



Measure Development Summary

Land Cover / Land Use

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Revision History

Revision #	Date	Revision Summary	Revised by
0.1	20081119	Initial version	Leona Svancara
0.2	20090203	Edits and updates	Leona Svancara
0.3	20090414	Added CCAP info	Leona Svancara
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Background and Justification

Land cover patterns are a reflection of the physical and chemical factors that shape the environment of a given land area (Whittaker 1967). In turn, land cover composition, configuration, and connectivity help shape overall biological diversity patterns including the complex of species occurring in an area, movements of individual organisms, and energy and material flows (Levin 1981, Noss 1990, Dunning et al. 1992; Franklin 1993, Taylor et al. 1993). Substantial changes in these land cover patterns occur in response to natural and anthropogenic processes and can have numerous impacts on ecological processes.

In many landscapes, humans are the primary drivers of landscape change (Vitousek et al. 1997, Sala et al. 2000). Given that human land uses tend to expand over time (Wade et al. 2003) and habitat loss is non-random (Seabloom et al. 2002), quantifying and monitoring the extent and pattern of natural land cover around protected areas is important to evaluate not only the current status of park biota, but also to identify potential threats and key conservation opportunities. It has been hypothesized that only protected areas with adequate expanses of surrounding habitat and linkages to other protected areas will be able to support current levels of biodiversity into the future (Hansen et al. 2001).

Maps depicting land cover and land use are necessary and fundamental to nearly all planning, management and monitoring programs at local, regional and national levels. Generally, the mapping of land cover is done by adopting a land cover classification system, delineating areas of relative homogeneity, then labeling these areas using classes defined by the classification system. This mapping takes many forms – no single mapping strategy will work best in all locations. The usefulness, efficiency, and cost-effectiveness of any land cover map is dependent on the scope and scale of questions being addressed, the spatial and temporal scale of imagery, the comprehensiveness of field and classification methods employed, and the level of accuracy desired. Key to selecting an adequate scale at which to evaluate the status and trends of land cover composition, configuration, and connectivity is identifying what is being managed (e.g., what species or processes; Beatley et al. 2000) and the scales to which those species/processes respond. Appropriate application of remotely-sensed imagery (e.g., aerial photos, multispectral, hyperspectral, laser) and methods (e.g., photo interpretation, maximum likelihood classification, object oriented image analysis) at relevant spatial and temporal scales follows. All of which depend on the timeframe, cost allowance, and accuracy level desired.

This MDS focuses on broad regional- to national-level questions and the extant mapping efforts that can be used to address them. Additional questions and analyses at local levels that incorporate finer spatial and temporal scale data are encouraged and expected.

Monitoring Questions and Objectives

Monitoring questions are stated in a general form, recognizing that refinements are necessary to clarify the desired objectives, the area of analysis, and suitable comparisons. General questions include:

- What is the areal extent of land cover types within and adjacent to parks?
- What proportion of adjacent land contains natural cover types and how much has been converted to urban or agricultural uses?
- What is the spatial relationship of park boundaries with converted lands?
- What are the patterns of relevant land cover types within and adjacent to parks?
- What parks are most isolated and which are potentially most at risk as evaluated by habitat conversion?
- In which biomes/ecoregions/divisions are lands surrounding parks more intact?
- How are land cover composition and connectivity changing?

Anticipated Inferences and Uses

- Provide information necessary to assess the status and trends in land cover composition, configuration, and connectivity within and adjacent to parks.
- Provide context for evaluating status and trends of land cover composition, configuration, and connectivity among regions of the country.
- Document changes in development, land conversion, and succession within and outside of park boundaries.
- Identify areas within and adjacent to parks where land use activities are most impacting habitat.
- Serve as base data for estimating conservation risk (see Conservation Status MDS).
- Reveal opportunities for cooperative management, conservation, and education.

Metrics

Area / Percent in Land Cover Types

Knowing the area and percent of each land cover type surrounding parks is necessary and fundamental to nearly all planning, management, and monitoring programs at local, regional, and national levels. The area of each land cover type is calculated in hectares (or sq kilometers) and the percent is calculated as the area of each land cover divided by the total area of land in the selected area of interest (e.g., km², county, biome, etc.).

