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Maryland's Green Infrastructure Assessment and GreenPrint Program

Overview

Maryland's recent green infrastructure assessment (GIA) identified approximately two million acres of ecologically significant undeveloped land throughout the state in an interconnected network of hubs and corridors. Only about 25% of this land is currently protected from future development. Maryland's green infrastructure, which provides essential ecosystem services such as protecting air and water quality, wildlife habitat and biodiversity, flood damage reduction, and carbon sequestration, is under ever-increasing pressure from urban and suburban growth. The GIA ranked the components of the green infrastructure network for their relative ecological value and vulnerability to development. Without some kind of protection (Figure 1), these lands will continue to be fragmented and swallowed up piecemeal by development. The GIA gave needed guidance as to the highest priority lands for protection.

Maryland's GreenPrint Program provides a funding source dedicated to protecting the state's most ecologically valuable lands as identified by the GIA. Through this funding source, the program aims to preserve a wide-ranging, interconnected "green infrastructure land network" that, over the long term, provides society with essential ecosystem services. It will also help ensure the continuance of industries such as forestry, agriculture, and fisheries that rely on a clean, healthy environment and abundant natural resources.

Highlights

- The GIA identified 33% of Maryland's total area as providing important green infrastructure benefits, including 90% of the state's interior forests; 87% of the state's remaining unmodified wetlands; 99% of the state's Natural Heritage Areas; 88% of the known occurrences of rare, threatened, or endangered species in the state; and 63% of the state's forest land. This means that Maryland's GIA approach did an excellent job of identifying a diversity of land types with diverse conservation values. Other states and regions may wish to use the Maryland GIA approach to assess green infrastructure in their jurisdiction.

- The GreenPrint legislation put protection of ecologically important land on the radar screen of governmental officials and the public in Maryland.

- Many local governments, especially in areas facing heavy development pressure, have expressed interested in using the GIA information to make planning decisions. Anne Arundel County won an award from the Maryland chapter of the American Planning Association for its green infrastructure-based greenways plan. The county also won the Governor's Smart Growth award for government innovation in 2002 for its greenways planning work.

- Private land trusts and other groups are very interested in using GIA data to prioritize their land protection and restoration efforts.

- Since 1999, 88,000 acres have been protected through the use of GIA information. About one-third of that land was protected with GreenPrint funding since July 2001.

- The ability to visually represent the interrelationship of lands in the green infrastructure network has proven critical to finalizing funding commitments for some large land purchases. The biggest one-seller land protection transaction in the state—the 1999 Chesapeake Forest Products property acquisition—protected 58,000 acres of mostly high value forest land on the Lower Delmarva Peninsula. The land was bought through Program Open Space (a land protection program administered by DNR since 1969) and The Conservation Fund using private foundation money. In Maryland, there were about 460 different parcels in the sale, and what closed the deal was being able to show the funders how the properties fit together spatially within an ecological landscape context, the green infrastructure land network.

Background and Context

Fifteen thousand acres of land are developed in Maryland each year (Figures 2 and 3). By 2030, if current trends continue, 800,000 additional acres of land will be developed, much of it in rural areas. As a consequence of this rapid piecemeal development, at least 180 native plant and 35 animal species have been extirpated from Maryland. Another 310 native plant and 165 animal species are classified as rare, threatened, or endangered in the state.

Concern about the health of Chesapeake Bay prompted Maryland and neighboring Virginia, Pennsylvania, and Washington, D.C., the Chesapeake Bay Commission, and the U.S. Environmental Protection Agency (EPA) to reaffirm their commitment to bay restoration by signing an updated and expanded Chesapeake Bay Agreement, known as Chesapeake 2000, in June 2000. Among other things, the partners

Figure 1: Current level of land protection in Maryland

Composite level of protection
Highest
Lowest
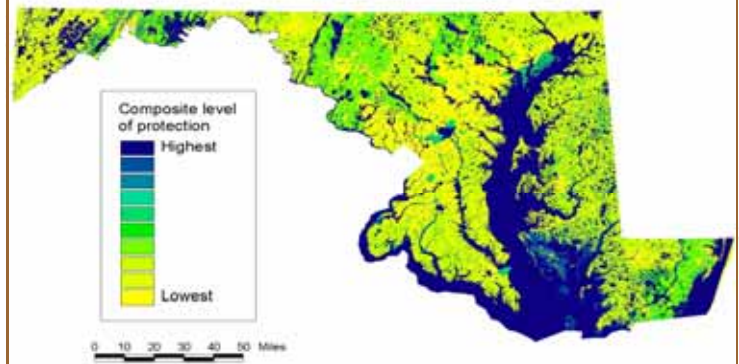
Credit: Maryland Department of Natural Resources, in Benedict 2002

pledged to protect 20% of the land in the bay's watershed by 2010 and to reduce the rate of sprawl development by 30% by 2012.

Fortunately, Maryland has one of the oldest land protection programs in the country. Program Open Space was created in 1969, and by 2003, program funding had purchased about 250,000 acres of state parks, wildlife habitat, and natural areas, and 36,000 acres of local parks. The program is funded through an annual appropriation by state legislators with money derived mostly from Maryland's real estate transfer tax, with occasional supplements from state general obligation bonds. For fiscal 2000–2003, the program received $230.5 million, which was split roughly in half between state acquisitions and funding to each of Maryland's counties and the city of Baltimore. Maryland has spent more than $1.2 billion on public land protection since 1969, mostly through Program Open Space.

The Rural Legacy Program, a keystone of Maryland's "Smart Growth Initiatives," was established in 1997. The Program encourages local governments and private land trusts to identify Rural Legacy Areas and to competitively apply for funds to complement existing land preservation efforts or to develop new ones. Easements or fee estate purchases are sought from willing landowners to protect areas vulnerable to sprawl development.

"It's a fundamental shift in thinking…to get governments to regard green infrastructure as they do other infrastructure investment."

— John Griffin, former Maryland Secretary of Natural Resources, Quote in Baltimore Sun; 12/04/98

Figure 2: Development patterns 1900 — 1960

Credit: Maryland Department of Planning, in Jenkins 2003

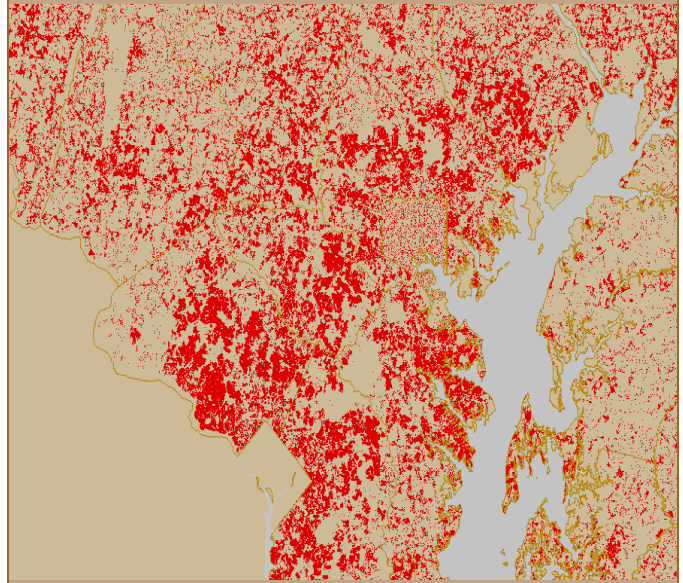## Figure 3: Development patterns 1961 — 1997
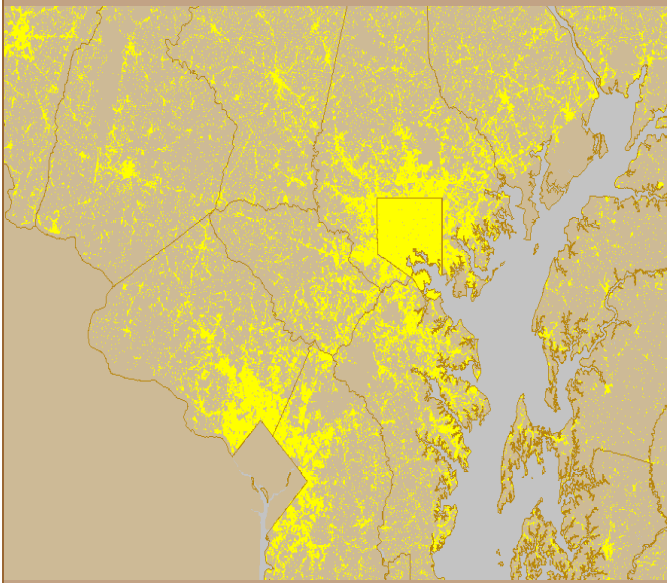
Credit: Maryland Department of Planning, in Jenkins, 2003

The governor appointed the Maryland Greenways Commission (the Commission) in 1991 as the primary statewide entity responsible for planning and coordination of greenways implementation. The Commission consisted of 25 members who reflected a cross section of greenways interests and the geographic diversity of the state. Elected local officials; local parks, planning, and environmental agencies; environmental, agricultural, and recreational interest organizations; business, real estate, and economic development organizations; and the general public were represented on the Commission.

