. The total protected area (in thousand acres = Mac) is indicated for each RPA region. The Pacific Coast region does not include Alaska, which is shown separately. Source: PAD-US (Conservation Biology Institute 2016).

Protected forest area

The PAD-US does not identify the specific land use or land cover that is contained in a protected area. Thus, the protected forest area has to be identified by other means. Earlier RPA Assessments estimated the protected forest area by intersecting the PAD-US with a medium resolution (15.4 acres/pixel; pixel = 250 m x 250 m) land cover map derived from remote sensing (Ruefenacht et al. 2008, USDA Forest Service 2004). It is now feasible to use a higher resolution (0.2 acre pixel; pixel = 30 m x 30 m) and more recent (2011) NLCD land cover map (Homer et al. 2015, U.S. Geological Survey 2014b). In addition, forest estimates can now be developed using the FIA database. Both of these sources of forest data, as well as the PAD-US, contain measurement errors that are not considered in this report. For the NLCD forest class, the producer's accuracy was 84 percent and the user's accuracy was 87 percent (Table 3). The target precision for area estimates in the FIA inventory is 3 percent per million acres of timberland (a subcategory of forest land) (Reams et al. 2005).

Protected forest area in the CONUS was estimated using three definitions of forest. With forest defined as a land cover, protected forest area was estimated by combining the PAD-US map with the 2011 NLCD; forest included the three NLCD upland forest classes and the NLCD woody wetland class (Table 2). The area of forest cover was estimated within each protected area, and the results were aggregated to estimate regional and national totals. With forest defined as a land use, protected forest area was estimated by combining the PAD-US map with FIA inventory plot data, circa 2013 (O'Connell et al. 2017). The protected status of each FIA plot was identified from PAD-US, and FIA statistical estimators were used to develop regional and national estimates of protected forest area. Two definitions of forest were used with the FIA data, including one encompassing all FIA forest land and another that excludes FIA woodlands (Table 19). FIA nonwoodland forest was included in the comparisons because it better approximates NLCD forest cover and RPA forest land.

When using the FIA database, parcel ownership and protected status were defined by PAD-US, not by FIA, to improve the comparison of results with the NLCD, which does not provide ownership information. In addition, the CONUS forest totals are not directly comparable to the National totals shown in Table 18 because the CONUS forest statistics do not include Alaska or Hawaii. Furthermore, the District of Columbia is omitted from all analyses because the PAD-US does not include that area.

The NLCD land cover map identified a total of 564 million acres of forest in the conterminous United States (Table 19). Of that area, 81 million acres (14.3 percent) occurred in a designated IUCN category, and an additional 109 million acres (19.4 percent) had de facto protection (i.e., protection conferred by public ownership alone). In comparison, the total forest area was calculated as 687 million acres of FIA forest land and 585 million acres

Table 19.—Protected forest area for three definitions of forest in the conterminous United States

IUCN Category[a]	Forest area defined as: NLCD forest cover	FIA forest land	FIA nonwoodland forest land	Percent of total IUCN protected forest area defined as: NLCD forest cover	FIA forest land	FIA nonwoodland forest land
	Thousand acres			*percent*		
Nature reserve (Ia)	1,006	1,238	1,109	1.2	1.3	1.4
Wilderness area (Ib)	26,961	32,690	26,681	33.5	34.2	33.2
National park (II)	7,082	8,020	7,450	8.8	8.4	9.3
Natural monument (III)	1,317	2,379	984	1.6	2.5	1.2
Habitat management (IV)	14,606	15,911	14,698	18.1	16.6	18.3
Protected landscape (V)	13,710	17,986	13,547	17.0	18.8	16.8
Sustainable use (VI)	15,905	17,426	15,994	19.7	18.2	19.9
Total IUCN protected forest area	80,587	95,647	80,463	100	100	100
de facto protection[b]	109,234	139,931	106,960			
Other unassigned	16,169	21,279	13,483			
Other unprotected	358,300	430,047	384,439			
Total forest area	564,290	686,904	585,345			
Percent of total forest area with IUCN protection	14.3	13.9	13.7			

[a] IUCN categories are defined in Table 17, but names have been shortened for formatting purposes.
[b] Federal and State ownership without IUCN assignment.
Excludes District of Columbia.
Entries may not sum to row or column totals because of rounding.
IUCN = International Union for the Conservation of Nature; NLCD = National Land Cover Database; FIA = Forest Inventory and Analysis.
Sources: FIA (O'Connell et al. 2017), NLCD (U.S. Geological Survey 2014b), PAD-US (Conservation Biology Institute 2016).

of FIA nonwoodland forest land. The percentage of that forest area in a designated IUCN category was 13.9 percent and 13.7 percent for FIA forest land and FIA nonwoodland forest land, respectively, with de facto protection of an additional 140 million acres (20.4 percent) of FIA forest land and 107 million acres (18.2 percent) of FIA nonwoodland forest. The percentage of total protected area (Table 18) that was forest (Table 19) was 39 percent based on NLCD forest and FIA nonwoodland forest, and 47 percent based on FIA forest land. Despite substantial differences in the absolute area of forest identified by the three definitions of forest, the shares of total forest area in each of the seven IUCN protection categories were similar (Table 19). Wilderness areas contained the largest shares of protected forest area, while the smallest shares were contained in nature reserves, national parks, and natural monuments.

The forest cover statistics represent substantial reductions in the total protected forest cover area compared to the statistics shown in the update to the 2010 RPA Assessment (USDA Forest Service 2016); the other two forest definitions were not reported in that update. Compared to an approximately 1 percent change in total protected area, there was a 33 percent reduction in estimated total protected forest cover area. This reduction is attributable to relative measurement accuracy. Compared to the higher resolution forest cover map used in this report, the lower resolution forest cover map used in the update to the 2010 RPA Assessment identified 16 percent more total forest area, which potentially accounts for half of the reduction in protected forest cover area. In addition, lower resolution maps tend to over-estimate forest area where forest is less fragmented and under-estimate forest area where forest is more fragmented (Nelson et al. 2009). This effect probably accounted for the rest of the reduction because forest is often the dominant land cover in protected areas, and the forest in protected areas is typically less fragmented than that in unprotected areas (Riitters et al. 2018).

