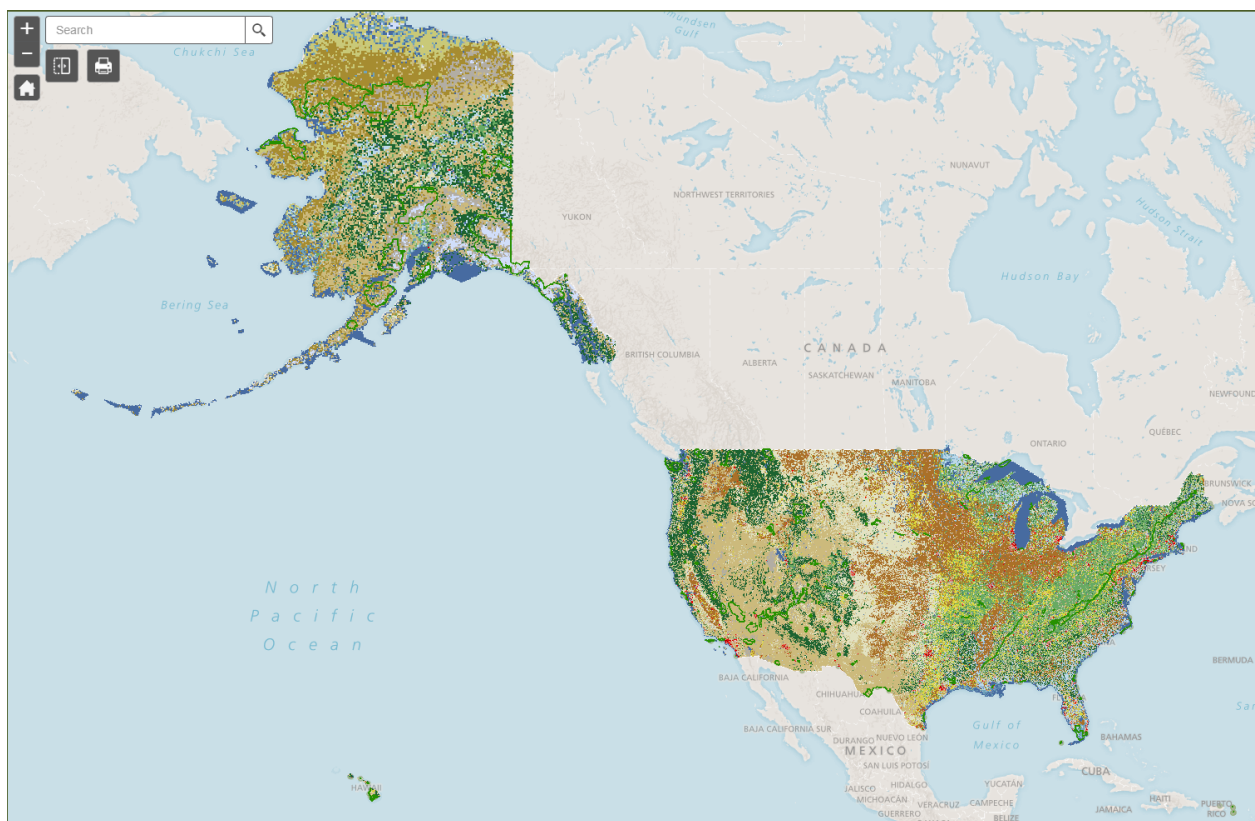




Data Quality Standards for Monitoring Environmental Setting of National Park Service Units

Natural Resource Report NPS/IMD/NRR—2018/1845



ON THE COVER

Landscape Dynamics Viewer showing quality controlled land cover data
NPS Inventory and Monitoring Division

Data Quality Standards for Monitoring Environmental Setting of National Park Service Units

Natural Resource Report NPS/IMD/NRR—2018/1845

Lisa Nelson¹, Michelle Kinseth² and Joe C. DeVivo¹

¹National Park Service
Inventory and Monitoring Division
1201 Oakridge Drive, Suite 150
Fort Collins, Colorado 80525

²Managed Business Solutions
1201 Oakridge Drive, Suite 150
Fort Collins, Colorado 80525

