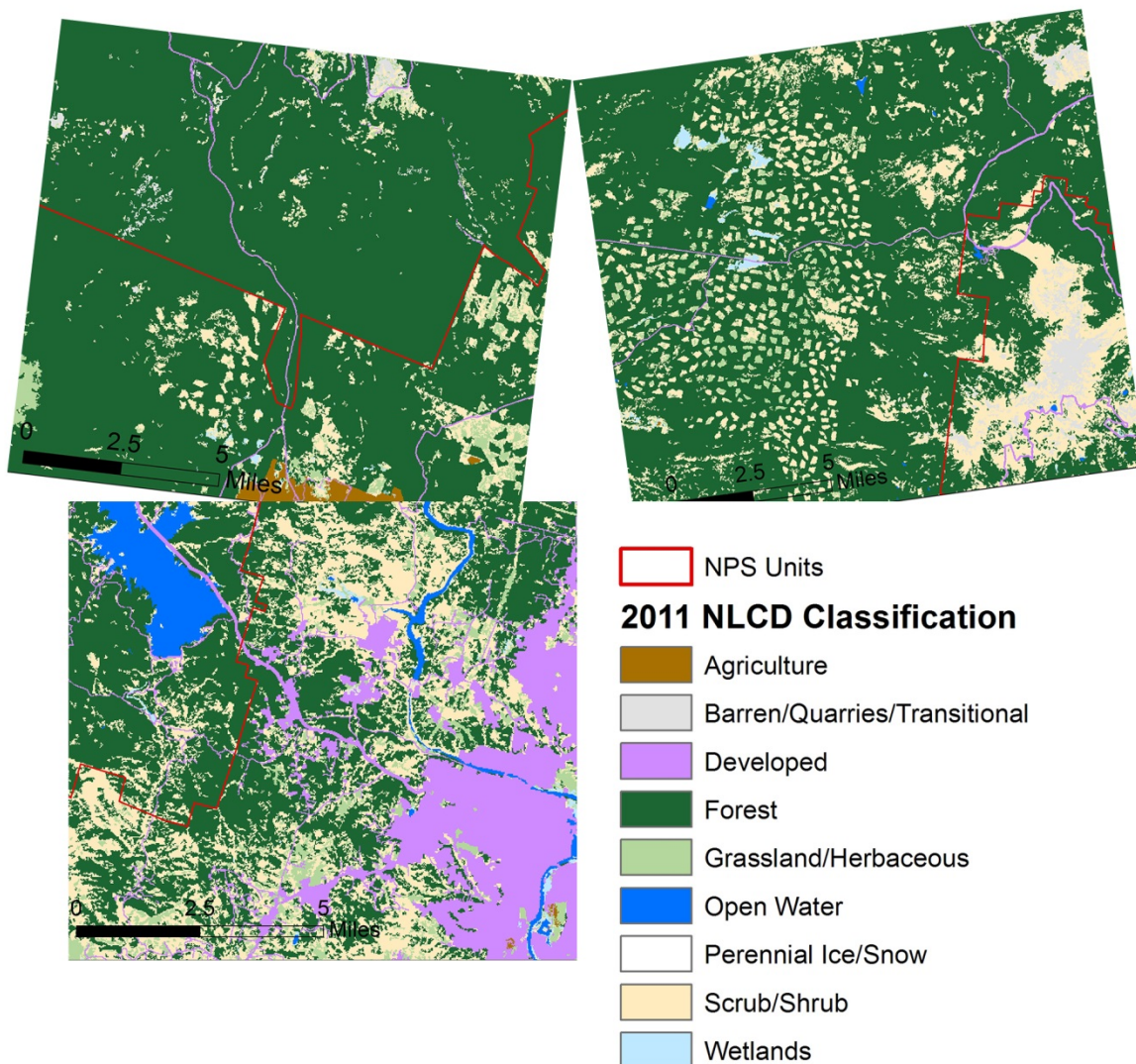




Land Cover and Land Use Monitoring Protocol for the Klamath Network

Standard Operating Procedures, Version 1.0



ON THE COVER

National Land Cover Database imagery for: southeastern Crater Lake National Park (top, left), eastern Whiskeytown National Recreation Area (bottom), and northwestern Lassen Volcanic National Park (top, right), showing probable human impacts in the form of development near the boundaries of these parks.

Map image design by: Lorin Groshong, Southern Oregon University

Land Cover and Land Use Monitoring Protocol for the Klamath Network

Standard Operating Procedures, Version 1.0

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Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

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These standard operating procedures are associated with the following protocol narrative, which is available from IRMA using this clickable link:

[Mohren, S. R., L. C. Groshong, D. A. Sarr, A. Snyder, and A. Chung-MacCoubrey. 2016. Land cover and land use monitoring protocol for the Klamath Network: Narrative. Natural Resource Report NPS/KLMN/NRR—2016/1342. National Park Service, Fort Collins, Colorado.](#)

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Master Standard Operating Procedures Revision History

Version 1.0

Revision History Log:

Previous Version of Master	Revision Date	Author	SOP # Changed and Old Version Number	SOP # Changed and New Version Number	New Version of Master

Changes to individual SOPs within this document will need to be tracked in the following ways:

- Document the change inside the SOP's revision history log, creating a new version number
- Document the change to the SOP inside this master SOP revision history log and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

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We are grateful to the many biologists, ecologists, park managers, and GIS specialists who contributed to this protocol throughout its development, with special thanks going out to Mac Brock (CRLA), Jen Beck (CRLA), Mark Buktenica (CRLA), Dave Hering (CRLA), Scott Girdner (CRLA), David Larson (LBE), Nancy Nordensten (LBE), Shawn Thomas (LBE), Shane Fryer (LBE), John Roth (ORCA), Elizabeth Hale (LAVO), Jason Mateljak (LAVO), Mike Magnuson (LAVO), Martin Hutten (LAVO), Michelle Havens (LAVO), Dave Roemer (RNSP), Leonel Arguello (RNSP), Dave Best (RNSP), Judy Wartella (RNSP), Jennifer Gibson (WHIS), Russ Weatherbee (WHIS), Sean Denniston (WHIS), and Dennis Odion (Southern Oregon University).

SOP 1: Preparation and Data Acquisition

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

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This SOP explains what procedures will be completed prior to implementing the analysis and reporting aspects of this protocol, including reviewing the budget, selecting the project staff, providing for equipment needs, developing a work plan, and data acquisition.

