

Inventory & Monitoring Division

National Park Service



Standard Operating Procedure 3.11.4

Calculating Statistics for National Landscape Dynamics Metrics: Area without Roads

Please cite this as:

Kinseth, M. and L. Nelson. 2018. Calculating statistics for national landscape dynamics metrics: Area without roads. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.4. National Park Service, Fort Collins, Colorado.

Summary

This internal SOP outlines processes for running metric statistics for area without roads for use in Landscape Dynamics.

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Overview

This internal Landscape Dynamics SOP provides guidance on processing statistics for areas without roads, derived from TIGER line/road data.

A python toolbox is used to calculate these statistics for a suite of areas of analysis (AOA). AOAs for area without roads statistics include all HUC12 watersheds that intersect park boundaries, and Custom AOAs. Standardized file geodatabases are used as the sources of these AOA polygons (SOPs 2.11.6 and 2.11.8; Kinseth and Nelson 2018d, a). Custom AOAs are not created by IMD-GIS and 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 2018a).

Metrics calculated with this SOP include frequency of roadless patches of a size (km²), and roadless area patchsize (in km²), by AOA. Output summary statistics are presented in 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 source road data
- SSMS connection to StatsQA database, proper permissions to write to StatsQA.
- Updated Landscape Dynamics AOA feature classes reflecting most recent LRD updates (2.11.6) and current/updated HUC12 features (by park) (SOP 2.11.7; Kinseth and Nelson 2018b); any custom AOAs provided by Networks or other IMD Staff (SOP 2.11.8; Kinseth and Nelson 2018a).
- Concurrent year National Hydrography Dataset (High Resolution) feature classes for NHDHArea and NHDHWaterbody, see NHD High-resolution source data SOP (SOP 2.11.10; Kinseth and Nelson 2018e).

Pre-Processing

1. Create a scratch directory on a local drive.
2. Copy all necessary source data, tables, etc., to the local scratch drive.
 - a. TIGER road data are located:
X:\ProjectData\LandscapeDynamics\Roads\SourceData\TIGER_YYYY

- b. NHDH Water data is located:
X:\ProjectData\LandscapeDynamics\SourceData\Hydrology\NHDH_Water\YYYY
- c. AOAs located:
X:\ProjectData\LandscapeDynamics\SourceData\Boundary

Note: If there is new/updated TIGER road source data, it must be processed before statistics are created (SOP 2.11.13; Kinseth and Nelson 2018f).

Processing

Copy all data locally, and do 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 2018a), 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 area without road statistics for updated/changed AOAs, use the temporary feature class(es), by geographical extent, created during AOA processing.
 - a. For HUC12 watersheds, based on park bounds derived from LRD boundary release, \HUC12_AOA.gdb\<geography>\<*_temp> (SOP 2.11.7; Kinseth and Nelson 2018b)
 - b. For Custom, based on new or altered Custom AOAs submitted by Network/Year, X:\ProjectData\LandscapeDynamics\SourceData\Boundary\Network_CustomAOAs\<Network>\<Year>\<*_temp> (SOP 2.11.8; Kinseth and Nelson 2018a)

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

2. If running area without roads 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 **Area Without Roads** tool:
 - a. General processing steps of the tool:
 - i. From source road input, select roads of interest, create distance from road raster (using Euclidean Distance) with 120m pixel/cell size, snap raster to Landcover Level 2 GeoTIFF (or other raster valid for geography); set all pixels outside defined distance from road (120m) to '1', and create a constant

raster; convert constant raster to polygon and erase NHDH water features (select only those larger than 0.0144km²); intersect polygon layer with terrestrial boundary and AOA layer and clip; delete any remaining/remnant patches smaller than 0.0144km² (120x120m cell size); calculate size of all remaining polygons (patches); run Frequency on patches; generate summary statistics for Frequency, and patch sizes for each AOA.

