

PALMS Standard Operation Procedure

Analyzing Protected-area Centered Ecosystems

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1.2	2010_02.26.2010	Finalize	NBP

Introduction

The following set of methods from the Park Analysis of Landscapes and Monitoring Support (PALMS, for a complete description see appendix A, Estimating Protected Area Centered Ecosystems), builds on the “Estimating Protected Area Centered Ecosystems” standard operating procedure (SOP) (Piekielek et al. 2010). It provides instruction on how to perform analyses presented in “Delineating the Ecosystems Containing Protected Areas for Monitoring and Management” (Hansen et al. in press), included as Appendix B of “Estimating Protected-Area Centered Ecosystems. This SOP provides different types of analysis for protected-area centered ecosystems. The results of this SOP should provide managers with an increased understanding of challenges to protecting the natural resources of parks and their surroundings. The analyses include:

- Land allocation – proportion of PACE area in public versus private ownership
- Proportion developed – percentage of the private lands in agriculture, near roads or with home densities above a minimum threshold
- Home density – total number of homes in 2000 (most recent census)
- Change in home density – percentage change in home density from 1940 to 2000
- Biophysical bias – degree to which areas of high gross primary productivity lie on private lands

The analyses presented here are in no way exhaustive and are meant to complement a suite of other analyses and mapping procedures proposed by others such as the NPScape program and the Socio-economic Indicator Mapping Procedure (Greb et al. 2008) to give two examples of many possible.

LIMITATIONS

All analyses require that a PACE boundary has been generated for the park in question. See Estimating Protected-Area Centered Ecosystems (Piekielek et al. 2010) for generating a PACE boundary included in this PALMS deliverables package.

Also see Estimating Protected-Area Centered Ecosystems appendix B for additional references supporting these analyses.

PERSONNEL

The following standard operating procedure (SOP) is an exercise in spatial analyses using geographical information systems (GIS).

SOFTWARE, KNOWLEDGE AND SKILLS

The following set of instructions was written for use with ESRI's ArcGIS (v9.2), although should be achievable with prior or forthcoming versions of ArcGIS or similar software. You will need the full suite of ArcGIS desktop tools including ArcCatalog and ArcToolbox. A skilled GIS user will

likely recognize a variety of methods that could be employed in this SOP to achieve the same end result.

The practitioner implementing this SOP should be an experienced and knowledgeable GIS user familiar with spatial datasets, projections, basic data management and have access to a host of base cartographic data layers for each park such as boundary files, digital elevation models, roads, towns, National Land cover data (NLCD), and others. The following instructions do not cover basic skills that are assumed of the user such as knowledge of how to search for, download and import spatial data into a GIS from internet sources, chose a projection in which to work, reprojecting data into a common projection, datum transformations and project management in ArcGIS. As a reminder, always carefully choose a projection in which to work and reproject data from different sources into that common projection using the appropriate datum transformations. Careful project management is vital to producing high-quality results from any GIS exercise.

ArcGIS tools in each step of the following sets of instructions are invoked without specific reference to their location in ArcToolbox or ArcGIS toolbars. An experienced GIS user will likely be familiar with these tools and their use. However, if some steps are new to the user, a good way to locate tools is to use the “Search” function in ArcToolbox. The names of most tools in the document that follows are quoted so that the user can type these names in the ArcToolbox search function. The user will become familiar with the location and use of a variety of tools by the end of this SOP. The ArcGIS Desktop help menu, ArcGIS Desktop online help, and www.esri.com “knowledgebase” are also useful places to find helpful and more detailed information than is provided in this document.

This document has been written so that any confident GIS user should be able to complete the following steps. Implementation of this SOP should not be limited to GIS professionals alone.