Despite the state's long history of land protection, the ecological value of the land had not been a primary focus of Program Open Space. The state greenways program was originally designed to provide ecological benefits through protection of a network of large public lands connected by natural corridors and to accommodate recreation where practical. However, the popularity of trails in the early years of the program overshadowed the ecological aspects. The GIA was begun in the mid-1990s to address the perception

among some groups that the greenways program was largely recreation-focused.

DNR leadership at that time favored a more strategic approach to land conservation and fostered the development of analytical tools and intra-agency initiatives that would facilitate strategic land conservation planning and targeting. DNR's Ecosystem Council recommended the development of a statewide Integrated Natural Resources Management Plan, part of which evolved into the green infrastructure assessment.

Process

Maryland Green Infrastructure Assessment

**Baltimore County Pilot Study —
Green Infrastructure Assessment**

To accomplish the GIA, DNR and Commission staff began supporting efforts to develop GIS-based landscape assessment tools. DNR gave the Baltimore County Department of Environmental Protection and

"We cannot separate man's actions on the land from what happens to our waters. Greenways offer the best way of protecting our waters, and ultimately the Chesapeake Bay, from what we do on the land."

— Maryland Greenways Commission 1990, p.11

Resource Management (DEPRM) a grant in 1997 to develop a rapid assessment methodology for identifying high priority resource lands. DEPRM used GIS to produce a series of watershed maps derived from data layers of natural vegetation types, stream systems, and topographic features. The methodology allowed the user to narrow the focus of conservation targeting through prioritization at the subwatershed, forest patch, and land parcel level. This multi-tiered approach is beneficial because field investigation is needed only in areas that show high resource protection values in multiple layers. The methodology provided the rapid assessment desired for identifying a connected system of forest resources that provide multiple ecological benefits, including water quality protection, biological diversity, and conservation or restoration of natural areas for both citizens and wildlife. This study served as the pilot project for development of the statewide green infrastructure assessment technique.

Statewide Green Infrastructure Assessment

The Commission staff worked with staff of DNR's Landscape and Watershed Analysis Division (formerly the Watershed Management and Analysis Division) on the statewide GIA using procedures adapted from Baltimore County's methodology. Through consideration of factors such as land cover, wetlands, sensitive species, roads, streams, terrestrial and aquatic conditions, floodplains, soils, and development pressure, the assessment identified a network of hubs (Figure 4) and corridors that contained the most ecologically critical remaining undeveloped lands. Much of the corridor system consists of protected river valleys and riparian corridors, which Maryland has been protecting since the early part of the twentieth century. Developed, agricultural, and mined lands are included in the resulting green infrastructure land network and provide excellent opportunities for ecologically superior restoration activities.

After the hubs and corridors were identified, DNR staff then used GIS methodologies to assess the network's components for vulnerability (Figure 5)

Figure 4: Average statewide hub size is 22,000 acres

Green Hubs

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Figure 5: Vulnerability ranking

Coastal Plain - West

Green Hub Vulnerability Ranking

Green Hub Vulnerability Ranking
High
Low
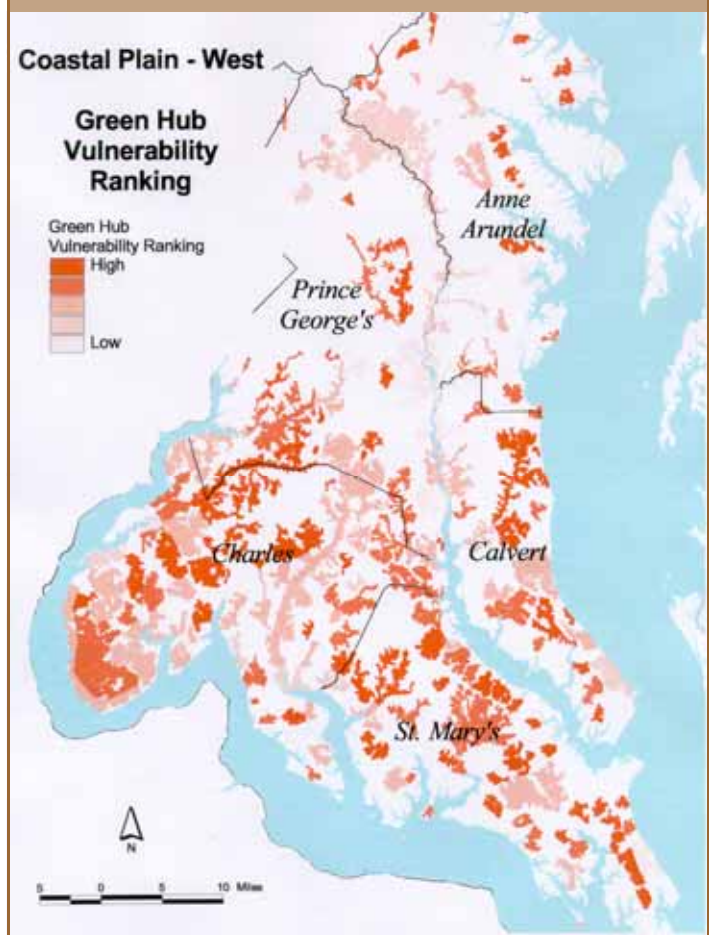
Credit: Maryland Department of Natural Resources, in Jenkins 2003

to development based on proximity to population centers, large bodies of water, and protected open space; access to infrastructure; and property ownership factors. They also considered the ecological value (Figure 6) of the components. Then they made a composite ranking of the components based on the ecological value, the vulnerability to growth, and the current degree of protection. The composite ranking (Figure 7) compared the lands in the network model for relative conservation value, feasibility for protection, and urgency of action to identify those that should be at the top of the state's land acquisition list.

Figure 6: Ecological ranking
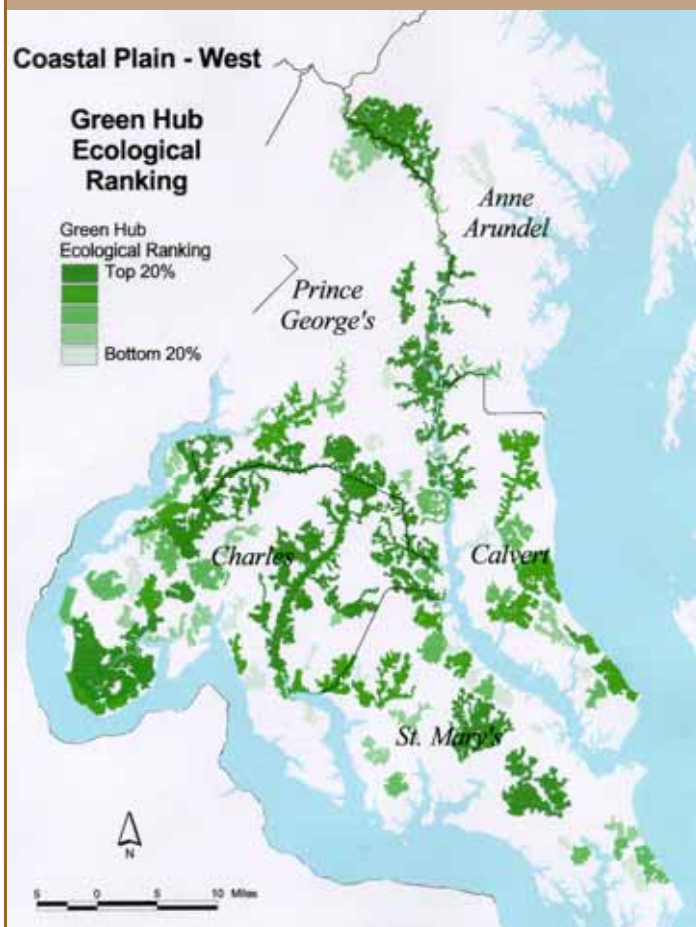
Credit: Maryland Department of Natural Resources, in Jenkins 2003