1 Decision to Implement

1.1 Initial Meeting

The Network Contact will meet with the Program Manager during the fiscal year (~April) prior to when this project is going to be implemented to make decisions on budget availability, staffing, and data availability. During this meeting, the Program Manager should ensure the budget is available to meet salary, equipment, and travel needs. The budget needed to implement this protocol can vary significantly depending on the staff available, so a preliminary discussion of the staff that will be needed to implement this protocol should occur at this time. The staffing decision should be finalized early enough so that contracts or agreements can be put into place if necessary. In addition, the Network Contact should complete a cursory review of the required data sources needed to meet the analysis needs (*SOP #10: Analysis and Reporting*) to make certain they will be available and have been updated from previous analyses prior to implementing this project. At this time, potential new data sources should be evaluated and a determination should be made on updating the protocol (*SOP #11: Revising the Protocol*) to include new data summaries and analyses. The Network Contact should review the "Data Sources and Conditions" section of the protocol narrative to make sure new data meet the data criteria rules.

1.2 Personnel

This protocol requires the involvement of the Program Manager, Data Manager, Network Contact, Project Lead, and GIS Specialist. The actual number of people needed to implement this protocol can vary and is dependent on their knowledge of the parks' natural resources, NPScape project, GIS abilities, and this protocol. For example, with the staff currently employed by the Network, the Data Manager could fill the role as the Data Manager, Network Contact, and Project Lead. Below is a description of the skills needed to fulfill these positions.

Network Program Manager

The Program Manager is ultimately responsible for ensuring that the fiscal and staffing resources are available for the completion of this protocol and determining who will serve as the Network Contact. The Program Manager should be in contact with the Network Contact well in advance of analysis years to assist with determining how to staff this project (see chapter 6, Operational Requirements). During analysis years, the Program Manager should also be in continuous communication with the Network Contact to make certain the project is getting completed on time and is meeting the Network work plan. The Program Manager is also responsible for working with park staff to ensure that products are relevant and useful.

Network Data Manager

The Data Manager is responsible for ensuring that staff members working on the project are following the KLMN data management plan (Mohren 2007) and will oversee the data management strategy throughout the entire project. Initially, the Data Manager will ensure that personnel have access to required data and documents. In addition, the Data Manager should be consulted when there are any data processing issues and kept abreast of any problems encountered. Upon completion, the Data Manager should review all data and information developed as part of this project, along with the filing structure, to ensure products are appropriately documented and archived as necessary. In addition, it is the Data Manager's responsibility to make final deliverables available via the KLMN website and IRMA.

Network Contact

If the Project Lead is not a KLMN employee, then the Program Manager should select a KLMN employee to be the Network Contact. If the Project Lead is a KLMN employee, then this person will also be responsible for the Network Contact's responsibilities. The Network Contact is the direct contact for this project and is responsible for representing the KLMN in all issues related to this protocol. The Network Contact should be in constant communication with the Program Manager and Project Lead on issues related to this project. The Network Contact should help with logistic, personnel, and procurement issues when necessary. The Network Contact should be up to speed on the current status of this project, including what work has been done in the past, what work is currently being done, and what work is planned for the future. The Network Contact is also responsible for the initial reviewing of datasets to determine if they are available for analysis and meet the criteria outlined in the narrative.

Project Lead

The Project Lead is responsible for running the day-to-day operations of this project. This individual should manage the logistics of the project, develop work plans and timelines, set priorities, and work with the GIS Specialist to develop reports. The Project Lead should work closely with the Network Contact to make sure the Network Contact has everything needed to implement the project.

GIS Specialist

The GIS Specialist is responsible for completing any GIS analysis described in this protocol. In addition, the GIS Specialist should work closely with the Project Lead to develop any reports that are part of this protocol. It is expected that the GIS Specialist will have the largest workload related to this project and will need to be able to budget time appropriately to complete the project within the given timeline.

Park Management Team and Resource Specialist

In December of each year the KLMN hosts a meeting to present the findings of each vital signs monitoring protocol implemented that year. This is the opportunity for park staff to provide input on this monitoring protocol. It is highly recommended that attending park staff are familiar with the most recent copy of their park's report. During the meeting, participants should discuss the usefulness of the report, whether changes should be made to the protocol, and any issues related to the implementation of the project.

1.3 Hiring, Qualifications, and Training

By April of the year prior to implementing this project, the KLMN Program Manager and Network Contact should have a discussion on what staffing vehicle (task agreement, contract, or park/network staff) the Network will use to complete this project. During this meeting, potential Project Leads and GIS Specialists should be discussed.

1.4 Equipment Needs

The following hardware and software are needed to implement this protocol:

- Desktop computer capable of running ArcGIS to complete analysis.
- Laptop computer capable of running ArcGIS to be used for demonstration of results to the park staff.
- ArcGIS software, ERDAS Imagine software, and statistical software such as SYSTAT or SPSS.
- Two 500 GB or larger external hard drives to deliver data and results to park staff.

1.5 Work Plan and Timeline

It is the Project Lead's responsibility to put together a work plan that includes a timeline and milestones for each year this project is going to be implemented. The work plan does not need to be an elaborate document and can usually be developed in 2–3 pages, but should include 1) a brief introduction, 2) the project staff, 3) timeline, 4) milestones, 5) a brief description of the analyses that

will be completed, and 6) data sources that will be used. The Project Lead should work closely with the GIS Specialist when developing the timeline to ensure milestone dates are appropriate. In addition, the Project Lead should give the Program Manager and Data Manager an opportunity to review the timeline since the individuals in these positions will be reviewing draft reports.

2 Implementation

2.1 Setting up the Project Folder

Each year that an analysis is going to be completed, the data that are collected or created are managed in the same manner as the previous analysis, to ensure that they are consistent over the years and can easily be found and interpreted by new Network or project staff. *SOP #9: Data Management* provides guidelines on how to set up the folder structure, describes where to put acquired data and finalized products, and discusses cleanup of files once the analysis and report writing is complete. It is the Data Manager's responsibility to set up this file structure prior to implementing the project.

2.2 Acquiring Data

The GIS Specialist is responsible for acquiring any of the datasets that will be used for this protocol. The following steps should be followed when acquiring data for this project.

1. Review *SOP #10: Analysis and Reporting* to determine what analysis is expected to be completed. Also review past reports to determine which datasets have either been reviewed or used for past analysis. Based on the analysis and reporting requirements and the datasets that have been used in the past, make a preliminary decision about which datasets need to be acquired.
2. Review past and potential new datasets. Then make a final determination as to which datasets will be used.
 - a. Datasets that have been used in the past should be used again unless justification for not doing so is appropriate.
 - b. When possible, datasets that have been reanalyzed over multiple years should be used so trend analysis can be completed.
 - c. Datasets must meet the requirements outlined in the narrative of this protocol.
3. Once selected, download the dataset and save it following the guidance provided in *SOP #9: Data Management*.
4. Once the analysis is completed, be sure reports identify which datasets were used.

