National Park Service
U.S. Department of the Interior

Natural Resource Program Center

> **NOTE: This document reflects the processes used to generate the fall 2010 release of NPScape data. There may be revised processes and documentation available.**
> **Check Reference Application (http://nrinfo.nps.gov) for most current version.**

NPScape Landcover Measure – Phase 2 North American Land Cover Metrics Processing SOP
Landcover Area per Category and Natural vs. Converted Landcover Metrics

Version: 20110405
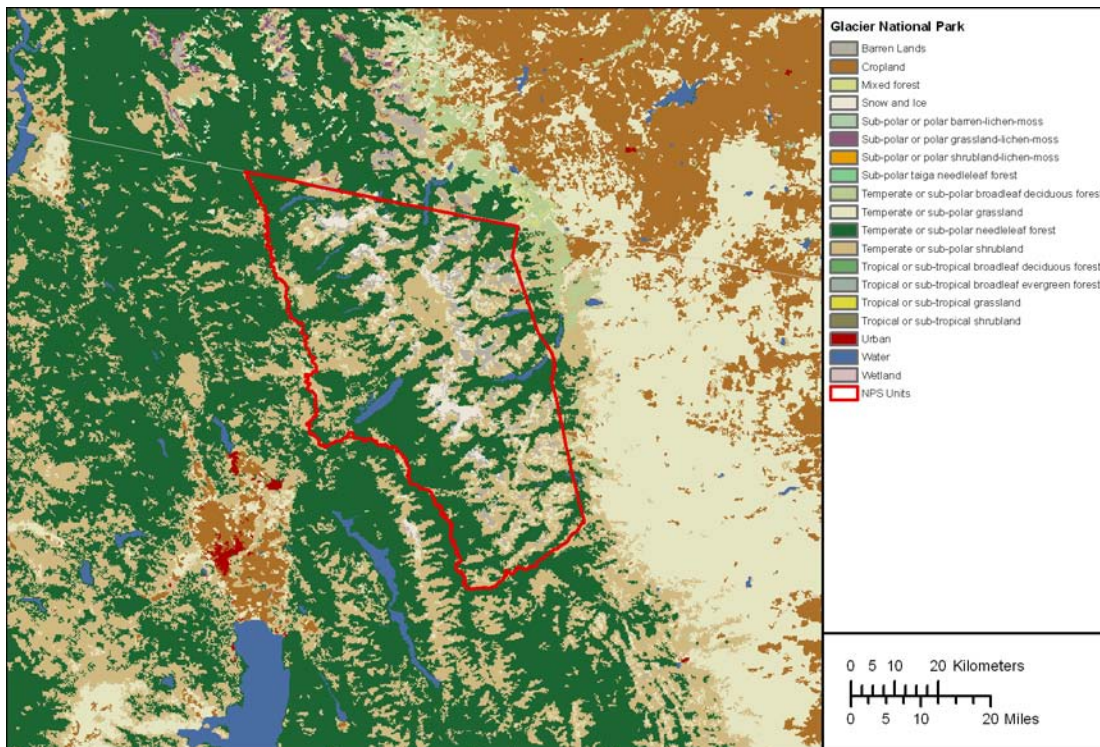
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Table of Contents

1.   Overview

This SOP provides guidance on how to process the following metrics for the Landcover Measure: North American Landcover Area per Category (NALC_LAC) and North American Percent Natural vs. Converted (NALC_LNC).

Download the NPScape landcover metrics methods zip file from the NPScape website (http://science.nature.nps.gov/im/monitor/npscape/methods.cfm).The zip file includes an ArcGIS™ toolbox containing NPScape landcover script tools, an ArcMap™ document for displaying outputs, and a copy of this SOP document.

The purpose of this SOP is threefold. First, because these directions were followed for the processing of the NPS dataset, it provides detailed documentation on the methodology the NPS Landscape Dynamics Project (NPScape) used to calculate these metrics. Second, this SOP provides any user with the ability to replicate the creation of these data. Finally, if a Park or Network has a need to process landcover metrics, this SOP provides a template for how spatial landcover data can be processed to generate these metrics.