Figure 7: Composite ranking
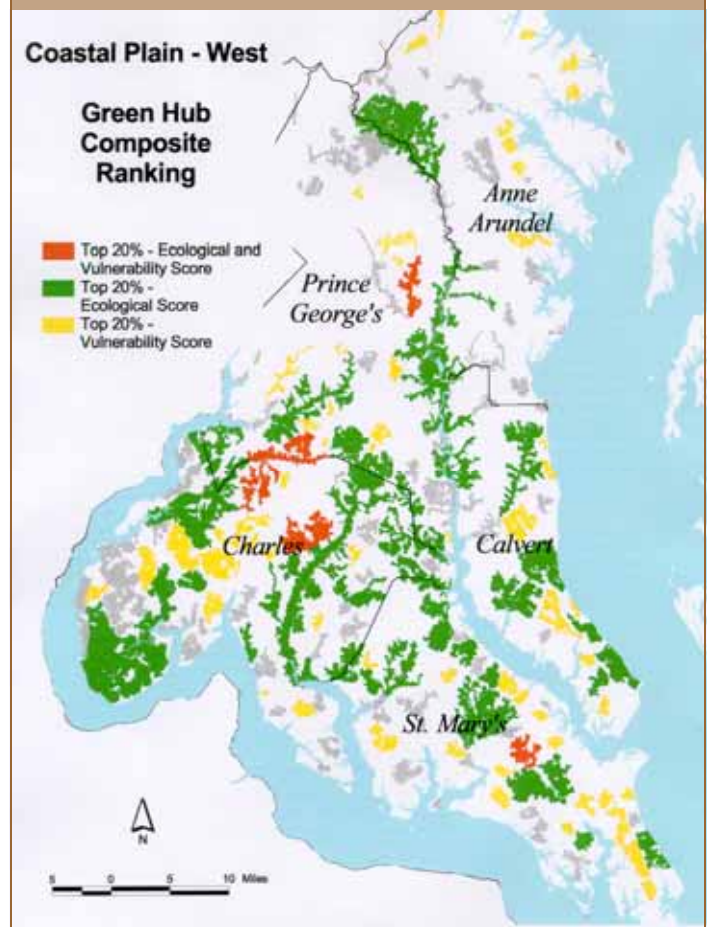
Credit: Maryland Department of Natural Resources, in Jenkins 2003

"From the landscape point of view, it frequently happens that a great deal of charming scenery is to be found along the stream; the water itself is interesting, the trees along the stream banks are apt to be numerous and well-developed, and the valley landscape is generally self-contained and full of interest. Moreover, it is generally true that the lowlands are less valuable for other city purposes than the uplands, so that they can be more cheaply purchased, and their withdrawal from occupation interferes less with the productive occupation of the land."

— from early 1900s report of Olmsted Brothers to Baltimore City,
in Maryland Greenways Commission 1990, p.1

Public Review of GIA Results

DNR staff took maps of their green infrastructure network on the road to have the methodology peer-reviewed by each county government's and Baltimore City's planning and zoning and recreation and parks departments. At each such meeting, they used a modeling exercise to explain what they had done and asked the local officials whether the output from the network design model seemed to reflect reality on the ground. In some cases, the local officials provided new information on sites within the identified green infrastructure network that had been developed and therefore were not dominated by natural land cover. DNR staff updated the green infrastructure network with the new information and produced the state's *Atlas of Greenways, Water Trails, and Green Infrastructure* in 2000.

The GreenPrint Program

Then-Governor Parris Glendening introduced legislation to establish the GreenPrint Program as the funding mechanism that would allow systematic protection of some of the critical lands identified in the GIA through purchase or conservation easement. The program took effect July 1, 2001 and is scheduled to be in effect until June 2006. DNR staff work with local and county governments and land trusts to protect property.

The program is entirely voluntary: the state prohibits condemnation of land for protection of green infrastructure and local governments are not required to use GIA data in making land protection or development decisions. Maryland's legislators specified that 25% of the money allocated to the GreenPrint program would finance the Maryland Agricultural Land Preservation Fund (MALPF) to protect green infrastructure in established agricultural districts. The State Board of Public Works, which includes the governor, comptroller, and treasurer, must approve GreenPrint purchases over $50,000. Affected local governments must also approve purchases. The

legislative Budget and Tax and Appropriations committees must review purchases over $2 million, but their approval is not required.

Program Open Space maintains a list of landowners who are willing to consider selling their land to the state. To ease administrative issues, GreenPrint uses the acquisition procedures developed by Program Open Space. Market value is used for fee simple acquisition, and easements sell for about 50% of market value. Landowners may maintain silvicultural practices on land protected through GreenPrint as long as they use a DNR-approved management plan and the practices do not conflict with GreenPrint's goals. Preference is given to acquisition of land in counties with less than 9% DNR-owned land, not counting MALPF easements.

GreenPrint dovetails with the state's nonregulatory Smart Growth program, in which identified priority growth areas receive preferential funding for "gray" infrastructure to encourage development within these boundaries. Development is permitted outside the priority areas, but the hope is that it will be discouraged because developers must pay for gray infrastructure there. The green infrastructure assessment provides guidance to local governments and developers as to the location of priority areas for protection within a jurisdiction's boundary or "set aside" areas within a parcel's boundary.

Results and Products
Statewide Green Infrastructure Assessment

Work on the GIA resulted in the vision for an interconnected network (Figure 8) of ecologically valuable hubs and corridors that if protected would help preserve the natural ecosystem functions on which all life in Maryland depends. The assessment also resulted in the identification of those lands in the network that are most ecologically valuable, most vulnerable to development, and most highly ranked for restoration activities. This prioritization serves to guide

"Just as we must carefully plan for and invest in our capital infrastructure — our roads, bridges, and water lines — we must invest in our environmental or green infrastructure — our forests, wetlands, streams, and rivers."

— Former Maryland Governor Parris Glendening, 1999

state, local, and private land protection, restoration, and development efforts.

The method can serve as a blueprint for other states and regions that want to conduct their own GIA. The high correspondence between lands identified in the GIA and lands previously identified as having conservation value indicates that the evaluation method used provides a good representation of the many different types of ecosystems that should be part of a comprehensive conservation approach.

> **Maryland's Green Infrastructure Network includes**
>
> ◆ 90% of the state's interior forests
>
> ◆ 87% of the state's remaining unmodified wetlands
>
> ◆ 99% of the state's Natural Heritage Areas
>
> ◆ 88% of the known occurrences of rare, threatened, or endangered species in the state
>
> ◆ 63% of the state's forest land
>
> *Source: Weber 2003*

GreenPrint Program

In the first 1.5 years of the GreenPrint Program, the state protected 30,000 acres of land, mainly hubs. The smallest property yet purchased through GreenPrint was 82 acres; the largest purchase from one owner consisted of multiple parcels totaling nearly 900 acres. Only 26% of the envisioned statewide hub and corridor network is currently protected, including state, federal, and locally owned areas.

County and Local Use of GIA Data

There has been considerable interest among county governments in using the GIA data in planning decisions, particularly among those communities that are facing greater development pressure. These areas are generally also more advanced in the use of GIS, so they have the resources needed to use the data. For example, Queen Anne's County is still rural, but it's changing rapidly. The county commissioners recently passed a resolution of support for incorporating green infrastructure into the planning decisions of all communities in the county so as to support basic ecological functions. Prince George's County is in the

Figure 8: 26% of the green infrastructure land network is protected

Credit: Maryland Department of Natural Resources, in Jenkins 2003

process of developing its own local green infrastructure plan, and Talbot County worked with The Conservation Fund to develop one.

The state and the counties are working together to focus conservation and restoration activities in priority areas of the statewide green infrastructure network. Counties must address this focus in their state-mandated Land Preservation, Parks, and Recreation Plans in order to be eligible for Program Open Space funds. The GreenPrint Program and the results of the GIA have helped to give a more strategic focus to Program Open Space and the Rural Legacy Program.

Spin-off Programs and Related Efforts

The statewide GIA spawned several countywide and multistate GIAs. The procedures used in the statewide assessment have served as the model for these spin-off projects. Efforts have also been made to convert complex GIS data into formats usable by people without GIS capabilities.

