



Land Cover Summary Statistics for Antietam National Battlefield

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This technical report documents the acquisition of source data, and calculation of land cover summary statistics datasets for Antietam National Battlefield. The source data and land cover calculations are available for use within the National Park Service (NPS) Inventory & Monitoring (I&M) Program. Land cover summary statistics datasets can be calculated for all geographic regions within the extent of the NPS; this report includes statistics calculated for the conterminous United States. The land cover summary statistics datasets are calculated from multiple sources, including Multi-Resolution Land Characteristics Consortium products in the National Land Cover Database (NLCD) and United States Geological Survey's (USGS) Earth Resources Observation and Science (EROS) Center products in the Land Change Monitoring, Assessment, and Projection (LCMAP) raster dataset. These summary statistics calculate land cover at up to three classification scales: Level 1, modified Anderson Level 2, and Natural versus Converted land cover. The output land cover summary statistics datasets produced here for Antietam National Battlefield utilize the most recent versions of the source datasets (NLCD and LCMAP). These land cover summary statistics datasets are used in the NPS I&M Program, including the NPS Environmental Settings Monitoring Protocol and may be used by networks and parks for additional efforts.

Background and Summary

The National Park Service (NPS) Inventory and Monitoring (I&M) Program inventories and monitors natural resources in park units across the NPS. Landscape dynamics, weather, and stream hydrology measures are monitored in areas inside and near parks with significant natural resources using methods outlined in the NPS Environmental Settings Protocol (DeVivo et al. 2018). For each park, landscape dynamics measures are calculated in areas of analysis (AOAs) such as a park boundary, a watershed, or a user-defined area within a park.

Land cover statistics for each AOA are derived from raster datasets from one or more sources, depending on the park. The National Land Cover Database (NLCD) provides data on land cover and associated changes for Alaska and the conterminous United States (CONUS). The Land Change Monitoring, Assessment, and Projection (LCMAP) data covers Hawaii and CONUS. Lastly, the Coastal Change Analysis Program (C-CAP) covers United States islands and territories and is produced through the National Oceanic and Atmospheric Administration's Office of Coastal Management.

Not all raster dataset sources are applicable for all NPS geographic regions. Only land cover sources applicable to Antietam National Battlefield (ANTI) are referenced in this report.

Data Records

One .csv file was created containing land cover summary statistics for ANTI. The .csv file in this database represents eleven NPS unit boundary-derived AOAs and contains data that are geographically referenced to the NAD 83 (2011) epoch 2010.00 datum as represented by the well-known identifier (WKID) 102039 (ESRI 2022a). These are spatially projected to the appropriate local spatial reference which is noted with each dataset (ESRI 2022b) ([Table 1](#)).

1. LandcoverStatistics_Output_Dataset.csv is a tabular dataset representing land cover summary statistics for all AOAs utilizing NLCD and LCMAP raster data included in the source dataset.

Table 1. Land Cover Summary Statistics for Antietam National Battlefield Data Package: List of data files.

File Name	Size	Description
LandcoverStatistics_Output_Dataset.csv	979.3 KB	ANTI Landcover Summary Statistics for NLCD and LCMAP landcover classes

Data Quality Evaluation

All data have been reviewed by staff in the NPS Inventory and Monitoring Division to ensure accuracy, completeness, and consistency with documented data quality standards (DeVivo et al, 2018), as well as for usability and reproducibility. The *Landcover Summary Statistics for Antietam National Battlefield Data Package* is suitable for its intended use as of the date of processing (2023-09-26).

Usage Notes

This data package is available for download from the NPS DataStore at <https://doi.org/10.57830/2301393>.

This data package can also be directly imported into R using the [NPSutils package](#) with the following code:

```
devtools::install_github("nationalparkservice/NPSutils")
library(NPSutils)
get_data_packages(2301393)
data <- load_data_package(2301393)
list2env(data, envir=.GlobalEnv)
```

This data package is designed to be used in conjunction with the data that describe the geospatial characteristics of the Areas of Interest (NPS-IMD-2022).