For additional comparisons, the IUCN protected forest area statistics shown in Table 19 were expanded to show protected forest area by ownership and by region for FIA forest land (Table 20), FIA nonwoodland forest land (Table 21), and NLCD forest cover (Table 22). Using the results for NLCD forest cover (Table 22) to illustrate ownership differences, approximately 95 percent of the total protected forest area is held in either Federal (43 million acres) or state (34 million acres) ownership. Across all ownerships, the protected forest area was almost evenly divided between the East (41 million acres) and the West (40 million acres). Of the CONUS total forest protected area, approximately 33 percent was found in the Rocky Mountain Region, 32 percent in the North Region, 18 percent in the South Region, and 17 percent in the Pacific Coast Region. These regional percentages differ from the percentages obtained for all land cover (Table 18) because a higher percentage of the East is forested compared to the West.

Regional and ownership differences depend on the definition of forest (see Tables 20, 21, 22). For FIA forest land, for example, the share of protected forest in the West increases from 49 percent (by the NLCD definition) to 55 percent (by the FIA forest land definition). The differences in estimated protected forest area between FIA forest land and FIA nonwoodland forest land were due mainly to western regions (Pacific Northwest and Rocky Mountain) where the share of the woodland forest types is larger.

Table 20.—Protected Forest Inventory and Analysis (FIA) forest land area in the conterminous United States by International Union for Conservation of Nature (IUCN) category, ownership, and Resources Planning Act (RPA) region

RPA region	Owner	Designated IUCN[a] Category (excludes de facto protection area)							Row total
		Ia	Ib	II	III	IV	V	VI	
		Thousand acres							
North[b]	Federal	17	1,624	306	15	483	553	15	3,012
	State	343	1,432	2,492	0	3,963	2,047	11,036	21,313
	Other	23	0	42	0	81	2,357	139	2,642
	Region total	383	3,056	2,839	15	4,527	4,957	11,190	26,967
Pacific Coast[c]	Federal	184	10,168	381	490	126	1,165	17	12,531
	State	24	0	306	25	278	2,438	716	3,786
	Other	0	37	0	0	9	3	144	194
	Region total	207	10,205	687	515	413	3,606	877	16,511
Rocky Mountain	Federal	491	18,152	2,986	1,689	1,215	2,253	3,848	30,634
	State	0	0	166	8	806	4,407	191	5,579
	Other	6	0	12	0	12	110	0	141
	Region total	497	18,152	3,164	1,698	2,034	6,770	4,039	36,353
South	Federal	18	1,253	784	151	3,078	1,361	12	6,656
	State	102	6	433	0	5,174	1,029	1,043	7,787
	Other	30	18	112	0	686	262	266	1,374
	Region total	150	1,276	1,330	151	8,937	2,652	1,320	15,817
CONUS[b]	Federal	710	31,197	4,456	2,345	4,902	5,332	3,891	52,834
	State	469	1,438	3,397	33	10,220	9,920	12,986	38,464
	Other	59	55	166	0	789	2,733	548	4,350
	CONUS total	1,238	32,690	8,020	2,379	15,911	17,986	17,426	95,647

[a] IUCN categories are described in Table 17.
[b] Excludes District of Columbia.
[c] Excludes Alaska and Hawaii.
Entries may not sum to row or column totals because of rounding.
Sources: FIA (O'Connell et al. 2017), PAD-US (Conservation Biology Institute 2016).

Table 21.—Protected Forest Inventory and Analysis (FIA) nonwoodland forest land area in the conterminous United States by International Union for Conservation of Nature (IUCN) category, ownership and Resources Planning Act (RPA) region

RPA region	Owner	Designated IUCN[a] Category (excludes de facto protection area)							Row total
		Ia	Ib	II	III	IV	V	VI	
		Thousand acres							
North[b]	Federal	17	1,624	306	15	483	553	15	3,012
	State	343	1,432	2,492	0	3,963	2,047	11,036	21,313
	Other	23	0	42	0	81	2,357	139	2,642
	Region total	383	3,056	2,839	15	4,527	4,957	11,190	26,967
Pacific Coast[c]	Federal	172	9,733	376	477	126	1,066	17	11,967
	State	24	0	282	25	272	2,434	716	3,753
	Other	0	34	0	0	0	3	144	181
	Region total	196	9,767	659	502	397	3,504	877	15,901
Rocky Mountain	Federal	398	12,589	2,567	311	553	967	2,416	19,801
	State	0	0	199	5	439	1,409	191	2,163
	Other	6	0	0	0	0	90	0	96
	Region total	404	12,589	2,686	316	991	2,466	2,608	22,060
South	Federal	18	1,246	763	151	2,981	1,349	12	6,519
	State	79	6	391	0	5,116	1,009	1,043	7,643
	Other	30	18	112	0	686	262	266	1,374
	Region total	127	1,269	1,266	151	8,782	2,621	1,320	15,536
CONUS[b]	Federal	605	25,191	4,012	953	4,142	3,936	2,460	41,299
	State	466	1,438	3,285	30	9,788	6,899	12,986	34,872
	Other	59	52	154	0	767	2,712	548	4,293
	CONUS total	1,109	26,681	7,450	984	14,698	13,547	15,994	80,463

[a] IUCN categories are described in Table 17.
[b] Excludes District of Columbia.
[c] Excludes Alaska and Hawaii.
Entries may not sum to row or column totals because of rounding.
Sources: FIA (O'Connell et al. 2017), PAD-US (Conservation Biology Institute 2016).

