

Inventory & Monitoring Division

National Park Service



Standard Operating Procedure 3.11.2

Calculating Statistics for National Landscape Dynamics Metrics: Pattern Morphology

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Summary

Internal SOP for running summary statistics for Landscape Pattern Morphology Metrics for use in Landscape Dynamics.

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Overview

This internal SOP provides guidance on how to process statistics for Pattern Morphology. Outputs include summary tables in SQL Server that summarize area by category for defined landscape morphology classes, as well as frequency tables of various landscape morphology patches. Pattern Morphology statistics are available for cover types Forest, Grassland, Shrubland, and Wetland.

Python scripts are used to calculate these statistics for a suite of areas of analysis (AOA). AOAs for statistics include 30km buffers of Park boundaries, and Custom AOAs, where pattern morphology data is available. Standardized file geodatabases are used as the sources of these AOA polygons (SOPs 2.11.6 and 2.11.8; Kinseth and Nelson 2018d, b). Custom AOAs are not created by IMD Central Office, they come from Park/Network/Cooperators and must follow guidelines and structure set forth in Custom Areas of Analysis SOP (SOP 2.11.8; Kinseth and Nelson 2018b).

Pattern morphology metrics calculated with this SOP include frequency and patch size of cover type patches (all morphology classes) (km²), frequency and patch size of cover type patches of morphology class Core (km²), and percent area of morphology class, by AOA. Output summary statistics are presented in a tabular format in a relational database.

It is assumed users of this SOP have prior knowledge of data paths, file locations, and repositories referenced in this SOP.

Requirements

- ArcGIS Pro, Spatial Analyst extension enabled.
- Network connection to X:\ drive for access to data.
- SSMS 2014 connection to StatsQA database, proper permissions to write to StatsQA.
- UPDATED Landscape Dynamics AOA feature classes reflecting most recent LRD updates (SOP 2.11.6; Kinseth and Nelson 2018d); any custom AOAs provided by Networks or other IMD Staff (SOP 2.11.8; Kinseth and Nelson 2018b).

Pre-Processing

1. Create a scratch directory on a local drive.
2. Copy all necessary source data, AOAs, tables, etc to the local scratch drive.
 - a. Source rasters are located:
X:\ProjectData\LandscapeDynamics\Pattern\SourceData,
X:\ProjectData\LandscapeDynamics\Pattern\Products\Seamless

- b. Reclassification tables are located:
X:\ProjectData\LandscapeDynamics\SourceData\Reclassification_Lookups\MSPA_Reclassifications.gdb.
- c. AOAs are located:
X:\ProjectData\LandscapeDynamics\SourceData\Boundary

Note: If running statistics for NEW Pattern Morphology source data, Pattern Morphology Raster Processing must occur before statistics can be created (SOP 2.11.15; Nelson and Kinseth 2018).

Processing

Copy all data locally, and run all processing locally.

AOA Feature Class(es)

In most cases, summary statistics will be updated annually only for those AOAs that have changed from the previous year. This AOA change is detected either with 1) new and/or updated Custom AOAs submitted by a Network or Cooperator through the annual update process (SOP 2.11.8; Kinseth and Nelson 2018b), or 2) Land Resources Division (LRD) releases an updated version of a Landscape Dynamics park boundary (SOP 2.11.5; Kinseth and Nelson 2018c).

1. For running pattern morphology statistics for updated/changed AOAs, use the temporary feature class(es), by geographical extent, created during AOA processing.
 - a. For 30km, derived from LRD boundary release,
\\LandscapeDynamics_AOA.gdb\<*_temp> (SOP 2.11.6; Kinseth and Nelson 2018d)
 - b. For Custom, based on new or altered Custom AOAs submitted by Network/Year,
\\Network_CustomAOAs\<Network>\<Year>\<*_temp> (SOP 2.11.8; Kinseth and Nelson 2018b)

NOTE: not all AOA types will have updated AOAs, and not all extents within each type will have updated AOAs.

