USDA
United States Department of Agriculture

Changing Landscapes

Land use planning curriculum for natural resource professionals

P rinciples, people, and policies
L and planning and pressures
A pproaches
N atural resource planning tools

N1: Developing a Natural Resource Assessment

Assessing natural resources is an important step in making environmentally sound development decisions. (Photo: http://www.usda.gov)

Overview

This factsheet describes a natural resource assessment, reviews its components, and discusses its importance in making environmentally sound development decisions.

Assessing Natural Resources in the Land Use Planning Process

Identifying the location, quality, and availability of natural resources is a fundamental first step in sound land use planning. Natural resource inventories can be completed at watershed, regional, local, or even at site scales. At a watershed or regional scale, natural resource assessments provide the information needed to make decisions related to managing forests; assessing water quality; acquiring open space; and managing stormwater, wildfire, and invasive species.

Larger scale natural resource assessments serve as a logical basis for substantiating decisions made during development of comprehensive plans and zoning ordinances. At a local level, municipal ordinances require natural resource inventories on parcels proposed for subdivision as part of the permit application. Information from these inventories is used to locate streets, utilities, and community amenities while protecting ecologically sensitive areas during the development process. Natural resource inventories have been used extensively for making sound, scientifically validated arguments for using cluster density and other low-impact development approaches.

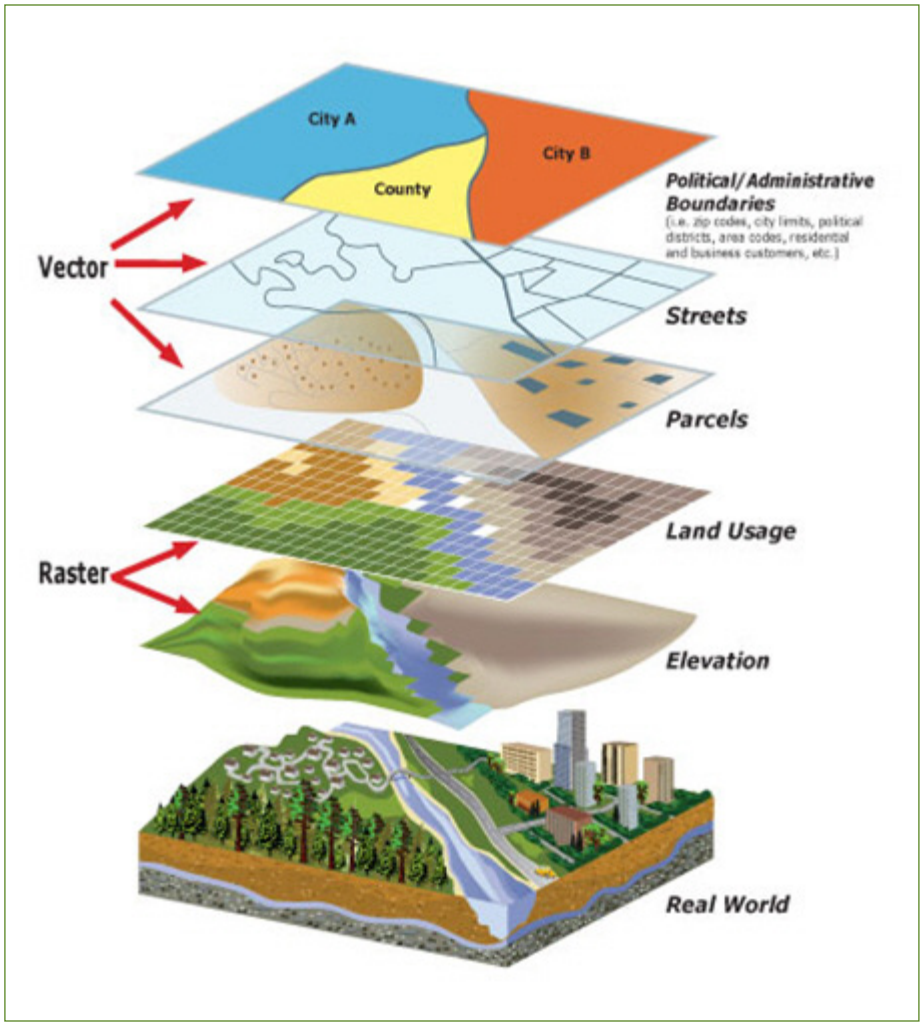
In his 1969 book *Design with Nature*, Ian McHarg describes how various types of information provided by a natural resource inventory can be graphically overlaid in a composite map that identifies the best places to locate development while best protecting natural features and function during the land development process. Today, ArcGIS is commonly used to create spatially explicit geodatabases and other graphic analysis overlays that help planners better understand how nature can be protected and celebrated in the design process. This methodology is used to quickly identify sites where development should not occur. Steep slopes, wetlands, hydric soils, riparian areas, and other conservation areas are quickly factored out of the design solution.