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Introduction and Summary

This report documents the standards used by the NPS Inventory and Monitoring central office for activities related to the collection, processing, storage, analysis, and publication of data as described in the national Park Environmental Settings Protocol (DeVivo et al. 2018). The policies and procedures documented complement the quality-assurance standard operating procedures conducted by the NPS Inventory and Monitoring central office and supplement the National Inventory & Monitoring Division Quality Management Plan (DeVivo in review). The plan also serves as a guide for all central office personnel who are involved in Environmental settings protocol activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Overview

The Environmental Settings protocol provides metrics for natural systems, conservation context, climate, and stream hydrology for areas within and around all park units within NPS. These derived metrics comprise a general set of measures for understanding the landscape context and condition of parks. The national park environmental setting protocol produces a suite of roughly 1,000 nationally-standardized metrics that are reported at multiple scales—from parks to watersheds to standardized areas around parks.

Protocol Activities and Modules

Data are acquired and derived from regionally- to nationally-standardized external source data through 20 different activities (Table 1). Metrics describing landscape dynamics (land cover, human use and disturbance, and conservation status) as well as climate and hydrologic conditions are derived for each relevant monitoring station or Area of Analysis of interest to each park. The periodicity of new data availability varies among data source ranging from daily to decadal, with some data updated intermittently following quality assurance procedures conducted by each data source provider. Landscape dynamics metrics are calculated annually when new data are published/available, or as updated or corrected versions of previously-published source data are made available. Climate and hydrologic metrics are derived annually.

Table 1. Protocol activity matrix for NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Category	Activity Number	Activity	Description
Site Recon, Establishment, and Maintenance	1	Area of Analysis (AOA)	Identification and generation of area of analysis (AOA) polygons for use in generating statistics for landscape dynamics metrics and identification of relevant climate and hydrologic monitoring stations (SOPs 2.11.6-2.11.8; Kinseth and Nelson 2018k, j, i)
External Data	2	Preprocess Land Cover Data	Acquisition and staging of appropriate land cover data for use in derivation of land cover and landscape pattern metrics (SOPs 2.11.9-2.11.11 and 2.11.15; Kinseth and Nelson 2018l, o, m, Nelson and Kinseth 2018a).
	3	Preprocess Census Data	Transformation and staging of census block data for use in derivation of human population and housing metrics (SOPs 2.11.12 and 2.11.16 Kinseth and Nelson 2018p, In Development).
	4	Preprocess Conservation Status Data	Transformation and staging of conservation type and ownership data for use in derivation of conservation status metrics (SOP 2.11.19; Kinseth and Nelson 2018n)
	5	Preprocess Road Data	Transformation and staging of census road data for use in derivation of road metrics (SOPs 2.11.13-14; Kinseth and Nelson 2018q, Nelson and Kinseth 2018b)
Derived Data	6	Calculate Land Cover Level 1 and 2 Metrics	For each AOA: Total and percent area of each land use / land cover class (SOP 3.11.3; Kinseth and Nelson 2018h).
	7	Calculate Natural and Converted Land Cover Metrics	For each AOA: Total and percent area of all natural or converted land use / land cover classes (SOP 3.11.6; Kinseth and Nelson 2018g)
	8	Calculate Impervious Surface Metrics	For each AOA: Total and percent area per impervious surface class. Average, minimum, and maximum patch size and total number of patches classified as impervious surface, and frequency of patches by size and class (SOP 3.11.5; Kinseth and Nelson 2018b).
	9	Calculate Pattern Morphology Metrics	For each AOA: Total and percent area per morphological class, frequency of Core class patches, by patch size, and frequency of cover type patches (all classes), by patch size; calculated for each AOA (SOP 3.11.2; Kinseth and Nelson 2018d)
	10	Calculate Land Cover Density Metrics	For each AOA: Total and percent area per density class, per individual class, and per class group (SOP 3.11.1; Kinseth and Nelson 2018c)
	11	Calculate Housing Metrics	For each AOA: Total and percent area per housing density class
	12	Calculate Human Population Metrics	For each AOA: Area-weighted population total and area-weighted population density (people per sq.km) (SOP 3.11.7; Kinseth and Nelson 2018e)