2. If running pattern morphology statistics for all AOAs of a type, use a local copy of the respective AOAs geodatabase (same locations as noted above), including all AOAs.

Run Summary Statistics Tool

1. Run the **Pattern Morphology** tool (Figure 1):
 - a. General processing steps of the tool:
 - i. Clip source raster to the area of analysis; Reclassify clipped raster using the appropriate reclassification table; Add and populate CLASSNAME attribute in reclassified output raster; Calculate using pixel count math the summary statistics for the reclassified raster with AOA_FEATURE_SQKM, TAREA_SQKM, PCT_AREA, and AOA_NAME fields in the output table.

2. Run statistics for the following AOAs, for all cover types, where pattern data is available.

a. 30km, Custom AOAs

The screenshot shows the 'Pattern Morphology' tool interface within a 'Geoprocessing' window. The interface has a title bar with standard window controls and a navigation pane on the left with a back arrow. The main area is titled 'Pattern Morphology' and contains two tabs: 'Parameters' (selected) and 'Environments'. A help icon (?) is in the top right. The 'Parameters' tab lists several input fields, each preceded by a red asterisk (*). The fields are: 'Pattern Morphology Raster Source Folder' (with a folder icon), 'Morphology Year' (text input), 'Pattern Morphology Source (NLCD)' (text input), 'Target Type (Forest, Grassland, Shrubland, Wetland)' (text input), 'Indicator Raster' (with a folder icon), 'No Transition Reclassification Table' (with a folder icon, containing the text 'MSPA_NoTransition_Reclass_RasterDisplay'), 'Source AOA Feature Dataset' (with a folder icon), 'Feature Class' (with a folder icon), 'AOA Suffix' (text input), 'Output Folder' (with a folder icon, containing the text 'Morph'), 'StatsQA Database Connection' (with a folder icon), and 'Full AOA List (Feature Class)' (with a folder icon). At the bottom right, there is a 'Run' button with a play icon.

Figure 1. Parameter entry gui for the Pattern Morphology Tool (Table 1). Depending on the number of AOAs, the script may take several hours to days to run.

Table 1: Options to use for parameters in the Pattern Morphology Tool.

Parameter	Notes
Pattern Morphology Raster Source Folder	Folder that contains the rasters for the cover type and source year of interest
Morphology Year	YYYYvYY (NLCD)
Pattern Morphology Source	NLCD
Target Type (Forest, Grassland, Shrubland, Wetland)	One of four cover type options
Indicator Raster	Indicator raster for cover type and source year of interest
No Transition Reclassification Table	MSPA_NoTransition_Reclass_RasterDisplay
Source AOA Feature Dataset	The feature dataset that contains the unique AOA feature classes.
Feature Class	The combined feature class list within the Source AOA Feature Dataset. Includes all the AOA feature classes to be included in the statistics calculations.
AOA Suffix	The identifier for the AOA type (i.e. 30km)
Output Folder	The local Scratch folder
Stats QA Database Connection	An optional parameter; can be left blank if summary statistics should not be copied to the database for QA.
Full AOA List (Feature Class)	The complete, combined feature class list within the Source AOA Feature Dataset. Includes all the AOA feature classes to be included in the statistics calculations. May be the same feature class as parameter "Feature Class"

Summary statistics table details

The **Pattern Morphology** tool will iterate through all AOAs in the input feature class and produce statistics in multiples tables (Table 2, Table 3, Table 4) within a file geodatabase; if desired, output statistics tables are then copied to SQL Server (StatsQA) for the QAQC process (SOP 3.11.13; Kinseth and Nelson 2018a).