Forest Service
Northeastern Area State and Private Forestry
11 Campus Blvd., Suite 200
Newtown Square, PA 19073
October 2014
http://www.na.fs.fed.us

NA–TP–01–14 N1
USDA is an equal opportunity provider and employer.

GIS analysis makes it possible to easily consider the location and importance of woodlots, sensitive environmental areas, views, and other secondary conservation areas. Planners and engineers can then use the new parcel map to begin the planning process using only the most suitable land—ensuring more environmentally sound design.

In established parks and open space, natural resource inventories and composite maps that identify important natural resources and features are invaluable components of a suitability analysis. When a suitability analysis is coupled with value ratings, this is referred to as a rubric analysis. A rubric analysis is used to evaluate the condition of vegetation, wildlife habitat, soils, streams, and other natural features. The conditional rating of those resources can help planners prioritize restoration and conservation objectives during the planning phase of a development project.



Geographic information systems use overlapping digital map layers to help users analyze data about important natural resources. (Map: Birmingham, AL, National Weather Service GIS Data Page)

Some Natural Resource Assessment Methods

- **Ohio Rapid Assessment Method** uses six metrics to assess wetlands: size, upland buffers and surrounding land use, hydrology, habitat alteration and development, special wetlands, and plant communities.
- **Penn State Cooperative Wetlands Center Rapid Wetland Condition Assessment** evaluates and scores a number of stressors, including buffer width, sedimentation, dissolved oxygen, vegetative and hydrologic alteration, and contamination.
- **USDA National Water and Climate Center Stream Visual Assessment Protocol** assesses the condition of aquatic systems by evaluating and scoring a number of significant factors, including riparian zone, aquatic habitat, and nutrient enrichment.
- **USDA Forest Service Forest Health Monitoring and Urban Forest Effects Model** determines the status, changes, and trends in urban forest condition. It also quantifies forest function (e.g., carbon storage and sequestration, stormwater management) by analyzing information on tree species, tree health, and tree size collected in random measurement plots and aerial surveys.

Content of a Natural Resource Inventory

Regardless of scale, most natural resource inventories have similar content; however, they can vary depending on the scale and degree of detail needed. Natural features, natural processes, historic landmarks, landscape features, and rare and threatened species are commonly inventoried in natural resource assessments. More indepth natural resource inventories often document community value and local issues related to each. This information can be extremely important in engaging stakeholders and for building consensus for planning decisions.

The following overview discusses important components of a natural resource inventory and how their protection is considered in the local planning process.

Watersheds

A watershed is the area of land that drains to a river or other body of water. Watersheds can range widely in size as well as the land uses and landscapes they contain. A watershed perspective helps planners manage the cumulative impacts of development in both space and time. Aerial views of watersheds can help planners assess how development might affect stormwater, nonpoint water pollution, wildlife movement, recreation, and fire management.

A watershed perspective helps planners manage the cumulative impacts of development.

