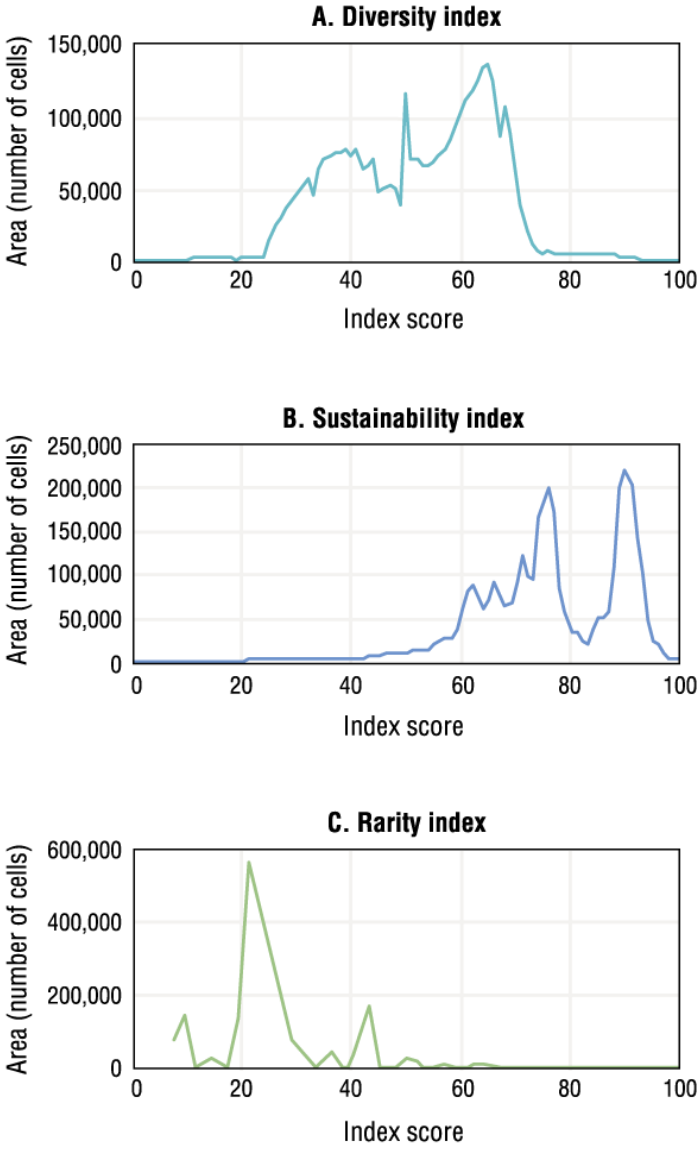
Relative Ecological Condition of Undeveloped Land in EPA Region 5

Exhibits

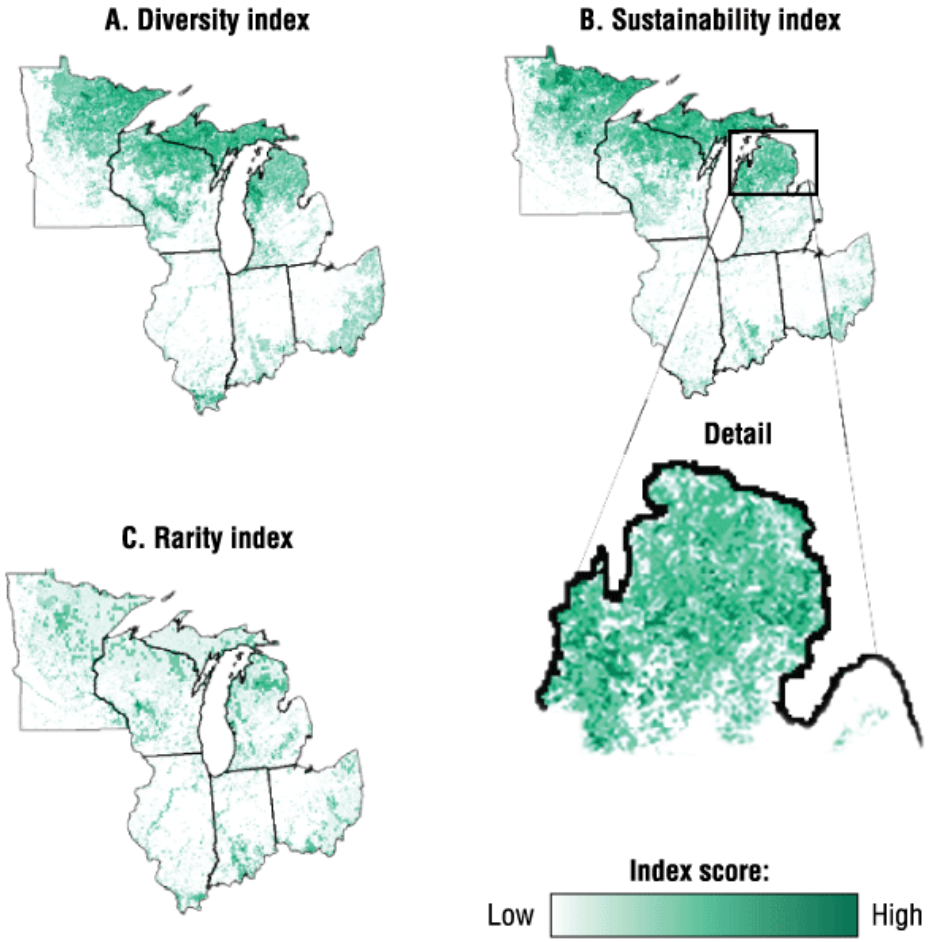
Exhibit 6-7. Distribution of index scores for the relative ecological condition of undeveloped land in EPA Region 5, 1990-1992[a]