Table 2. Summary statistics table details, by grouped morphology class types

P<f, g, s, w>morph_<EdgeWidth>_stats

Field	Definition
VALUE	Identifier of CLASSNAME
COUNT	Number of cells in respective morphology class
CLASSNAME	Descriptive name of morphology class
AOA_NAME	The AOA name specified in the script input
EDGE_WIDTH	1 (cell width), or 5 (cell width)
AOA_AREA_SQKM	Area of respective AOA polygon feature, in square kilometers, taken from vector source
TAREA_SQKM	Total area of respective AOA, in square kilometers, calculated from raster cells: $TAREA_SQKM = (SUM(COUNT) * cell\ size^2) / 1,000,000$
AREA_SQKM	Total area, in square kilometers, of each morphology class, calculated from raster cells $AREA_SQKM = (COUNT * cell\ size^2) / 1,000,000$
PCT_AREA	Percent area of respective morphology class, within respective AOA $PCT_AREA = (AREA_SQKM / TAREA_SQKM) * 100$
DATE_CALC	Date the statistics were calculated, YYYYMMDD format
PARK_CODE	If applicable, four-letter park code
CreateDate	Date the statistics were calculated for the respective AOA
TOTAL_AOA_AREA_SQKM	Area calculated, in script, from the feature class (AOA) in use
DATA_YEAR	Year the source data represents
DATA_VERSION	Source and year
COVER_TYPE	Source data cover type, from parameter field Target Type
AOA_DATE	Date AOA was created in GIS; from AOA source feature class
Code_Class_Area	Code indicating statistics values are related to Morphology Class areas, by Window Size; values are added to table in QAQC. (Appendix 3)
Code_Percent_Area	Code indicating statistics values are related to Morphology Percent Class areas, by Window Size; values are added to table in QAQC. (Appendix 3)

Table 3. Summary statistics table details, morphology class type Core

P<f, g, s, w>morph_<EdgeWidth>_core_stats

Field	Definition
FREQUENCY	Number of occurrences of respective patch size
PATCHSIZE_SQKM	Based on frequency/count of joined cells (1 cell, 30m (900m2)) Based only on patches categorized as Core
EDGE_WIDTH	1 (cell width), or 5 (cell width)
AOA_NAME	The AOA name specified in the script input
DATE_CALC	Date the statistics were calculated, YYYYMMDD format
PARK_CODE	If applicable, four-letter park code
CreateDate	Date the statistics were calculated for the respective AOA
DATA_YEAR	Year the source data represents
DATA_VERSION	Source and year
COVER_TYPE	Source data cover type, from parameter field Target Type
AOA_DATE	Date AOA was created in GIS; from AOA source feature class
Code_Core_Freq	Code indicating statistics values are related to Morphology Core areas; Edge Width 1: PM_PF_CORE1-1; Edge Width 5: PM_PF_CORE2-1. (Appendix 3)

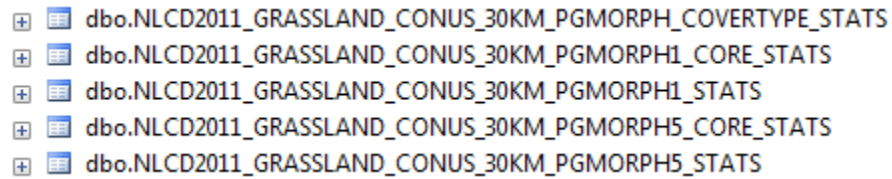
Table 4. Summary statistics table details, morphology cover type

P<f, g, s, w>morph_covertime_freq

Field	Definition
FREQUENCY	Number of occurrences of respective patch size
PATCHSIZE_SQKM	Based on frequency/count of joined cells (1 cell, 30m (900m2)) Area of patches of respective cover type found within the AOA, not based on edge width or classification (class type) of patch
AOA_NAME	The AOA name specified in the script input
DATE_CALC	Date the statistics were calculated, YYYYMMDD format
CreateDate	Date the statistics were calculated for the respective AOA
PARK_CODE	If applicable, four-letter park code
DATA_YEAR	Year the source data represents
DATA_VERSION	Source and year
COVER_TYPE	Source data cover type, from parameter field Target Type
AOA_DATE	Date AOA was created in GIS; from AOA source feature class
Code_Covertime_Freq	Code indicating statistics values are related to general covertime; PM_PF1 (Appendix 3)

Post-Processing

1. After the tool runs successfully for all cover types, and all AOAs, confirm all the summary statistics output table(s) are copied to SQL Server (if desired). Check for tables in StatsQA database in SQL Server (Figure 2).