Percent Natural / Converted

Total change in natural land cover is perhaps the simplest indicator of biotic integrity (O'Neill et al. 1997). Calculating the percent of natural land cover remaining in an area provides a general indication as to the overall landscape condition surrounding protected areas and offers insight into potential threats (i.e., how much land has been converted and

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where is it located in relation to the park boundary) as well as opportunities (i.e., connectivity of natural cover). Calculating the proportion of converted (agriculture and urban) land, also known as the U-index (O'Neill et al. 1988), can be used to measure general land use pressure by humans.

Table 1. NLCD land cover classes, and reclassification for calculating percent of natural and converted land cover.

Anderson I	Anderson II	Natural/Converted
1 Open Water	11 Open Water	Natural
	12 Perennial Ice/Snow	Natural
2 Developed	21 Developed Open Space	Converted
	22 Developed Low Intensity	Converted
	23 Developed Medium Intensity	Converted
	24 Developed High Intensity	Converted
3 Barren/Quarries/Transition:	31 Barren Land	Natural
	32 Unconsolidated Shore	Natural
4 Forest	41 Deciduous Forest	Natural
	42 Evergreen Forest	Natural
	43 Mixed Forest	Natural
5 Shrub/Scrub	51 Dwarf Scrub	Natural
	52 Shrub/Scrub	Natural
7 Grassland/Herbaceous	71 Grassland/Herbaceous	Natural
	72 Sedge/Herbaceous	Natural
	73 Lichens	Natural
	74 Moss	Natural
8 Agriculture	81 Pasture/Hay	Converted
	82 Cultivated Agriculture	Converted
9 Wetlands	90 Woody Wetlands	Natural
	95 Emergent Herbaceous Wetlands	Natural

Percent of natural land cover in an area can be used to describe four broad types of landscapes, each associated with particular levels of loss and connectivity (McIntyre and Hobbs 1999, 2000, Hobbs 2005). These landscapes cover a gradient from intact (>90% habitat remaining) to variegated (60-90% remaining), fragmented (10-60% remaining), and relictual (<10% remaining). Divisions between these four categories can be seen as critical thresholds (McIntyre and Hobbs 1999) where small changes in the spatial patterning of resources can produce abrupt ecological responses (Turner and Gardner 1991). While a single threshold value cannot adequately describe responses of all species to changes in landscape pattern or extent (Andr n 1994, With and Crist 1995, Bascompte and Sol  1996, Parker and Mac Nally 2002, Lindenmayer et al. 2005, Svancara et al. 2005), certain levels of natural land cover may act like “red-flags” for some species (Hansen and Urban 1992).

The percent natural/converted land cover is calculated as the area of natural/converted land cover divided by the total area of land in the selected area of interest (e.g., km², county, biome, etc.). The definition of “natural” will vary depending on the scope of

question asked and typically requires aggregating the original land cover/land use data to broad ‘converted’ versus ‘natural’ categories as is shown in Table 1 for the 2001 NLCD.

Changes in Percent Natural / Converted

The change in percent natural and/or converted for each area of interest is calculated as the percent change in natural/converted land cover types between time x and time x+1. This metric can be calculated using the NLCD 1992-2001 Change Product, NLCD 2006, C-CAP, or the USGS Land Cover Trends data.

Changes in Area of Land Cover Type

The change in area and percent of each land cover type for each area of interest is calculated as the percent change in each land cover types between time x and time x+1. This metric can be calculated using the NLCD 1992-2001 Change Product, NLCD 2006, C-CAP, or the USGS Land Cover Trends data. The NLCD change codes and legend are provide in Appendix 1.

Area in Canopy Cover Classes

The area of each canopy cover class for forested regions is calculated in hectares (or sq kilometers) and the percent is calculated as the area of each class divided by the total area of forested land in the selected area of interest (e.g., km², county, biome, etc.).

Area in Impervious Surface

The area of impervious surface is calculated in hectares (or sq kilometers) and the percent is calculated as the area divided by the total area of land in the selected area of interest (e.g., km², county, biome, etc.).

Overall Percent Change in Agricultural Land

The overall change in agricultural land for each area of interest is calculated as the percent change in agricultural land between time x and time x+1. This metric can be calculated at the county level between 1790 and 2000 based on Waisanen and Bliss (2002). Additional calculations of change in agricultural land at finer spatial resolutions are possible using with the USGS Land Cover Trends Project (1973-2000), the NLCD Change Product and NLCD 2006 (1992-2006), or C-CAP (1995-2006).