[a]**Coverage:** Undeveloped land in EPA Region 5, based on the 1992 National Land Cover Dataset (NLCD). For this analysis, "undeveloped" land is any land that the NLCD classifies as bare rock/sand/clay, deciduous forest, evergreen forest, mixed forest, shrubland, grasslands/herbaceous, woody wetlands, emergent herbaceous wetlands, or open water.

Data source: *U.S. EPA, 2006*

Exhibit 6-8. Relative ecological condition of undeveloped land in EPA Region 5, 1990-1992[a]



[a]**Coverage:** Undeveloped land in EPA Region 5, based on the 1992 National Land Cover Dataset (NLCD). For this analysis, "undeveloped" land is any land that the NLCD classifies as bare rock/sand/clay, deciduous forest, evergreen forest, mixed forest, shrubland, grasslands/herbaceous, woody wetlands, emergent herbaceous wetlands, or open water.

Data source: *U.S. EPA, 2006*

Introduction

Ecological condition in the ROE is approached using questions broadly relating to landscape, biological diversity, ecological function, and the physical and chemical makeup of the environment, but no attempt is made at the national level to capture ecological condition in a small number of indices. In this indicator, the ecological condition of undeveloped land in EPA Region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) is characterized based on three indices derived from criteria representing diversity, self-sustainability, and the rarity of certain types of land cover, species, and higher taxa (White and Maurice, 2004). In this context, "undeveloped land" refers to all land use not classified as urban, industrial, residential, or agricultural.

Geographic units referred to as cells are used to quantify geographic information. A spatially explicit model using ecological theory and geographic information system (GIS) technology was used to create 20 data layers of 300-meter by 300-meter cells. These layers originate from several sources, including water quality datasets, state Natural Heritage Program databases (for species abundance), and the 1992 National Land Cover Dataset (NLCD), which was constructed from satellite imagery (Landsat) showing the land area of the contiguous U.S. during different seasons (i.e., leaves-on and leaves-off) during the early 1990s. In many locations, the best available Landsat images were collected between 1991 and 1993, with data in a few locations ranging from 1986 to 1995. For this indicator, data layers were combined to generate three indices, which represent estimates of three criteria:

- **Ecological diversity.** The relative diversities of populations (species), communities, and ecological systems in any given location on the landscape. Four data layers were used to derive this index.

- **Ecological self-sustainability.** The potential for an ecological system to persist for years without external management; it is negatively impacted by two factors: landscape fragmentation and the presence of chemical, physical, and biological stressors. Twelve data layers were used to derive this index.

- **Rarity.** The rarity of land cover, species, and higher taxa. Four data layers were used to derive this index.

The model produces composite layers that are statistically independent. The scores for each criterion are normalized from 1 to 100 and each layer contributes equally to the final index (all of the data layers are weighted equally). In all the data layers and the resultant criteria layers, scores are normalized from 0 to 100. Zero always indicates the lowest quality, the greatest stress, or the least valuable observation, and 100 indicates the highest quality, least stress, or most valuable observation. While it has not been done for this indicator, the three composite scores can be summed to result in a final "ecological condition" score for each cell (White and Maurice, 2004). Cell counts (a measure of geographic coverage) are used to indicate the distributions of scores associated with three index scores of ecological condition of undeveloped land: diversity, sustainability, and rarity.

What The Data Show

The frequency distributions of the 1992 baseline scores are quantified and plotted for each criterion (Exhibit 6-7), and these provide a baseline against which to track future landscape trends in diversity, sustainability, and rarity. Diversity scores generally run from 20 to 80 across the region, signifying that most areas are in the moderate diversity range. More than 90 percent of the region has sustainability scores above 50, but rarity scores above 50 are seldom encountered. The highest index scores are found largely in the northern forests of Minnesota, Wisconsin, and Michigan and along the large rivers in Ohio, Indiana, and Illinois (Exhibit 6-8).