Note: for island extents, the distance from roads used is 30m, the minimum water feature size is 0.0009km², and minimum roadless area patch size is also 0.0009km² (30m x 30m cell size).

2. AOAs to run, for all TIGER data years:

a. HUC12 AOAs, Custom AOAs

The screenshot shows the 'Area Without Roads' tool interface. The 'Parameters' tab is active, displaying a list of required inputs marked with red asterisks. The inputs include file paths for road data, terrestrial areas, and AOAs, as well as a data year, an output folder, and a snap raster. There is also a 'Select Statement' dropdown menu with a default value, an 'Islands' checkbox, a 'StatsQA Database Connection' field, and a 'Full AOA List' field. A 'Run' button is located at the bottom right of the parameter list.

Figure 1. Parameter entry gui for the Area without Roads Tool (Table 1). Depending on the number of AOAs*, the script may take a day or more to run

*In cases where there are more than approximately 600 AOA features (for instance, HUC12 AOAs), the tool might fail before the end of the AOA list is reached. See Appendix 4 for more.

Table 1: Options to use for parameters in the Area without Roads Tool.

Parameter	Notes
Road Source Feature Class	For TIGER roads, use a local copy of TIGER_YYYY.gdb and select the appropriate geographical extent
Data Year	Four-digit year of road source data, YYYY
Terrestrial Areas Feature Class	From LandscapeDynamics_Geographical_Boundaries.gdb, select the appropriate geographical extent
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 used in the statistics calculations. This might be the full feature class list, or a partial feature class list such as a *_temp feature class for updated/changed AOAs only.
AOA Suffix	The identifier for the AOA type (i.e. HUC12)
Output Folder	The local Scratch folder
Erase Features (optional)	NHDH water for YYYY corresponding to road source data. Exception: for 2010 TIGER, use water features obtained in 2015. Though an optional parameter, erase features should always be used if road source is TIGER. In all instance, use a local copy, X:\ProjectData\LandscapeDynamics\SourceData\Hydrology\NHDH_Water
Snap Raster	Landcover Level 2 raster to match geographical extent of road source data
Select Statement (optional)	This statement determines the types of roads included in the analysis. Default select statement is pre-populated in the tool and should not be altered or removed, except in rare and specific circumstances such as an alternate road source other than TIGER.
Islands (optional)	If the AOA of interest is on an island, this box MUST be checked. This applies to all AOAs for Hawaii, USVI, Guam, American Samoa, CNMI, and Puerto Rico. The distance-from-road threshold distance and minimum patch size are reduced for all island AOAs.
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*	The complete, combined feature class list within the Source AOA Feature Dataset. Includes all the AOAs to be used in the statistics calculations. May be the same feature class as parameter "Feature Class" (see Appendix 4)

Summary statistics table details

The **Area without Roads** tool will iterate through all AOAs in the input feature class and produce statistics tables within a file geodatabase (Table 2, Table 3); if needed, output statistics tables are copied to SQL Server for the QAQC process (SOP 3.11.15; Kinseth and Nelson 2018g).

Table 2. Summary statistics table details [awr_<YYYY>_<geography>_<AOA type>_clipped]

Field	Definition
AOA_NAME	The AOA name specified in the script input
PATCH_AREA_SQKM	The area in km ² of all patches of roadless area in AOA
Count	The number of patches of a size
TOTAL_AOA_AREA_SQKM	Total area of the AOA polygon in km ²
AREA_SQKM	Terrestrial area within an AOA (may be equal to TOTAL_AOA_AREA_SQKM in some cases) in km ²
THRESHOLD_DISTANCE	Distance from road, in meters, used to calculate area without roads (also cell size used in Euclidean Distance raster creation)
TERRESTRIAL_AOA_AREA_SQKM	The terrestrial area of the AOA (equal to AREA_SQKM); if AOA is coastal or on the border, this area will be less than TOTAL_AOA_AREA_SQKM
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
AOA_DATE	Date AOAs were officially incorporated for use in Landscape Dynamics
Code_Area_Patch	Code indicating statistics values are related to roadless area patches; AWR2

