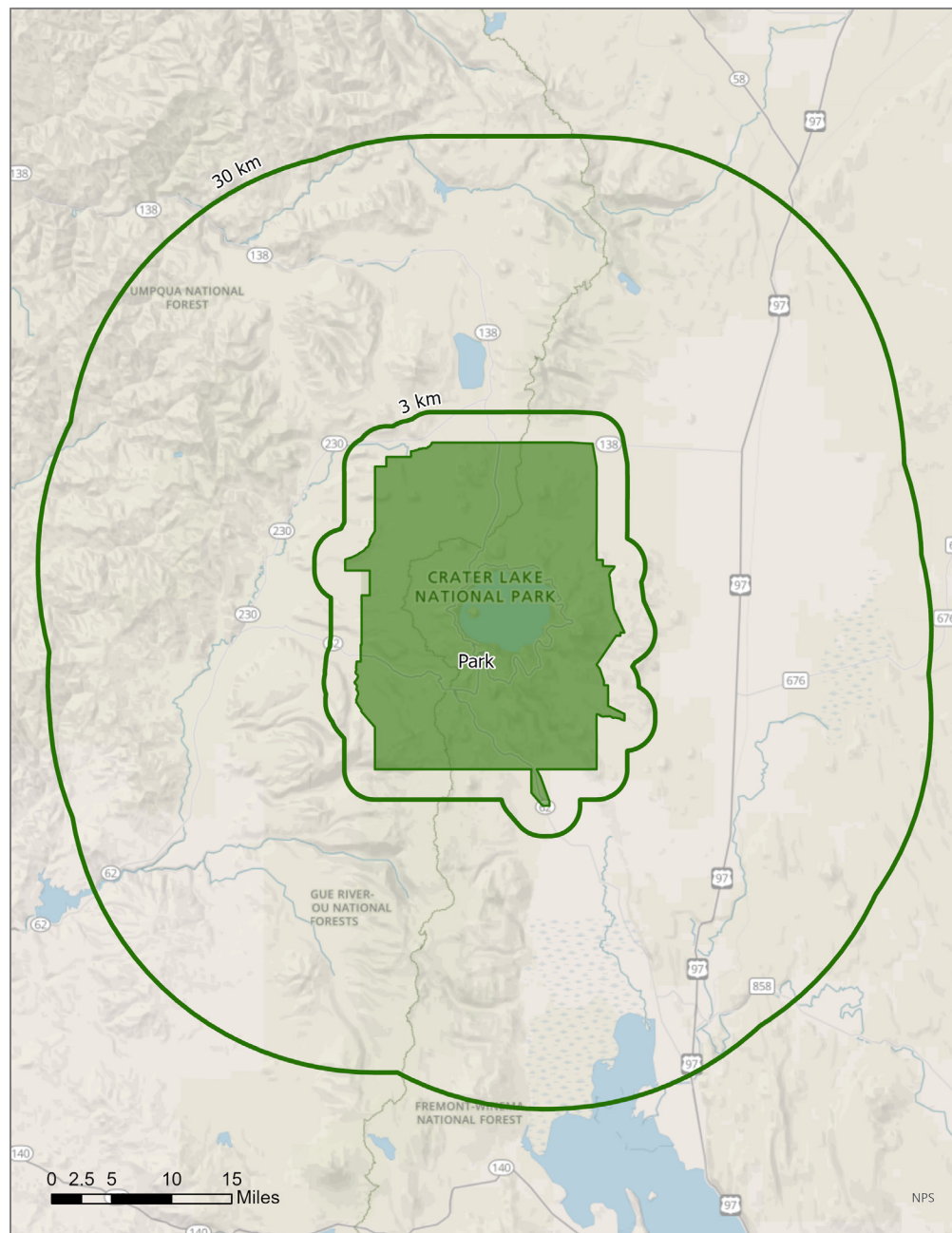




Land Cover Summary Statistics for Klamath Network Park Units



Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Crater Lake National Park (CRLA).

Land cover summary statistics for Klamath Network park units

Science Report NPS/SR—2024/181

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Please cite this publication as:

Cleary, S. 2024. Land cover summary statistics for the Klamath Network park units. Science Report NPS/SR—2024/181. National Park Service, Fort Collins, Colorado.

<https://doi.org/10.36967/2303211>

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Abstract

This report documents the acquisition of source data, and calculation of land cover summary statistics datasets for six National Park Service Klamath Network park units: Crater Lake National Park, Lassen Volcanic National Park, Lava Beds National Monument, Oregon Caves National Monument and Preserve, Redwood National and State Parks, and Whiskeytown National Recreation Area, and the seven custom areas of analysis. The source data and land cover calculations are available for use within the National Park Service (NPS) Inventory and Monitoring 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 the 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 the six Klamath Network park units and seven custom areas of analysis utilize the most recent versions of the source datasets (NLCD and LCMAP). These land cover summary statistics datasets are used in the NPS Inventory and Monitoring 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. Last, 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 (NOAA OCM).

Not all raster dataset sources are applicable for all NPS geographic regions. Only land cover sources applicable to Klamath Network park units are referenced in this report.

This report represents a summary of land cover statistics and is non-interpretive in nature. While this report compares data between time periods, comparisons do not provide any indications of significance or reasons behind why differences may be seen.

Data Records

One .csv file was created containing land cover summary statistics for Klamath Network park units and custom AOAs. The .csv file in this database represents 112 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).

1. LandcoverStatistics_Output_Dataset.csv (9.9 MB) is a tabular dataset representing land cover summary statistics for all AOAs utilizing NLCD and LCMAP raster data included in the source dataset.

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 *Land Cover Summary Statistics Data Package for Klamath Network Park Units* is suitable for its intended use as of the date of processing (2024-06-27).

Usage Notes

This data package is available for download from the NPS DataStore at <https://doi.org/10.57830/2303212>.