Table 22.—Protected National Land Cover Database (NLCD) forest cover area in the conterminous United States by International Union for Conservation of Nature (IUCN) category, ownership, and Resources Planning Act (RPA) region

RPA region	Owner	Designated IUCN[a] Category (excludes de facto protection area)							Row total
		Ia	Ib	II	III	IV	V	VI	
		Thousand acres							
North[b]	Federal	14	1,505	280	6	511	542	27	2,884
	State	377	1,403	2,508	0	3,958	2,135	10,249	20,631
	Other	16	0	34	0	68	2,331	87	2,537
	Region total	407	2,908	2,823	6	4,537	5,009	10,362	26,052
Pacific Coast[c]	Federal	120	8,274	348	380	103	914	16	10,155
	State	22	0	255	12	179	1,922	651	3,042
	Other	0	9	1	1	2	8	116	137
	Region total	143	8,283	604	393	284	2,844	783	13,333
Rocky Mountain	Federal	319	14,185	2,211	803	780	1,538	3,484	23,321
	State	1	2	153	4	761	1,954	180	3,055
	Other	5	1	3	0	30	88	0	127
	Region total	325	14,188	2,368	808	1,571	3,579	3,664	26,503
South	Federal	9	1,556	790	111	2,924	1,088	4	6,481
	State	89	10	365	0	4,621	925	837	6,848
	Other	33	15	132	0	670	265	254	1,368
	Region total	131	1,581	1,287	111	8,215	2,278	1,096	14,698
CONUS[b]	Federal	462	25,520	3,629	1,300	4,318	4,081	3,531	42,841
	State	490	1,416	3,282	16	9,518	6,937	11,917	33,576
	Other	54	26	171	1	770	2,692	456	4,169
	CONUS total	1,006	26,961	7,082	1,317	14,606	13,710	15,905	80,587

[a] IUCN categories are described in Table 17.
[b] Excludes District of Columbia.
[c] Excludes Alaska and Hawaii.
Entries may not sum to row or column totals because of rounding.
Sources: NLCD (U.S. Geological Survey 2014b), PAD-US (Conservation Biology Institute 2016).

Forest Carbon

As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), each year the United States reports economy-wide greenhouse gas (GHG) emissions and removals in the National Inventory Report (NIR) of GHG emissions and sinks for the period from 1990 to 2 years before present (e.g., 1990-2017; US EPA 2019). The NIR land use, land use change, and forestry (LULUCF) chapter includes six land use categories (Table 23) that are organized within a national land-use categorization system to estimate area and GHG fluxes associated with land use and land use change. The NIR uses land area estimates by land use and land use change category to represent the U.S. land base. Only land directly influenced by human intervention (i.e., managed) is used to compile estimates of GHG emissions and removals. This results in 36 possible land use and land use change categories in the NIR (Table 24). The Intergovernmental Panel on Climate Change (IPCC) provides guidance (Eggleston et al. 2006) for NIR compilers to ensure transparency, consistency, completeness, comparability, and accuracy in annual submissions to the UNFCCC.

Table 23.—Land use categories in the U.S. national greenhouse gas inventory report

Land use category	Definition
Forest land	Areas at least 120 feet (36.6 meters) wide and at least one acre (0.4 hectare) in size with at least 10 percent cover (or equivalent stocking) by live trees including land that formerly had such tree cover and that will be naturally or artificially regenerated. Trees are woody plants having a more or less erect perennial stem(s) capable of achieving at least 3 inches (7.6 centimeters) in diameter at breast height, or 5 inches (12.7 cm) diameter at root collar, and a height of 16.4 feet (5 m) at maturity in situ. Forest land includes all areas recently having such conditions and currently regenerating or capable of attaining such condition in the near future. Forest land also includes transition zones, such as areas between forest and non-forest lands that have at least 10 percent cover (or equivalent stocking) with live trees and forest areas adjacent to urban and built-up lands. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if they are less than 120 feet (36.6 m) wide or an acre (0.4 ha) in size. However, land is not classified as Forest land if completely surrounded by urban or developed lands, even if the criteria are consistent with the tree area and cover requirements for Forest land. These areas are classified as Settlements. In addition, Forest land does not include land that is predominantly under an agricultural land use. Data sources: FIA (CONUS and coastal AK), NRI (non-Federal lands in HI), NLCD (federal lands in HI).
Cropland	Areas used for the production of adapted crops for harvest; this category includes both cultivated and non-cultivated lands. Cultivated crops include row crops or close grown crops and also hay or pasture in rotation with cultivated crops. Non-cultivated cropland includes continuous hay, perennial crops (e.g., orchards) and horticultural cropland. Cropland also includes land with agroforestry, such as alley cropping and windbreaks, if the dominant use is crop production, assuming the stand or woodlot does not meet the criteria for Forest land. Lands in temporary fallow or enrolled in conservation reserve programs (i.e., set-asides) are also classified as Cropland, as long as these areas do not meet the Forest land criteria. Roads through Cropland, including interstate highways, state highways, other paved roads, gravel roads, dirt roads, and railroads are excluded from Cropland area estimates and are, instead, classified as Settlements. Data sources: NRI (non-Federal lands in CONUS and HI), NLCD (federal lands and AK).

(continued on next page)

Table 23 (continued).—Land use categories in the U.S. national greenhouse gas inventory report

