National Park Service
U.S. Department of the Interior

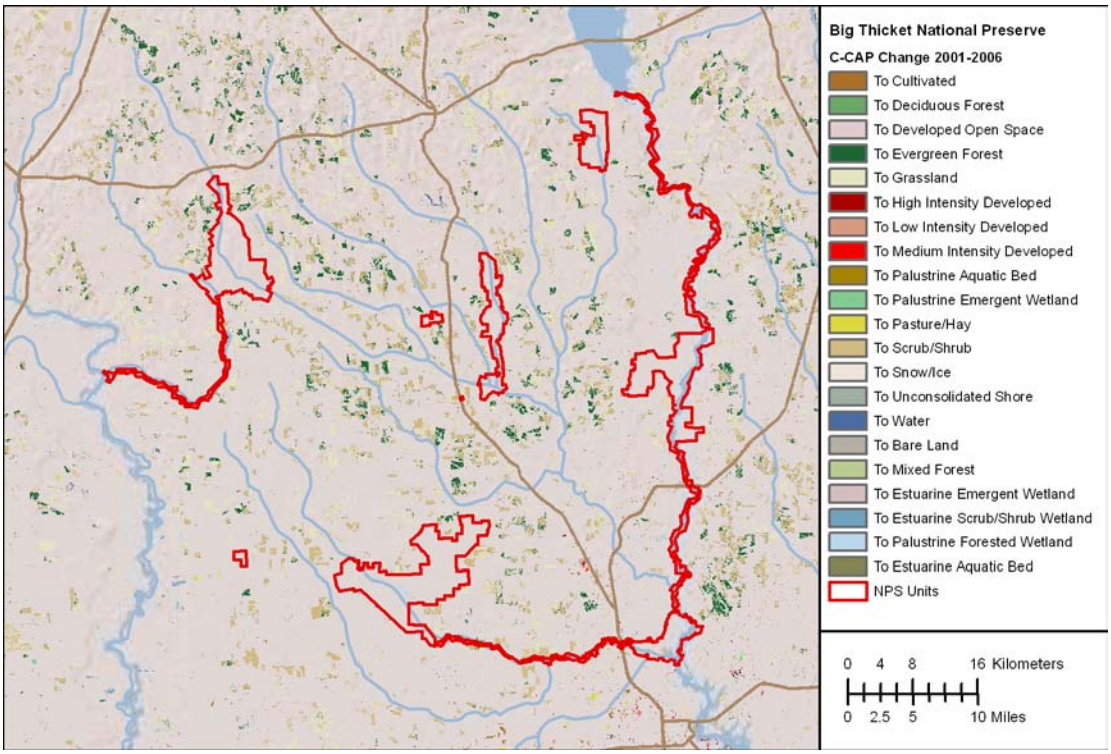
Natural Resource Program Center

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 Coastal Change Analysis Program Landcover Metrics Processing SOP

Landcover Area per Category and Landcover Change Metrics

Version: 20110407



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1. Overview

This SOP provides guidance on how to process the following metrics for the Landcover Measure: Coastal Change Analysis Program (CCAP) Landcover Area per Category (CCAP_LAC) and Coastal Change Analysis Program Landcover Change (CCAP_LCC).

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 Coastal Change Analysis Program Landcover dataset (CCAP) is a medium resolution raster of coastal landcover extending along the east, west, and Gulf coasts of the continental US, plus the Great Lakes, and also including the entire major islands of Hawaii and the island of Guam. Metrics derived from this data source include:

1. CCAP_LAC2: CCAP native CCAP landcover classes

2. CCAP_LCC: CCAP native change classes for 1996-2001 and 2001-2006

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 pre-processed source data. For details on how the pre-processed 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

Three datasets are required for processing these metrics: the Coastal Change Analysis Program Landcover (CCAP) landcover raster, the CCAP change rasters, and area of analysis polygons.

- **Source 1:** NPScape preprocessed source version of the NOAA Coastal Services Center - Coastal Change Analysis Program Regional Land Cover or Landcover Change (NOAA Coastal Services Center 2010):

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

  The NPScape preprocessed CCAP landcover source includes several file geodatabase rasters in the USA Contiguous Albers Equal Area Conic spatial reference: one each for the western continental U.S. for 1996, 2001, and 2006, and one each for the eastern continental U.S. and Gulf of Mexico for the same dates, plus rasters for Hawaii (2001 only) and Guam (2005 only).