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(2303212)
data <- load_data_package(2303212)
list2env(dat, envir=.GlobalEnv)
```

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

Methods

This report documents the methods used to calculate land cover summary statistics datasets for AOAs pertinent to Klamath Network park units 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 from NLCD and LCMAP source raster datasets for available Klamath Network park units' AOAs (see Code Availability section for details). 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.

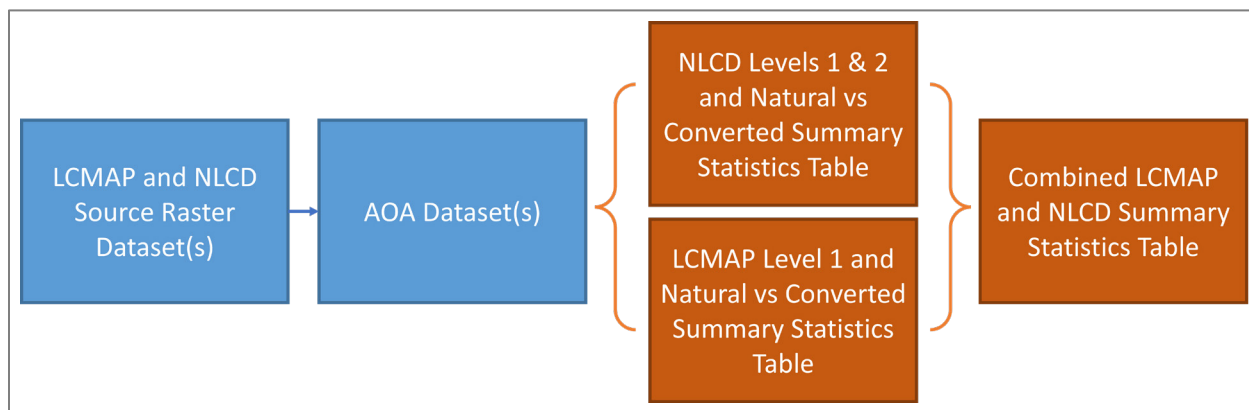


Figure 1. Generalized process flow for land cover summary statistics calculations. Orange boxes indicate datasets documented by this report.

Study Area

The six park units and seven custom AOAs analyzed are located within the Klamath Network, spanning across southern Oregon and northern California.

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 112 AOAs pertinent to Crater Lake National Park (CRLA), Lassen Volcanic National Park (LAVO), Lava Beds National Monument (LABE), Oregon Caves National Monument and Preserve (ORCA), Redwood National and State Parks (REDW), and Whiskeytown National Recreation Area (WHIS).

Statistics are presented in this report for standard AOAs (park, 3 km, and 30 km buffer AOAs). Statistics have additionally been calculated for seven Custom AOAs pertinent to Klamath Network

(see Appendix A). While the statistics for Custom AOAs are not presented in this report, they are included in the output dataset.

Source Land Cover Data

National Land Cover Database

NLCD data cover CONUS at a pixel resolution of 30 m 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 1; MRLC 2019).

Land Change Monitoring, Assessment, and Projection

LCMAP data cover CONUS at a pixel resolution of 30 m 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 1; EROS 2022).

Table 1. 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).

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

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 2).

Table 2. 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

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 (Tables 4–7 in Appendix B). Summaries of data for each park are presented in Appendices C through H.

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/10.57830/2301786>.

Literature Cited

- DeVivo, J. C., L. Nelson, M. Kineth, T. Philippi, and W. B. Monahan. 2018. Protocol for monitoring environmental setting of National Park Service units: landscape dynamics, climate, and hydrology. Natural Resource Report NPS/IMD/NRR—2018/1844. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2258457>
- Earth Resources Observation and Science Center (EROS). 2022. LCMAP product mosaic downloads. Available at <https://eros.usgs.gov/lcmap/apps/data-downloads> (accessed 01 March 2023).
- Environmental Systems Research Institute (ESRI). 2022a. Geographic coordinate systems. Available at <https://developers.arcgis.com/rest/services-reference/geographic-coordinate-systems.htm>
- Environmental Systems Research Institute (ESRI). 2022b. Projected coordinate systems. Available at <https://developers.arcgis.com/rest/services-reference/projected-coordinate-systems.htm>
- Jin, S., C. G. Homer, L. Yang, P. Danielson, J. Dewitz, C. Li, Z. Zhu, G. Xian, and D. Howard. 2019. Overall methodology design for the United States National Land Cover Database 2016 products. Remote Sensing, 11(24). <https://doi.org/10.3390/rs11242971>
- Kineth, M., and L. Nelson. 2022. Boundary-derived areas of analysis for National Park Service units, Fall 2021. NPS/NRSS/DRR—2022/3. <https://doi.org/10.36967/2287628>
- Multi-Resolution Land Characteristics Consortium (MRLC). 2019. National Land Cover Database website. Available at <https://www.mrlc.gov/data> (accessed 1 March 2023).
- NPS Natural Resource Inventory and Monitoring Division (NPS-IMD). 2022. NPS Unit Boundary-derived Areas of Analysis, Fall 2021. <https://doi.org/10.57830/2287631>
- United States Geological Survey (USGS). 2022. Land change monitoring, assessment, and projection (LCMAP) collection 1.3 science products for the conterminous United States: USGS data release. <https://doi.org/10.5066/P9C46NG0>

Appendix A. Custom Areas of Analysis

Table 3 lists the Custom Areas of Analysis pertinent to Klamath Network. Custom AOA summary statistics are included in the output dataset.