Table 2 (continued). Protocol activity matrix for NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Category	Activity Number	Activity	Description
Derived Data (continued)	13	Calculate Road Density Metrics	For each AOA: Total length of roads, length of roads per sq. km (SOP 3.11.8; Kinseth and Nelson 2018f)
	14	Calculate Area Without Roads Metrics	For each AOA: Area of patches without roads, and frequency of patches of area without roads, by patch size (SOP 3.11.4; Kinseth and Nelson 2018a)
	15	Calculate Conservation Status Metrics	For each AOA: Total and percent area per protection category, total and percent area per ownership category, frequency of ownership per ownership category, and sum of all area per ownership category
	16	Calculate Climate Station Metrics	For each monitoring station: Number of days above or below thresholds of interest for temperature and precipitation, Number of days between the last and first frost of each calendar year, Heating and cooling degree days, Monthly temperature, precipitation, and snowpack departures from climate normals (SOP 3.6.1; Nelson 2018)
	17	Calculate Climate Gridded Metrics	For each AOA: Number of days above or below thresholds of interest for temperature and precipitation, Number of days between the last and first frost of each calendar year, Heating and cooling degree days, Monthly temperature, precipitation, and snowpack departures from climate normals. Monthly Palmer Drought Severity Index and Standardized Precipitation Index. (SOP 3.6.1; Nelson 2018)
	18	Calculate Hydrologic Index Tool Metrics	For each monitoring station: calculate metrics describing duration, frequency, magnitude, timing, and rates of change of flow events (SOP 3.3.1; DeVivo 2018a).
	19	Calculate Fundamental Daily Streamflow Statistics	For each monitoring station: Calculate metrics used to classify streams based on daily flow signal, including mean, coefficient of variation, skewness, kurtosis, the autoregressive lag-one, correlation coefficient, amplitude, and phase (SOP 3.3.1; DeVivo 2018a).
	20	Calculate Indicators of Hydrologic Alteration	For each monitoring station: Calculate metrics describing monthly water conditions, annual extreme water conditions, timing of annual extreme conditions, frequency and duration of high and low pulses, and rate and frequency of water condition changes (SOP 3.3.2; DeVivo 2018b).

Sampling Design

Information regarding the sampling design is provided in Table 2 (DeVivo et al. 2018).

Table 3. Activity-level sample design matrix for the NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Category	Activity Number	Activity	Sampling Design	Revisit Design
Derived Data	6	Calculate Land Cover Level 1 and 2 Metrics	Targeted; calculated for each AOA	Revisit annually to every five years depending on availability of updates from data sources.
	7	Calculate Natural and Converted Land Cover Metrics	Targeted; calculated for each AOA	Revisit annually to every five years depending on availability of updates from data sources.
	8	Calculate Impervious Surface Metrics	Targeted; calculated for each AOA	Revisit annually to every five years depending on availability of updates from data sources.
	9	Calculate Pattern Morphology Metrics	Targeted; calculated for each AOA	Revisit annually to every five years depending on availability of updates from data sources.
	10	Calculate Land Cover Density Metrics	Targeted; calculated for each AOA	Revisit annually to every five years depending on availability of updates from data sources.
	11	Calculate Housing Metrics	Targeted; calculated for each AOA	Revisit every ten years.
	12	Calculate Human Population Metrics	Targeted; calculated for each AOA	Revisit every ten years.
	13	Calculate Road Density Metrics	Targeted; calculated for each AOA	Revisit annually.
	14	Calculate Area Without Roads Metrics	Targeted; calculated for each AOA	Revisit annually
	15	Calculate Conservation Status Metrics	Targeted; calculated for each AOA	Revisit annually.
	16	Calculate Climate Station Metrics	Targeted; calculated for each Monitoring Station	Revisit annually.
	17	Calculate Climate Gridded Metrics	Targeted; calculated for each AOA	Revisit annually.
	18	Calculate Hydrologic Index Tool Metrics	Targeted; calculated for each Monitoring Station	Revisit annually.
	19	Calculate Fundamental Daily Streamflow Statistics	Targeted; calculated for each Monitoring Station	Revisit annually.
	20	Calculate Indicators of Hydrologic Alteration	Targeted; calculated for each Monitoring Station	Revisit annually.