Issues and Assumptions

The issues and assumptions inherent in land cover/land use analyses are a result of 1) thematic scale, 2) spatial scale, 3) spectral scale, and 4) overall study objectives. The standards and methodologies employed by each mapping effort will differ, thus so will the overall applicability of that data to any given situation. The following issues and assumptions are general in nature, applying to any and all land cover mapping product:

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- Land cover / land use classes assume single homogeneous categories based on the dominant type and do not necessarily differentiate patch/stand characteristics such as stand age or understory composition. In many cases, such as NLCD, the classes do not isolate disturbances. For example, an area with a great deal of forest clearing (e.g., logging) may be classified as forest, grass, or shrub.
- Boundaries between vegetation types along real environmental gradients are seldom as sharp as implied by land cover maps. Transition areas between classes represent gradients of condition that likely change positively and negatively with time. Similarly, aggregating thematic classes (e.g., 'natural' versus 'converted') implies simple relationships when realistically they are also gradients variable with temporal and spatial scale.
- Products are not necessarily consistent across mapping extents. For example, GAP products are often inconsistent across state lines. Regional GAP products are developed across multiple states to alleviate this issue but, there may still be inconsistencies between regions. Similarly, NLCD and LANDFIRE products are developed by mapping zone and, while efforts are made to eliminate inconsistencies, they may still occur.
- Calculating the proportion of area in any manner is always a function of the sampling unit being measured (e.g., county, biome, grid cell size) and must be interpreted within that context.
- The described metrics will not account for land units smaller than the minimum mapping unit of the input datasets and is valid only at the point in time that the data were acquired. In addition, as with all spatial analyses, inaccuracies in the input data will multiply in the output.

Data Descriptions

Data Availability

Data on land cover and/or land use is available from multiple sources at several spatial and temporal scales. Those consistently available at regional and national scales include:

- National Land Cover Data (NLCD)
- USGS Land Cover Trends Project
- LANDFIRE
- Gap Analysis Program (GAP)
- NatureServe Ecological Systems
- NOAA Coastal Change Program (C-CAP)
- National Agricultural Statistics Service (NASS)
- National Resources Inventory (NRI)
- Waisanen and Bliss (2002)

National Land Cover Data (NLCD)

The National Land Cover Database (NLCD) has encompassed three major successful data releases under the Multi-Resolution Land Characteristics (MRLC) Consortium, a group of Federal agencies working together to obtain imagery and derive land cover data for the Nation. These products include a 1992 coterminous U.S. land cover dataset with one thematic layer of land cover (NLCD 1992); an updated 50-state/Puerto Rico land cover database with three thematic layers including land cover, percent imperviousness, and percent tree canopy (NLCD 2001); and an NLCD 1992-2001 land cover change product that was specially designed to identify land cover change between the two datasets (NLCD 1992 and 2001). A fourth data release (NLCD 2006) is currently in development and, using NLCD 2001 as a base map, will reflect changes between 2001 and 2006. NLCD data currently serve numerous Federal, State, local, and non-Governmental programs that seek to understand the impact of land cover on both ecological and social systems.

The 21 land cover classes (modified from Anderson et al. 1976, Level II) that make up the NLCD were derived from consistent analysis of multi-date Landsat Thematic Mapper (TM) imagery. Different methodologies were used for the 1992 and the 2001 products. For NLCD 1992, early to mid-1990s TM multi-band mosaics were processed using an unsupervised clustering algorithm (Vogelmann et al. 2001). Both leaves-off and leaves-on data sets were analyzed and the resulting clusters were labeled using aerial photography and ground observations. Clusters that represented more than one land cover class were identified and, using various ancillary data sets, models were developed to split the confused clusters into the correct land cover classes. For NLCD 2001, image mosaics from the late-1990s to 2000 were processed using a decision tree classification and following a carefully planned methodology to offer users a full range of flexible applications (see Homer et al. 2004 for overall database philosophy and methodology). NLCD 2006 will be produced using a basic model of change detection developed by the NOAA C-CAP program with areas identified as change (2001-2006) extracted from the image sets and classified according to NLCD 2001 methods.