Table 3. Custom Area(s) of Analysis (AOAs) pertinent to the Klamath Network used to calculate land cover summary statistics. [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.]

AOA Code	Description
KLMN_WHIS_Custom	Custom Area of Analysis covering Whiskeytown National Recreation Area.
KLMN_REDW_Custom	Custom Area of Analysis covering Redwood National and State Parks.
KLMN_ORCA_Custom	Custom Area of Analysis covering Oregon Caves National Monument and Preserve.
KLMN_LAVO_Custom	Custom Area of Analysis covering Lassen Volcanic National Park.
KLMN_LABE_JackFire_Custom	Custom Area of Analysis covering a subset of Lava Beds National Monument.
KLMN_LABE_Custom	Custom Area of Analysis covering Lava Beds National Monument.
KLMN_CRLA_Custom	Custom Area of Analysis covering Crater Lake National Park.

Appendix B. Reclassification Tables

Tables 4–7 show the reclassification values used in this study.

Table 4. 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 5. 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)

Table 5 (continued). 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)
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 6. 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)

Table 6 (continued). 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)
Dwarf Scrub (51)	Natural (2)
Sedge/Herbaceous (72)	Natural (2)
Lichens (73)	Natural (2)
Moss (74)	Natural (2)

Table 7. 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)

Appendix C. Crater Lake National Park

Crater Lake National Park (CRLA) is located in Oregon. Figure 2 shows the location of CRLA, along with the surrounding 3 km buffer and 30 km buffer AOAs.

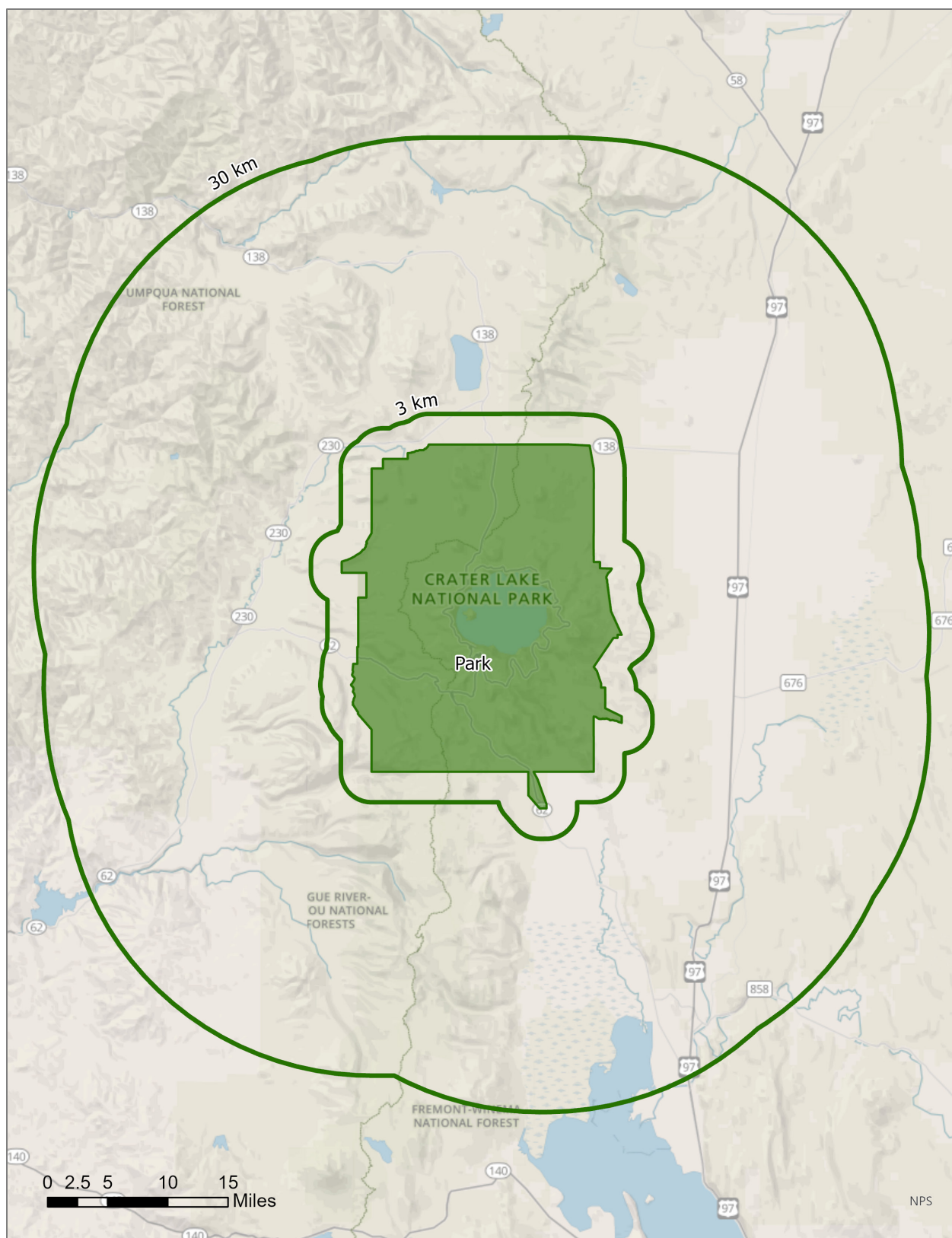


Figure 2. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Crater Lake National Park (CRLA). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for 26 AOAs relevant to CRLA (Table 8).

Table 8. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Crater Lake National Park (CRLA). [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	CRLA_Park	Area of Analysis within the boundary of Crater Lake National Park.
Boundary Based AOA	CRLA_3km	Area of Analysis within a three-kilometer buffer of Crater Lake National Park, originating from the boundary of the park.
	CRLA_30km	Area of Analysis within a 30-kilometer buffer of Crater Lake National Park, originating from the boundary of the park.
	CRLA_3km_Donut	Donut Area of Analysis capturing the area between Crater Lake National Park boundary and the three-kilometer buffer boundary.
	CRLA_30km_Donut	Donut Area of Analysis capturing the area between Crater Lake National Park boundary and the 30-kilometer buffer boundary.
Watershed	CRLA_180102010207	Tiny Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010301	Silent Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010302	Cow Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010501	Crater Lake watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010406	Scott Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010502	Sand Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102010505	Town of Fuego-Williamson River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.

Table 8 (continued). Area(s) of Analysis (AOAs) used to calculate land cover statistics for Crater Lake National Park (CRLA). [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
Watershed (continued)	CRLA_180102010602	Egan Spring-Williamson River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102030101	Upper Annie Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102030102	Lower Annie Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_180102030105	Crooked Creek-Wood River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070106	Bybee Creek-Rogue River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070104	Crater Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070105	Foster Creek-Rogue River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070108	Union Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070109	Castle Creek-Rogue River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070204	Red Blanket Creek watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070103	National Creek-Rogue River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.
	CRLA_171003070101	Minnehaha Creek-Rogue River watershed Area of Analysis boundary found to be intersecting with Crater Lake National Park.

Data Summary