Delmarva Peninsula Conservation Corridor

Maryland's GIA approach was used on the Delmarva Peninsula (Figure 9) in cooperation with Delaware and Virginia. Congressman Wayne Gilchrest (R-MD-1st District) introduced the concept; he envisioned a network of working lands--farms and forests--linked and managed in harmony with the natural landscape. The conservation corridor project has the goals of sustaining working lands and protecting the rural

Figure 9

Delmarva Conservation Corridor
Chesapeake Bay to the Delaware Bay
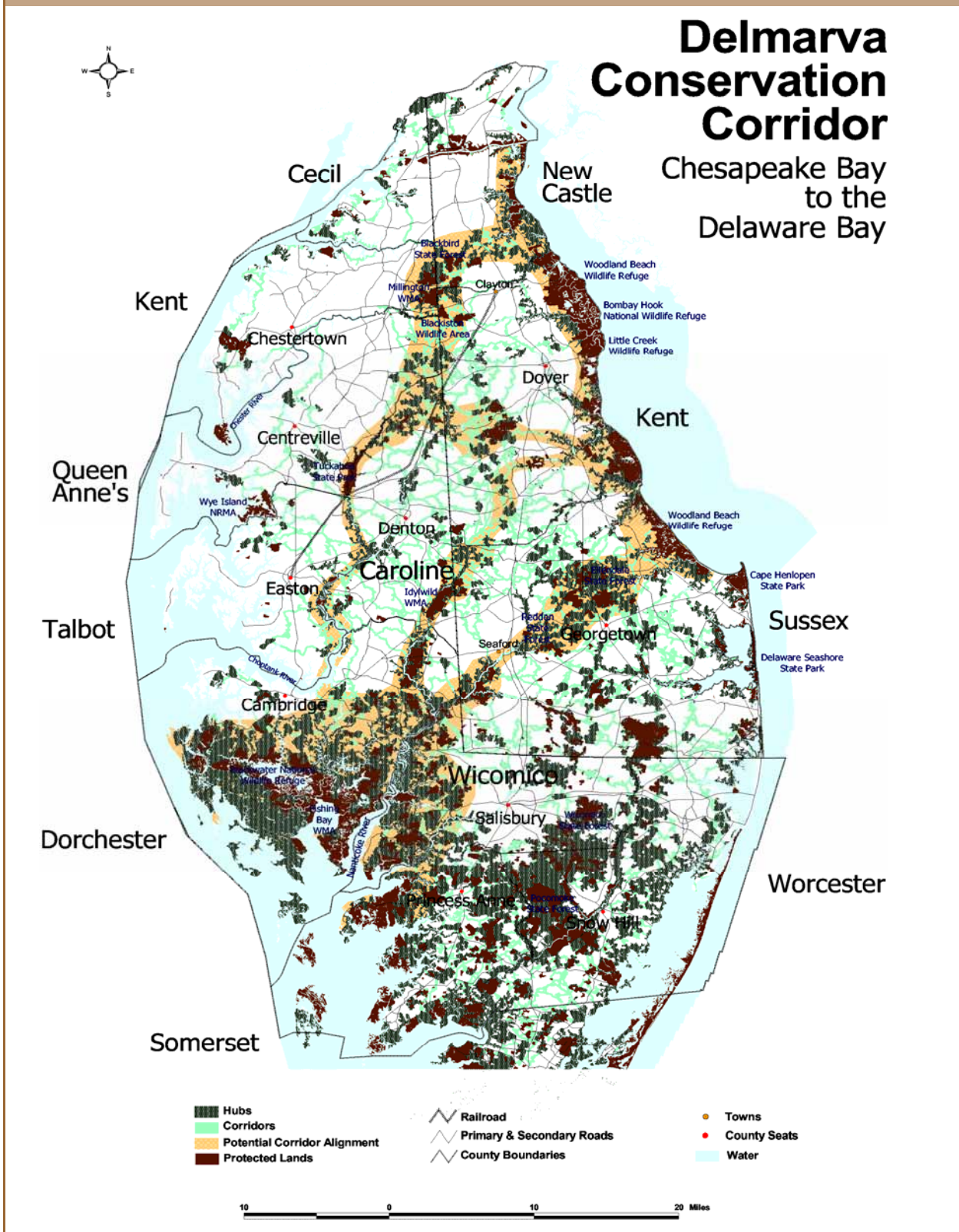
Credit: Maryland Department of Natural Resources, in Jenkins 2003

character and biodiversity of the Delmarva Peninsula. Work began on the conservation corridor concept in the late 1990s when DNR, the U.S. Fish and Wildlife Service, Delaware state natural resources staff, and regional planners in Virginia began collaborating, at the congressman's request, on how best to demonstrate and implement the vision of an interconnected working and natural landscape. The team decided to utilize the existing GIA methodology. They determined what data existed, ran the computer analysis, and came up with a hub and corridor network model that stretches across the political boundaries of the peninsula. The cooperators are working on a plan to be submitted to the U.S. Department of Agriculture on how each state will meet Congressman Gilchrest's vision.

## Chesapeake Bay Watershed Resource Lands Assessment

The U.S. EPA has placed the Chesapeake Bay and its tidal waters on the impaired waters (303d) list because of nitrogen and phosphorus pollution. The agency is scheduled to impose federal regulations to clean up the bay in 2011 if certain goals have not been met. The Chesapeake 2000 Agreement contains more than 100 specific commitments to restore and protect water quality and habitat in the bay and on the lands contained within the 64,000-square mile bay watershed. These include permanently preserving from development 20% of the lands in the watershed by 2010 and reducing by 30% the rate of loss of farm and forest land to sprawl development by 2012.

Another commitment requires the partners to work together on a "resource lands assessment" (RLA) that would identify the most important farms, forests, and wetlands in the bay's watershed and assess their relative value from ecological, cultural, and economic perspectives. The RLA Task Force had analyzed the procedures used in similar efforts and decided to use the Maryland/Delmarva Peninsula GIA approach for the ecological component of the watershed-wide assessment. The task force has identified the system's hubs and corridors throughout the bay watershed. Significant issues that remain are how to bring the economic, cultural, and ecological assessment pieces together and how to solicit public review and input. The assessment provides all players in the land protection arena with information that will increase the efficiency and effectiveness of their activities.

Anne Arundel County Greenways Plan

Anne Arundel County was the first in the state to base its greenways plan on the concept of green infrastructure (Figure 10) and the results of the statewide green infrastructure assessment. They adapted many of the procedures developed in the statewide GIA to their county-level assessment. For example, the county set the minimum threshold size for hubs at 50 acres instead of the 250 acres used in the statewide GIA. The county won an award in early 2003 from the Maryland chapter of the American Planning Association for their greenways master plan. The

Figure 10: Anne Arundel County Greenways Plan — Hub and corridor network
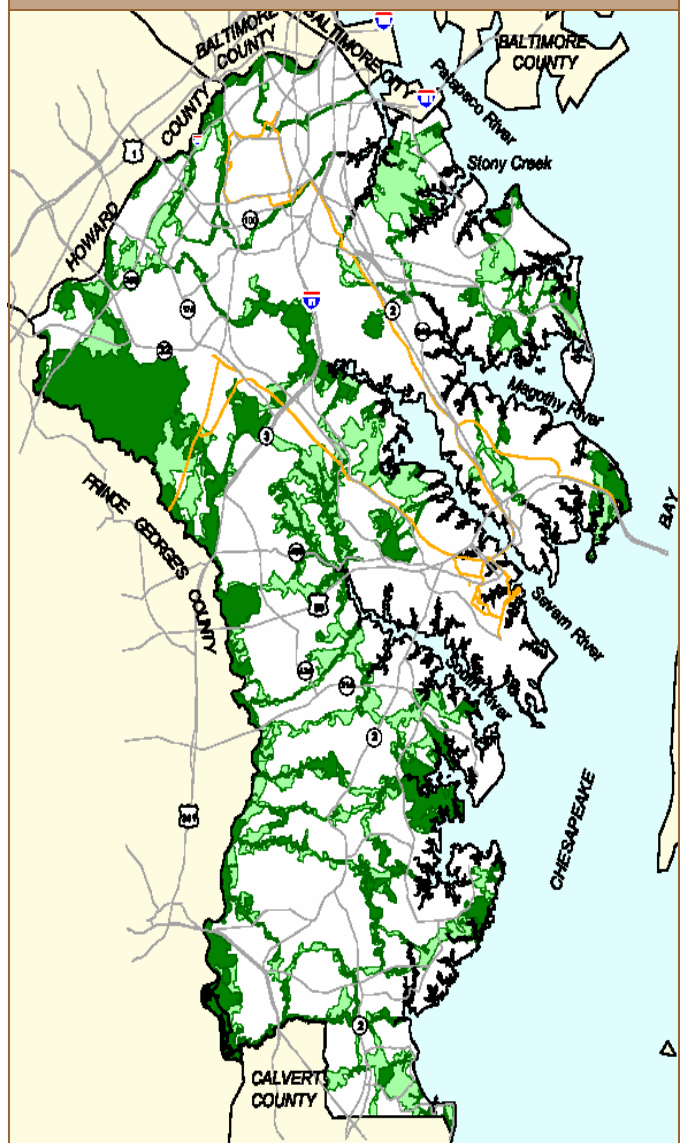
Credit: Anne Arundel County, in Jenkins 2003

county also won the Governor's Smart Growth award for government innovation in 2002.