Limitations

- Trend information is not available for this indicator. Establishing trends in the indicator may be limited by the availability of comparable land cover/land use data in the future.
- Although this indicator is designed to be comparable across undeveloped land within Region 5, layers were ranked within ecoregions for some of the components in order to account for different geophysical, geochemical, or climatic features of each ecoregion.
- Aquatic systems and connectivity resulting from water flow paths are not adequately covered and small, but potentially keystone, systems are not a part of the analysis (U.S. EPA, 2005).
- The data layers that contribute to each index were weighted equally, which may not reflect the actual relative importance of each layer (U.S. EPA, 2005).
- The resolution and uncertainty of the results make comparing the ecosystem condition score for one individual cell (300 meters by 300 meters) with another inappropriate, but this is not the case for comparison between larger landscapes (U.S. EPA, 2005).
- The model has not yet been field-validated to ensure that modeled results reflect actual ecosystem condition.

Data Sources

Maps and frequency distributions for the three indices were provided by EPA Region 5 (U.S. EPA, 2006). An EPA report available online contains several related maps produced by the Critical Ecosystem Assessment Model (CrEAM), along with a list of the various datasets used as inputs for the model (White and Maurice, 2004, appendices). Results from the CrEAM model are no longer available as digital map layers.

References

U.S. EPA (United States Environmental Protection Agency). 2006. Data provided to ERG (an EPA contractor) by Mary White, EPA Region 5. August 3, 2006.

U.S. EPA. 2005. SAB review of the EPA Region 5 Critical Ecosystem Assessment Model. EPA/SAB/05/011. Washington, DC. http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/A6D38FFBCAB115E38525702A006B6A86/$File/cream_sab-05-011.pdf

White, M.L., and C. Maurice. 2004. CrEAM: A method to predict ecological significance at the landscape scale. Chicago, IL: U.S. Environmental Protection Agency.

Metadata (Technical Documentation)

Identification

1. Indicator Title

Relative Ecological Condition of Undeveloped Land in EPA Region 5

2. ROE Question(s) This Indicator Helps to Answer

This indicator is used to help answer one ROE question: "What are the trends in the extent and distribution of the Nation's ecological systems?"

3. Indicator Abstract

This indicator assesses the ecological condition of undeveloped land in EPA Region 5 circa 1992. This indicator provides a broad understanding of the diversity, self-sustainability, and the rarity of certain types of land cover, species, and higher taxa.

4. Revision History

May 2008	-	Original indicator posted
March 2010	-	Metadata updated

Data Sources

5. Data Sources

This indicator is based on three indices (ecological diversity, ecological self-sustainability, and rarity) developed by EPA Region 5 for assessing the ecological condition of undeveloped land in their Region. It is based on 20 geographic information system (GIS) data layers from circa 1992 including land cover, species abundance, and water quality.

6. Data Availability

Maps and frequency distributions for the three indices were provided by EPA Region 5. An EPA report contains several related maps produced by the Critical Ecosystem Assessment Model (CrEAM) (White and Maurice, 2004, appendices). Results from the CrEAM model are no longer available as digital map layers, however, and CrEAM metadata are no longer available online. For more information, contact Dr. Mary White at white.mary@epa.gov or (312) 353-5878.

Most of the underlying data layers are in the public domain. For example, data from the 1992 NLCD can be obtained from http://landcover.usgs.gov/natllandcover.php. The rare and endangered species data were provided to EPA Region 5 under a confidential business agreement, so they cannot be given out in their original form; EPA is only allowed to disseminate the summary results. However, with the advent of NatureServe (http://www.natureserve.org/ EXIT Disclaimer), these data can now be obtained with fewer restrictions.

Methodology

7. Data Collection

This indicator was derived from a set of 20 geographic information system (GIS) data layers. These layers originate from several sources, including water quality datasets, state Natural Heritage Program databases (for species abundance), the 1992 National Land Cover Dataset (NLCD), and other sources. Accordingly, the layers reflect a wide range of measurement techniques. For example, Natural Heritage Program databases may be based on ground surveys, while the NLCD was constructed from satellite imagery (Landsat). Like measuring techniques, the most appropriate sampling design and the corresponding resolution depend on the parameter being measured. For example, the 1992 NLCD was constructed from satellite imagery showing the land area of the contiguous U.S. during different seasons (i.e., leaves-on and leaves-off) during the early 1990s. In many locations, the best available Landsat images were collected between 1991 and 1993, with data in a few locations ranging from 1986 to 1995. The NLCD has a pixel resolution of 30 meters (m). For consistency with the NLCD, the scientists who developed this indicator sought to ensure that the other data layers were also generally representative of the 1990 to 1992 time period. They also verified that all layers had been consistently collected over the six states that make up EPA Region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin).