Given the different methodologies used in NLCD 1992 and 2001 products, as well as inherent differences in source image seasonality and georegistration, classification accuracy, and map legends, direct comparison of the two datasets is subject to error. To optimally compare the products, the USGS NLCD design team created the NLCD 1992-2001 Retrofit Change product using a multistage processing method incorporating both NLCD products in procedures that included (1) reclassification of both eras of land cover using a decision tree classifier at Anderson Level I, (2) filtering intermediate results with confidence parameters, (3) determining changed versus nonchanged pixels, and (4) labeling the final change product using a "from-to" change classification code.

Accuracy assessments of NLCD 1992 (Stehman et al. 2003, Wickham et al. 2004) suggested measurements of composition and pattern should be based on eight generalized categories (Riitters et al. 2006). Similar assessments for NLCD 2001 are not yet completed. Similarly, the NLCD 1992-2001 Retrofit Change product is available in

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provisional status until a formal accuracy assessment can be completed (Coan et al. in progress).

Although a clear funding path has not been identified, the MRLC would like to make NLCD a land cover monitoring program and produce updates on a five year cycle. With this objective in mind, the NLCD 2006 update is in the process of development with initial research ongoing in Washington, South Dakota, southern California, New England, and the Mississippi Delta.

USGS Land Cover Trends Project

The USGS Land Cover Trends Project is a focused on understanding the rates, trends, causes, and consequences of land cover change from 1973-2000 within the coterminous US. The goals of the project are to 1) develop a comprehensive methodology for estimating regional land cover change, 2) characterize the spatial and temporal characteristics of change for five time periods (1973, 1980, 1986, 1992, 2000), 3) document the regional driving forces and consequences of change, and 4) prepare a national synthesis of land cover change. The classification system consists of 11 general land cover classes (Anderson Level I, Anderson et al. 1976) and full discussion of project methodology is available in Loveland et al. (2002).

Results for several ecoregions across the coterminous US are available, including all of the eastern and Great Plains portions of the US. All data and reports are freely available from the USGS Land Cover Trends Project website (<http://landcoverrends.usgs.gov/>). The project is scheduled to complete the initial 30-year assessment in 2010.

LANDFIRE

The Landscape Fire and Resource Management Planning Tools Project (LANDFIRE), is a five-year, multi-partner project producing consistent and comprehensive maps describing vegetation, wildland fuel, and fire regimes across the U.S. Developed products include existing vegetation type, biophysical setting, fire regime groups, and fire regime condition class departure index and are designed to facilitate regional- and national-level strategic planning and reporting of wildland fire management activities. These products are produced at scales that may be useful for prioritizing and planning hazardous fuel reduction and ecosystem restoration projects; however, the applicability of data products varies by location and specific use, and products may need to be adjusted by local users.

The Existing Vegetation Type (EVT) layer represents the vegetation currently present at a given site. Existing vegetation is mapped through a predictive modeling approach using a combination of field reference information, Landsat imagery, and spatially explicit biophysical gradient data. The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. The BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to fire regime condition class (Schmidt et al. 2002; www.frcc.gov). Existing vegetation and biophysical setting map units are based on NatureServe's Ecological

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Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer et al. 2003).

The Fire Regime Groups layer represents an integration of fire frequency and severity simulated using the vegetation and disturbance dynamics model LANDSUM (Keane et al. 2002). These groups are intended to characterize the presumed historical fire regimes within landscapes based on interactions between vegetation dynamics, fire spread, fire effects, and spatial context (Hann et al. 2004). The Fire Regime Condition Class (FRCC) Departure Index depicts the amount that current vegetation has departed from simulated historical vegetation reference conditions (Hann and Bunnell 2001; Hardy et al. 2001; Hann et al. 2004; Holsinger et al. 2006). This departure results from changes to species composition, structural stage, and canopy closure. Historical vegetation reference conditions were simulated using the vegetation and disturbance dynamics model LANDSUM (Keane et al. 2002; Keane et al. 2006; Pratt et al. 2006). Definitions and methodologies for both products were derived from the Interagency Fire Regime Condition Class Guidebook (Hann et al. 2004, Holsinger et al. 2006).

LANDFIRE has implemented an Operations and Maintenance Strategy, the first product of which is known as "Refresh." Refresh involves a systematic critique of existing data products and a consistent update of vegetation layers according to changes resulting from disturbance processes. In addition, products will be updated to correct some mapping inaccuracies that were detected after the initial mapping effort as part of a long-term endeavor to continually improve LANDFIRE data.