Methods

This report documents the methods used to calculate land cover summary statistics datasets for AOAs relevant to ANTI using source land cover data available as of the date of this report's publication.

Using custom scripts and scripted tools, land cover summary statistics were calculated (see Code Availability section for details).

Land cover summary statistics were calculated from NLCD and LCMAP source raster datasets for available ANTI AOAs. [Figure 1](#) depicts a flowchart of output summary statistics datasets representing modified Anderson Level 2, Level 1, and Natural versus Converted land cover classifications for a user-defined list of AOAs. Not all land cover sources were available for all AOAs.

Study Area

ANTI is located in Maryland within the National Capital Region. [Figure 2](#) shows the location of ANTI, along with surrounding 3 km buffer and 30 km buffer AOAs.

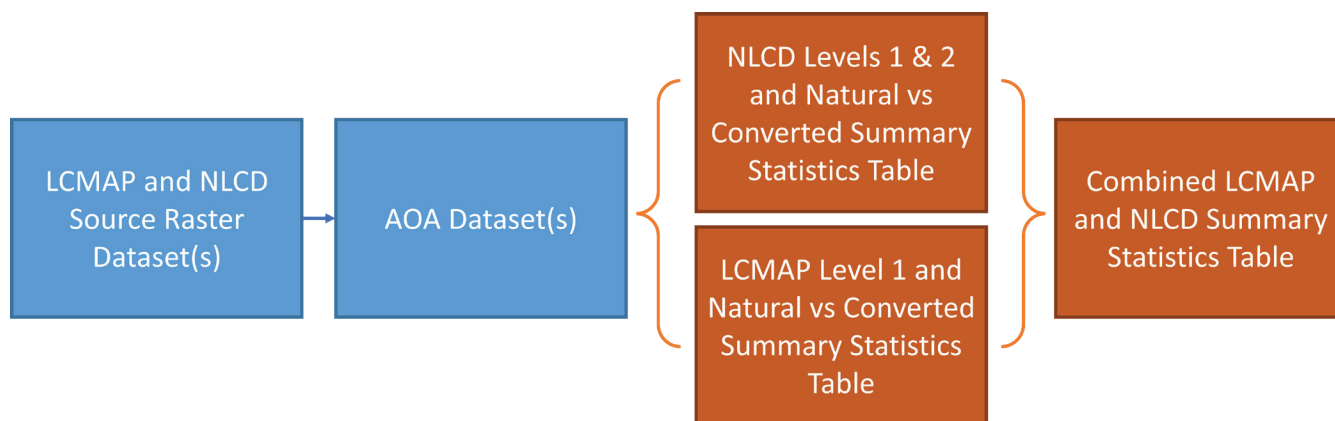


Figure 1. Generalized process flow for land cover summary statistics calculations. Orange boxes indicate datasets documented by this report.