Land use category	Definition
Grassland	Plant cover is composed principally of grasses, grass-like plants (i.e., sedges and rushes), forbs, or shrubs suitable for grazing and browsing, and includes both pastures and native rangelands. This includes areas where practices such as clearing, burning, chaining, and/or chemicals are applied to maintain the grass vegetation. Grassland may have three or fewer years of hay production that is otherwise pasture or rangelands. Savannas, deserts, and tundra are considered Grassland. Drained wetlands are considered Grassland if the dominant vegetation meets the plant cover criteria for Grassland. Woody plant communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also classified as Grassland if they do not meet the criteria for Forest land. Grassland includes land managed with agroforestry practices, such as silvopasture and windbreaks, if the land is principally grasses, grass-like plants, forbs, and shrubs suitable for grazing and browsing, and assuming the stand or woodlot does not meet the criteria for Forest land. Roads through Grassland, including interstate highways, state highways, other paved roads, gravel roads, dirt roads, and railroads are excluded from Grassland and are, instead, classified as Settlements. Data sources: NRI (non-federal lands in CONUS and HI), NLCD (federal lands and AK), FIA (woodland areas in CONUS).
Wetlands	Land covered or saturated by water for all or part of the year, in addition to the areas of lakes, reservoirs, and rivers. Managed Wetlands are those where the water level is artificially changed, or were created by human activity. Certain areas that fall under the managed Wetlands definition are included in other land uses based on the IPCC guidance, including Cropland (drained wetlands for crop production and also systems that are flooded for most or just part of the year, such as rice cultivation and cranberry production), Grassland (drained wetlands dominated by grass cover), Forest land (including drained or un-drained forested wetlands), and Settlements (drained wetlands in developed areas Data sources: NRI (non-Federal lands in CONUS and HI), NLCD (federal lands and AK).
Settlements	Developed areas consisting of units of 0.25 acres (0.1 ha) or more that includes residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; parks within urban and built-up areas; and highways, railroads, and other transportation facilities. Also included are tracts of less than 10 acres (4.05 ha) that may meet the definitions for Forest land, Cropland, Grassland, or Other land but are completely surrounded by urban or built-up land, and so are included in the Settlements category. Rural transportation corridors located within other land uses (e.g., Forest land, Cropland, and Grassland) are also included in Settlements. Data sources: NRI (non-Federal lands in CONUS and HI), NLCD (federal lands and AK).
Other land	Bare soil, rock, ice, and all land areas that do not fall into any of the other five land-use categories. Data sources: NRI (non-Federal lands in CONUS and HI), NLCD (federal lands and AK).

Table 24.—Land use and land use change categories in the National Inventory Report of greenhouse gas emissions and sinks in the United States

	Forest land	Cropland	Grassland	Settlements	Wetlands	Other land
Forest land	FLRFL	FLCCL	FLCGL	FLCSL	FLCWL	FLCOL
Cropland	CLCFL	CLRCL	CLCGL	CLCSL	CLCWL	CLCWL
Grassland	GLCFL	GLCCL	GLRGL	GLCSL	GLCWL	GLCOL
Settlements	SLACFL	SLCCL	SLCGL	SLRSL	SLCWL	SLCOL
Wetlands	WLCFL	WLCCL	WLCGL	WLCSL	WLRWL	WLCOL
Other land	OLCFL	OLCCL	OLCGL	OLCSL	OLCWL	OLROL

FL = Forest land; CL = Cropland; GL = Grassland; SL = Settlements; WL = Wetlands; OL = Other land; R = Remaining; C = Converted to
Source: US EPA 2019.

Historically, there have been inconsistencies in U.S. forest land area and carbon estimates reported in the NIR and those reported in the RPA Assessment and FIA program. The inconsistencies were mainly due to the different assumptions, definitions, domains, estimation systems, and reporting requirements used for each reporting instrument. In recent years, methods and models have been developed across reporting teams to improve the consistency between reports. This has proven particularly effective for RPA Assessment projections, which now rely on the same FIA data used in the NIR to compile baseline estimates. This has improved alignment of contemporary estimates between the reports and provided a consistent transition from the baseline reporting period compiled for the NIR to projections of forest land and woodland area compiled for the RPA Assessment. Because each report has unique reporting requirements (e.g., reporting intervals, carbon pools included, managed vs. all lands, and definitions), differences in estimates of forest land area and associated carbon stocks and stock change will continue. However, with the recent alignment, it is now possible to reconcile the differences in these estimates.

The forest land category, which includes GHG emissions and removals from forest land remaining forest land (FLRFL) and land converted to forest land (all categories in the forest land column of Table 24), offsets more than 10 percent (-638 million metric tons [MMT] carbon dioxide equivalent [CO_2 eq.]) of economy-wide GHG emissions each year and accounts for an estimated 95 percent of all removals in the land sector (Domke et al. 2019, US EPA 2019). This estimate includes GHG emissions from fire, draining of organic soils, fertilizer applications, and decomposition of dead organic matter. The estimates also include GHG removals from sequestration of atmospheric CO_2 in live vegetation (e.g., aboveground and belowground biomass) and the accumulation of carbon in dead organic matter (e.g., dead wood, litter) and forest soils. These change estimates are based on all annual FIA plots with at least one forest land condition. Remeasured FIA plots are used to obtain annual estimates of forest land area change and carbon stock change (US EPA 2019).

Since 1990, forest land area estimates have increased on average by 0.05 percent per year (361,000 acres), for a total of about nearly 10 million acres through 2017 (US EPA 2019). These increases are mainly due to the conversion of abandoned croplands to forest land (Woodall et al. 2015) and the reversion and expansion of trees in grassland ecosystems in the Great Plains and Western United States (US EPA 2019). There have also been losses in forest land over the past 27 years, predominately due to the conversion of forests to settlements, grasslands, and croplands (Domke et al. 2019, US EPA 2019, Woodall et al. 2015). Differences between gross gains and gross losses equate to a slight net gain in forest.

The ecosystem dynamics associated with land change are complicated, particularly within the forest land category, where substantial amounts of live and dead organic matter may have accumulated over time (Woodall et

al. 2015). The time it takes for carbon stocks to reach equilibrium (i.e., the point at which the new land use reaches a stable state) following a land use conversion can vary substantially due to differences in climate, soil type, geology, vegetation, and type of land use conversion, and other factors. When calculating emissions and removals associated with land use conversions, a 20-year default is specified in IPCC Good Practice Guidance (Eggleston et al. 2006). Following the 20-year IPCC default, land will be transferred from the conversion category (e.g., GLCFL) to a remaining category (e.g., FLRFL) (Table 24). The net carbon flux associated with forest land conversion in the United States represents a net loss of 5 MMT CO_2 eq. per year with gains in forest land constituting -119 MMT CO_2 eq. per year and losses resulting in emissions of -125 MMT CO_2 per year over the last decade (Domke et al. 2019, US EPA 2019). The estimated emissions constitute decades, and possibly centuries, of accumulated carbon within these forest ecosystems that is abruptly or gradually released into the atmosphere or transferred to the new land use during conversion. In contrast, the gains in forest land include the transfer of ecosystem carbon stocks (e.g., live biomass, dead wood) from the previous land use as well as the carbon sequestration from new growth of live biomass and the accumulation of carbon in newly dead organic matter and soils over the 20 years since land use conversion.