Sensitive ecosystems are, for the most part, represented in proportion to their occurrence. However, aquatic systems and connectivity resulting from water flow paths are not fully covered, and small, but potentially keystone, systems are not a part of the analysis.

EPA's Science Advisory Board (SAB) reviewed the process for creating this indicator, concluding that for the most part, the measurements are scientifically and technically valid (http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/A6D38FFBCAB115E38525702A006B6A86/$File/cream_sab-05-011.pdf (47 pp, 331K, About PDF)). Sampling and analytical methods are described in an EPA report (White and Maurice, 2004), along with a list of the various datasets used as inputs.

8. Indicator Derivation

This indicator was developed using the Critical Ecosystem Assessment Model (CrEAM). Multiple data layers were aggregated (by majority) into composite layers (or indices) composed of 300-meter by 300-meter cells. The indicator presents three of these composite layers, or indices:

1. Ecological diversity. The relative diversities of populations (species), communities, and ecological systems in any given location on the landscape. Four of the 20 data layers were used to derive this index.
2. Ecological self-sustainability. The potential for an ecological system to persist for years without external management; it is negatively impacted by two factors: landscape fragmentation and the presence of chemical, physical, and biological stressors. Twelve of the 20 data layers were used to derive this index.
3. Rarity. The rarity of land cover, species, and higher taxa. Four of the 20 data layers were used to derive this index.

Each of the three composite layers was constructed from a different subset of 20 base layers. The model produces composite layers that are statistically independent. The scores for each criterion are normalized from 1 to 100 and each layer contributes equally to the final index (all of the selected data layers are weighted equally). Scores are again normalized in the resultant criteria layers. Zero always indicates the

lowest quality, the greatest stress, or the least valuable observation, and 100 indicates the highest quality, least stress, or most valuable observation. Cell counts (a measure of geographic coverage) are used to indicate the distributions of scores across the landscape. Scores were only calculated for the 3,634,183 cells considered to be undeveloped land (that is, not classified as urban, industrial, residential, or agricultural by the NLCD). The analysis was ranked within ecoregions for some of the indicators to account for different geophysical, geochemical, and climatic regions. Analytical methods are described in an EPA report (White and Maurice, 2004).

No attempt was made to extrapolate data beyond the time of measurement. The underlying data layers all represent a single snapshot in time (circa 1992), as does the final indicator. Spatially, all of the underlying datasets were collected nationwide or a consistent statewide basis.

In general, the SAB review (http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/A6D38FFBCAB115E38525702A006B6A86/$File/cream_sab-05-011.pdf (47 pp, 331K)) concluded that the data in this indicator represent the best available information to indicate the ecological condition of undeveloped land. A sensitivity analysis showed that the criteria chosen and the data used to determine a metric for each criteria were robust and non-duplicative. The SAB recommended some improvements for future iterations of the model, however. Use of the indicator is limited by the available inputs. The model has not yet been field-validated to ensure that modeled results reflect actual ecosystem condition.

9. Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) procedures are documented in the report submitted to the SAB, which is no longer available online.

Analysis

10. Reference Points

There are no established reference points, thresholds, or ranges of values for this indicator, as it represents a relative comparison of the condition of the undeveloped land within EPA Region 5.

11. Comparability Over Time and Space

All of the underlying datasets were collected nationwide or on a consistent statewide basis. All data represent a single snapshot in time.

12. Sources of Uncertainty

Content under review.

13. Sources of Variability

Content under review.

14. Statistical/Trend Analysis

Trend information is not available for this indicator, as it indicator represents a single snapshot in time.

Establishing trends in the indicator may be limited by the future availability of comparable land cover/land use data.

Limitations

15. Data Limitations

Limitations to this indicator include the following:

1. Trend information is not available for this indicator. Establishing trends in the indicator may be limited by the availability of comparable land cover/land use data in the future.
2. Although this indicator is designed to be comparable across undeveloped land within Region 5, layers were ranked within ecoregions for some of the components in order to account for different geophysical, geochemical, or climatic features of each ecoregion.
3. Aquatic systems and connectivity resulting from water flow paths are not adequately covered and small, but potentially keystone, systems are not a part of the analysis.
4. The data layers that contribute to each index were weighted equally, which may not reflect the actual relative importance of each layer.
5. The resolution and uncertainty of the results make comparing the ecosystem condition score for one individual cell (300m x 300m) with another inappropriate, but this is not the case for comparison between larger landscapes.
6. The model has not yet been field validated to ensure that modeled results reflect actual ecosystem condition.

References

16. Data Reference

White, M.L., and C. Maurice. 2004. CrEAM: A method to predict ecological significance at the landscape scale. Chicago, IL: U.S. Environmental Protection Agency.