DATA REQUIRED

All datasets used in the following analyzes are provided within this SOP package from the PALMS project. Although there is no plan to update any of the included datasets, there are numerous sources which will likely generate similar datasets in the future and which could be used in update analyses. It is incumbent upon the user to locate, download and incorporate any data updates into future analyses. The following is a brief description of datasets included with this SOP:

1. CUS_UPPT_100 – this layer was generated by Theobald (2005) by combining a number of datasets to classify land ownership in the contiguous U.S. as one of four classes: private; private protected; public; Indian tribal. It is provided as part of the deliverables package with the PALMS SOP “Estimating Protected-Area Centered Ecosystems (Piekielek et al. 2010)”.
2. Gppann5_al – this dataset contains the average annual gross primary productivity for the contiguous U.S. at the 1 kilometer scale from years 2000-2004. It was derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) MOD 17 data product.
3. Hd_1940 – modeled housing density produced by Theobald (2005) at the 100 meter scale for the contiguous US for year 1940.
4. Hd_2000 – modeled housing density produced by Theobald (2005) at the 100 meter scale for the contiguous US for year 2000.

PACE to park area ratio

A quick and easy way to “eyeball” how challenging it might be to conserve natural resources that are within a PACE boundary and not within the boundaries of the park in question is to look at their relative sizes. In prior applications to park areas it’s been noted that this ratio can differ dramatically between high altitude parks which exist in the headwater regions of watersheds, and those that are located in lower portions of watersheds.

Potential Issues

- ✓ None known

Data

This analysis requires a GIS layer for both the park boundary and PACE boundary. See ESTIMATING PROTECTED-AREA CENTERED ECOSYSTEMS (Piekielek et al. 2010) from the PALMS deliverables package for methods to delineate a PACE boundary for a park.

Instructions

Since PACE boundaries generally include the park area as well as surroundings areas, we need to erase the park area from the PACE boundary before creating a ratio of their sizes:

1. In ArcGIS add both the park boundary and PACE boundary.
2. Use the ‘Erase’ tool to remove the park area from the PACE area.
3. Use the ‘Calculate Area’ tool to update the area for your new PACE boundary that does not include the park area.
 - a. Use the ‘Calculate Area’ tool again on your park boundary file if it either does not include an area field already, or if you’re not confident that the area provided is current. If you’re not sure it’s usually safest to recalculate a polygon shapefile’s area to make sure you’re using the correct area number.
4. Divide the new PACE area by the park area.

Wrap-up

- Compare results to other parks

Ownership

A major challenge to any park manager interested in protecting portions of their PACE that lie outside of their park's boundaries is collaborating with other landowners. Where other land management agencies which have preservation or conservation mandates are the owners of concern there's a reasonable expectation that common goals will allow for collaboration. However, where private landowners are concerned there's no such expectation and establishing collaborative conservation efforts are expected to be difficult. Even when currently undeveloped, private lands could be subjected to development which is incompatible with park natural resource conservation goals in the future. This analysis step quantifies the extent to which lands within the PACE area are under public versus private ownership.

Potential Issues

- ✓ Data limitations on ownership boundaries are sometimes a minor hurdle here

Data

This analysis uses a national data layer CUS_UPPT_100 generated by Theobald (2005) which was in turn derived from the Protected Area Database (PAD) version 4.6, 2007 among other datasets: <http://www.protectedlands.net/>

The PAD database is updated periodically and could be used for future analyses of PACE boundaries. The Data Quality Information section of this file's metadata has a more complete description of how the CUS_UPPT_100 layer was generated from the PAD database.

Instructions

1. Using the PACE layer from the previous step which does not include the park area, add the CUS_UPPT_100 layer.
2. Use the 'Extract by mask' command to extract ownership information for only the PACE area.
3. Open the new raster's attribute table, right-click on the COUNT field, click the 'Statistics' option and write down the number in the 'Sum' row. This is the number of 100 square meter pixels there are in this new raster file and should approximately match the total area of your PACE_erase layer
4. Look at the metadata for the CUS_UPPT_100 raster to see which values represent which ownerships.
5. Back in the attribute table for the new raster file; divide the COUNT from each VALUE row by the total Sum that you wrote down earlier. This represents the proportion of land in the PACE in each ownership type. You can also represent this as an area in each ownership type.

Wrap-up

- Compare results to other parks

Housing densities

Building on the theme of land ownership, this analysis step looks at housing densities as an indicator of development pressure in the PACE. Both current housing densities as well as the change in housing density over time can give an indication of the extent to which areas around the park are developed, or becoming developed and therefore threatening ecological function within the PACE.