SOP 2: Conservation Status Metrics

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

1 Overview

The National Park Service Inventory and Monitoring Division's NPScape program provides landscape dynamics measures at broad regional and ecosystem scales. NPScape data and tools, which are publicly accessible, can be tailored to individual park or network needs. The Klamath Network (KLMN) will follow the methods developed by the NPScape team to calculate conservation status metrics (National Park Service 2014).

NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct link to the conservation status measure SOP (*Conservation Status Measure – Protected Area and Ownership/Governance*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521469&file=NPScape_SO_P_ConservationStatus.pdf.

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the conservation status metrics: ownership source data and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for the park-manager-selected scale (excluding LABE Jack Fire AOA) and the regional scale. All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

The data source we will use is the U.S. Geological Survey's Protected Areas Database of the United States (PAD-US). Data can be found on the NPS Inventory and Monitoring Division website, under NPScape>GIS Data or directly from the USGS National Gap Analysis Program website.

This is the direct link to the conservation status data:

<http://gapanalysis.usgs.gov/padus/data/download/>

This geodatabase should be downloaded and extracted into the KLMN SourceData folder:

[KLMN File Server]:
\\Monitoring\\LandCoverUse\\Data\\YEAR\\SourceData\\

3 Processing and Procedures

Execute the NPScape Conservation Status toolbox and use the ProtectedAreaDatabaseUS_Metrics tool; follow the quality control steps noted in the NPScape conservation status measure SOP.

4 Results

Results from the NPScape Conservation Status toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\\LandCoverUse\\Data\\YEAR\\PARK\\ConservationStatus_Tools\\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScape standard operating procedure: Conservation status measure – protected area and ownership/governance. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 3: Land Cover Metrics

Version 1.0

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1 Overview

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NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct link to the land cover measure SOP (*Land Cover Measure – Area per Category, Impervious Surface, Change Index, and Natural vs. Converted*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=520982&file=NPScape_SO_P_LandCover.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the land cover metrics: a land cover dataset and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for all three AOA types.

All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

The data source we will use is the U.S. Geological Survey's National Land Cover Database. Data can be found on the NPS Inventory and Monitoring Division website, under NPScape>GIS Data.

This is the direct link to the land cover data:

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm?tab=3

Rasters should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

3 Processing and Procedures

Execute the NPScape Land Cover Status toolbox and follow the quality control steps noted in the NPScape land cover measure SOP. Three tools will be used:

Generic_AreaPerCategory_Land_Cover_Metric, ImperviousSurface_Metric, and Natural_Converted_AreaPerCategory_Land_Cover_Metric.

4 Results

Results from the NPScape Land Cover toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Land_CoverTools\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScape standard operating procedure: Land cover measure – area per category, impervious surface, change index, and natural vs. converted. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 4: Pattern Metrics

Version 1.0

Please follow these instructions for changes to this SOP:

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1 Overview

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NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct links to the pattern measure SOPs (*Pattern Measure – Area Density* and *Pattern Measure – Morphology*) are found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521494&file=SOP_Pattern Metrics_Density.pdf

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521498&file=SOP_Pattern Metrics_Morphology.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis and NPScape tool versions will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the pattern metrics: land cover rasters of habitat type and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for the park-manager-selected scale and the regional scale. All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

The data source we will use is U.S. Geological Survey's National Land Cover Database. Data can be found on the NPS Inventory and Monitoring Division website, under NPScene>GIS Data.

This is the link to the density and morphology datasets:

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm?tab=4

The rasters should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

3 Processing and Procedures

Execute the NPScene Pattern toolbox and follow the quality control steps noted in the NPScene pattern measure SOPs. Use tools PatternDensity_Metric and PatternMorphology_Metric. The tool should be run for three Anderson level 1 classes: Forest, Grassland, and Shrubland.

4 Results

Results from the NPScene Pattern toolbox should be stored within the metric name folders.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Pattern_Morphology\ProcessedData

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\ PARK \Pattern_Density\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014a. NPScene standard operating procedure: Pattern measure – area density. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

National Park Service. 2014b. NPScene standard operating procedure: Pattern measure – morphology. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 5: Housing Metrics

Version 1.0

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1 Overview

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NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct link to the housing measure SOP (*Housing Measure – Current and Projected Housing Density*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521103&file=NPScape_SO_P_HousingDensity.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis and NPScape tool versions will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the housing metrics: housing density data and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for the park-manager-selected scale (excluding LABE Jack Fire AOA) and the regional scale. All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

The data source we will use is the Spatially Explicit Regional Growth Model (SERGoM), which is parameterized using data from the U.S. Census Bureau. Data can be found on the NPS Inventory and Monitoring Division website, under NPScope>GIS Data.

This is the link to the housing density data:

http://science.nature.nps.gov/im/monitor/npscope/gis_data.cfm?tab=1

This geodatabase should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

3 Processing and Procedures

Execute the NPScope Housing Density toolbox and use the Housing Density tool; follow the quality control steps noted in the NPScope housing measure SOPs.

4 Results

Results from the NPScope Housing Density toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Housing_Tools\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScope standard operating procedure: Housing measure – current and projected housing density. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 6: Population Metrics

Version 1.0

Please follow these instructions for changes to this SOP:

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- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
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Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

1 Overview

The National Park Service Inventory and Monitoring Division's NPScape program provides landscape dynamics measures at broad regional and ecosystem scales. NPScape data and tools, which are publicly accessible, can be tailored to individual park or network needs. The Klamath Network (KLMN) will follow the methods developed by the NPScape team to calculate population metrics (National Park Service 2014).

NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct link to the population measure SOP (*Population Measure – Current Density and Total*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521504&file=NPScape_SO_P_PopulationMetrics_Census.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis and NPScape tool versions will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the population metrics: population data and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for the park-manager-selected scale (excluding LABE Jack Fire AOA) and the regional scale. All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

Our data source for this measure is the U.S. Census Bureau. Data can be found on the NPS Inventory and Monitoring Division website, under NPScape>GIS Data.

This is the link to the data:

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm?tab=0

Geodatabases should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

3 Processing and Procedures

Execute the NPScape Population toolbox and use the Population Density and Total tool; follow the quality control steps noted in the NPScape population measure SOP.

4 Results

Results from the NPScape Population toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Population_Tools\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScape standard operating procedure: Population measure – current density and total. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 7: Road Metrics

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

1 Overview

The National Park Service Inventory and Monitoring Division's NPScape program provides landscape dynamics measures at broad regional and ecosystem scales. NPScape data and tools, which are publicly accessible, can be tailored to individual park or network needs. The Klamath Network (KLMN) will follow the methods developed by the NPScape team to calculate road metrics (National Park Service 2014).

NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

The direct link to the road measure SOP (*Roads Measure – Road Density, Distance from Roads, and Area without Roads*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=521765&file=NPScape_SO_P_Road.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis and NPScape tool versions will be noted in KLMN publications.

2 Data Sources

There are three datasets required for processing the road metrics: one roads feature class for the park-manager-selected and the regional AOAs, a second roads feature class for the park AOA, and the spatial extent of the analysis or Area of Analysis (AOA).

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for all three AOAs. All AOA layers can be downloaded from IRMA at <https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

Two road data sources will be used: park roads data as well as TIGER data. At the park scale, we will use the park's current road data which should be requested from park staff. At the park-manager-selected scale and the regional scale, we will use TIGER data. TIGER data can be found on the NPS Inventory and Monitoring Division website, under NPScape>GIS Data.

This is the link to the TIGER datasets:

http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm?tab=2

Geodatabases should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

3 Processing and Procedures

Prior to running the tool, the following road types should be selected in the TIGER dataset: S1100, S1200, S1400, and S1500. Other road types are omitted from analysis.

Execute the NPScape Roads toolbox and follow the quality control steps noted in the NPScape road measure SOP. Use tools RoadDistance_Metric, RoadDensity_Metric, and Areas_Without_Roads_Metric.

Note that for roadless areas, after data are processed as in the NPScape SOP, the final data in the report are presented after water bodies are erased and polygons smaller than 0.0144 km² are removed.

4 Results

Results from the NPScape Roads toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Roads_Tools\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScape standard operating procedure: Roads measure – road density, distance from roads, and area without roads. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 8: Disturbance Metrics

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

1 Overview

The National Park Service Inventory and Monitoring Division's NPScape program provides landscape dynamics measures at broad regional and ecosystem scales. NPScape data and tools, which are publicly accessible, can be tailored to individual park or network needs. The Klamath Network (KLMN) will follow the methods developed by the NPScape team to calculate disturbance metrics (National Park Service 2014).

NPScape methods can be found on the NPS Inventory and Monitoring Division website, under NPScape>Methods:

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

While no disturbance measure exists in NPScape, the land cover (area per category) tools can be used. The direct link to the land cover measure SOP (*Land Cover Measure – Area per Category, Impervious Surface, Change Index, and Natural vs. Converted*) is found under the link to SOPs and Tools:

https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=520982&file=NPScape_SO_P_LandCover.pdf

While NPScape methods will be followed, this document provides guidance specific to the KLMN. Data sources used in the analysis and NPScape tool versions will be noted in KLMN publications.

2 Data Sources

There are two datasets required for processing the disturbance metrics: a disturbance raster and the spatial extent of the analysis or Area of Analysis (AOA). A reclassification table should be used for class verification.

2.1 Areas of Analysis (AOAs)

The GIS layers for the AOAs that should be used for this analysis can be opened with ArcGIS software. As described in the narrative, we will be completing this analysis for all three AOAs. All AOA layers can be downloaded from IRMA at

<https://irma.nps.gov/DataStore/Reference/Profile/2225084>.

2.2 Source Data

The data source is LANDFIRE, a program shared between the USDA Forest Service and U.S. Department of the Interior. Rasters may need to be re-projected into the Albers Equal Area projection.

Data can be found online at the LANDFIRE website by selecting the Data>Disturbance links. This is the direct link to LANDFIRE data:

http://www.landfire.gov/disturbance_2.php

Rasters should be downloaded and extracted into the KLMN Source folder:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\SourceData\

The LANDFIRE reclassification table can be downloaded from:

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\

3 Processing and Procedures

Execute the NPScape Land Cover toolbox and use the Generic_AreaPerCategory_Land_Cover_Metric; then follow the complete quality control steps noted in the NPScape land cover SOP. A LANDFIRE reclassification table should be used for class verification. Note that this SOP uses the same toolbox as SOP 3, but not the same dataset.

4 Results

Results from the NPScape Land Cover toolbox should be stored within the metric name folder.

[KLMN File Server]:
\\Monitoring\LandCoverUse\Data\YEAR\PARK\Disturbance\ProcessedData

When the project is complete, data should be archived (see *SOP #9: Data Management*).

5 Literature Cited

National Park Service. 2014. NPScape standard operating procedure: Land cover measure – area per category, impervious surface, change index, and natural vs. converted. National Park Service, Natural Resource Stewardship and Science. Fort Collins, Colorado.

SOP 9: Data Management

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP explains the procedures for implementing data management for this project. This project will involve a large number of files, including original datasets, processed datasets, scripts and toolboxes, analysis documents (e.g., summary spreadsheets, reclassification tables, statistical outputs), and reports; thus, care must be taken to ensure that all data and information products are properly organized and documented to serve current and future project team members.

1 File Structure

Sections of the Network file server are reserved for the land cover / land use monitoring project (Figure 9-1). One space will include a working file section and one space will include an archival section. Working files are stored in the Monitoring folder and finalized files are stored in the Archive folder. The folder structure within Monitoring and Archive are identical.

Within both the monitoring and archive folders, the LandCoverUse folders contain two standard folders: Data and Documents. These folders will contain all the data and information for the project as follows:

- **Data.** Most of the items needed to implement this protocol including, but not limited to, raw data, derived data, metadata, layer files, reclassification files, scripts, GIS templates, and toolboxes. This includes the outputs from the GIS analyses described in SOPs 2 through 8.
- **Documents.** Reports, budgets, work plans, emails, and protocols associated with a specific project.

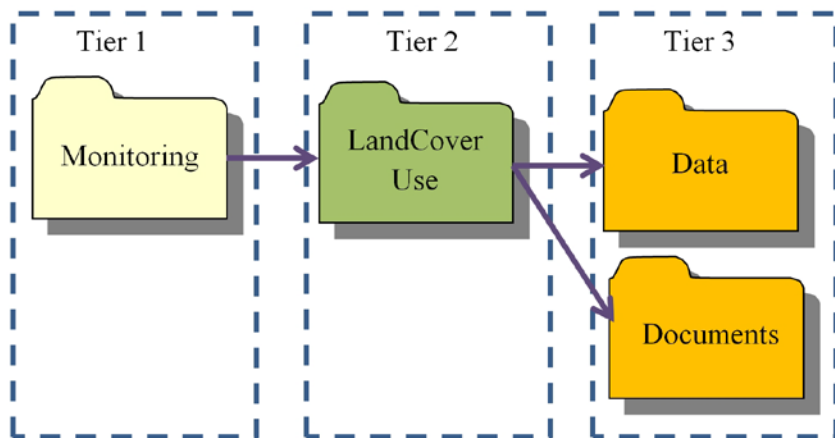


Figure 9-1. File structure the KLMN will use to store all land cover / land use files. All land cover / land use content from a single implementation year are archived in a separate folder after completion of that year's report.