Data Quality Objectives

Data quality values and quality objectives for implementation are provided in Table 4 and Table 4.

Table 4. Data Quality Values (DQVs) for the NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Type	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	Source data used for derivation of landscape dynamics, climate, and hydrologic measures must be accompanied by suitable documentation—including a quality assurance plan—to allow for evaluation of data quality prior to use.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Monitoring station locations for hydrologic and climate metrics are selected for inclusion in this protocol based on proximity to park units. Hydrologic monitoring stations may also be selected based on connectivity of the monitored resource to parks (only those stations that are deployed in waters flowing into or out of park boundaries are included).
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	For landscape dynamics metrics, data values are comparable over time regardless of source data used for metric calculation. Data sources are selected, in part, based on planned repeat intervals of data collection and dissemination. Potential and new sources are evaluated to ensure that derived metric calculations maintain comparability across location and time.
	Completeness	All data/ measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	Data sources used for metric calculation must cover the entire Area of Analysis being evaluated and/or the entire period of record being analyzed. Source data used for derivation of climate and hydrologic measures must be accompanied by suitable documentation—including a quality assurance plan—to allow for evaluation of data quantity across periods of record of interest prior to use.

Table 5 (continued). Data Quality Values (DQVs) for the NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Type	Data Quality Value	Definition	Protocol Considerations
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	For any given park unit, definitions of derived metrics will remain constant over time, regardless of source data used or methods used for calculation.
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	The Central Office must identify and ensure that potentially protected data, including sensitive species location data, sensitive cultural resource information, and other data as protected by DO#66 are not released to the public. Protected data may be released in limited cases only with park Superintendent approval following park procedures. Wherever defined and approved by park staff, the Central Office will adopt network-defined procedures for consistent dissemination of protected information (location fuzzing, redaction, etc.)

Table 6. Quality Objectives for NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Activity	Measure/Quality Indicator	Quality Objective
1. Area of Analysis Definition	Location Accuracy	Areas of Analysis (AOAs) contain or are adjacent to park of interest
6-15. Shared Landscape Dynamics Measurement Quality Objectives	Completeness	Metrics calculated for 100% of AOAs
	Precision	Metrics for area are reported with a precision of +/- 0.01 km ² for raster- and vector-based calculations.
6. Land Cover Level 1 and 2 Metrics	Metric Resolution	Reported to 0.01km ²
	Classification Summary	Level 1: (NLCD): 9 classes Level 2 (NLCD or CCAP): 20 or 21 classes (continental U.S. – varies by source date) 20 classes (Alaska) 29 classes (Hawaii) 17, 18, or 20 classes (outlying islands)

Table 7 (continued). Quality Objectives for NPS Park Environmental Setting Protocol (DeVivo et al. 2018).

Activity	Measure/Quality Indicator	Quality Objective
7. Natural and Converted Land Cover Metrics	Metric Resolution	Reported to 0.01km ²
	Classification Summary	2 classes
8. Impervious Surface Metrics	Metric Resolution	Reported to 0.01km ²
	Classification Summary	100 classes (discrete) 9 classes (grouped)
9. Pattern Morphology Metrics	Metric Resolution	Reported to 0.01km ²
	Classification Summary	7 classes for 2 edge widths: 30m and 150m
10. Land Cover Density Metrics	Metric Resolution	Reported to 0.01km ²
	Classification Summary	6 classes (grouped)
11. Housing Metrics	Metric Resolution	TBD ^a
	Classification Summary	TBD ^a
12. Human Population Metrics	Metric Resolution	Reported to 0.01km ²
13. Road Density Metrics	Metric Resolution	Reported to 0.01km ²
14. Area without Roads Metrics	Metric Resolution	Reported to 0.01km ²
15. Conservation Status Metrics	Metric Resolution	TBD ^b
	Classification Summary	TBD ^b
16. Climate Station Metrics	Comparability	100% of metrics calculated or retrieved via R code match those published by ACIS (for ACIS-provided data only).
17. Gridded Climate Metrics	Comparability	100% of metrics calculated or retrieved via R code match those published by PRISM or index-based source.
18. Hydrologic Index Tool Metrics	Comparability	100% of metrics calculated via R code match those published by USGS.
19. Fundamental Daily Streamflow Statistics	Comparability	100% metrics calculated via R code match those published by USGS.
20. Indicators of Hydrologic Alteration Metrics	Comparability	100% of metrics calculated via R code match those calculated using the desktop tool developed by The Nature Conservancy.