Staff of the county Parks and Recreation Department diligently engaged the public in the countywide GIA process, with the dual goals of getting public feedback on the plan and educating citizens about conservation ecology. They created a Web site with information about the plan and the analysis process, a questionnaire, newsletters, and an e-mail for feedback. They had radio, cable TV, and newspaper coverage of the plan and public meetings, which featured large-scale maps on which people could look at the green infrastructure plans around their neighborhoods. The response to the plan by the public and local officials was overwhelmingly favorable, said Brian Woodward, formerly of the county's Parks and Recreation Department. He also reported that a coalition of private land trusts in the county has agreed to use the plan to set their priorities for land protection. The county has received several hundred acres of donated land in response to these efforts.

The county officially adopted the plan in 2002, and the Parks and Recreation Department is working to make sure that the other county land management agencies are aware of the plan and use it in their decision making processes. For example, county agencies can recommend to developers of lands in the identified greenways system that they conserve certain important areas as open space.

Catoctin Mountain Explorer

Many private land trusts lack the expertise to manipulate GIS data and the money to purchase expensive GIS-capable computers and software. Staff of The Conservation Fund and DNR worked extensively with the Catoctin Land Trust to create a GIS-based tool, the Catoctin Mountain Explorer (Figure 11), that does not require GIS capability. The tool allows the land trust staff to make decisions about land protection (Figure 12) and restoration priorities without using GIS. The Fund and DNR worked with the land trust to determine what kinds of landscape analysis abilities they wanted, then

created analyses to meet those needs. The Explorer allows the land trust staff to work with data down to the individual parcel level and to highlight certain characteristics of greatest interest. For example, they have used the tool to identify the most strategic green infrastructure lands for riparian forest restoration (Figure 13) in the Catoctin area and to determine which lands are in the viewshed (Figure 14) of a highway that cuts through the Catoctins.
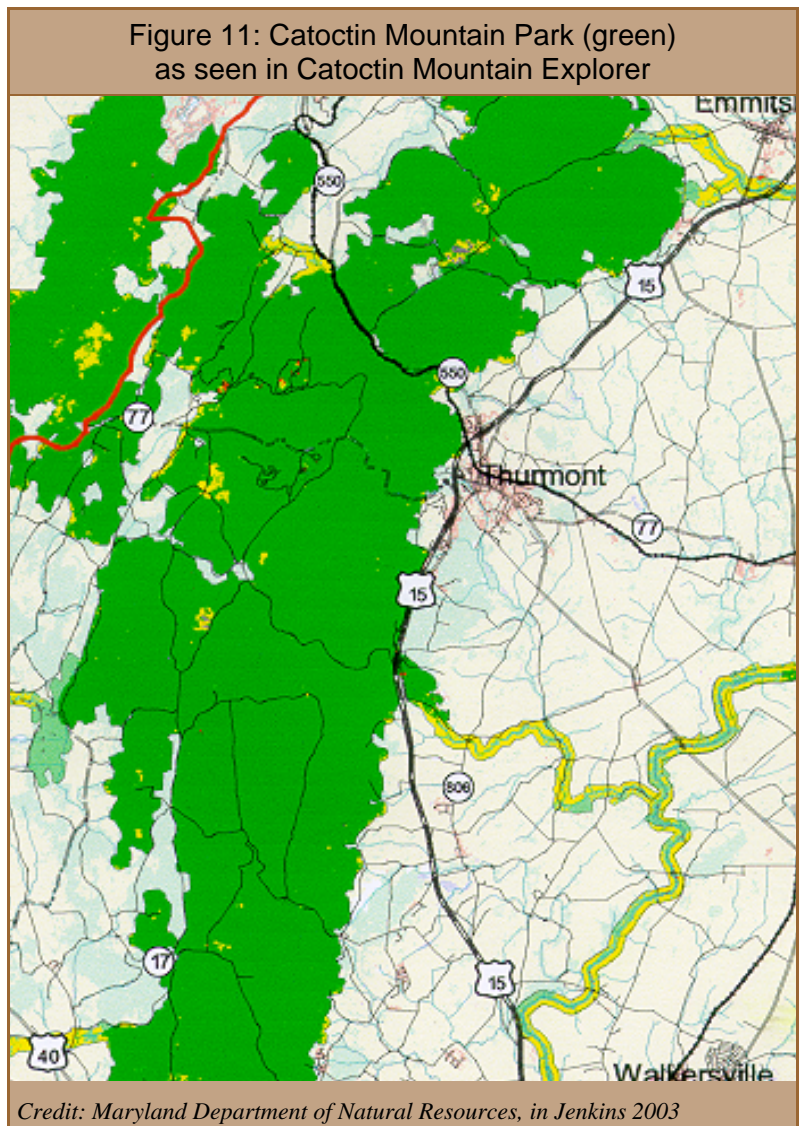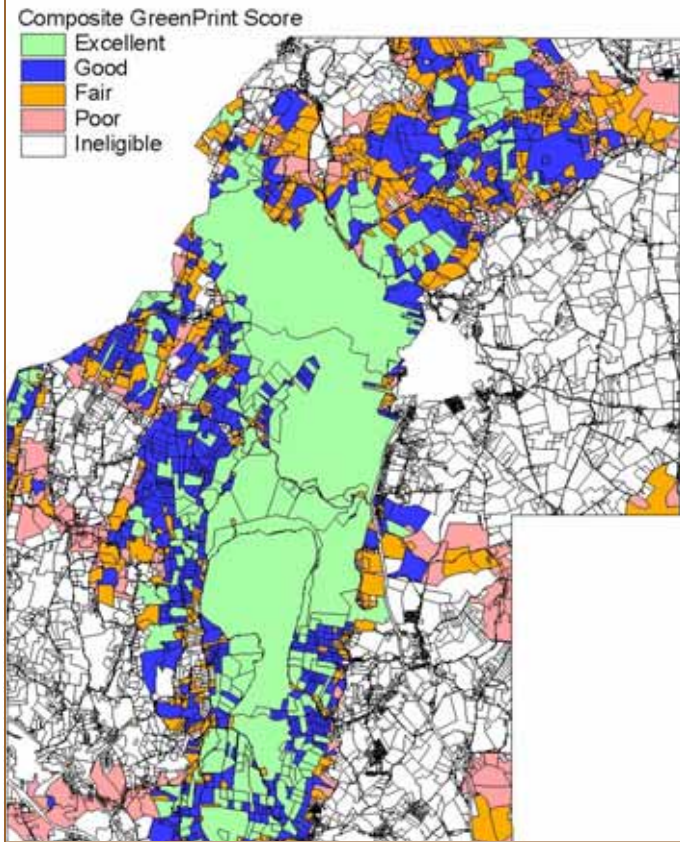

Figure 11: Catoctin Mountain Park (green) as seen in Catoctin Mountain Explorer

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Figure 12: Suitability for GreenPrint by land parcel, Catoctin Mountain Park, as seen in Catoctin Mountain Explorer

Composite GreenPrint Score
- Excellent
- Good
- Fair
- Poor
- Ineligible

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Figure 13: Strategic forest restoration in Catoctin Mountain Park. Reforesting the banks of a waterway helps improve water quality.