Gap Analysis Program (GAP)

The Gap Analysis Program (GAP), conceived and launched in the late 1980s, represented the first comprehensive effort to map elements of biodiversity (land cover and species distribution) over large areas and identify those which were under-represented (i.e., 'gaps') in the network of conservation lands. Actual (existing) land cover is one of the three main data layers developed and used by GAP to a) determine species and natural community representation within areas being managed for biodiversity conservation; b) provide spatial data that can be used to model wildlife habitat distributions; and c) provide a single temporal data set for monitoring trends (GAP 2007). As part of the MRLC, GAP works with federal partners to obtain imagery and derive land cover products for the nation.

Since the initial GAP project in Idaho (1989), a wide range of tools and procedures have become available including standardized vegetation classifications, consistent sets of satellite images, and vastly improved methodologies. Because of this, inconsistencies may arise when comparing across state lines. Recently, the GAP program has initiated regional efforts (ReGAP) to update and extend the analyses across broader areas. For example, the Southwest ReGAP effort encompassed 5 states (NV, UT, CO, AZ, and NM).

GAP does not require rigid compliance with a certain methodology or imagery source, but rather implements standards for products. At a minimum, GAP land cover maps meet or exceed the following: 1) a nominal map scale of 1:100,000, 2) thematic classes based

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on the National Vegetation Classification System (NVCS) alliances or aggregations of alliances (though more recent efforts have used Ecological Systems, Comer et al. 2003), 3) complete metadata, and 4) Landsat TM imagery as a primary source of data with the base year for all TM scenes less than 3 years old at the start of the project. While initial state GAP efforts had a minimum mapping unit of 100ha for uplands and 40 ha for special features such as riparian areas, more recent efforts typically use 2ha and 0.5ha, respectively. Lastly, GAP requires a standardized method for assessing the accuracy of all land cover maps (for additional information see GAP 2007).

GAP is operational nationwide and has also been implemented in several other countries. GAP data are freely distributed through the GAP NBII portal (http://gapanalysis.nbii.gov/portal/community/GAP_Analysis_Program/Communities/GAP_Home/). At this time, final GAP land cover products are available online for 40 states and Puerto Rico. Draft versions for 9 of the 10 missing states (NE, WI, IL, OH, NC, VT, NH, AL, MN) are available via the state GAP or cooperator web pages. The Alaska GAP program is relying on LANDFIRE data, expected to be available in 2009. In addition, land cover data representing updates to the state-level analyses are available for 3 Re-GAP efforts: the Southeast (KY, VA, TN, NC, SC, GA, AL, MS, FL), the Southwest (NV, UT, CO, AZ, NM) and, in draft form, the Northwest (WA, OR, ID, MT, WY). Updates efforts for the Northeast and California are pending. Dates of the data vary by state and region as do revisions or updates.

NatureServe Ecological Systems

NatureServe developed a national composite map of ecological systems based on LANDFIRE and GAP data sources. The thematic classes are ecological systems (see Comer et al. 2003) and are attributed with the upper levels of the 2008 National Vegetation Classification System (Class, Subclass, Formation, Division). An additional level (“macrogroup”) between the 44 Divisions and 512 ecological systems is being developed. As a composite product, these data reflect the same spatial and temporal scale, as well as inherent errors and assumptions, as do the original source data. The data are provided at 30m spatial resolution.

These data are available from Pat Comer at NatureServe, Boulder, CO.

NOAA Coastal Change Analysis Program (C-CAP)

The Coastal Change Analysis Program (C-CAP) is a nationally standardized land cover and land change database for the coastal regions of the US. Developed from Landsat TM satellite imagery, C-CAP data are mapped at 1:100,000 scale with a minimum mapping unit of one acre (i.e., 4 Landsat pixels). Similar to NLCD, C-CAP follows the Anderson classification system and maps 22 land cover classes representing major land cover types. A partnership between NOAA and USGS establishes NOAA as the provider of land cover data for the coastal regions of the NLCD. C-CAP data maintain average accuracies of 85%, though some classes are higher, and some lower.