^a Not implemented at protocol inception due to lack of suitable source data.

^b Not implemented at protocol inception due to errors in source data.

Taxonomic Data Standards

No biological data are collected or managed as a part of this protocol.

Protected Data Standards

At the time of implementation, no protected data are used as a part of this protocol (all data sources are available in the public domain). If/when new data sources are evaluated for use in the implementation of this protocol, each will be screened to determine whether they contain data that should be protected, and rules for dissemination will be established in consultation with appropriate parks.

Literature Cited

- DeVivo, J. C. 2018a. Calculation of Hydrologic Indicator Tools metrics and Fundamental Daily Streamflow Statistics. Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—3.3.1. National Park Service, Fort Collins, Colorado.
- DeVivo, J. C. 2018b. Calculation of Indicators of Hydrologic Alteration metrics. Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—3.3.2. National Park Service, Fort Collins, Colorado.
- DeVivo, J. C. in review. DRAFT quality management plan for the National Park Service Inventory & Monitoring Program: guidance for vital signs monitoring protocols Fort Collins, Colorado.
- DeVivo, J. C., L. Nelson, M. Kineth, T. Philippi, and W. B. Monahan. 2018. Protocol for monitoring environmental setting for National Park Service units: Landscape dynamics, climate, and hydrology. Natural Resource Report NPS/IMD/NRR—2018/1844. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018a. 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.
- Kineth, M. and L. Nelson. 2018b. Calculating statistics for national landscape dynamics metrics: Impervious surface. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.5. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018c. Calculating statistics for national landscape dynamics metrics: Pattern density. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.1. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018d. Calculating statistics for national landscape dynamics metrics: Pattern morphology. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.2. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018e. Calculating statistics for national landscape dynamics metrics: Population density and total population. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.7. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018f. Calculating statistics for national landscape dynamics metrics: Road density. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.8. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018g. Calculating statistics for national landscape dynamics metrics: Total and percent area for natural and converted land cover. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.11.6. National Park Service, Fort Collins, Colorado.

- Kineth, M. and L. Nelson. 2018h. 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. 2018i. 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.
- Kineth, M. and L. Nelson. 2018j. Creating HUC12 areas of analysis for use with the IMD Environmental Settings Protocol. Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—2.11.7. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018k. NPS unit boundary processing: Boundary-derived areas of analysis for use as a Part of the IMD Environmental Settings Protocol Inventory & Monitoring Division Standard Operating Procedure NPS/IMD/SOP—2.11.6. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018l. Processing land cover source data to derive landscape dynamics metrics: Anderson Level 1 and 2 classification, and natural vs. converted land use Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.9. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018m. Processing land cover source data to derive landscape dynamics metrics: Impervious surface. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.11. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018n. Processing land cover source data to derive landscape dynamics metrics: Protected area data. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.19. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018o. 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. 2018p. Processing source data to derive landscape dynamics metrics: Population source data. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.12. National Park Service, Fort Collins, Colorado.
- Kineth, M. and L. Nelson. 2018q. 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. In Development. Processing land cover source data to derive landscape dynamics metrics: Housing density source data—Version 1.0 Inventory & Monitoring Program

Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.16. National Park Service, Fort Collins, Colorado.

Nelson, L. 2018. Processing climate metrics as a part of the IMD Environmental Settings Protocol. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—3.6.1. National Park Service, Fort Collins, Colorado.

Nelson, L. and M. Kinseth. 2018a. 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.

Nelson, L. and M. Kinseth. 2018b. Processing source data to derive landscape dynamics metrics: Area without roads. Inventory & Monitoring Program Standard Operating Procedure NPS/NRSS/IMD/SOP—2.11.14. National Park Service, Fort Collins, Colorado.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525