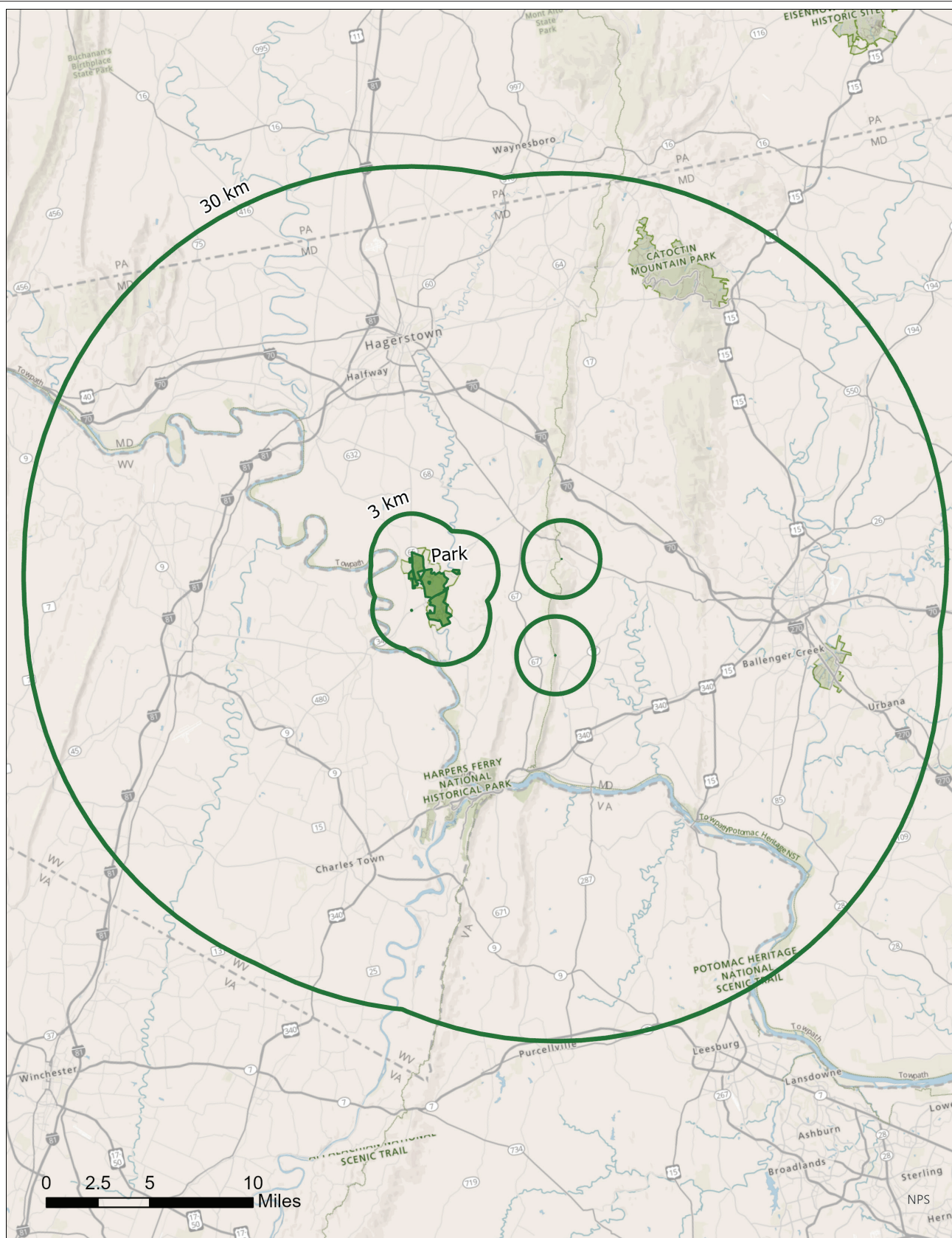


Figure 2. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating summary land cover statistics for Antietam National Battlefield (ANTI). Basemap is NPS Park Tiles Standard.

Areas of Analysis

As part of the I&M Program’s Environmental Settings Protocol, AOAs have been identified for each park for which landscape dynamics statistics are to be calculated (Kinseth and Nelson 2022). These include a combination of watersheds, areas defined by park boundaries, and in some cases custom AOAs within or near parks. Land cover statistics were calculated for eleven AOAs relevant to ANTI ([Table 2](#)).

Source Land Cover Data

National Land Cover Database

NLCD data covers CONUS at a pixel resolution of 30m with up to 20 land cover classes based on the modified Anderson Level 2 classification system (Jin et al. 2019). These data are produced every two to five years through the Multi-Resolution Land Characteristics Consortium (MRLC) coordinated by the United States Geological Survey (USGS) in the Department of the Interior ([Table 3](#); MRLC 2019).

Land Change Monitoring, Assessment, and Projection

LCMAP data covers CONUS at a pixel resolution of 30m with up to eight land cover classes referred to as Primary Land Cover (LCPRI), which is cited as being similar to Anderson Level 1 (USGS 2022). For the remainder of this report, the LCMAP product will be referred to as Level 1 classification. Datasets for LCMAP are produced annually by the USGS Earth Resources Observation and Science (EROS) Center ([Table 3](#); EROS 2022).