Tables 9–11 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer 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 9. Percent area change over time by Level 1 land cover classes within the park boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.22	0.22	0.01
Cropland	0.00	0.00	0.00
Grass/Shrub	3.76	7.27	3.52
Tree Cover	85.26	76.97	-8.28
Water	7.19	7.17	-0.02
Wetlands	0.01	0.01	0.00
Ice/Snow	0.09	0.09	0.00
Barren	3.49	8.26	4.78

Table 10. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.26	0.26	0.00
Cropland	0.05	0.03	-0.01
Grass/Shrub	5.50	7.69	2.19
Tree Cover	87.11	80.92	-6.19
Water	4.69	4.68	-0.01
Wetlands	0.05	0.05	0.00
Ice/Snow	0.06	0.06	0.00
Barren	2.30	6.32	4.02

Table 11. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.43	0.39	-0.04
Cropland	3.27	3.09	-0.18
Grass/Shrub	11.74	10.67	-1.06
Tree Cover	78.33	78.47	0.14
Water	1.68	1.67	-0.01
Wetlands	3.91	3.92	0.01
Ice/Snow	0.03	0.03	0.00
Barren	0.62	1.76	1.14

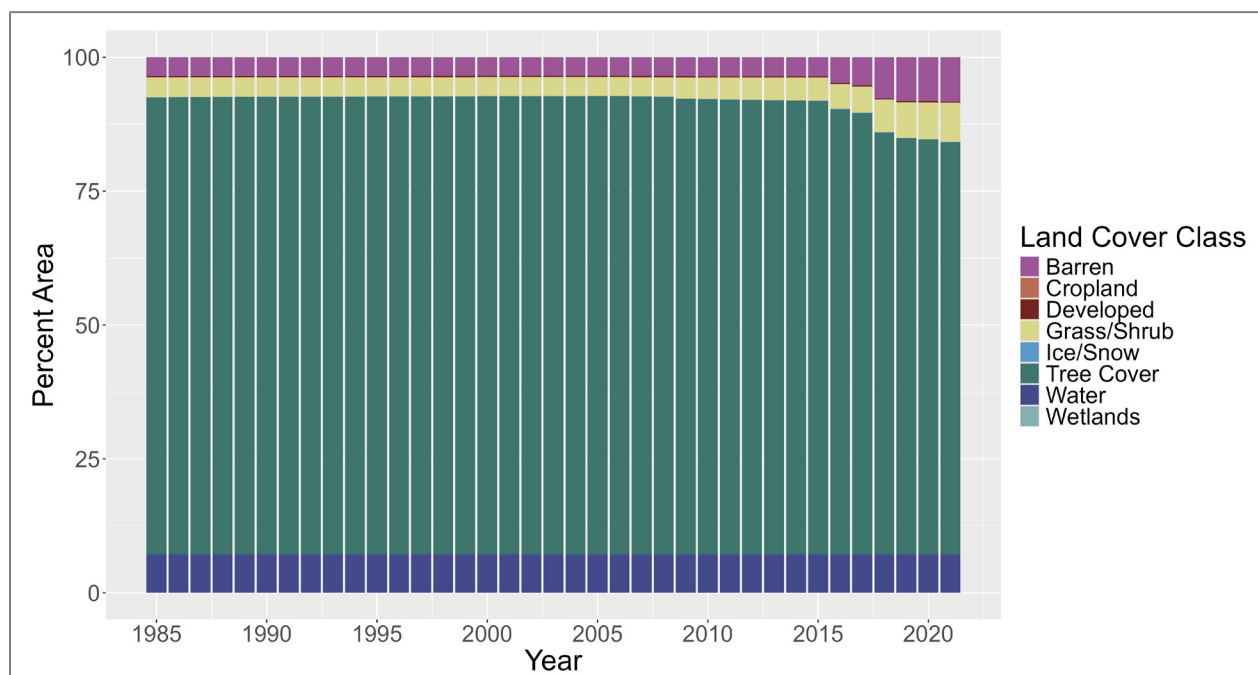


Figure 3. Annual percent area coverage for Level 1 land cover classes within the park boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

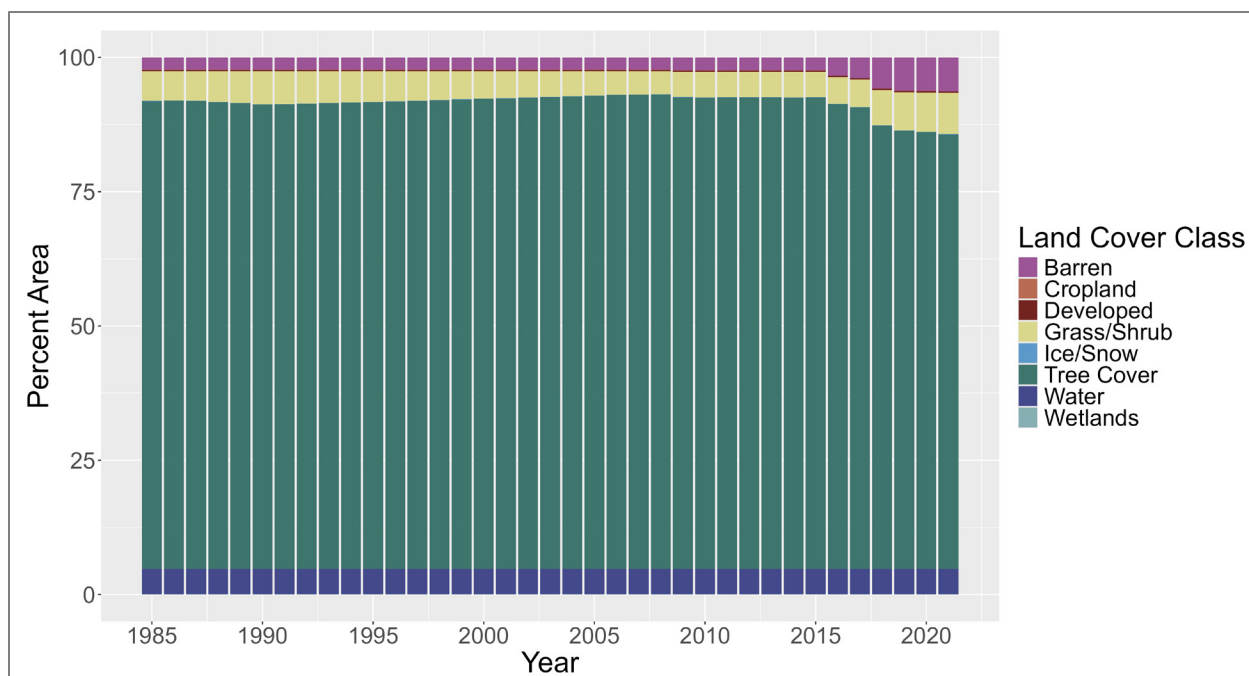


Figure 4. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

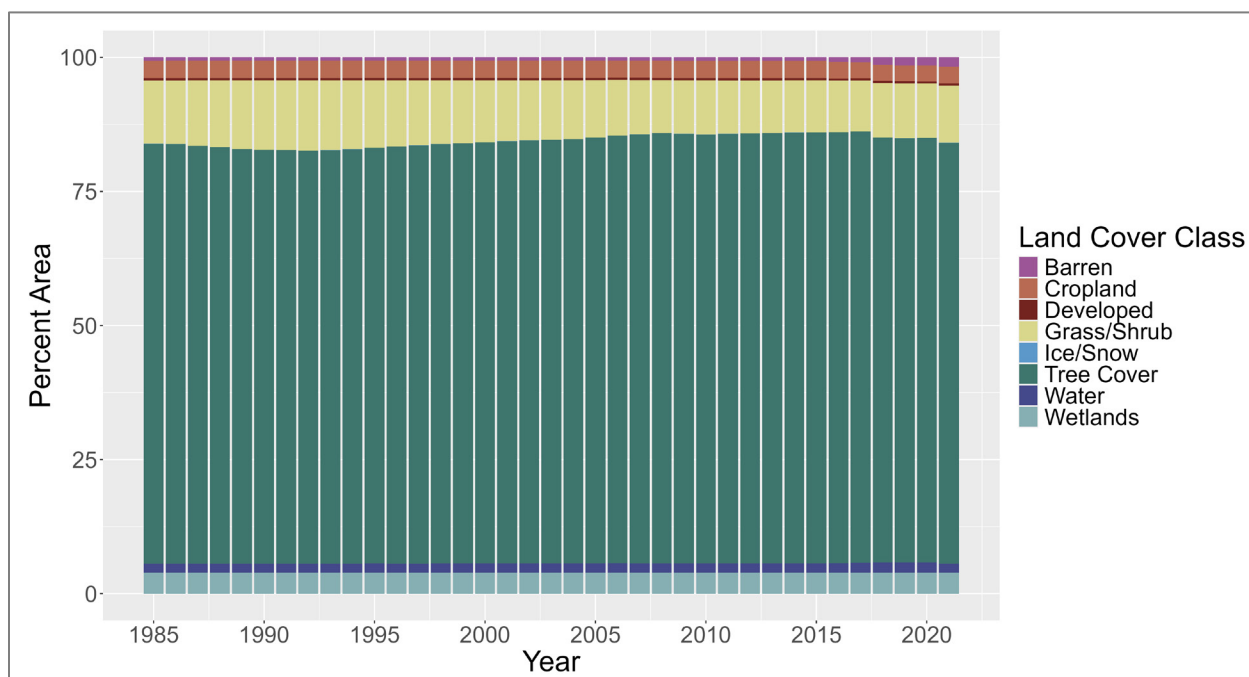


Figure 5. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Crater Lake National Park (CRLA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

Appendix D. Lassen Volcanic National Park

Lassen Volcanic National Park (LAVO) is located in California. Figure 6 shows the location of LAVO, along with the surrounding 3 km buffer and 30 km buffer AOAs.

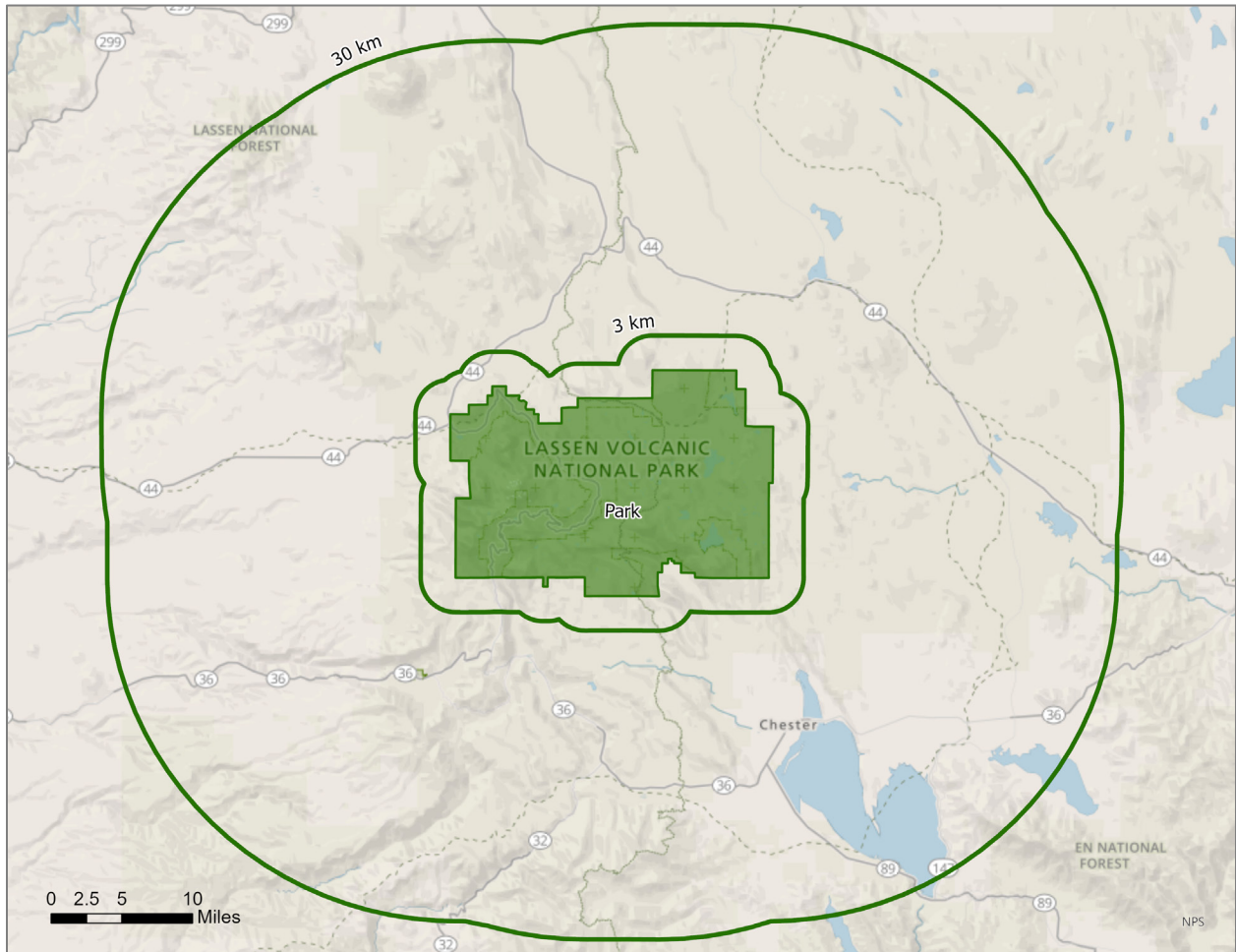


Figure 6. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Lassen Volcanic National Park (LAVO). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for 20 AOAs relevant to LAVO (Table 12).

Table 12. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Lassen Volcanic National Park (LAVO). [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	LAVO_Park	Area of Analysis within the boundary of Lassen Volcanic National Park.
Boundary Based AOA	LAVO_3km	Area of Analysis within a three-kilometer buffer of Lassen Volcanic National Park, originating from the boundary of the park.
	LAVO_30km	Area of Analysis within a 30-kilometer buffer of Lassen Volcanic National Park, originating from the boundary of the park.
	LAVO_3km_Donut	Donut Area of Analysis capturing the area between Lassen Volcanic National Park boundary and the three-kilometer buffer boundary.
	LAVO_30km_Donut	Donut Area of Analysis capturing the area between Lassen Volcanic National Park boundary and the 30-kilometer buffer boundary.
Watershed	LAVO_180201530104	Bailey Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201530105	Digger Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201530101	Deer Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201560301	Upper Mill Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201530202	Upper South Fork Battle Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201210101	Warner Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201210102	Willow Creek-North Fork Feather River watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180201210103	Louse Creek-North Fork Feather River watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.

Table 12 (continued). Area(s) of Analysis (AOAs) used to calculate land cover statistics for Lassen Volcanic National Park (LAVO). [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
Watershed (continued)	LAVO_180201210401	Benner Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180200030706	Box Canyon-Hat Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180800030101	Headwaters Pine Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180200030601	Snag Lake watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180200030604	Upper Butte Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180200030702	Lost Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.
	LAVO_180200030703	Headwaters Hat Creek watershed Area of Analysis boundary found to be intersecting with Lassen Volcanic National Park.

Data Summary

Tables 13–15 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer AOAs. Using Level 1 land cover data from LCMAP rasters, Figures 7–9 depict the percent area of each land cover class and how it has changed over time.