Standard baseline data consists of a recent coastal land cover map, an earlier land cover map (usually 5 years previous), and a database of change between the two. Products generally reflect 1996, 2001, and 2006 time periods. Although C-CAP only maps coastal

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areas that fall within defined estuarine drainage areas (EDA), these areas are quite extensive. A graphic of the areas mapped by C-CAP is available (<http://www.csc.noaa.gov/crs/lca/locateftp.html>). All of Hawaii is included with high resolution data (based on 2.4m Quickbird imagery) available for some portions.

The goal of C-CAP is to inventory coastal intertidal areas, wetlands, and adjacent uplands and monitor these habitats every five years. These data are freely available at the NOAA C-CAP website (<http://csc.noaa.gov/crs/lca/ccap.html>).

National Agricultural Statistics Service (NASS)

The USDA's National Agricultural Statistics Service (NASS) provides consistent, comparable, and detailed agriculture data by conducting the Census of Agriculture every five years for every county in the U.S, Puerto Rico, Guam, the US Virgin Islands, and the Commonwealth of Northern Mariana Islands. The first agricultural census was taken in 1840 as part of the sixth decennial census of population. A separate middecade census of agriculture was conducted in 1925, 1935, and 1945. From 1954 to 1974, the census was taken for the years ending in 4 and 9. In 1976, Congress authorized the census of agriculture to be taken for 1978 and 1982 to adjust the data reference year so that it coincided with other economic censuses. This adjustment in timing established the agriculture census on a 5-year cycle collecting data for years ending in 2 and 7.

The census aims to include all operators of US farms or ranches that sold or normally would have sold \$1000 worth of agricultural products during the census year. NASS maintains a list of these farms and ranches to which one of two census report forms are mailed in December of the census year. All operators provide crop acreage and quantities harvested, inventories of livestock and poultry, value of products sold, land use and ownership, irrigation activities, amount of commodity credit loans, number of hired laborers, federal program payments (e.g., Conservation Reserve Program), and operator characteristics. Selected operators provide additional information on production expenses (including interest), fertilizer and chemical use, machinery and equipment, market value of land and buildings, and income from farm-related sources. Statistical estimation procedures are used to account for nonresponse and incomplete coverage.

Census of Agriculture data at county and state levels is freely available through www.nass.usda.gov or www.agcensus.usda.gov. NASS will release the 2007 Census data beginning in February 2009.

Natural Resources Inventory (NRI)

The USDA Natural Resources Conservation Service's National Resources Inventory (NRI) is a scientifically-designed, longitudinal panel survey of land use and natural resource conditions and trends on U.S. non-Federal lands, including those lands owned privately, by tribal and trust, and by state and local governments. The NRI was conducted every 5 years between 1977 and 1997, but currently is in transition to a continuous, or annual, inventory process.

An historical overview, as well as sample design, data collection, and estimation procedures used in the periodic 5-year NRI are provided in Nusser and Goebel (1997)

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and NRCS (1997). NRI data were collected at more than 800,000 sample sites nationwide and the data can be legitimately used to analyze issues at many geographic levels -- national, regional, State, and sub-State (multi-county). The NRI was not designed to provide statistical estimates for counties or 8-digit hydrologic units; however, examining the data at various geographic levels, including county or 8-digit hydrologic unit, is a legitimate analytical technique for gaining additional insight into the database (NRCS 1997). Anyone who intends to work with NRI data, especially at the county or 8-digit hydrologic unit scales, should read carefully the technical guidance as to the suitability and limitations of the data and the error-estimation procedures (NRCS 1997).

For the Annual NRI, data are gathered each year for a scientifically selected subset of the foundation sample sites established for the periodic NRI. This subsample includes a set of Core sample sites, which are sampled every year, and Rotation (or supplemental) sample site that vary by inventory year and allow an inventory to focus on an emerging issue.

Data for the 48 coterminous states, Hawaii, Puerto Rico, and the U.S. Virgin Islands are contained on a single CD and can be ordered for \$50.00 from <http://www.ncgc.nrcs.usda.gov/products/nri/order.html>.