Table 2. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Antietam National Battlefield. [Boundary Type: Indicator of the type of AOA, whether the park itself, a watershed, or an AOA calculated from the boundary or the park. AOA Code: Four letter park code accompanied by a unique AOA identifier code. Description: Definition and description of the AOA and the area it covers.]

Boundary Type	AOA Code	Description
Boundary	ANTI_Park	Area of Analysis within the boundary of Antietam National Battlefield.
Boundary Based Area of Interest	ANTI_3km	Area of Analysis within a three-kilometer buffer of Antietam National Battlefield, originating from the center point of the park.
Boundary Based Area of Interest	ANTI_30km	Area of Analysis within a 30-kilometer buffer of Antietam National Battlefield, originating from the center point of the park.
Boundary Based Area of Interest	ANTI_3km_Donut	Donut Area of Analysis capturing the area between Antietam National Battlefield boundary and the three-kilometer buffer boundary.
Boundary Based Area of Interest	ANTI_30km_Donut	Donut Area of Analysis capturing the area between Antietam National Battlefield boundary and the 30-kilometer buffer boundary.
Watershed	ANTI_020700080102	Middle Catocin Creek watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.
Watershed	ANTI_020700041008	Dog Creek-Little Antietam Creek watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.
Watershed	ANTI_020700041009	Sharmans Branch-Antietam Creek watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.
Watershed	ANTI_020700080103	Lower Catocin Creek watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.
Watershed	ANTI_020700080201	Israel Creek watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.
Watershed	ANTI_020700041106	Rattlesnake Run-Potomac River watershed Area of Analysis boundary found to be intersecting with Antietam National Battlefield.

Calculation of Land Cover Summary Statistics

Land cover summary statistics were calculated from source land cover rasters, using one or more AOAs to define the boundary for the statistics calculations. All source datasets must be downloaded and stored in the appropriate location before running the statistical calculations ([Table 4](#)).

The land cover summary statistics were calculated from a series of custom Python tools run in sequence. First, the source AOAs were aggregated into a single dataset. Then, source land cover rasters were processed, clipped to the maximum spatial extent of each AOA, and projected to the appropriate spatial reference. The clipped rasters were then reclassified as either Level 1 (LCMAP) or Level 2 (NLCD). Then, the area and percent area of each land cover class within the raster were calculated into an output table. From the output table, additional land cover classifications were derived, including Level 1 (LCMAP and NLCD), Level 2 (NLCD) and Natural versus Converted (all sources). A total of eight Level 1 LCMAP land cover metrics, nine Level 1 NLCD land cover metrics, 20 Level 2 NLCD land cover metrics, and two Natural versus Converted metrics were calculated for each AOA ([Appendix A](#); [Tables A1 - A4](#)).

Code Availability

A custom Python toolbox was used to execute the methods in the report (CREATE_IMD_LandcoverStatistics.pyt). ArcGIS Pro 2.9+ (including the Spatial Analyst extension) and Python 3.7+ are both required to access and run the processes referenced in this report. The custom Python toolbox can be accessed at <https://doi.org/10.57830/2300941>. The RMarkdown file needed to produce this report and data package can be accessed at <https://doi.org/10.57830/2300940>.

Table 3. Extent and availability of source raster datasets for land cover statistics calculations from the Land Change Monitoring, Assessment, and Projection (LCMAP) & National Land Cover Database (NLCD) sources.

Source	Geographic Extent	Period of Record
LCMAP	CONUS	1985 - 2021 (annual)
NLCD	CONUS	2001 - 2021 (dates vary)

Table 4. Required locations of land cover summary statistics raster and areas of analysis source datasets.

Source Dataset	Save Location
Area(s) of Analysis	\\data\\raw\\AOAs\\<source folder>
Land Cover Raster(s)	\\data\\raw\\source

Data Summary

[Tables 5 - 7](#) show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3km, and 30km AOAs. Using Level 1 land cover data from LCMAP rasters, [Figures 3 - 5](#) depict the percent area of each land cover class and how it has changed over time.