Table 13. Percent area change over time by Level 1 land cover classes within the park boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.11	0.11	0.00
Cropland	0.00	0.00	0.00
Grass/Shrub	13.21	25.64	12.42
Tree Cover	78.57	66.16	-12.40
Water	1.65	1.57	-0.08
Wetlands	0.24	0.22	-0.02
Ice/Snow	0.12	0.12	0.00
Barren	6.10	6.17	0.07

Table 14. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.12	0.11	-0.01
Cropland	0.00	0.00	0.00
Grass/Shrub	10.35	18.43	8.07
Tree Cover	83.89	75.85	-8.04
Water	1.05	1.00	-0.05
Wetlands	0.31	0.30	-0.01
Ice/Snow	0.07	0.07	0.00
Barren	4.21	4.24	0.04

Table 15. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.43	0.38	-0.05
Cropland	0.25	0.25	0.00
Grass/Shrub	14.48	23.77	9.28
Tree Cover	80.63	71.50	-9.13
Water	2.02	1.96	-0.06
Wetlands	1.00	0.83	-0.17
Ice/Snow	0.01	0.01	0.00
Barren	1.18	1.31	0.13

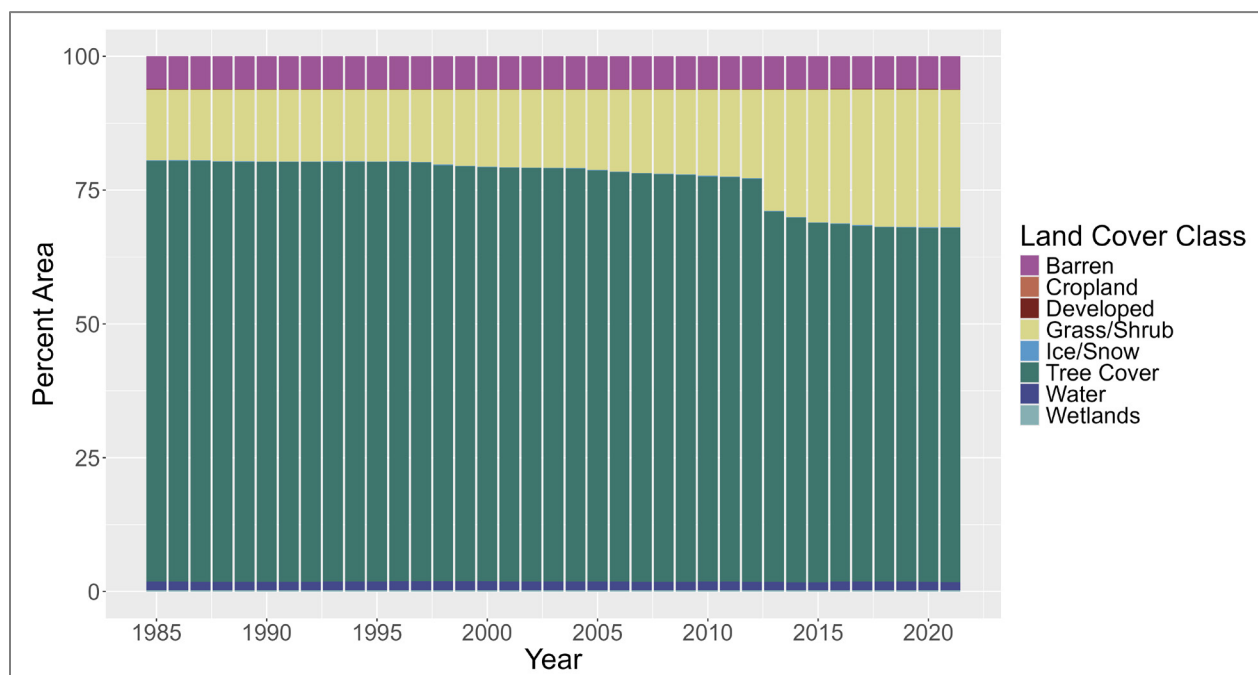


Figure 7. Annual percent area coverage for Level 1 land cover classes within the park boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

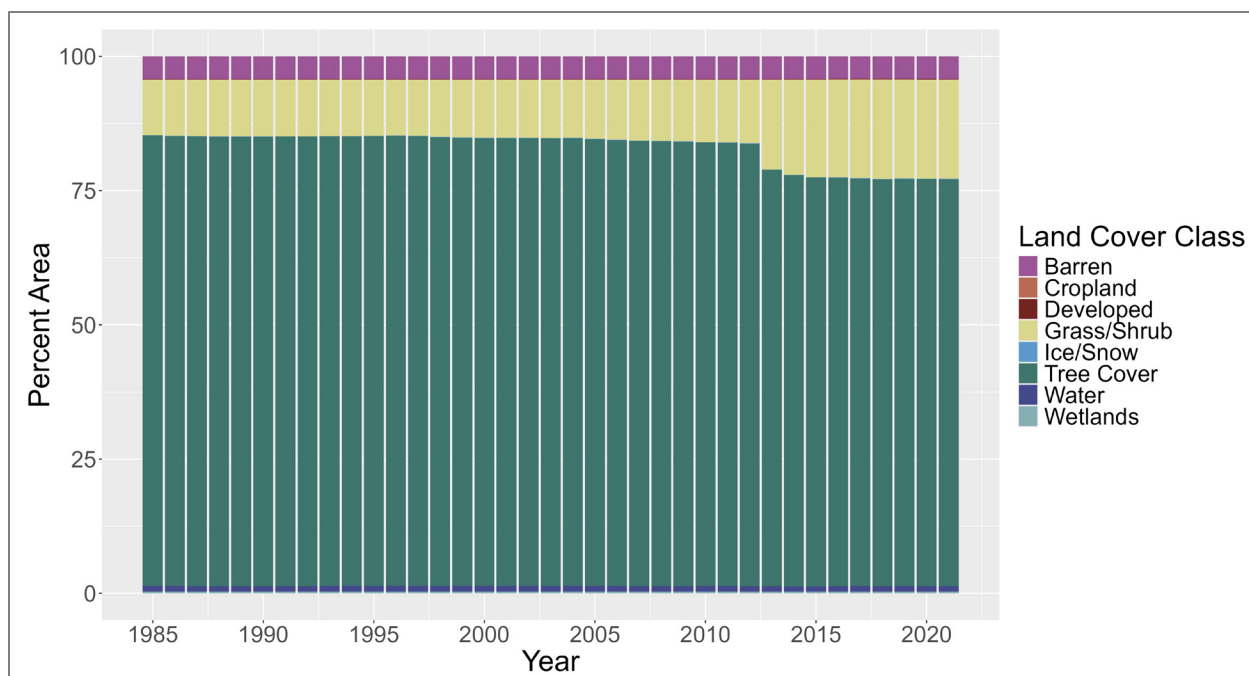


Figure 8. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

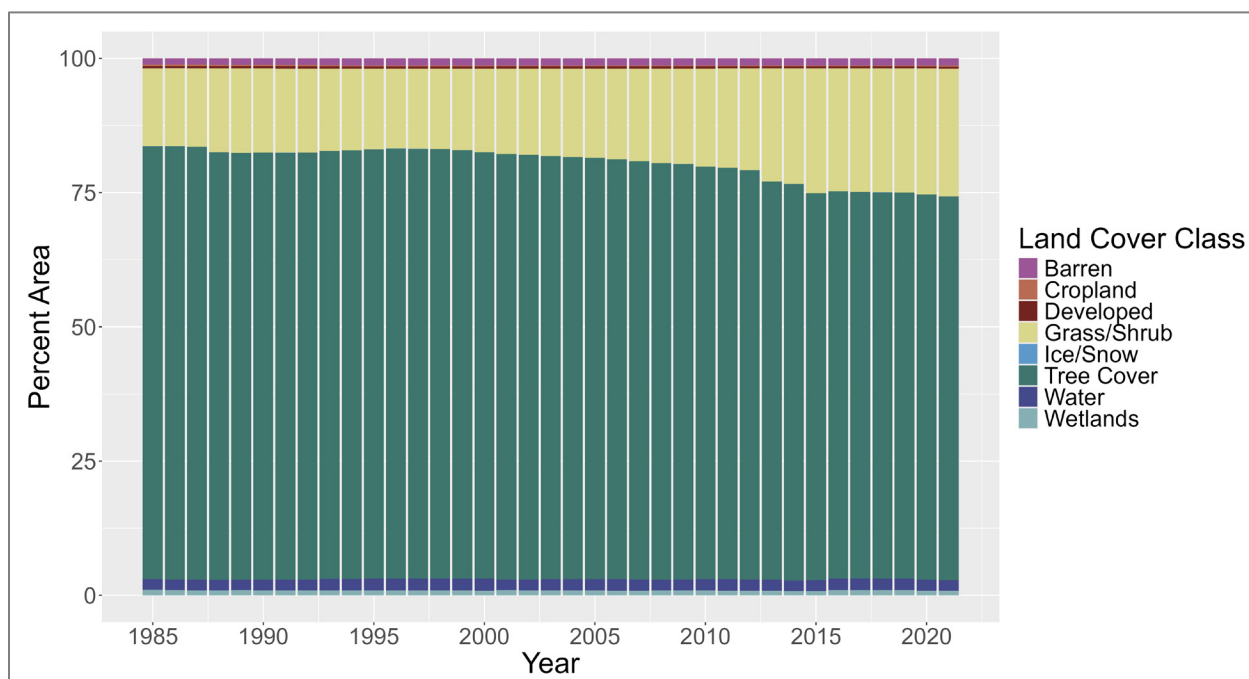


Figure 9. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Lassen Volcanic National Park (LAVO) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

Appendix E. Lava Beds National Monument

Lava Beds National Monument (LBE) is located in California. Figure 10 shows the location of LBE, along with the surrounding 3 km buffer and 30 km buffer AOAs.

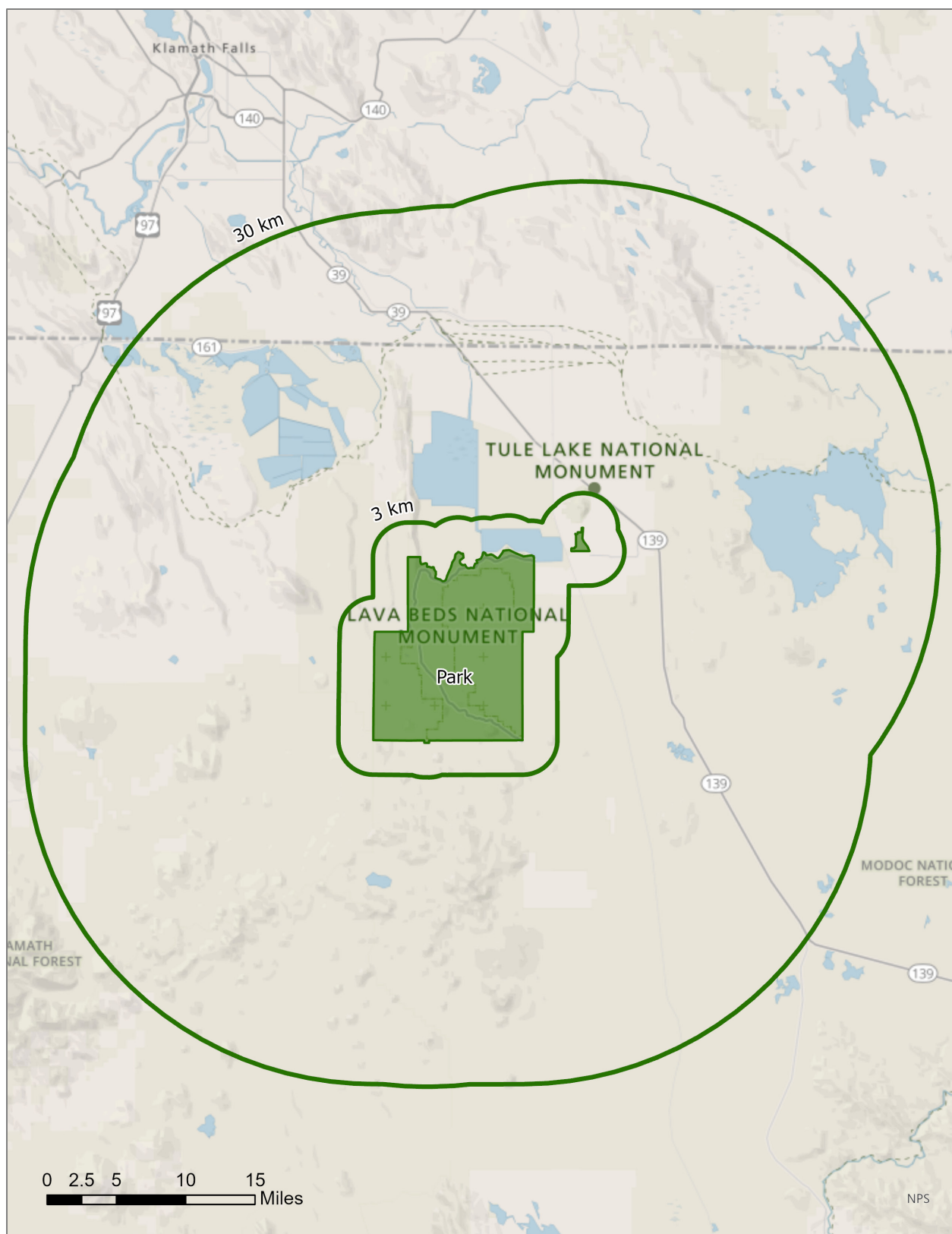


Figure 10. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Lava Beds National Monument (LBE). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for 11 AOAs relevant to LABE (Table 16).

Table 16. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Lava Beds National Monument (LABE). [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	LABE_Park	Area of Analysis within the boundary of Lava Beds National Monument.
Boundary Based AOA	LABE_3km	Area of Analysis within a three-kilometer buffer of Lava Beds National Monument, originating from the boundary of the park.
	LABE_30km	Area of Analysis within a 30-kilometer buffer of Lava Beds National Monument, originating from the boundary of the park.
	LABE_3km_Donut	Donut Area of Analysis capturing the area between Lava Beds National Monument boundary and the three-kilometer buffer boundary.
	LABE_30km_Donut	Donut Area of Analysis capturing the area between Lava Beds National Monument boundary and the 30-kilometer buffer boundary.
Watershed	LABE_180102041401	Sheep Camp Butte watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.
	LABE_180102041001	The Panhandle watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.
	LABE_180102041002	The Frog Pond-Tule Lake watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.
	LABE_180102041003	Robinson Flat-Tule Lake watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.
	LABE_180102041109	Copic Bay watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.
	LABE_180102041402	Town of Laird Landing watershed Area of Analysis boundary found to be intersecting with Lava Beds National Monument.

Data Summary

Tables 17–19 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer AOAs. Using Level 1 land cover data from LCMAP rasters, Figures 11–13 depict the percent area of each land cover class and how it has changed over time.

Table 17. Percent area change over time by Level 1 land cover classes within the park boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.35	0.19	-0.16
Cropland	0.36	0.28	-0.08
Grass/Shrub	75.01	77.05	2.05
Tree Cover	8.01	5.57	-2.43
Water	0.01	0.01	0.00
Wetlands	0.00	0.00	0.00
Ice/Snow	0.00	0.00	0.00
Barren	16.26	16.89	0.63

Table 18. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.62	0.48	-0.14
Cropland	14.28	15.58	1.30
Grass/Shrub	58.09	63.01	4.92
Tree Cover	12.57	7.56	-5.01
Water	3.27	1.55	-1.72
Wetlands	0.00	0.14	0.14
Ice/Snow	0.00	0.00	0.00
Barren	11.17	11.68	0.50

Table 19. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.80	0.65	-0.15
Cropland	16.57	16.28	-0.29
Grass/Shrub	45.53	46.66	1.13
Tree Cover	29.87	30.04	0.16
Water	3.43	2.07	-1.35
Wetlands	1.15	1.38	0.22
Ice/Snow	0.00	0.00	0.00
Barren	2.65	2.93	0.28

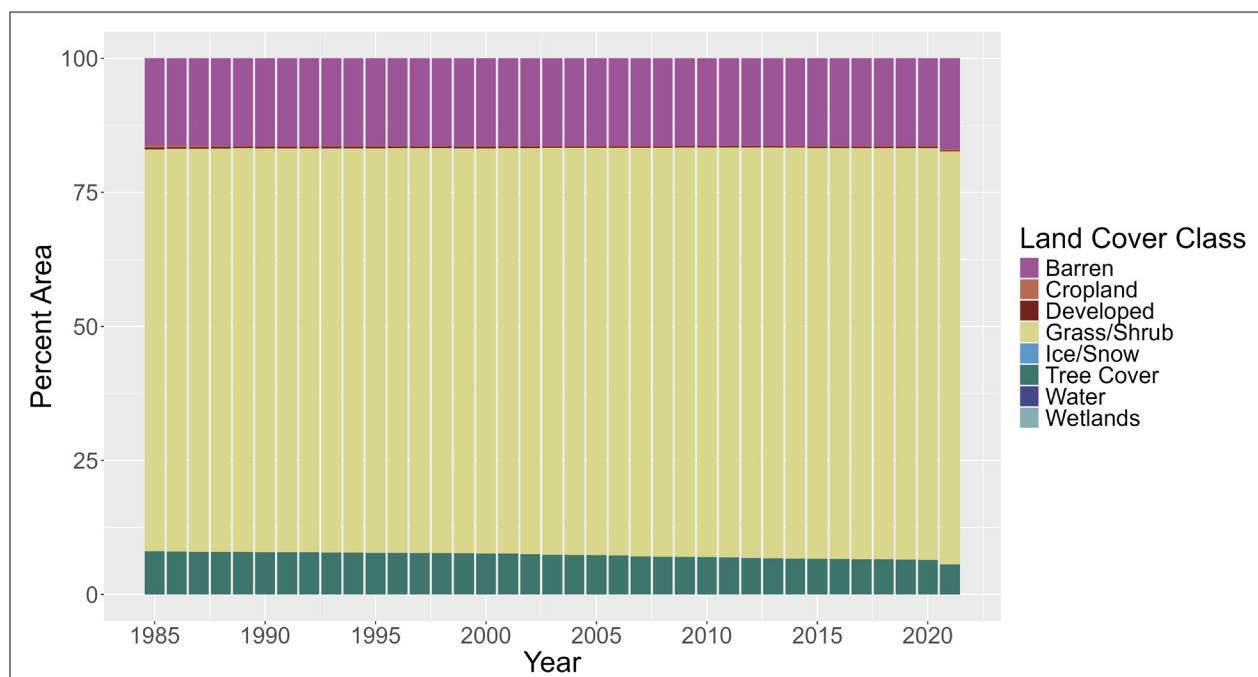


Figure 11. Annual percent area coverage for Level 1 land cover classes within the park boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

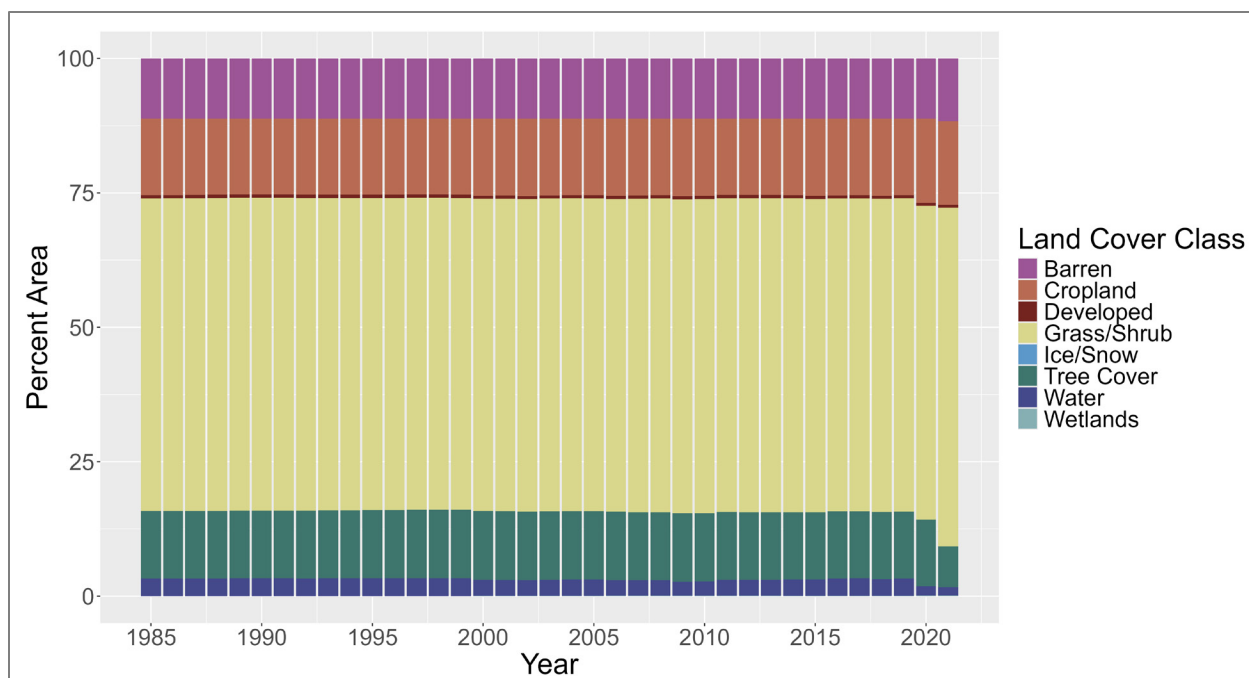