In most of the other land use categories within the LULUCF sector, only emissions and removals associated with changes in soils are currently reported in the NIR (US EPA 2019). The exception to this is woodlands, which are classified as grasslands because the perennial woody vegetation does not reach the thresholds for tree cover, areal extent, tree height, or a combination of these, to be considered forest land, and trees in urban areas are included in the settlements category. Woodlands release and transfer an estimated 13.3 MMT CO_2 eq. annually in above and belowground biomass, dead wood, and litter. Most of this is transferred to the forest land category. Urban trees in settlements in the United States sequestered an estimated 113.7 MMT CO_2 eq. over the 27-year reporting period (US EPA 2019).

Urban Land Base

The RPA Assessment relies on NRI and NLCD data to depict the broader land base in the United States. However, U.S. Census Bureau definitions and data are used in analyses of urban forests and urban trends. Unlike NRI or NLCD definitions, Census Bureau definitions are tied to population density and provide a different look at the concentration of human populations in proximity to treed environments. This section provides the Census Bureau definitions that underpin these analyses in the RPA Assessment.

The U.S. Census Bureau (2017a) currently defines urban land as “a densely settled core of census tracts and/or census blocks that meet minimum population density requirements, along with adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with the densely settled core.” To qualify as an urban area, the territory identified must

encompass at least 2,500 people, of which at least 1,500 reside outside institutional group quarters. The Census Bureau identifies two types of urban areas: (1) urbanized areas (UAs) of 50,000 or more people; and (2) urban clusters (UCs) of at least 2,500 and less than 50,000 people (U.S. Census Bureau 2017b). The definitions of urban, however, have changed over time. A substantial change between 1990 and 2000 required redefining 1990 urban land for consistent temporal comparisons (Nowak et al. 2005). No adjustments were made to the 1990 and 2000 census data to account for changes in the 2010 Census, which were considered minor for the purpose of comparing trends.

In the 2000 census, urbanized areas and urban clusters were derived from census blocks and block groups with population densities of 1,000 people per square mile (386.1 people per square kilometer) in the core and 500 people per square mile (193.1 people per square kilometer) in the surrounding area. In addition, surrounding areas were included within a distance of 2 1/2 miles along a connected corridor (i.e., a road), they included less densely populated blocks or block groups less than 1/2 mile between more densely populated blocks or block groups, and they included blocks or block groups with large airports but little to no population (Nowak et al. 2005; U.S. Census Bureau 2003, 2004).

In the 2010 census, urban land was redrawn and redefined. While the 2000 census general definition of urbanized area and urban cluster was maintained, census tracts rather than blocks or block groups were used to delimit the urban core; institutional populations (i.e., correctional facilities and military installations) were limited within the urban designation; smaller airports were included; more limitations were added regarding the distance of noncontiguous areas and which ones are included within the surrounding areas; and areas of high impervious surfaces but with smaller population density were incorporated with surrounding areas and included with the urban designation (U.S. Census Bureau 2017b). While the term “urban land” may be perceived as an area typically associated with large cities, the current census definition also covers areas in smaller communities that meet the minimum census population density for urban land.

By 2010, more than 80 percent of the U.S. population lived in urban areas, an increase from 75 percent in 1990. Urban land area in the United States also expanded during that time, increasing from 2.1 percent (47 million acres) in 1990 to 3.0 percent in 2010 (68 million acres) (Fig. 15). This growth averaged 1.1 million acres per year in the 1990s and 1.0 million acres per year in the 2000s. The urban land base is smaller than the NRI developed land base (113.3 million acres in 2012; Table 4) and NLCD developed land base (112.1 million acres in 2011; Table 9). While all three classifications are different, they exhibited similar growth trends over the recent decades. NRI developed land averaged an annual growth rate of 1.4 million acres per year (1982-2012), urban land averaged +1.0 million acres per year (1990-2010), and NLCD developed land averaged +0.5 million acres per year (2001-2011).