Potential Issues

- ✓ Data quality and limitations

Data

This analysis uses housing density data layers generated by Theobald (2005) using the SerGomm model. The SerGomm model downscales US Census housing information to the 100 meter scale based on groundwater well locations, accessibility to urban areas along roadways, land cover characteristics and other factors. See ESTIMATING PROTECTED-AREA CENTERED ECOSYSTEMS (Piekielek et al. 2010) and Appendix B (Hansen et al. in press), as well as its references for more information.

Instructions

1. Add the “hd_2000” and “hd_1940” data layers included in this SOP deliverable package to the ArcGIS project used for the above analysis steps.
2. Use the ‘Extract by mask’ tool and the PACE boundary layer which includes the park area as well, to extract housing densities for the PACE area for years 1940 and 2000.
3. Reference the “hd” metadata and look at the housing densities for all 9 classes which report homes present (‘0’ indicates ‘undeveloped’ and therefore no homes, similarly ‘10’ indicates ‘commercial/industrial’ with few homes and no density reported). For your reference the following table contains each classes’ midpoint housing density to be used to calculate a total number of homes for the PACE:

PALMS

Park Analysis of Landscapes and Monitoring Support

HDXXXX VALUE	Midpoint housing density by 100 meter raster cell
0	0
1	0.015
2	0.041
3	0.047
4	0.070
5	0.104
6	0.188
7	0.757
8	3.51
9	2.785
10	0

Table 1. Midpoint housing densities by bhc raster class

4. Open the “hd_1940” raster’s attribute table and multiply the COUNT for each 9 classes which contain homes by that classes midpoint housing density and sum these numbers to report a total estimated number of homes for 1940.
5. Repeat the above step for the “hd_2000” layer and report a total estimated number of homes for the year 2000.
6. Subtract the 1940 housing number from the 2000 number and divide by the 1940 number to report a percent change in number of homes from 1940 to 2000.

Both the total number of homes within a PACE for the present day, as well as the percent change from historical levels to present levels indicate the degree of development pressure that the PACE in question is facing and hence the degree of challenge to protect the PACE’s ecological resources.

Wrap-up

- Compare results to other parks

Biophysical bias

Biophysical bias can be evaluated based on gross primary productivity (GPP) derived from MODIS satellite data (Running et al. 2004). GPP integrates the effects of climate, soils, and vegetation history and is an index of equitability for plant growth and foods available at higher trophic levels (Phillips et al. in press). Some parks located at high elevations with cold climates, on poor soils, or in dry areas and organisms within them are expected to be more dependent on the more mesic environments in the surrounding landscape.

Potential Issues

- ✓ None known

Data

This analysis uses MODIS GPP data averaged from years 2000 – 2004. There are no plans to update this dataset. See the MODIS website for more information or for those interested in updating this dataset:

<http://modis-land.gsfc.nasa.gov/npp.htm>

Instructions

1. Add the file “gppan5_al” included in this SOP deliverable package to the ArcGIS project that you’ve been using for the above analyses.
2. Use the ‘Extract by Mask’ tool on the CUS_UPPT_100 again, but this time use the PACE boundary which includes the park area.
3. Reclassify this new ownership raster so that it contains only 2 classes, one for public and one for private.
4. Add the Spatial Analyst toolbar, on the toolbar’s Spatial Analyst dropdown menu go to Options and select the Extent tab as depicted in Figure 1.
5. Select an analysis extent that’s the ‘same as’ your new ownership boundary.

This step will subset the “gppan5_al” file to the PACE area and create a .VAT table for the next step:

6. Again under the Spatial Analyst dropdown menu go to ‘Raster Calculator’ and double click the “gppan5_al” to add it to the formula window. Press the ‘Evaluate’ button.

The result of the previous step should have created a “Calculation” raster layer that was automatically added to your project.

7. Use the ‘Zonal Statistics as Table’ tool with your reclassified ownership raster as the zone data and the Calculation layer as the value raster. Assign a location to save the output table.

When opened the output table will have statistics of GPP by the 2 ownership classes public and private. Of particular interest should be the MEAN field. Compare the mean GPP for public versus private lands within the PACE area.