Existing Land Cover

Satellite imagery and aerial photography are used to view land cover and land use at varying resolutions and scales. At larger scales, they can help determine existing land uses and the linkages between them that may exist. Satellite imagery is useful in providing a spatial view of the impact of new development when it is overlaid with existing land use. Satellite imagery is also often used to identify the locations of natural areas, rare habitat, historic land use, or ecological function necessary in making conservation decisions. Land cover is used to develop land use maps that provide data for the development of zoning maps and land use ordinances.

Floodplains

Floodplains are landscapes near rivers and streams that are prone to flooding. They are important for agricultural use, providing plant and wildlife habitat, and enabling water infiltration that replenishes water tables. Floodplains are officially defined by the reoccurrence of periodic flooding from a storm intensity type. For instance, a 100-year storm has a 1 in 100 chance of occurring in any given year. The Federal Emergency Management Agency is responsible for mapping and modeling flood-prone areas. Ordinances that address development should be crafted with storm intensity in mind. Standards should be developed that reflect the intensity of storm events, build on floodplain delineations, and prevent and buffer development in sensitive floodplain.

It is important to inventory water resources.

Rivers, Streams, and Riparian Areas

Inventorying water resources has become more important with recent Federal and State regulations mandating the management of stormwater and nonpoint sources of pollution. Water flow and quality provide critical data for regulating proposed development. Stormwater management plans address the volume of stormwater runoff in new development and redevelopment, especially when expected runoff impacts rivers and streams designated as being impaired.

> Water flow and quality provide critical data for regulating proposed development.

Watercourses can be classified as perennial (permanently flowing), ephemeral (flowing only shortly after rain), or intermittent (flowing during seasonal wet periods). Watercourse inventories should include location; pollution and water quality data; and processes that further impact water quality such as erosion, scouring, invasive plants, and even trash. Riparian areas are low areas adjacent to rivers and streams. An inventory should map the width of the riparian area setback or "buffer" and assess the quality of its soils and vegetation. The width of riparian buffers can range from 50 to 300 feet on either side of the stream, but should never be less than 40 feet.

Wetlands

Wetlands are areas inundated by surface or groundwater in an amount sufficient to support plants that are adapted to the level of saturation of the existing soil. Wetlands can also be found on slopes and other steep areas with springs. In most States, wetlands are regulated by the U.S. Army Corps of Engineers, the State's environmental protection department, or both.

Wetlands are one important component of a natural resource inventory.

The U.S. Fish and Wildlife Service and Army Corps of Engineers classify wetland types by three characteristics: vegetation, hydrology, and soils. Wetland soils are characterized by the presence of organic or peat soils. Although many agencies and departments provide maps that identify soils and water levels, they should not be relied upon for delineating wetlands. Field surveys are required to delineate wetlands. Surveys should be used to document wetland boundaries in natural resource inventories being used for local and site-level planning and the development of wetland ordinances. A general wetland protection ordinance requires a minimum buffer of 50 feet around wetlands, although wider buffers are preferred.

Hydric Soils

Hydric soils are formed by long-term water saturation. Characteristics include poor drainage, ponding, low aeration, and an iron deposition layer. Hydric soils (and nonhydric soils that include seams of hydric soils) are not suitable for development because of instability issues. Natural resource inventories should include specific information about soils and delineate areas of hydric soils as identified in U.S. Geological Survey maps.

Soil Suitability for Septic System Construction

Soils that are not suitable for septic systems tend to be hydric with seasonal or permanent high water tables, have poor natural drainage, are inundated with flood waters, or have a shallow depth to bedrock that does not allow infiltration. Slopes over 12 percent are not suitable for septic systems because of erosion and downslope seepage. Septic systems on alluvial, sandy, or well-drained soils near streams can contaminate ground and surface water. Most septic system regulations require a minimum depth of 24 inches of natural soil above the seasonal high water table. Onsite testing is required to identify the suitability of soils for viable sewer systems and is mandated as part of the construction permit process in most places.