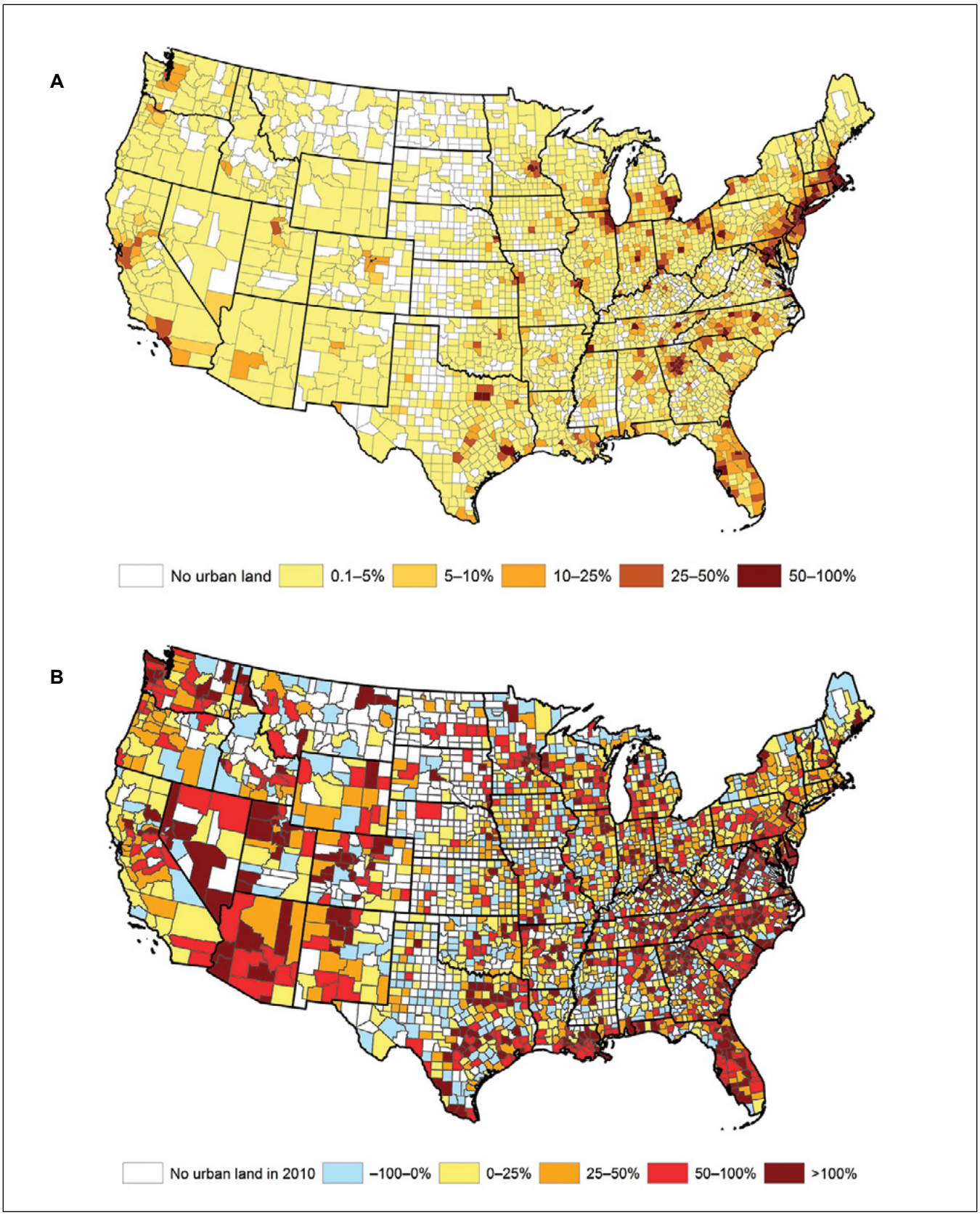

Figure 15.—(A) Percent census-defined urban land by county, 2010, and (B) percent change in urban land, 1990 to 2010, for the conterminous United States. Sources: U.S. Census Bureau (2010); Nowak and Greenfield (2018).

Growth at the county level was typically highest within the most urbanized counties. States with the greatest amount of urban land in 2010 were Texas (5.6 million acres), California (5.3 million acres), and Florida (4.7 million acres). States with the greatest percentage of urban land in 2010 were in the Northeast and include New Jersey (39.8 percent), Rhode Island (38.7 percent), and Massachusetts (38.0 percent) (Nowak and Greenfield 2018). The greatest amount of urban land growth from 1990 to 2010 occurred in Texas (1.9 million acres), Florida (1.8 million acres), and Georgia (1.4 million acres), while the greatest percentage growth in urban lands occurred in Nevada (128.6 percent), Delaware (91.4 percent), and North Carolina (87.8 percent).

Because the Census Bureau defines urban land based on human population, not land cover, the urban definition can overlap with forest areas (i.e., forest land can be contained within urban areas). Based on an analysis of overlap of U.S. Forest Service forest inventory plots within Census-defined urban land, it is estimated that 13.8 percent of urban land is FIA forest land in the conterminous United States, or about 1.5 percent of FIA forest land is within urban areas (Nowak et al. 2013).

CONCLUSIONS

The RPA Assessment uses a combination of land use and land cover data to evaluate trends in the United States land base and project future changes. The main objective of this document was to clearly lay out how the RPA Assessment uses these different sources of data to analyze forest trends. The selection of data sources was based on the utility of different data to address particular questions about forest resources. In this report, the authors compared and contrasted differences in definitions and approaches between three major data sources (NRI, NLCD, and FIA) and documented the recent status and trends of land use and land cover area according to those sources. While the general definitions of land uses and land covers are superficially similar among these databases, it is necessary to understand the conceptual and technical differences between them in order to evaluate and compare their trends. Some differences can be rationalized based on the sensitivity of the different databases to the underlying drivers of landscape change over time. The RPA Assessment will continue to use both land use and land cover separately and in combination because each source offers unique and complementary perspectives on land base trends. In summary, the wealth of land use and land cover data available to support forest assessments is constantly expanding and improving over time. When used appropriately and thoughtfully, these and many other databases will support the continued improvement of forest and range assessments in the RPA Assessment analyses.

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APPENDIX 1

National Resources Inventory (NRI) Land Base Changes and Transitions for the Conterminous United States, by Resources Planning Act (RPA) Region, 2002-2012

Table 25.—NRI land base changes and transitions for the North Region, 2002 to 2012

	2012 Land use[a]							
2002 Land use	**Crop**	**Pasture**	**Rangeland**	**Forest**	**Other rural**	**Developed land**	**CRP**	**2002 total**
				Thousand acres				
Crop	136,153	3,752	0	214	491	879	733	142,221
Pasture	3,607	31,129	1	1,712	306	417	112	37,283
Rangeland	0	0	46	1	2	0	0	48
Forest	167	387	0	152,946	395	1,298	0	155,193
Other rural	109	189	0	300	12,511	89	0	13,198
Developed land	72	30	0	108	9	39,865	0	40,083
CRP	2,128	573	0	79	21	14	3,752	6,567
2012 total	142,236	36,059	47	155,359	13,734	42,562	4,597	394,594
Net change	15	-1,224	-1	166	535	2,479	-1,969.8	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NRI (USDA 2015).