Waisanen and Bliss (2002)

In 2002, Pamela Waisanen and Norman Bliss published an article summarizing changes in population and agricultural land in counties of the coterminous United States from 1790-1997. Although this is not an ongoing monitoring effort, the data are included here because they represent one of the best (if not the only) historical compilations of agricultural land in the country. Excerpt from their abstract, the purpose was to provide data on the timing of land conversion as an input to dynamic models of the carbon cycle, although a wide variety of applications exist for the physical, biological, and social sciences. The spatial data represent the appropriate county boundaries for each census year between 1790 and 1997, and the census attributes are attached to the appropriate spatial region. The resulting time series and maps show the history of population (1790–1990) and the history of agricultural development (1850–1997). The patterns of agricultural development reflect the influences of climate, soil productivity, increases in population size, variations in the general economy, and technological changes in the energy, transportation, and agricultural sectors.

These data are freely available from <http://landcover.usgs.gov/cropland/>.

Data Dimensions (spatial, temporal, thematic)

National Land Cover Dataset 1992 (NLCD1992)

- State level data available for coterminous U.S.
- Early to mid-1990s Landsat TM
- 30m spatial resolution, intended for regional-national application only
- 21 thematic classes (modified Anderson 1976, Level II)
- Available for free at <http://www.mrlc.gov/>

National Land Cover Database 2001 (NLCD2001)

- Mapping zone level data available for all 50 states plus Puerto Rico
- Late-1990s to 2000 Landsat TM and ETM
- 30m spatial resolution, intended for regional-national application only
- 21 thematic classes (modified Anderson 1976, Level II)
- Imperviousness and Tree Canopy data also available
- Available for free at <http://www.mrlc.gov/>

National Land Cover Dataset 1992/2001 Change

- Mapping zone level data available for coterminous U.S.
- 2000-2002 Landsat TM and late-1990s to 2000 Landsat TM and ETM
- 30m spatial resolution, intended for regional-national application only
- 8 thematic classes (Anderson 1976, Level I), 55 from-to change classes
- Available for free at <http://www.mrlc.gov/>

USGS Land Cover Trends Project

- Ecoregion level data for the coterminous U.S.
- Landsat Multispectral Scanner (MSS), Thematic Mapper (TM), and Enhanced Thematic Mapper (ETM+)
- 5 time periods: 1973, 1980, 1986, 1992, 2000
- 30m spatial resolution, intended for regional-national application only
- 11 thematic classes (Anderson 1976, Level I)
- Available for free at <http://landcover Trends.usgs.gov/>

LANDFIRE

- Mapping zone level data available for coterminous U.S. (Alaska and Hawaii in progress)
- Early to mid-1990s Landsat TM and late-1990s to 2000 Landsat TM and ETM
- 30m spatial resolution, intended for regional-national application only
- 400-450 thematic classes based on Ecological Systems (Comer et al. 2003)
- Available for free at <http://www.landfire.gov>

Gap Analysis Program (GAP)

- State level data available for 49 states plus Puerto Rico (AK pending) and 3 regions (Southwest, Southeast, Northwest).
- 1:100,000 scale with a typical minimum mapping unit of 2ha (upland) and 0.5ha (riparian and special features).
- Thematic classes based on NVCS alliances or Ecological Systems
- Standardized accuracy assessments
- Dates of the data vary state and region as do revisions and updates.
- Available for free at <http://gapanalysis.nbii.gov/>

NatureServe Ecological Systems

- Composite of Landfire and GAP products
- Dates and imagery sources vary with original Landfire/GAP data

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- 30m spatial resolution, intended for regional-national application only
- Thematic classes based on Ecological Systems (Comer et al. 2003), attributed with higher levels of NVCS
- Available from NatureServe, Boulder, CO

NOAA Coastal Change Assessment Program (C-CAP)

- All coastal areas of the coterminous US and Hawaii
- Late-1990s to 2006 Landsat TM
- 3 temporal products: 1996, 2001, 2006
- 1 acre (4 pixel) minimum mapping unit, intended for regional application
- 22 thematic classes (modified Anderson 1976, Level II)
- Change data also available
- Available for free at <http://csc.noaa.gov/crs/lca/ccap.html>

National Agricultural Statistics Service (NASS)

- County level data for all U.S. states, Puerto Rico, Guam, the US Virgin Islands, and the Commonwealth of Northern Mariana Islands
- Several agricultural related variables including crop acreage and quantities harvested, inventories of livestock and poultry, value of products sold, land use and ownership, irrigation activities, amount of commodity credit loans, number of hired laborers, federal program payments, operator characteristics, production expenses, fertilizer and chemical use, machinery and equipment, market value of land and buildings, and income from farm-related sources.
- Every 5 years for years ending in “2” and “7”
- Available for free at www.nass.usda.gov or www.agcensus.usda.gov