Groundwater and Wellhead Areas

Mapping and protecting the functions of groundwater recharge areas and wellheads are crucial for protecting drinking water. Groundwater is impacted by grade changes and runoff, leakage from underground storage tanks, and increases in nitrogen. Groundwater and well recharge protection needs vary greatly depending on adjacent land use, soil types, land cover, water table depth, slope, and even vegetation. A common standard for limiting disturbances in important recharge areas is to require that disturbance be at least 1,000 feet from a known well. Water recharge areas are often protected on a more regional scale in comprehensive planning or in the development of land use plans that designate the areas as protected lands.

Mapping and protecting the functions of groundwater recharge areas and wellheads are crucial for protecting drinking water.

Impervious Surfaces

Impervious surfaces are surfaces that do not allow water infiltration. They include parking lots, roofs, roads, and other built structures in the landscape. Impervious surfaces increase the volume of runoff and are a significant source of pollution. Municipalities should consider the impact of impervious surfaces and set standards that limit the amount of imperious surface in new and existing development.

Topography and Steep Slopes

For inventory and mapping purposes, slopes are often categorized as precautionary or prohibitive. Prohibitive slopes are those over 25 percent where grading and land development should be avoided. Precautionary slopes of 15–25 percent should also be avoided if possible, or at least require special engineering and site planning, such as step-down foundations and a grading plan designed by a licensed engineer.

Forest Blocks and Woodlands

Forest blocks and wooded areas should be inventoried using aerial photographs and satellite imagery. Field inventories are required for more detailed information on tree species, forest condition and structure, understory vegetation, invasive species, wildlife, wildfire fuel loads, and other factors.

Inventory forest blocks and wooded areas using aerial photographs and satellite imagery.

Wildlife Habitat and Corridors

The quality of wildlife habitat is determined by the type and distribution of desirable shelter and food, patch size, and corridor connectivity. A wildlife corridor is any linear landscape that connects two or more natural areas and provides for wildlife movement. Longer and wider

corridors are typically required to support larger animals and bird populations. Development can fragment and isolate wildlife habitat, thus impeding migration, roaming, foraging, and living. Wildlife habitat and corridors can be protected by properly siting development. Planners should first use watershed or regional data to ensure that landscape-scale linkages exist and then work with a biologist or natural resource professional to field check the site to obtain any additional information that may be relevant.

If a municipality chooses to protect sensitive habitat, it can incorporate a Wildlife Habitat Overlay District into the provisions of its comprehensive land use regulation ordinance. The purpose of the Wildlife Habitat Overlay District is to reduce the continuing loss of habitat for native species in rural districts, while simultaneously accommodating development in those districts. The intent is to minimize the removal of woody vegetation that breaks large, unfragmented blocks of forest into smaller patches of forest; it also minimizes activities that block or limit species movement between unfragmented blocks of forest. An example of a Wildlife Habitat Overlay District can be found at
http://www.beginningwithhabitat.org/pdf/Brunswick%20Wildlife%20Habitat%20Overlay%20District.pdf.

Important and Sensitive Natural Areas

Rare, threatened, and other important plants and animals may be present on land where development is planned. Field surveys and mapping are often required to document the location of important species; habitat; or other landscape characteristics such as waterfalls, bluffs, ridges, and unique geological features. Natural resource inventories should also document the presence of threats to rare, threatened, or important local species. A common threat that these inventories often address is the impact of invasive species on ecological function or successional processes.

Landowners and communities can work with the U.S. Fish and Wildlife Service to develop habitat conservation plans for endangered species, such as this California tiger salamander. (Photo: John Cleckler, U.S. Fish & Wildlife Service)