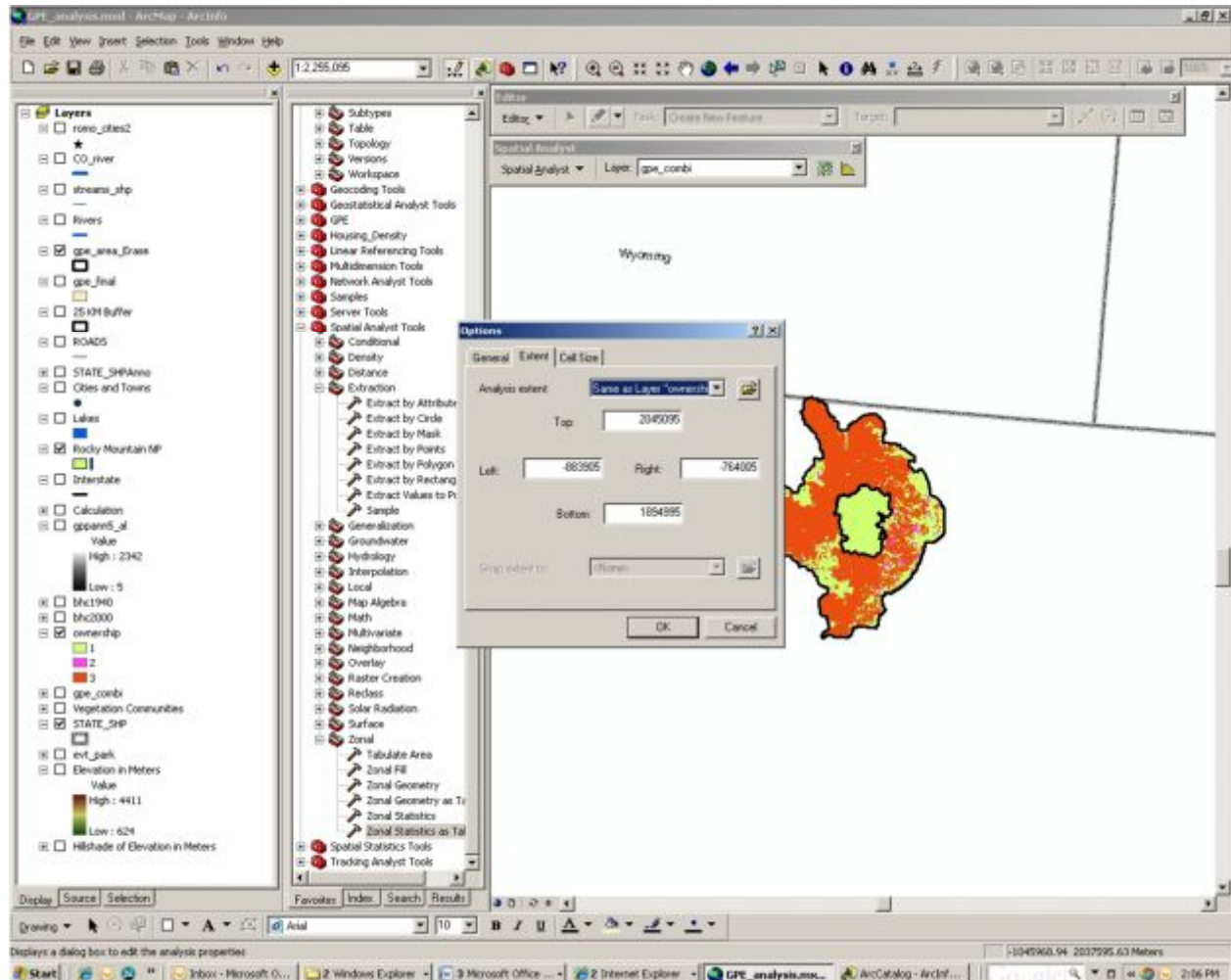


Figure 1. Setting the analysis extent for Spatial Analyst

Wrap-up

- Compare any biophysical bias between public and private lands in the PACE to those of other parks.
- Of primary concern are situations where public land mean GPP is significantly lower than private mean GPP. See ESTIMATING PROTECTED-AREA CENTERED ECOSYSTEMS Appendix A for further discussion.

Additional Analyses

There are any number of complimentary analyses that could be performed within the PACE area to assess threat levels to land use change, likely impacts as a result of land use change and other challenges to management and protection of a PACE area. This SOP has been presented as a baseline set of for PACE areas.

Literature cited

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