Beyond the first three tiers of the filing hierarchy, there is more room for flexibility. The Project Lead, Data Manager, and GIS Specialist can create additional folders to help keep data and information organized. Some folders, described below in Figure 9-2, have already been created.

Monitoring (working) folder:

[KLMN File Server]:
 \Monitoring\LandCoverUse\Documents\

Within the Documents folder there are three subfolders:

- Protocol
- Reports
- WASO_NPScape

The protocol folder contains the current and previous versions of this protocol. The report folder contains any reports or publications that are developed as part of this protocol. The WASO_NPScape folder contains important documents that were developed by the NPScape team, including but not limited to interpretive guides, measurement development summaries, overview documents, resource briefs, standard operating procedures, and technical guidelines. Note that administrative documents should be stored in the KLMN administrative folder as described in the KLMN data management plan.

Within the Data folder there is a folder for the current year. Within the YEAR folder is a PARK and Source folder. Within each PARK folder is a folder for each indicator:

Data\YEAR\Source

Data\YEAR\PARK\Indicator (e.g., Conservation Status, Land Cover, etc.)
 SOPs 2 through 8 outline locations for source and indicator data. Toolboxes should be set up to use these locations as their default location.

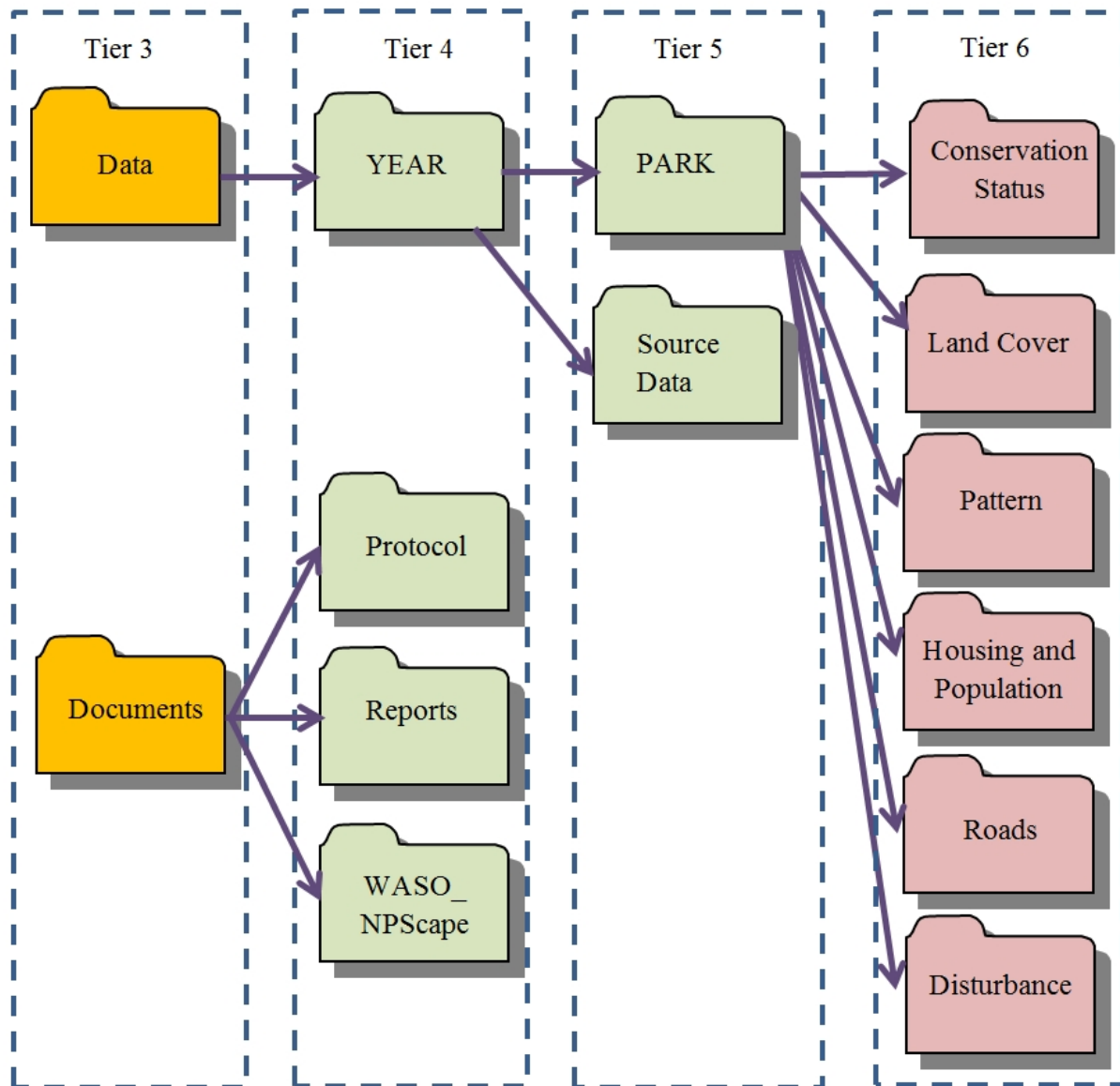


Figure 9-2. Additional folders used to manage data and information for the land cover / land use protocol.

2 Data Delivery Form

The Klamath Network will utilize a Certification form submitted by the Project Lead to ensure:

1. The data are complete for the period of time indicated on the form.
2. The data have undergone the quality assurance checks indicated in the land cover / land use monitoring protocol.

3. Metadata for all data have been provided (when applicable).
4. Project timelines are being followed and all products from the field season have been submitted.
5. The correct level of sensitivity is associated with the deliverables.

Certification forms can be obtained from the KLMN Data Manager. An example of the Certification form is included at the end of this SOP.

3 Metadata

As discussed above, this project is a GIS intensive study that requires the acquisition of a variety of non-NPS datasets. In addition, a large number of new datasets will be developed that will require metadata. As one of the standards mentioned in the narrative of this protocol, any dataset the KLMN utilizes to complete an analysis must have metadata associated with it, and that metadata should be stored with the GIS layer on the KLMN server following the folder structure described above. The GIS Specialist should review the metadata before starting an analysis to make certain it is complete and makes the dataset understandable. In addition, once an analysis is complete, metadata for each dataset will need to be developed by the GIS Specialist. This should be complete FGDC- and NPS-compliant metadata and should be prepared before certifying the data.