Table 5. Percent area Change over time by Class 1 land cover classes within the park boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	3.19	3.17	-0.02
Cropland	82.40	82.46	0.06
Grass Shrub	0.22	0.15	-0.07
Tree Cover	13.20	13.33	0.13
Water	0.31	0.31	0.00
Wetlands	0.58	0.58	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.09	0.00	-0.09

Table 6. Percent area Change over time by Class 1 land cover classes within the three-kilometer buffer boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	3.27	3.83	0.56
Cropland	55.40	55.15	-0.25
Grass Shrub	0.47	0.29	-0.18
Tree Cover	38.07	38.00	-0.07
Water	1.67	1.67	0.00
Wetlands	1.02	1.02	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.10	0.04	-0.07

Table 7. Percent area Change over time by Class 1 land cover classes within the 30-kilometer buffer boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	8.95	11.90	2.95
Cropland	53.91	51.95	-1.96
Grass Shrub	0.45	0.41	-0.04
Tree Cover	34.00	32.85	-1.15
Water	1.28	1.28	0.01
Wetlands	1.08	1.08	-0.01
Ice/Snow	0.00	0.00	0.00
Barren	0.34	0.54	0.20

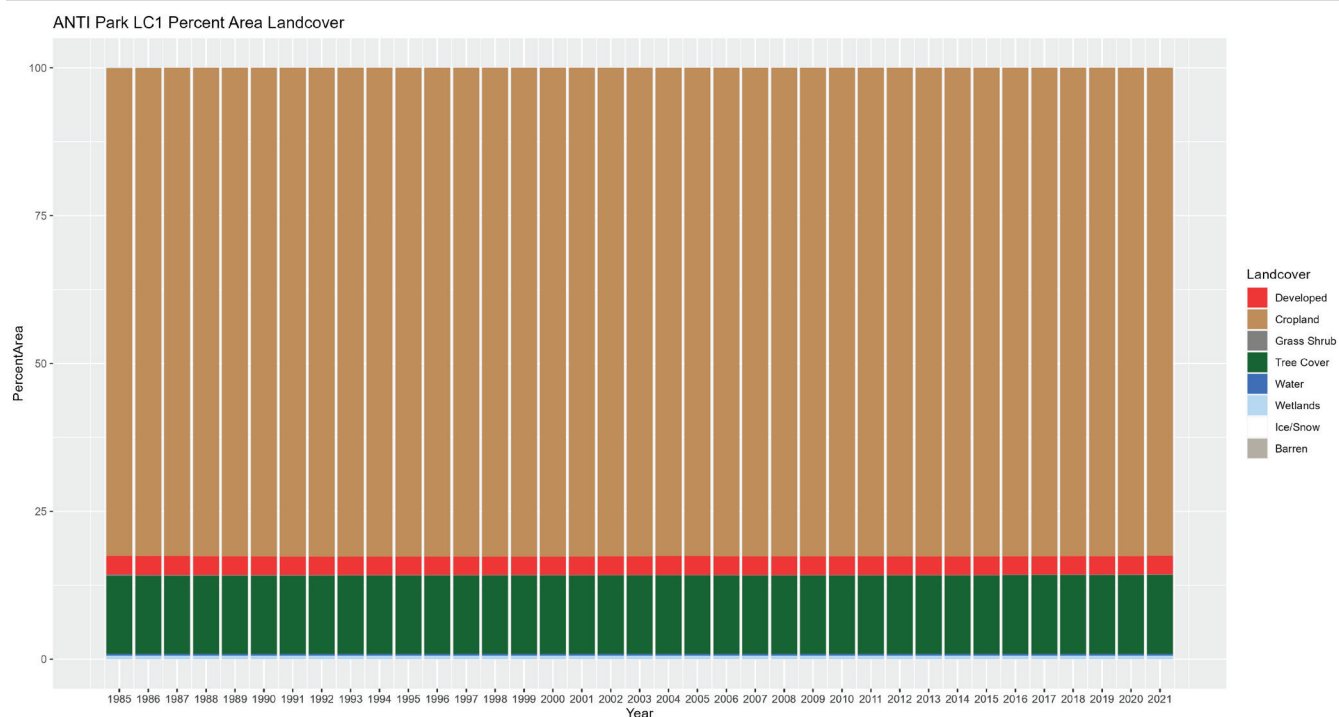


Figure 3. Annual percent area coverage for Class 1 land cover classes within boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Protection (LCMAP) Program for years 1985 - 2021.

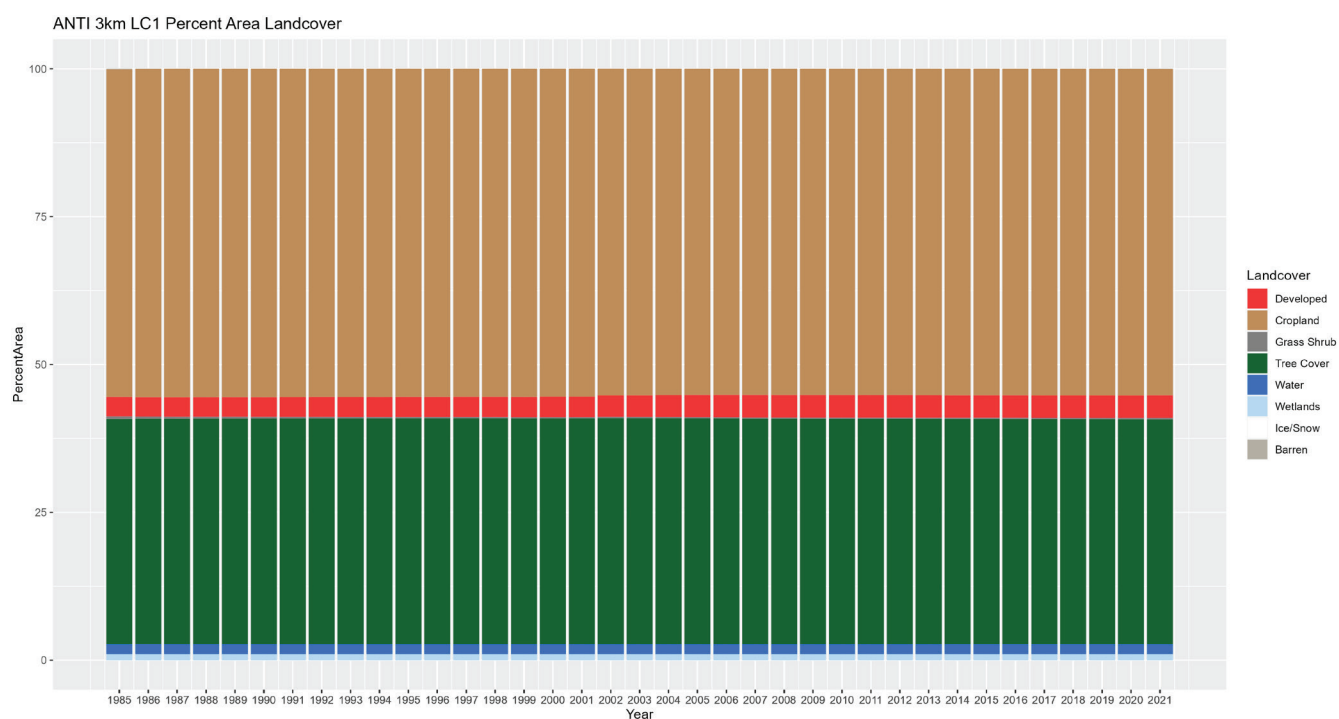


Figure 4. Annual percent area coverage for Class 1 land cover classes within the 3km buffer boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Protection (LCMAP) Program for years 1985 - 2021.