  The file geodatabase raster for Hawaii for 2001 is in UTM Zone 5N NAD83 while the one for Guam for 2005 is in UTM Zone 55N WGS84.

  The NPScape preprocessed CCAP Landcover Change geodatabase includes four rasters in the USA Contiguous Albers Equal Area Conic spatial reference: one each for the western continental U.S. for 1996-2001 and 2001-2006, and one each for the eastern continental U.S. and Gulf of Mexico for the same dates.

- **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. For Hawaii, UTM Zone 5N NAD83 is used while Guam data are projected to UTM Zone 55N WGS84. Note that the NPScape preprocessed source data are already re-projected. Therefore, only the area of analysis polygon feature may require re-projection.

2.3. Determine Reclassification Scheme and Create 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 the native CCAP (LAC2) landcover classifications. The LCC metric relies on the identification of native CCAP change classes. 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

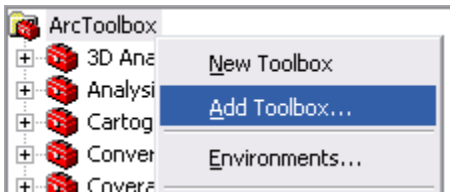
3.2. Processing Step 2 – Create Reclassification Tables

If different reclassification tables than those provided are needed, use ArcCatalog™ to create the new 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 Classes and Create Summary Tables

ArcGIS ™ script tools using Python scripts are used to produce CCAP 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 CCAP tools are available depending on the desired output raster (CCAPLandcover_Metric, CCAPLandcover_Change_Metric or CCAPLandcover_SingleYear_Metric). CCAPLandcover_Metric calculates outputs for the three landcover dates (1996, 2001, and 2006), while the

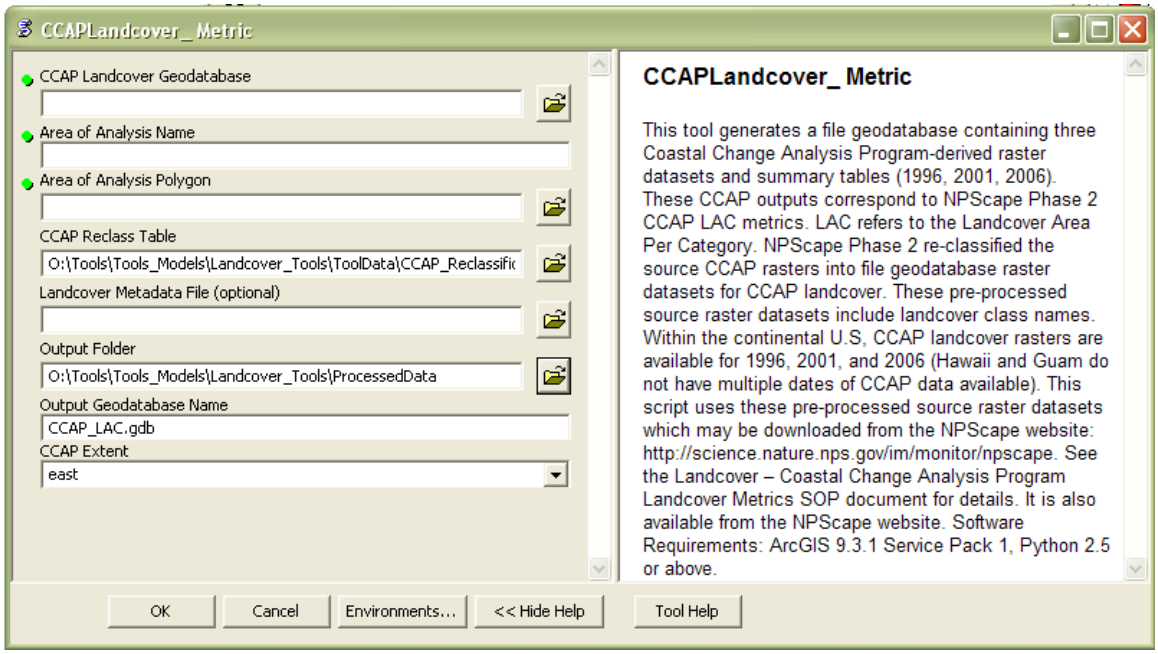
CCAPLandcover_SingleYear_Metric tool produces outputs for only one year. The CCAPLandcover_Change_Metric tool outputs change products for one 'change year' period (1996 to 2001 or 2001 to 2006).