The North American Landcover dataset (NALC) is a medium resolution raster of landcover extending from Mexico to the Arctic. Metrics derived from this data source include:

1. NALC_LAC1: NALC reclassified to Anderson Level 1 landcover classes

2. NALC_LAC2: NALC native landcover classes

3. NALC_LNC: NALC reclassified to Natural or Converted landcover classes

Outputs include reclassified rasters and summary tables with thematic class areas and percent total area values.

This document summarizes the methods used to generate these outputs for any area of analysis from the NPScape preprocessed source data. For details on how the preprocessed source data were created, see Appendix 6.2.

Unless noted, the data sources and tools used are assumed to be in ESRI ArcGIS™ format, version 9.3.1 Service Pack 1.

2.   Data Acquisition and Preprocessing

2.1. Source Data

Two datasets are required for processing these metrics: the preprocessed North American Landcover (NALC) raster and area of analysis polygons.

- **Source 1:** NPScape preprocessed source version of the Commission for Environmental Cooperation (2010): North American Land Change Monitoring System - Land Cover 2005:

  http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm

  NPScape preprocessed NALC 2005 Landcover includes three file geodatabase rasters composed of 250m pixels in either the USA Contiguous Albers Equal Area Conic or Alaska Albers Equal Area Conic spatial reference (see Appendices for details).

- **Source 2:** Area of Analysis Polygons

  An Area of Analysis (AOA) polygon may be any topologically correct polygon feature covering an area of interest. AOA polygon geometries must be free of topological errors like slivers or donuts. Example AOAs include buffered NPS park areas, watershed boundaries, study areas, or ecoregion boundaries.

2.2. Re-Projection of Source Data

Each source dataset must be re-projected into a common spatial reference. For CONUS areas, the NPScape project uses USA Contiguous Albers Equal Area Conic USGS as its standard projection. For Alaska, Alaska Albers Equal Area Conic is used. NAD_83 is the datum for both projections. Note that the NPScape pre-processed source data are already re-projected. Therefore, only the area of analysis polygon feature may require re-projection.

2.3.   Reclassification Tables

NPScape uses reclassification (recode) tables to thematically group landcover data into cover classes. The LAC (landcover area per category) metrics use thematic classifications based on Anderson Level 1 (LAC1) and native NALC (LAC2) landcover classifications. The LNC metric relies on the identification of native NALC thematic classes as either Natural or Converted. See Appendix 6.3 for details.

These tables are bundled with the NPScape Landcover Metrics tools zip file in the ToolData folder.

3.   Processing and Analysis

3.1. Processing Step 1 – Re-project Source Data

If the source AOA polygon(s) are not in the standard projection, use ArcGIS™ to create re-projected versions of these sources.

ArcToolbox → Data Management Tools → Projections and Transformations → Feature → Project

3.2.   Processing Step 2 – Create Reclassification Tables

If different reclassification tables than those provided are needed, use ArcCatalog™ to create new LAC1 and LNC reclassification tables. The tables can be personal or file geodatabase tables, or dBase tables, but file geodatabase tables are recommended.

3.3.   Processing Step 3 – Reclassify Landcover and Create Summary Tables

ArcGIS ™ script tools using Python scripts are used to produce NALC metric outputs.

Open ArcMap™ and open ArcToolbox. Right-click on ArcToolbox and choose 'Add Toolbox…'.
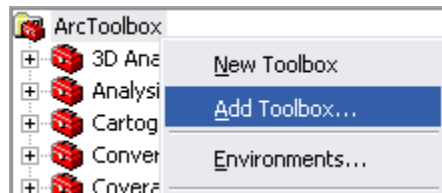
Navigate to the folder where the methods zip file was unzipped. Select the NPScape_LandcoverTools.tbx file to add.

Three NALC tools are available depending on the desired output raster (Landcover Level 1, Landcover Level 2 or Natural vs. Converted Landcover).