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Figure 14: Viewshed analysis of Catoctin Mountain Park from Highway 15. The presence of hydric (wet) soils is another factor in determining the value of protecting a piece of property.
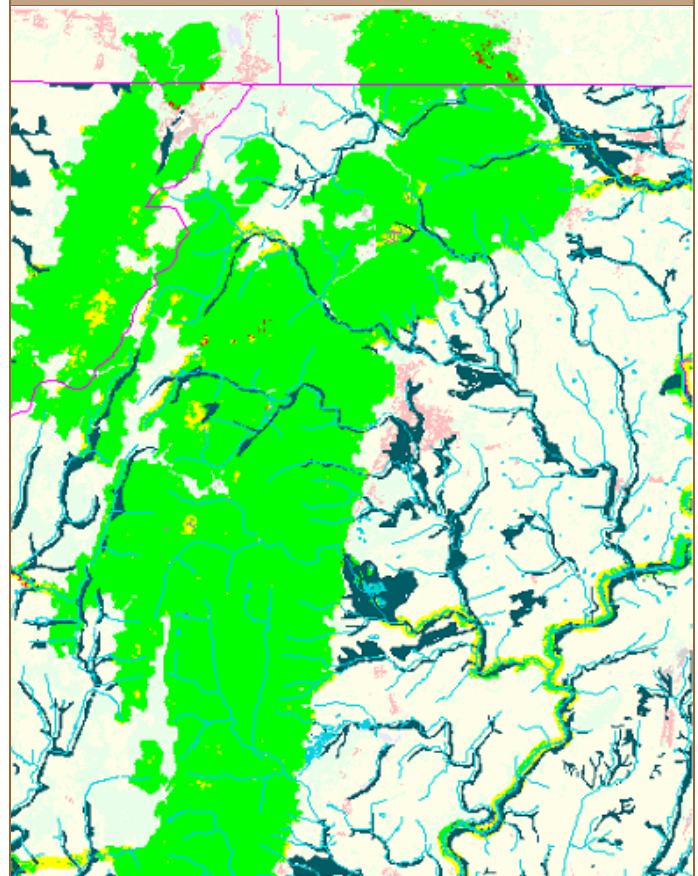
Non-Wetland Hydric Soils

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Management and Stewardship

Restoration

Within the green infrastructure network model, there are gaps such as farm fields, and residential and mined areas where restoration of natural habitats could greatly improve the integrity of the green infrastructure network. DNR staff used GIS data sets to identify areas that could most benefit from restoration—where they know great ecological benefit will result from limited restoration dollars because the land is connected to or part of the green infrastructure land network. The idea is to marry the restoration with green infrastructure to fill in the gaps (Figure 15) in the network from a habitat and water quality perspective. DNR's emphasis in restoration projects (Figure 16) has been on wetlands, streams, riparian forest buffers, and afforestation— establishing a forest where there was not one before.
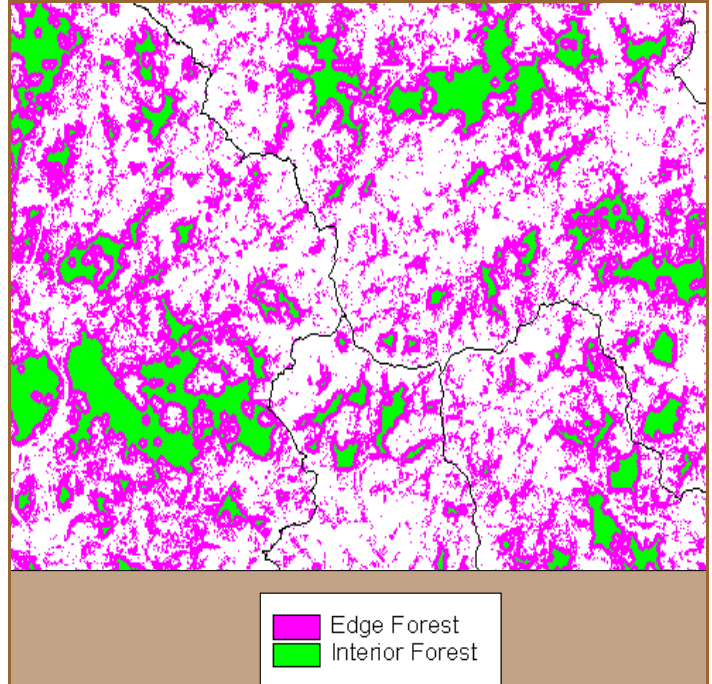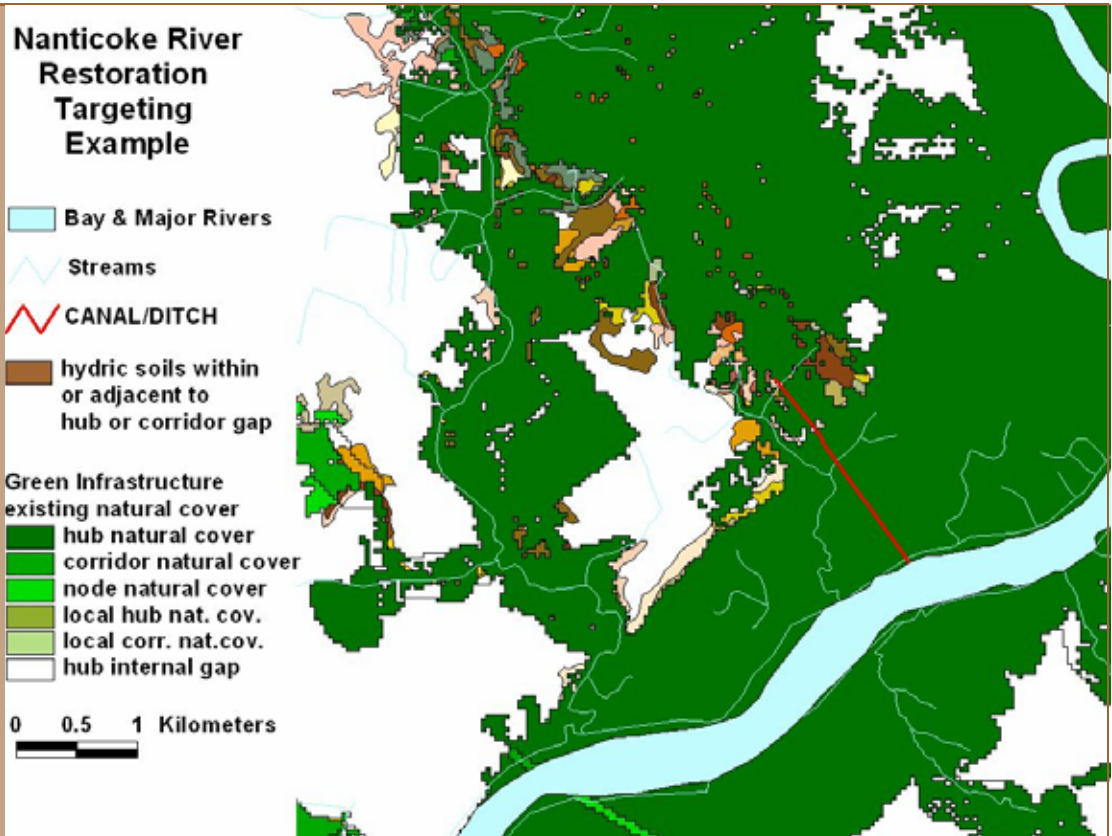

Figure 15: "Internal" gaps are breaks in the continuity of large forest blocks, which can increase edge effects on interior species.

Credit: Maryland Department of Natural Resources, in Benedict 2002

Figure 16: "External" gaps are targeted for work at the forest edge, in effect "expanding" the network through restoration.

Credit: Maryland Department of Natural Resources, in Benedict 2002

On the Upper Eastern Shore, DNR worked with the owners of Chino Farms (Figure 17)—the largest farm in the area at about 6,000 acres—the local government in Queen Anne's County, the Upper Eastern Shore Tributary Team (a governor-appointed nutrient management group), and a consulting firm to accomplish wetland restoration and tree planting on 52 acres. The Tributary Team received a $12,000 habitat restoration grant from DNR. The county matched that through the forest conservation "fee in lieu" program, under which a developer who clears trees and can't find a site to replace them can pay into a fund, and the county assumes the responsibility of planting trees for them. A planting plan was developed that, like the GIA, was based on scientific landscape ecology principles. In spring 2001 the cooperators planted trees in wetland and upland areas to increase the connectivity between land parcels, to reduce forest edge, and to increase the interior forest area (Figure 18). DNR and Washington College (located in Chestertown, MD) began a monitoring program at the site in 2002 to see how use of the area by birds changes over time. This project demonstrates how state and federal incentive programs can be used to make local habitat improvements without infringing on private property rights. The whole Chino Farms property is under easement to The Conservation Fund.