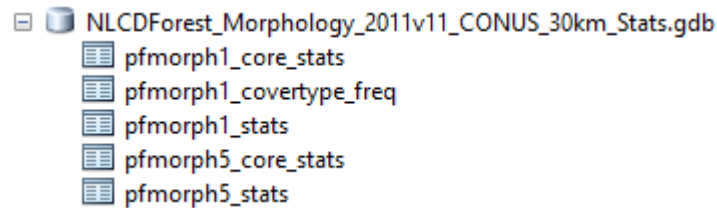


The screenshot shows a list of five tables in the StatsQA database, each preceded by a small icon representing a table. The table names are:

- dbo.NLCD2011_GRASSLAND_CONUS_30KM_PGMORPH_COVERTYPE_STATS
- dbo.NLCD2011_GRASSLAND_CONUS_30KM_PGMORPH1_CORE_STATS
- dbo.NLCD2011_GRASSLAND_CONUS_30KM_PGMORPH1_STATS
- dbo.NLCD2011_GRASSLAND_CONUS_30KM_PGMORPH5_CORE_STATS
- dbo.NLCD2011_GRASSLAND_CONUS_30KM_PGMORPH5_STATS

Figure 2. Example of tables in the StatsQA Database.

2. Move the output geodatabase (Figure 3) from local Scratch location to X:\ProjectData\LandscapeDynamics\Pattern\Products\Statistics\YYYY



The screenshot shows a file explorer window displaying a folder named 'NLCDForest_Morphology_2011v11_CONUS_30km_Stats.gdb'. Inside this folder, there are five sub-files, each with a small icon representing a geodatabase table. The file names are:

- pfmorph1_core_stats
- pfmorph1_covertime_freq
- pfmorph1_stats
- pfmorph5_core_stats
- pfmorph5_stats

Figure 3. Example output geodatabase (GDB)

3. Move to Morphology QAQC (SOP 3.11.13; Kinseth and Nelson 2018a).

Literature Cited

- Environmental Systems Research Institute (ESRI). 2017. How To: Redirect where ArcInfo Workstation and/or ArcGIS writes temporary or scratch files during processing website. <http://support.esri.com/en/technical-article/000001418> (accessed 12/19/2017).
- Kineth, M. and L. Nelson. 2018a. Calculating statistics for national landscape dynamics metrics: Total and percent area per national land cover category. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.3. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018b. Creating custom areas of analysis for use as a part of the IMD Environmental Settings Protocol. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.8. National Park Service, Fort Collins, Colorado.
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- Nelson, L. and M. Kineth. 2018. Processing land cover source data to derive landscape dynamics metrics: Pattern. Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—2.11.15. National Park Service, Fort Collins, Colorado.

Appendix 1: Data Availability and Known Issues

Data availability

Pattern Morphology is derived from available NLCD (multiple years). NLCD data is updated approximately every five years.

Issues

Pattern Morphology summary statistics are only available for Grassland, Forest, Shrubland, or Wetland cover types (SOP 2.11.15; Nelson and Kineth 2018), and summary statistics for Pattern Morphology are available only for AOAs where data are available (NLCD-based, 30m resolution).

Spatial Reference

Data for the varying geographies should be in the spatial reference noted (Table 5).