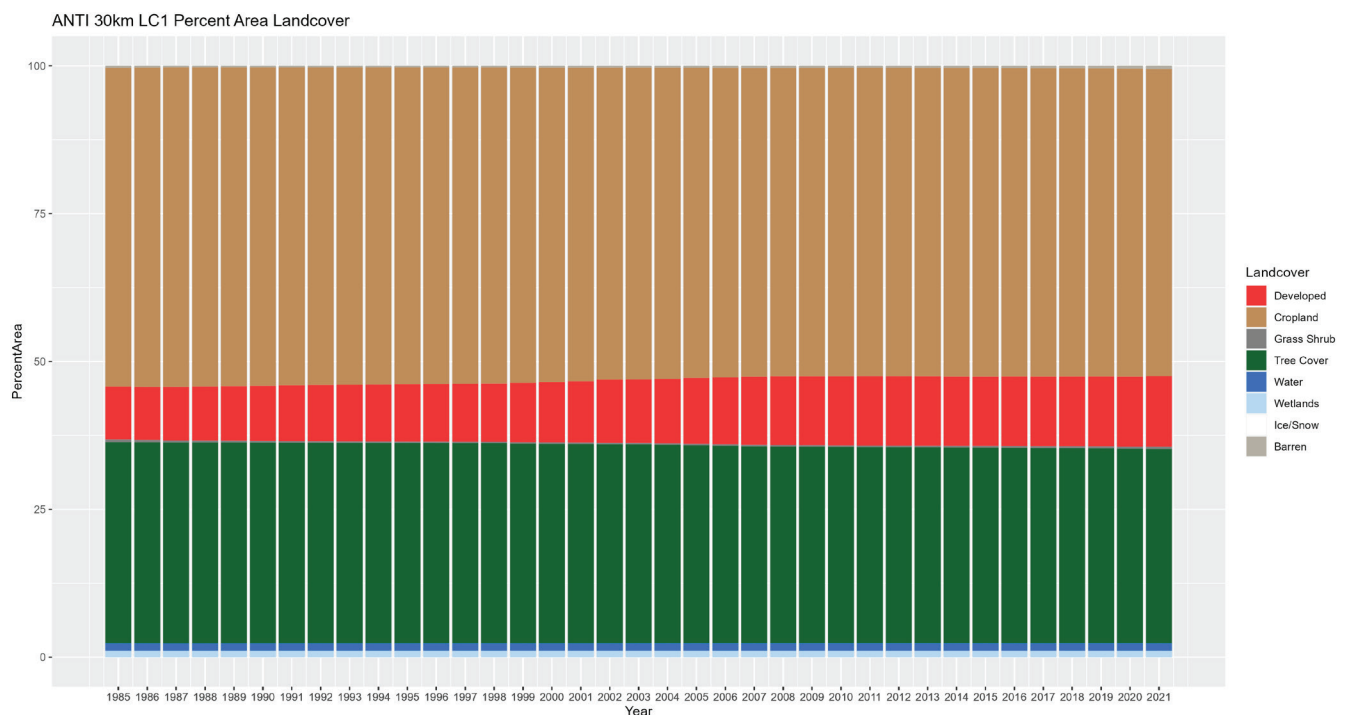


Figure 5. Annual percent area coverage for Class 1 land cover classes within the 30km buffer boundary of Antietam National Battlefield (ANTI) based on data from the Land Change Monitoring, Assessment, and Protection (LCMAP) Program for years 1985 - 2021.

References

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Appendix A. Reclassification Tables

Table A1. Table with reclassification values for NLCD Anderson level 1 classifications. Reclassified values were used for land cover summary statistics calculations.