Table 3. Summary statistics table details

awr_<YYYY>_<geography>_<AOA type>_freq

Field	Definition
AOA_NAME	The AOA name specified in the script input
PATCH_AREA_SQKM	The area in km ² of all patches of roadless area in AOA
FREQUENCY	The sum of all occurrences of patches of a size within an AOA
THRESHOLD_DISTANCE	Distance from road, in meters, used to calculate area without roads (also cell size used in Euclidean Distance raster creation)
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
AOA_DATE	Date AOAs were officially incorporated for use in Landscape Dynamics
Code_AwR_Freq	Code indicating statistics values are related to roadless area patch frequency; AWR1

Post-Processing

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

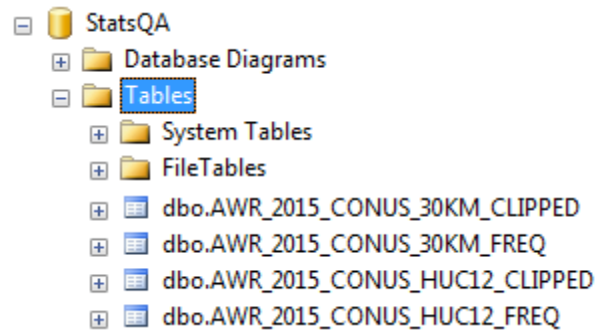


Figure 2. Output geodatabase (GDB) example

2. **MOVE** the output geodatabase (Figure 3) from local drive to X:\ProjectData\LandscapeDynamics\Roads\Products\Statistics\<YYYY>

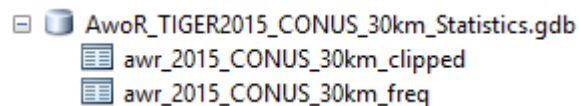


Figure 2. Output geodatabase (GDB) example

3. Proceed to Area without Roads QA/QC (SOP 3.11.15; Kinseth and Nelson 2018g)

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. 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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- Kineth, M. and L. Nelson. 2018c. NPS unit boundary processing: Boundaries for use for analysis and reporting as a part of the IMD Environmental Settings Protocol. Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—2.11.5. National Park Service, Fort Collins, Colorado.
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- Kineth, M. and L. Nelson. 2018e. Processing source data to derive landscape dynamics metrics: NHD high-resolution source data. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.10. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018f. Processing source data to derive landscape dynamics metrics: Road source data. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.13. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018g. Quality assurance and quality control for landscape dynamics metrics: Area without roads. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.15. National Park Service, Fort Collins, Colorado.

Appendix 1: Data Availability and Known Issues

Data Availability and Update Schedule

Tiger Roads is a product of the US Census. Since 2013, TIGER line/road data in file geodatabase format has been released annually. NHDH data is also released annually, see NHD High-resolution source data SOP (SOP 2.11.10; Kinseth and Nelson 2018e).

Area without Roads at International Borders

Any AOA that abuts or is within 10km distance of an international border (Canada, Mexico) will not reflect accurate roadless area patch sizes for Area without Roads summary statistics. TIGER Roads data only represents roads for the Continental US, AK, HI, and outlying island territories. Any roads crossing international borders are not accounted for beyond the border, because the area without roads tool uses a 10km buffer of an AOA to fully capture road networks, those international boundary areas will not be accurately represented in the statistics processing. This should be taken into account when reporting on roadless area for these AOAs.

Possible Summary Statistics Issues

Patches at the edge of a desired AOA are potentially clipped patches of larger patches of areas without roads. Take into account the possible clipped-edge effect when considering patches and patch-sizes for an AOA. Utilize the seamless area without roads layers on the Landscape Dynamics Viewer to determine the extent of any edge patches

(<https://nps.maps.arcgis.com/apps/webappviewer/index.html?id=2ec2585fa978404fbe316ec280645518>)

Spatial Reference

Data for the varying geographies should be in the spatial reference noted, by extent (Table 4).