Table 26.—NRI land base changes and transitions for the Pacific Coast Region, 2002 to 2012

	2012 Land use[a]							
2002 Land use	**Crop**	**Pasture**	**Rangeland**	**Forest**	**Other rural**	**Developed land**	**CRP**	**2002 total**
				Thousand acres				
Crop	17,779	623	82	12	138	186	357	19,178
Pasture	387	3,334	139	38	65	82	30	4,075
Rangeland	106	59	33,320	62	69	292	4	33,912
Forest	4	14	157	38,610	25	235	0	39,045
Other rural	25	14	82	35	3,683	25	0	3,865
Developed land	8	5	15	21	3	9,404	0	9,457
CRP	139	159	25	0	4	0	1,498	1,824
2012 total	18,449	4,209	33,819	38,778	3,987	10,224	1,890	111,356
Net change	-729	134	-92	-267	122	767	65.5	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NRI (USDA 2015).

Table 27.—NRI land base changes and transitions for the Rocky Mountain Region, 2002 to 2012

	2012 Land use[a]							
2002 Land use	**Crop**	**Pasture**	**Rangeland**	**Forest**	**Other rural**	**Developed land**	**CRP**	**2002 total**
				Thousand acres				
Crop	116,819	2,810	515	15	278	385	1,554	122,377
Pasture	1,334	13,169	489	56	40	102	103	15,291
Rangeland	839	143	258,377	227	587	742	10	260,935
Forest	29	28	169	30,123	21	101	0	30,470
Other rural	104	18	184	129	11,942	41	2	12,419
Developed land	18	4	31	7	2	13,478	0	13,540
CRP	3,498	1,692	288	3	3	0	10,041	15,526
2012 total	122,641	17,864	260,052	30,560	12,881	14,849	11,710	470,558
Net change	264	2,573	-883	90	462	1,309	-3,815.9	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NRI (USDA 2015).

Table 28.—NRI land base changes and transitions for the South Region, 2002 to 2012

2002 Land use	2012 Land use[a]							2002 total
	Crop	Pasture	Rangeland	Forest	Other rural	Developed land	CRP	
	Thousand acres							
Crop	74,842	5,409	254	643	339	722	676	82,885
Pasture	3,062	54,438	485	2,475	382	939	143	61,924
Rangeland	164	133	109,293	386	334	590	0	110,900
Forest	178	1,022	106	181,410	610	2,468	3	185,797
Other rural	60	167	72	278	12,606	159	0	13,342
Developed land	48	47	9	151	22	40,732	0	41,009
CRP	589	1,262	73	694	13	10	5,202	7,842
2012 total	78,942	62,477	110,292	186,038	14,306	45,620	6,024	503,698
Net change	-3,943	553	-608	242	963	4,611	-1,818.1	

[a] NRI land use classifications are defined in Table 1, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NRI (USDA 2015).

APPENDIX 2

National Land Cover Database (NLCD) Land Cover Changes and Transitions for the Conterminous United States on Federal Land and for All Ownerships, by Resources Planning Act (RPA) Region, 2001 to 2011

Table 29.—National Land Cover Database (NLCD) Federal land cover changes and transitions for the North Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	**Crop**	**Pasture**	**Shrub**	**Grass**	**Forest**	**Developed**	**Other**	**2001 total**
				thousand acres				
Crop	243	<1	<1	<1	2	1	10	256
Pasture	<1	128	<1	<1	<1	1	1	132
Shrub	<1	<1	342	5	71	<1	1	419
Grass	1	<1	25	175	4	2	4	211
Forest	1	1	72	63	13,084	3	25	13,249
Developed	<1	<1	<1	<1	<1	442	<1	442
Other	1	<1	1	4	10	<1	1,654	1,670
2011 total	246	130	441	248	13,171	450	1,694	16,380
Net change	-10	-2	22	38	-78	7	24	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 30.—National Land Cover Database (NLCD) Federal land cover changes and transitions for the Pacific Coast Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	123	<1	<1	1	<1	1	2	128
Pasture	1	133	<1	<1	1	1	7	142
Shrub	1	1	46,089	65	62	2	74	46,294
Grass	1	<1	74	3,959	5	1	21	4,062
Forest	<1	<1	437	209	36,530	1	14	37,191
Developed	<1	<1	<1	<1	<1	994	<1	994
Other	2	1	32	8	4	1	5,670	5,718
2011 total	128	135	46,633	4,242	36,601	999	5,788	94,527
Net change	1	-7	340	181	-589	6	70	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes Alaska and Hawaii.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 31.—National Land Cover Database (NLCD) Federal land cover changes and transitions for the Rocky Mountain Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	343	<1	10	2	1	<1	8	365
Pasture	<1	629	10	3	3	1	7	654
Shrub	13	14	146,025	654	101	16	82	146,904
Grass	11	4	272	33,235	42	4	64	33,632
Forest	1	3	1,856	797	79,873	1	31	82,561
Developed	<1	<1	<1	<1	<1	1,123	<1	1,124
Other	3	5	85	18	43	3	13,449	13,606
2011 total	372	656	148,258	34,709	80,062	1,149	13,639	278,846
Net change	7	2	1,354	1,077	-2,499	25	34	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 32.—National Land Cover Database (NLCD) Federal land cover changes and transitions for the South Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	312	<1	2	1	11	1	2	329
Pasture	1	331	6	1	5	1	2	348
Shrub	1	<1	1,617	27	78	5	19	1,747
Grass	4	<1	64	794	28	5	7	901
Forest	2	2	229	106	18,114	12	52	18,516
Developed	<1	<1	<1	<1	<1	946	<1	946
Other	3	1	5	13	28	1	3,605	3,656
2011 total	322	335	1,923	942	18,264	972	3,685	26,444
Net change	-7	-13	176	40	-252	26	30	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 33.—National Land Cover Database (NLCD) Federal land cover changes and transitions on conterminous United States, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	1,021	1	13	3	14	4	21	1,078
Pasture	2	1,222	17	5	9	4	17	1,276
Shrub	15	15	194,074	751	311	24	175	195,364
Grass	16	5	435	38,164	79	11	95	38,806
Forest	4	6	2,593	1,175	147,601	16	121	151,517
Developed	<1	<1	<1	<1	<1	3,506	<1	3,506
Other	9	7	123	43	84	5	24,377	24,649
2011 total	1,068	1,257	197,256	40,141	148,098	3,570	24,807	416,197
Net change	-10	-20	1,892	1,335	-3,419	64	157	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Sources: NLCD (U.S. Geological Survey 2014a, b), PAD-US (Conservation Biology Institute 2016).