Figure 12. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

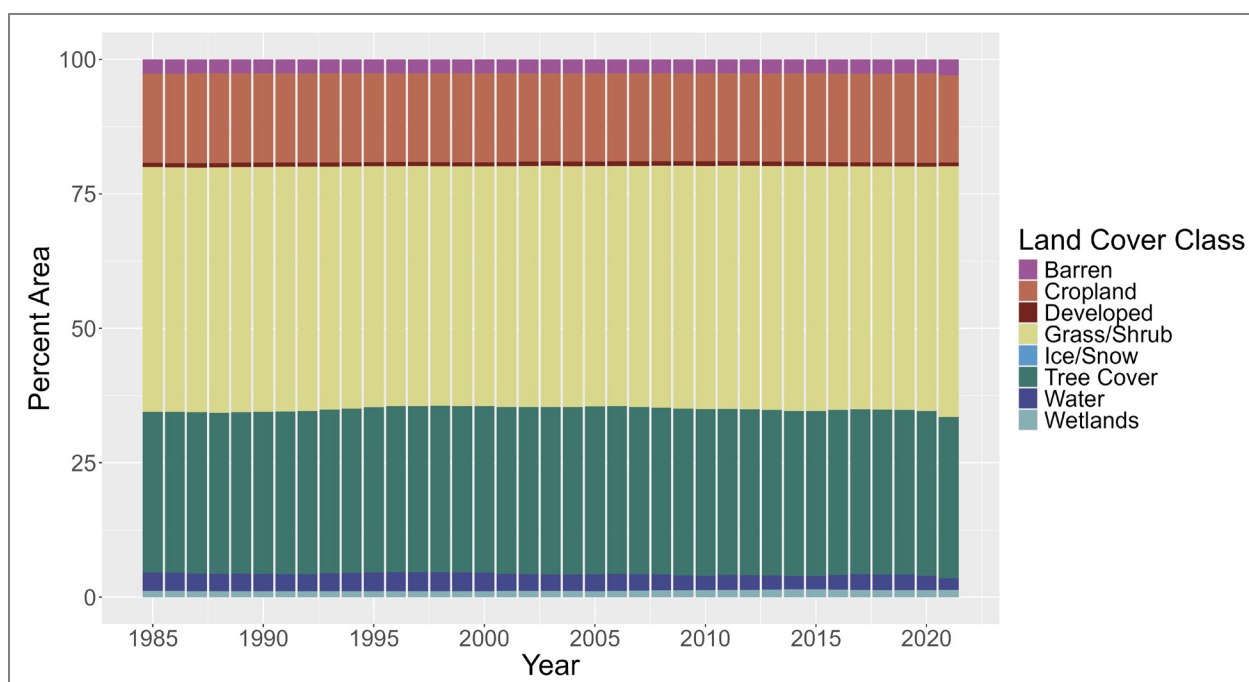


Figure 13. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Lava Beds National Monument (LBE) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

Appendix F. Oregon Caves National Monument and Preserve

Oregon Caves National Monument and Preserve (ORCA) is located in Oregon. Figure 14 shows the location of ORCA, along with the surrounding 3 km buffer and 30 km buffer AOAs.

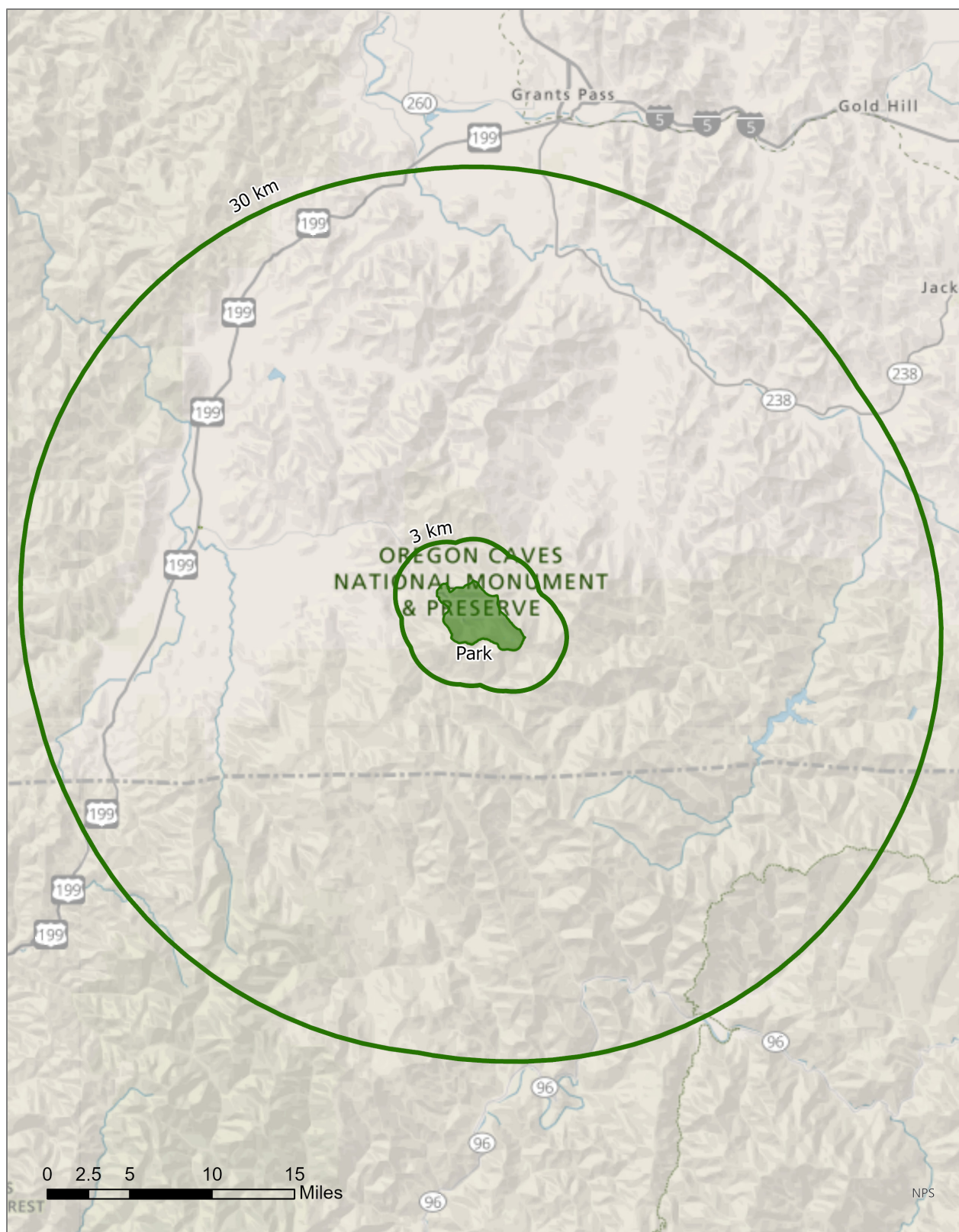


Figure 14. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Oregon Caves National Monument and Preserve (ORCA). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for eight AOAs relevant to ORCA (Table 20).

Table 20. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Oregon Caves National Monument and Preserve (ORCA).
[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	ORCA_Park	Area of Analysis within the boundary of Oregon Caves National Monument and Preserve.
Boundary Based AOA	ORCA_3km	Area of Analysis within a three-kilometer buffer of Oregon Caves National Monument and Preserve, originating from the boundary of the park.
	ORCA_30km	Area of Analysis within a 30-kilometer buffer of Oregon Caves National Monument and Preserve, originating from the boundary of the park.
	ORCA_3km_Donut	Donut Area of Analysis capturing the area between Oregon Caves National Monument and Preserve boundary and the three-kilometer buffer boundary.
	ORCA_30km_Donut	Donut Area of Analysis capturing the area between Oregon Caves National Monument and Preserve boundary and the 30-kilometer buffer boundary.
Watershed	ORCA_171003110201	Upper Sucker Creek watershed Area of Analysis boundary found to be intersecting with Oregon Caves National Monument and Preserve.
	ORCA_171003110202	Middle Sucker Creek watershed Area of Analysis boundary found to be intersecting with Oregon Caves National Monument and Preserve.
	ORCA_171003110203	Grayback Creek watershed Area of Analysis boundary found to be intersecting with Oregon Caves National Monument and Preserve.

Data Summary

Tables 21–23 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer AOAs. Using Level 1 land cover data from LCMAP rasters, Figures 15–17 depict the percent area of each land cover class and how it has changed over time.

Table 21. Percent area change over time by Level 1 land cover classes within the park boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.06	0.06	0.00
Cropland	0.00	0.00	0.00
Grass/Shrub	11.87	2.02	-9.85
Tree Cover	86.77	96.62	9.85
Water	0.00	0.00	0.00
Wetlands	1.30	1.30	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.00	0.00	0.00

Table 22. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	0.07	0.06	-0.01
Cropland	0.00	0.01	0.01
Grass/Shrub	9.97	3.63	-6.34
Tree Cover	89.02	95.33	6.31
Water	0.00	0.00	0.00
Wetlands	0.92	0.92	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.02	0.05	0.02

Table 23. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	1.53	1.72	0.19
Cropland	2.29	2.48	0.19
Grass/Shrub	20.41	31.03	10.61
Tree Cover	74.35	60.94	-13.41
Water	0.10	0.10	0.00
Wetlands	1.21	1.20	-0.01
Ice/Snow	0.00	0.00	0.00
Barren	0.11	2.53	2.42

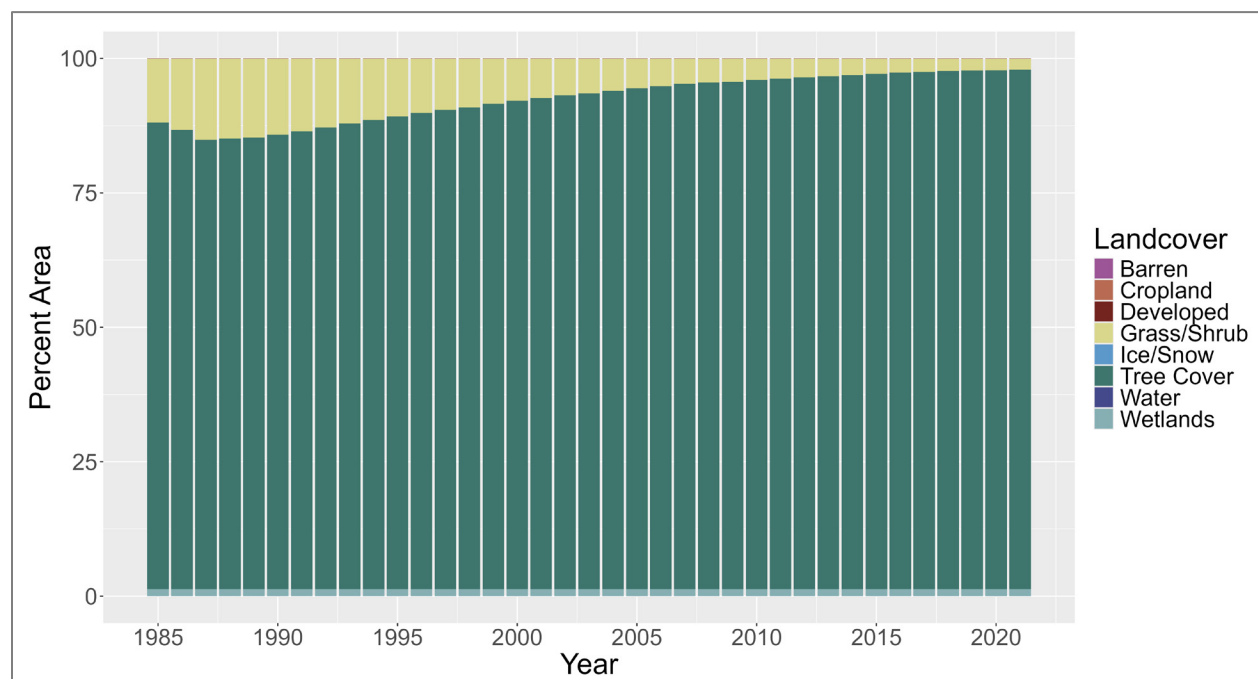


Figure 15. Annual percent area coverage for Level 1 land cover classes within the park boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

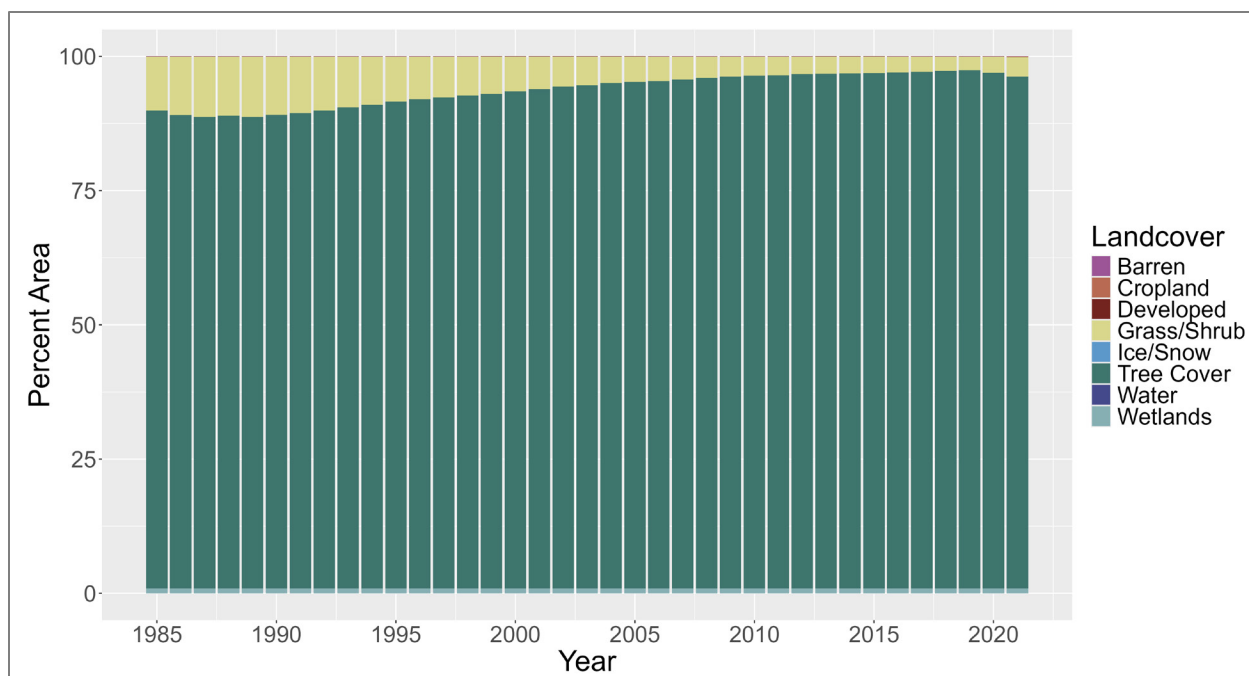


Figure 16. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

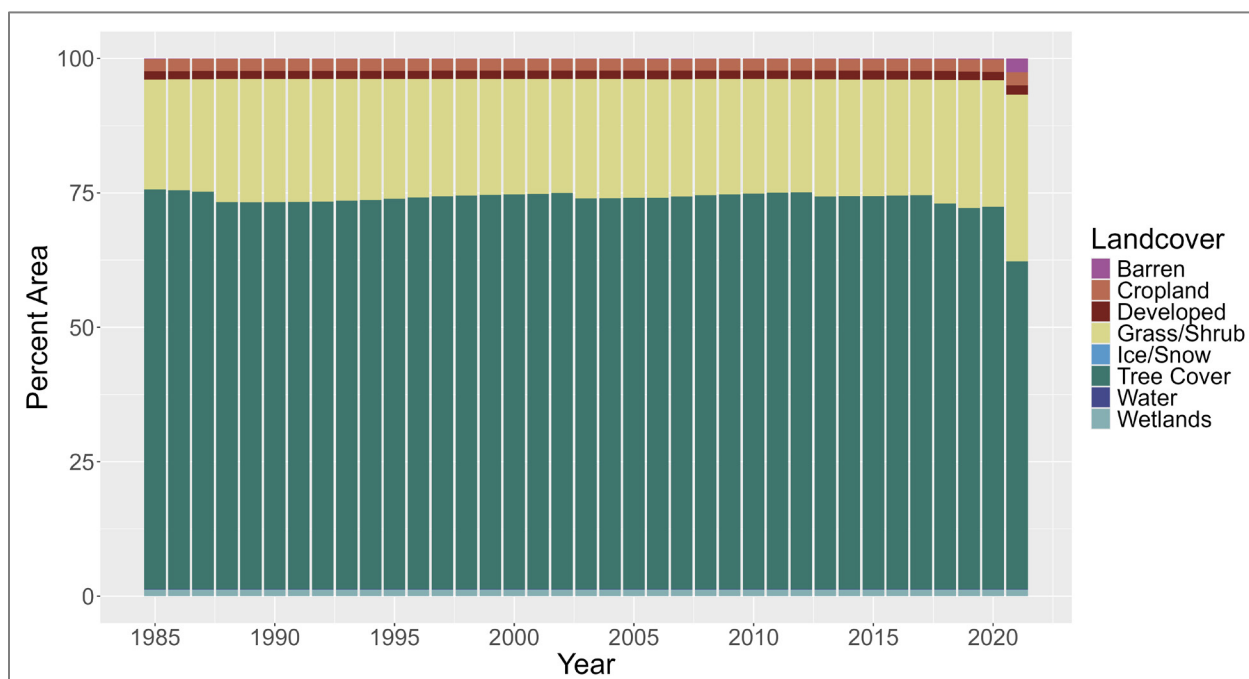


Figure 17. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Oregon Caves National Monument and Preserve (ORCA) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

Appendix G. Redwood National and State Parks

Redwood National and State Parks (REDW) are located in California. Figure 18 shows the location of REDW, along with the surrounding 3 km buffer and 30 km buffer AOAs.

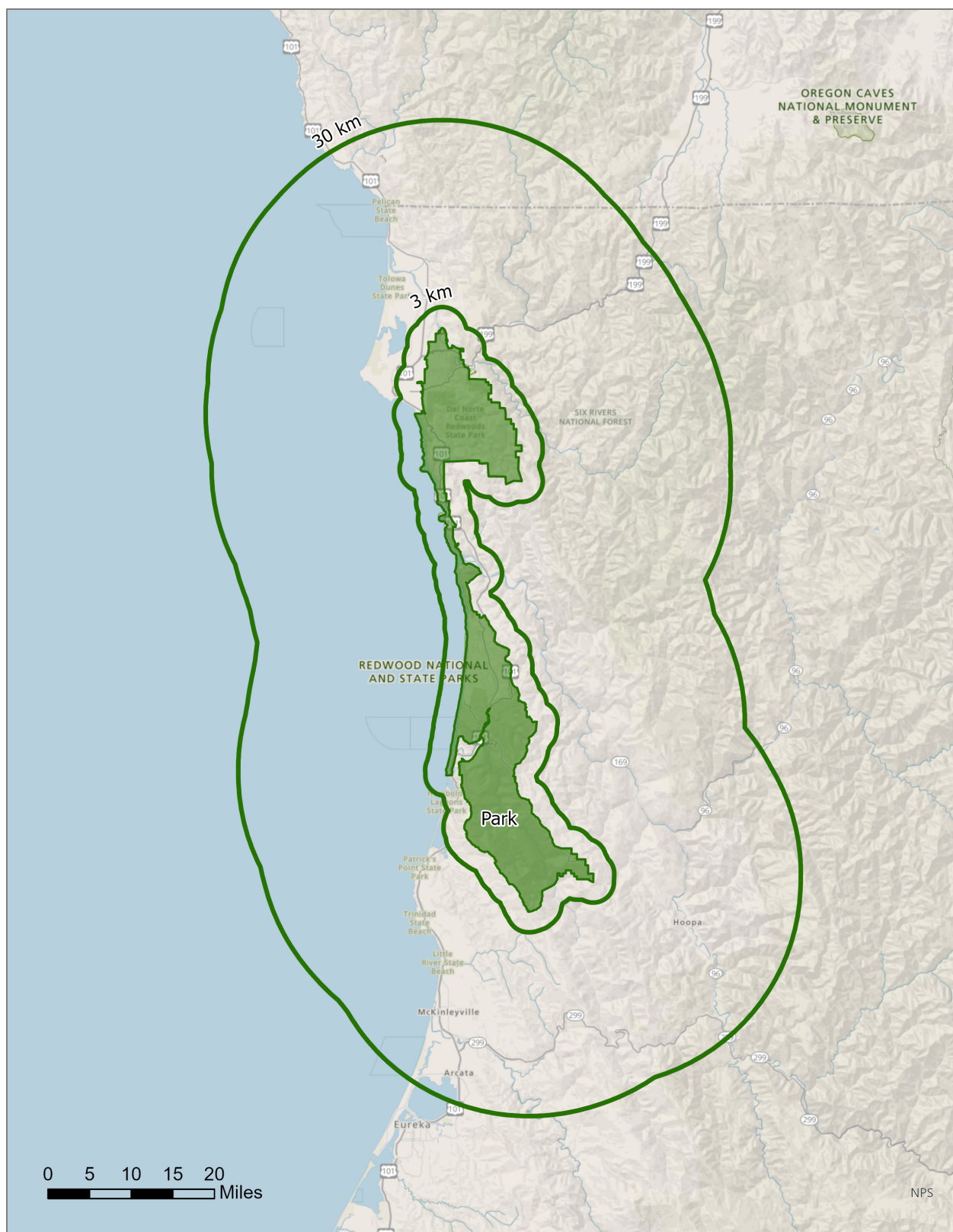


Figure 18. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Redwood National and State Parks (REDW). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for 25 AOAs relevant to REDW (Table 24).

Table 24. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Redwood National and State Parks (REDW). [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	REDW_Park	Area of Analysis within the boundary of Redwood National and State Parks.