Table 5. Standard spatial references by processing extent

Processing Extent	Spatial Reference Name (datum)	Well-known ID (WKID)
North America (US, Canada, Mexico)	USA Contiguous Albers Equal Area Conic USGS (NAD83)	WKID: 102039
CONUS	USA Contiguous Albers Equal Area Conic USGS (NAD83)	WKID: 102039
Puerto Rico and USVI	USA Contiguous Albers Equal Area Conic USGS (NAD83)	WKID: 102039
Alaska	Alaska Albers Equal Area Conic (NAD83)	WKID: 3338
Hawaii	UTM Zone 5N (NAD83)	WKID: 26905
American Samoa	NAD_1983_HARN_UTM_Zone_2S (NAD83 HARN)	WKID: 2195
<i>Transform (if needed):</i>	WGS_1984_(ITRF00)_To_NAD_1983 + NAD_1983_HARN_To_WGS_1984_2	
Guam	WGS_1984_UTM_Zone_55N (WGS84)	WKID: 32655
<i>Transform (if needed):</i>	WGS_1984_(ITRF00)_To_NAD_1983	
CN Mariana Islands	WGS_1984_UTM_Zone_55N (WGS84)	WKID: 32655
<i>Transform (if needed):</i>	WGS_1984_(ITRF00)_To_NAD_1983	

Appendix 2: Source Data

(X:\ProjectData\LandscapeDynamics\Pattern\Products\Seamless\), each cover type has two associated rasters for use in running the statistics (example shown):

  Pattern_ShrublandMorphology_EW1_NLCD2011.tif
  Pattern_ShrublandMorphology_EW5_NLCD2011.tif

Appendix 3: Morphology Metric Codes

Code, metric, and definition crosswalk table for Pattern Morphology.

Morphology Classname	Classname Value	Code, Area of Class (Edge Width 1)	Code, Area of Class (Edge Width 5)	Code, Percent of Class (Edge Width 1)	Code, Percent of Class (Edge Width 5)
Branch	1	PM1-1	PM2-1	PM3-1	PM4-1
Bridge	5	PM1-2	PM2-2	PM3-2	PM4-2
Core	4	PM1-3	PM2-3	PM3-3	PM4-3
Edge	2	PM1-4	PM2-4	PM3-4	PM4-4
Islet	3	PM1-5	PM2-5	PM3-5	PM4-5
Loop	7	PM1-6	PM2-6	PM3-6	PM4-6
Perforation	6	PM1-7	PM2-7	PM3-7	PM4-7

Cover Type	Code, Morphology Frequency	Code, Core Frequency (Edge Width 1)	Code, Core Frequency (Edge Width 5)
ALL	PM_PF1	PM_PF_CORE1-1	PM_PF_CORE2-1

Appendix 4: Error Handling

In some cases, **Pattern Morphology** may fail before completion of summary statistics for all AOAs of interest. This is particularly true for morphology, as the raster data can max out the available memory in ArcGIS and cause the program to crash mid-run. Additionally, unannounced and unavoidable forced rebooting of computers can also interrupt a statistics run.

Memory Error

If the error appears to be due to memory issues within ArcGIS or the local computer see ESRI (2017) to set the temp directory to a location with more space available. This may not completely resolve the memory issue, but it can help:

1. Use the following procedure to set an ARCTMPDIR system environment variable:
 - a. Navigate to Start > Control Panel > System and Security > System
 - b. Select Advanced system settings, and click the Environment Variables button.
 - c. Under System variables, click the New button and enter the following:
variable name: ARCTMPDIR
variable value: C:\temp (Replace c:\temp in the above with a disk location appropriate for the current user. The current user must have full read/write access to this location.)
 - d. Click OK on the New System Variable dialog box and click OK on the System Properties dialog box.
 - e. Restart ArcInfo or ArcGIS Desktop for this change to take effect.

Forced Reboot Error

If the script is interrupted for reasons other than memory, such as a computer reboot, resume the tool making sure the final parameter (Complete AOA Feature Class) is populated. This will allow the script to bypass AOAs already calculated in the partial statistics output table, and finish processing for missing AOAs only.