Figure 17: Chino Farms ecological score. Darker green areas are more valuable ecologically.
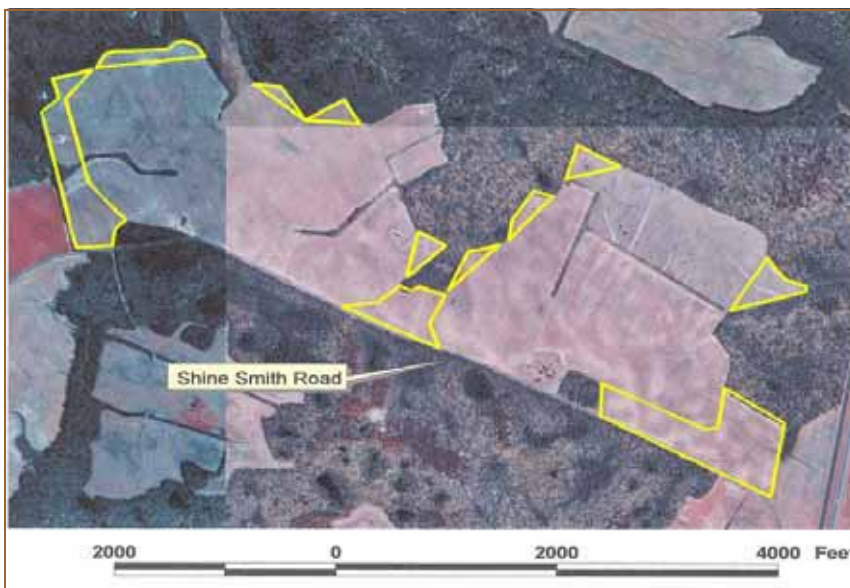
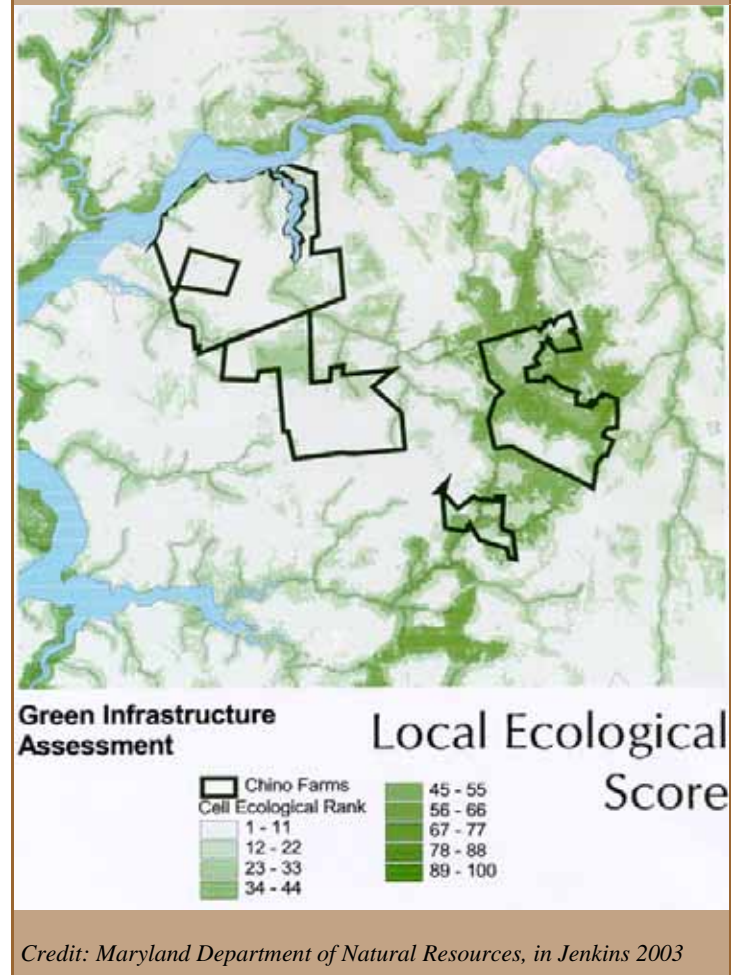*Credit: Maryland Department of Natural Resources, in Jenkins 2003*

Figure 18: Tree planting was done in the yellow boxed areas to decrease edge effects and increase the connectivity of the two parcels.

Credit: Maryland Department of Natural Resources, in Jenkins 2003

Financing and Cost-Benefit Analysis

Financing

Money for the GreenPrint program comes from general obligation bonds. The program was funded at $35 million for the first fiscal year, including the 25% of funds allocated to MALPF to protect green infrastructure in established agricultural districts. In FY 2003, the program was funded at $16 million, with $4 million of that going to MALPF. In FY 2004, a total of $5 million is under consideration, but it's uncertain whether that money will be available. The original goal of the program was to increase the amount of protected green infrastructure network land by 10,000 acres per year.

Program Open Space funding has been used to buy some lands in the green infrastructure network model. Land purchases through this program account for the bulk of the more than $1.2 billion that Maryland has spent on public land protection since 1969. The program is funded through an annual appropriation by state legislators with money derived mostly from the state real estate transfer tax, with occasional supplements from state general obligation bonds. Most funding is split roughly in half between state acquisitions and funding to each of Maryland's counties and the city of Baltimore.

Cost-Benefit Analysis

Dr. Robert Costanza and his research team at the University of Vermont's Gund Institute for Ecological Economics are worldwide experts in assessing the economic value of ecological services. Costanza's team is working with DNR to quantify the value of various ecosystem services, including carbon sequestration, that the remaining green infrastructure provides. DNR's Power Plant Review Program funds this research. Staff hopes that the collaboration will continue and that the ability to quantify the value of ecosystem services at finer scales in different physiographic regions will be enhanced.

Benefits

Maryland's efforts to protect the green infrastructure network provide the following benefits:

- reverse past trend of "haphazard conservation" by identifying for state agencies, land planners, citizens, and developers the most valuable and vulnerable lands for protection and leveraging public and private investments in land conservation;

- provide a focal point to coordinate existing conservation programs with one another and increase their overall effectiveness;

- conserve and connect large contiguous land areas with multiple important natural resource features;

- ensure the preservation of natural resources in each region that help clean the air and water;

- provide urgently needed additional funding so that agencies can act immediately to protect vulnerable lands;

- address commitments in the Chesapeake Bay Agreement to protect 20% of the watershed and to reduce the rate of sprawl development by 30%;

- enhance property values;

- produce a tangible improvement in quality of life;

- support the diverse economy of the state, especially natural resource-based industries such as fisheries, forestry, and tourism, and the jobs therein; and

- identify and/or protect lands that

  ⇒ serve as natural filter systems for trapping pollutants before they reach Chesapeake Bay;

  ⇒ provide cover and passage for wildlife;

  ⇒ supply a "geneway" for the enhancement of biological diversity through the provision of important wildlife habitat and corridors that link existing habitat areas;

  ⇒ serve as an outdoor classroom for teaching about Maryland's natural environment; and

  ⇒ provide public access to and recreational opportunities in the natural world, including Chesapeake Bay.

Application of Green Infrastructure Principles

Principle 1: Protect green infrastructure before development.

Maryland's GIA and the GreenPrint Program were initiated because of the rapid pace of development in the state, which is driven by the growth and expansion of the Washington, D.C. and Baltimore suburbs. The Chesapeake Bay Agreement, in which Maryland, Virginia, Pennsylvania, and Washington, D.C. agreed to protect 20% of the watershed from development by 2010, was another primary motivator for the GreenPrint program.

Principle 2: Engage a diverse group of stakeholders.

When DNR staff completed a draft of the GIA, they took the results to each county's planning and zoning and parks and recreation departments for input and feedback. Any local or county government or private land trust is eligible to utilize GreenPrint funding to protect a parcel of land. DNR has worked with all levels of government in Maryland to encourage use of GIA data in making planning decisions.

Principle 3: Linkage is key.

Maryland's GIA first identified hubs, which were then linked through ecologically valuable corridors such as stream channels and mountain ridges. These linkages allow for the safe movement of wildlife and preserve natural areas' abilities to provide ecosystem services, such as water filtration.

Principle 4: Work at different scales and across boundaries.

The GIA was a statewide effort, but it has spawned several similar programs at the county and multistate level. Assessments have been done for areas ranging from a small subwatershed to the entire Chesapeake Bay watershed. The data analysis processes developed in the statewide GIA serve as a model for these off-shoot programs.