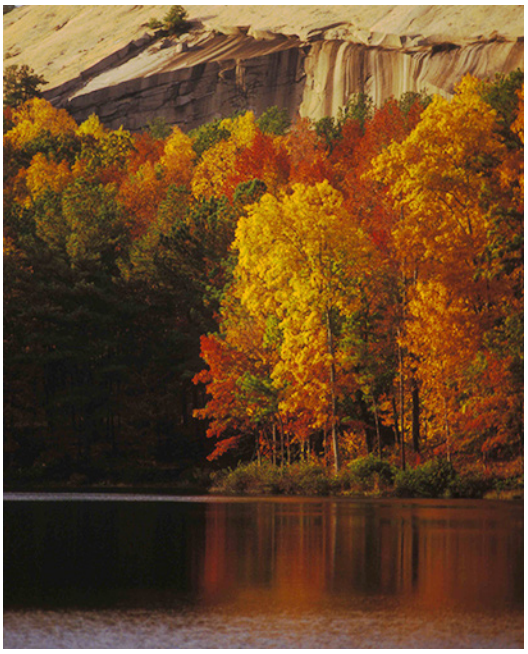
The Endangered Species Act of 1973 recognized that endangered and threatened species of wildlife and plants "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." Habitat conservation plans under section 10(a) (1) (B) of the act provide for partnerships with non-Federal parties to conserve the ecosystems upon which listed species depend, ultimately contributing to their recovery. Private landowners can work with the U.S. Fish and Wildlife Service to develop habitat conservation plans and apply for incidental take permits that specifically describe measures to minimize and mitigate the effects of their actions to ensure that species will be conserved. To learn more, see
http://www.fws.gov/endangered/esa-library/pdf/hcp.pdf.

Agriculture

Agricultural lands support businesses and families, and contribute to the character of a place. Prime farmland and soils should be inventoried and mapped as part of comprehensive and other plans. Agricultural inventories often document important historic features such as barns and schoolhouses. Agricultural lands support woodlots, steep slopes, riparian areas, and corridors that should be identified and assessed in a natural resource inventory.

Viewsheds

Desirable views of ridgelines, lakes , riparian areas, and other community icons often have symbolic meaning to local residents. Desirable views can increase the value and salability of homes. Important views can be protected by adding restrictions to zoning ordinances that limit development on ridgelines, protect special features, require the use of certain colors and building materials that blend into landscapes, and direct the placement of structures and infrastructure within visually important landscapes.



Important views can be protected by adding restrictions to zoning ordinances.

Urban and Community Forestry

It's crucial to understand the location, health, and structure of street and park trees in order to manage and protect them. Inventories of a community's tree population can be made using hand-held GPS units to enter each tree's data into a computer database. Tree inventories can provide useful data for developing tree maintenance, tree removal, and tree planting plans and budgets.

Percent canopy coverage has recently become more important when assessing the urban forest. Light detection and ranging and other aerial imaging methods are used to assess canopy cover and set goals for tree planting and canopy cover gains. Common goals for tree canopy are 40 percent in urban and high-density suburban areas, 50 percent in low-density suburban areas, 25 percent in high-density residential areas, and 15 percent in commercial areas. Tree inventories are being used to identify the composition of urban forests so that they can be diversified by species. Communities are using urban tree canopy coverage to set and meet tree-planting goals and strategically direct tree planting for economic vitality, human health, and even stormwater management in urban areas throughout the United States.

Historic and Landmark Trees

Although entire woodlots and forests can be considered historic landscapes, more often historic value is attached to single trees or small groups of trees. An inventory of historic trees should include a survey of the trunk location and basal elevation as well as tree health. Documenting the drip line (outermost edge) of the canopy during a natural resource inventory helps ensure that the trees are adequately protected when developing grading plans during the engineering phase of the design process.

Historic value can be attached to single trees in a community.

Historic and Cultural Features

A thorough natural resource inventory should also document information obtained from local historians and ethnic organizations to identify and assess the importance of cultural features such as old buildings, bridges, ruins, earthworks, burial grounds, stone walls, copses of trees, witness trees, and bluffs and geological features.

Environmental Impact Assessments

The enactment of the Federal National Environmental Protection Act in 1970 mandated the completion of environmental impact reports for any Federal project or program that could modify or harm the environment. These reports consider all elements of the environment: physical, social, and economic. Reports for dams and other large projects have been especially large in scale.