General processing steps of the tools are:

- Clip source raster to the area of analysis

- Reclassify clipped source using the appropriate reclassification table (see Appendix 6.3)

- Add and populate CLASSNAME attribute in reclassified output raster

- Generate summary statistics tables for reclassified raster

- Add and populate CLASSNAME, TAREA_SQKM, PCT_AREA, and
  AOA_NAME fields in statistics table

- Import metadata

Open one of the tools (the NorthAmericanLandcoverLevel2_Metric tool is shown below) and enter the parameters as shown. The output folder defaults to the Landcover_Tools\ProcessedData subfolder from the unzipped archive. The required reclassification table is located in the ToolData subfolder. Depending on the size of the area of analysis, the script may take several minutes to run. When finished, the layers and statistics tables should be added to the map. If layers don't appear, make sure the Geoprocessing → Geoprocessing Options → Display/Temporary Data: 'Add results of geoprocessing options to display; is checked.
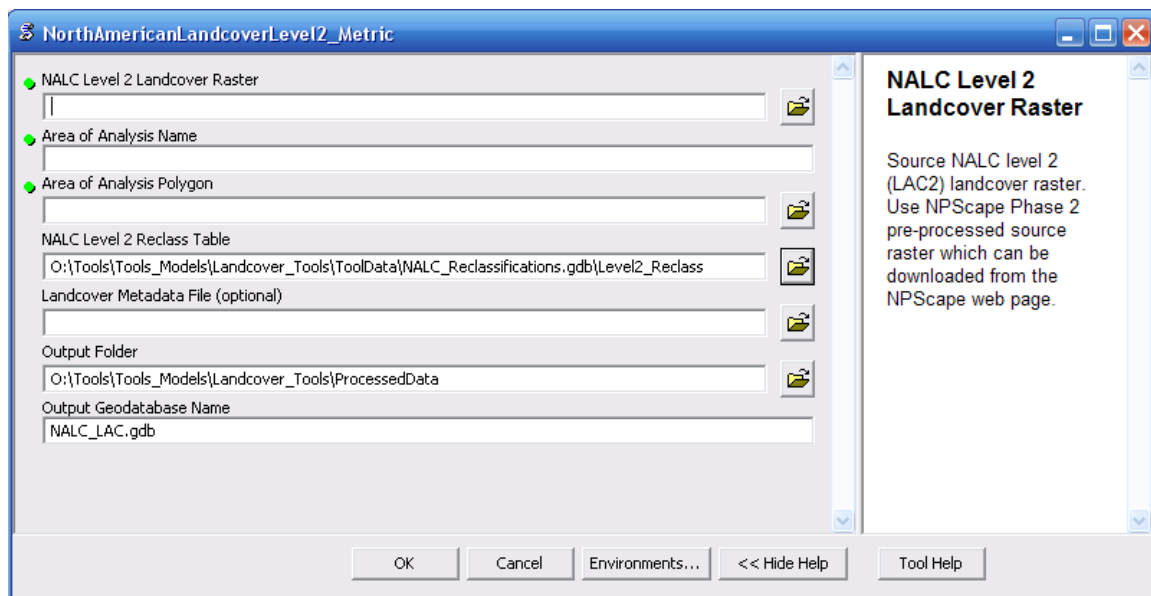
The following parameters are necessary to run the script tool:

- NALC Landcover Raster: location and name of the preprocessed NPScape NALC source raster; *note: the level 2 landcover source raster is used for all the Level1_Metric and Level2_Metric scripts*.

- AOA Name: name of the area of analysis (60 character limit)

- Area of Analysis: location and name of the AOA polygon feature class

- NALC Reclass Table: full path to the NALC reclassification table; located in Landcover_Tools\ToolData

- Landcover Metadata File (optional): full path to the landcover metadata XML file

- Output Folder: full path location of output folder; defaults to Landcover_Tools\ProcessedData

6

- Output Geodatabase Name: name of the output file geodatabase (must end with .gdb)

Output rasters (see Appendix 6.3 for classification details):

nalc_lac1 = reclassified Anderson Level 1 raster with 9 landcover classes

nalc_lac2 = clipped native NALC raster with 19 landcover classes

nalc_lnc = reclassified Natural/Converted raster with 2 landcover classes

Attributes of the output rasters include:

VALUE: landcover thematic class identifier

COUNT: number of cells (pixels) in each landcover class

CLASSNAME: descriptive name of landcover class

A summary statistics table is produced for each raster: nalc_<metric abbreviation>_stats

Summary table attributes include those listed above plus:

AOA_AREA_SQKM: total area of AOA in square kilometers

TAREA_SQKM: total area of raster data within AOA in square kilometers of area of analysis:

$$TAREA\_SQKM = (SUM(COUNT) * cell\ size^2) / 1,000,000$$

AREA_SQKM: total area in square kilometers of each landcover class:

$$AREA\_SQKM = (COUNT * cell\ size^2) / 1,000,000$$

PCT_AREA: percent total area of each landcover class:

$$PCT\_AREA = (AREA\_SQKM / TAREA\_SQKM) / * 100$$

AOA_NAME = the name specified in the script tool input

4.   Quality Control

4.1.   Verify Spatial and Thematic Integrity

Use the ArcMap™ document (Landcover_Tools\Landcover_Metrics.mxd) provided to open the landcover rasters. Overlay them with area of analysis polygon. Verify that raster edges align correctly and that the cells align from raster to raster. Use the Effects → Swipe tool to help verify this. Note that the NPScape layer files for landcover (Landcover_Tools\ProcessedData*.lyr) are used to standardize the NALC raster symbology.

Add the source raster(s) to the map and use the Swipe tool to verify that the processed raters' pixels align with the source pixels.

Zoom into an area and visually compare the outputs of each landcover grid by identifying all layers for a few points. Verify the following values:

> The Pixel Value for the landcover grid should equal the OUT value in the respective reclassification table:

> > NALC_LAC1: Level1_Reclass

> > NALC_LAC2: Level2_Reclass

> > NALC_LNC: Natural_Converted

The original OID value (in the respective source raster) should equal the TO values in the respective recode table.

4.2. Verify Values for Calculated Areas

Open each landcover statistics table (nalc_*_stats) and verify that the TAREA_SQKM values are equivalent across all the tables. Sort the PCT_AREA field in descending order and look for outlying (zero or negative values, more than one value near 100, sum of values <> 100).

Select one record from each statistics table and double-check the result column values by re-calculating them by hand:

> 1. Multiply the value of the COUNT field by the square of the cell size and divide by 1,000,000. (this results in the area for the class in km^2, i.e. AREA_SQKM).

> 2. Compare the value from step 1 with the value in the appropriate field in nalc_*_stats. The values should be equivalent.

> 3. Select one record from each statistics table and double-check the result column values by re-calculating them by hand:

> > PCT_AREA = (AREA_SQKM / TAREA_SQKM) * 100

5.   Literature Cited

Commission for Environmental Cooperation. 2010. 2005 Land Cover of North America at 250 meters. http://www.cec.org/naatlas/

6.   Appendices

6.1. Known Issues

Data Availability

NALC data are not available for off-shore parks (e.g. Dry Tortugas), Puerto Rico, the Virgin Islands, Hawaii, or the outlying Pacific Islands.

Data Extent

Source NALC raster data extend a few kilometers off the coasts and lakeshores of North America. Therefore, coastal AOAs may not include seamless coverage of the source data. In these areas, the AOA_AREA_SQKM attribute will be greater than the TAREA_SQKM value.

Natural vs. Converted Landcover (LNC)

The reclassification logic used for this metric skews toward 'natural' landcover classes. Therefore, the resulting grid may be more heavily weighted in percent total area for these classes.

6.2. Source Data Processing

6.2.1.   Source Data

North American Landcover (NALC) and spatial extent (Area of Analysis) data were obtained from the following two sources:

- **Source 1:** Commission for Environmental Cooperation (CEC) North American Land Change Monitoring System - Land Cover 2005: http://www.cec.org/Page.asp?PageID=924&ContentID=2819

   NALC 2005 Landcover is an IMG (Leica Imagine) raster composed of 250m pixels within 19 thematic classes. Its native spatial reference is Lambert Azimuthal Equal Area (see Appendix 6.4).

- **Source 2:** Areas of Analysis - US Fish and Wildlife Service Landscape Conservation Cooperatives (LCCs): http://www.fws.gov/GIS/data/national/index.htm

6.2.2.   Pre-Processing Step 1 – Re-project Source Data

The source landcover raster and LCCs were projected into the standard NPScape projection (CONUS: USA Contiguous Albers Equal Area Conic USGS, NAD_83; Alaska: Alaska Albers Equal Area Conic, NAD_83) using ArcGIS™:

NALC raster:

ArcToolbox → Data Management Tools → Projections and Transformations → Raster → Project Raster or Feature → Project

LCC polygons:

ArcToolbox → Data Management Tools → Projections and Transformations → Feature → Project

6.2.3.   Preprocessing Step 2 – Create Reclassification Tables

Two reclassification tables were created using the values listed in Appendix 6.3. The tables are file geodatabase tables (NALC_Reclassifications.gdb).