The CCAPLandcover_Metric tool can be used only for CONUS areas, not for Hawaii or Guam. The CCAPLandcover_SingleYear_Metric tool can be used for all areas including Hawaii and Guam. Be sure to select the correct date when using Hawaii (2001) or Guam (2005) locations. Since change data are available only for CONUS areas, the CCAPLandcover_Change_Metric tool cannot be used for Hawaii or Guam areas.

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 to statistics table
- Import metadata

Open one of the tools (the *CCAPLandcover_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.



The following parameters are necessary to run this script tool:

- CCAP Landcover Geodatabase (for *CCAPLandcover_Metric* tool): location and name of the preprocessed NPScape CCAP source geodatabase (contains all three dates of CCAP data)

  OR

  CCAP Landcover or Change Raster (for *CCAPLandcover_SingleYear_Metric* and *CCAPLancover_Change_Metric* tools): location and name of the preprocessed NPScape CCAP source raster (1996, 2001, or 2006) or change raster (19962001 or 20012006)

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

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

- CCAP Reclass Table: full path to the CCAP 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

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

- CCAP Extent: the extent of the source CCAP landcover (east or west)

Output rasters (see Appendix 6.3 for classification details):

CCAP_lac2_YYYY = clipped native CCAP raster with 28 landcover classes (YYYY = source year)

CCAP_lcc_YYYYYYYY (*from CCAPLandcover_Change_Metric only*) = reclassified change raster up to 625 landcover change classes (YYYYYYYY = change years)

A summary statistics table is produced for each raster: CCAP_<metric abbreviation>_<YYYY>_stats

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

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 the area of analysis polygon. Verify that edges align correctly and that the grid cells align from grid to grid. Use the Effects → Swipe tool to help verify this. Note that the NPScape layer files for landcover (NPScape data root folder\Landcover*.lyr) may be used to standardize the grid symbology.

Add the source raster(s) to the map and use the Swipe tool to verify that the processed grids' 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 recode table:

CCAP_LAC2: Level2_Reclass (or Level2_Reclass_Hawaii)

CCAP_LCC: CCAP_Change_Classification (if relevant)

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 (CCAP_*_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 CCAP_*_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

NOAA Coastal Services Center. 2010. Coastal Change Analysis Program Regional Land Cover: http://www.csc.noaa.gov/digitalcoast/data/ccapregional/

6. Appendices

6.1. Known Issues

Data Availability

CCAP landcover data are not available for parks in Puerto Rico, the Virgin Islands, or Saipan and Samoa.

CCAP landcover data are available for Guam for 2005 only.

CCAP landcover data are available for Hawaii for 2001 only.

CCAP landcover change data are not available for areas outside the continental U.S.

Spatial Registration Issues

Source CCAP data are provided state-by-state. As of Fall 2010, CCAP 2001 and 2006 landcover data from California, Oregon, and Washington have spatial registration issues.

2001 – California and Oregon source rasters (GeoTIFF) are offset 10m to the south from 1996 source rasters. This offset was corrected using the Shift tool (Projections and Transformations → Raster tools) to move the source rasters 10m north. The 2001 Washington source raster does not have the offset issue.

2006 – The Washington source raster (GeoTIFF) is offset 10m to the south from the 1996 source raster. This offset was corrected using the Shift tool (Projections and Transformations → Raster tools) to move the source raster 10m north. California and Oregon 2006 source rasters do not have an offset issue.

In all cases of shifting and mosaicking, the 2001, 2006, and 20012006 source rasters were snapped to the 1996 source raster.