Principle 5: Use sound science.

The GIA was designed so that land protection decisions could be made on the basis of sound science.

Parameters such as land cover, wetlands, elevation, floodplains, protected lands, roads, watershed boundaries, habitat components, development pressure, and zoning regulations were factored into the GIA. The GreenPrint Program and the results of the GIA have helped to strategically focus Program Open Space and the Rural Legacy Program on key preservation priorities.

Principle 6: Fund up-front as a public investment.

Former Governor Glendening committed $35 million of general state funds to the GreenPrint Program for land protection in the first fiscal year of the program. Since then, however, the program's funding has been cut and the fate of the program is now uncertain. Program Open Space has been well-funded for more than 30 years through a dedicated percentage of the state real estate transfer tax and occasionally from general obligation bond funds.

Principle 7: Green infrastructure benefits all.

The protection of green infrastructure in Maryland helps ensure the continued supply of a vast array of priceless ecosystem services such as flood protection, water and air quality improvement, aesthetic beauty, wildlife habitat, conservation of a varied genetic pool among native plants and animals, support for natural resource-based industries and tourism, and a multitude of recreation opportunities.

Principle 8: Make green infrastructure the framework for conservation and development.

The GIA laid the groundwork for identifying the most critical lands for protection. Now, state and local governments and private organizations can work with DNR through the GIA and the state's various land conservation programs towards clear and common goals of protecting the most ecologically valuable and vulnerable lands. The philosophy behind GreenPrint meshes well with the state's Smart Growth program, in which development is targeted to specific areas. The MALPF, the Rural Legacy Program, Program Open Space, GreenPrint, and other land conservation programs are being coordinated to focus on the state's highest priority conservation lands, such as those identified in the GIA. This indicates the growing acceptance and institutionalization of the GIA results in Maryland.

Evaluation

Unique, innovative, outstanding elements

- Maryland's Program Open Space, founded in 1969, is one of the oldest state government-sponsored land protection programs.

- The innovative procedures used to assess green infrastructure network components for relative ecological value and vulnerability to development threat have been used as a model in other places.

- The GreenPrint Program, Program Open Space, and the Rural Legacy Program allow the state to protect the most ecologically valuable and vulnerable lands. Both Program Open Space and the Rural Legacy Program now conduct green infrastructure parcel assessments as part of the acquisition/easement decision making process.

- DNR completed the purchase from one owner of 58,000 acres of mostly high value forest land on the Lower Delmarva Peninsula (Figure 19).

- The statewide GIA has inspired several county governments to implement and/or support use of green infrastructure information in planning decisions and/or to do their own county-level GIAs.

Challenges

- Money is of course always a challenge. DNR staff must be creative in working with partners to leverage money and staff resources to use information from the GIA most advantageously.

- Convincing local government officials to take GIA information into account in making planning and development decisions can be difficult, but program leaders feel like they've had good success overall, especially in areas with heavy development pressure.

- DNR staff need to concentrate more on working with the local land trust community and helping them effectively use the GIA information, even if they lack GIS capabilities.

Figure 19: Ecological score of lands in the 58,000-acre purchase (blue) and of other lands in the green infrastructure network (green) on Maryland's Lower Eastern Shore. Most of the land in the 58,000-acre purchase was of high ecological value for filling in gaps in the network.
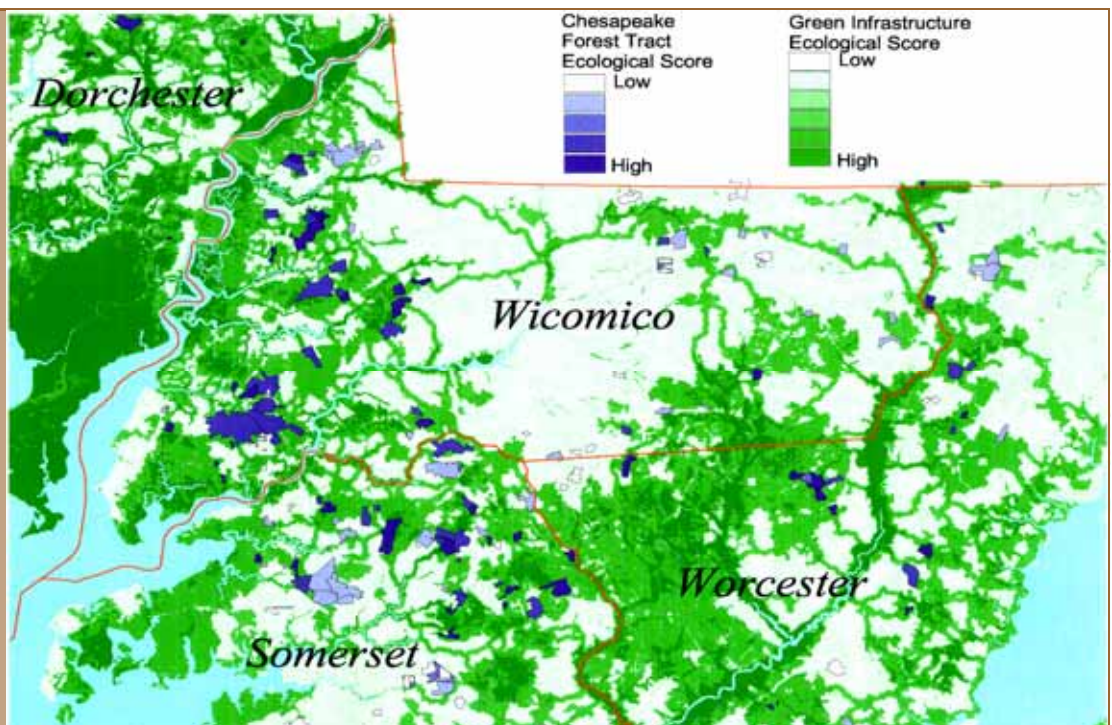
Credit: Maryland Department of Natural Resources, in Jenkins 2003

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Additional information about green infrastructure concepts and approaches can be viewed at www.greeninfrastructure.net.

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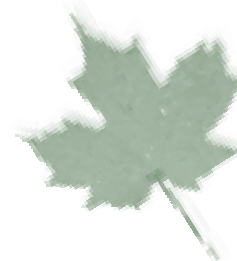
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About Green Infrastructure

Green infrastructure is a strategic approach to land and water conservation that links lands for the benefit of nature and people, helps identify conservation priorities, and provides a planning framework for conservation and development. Green infrastructure is different from conventional approaches to conservation because it looks at conservation values and actions in concert with land development and growth management. Green infrastructure projects bring public and private partners together to work collaboratively toward a common land conservation goal. They help move beyond jurisdictional and political boundaries by providing a process for identifying, protecting, and restoring interconnected green space networks that conserve natural ecosystem functions and provide associated benefits to human populations. The green infrastructure approach appeals to people concerned about biodiversity, habitat, and land conservation as well as people interested in open space and land use planning at the community, region, or statewide scale. It also appeals to smart growth advocates because of its potential to lessen impacts and reduce the costs of built infrastructure.

Green Infrastructure Case Study Series

This series of case studies highlights successful and innovative green infrastructure projects from around the country. The series was undertaken so that readers can learn from and improve upon approaches tried by others. We hope that thorough, well-documented examples will allow readers to see the many possibilities and to adapt successful practices to their unique situations and challenges. Each case study addresses the same basic pieces of the story: overview, highlights, background and context, process, public education and participation, results and products, management and stewardship, financing, application of green infrastructure principles, and evaluation. Eight principles of green infrastructure, which are elements of most successful efforts, form the core of the case studies. The series illustrates concrete, real-life examples of how to assess and protect green infrastructure, including details about how each step was implemented.

About The Conservation Fund

The Conservation Fund is a national, nonprofit land conservation organization that forges partnerships to protect America's legacy of land and water resources. Through land acquisition, community planning, and leadership training, the Fund and its partners demonstrate sustainable conservation solutions emphasizing the integration of economic and environmental goals. Since 1985, the Fund has protected more than 4 million acres of open space, wildlife habitat, and historic sites across America.

The Conservation Fund's Green Infrastructure Program was created in 1999 to build the capacity of land conservation professionals and their partners to undertake strategic conservation activities that are proactive, systematic, well integrated, and applied at multiple scales. The program is a cooperative effort of the Fund and multiple public and private partners. Program products include a national course, workshops and conference sessions, publications, case studies, demonstration projects, a website, and related educational materials.

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