Table 34.—National Land Cover Database (NLCD) All owner land cover changes and transitions for the North Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	121,783	103	22	31	39	595	286	122,859
Pasture	297	47,997	10	21	27	291	67	48,712
Shrub	11	7	5,120	45	801	32	14	6,030
Grass	72	12	248	6,826	79	73	49	7,358
Forest	91	82	1,210	860	177,331	465	414	180,451
Developed	<1	<1	<1	<1	<1	38,977	1	38,979
Other	25	9	14	38	82	57	18,647	18,873
2011 total	122,278	48,210	6,624	7,822	178,360	40,489	19,479	423,262
Net change	-581	-502	594	464	-2,091	1,511	606	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Source: NLCD (U.S. Geological Survey 2014a, b).

Table 35.—National Land Cover Database (NLCD) All owner land cover changes and transitions for the Pacific Coast Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	17,632	11	43	47	2	92	33	17,860
Pasture	7	4,553	20	9	3	43	21	4,655
Shrub	109	21	76,713	188	336	53	144	77,563
Grass	75	8	577	17,635	33	89	77	18,495
Forest	6	3	1,729	1,177	63,484	30	210	66,639
Developed	<1	<1	<1	<1	<1	10,772	<1	10,773
Other	22	10	281	36	36	22	10,091	10,498
2011 total	17,850	4,605	79,363	19,093	63,894	11,102	10,575	206,482
Net change	-9	-50	1,800	598	-2,745	329	77	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes Alaska and Hawaii.
Column sums may reflect rounding errors.
Source: NLCD (U.S. Geological Survey 2014a, b).

Table 36.—National Land Cover Database (NLCD) All owner land cover changes and transitions for the Rocky Mountain Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	103,647	37	118	221	32	208	180	104,443
Pasture	87	21,161	109	155	45	67	83	21,707
Shrub	155	146	251,699	958	274	233	218	253,683
Grass	901	125	508	201,820	145	115	341	203,956
Forest	39	28	2,758	1,106	117,865	27	97	121,921
Developed	<1	<1	<1	<1	<1	16,109	<1	16,110
Other	102	48	138	262	104	34	26,928	27,616
2011 total	104,931	21,547	255,330	204,522	118,465	16,793	27,847	749,435
Net change	488	-160	1,648	566	-3,456	683	231	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NLCD (U.S. Geological Survey 2014a, b).

Table 37.—National Land Cover Database (NLCD) All owner land cover changes and transitions for the South Region, 2001 to 2011

	2011 Land cover[a]							
2001 Land cover	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	2001 total
				thousand acres				
Crop	63,614	58	259	108	376	300	135	64,850
Pasture	200	57,964	415	184	738	512	131	60,144
Shrub	177	127	79,772	1,821	4,177	232	218	86,524
Grass	289	37	1,657	51,257	1,682	333	206	55,461
Forest	172	250	7,970	5,677	196,063	1.012	1,350	212,493
Developed	<1	<1	1	2	1	41,255	1	41,260
Other	100	20	108	142	535	97	23,539	24,540
2011 total	64,553	58,456	90,182	59,189	203,571	43,740	25,581	545,272
Net change	-297	-1,688	3,658	3,728	-8,922	2,480	1,041	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Column sums may reflect rounding errors.
Source: NLCD (U.S. Geological Survey 2014a, b).

Table 38.—National Land Cover Database (NLCD) All owner land cover changes and transitions for the conterminous United States, 2001 to 2011

2001 Land cover	2011 Land cover[a]							2001 total
	Crop	Pasture	Shrub	Grass	Forest	Developed	Other	
	thousand acres							
Crop	306,676	209	442	407	450	1,195	635	310,012
Pasture	591	131,675	554	368	813	914	302	135,217
Shrub	453	301	413,305	3,013	5,587	549	593	423,800
Grass	1,337	183	2,989	277,538	1,940	610	673	285,270
Forest	308	363	13,666	8,820	554,743	1,533	2,071	581,504
Developed	<1	<1	2	2	1	107,113	2	107,121
Other	248	87	541	478	757	210	79,206	81,527
2011 total	309,613	132,818	431,499	290,625	564,290	112,124	83,482	1,924,452
Net change	-399	-2,399	7,700	5,356	-17,214	5,002	1,955	

[a] Aggregated class descriptions are defined in Table 2, but names have been shortened for formatting purposes.
Excludes District of Columbia.
Column sums may reflect rounding errors.
Source: NLCD (U.S. Geological Survey 2014a, b).

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The Resources Planning Act (RPA) Assessment uses a combination of land use and land cover data to evaluate trends in the United States land base and project future changes. This publication describes how the RPA Assessment uses the National Resources Inventory, National Land Cover Database, and Forest Inventory and Analysis to support analyses of forest trends. The authors compare and contrast differences in definitions and approaches of these three major data sources and document the recent status and trends of land use and land cover area according to these sources. While the general definitions of land uses and land covers are superficially similar among these sources, understanding the conceptual and technical differences between them is necessary to evaluate and compare trends in the U.S. land base. Some differences can be rationalized based on the sensitivity of the different databases to the underlying drivers of landscape change over time. However, the major difference is the perception of the land base in terms of its intended human use versus its current biophysical cover. The RPA Assessment will continue to use both land use and land cover data separately and in combination because each source offers both unique and complementary perspectives on land base trends.

KEY WORDS: RPA Assessment, land use, land cover, forest land use, forest land cover.