NLCD Land Cover Level 1 Class (Value)	NLCD Land Cover Level 1 Reclassification (Value)
Open Water (11)	Open Water (1)
Perennial Ice/Snow (12)	Perennial Ice/Snow (6)
Developed (21)	Developed (2)
Developed (22)	Developed (2)
Developed (23)	Developed (2)
Developed (24)	Developed (2)
Barren/Quarries/Transitional (31)	Barren/Quarries/Transitional (3)
Forest (41)	Forest (4)
Forest (42)	Forest (4)
Forest (43)	Forest (4)
Scrub/Shrub (52)	Scrub/Shrub (5)
Grassland/Herbaceous (71)	Grassland/Herbaceous (7)
Agriculture (81)	Agriculture (8)
Agriculture (82)	Agriculture (8)
Wetlands (90)	Wetlands (9)
Wetlands (95)	Wetlands (9)
Scrub/Shrub (51)	Scrub/Shrub (5)
Grassland/Herbaceous (72)	Grassland/Herbaceous (7)
Grassland/Herbaceous (73)	Grassland/Herbaceous (7)
Grassland/Herbaceous (74)	Grassland/Herbaceous (7)

Table A2. Table with reclassification values for NLCD Anderson level 2 classifications. Reclassified values were used for land cover summary statistics calculations.

NLCD Land Cover Level 2 Class (Value)	NLCD Land Cover Level 2 Reclassification (value)
Woody Wetlands (90)	Woody Wetlands (90)
Shrub/Scrub (52)	Shrub/Scrub (52)
Perennial Ice/Snow (12)	Perennial Ice/Snow (12)
Open Water (11)	Open Water (11)
Mixed Forest (43)	Mixed Forest (43)
Herbaceous (71)	Herbaceous (71)
Hay/Pasture (81)	Hay/Pasture (81)
Evergreen Forest (42)	Evergreen Forest (42)
Emergent Herbaceous Wetlands (95)	Emergent Herbaceous Wetlands (95)
Developed, Open Space (21)	Developed, Open Space (21)
Developed, Medium Intensity (23)	Developed, Medium Intensity (23)
Developed, Low Intensity (22)	Developed, Low Intensity (22)
Developed, High Intensity (24)	Developed, High Intensity (24)
Deciduous Forest (41)	Deciduous Forest (41)
Cultivated Crops (82)	Cultivated Crops (82)
Barren Land (31)	Barren Land (31)
Dwarf Shrub (51)	Dwarf Shrub (51)
Sedge/Herbaceous (72)	Sedge/Herbaceous (72)
Lichens (73)	Lichens (73)
Moss (74)	Moss (74)

Table A3. Table with reclassification values for NLCD natural/converted classifications. Reclassified values were used for land cover summary statistics calculations.

NLCD Land Cover Level 1 Class (Value)	NLCD Land Cover Natural vs Converted Reclassification (value)
Open Water (11)	Natural (2)
Perennial Ice/Snow (12)	Natural (2)
Developed, Open Space (21)	Converted (1)
Developed, Low Intensity (22)	Converted (1)
Developed, Medium Intensity (23)	Converted (1)
Developed, High Intensity (24)	Converted (1)
Barren/Quarries/Transitional (31)	Natural (2)
Deciduous Forest (41)	Natural (2)
Evergreen Forest (42)	Natural (2)
Mixed Forest (43)	Natural (2)
Scrub/Shrub (52)	Natural (2)
Grassland/Herbaceous (71)	Natural (2)
Pasture/Hay (81)	Converted (1)
Cultivated Crops (82)	Converted (1)
Woody Wetlands (90)	Natural (2)
Emergent Herbaceous Wetlands (95)	Natural (2)
Dwarf Scrub (51)	Natural (2)
Sedge/Herbaceous (72)	Natural (2)
Lichens (73)	Natural (2)
Moss (74)	Natural (2)

Table A4. Table with reclassification values for LCMAP natural/converted classifications. Reclassified values were used for land cover summary statistics calculations.

LCMAP Land Cover Level 1 Class (Value)	LCMAP Land Cover Natural vs Converted Reclassification (Value)
Developed (1)	Converted (1)
Cropland (2)	Converted (1)
Grass/Shrub (3)	Natural (2)
Tree Cover (4)	Natural (2)
Water (5)	Natural (2)
Wetlands (6)	Natural (2)
Ice/Snow (7)	Natural (2)
Barren (8)	Natural (2)