6.2.4.   Preprocessing Step 3 – Reclassify Landcover Classes to Produce Preprocessed Sources

Python scripts are used to produce NALC preprocessed source outputs.

Output rasters (see Appendix 6.3 for thematic classification details):

nalc_lac1 = reclassified Anderson Level 1 raster with 10 landcover classes

nalc_lac2 = clipped native NALC raster with 19 landcover classes

nalc_lnc = reclassified Natural/Converted raster with 2 landcover classes

General processing steps:

- Reclassify source raster using the appropriate reclassification table (see Appendix 6.3). This generates a file geodatabase raster dataset.

- Add and populate CLASSNAME attribute in reclassified source raster

- Import metadata

6.3.   *Reclassification and Landcover Classification Tables*

6.3.1.   <u>NALC Landcover Classification</u>

VALUE	CLASSNAME
1	Temperate or sub-polar needleleaf forest
2	Sub-polar taiga needleleaf forest
3	Tropical or sub-tropical broadleaf evergreen forest
4	Tropical or sub-tropical broadleaf deciduous forest
5	Temperate or sub-polar broadleaf deciduous forest
6	Mixed forest
7	Tropical or sub-tropical shrubland
8	Temperate or sub-polar shrubland
9	Tropical or sub-tropical grassland
10	Temperate or sub-polar grassland
11	Sub-polar or polar shrubland-lichen-moss
12	Sub-polar or polar grassland-lichen-moss

13	Sub-polar or polar barren-lichen-moss
14	Wetland
15	Cropland
16	Barren Lands
17	Urban
18	Water
19	Snow and Ice

6.3.2.   NALC to Anderson Level 1 Reclassification

FROM_VAL	TO_VAL	OUT_VAL	CLASSNAME
1	1	4	Forest
2	2	4	Forest
3	3	4	Forest
4	4	4	Forest

5	5	4	Forest
6	6	4	Forest
7	7	5	Scrub/Shrub
8	8	5	Scrub/Shrub
9	9	7	Grassland/Herbaceous
10	10	7	Grassland/Herbaceous
11	11	5	Scrub/Shrub
12	12	7	Grassland/Herbaceous
13	13	3	Barren/Quarries/Transitional
14	14	9	Wetlands
15	15	8	Agriculture
16	16	3	Barren/Quarries/Transitional
17	17	2	Developed
18	18	1	Open Water
19	19	10	Snow and Ice

6.3.3. <u>NALC to Natural/Converted Reclassification</u>

FROM_VAL	TO_VAL	OUT_VAL	CLASSNAME
1	1	2	Natural
2	2	2	Natural
3	3	2	Natural
4	4	2	Natural
5	5	2	Natural
6	6	2	Natural
7	7	2	Natural
8	8	2	Natural
9	9	2	Natural
10	10	2	Natural
11	11	2	Natural
12	12	2	Natural
13	13	2	Natural

14	14	2	Natural
15	15	1	Converted
16	16	2	Natural
17	17	1	Converted
18	18	2	Natural
19	19	2	Natural

6.4.   Source Data Details

6.4.1.   <u>NALC Native Projection Information</u>

NALC data are produced with a Lambert Azimuthal Equal Area projection. This is a non-standard ArcGIS™ spatial reference. The spatial reference properties are:

Horizontal_Coordinate_System_Definition:
  Planar:
    Map_Projection:
      Map_Projection_Name: Lambert Azimuthal Equal Area
      Lambert_Azimuthal_Equal_Area:
        Longitude_of_Projection_Center: -100.00
        Latitude_of_Projection_Center: 45.00
        False_Easting: 0.0
        False_Northing: 0.0
    Planar_Coordinate_Information:
      Planar_Coordinate_Encoding_Method: Row and column
      Coordinate_Representation:
        Abscissa_Resolution: 250.0
        Ordinate_Resolution: 250.0
      Planar_Distance_Units: Meters
  Geodetic_Model:
    Horizontal_Datum_Name: None
    Ellipsoid_Name: Sphere
    Semi-major_Axis: 6370977

    Denominator_of_Flattening_Ratio: 1.0