Boundary Based AOA	REDW_3km	Area of Analysis within a three-kilometer buffer of Redwood National and State Parks, originating from the boundary of the park.
	REDW_30km	Area of Analysis within a 30-kilometer buffer of Redwood National and State Parks, originating from the boundary of the park.
	REDW_3km_Donut	Donut Area of Analysis capturing the area between Redwood National and State Parks boundary and the three-kilometer buffer boundary.
	REDW_30km_Donut	Donut Area of Analysis capturing the area between Redwood National and State Parks boundary and the 30-kilometer buffer boundary.
Watershed	REDW_180102091002	Tully Creek-Klamath River watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091001	Pine Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091003	Roach Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091006	Tectah Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091007	Ah Pah Creek-Klamath River watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091103	McGarvey Creek-Klamath River watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180102091101	Turwar Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.

Table 24 (continued). Area(s) of Analysis (AOAs) used to calculate land cover statistics for Redwood National and State Parks (REDW).
[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
Watershed (continued)	REDW_180102091102	Hunter Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010307	Rock Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010309	Lower South Fork Smith River watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010402	Mill Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010404	Smith River watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010504	Elk Creek-Frontal Pacific Ocean watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010501	Lake Earl watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101010503	Wilson Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101020104	Bridge Creek-Redwood Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101020105	Prairie Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101020106	McArthur Creek-Redwood Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101020501	Maple Creek watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.
	REDW_180101020503	Luffenholtz Creek-Frontal Pacific Ocean watershed Area of Analysis boundary found to be intersecting with Redwood National and State Parks.

Data Summary

Tables 25–27 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer AOAs. Using Level 1 land cover data from LCMAP rasters, Figures 19–21 depict the percent area of each land cover class and how it has changed over time.

Table 25. Percent area change over time by Level 1 land cover classes within the park boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	1.02	1.12	0.10
Cropland	0.13	0.12	0.00
Grass/Shrub	6.73	2.72	-4.01
Tree Cover	85.88	90.00	4.12
Water	4.35	4.38	0.03
Wetlands	0.66	0.66	0.00
Ice/Snow	0.00	0.00	0.00
Barren	1.24	0.99	-0.25

Table 26. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	2.19	2.47	0.28
Cropland	0.57	0.57	0.00
Grass/Shrub	7.90	4.93	-2.97
TreeCover	71.24	74.02	2.78
Water	16.19	16.19	0.00
Wetlands	1.20	1.20	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.72	0.62	-0.10

Table 27. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	2.20	2.38	0.18
Cropland	1.06	1.04	-0.02
Grass/Shrub	9.03	9.58	0.55
TreeCover	70.42	69.66	-0.77
Water	15.99	16.00	0.01
Wetlands	0.77	0.77	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.53	0.57	0.04

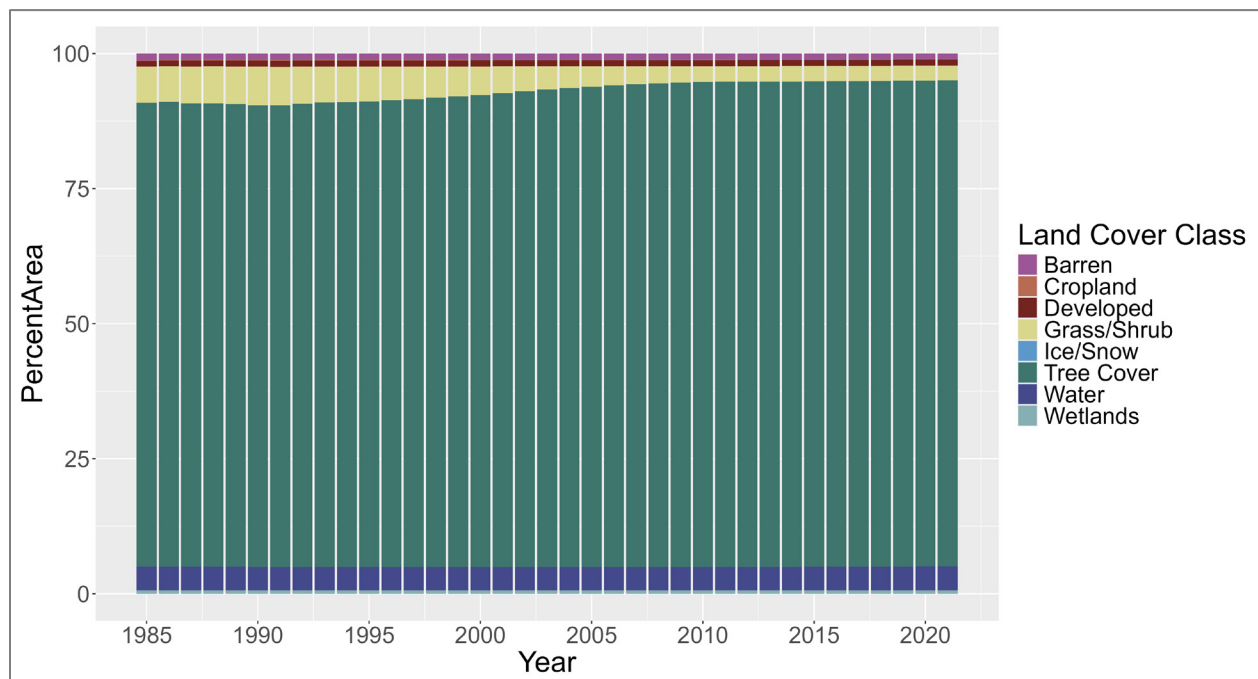


Figure 19. Annual percent area coverage for Level 1 land cover classes within the park boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

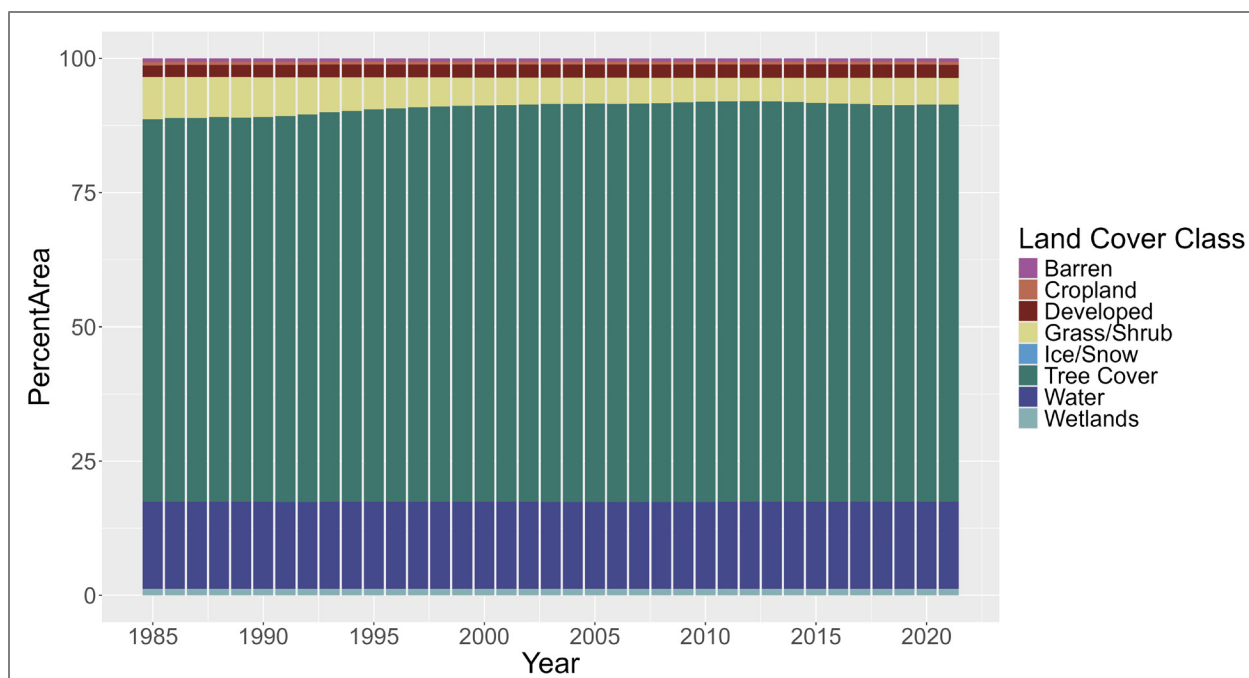


Figure 20. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

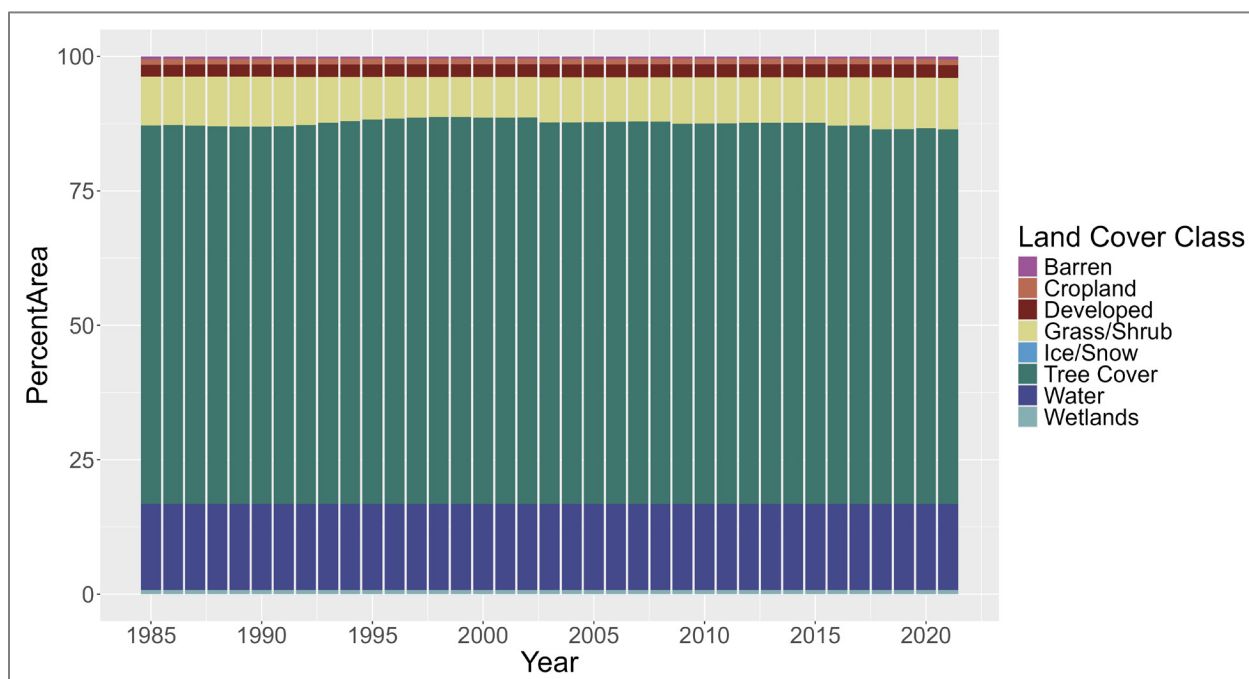


Figure 21. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Redwood National and State Parks (REDW) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

Appendix H. Whiskeytown National Recreation Area

Whiskeytown National Recreation Area (WHIS) is located in California. Figure 22 shows the location of WHIS, along with the surrounding 3 km buffer and 30 km buffer AOAs.

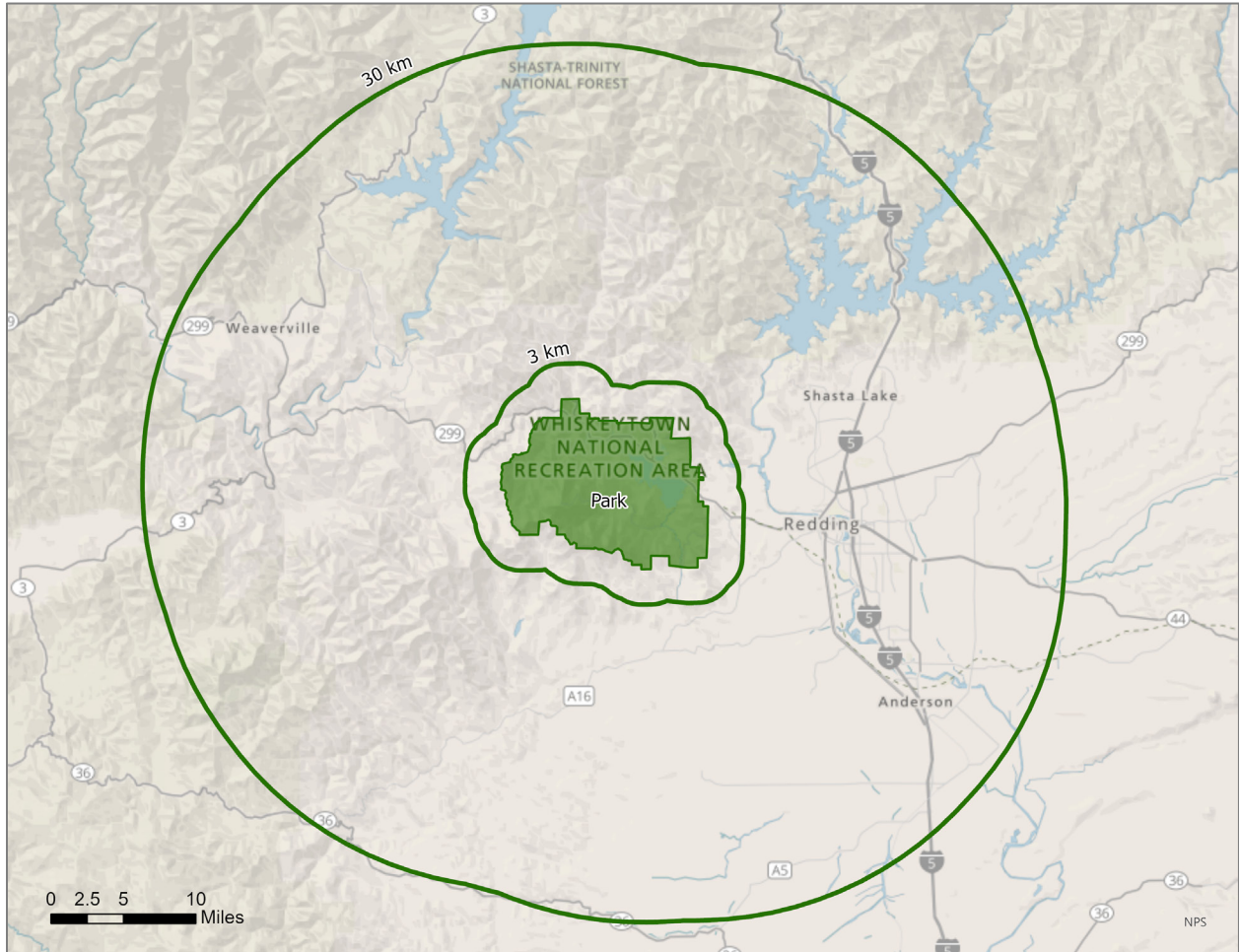


Figure 22. Park, 3 km, and 30 km buffer areas of analysis (AOAs) used in calculating land cover summary statistics for Whiskeytown National Recreation Area (WHIS). Basemap is NPS Park Tiles Standard.

Areas of Analysis