4 Cleanup

Since this project has such a strong GIS component, a large number of files will be created that are either in draft form or are used for temporary purposes. In order to ensure the file structure is easy to use for future employees, the GIS Specialist should review all the data and information in the project folder and remove anything that is no longer needed. This should be completed after all data have been certified and documented and the final report has been completed.

5 Archiving and Backup

Once the project has been finalized, the KLMN Data Manager will move all products to their respective folders in the Archive folder. Permissions are set on these folders so that they can only be edited by specific Network staff. Any subsequent changes made to this dataset must be documented in an edit log and in the metadata.

The KLMN relies on Southern Oregon University (SOU) for regular backup and short-term storage requirements. Incremental backups are done nightly to store information that has been edited. The full backup tapes are stored for one year and then are overwritten. In the KLMN office, the Data Manager copies all contents of the server to an external hard drive on a quarterly basis; the hard drives are stored in a fireproof cabinet. From the four backups created in a year, one hard drive is never overwritten; thus the Network will always have one backup for each calendar year. In addition, the Data Manager will post final deliverables to IRMA.

6 Literature Cited

Mohren, S. R. 2007. Data management plan, Klamath Inventory and Monitoring Network. Natural Resource Report NPS/KLMN/NRR—2007/012. National Park Service, Fort Collins, Colorado.

KLMN Data Delivery Form

1) Delivery date: _____

2) Certified by: _____

Title: _____

Affiliation: _____

3) Agreement code: _____

Project title: _____

4) Range of dates for certified data: _____

5) Description of data being certified: _____

6) List the parks covered in the certified dataset, and provide any park-specific details about this certification.

Park	Details

7) This certification refers to data in accompanying files. Check all that apply and indicate file names (folder name for images) to the right:

_____ Hardcopy Datasheet(s): _____
_____ PDF Datasheet(s): _____
_____ Database(s): _____
_____ Spreadsheet(s): _____
_____ Spatial data theme(s): _____
_____ GPS file(s): _____
_____ Geodatabase file(s): _____
_____ Photograph(s): _____
_____ Data Logger(s) files: _____
_____ Other (specify): _____
_____ Certified data are already in the master version of a park, KLMN or NPS database.
Please indicate the database system(s): _____

8) Is there any sensitive information in the certified data which may put resources at greater risk if released to the public (e.g., spotted owl nest sites, cave locations, rare plant locations)?

_____ No _____ Yes Details:

9) Were all data processing and quality assurance measures outlined in the protocol followed?

Yes / No

If No or if there were issues, explain

10) Who reviewed the products?

11) Results and summary of quality assurance reviews, including details on steps taken to rectify problems encountered during data processing and quality reviews.

SOP 10: Analysis and Reporting

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This SOP provides the general scheme for executing the data analysis and reporting elements of the Klamath Network (KLMN) land cover / land use protocol. It includes general guidance on how to analyze the data and information developed as part of this protocol; this will ensure that the results of this project are consistent with objectives and are available to the park managers, resource specialists, the scientific community, and the public.

1 Reporting

Starting in 2021 and every six years thereafter we will develop an Analysis and Synthesis (A&S) report. Unlike other KLMN protocols that use both annual reports and A&S reports to convey findings, this protocol will only prepare periodic A&S reports and potentially, Resource Briefs, which are short summaries that highlight the results of each park's A&S report. This is because there will be no analysis activity in the non-reporting years. The general analyses associated with this protocol are discussed below.

1.1 Audience

All reporting aspects of this protocol are developed for a target audience that includes the superintendents, resource managers, and technical professionals of the parks within the Network. However, we also feel these reports (and associated datasets) may be useful to inventory and monitoring staff, service-wide program managers, interpretive specialists, external scientists, and partners.

1.2 Report Format

Analysis and Synthesis reports will be developed using templates from the NPS Natural Resource Publications office with current NPS formatting and style. Analysis and Synthesis reports will be developed using the preformatted Microsoft Word Natural Resource Report template (<http://www.nature.nps.gov/publications/nrpm/templates.cfm>). This template and documentation of the NPS publication standards are available at: <http://www.nature.nps.gov/publications/nrpm/>

1.3 Reporting Schedule

The reports that are prepared under this protocol are expected to change over time, as the data time series mature, and in response to the evolving questions and information needs of the KLMN parks. Given the modest funding available for this protocol, initial plans are to have two types of reports:

A one-time *Summary Report* was prepared for each park in 2016 to characterize the historical and current condition of the indicators and metrics described in this protocol. See Ives et al. (2016) for the LAVO Summary Report which serves as a model for the other parks' reports (*in prep*). These reports summarize current and historical data that may provide a baseline for future analyses.

From 2021 and onward, *Analysis and Synthesis Reports* will be prepared to describe the temporal changes in the indicators and metrics described below. These analyses will follow standardized methods to ensure comparability across years, but may include supplemental analyses to address new questions.

2 Analysis

As described in the narrative and demonstrated in the SOPs, the KLMN will focus on six general indicators to examine land cover and land use in and around the parks, including: *Land Cover*, *Conservation Status*, *Pattern*, *Roads*, *Housing and Population*, and *Disturbance*. For each of the metrics calculated as part of these six indicators, we will report status and trend information, as appropriate. Table 10-1 lists metrics that will be examined as part of this protocol.

Table 10-1. Indicators evaluated by the land cover and land use protocol. Also included are specific measures, objectives addressed, scale of analyses, and relevant SOPs in this protocol. Abbreviations for Areas of Analysis (AOA) include: P = Park, PM = Park-Manager-Selected, and R = Regional.

Indicator	Measure	AOA Scale	Objective	SOP
Conservation Status	Percent & Total Protected	PM ¹ & R	1 & 2	2
	Percent & Total Ownership		1 & 2	2
Land Cover	Area/Percent in Land Cover Types	P, PM & R	1 & 2	3
	Natural vs. Converted		1 & 2	3
	Impervious Surface		1 & 2	3
Landscape Pattern	Morphological Pattern Analysis	PM & R	2	4
	Patch Size by Cover Type		2	4
	Distribution of Patch Sizes for Cover Types		2	4
	Density Analysis of Cover Types		2	4
Housing and Population	Housing Density	PM ¹ & R	3	5
	Recent Change in Housing Density		3	5
	Total Population		3	6
	Population Density		3	6
	Recent Population Change		3	6
Roads	Road Density	P, PM & R	2	7
	Road Length		2	7
	Distance to Roads		2	7
	Area without Roads		2	7
Disturbance	Total Area by Disturbance Type	P, PM & R	4	8
	Disturbance Occurrence		4	8

¹ LABE Jack Fire AOA not included

2.1 Analysis Area

As described in the narrative, we have designated three possible Areas of Analysis (AOA) to define the scale for our analyses. Table 10-2 lists the spatial scale at which each indicator will be analyzed.