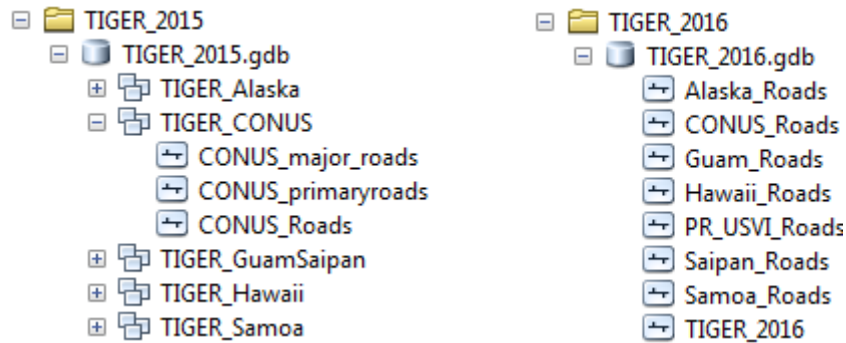
Table 4. Standard spatial references by processing extent

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	

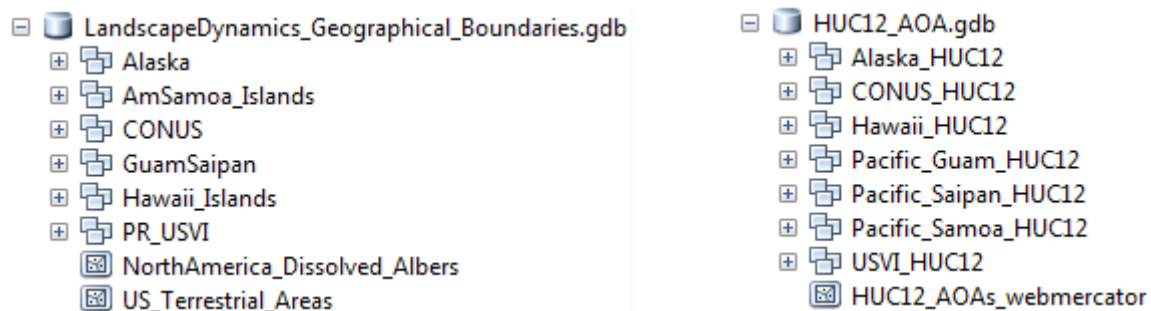
Appendix 2: Source Data

Source TIGER Data *example* (X:\ProjectData\LandscapeDynamics\Roads\SourceData)

Note: beginning in 2016, TIGER roads data will contain one feature class for roads, by extent:

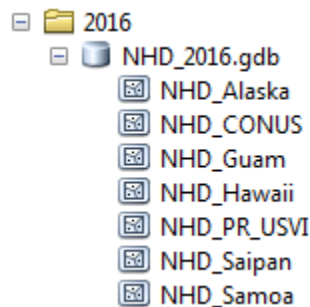


Source Terrestrial Area Boundaries and Standardized Source AOAs (Custom AOAs example not shown) (X:\ProjectData\LandscapeDynamics\SourceData\Boundary):



Example NHDH Water Data, by year

(X:\ProjectData\LandscapeDynamics\SourceData\Hydrology\NHDH_Water)



Appendix 3: Area without Roads Metric Codes

Code, metric, and definition crosswalk table for Road Density.

Metric	Code
Roadless Patch Frequency	AWR1
Roadless Patch Area	AWR2

Appendix 4: Error Handling

In some cases, the **Area without Roads** tool may fail before completion of summary statistics for all AOAs of interest. This is particularly true for HUC12 AOAs in Alaska and CONUS, as the raster data can max out 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 with the appropriate feature class. This will allow the script to bypass AOAs already calculated in the partial statistics output table, and finish processing for missing AOAs only.