California and other States have enacted their own Environmental Protection Acts, which require environmental impact statements and reports from municipalities and counties for large subdivision and other development. These environmental statements identify the significant impact of a development on the environment, how any such impact might be mitigated or avoided, and possible alternatives to the project. This information is then considered in decisions to approve, deny, or modify a proposed project. Some States require that these reports also consider the impacts of proposed development on air and water quality; traffic; and the increased need for schools, police and fire, and other public services. They may also require that a study and statement be prepared concerning how a proposed development adds to cumulative social, economic, and environmental impacts, both good and bad.

Case Study — Ordinance No. 363, Township of Lower Makefield, Bucks County, Pennsylvania

THE TOWNSHIP OF LOWER MAKEFIELD
BUCKS COUNTY, PENNSYLVANIA

(Web site: http://www.lmt.org)

In response to State and Federal stormwater management requirements, Lower Makefield Township in Bucks County amended its Subdivision and Land Development Ordinance in December 2006. The amendment provided for the use of Low-Impact Development (LID) alternatives for both project design and stormwater management. The township believed that LID strategies supported its comprehensive plan and met multiple objectives such as mitigating floods, reducing impervious surfaces, and protecting open space. The amendment required that development plans submitted to the township include an approved Existing Resources and Site Analysis Map (ERSAM) as well as an onsite visit to verify the submitted ERSAM Plan.

ERSAM contents include soils, slopes, floodplains, watercourses, trees and vegetative cover, wetlands, important views, commonly used trails, and other natural features. The ERSAM is used to develop a required Natural Resource Conservation Plan that describes a number of LID design objectives, including how stormwater will be captured on site, how existing contours and vegetation will be respected, how building layout will provide for advantageous solar orientation, and how open space and other resources will be conserved. The requirements of the ERSAM plan are separate from the detailed hydrological studies required for development of a stormwater management plan. To learn more, see http://www.lmt.org/departments/planning-zoning/.

Relevant Factsheets

P5 – *Principles of Ecosystem Services* – Provides a basic overview of ecosystem processes, services, and products. It discusses the impact of difficulties in estimating the monetary value of carbon sequestration and other ecosystem services. It explains how compensation for conserving ecosystem services is being considered as a viable option to provide an incentive for increased natural resource protection and management.

A1 – *Using Smart Growth Principles to Plan Sustainable Communities* – Introduces the principles and strategies of smart growth to create communities that are walkable, affordable, and offer more opportunities to manage growth in concert with conservation.

A3 – *Managing Stormwater with Green Infrastructure* – Discusses stormwater and its associated environmental and social costs while providing an overview of some of the commonly used best management practices and ordinances for stormwater management.

N2 – *Comprehensive Planning for Natural Resource Conservation* – Explains some of the tools and processes required for comprehensive planning.

N3 – *Regulatory Approaches to Protecting Natural Resources* – Discusses regulatory land planning tools that are commonly used to protect natural resources.

Resources

Arendt, R. 1994. Designing open space subdivisions: a practical step-by-step approach. Media, PA: Natural Lands Trust. 149 p.

Arendt, R. 1994. Rural by design: maintaining small town character. Chicago: American Planning Association Planners Press. 441 p.

Forman, R.; Godron, M. 1986. Landscape ecology. New York: John Wiley and Sons. 640 p.

McHarg, I. 1969. Design with nature. 1st ed. Garden City, NY: Natural History Press. 197 p.

Steiner, F. 2008. The living landscape, second edition: an ecological approach to landscape planning. 2d ed. Washington, DC: Island Press. 394 p.

Acknowledgements

Author

William Elmendorf, Ph.D., Associate Professor of Urban and Community Forestry, Penn State

Editors

Donna Marie Foster, U.S. Forest Service, Northeastern Area State and Private Forestry
Sandra Clark, U.S. Forest Service, Northeastern Area State and Private Forestry

Designer

Deborah Muccio, U.S. Forest Service, Northeastern Area State and Private Forestry