Table 10-2. Area of Analysis (AOA) that will be used to analyze each indicator.

Indicator	Park Scale	Park-Manager-Selected Scale	Regional Scale (30 km)
Conservation Status		X ¹	X
Land Cover	X	X	X
Pattern	X	X	X
Housing and Population		X ¹	X
Roads	X	X	X
Disturbance	X	X	X

¹ LABE Jack Fire AOA not included

2.2 Analysis Methods

In this section we provide a description of the analysis that we will complete for each of the indicators. It should be noted that the Project Lead will not be limited to these analyses for future A&S reports. However, the analyses listed below should be completed every six years to fulfill the intent of the protocol, unless proper justification can be made for not completing one or more of the described analyses.

2.3 Status and Summaries

Once the GIS and quality control processes are completed, status information for each indicator will be presented using summary tables and user-friendly graphics such as histograms, bar charts, and maps. Summaries will be provided for all metrics described below and should provide a repeatable and interpretable view of the land cover and land use conditions at a given point in time.

Conservation Status and Ownership

Basic metrics that will be summarized for conservation status and ownership include the following:

- Total area and percent of area that are classified with a GAP Protection Status of 1, 2, 3, or 4.
- Total area and percent of area for each land owner/steward.

Land Cover

Basic metrics that will be summarized for land cover include the following:

- Total area and percent of area for each Anderson Level 2 land cover type.
- Total area and percent of area for each Impervious Surface group
- Total area and percent of area for Natural and Converted land

Pattern

Basic landscape pattern metrics that will be summarized for Anderson Level 1 classes of Forest, Grassland, and Shrubland include the following:

- Total area, percent of AOA, and percent of land cover type for each morphological class (e.g., Core, Islet, Edge, Bridge)
- Count and area for each patch size class
- Total area, percent of AOA, and percent of land cover type for each density class (e.g., Rare, Patchy, Dominant, Intact)

Housing and Population

Basic metrics that will be summarized for housing and population include the following:

- Total population and population density
- Area, percent of total area, and percent of census area by housing density category

Roads

Basic metrics that will be summarized for roads include the following:

- Total road length
- Road density
- Count and total area by roadless area size category
- Distance from roads of any given mapped area.

Disturbance

Basic metrics that will be summarized for disturbance include the following:

- Area and percent of AOA for fire related disturbances
- Area and percent of AOA for non-fire related disturbances

2.4 Trend Analyses

The 2016 reports (e.g., Ives et al. 2016) presented summaries for the metrics described above. Starting in 2021, we will begin looking at trends in the metrics described above using a variety of statistical tools. As the length of the time series increases, techniques will change from standard change assessment to more formal trend analyses.

For the initial trend report we expect to have complete data from three to five time periods for the metrics described above. The first evaluations of trend will employ simple trend analyses of each metric to document whether changes result in slopes that are significantly different from zero. Maps for the three types of AOAs around each park will be prepared and presented. In addition to these methods, there are also several methods for detecting and estimating trends using nonparametric techniques (e.g., Mann-Kendall, Wilcoxon-Mann-Whitney, Sen slope) that can be used to examine the data in this protocol.

When we have five or more sample periods to analyze, we will begin using more complex tools for trend detection and description, including time series analysis. These methods will increase in power and accuracy over time. Time series analysis implements a wide variety of temporal modeling approaches, including linear and nonlinear filtering, Fourier analysis, exponential smoothing, Box-Jenkins approach (Box et al. 1994), and Auto-Regressive Integrated Moving Average (ARIMA) modeling.

A few issues that should be examined prior to completing the time series analyses are autocorrelation and stationarity (Lee and Wong 2001). Temporal autocorrelation is basically the similarity between observations as a function of the time separation between those observations. Since parametric statistics are based on the assumption of independence of the individual observation, data that are autocorrelated would violate this assumption (Fortin and Dale 2005). For data that show signs of autocorrelation, as would be expected with housing and population data, this can influence what

statistical tools we should use to complete the time series analysis. There are several ways to account for autocorrelations, such as using a conservative alpha value and adjusting the sample size.

A stationary time series is one where the statistical properties (mean, variance, autocorrelation, etc.) are all fairly constant over time. This is rare in ecological datasets, which are highly dynamic in time and space. If a dataset is not stationary, it will be difficult to utilize the current data to predict future data behavior unless the data are transformed.

Obviously, many landscape factors show strong autocorrelation and non-stationarity over time. Therefore, standard trend analysis techniques will need to be supplemented with other techniques for documenting change. For many of the indicators, variance will be low across years, and remote sensing or sampling techniques will allow a nearly complete census of the landscapes in and around the parks. In such cases, the standard statistical estimates, complex time series analyses, and hypothesis testing techniques will not be used. It may be sufficient to say, for example, that population increased and to show maps demonstrating where and to what degree population density changed over the time period. In all analyses, we will attempt to present data in visually engaging and straightforward means that are appropriate for the metric or indicator of interest.

2.5 Additional Analyses

Using the ownership and status categories defined above, we can also calculate a Conservation Risk Index (CRI) that represents a comprehensive measure of whether particular land units protect their natural environments on the same scale as those it converts (Hoekstra et al. 2005). CRI is not intended to be used in isolation but can provide valuable information when combined with other data from this protocol.

Modeling and Pattern Analyses

An important adjunct to both status and trend analyses are explorations of the spatial patterns and their hypothesized drivers. Chi-Square test, Joint-Count statistics, and Moran's I can be used to examine clustering of land cover types and areas with increasing/decreasing population and housing densities (Lawson and Denison 2002, Rogerson 2001). Where feasible, we will also prepare geostatistical spatial-temporal models of factors (e.g., Turner et al. 1996, Kyriakidis and Journal 1999) associated with land cover change in both park and adjoining areas by modeling probabilities of change for individual landscape units of a certain size. Modeling should increase our understanding of the ownership and landscape factors associated with change. Given the limited funding, modeling will be a lower priority than the status and trend analyses, but it would be an excellent adjunct if we can locate additional staffing or financial resources. Although tentative at this time, modeling presents a desirable goal because it will provide us with insights into potential drivers of landscape change in and around the parks.

3 Literature Cited

Bloomfield, P. 2000. Fourier analysis of time series: An introduction, 2nd ed. John Wiley & Sons, New York.