Land cover statistics were calculated for 15 AOAs relevant to WHIS (Table 28).

Table 28. Area(s) of Analysis (AOAs) used to calculate land cover statistics for Whiskeytown National Recreation Area (WHIS). [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	WHIS_Park	Area of Analysis within the boundary of Whiskeytown National Recreation Area.
Boundary Based AOA	WHIS_3km	Area of Analysis within a three-kilometer buffer of Whiskeytown National Recreation Area, originating from the boundary of the park.
	WHIS_30km	Area of Analysis within a 30-kilometer buffer of Whiskeytown National Recreation Area, originating from the boundary of the park.
	WHIS_3km_Donut	Donut Area of Analysis capturing the area between Whiskeytown National Recreation Area boundary and the three-kilometer buffer boundary.
	WHIS_30km_Donut	Donut Area of Analysis capturing the area between Whiskeytown National Recreation Area boundary and the 30-kilometer buffer boundary.
Watershed	WHIS_180201540106	South Fork Clear Creek-Clear Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540303	Olney Creek-Sacramento River watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540301	Spring Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540302	Sulphur Creek-Sacramento River watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540103	Willow Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540104	French Gulch-Clear Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201540105	Whiskeytown Lake-Clear Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180102110702	Grass Valley Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.

Table 28 (continued). Area(s) of Analysis (AOAs) used to calculate land cover statistics for Whiskeytown National Recreation Area (WHIS).
 [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
Watershed (continued)	WHIS_180201520301	Upper North Fork Cottonwood Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.
	WHIS_180201520304	Lower North Fork Cottonwood Creek watershed Area of Analysis boundary found to be intersecting with Whiskeytown National Recreation Area.

Data Summary

Tables 29–31 show how the percent area for each land cover class changed from 1985 to 2021 for the Park, 3 km buffer, and 30 km buffer AOAs. Using Level 1 land cover data from LCMAP rasters, Figures 23–25 depict the percent area of each land cover class and how it has changed over time.

Table 29. Percent area change over time by Level 1 land cover classes within the park boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	1.95	0.87	-1.08
Cropland	0.01	0.04	0.03
Grass/Shrub	12.58	78.43	65.85
Tree Cover	77.92	12.95	-64.97
Water	7.04	6.97	-0.06
Wetlands	0.50	0.50	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.00	0.24	0.24

Table 30. Percent area change over time by Level 1 land cover classes within the three-kilometer buffer boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	1.77	0.83	-0.95
Cropland	0.02	0.22	0.20
Grass/Shrub	21.95	82.91	60.96
Tree Cover	72.68	12.30	-60.38
Water	3.26	3.23	-0.02
Wetlands	0.30	0.30	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.02	0.21	0.19

Table 31. Percent area change over time by Level 1 land cover classes within the 30-kilometer buffer boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program.

Landcover Class	1985 (%)	2021 (%)	Change (%)
Developed	1.77	0.83	-0.95
Cropland	0.02	0.22	0.20
Grass/Shrub	21.95	82.91	60.96
Tree Cover	72.68	12.30	-60.38
Water	3.26	3.23	-0.02
Wetlands	0.30	0.30	0.00
Ice/Snow	0.00	0.00	0.00
Barren	0.02	0.21	0.19

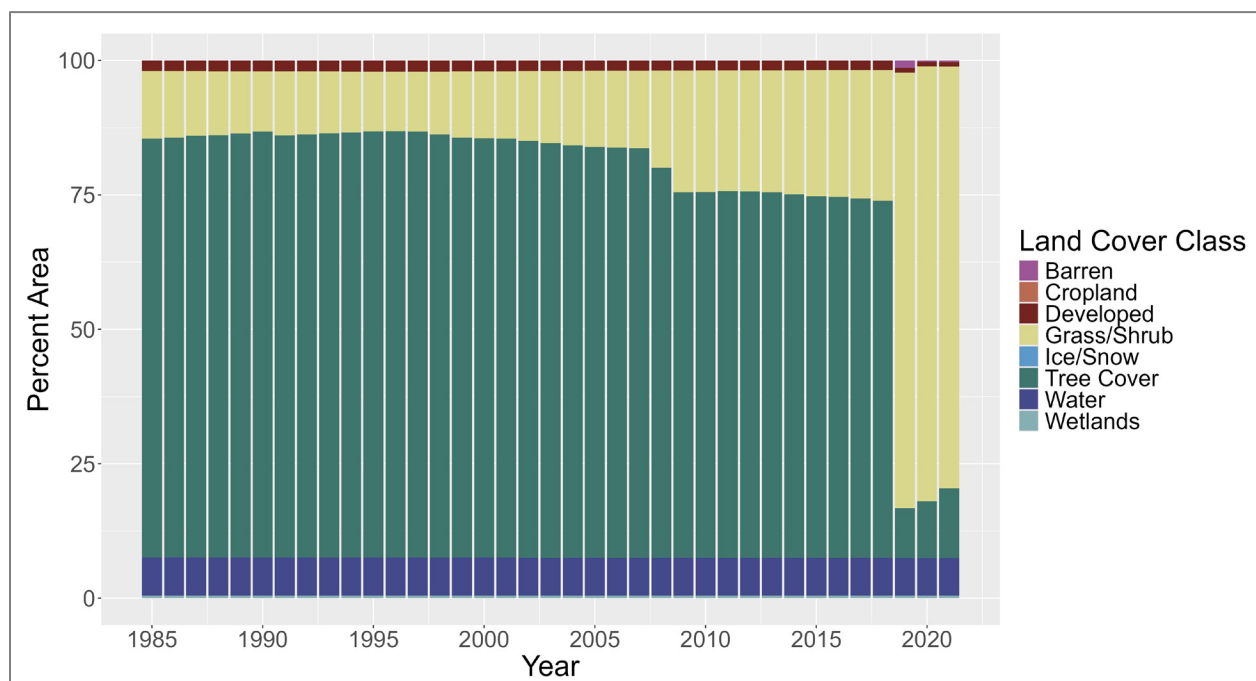


Figure 23. Annual percent area coverage for Level 1 land cover classes within the park boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

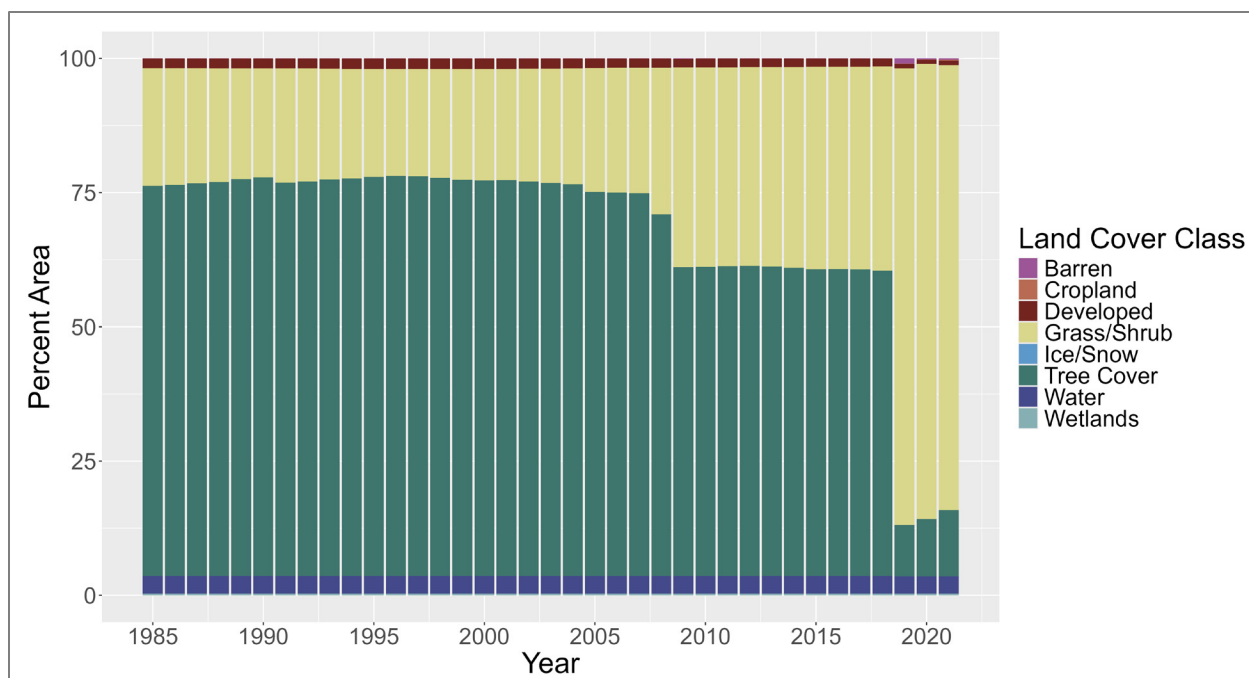


Figure 24. Annual percent area coverage for Level 1 land cover classes within the three-kilometer buffer boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

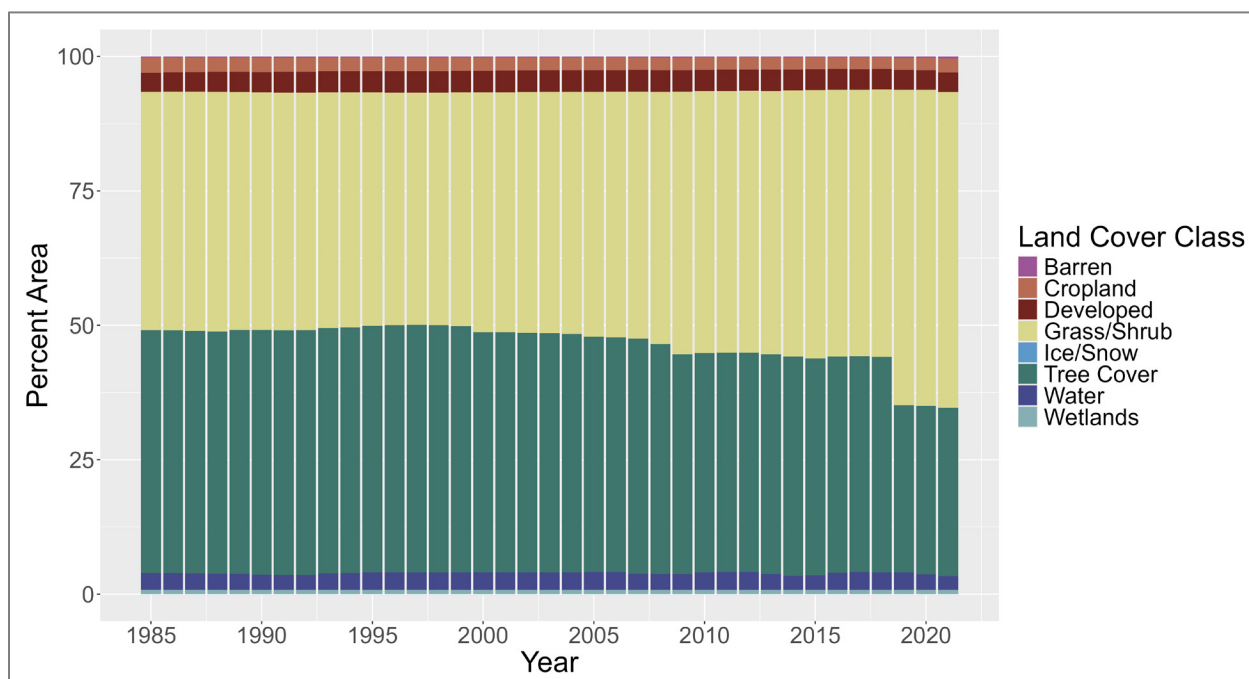


Figure 25. Annual percent area coverage for Level 1 land cover classes within the 30-kilometer buffer boundary of Whiskeytown National Recreation Area (WHIS) based on data from the Land Change Monitoring, Assessment, and Projection (LCMAP) Program for years 1985–2021.

National Park Service
U.S. Department of the Interior



Science Report NPS/SR—2024/181
<https://doi.org/10.36967/2303211>

Natural Resource Stewardship and Science

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