National Resources Inventory (NRI)

- Sample data for all nonfederal lands in the 48 coterminous states, Hawaii, Puerto Rico, and the US Virgin Islands
- Nationally consistent results for 1982, 1987, 1992, and 1997
- Available at a cost from <http://www.ncgc.nrcs.usda.gov/products/nri/order.html>

Waisanen and Bliss (2002)

- County level data for coterminous U.S.
- Area and proportion of agricultural land from 1850–1997 and population size and density from 1790-1990.
- Available for free from <http://landcover.usgs.gov/cropland/>

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Appendix 1. NLCD Change Product cover types and codes.

Attribute_Definition_Source: NLCD 2001

1: Modified Anderson Level I class code for Open Water
2: Modified Anderson Level I class code for Urban
3: Modified Anderson Level I class code for Barren
4: Modified Anderson Level 1 class code for Forest
5: Modified Anderson Level 1 class code for Grassland/Shrub
6: Modified Anderson Level 1 class code for Agricultural Land
7: Modified Anderson Level I class code for Wetlands
8: Modified Anderson Level I class code for Perennial Ice/Snow
12: Land cover change code for Open Water to Urban
13: Land cover change code for Open Water to Barren
14: Land cover change code for Open Water to Forest
15: Land cover change code for Open Water to Grassland/Shrub
16: Land cover change code for Open Water to Agriculture
17: Land cover change code for Open Water to Wetlands
18: Land cover change code for Open Water to Ice/Snow
21: Land cover change code for Urban to Open Water
23: Land cover change code for Urban to Barren
24: Land cover change code for Urban to Forest
25: Land cover change code for Urban to Grassland/Shrub
26: Land cover change code for Urban to Agriculture
27: Land cover change code for Urban to Wetlands
28: Land cover change code for Urban to Ice/Snow
31: Land cover change code for Barren to Open Water
32: Land cover change code for Barren to Urban
34: Land cover change code for Barren to Forest
35: Land cover change code for Barren to Grassland/Shrub
36: Land cover change code for Barren to Agriculture
37: Land cover change code for Barren to Wetlands
38: Land cover change code for Barren to Ice/Snow
41: Land cover change code for Forest to Open Water
42: Land cover change code for Forest to Urban
43: Land cover change code for Forest to Barren
45: Land cover change code for Forest to Grassland/Shrub
46: Land cover change code for Forest to Agriculture
47: Land cover change code for Forest to Wetlands
48: Land cover change code for Forest Forest to Ice/Snow
51: Land cover change code for Grassland/Shrub to Open Water
52: Land cover change code for Grassland/Shrub to Urban
53: Land cover change code for Grassland/Shrub to Barren
54: Land cover change code for Grassland/Shrub to Forest
56: Land cover change code for Grassland/Shrub to Agriculture
57: Land cover change code for Grassland/Shrub to Wetlands
58: Land cover change code for Grassland/Shrub to Ice/Snow
61: Land cover change code for Agriculture to Open Water
62: Land cover change code for Agriculture to Urban
63: Land cover change code for Agriculture to Barren
64: Land cover change code for Agriculture to Forest
65: Land cover change code for Agriculture to Grassland/Shrub
67: Land cover change code for Agriculture to Wetlands

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68: Land cover change code for Agriculture to Ice/Snow
71: Land cover change code for Wetland to Open Water
72: Land cover change code for Wetland to Urban
73: Land cover change code for Wetland to Barren
74: Land cover change code for Wetland to Forest
75: Land cover change code for Wetland to Grassland/Shrb
76: Land cover change code for Wetland to Agriculture
78: Land cover change code for Wetland to Ice/Snow
81: Land cover change code for Ice/Snow to Open Water
82: Land cover change code for Ice/Snow to Urban
83: Land cover change code for Ice/Snow to Barren
84: Land cover change code for Ice/Snow to Forest
85: Land cover change code for Ice/Snow to Grassland/Shrub
86: Land cover change code for Ice/Snow to Agriculture
87: Land cover change code for Ice/Snow to Wetlands