Thematic Classification Inconsistencies

The Hawaii source data used a different classification scheme than the CONUS and Guam data. A separate set of reclassification tables was developed for the Hawaii areas. See Appendix 6.3 for details.

6.2. Source Data Processing

6.2.1. Source Data

Coastal Change Analysis Program Landcover (CCAP) and spatial extent (Area of Analysis) data were obtained from the following sources:

- **Source 1:** NOAA Coastal Services Center - Coastal Change Analysis Program Regional Land Cover: http://www.csc.noaa.gov/digitalcoast/data/ccapregional/

  CCAP Landcover is an IMG (Leica Imagine) raster composed of 30m pixels within 28 thematic landcover classes (http://www.csc.noaa.gov/crs/lca/tech_cls.html). Temporal coverage for the CCAP landcover varies. Most CONUS areas are 1996, 2001, and combinations of 2005 and 2006. Hawaii is 2001 and Guam is 2005. CCAP Landcover Change rasters are available for 1996-2001 and 2001-2006. The native change rasters include up to 625 change classes.

  Its native spatial reference is USA Contiguous Albers Equal Area Conic (USGS version).

  As of Fall 2010, source raster data for California, Oregon, and Washington displayed spatial registration inconsistencies for 2001 and 2006. This mis-registration was removed during preprocessing by shifting affected source raster data. See Appendix 6.1 for details.

- **Source 2:** Area of Analysis Polygons (NPS unit boundaries with 30 km buffer)

  For CCAP processing, NPScape used NPS parks buffered by 30 kilometers as AOA polygons.

6.2.2. Re-Projection of Source Data

The source landcover rasters were projected into the standard NPScape projection (CONUS: USA Contiguous Albers Equal Area Conic USGS, NAD_83; Hawaii: UTM Zone 5N NAD83; Guam: UTM Zone 55N WGS84) using ArcGIS™:

CCAP rasters:

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

6.2.3. Determine Reclassification Scheme and Create Tables

The LAC (landcover area per category) metrics use thematic classifications based on the native CCAP (LAC2) landcover classifications. The LCC metric relies on the identification of native CCAP change classes. The CONUS and Guam areas shared the same reclassification scheme, while Hawaii's scheme differed. See Appendix 6.3 for details.

6.3. Reclassification and Landcover Classification Tables

6.3.1. CCAP Landcover Classification (Level 2) – CONUS and Guam

VALUE	CLASSNAME
1	Unclassified
2	Developed High Intensity
3	Developed Medium Intensity
4	Developed Low Intensity
5	Developed Open Space
6	Cultivated Crops
7	Pasture/Hay
8	Grassland/Herbaceous
9	Deciduous Forest
10	Evergreen Forest
11	Mixed Forest
12	Scrub/Shrub
13	Palustrine Forested Wetland
14	Palustrine Scrub/Shrub Wetland
15	Palustrine Emergent Wetland (Persistent)
16	Estuarine Forested Wetland
17	Estuarine Scrub/Shrub Wetland
18	Estuarine Emergent Wetland
19	Unconsolidated Shore
20	Barren Land

21	Open Water
22	Palustrine Aquatic Bed
23	Estuarine Aquatic Bed
24	Tundra
25	Perennial Ice/Snow
26	Dwarf Scrub
27	Sedge / Herbaceous
28	Moss
29	Lichens

6.3.2. CCAP Landcover Classification (Level 2) – Hawaii

VALUE	CLASSNAME
1	Recent Lava Flow
2	Developed High Intensity
3	Developed Low Intensity
6	Cultivated Crops
8	Grassland/Herbaceous
9	Deciduous Forest
10	Evergreen Forest
11	Mixed Forest
12	Scrub/Shrub
13	Palustrine Forested Wetland
14	Palustrine Scrub/Shrub Wetland

15	Palustrine Emergent Wetland (Persistent)
16	Estuarine Forested Wetland
17	Estuarine Scrub/Shrub Wetland
18	Estuarine Emergent Wetland
19	Unconsolidated Shore
20	Barren Land
21	Open Water

6.3.3. CCAP Change Classification

Refer to the NPScape CCAP_Reclassification.gdb CCAP_Change_Classification_YYYYYYYY tables for details. These tables preserve the change classes from the source CCAP change rasters.