- Box, G. E. P., G. M. Jenkins, and G. C. Reinsel. 1994. Time series analysis: Forecasting and control. Prentice-Hall, Englewood Cliffs, New Jersey.
- Fortin, M., and M. Dale 2005. Spatial analysis: A guide for ecologists. Cambridge University Press, Cambridge, UK.
- Hoekstra, J. M., T. M. Boucher, T. H. Ricketts, and C. Roberts. 2005. Confronting a biome crisis: Global disparities of habitat loss and protection. *Ecology Letters* 8:23-29.
- Ives, J., A. Snyder, A. Chung-MacCoubrey, J. King, L. Groshong, and S. Mohren. 2016. Land cover and land use monitoring in the Klamath Network: 2016 summary for Lassen Volcanic National Park. NPS/KLMN/NRR—2016/1308. National Park Service, Fort Collins, Colorado.
- Kyriakidis, P., and A. Journel. 1999. Geostatistical space-time models: A review. *Mathematical Geology* 31:651-684.
- Lawson, A. B., and D. G. T. Denison. 2002. Spatial cluster modelling. Chapman & Hall/CRC, New York.
- Lee, J., and D. Wong. 2001. Statistical analysis with ArcView GIS. John Wiley & Sons, New York.
- Rogerson, P. A. 2001. Statistical methods for geography. Sage Publications, Thousand Oaks, California.
- SYSTAT Software Inc. SYSTAT 12 user manual. San Jose, California.
- Turner, M. G., D. N. Wear, and R. O. Flamm. 1996. Land ownership and land-cover change in the Southern Appalachian Highlands and the Olympic Peninsula. *Ecological Applications* 6(4):1150-1172.
- Velleman, P. F., and D. C. Hoaglin. 1981. Applications, basics, and computing of exploratory data analysis. Wadsworth, Belmont, California.

SOP 11: Revising the Protocol

Version 1.0

Please follow these instructions for changes to this SOP:

- Document the change inside this SOP's revision history log, creating a new version number
- Document the change to this SOP inside the master SOP revision history log at the top of this document and create a new version number
- Update Table 11-1 in SOP 11: Revising the Protocol

Revision History Log:

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version

This document explains how to make and track changes to the Klamath Network (KLMN) land cover and land use monitoring protocol, including its accompanying SOPs and Appendix. While this monitoring protocol has been developed using current standardized methodology, all long-term monitoring programs need to be flexible to adapt to changes. As new technologies, methods, data sources, and equipment become available, this protocol will be updated as appropriate. Current best practices will be weighed against the continuity of protocol information in determining revisions. Project staff should refer to this SOP whenever edits are necessary and should be familiar with the protocol versioning system in order to identify and use the most current versions of the protocol documents.

All edits require review for clarity and technical soundness. Small changes to existing documents (e.g., formatting, simple clarification of existing content, small changes in the task schedule or project budget, or general updates to information management handling SOPs) may be reviewed in-house by project cooperators and Klamath Network staff. However, major changes to data collection or analysis techniques, sampling design, or response design will trigger an outside review. The Project Lead should coordinate with the Klamath Network Contact to determine if outside review is needed.

Revision Procedures

The following procedures will ensure that both minor and major revisions to this document will align with the monitoring plan.

1. Discuss proposed changes with all project staff prior to making modifications. Consensus should be reached regarding who will be making the changes and in what timeframe.
2. Make the agreed-upon changes in the appropriate sections of the protocol. Note that a change in one section may require changes in another section. For example, a change in SOP numbering should be reflected in the narrative, or a change in the narrative may require changes to several SOPs. Also, the project task list and other appendices may need to be updated to reflect changes in timing or responsibilities for the various project tasks.
3. Document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes in the document being edited (e.g., if there is a change to an SOP, log those changes in that document). Changes to individual SOPs will also require a new version of this master SOP document. Version numbers increase incrementally by hundredths (e.g., version 1.01, 1.02) for minor changes. Major revisions should be designated with the next whole number (e.g., version 2.0, 3.0). Record the previous version number, date of revision, and author of revision; identify paragraphs and pages where changes are made, rationale for revisions, and the new version number.
4. Circulate the changed document for internal review among project staff and cooperators. Minor changes and clarifications will be reviewed in-house. When significant changes in methodology are suggested, revisions will first undergo internal review by the project staff. Additional external review including, but not limited to, National Park Service staff with appropriate skills and knowledge will be required.
5. Upon ratifying and finalizing changes:
 - a. Ensure that the version number, date, and file name are updated properly throughout the document.
 - b. Make a copy of each changed file to the protocol archive folder (i.e., a subfolder under the Protocol folder in the project workspace).
 - c. The copied files should be renamed by appending the revision date in YYYYMMDD format. In this manner, the revision date becomes the version number and this copy becomes the “versioned” copy to be archived and distributed.
 - d. The current, primary version of the document (i.e., not the versioned document just copied and renamed) does not have a date stamp associated with it.
 - e. Inform the Data Manager so the new version number(s) can be incorporated into the project metadata.
6. As appropriate, create PDF files of the versioned documents to post to the Internet and share with others. These PDF files should have the same name and be made from the versioned copy of the file.

7. Send a digital copy of the revised monitoring plan to the Network Contact and Network Data Manager. The revised monitoring plan will be forwarded to project and park staff who had been using a previous version of the affected document. Ensure that field staff have a hardcopy of the new version.
8. The Network Data Manager will place a copy of the revised protocol in the proper folder on the Klamath Network server. In addition, the Network Data Manager will archive the previous version in the Klamath Network archive folder.
9. The Network Data Manager will post the revised version and update the associated records in the proper I&M databases, including but not limited to IRMA, KLMN website, and the Protocol database.
10. Update Table 11-1 to list the most up-to-date current version of all protocol sections.

Table 11-1. Protocol version tracking table showing latest version and effective date.

	Latest Version	Effective Date
Protocol Narrative	1.0	11/8/2016
SOP 1. Preparations and Data Acquisition	1.0	11/8/2016
SOP 2. Conservation Status Metrics	1.0	11/8/2016
SOP 3. Land Cover Metrics	1.0	11/8/2016
SOP 4. Pattern Metrics	1.0	11/8/2016
SOP 5. Housing Metrics	1.0	11/8/2016
SOP 6. Population Metrics	1.0	11/8/2016
SOP 7. Road Metrics	1.0	11/8/2016
SOP 8. Disturbance Metrics	1.0	11/8/2016
SOP 9. Data Management	1.0	11/8/2016
SOP 10. Data Analysis and Reporting	1.0	11/8/2016
SOP 11. Revising the Protocol	1.0	11/8/2016

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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