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ENDANGERED by Sprawl

HOW RUNAWAY DEVELOPMENT THREATENS AMERICA'S WILDLIFE

by Reid Ewing and John Kostyack
with Don Chen, Bruce Stein, and Michelle Ernst

National Wildlife Federation
Smart Growth America
Nature Serve

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NATIONAL WILDLIFE FEDERATION® www.nwf.org™

Smart Growth America
Better Choices For Our Communities

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A Network Connecting Science With Conservation

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About the Sponsoring Organizations

Protecting wildlife through education and action since 1936, the **National Wildlife Federation** is America's conservation organization creating solutions that balance the needs of people and wildlife now and for future generations. Visit **www.nwf.org**

Smart Growth America is a national coalition promoting a better way to grow: one that preserves open space and farmland, revitalizes neighborhoods, keeps housing affordable, and provides more transportation choices. Visit **www.smartgrowthamerica.org**.

NatureServe is a non-profit conservation group that provides the scientific information and tools needed to guide effective conservation action. NatureServe and its network of natural heritage programs are the leading source for information about rare and endangered species and threatened ecosystems. Visit www.natureserve.org.

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Being smart about growth means **revitalizing existing cities** and suburbs and making **efficient use of land**, rather than building in outlying farm fields and forests. It means making cities and suburbs affordable places to live, so that **everyone can participate** in and benefit from this revitalization.

Preface

BY PARRIS GLENDENING, *Governor of Maryland, 1995-2003*

Any discussion of habitat loss always reminds me of the fate of the Maryland black bear. By the middle of the last century, human activities had brought the bear to the brink of extinction. It took tremendous effort and many years, but by the time I took office in 1995, the bear had been successfully reintroduced to wild parts of the state.

Today, however, those wild parts are giving way to subdivisions and shopping centers. Now that we humans have sprawled our way into bear habitat, many are regarding them as a nuisance and want the bears removed or destroyed. All across the nation, similar encounters—and debates—focus on deer, fox and so many of nature's other 'critters' that wander into our backyards, which were once their home. To my mind, though, it would be terrible public policy to punish the animals for our bad planning.

This report makes clear the degree to which we are punishing wildlife with sprawl from one end of the country to the other. It shows how fast we're losing the one-of-a-kind landscapes and critical ecosystems that support a vast array of wildlife - and ultimately, our own kind. Beyond that, though, the authors offer hope that people, intelligent as we are, can halt this trend, if we act boldly and quickly enough.

That was what we were trying to do in Maryland in the late 1990s, when we adopted a program called Smart Growth. We asked local governments to stop reckless, irresponsible development and set aside areas where growth should occur; and we said state money for schools, roads, sewers, and anything else would go only to those well-planned areas.

Being smart about growth means revitalizing existing cities and suburbs and making efficient use of land, rather than building in outlying farm fields and forests. It means making cities and suburbs affordable places to live, so that everyone can participate in and benefit from this revitalization. It means giving the "green infrastructure" of wildlife habitats and open space the same level of attention and concern as the "gray infrastructure" of roads, sewers and utilities. And it means giving citizens a meaningful say in how our communities change, using tools such as the Endangered Species Act. As this report explains, this law provides an important catalyst for important actions that protect wildlife from sprawl, but it is itself endangered, with Congress considering proposals to weaken it in the coming months.

Above all, smart growth is about making communities better as they grow so that they are not only more environmentally responsible, but also more vibrant, beautiful and fulfilling for the people who live in them. The best way to protect natural habitat is to become far more conscious and intentional about creating wonderful human habitat. Once you read this report, I am sure you'll agree.

Rapid consumption of land could threaten the survival of nearly **one out of every three imperiled species** in the U.S....Runaway development threatens the very survival of these national treasures and underscores the urgency for comprehensive **habitat protection** strategies and planning for **green infrastructure**.

Executive Summary

Over the next half century, up to one third of the world's plant and animal species may be lost forever. Conservation biologists regard this as the first mass extinction since the age of the dinosaurs.[1] In the United States alone, thirty percent of the nation's plant and animal species are at risk of disappearing, and over 500 species are missing or may already be extinct.[2]

For an estimated 85 percent of these imperiled species, the loss or degradation of their habitats is the principal threat to their continued existence.[3] The conversion of natural areas for homes, offices, and shopping centers has become one of the most serious threats to America's native plant and animal species. Indeed, by some estimates the amount of land covered by urban and suburban development has increased by nearly 300 percent since 1955 while population has increased by only 75 percent.[4] Furthermore, the pace of land development has been accelerating in each successive decade since the 1950s.[5]

As suburban development continues to sprawl outward, habitat loss and degradation are also likely to accelerate. This report estimates the pace of land consumption in the country's fastest growing large metro areas over the next 25 years, and investigates what those metropolitan areas are doing to protect their natural lands from overdevelopment. In this report, we sometimes refer to natural lands as "green infrastructure" because it carries the implicit message that these open spaces are necessities that play important functional roles (e.g. filtration of water, wildlife habitat, etc.,) and thus are deserving of serious public planning and investment.

Runaway Development will Deplete Natural Lands in Metro Areas

At the current pace of low-density development, the next 25 years of population growth will likely result in the consumption of between 6 and 60 percent of the remaining non-federal natural lands in the nation's fastest growing large metropolitan areas. However, these metropolitan-wide statistics, which are drawn from U.S. Census and U.S. Department of Agriculture databases, only tell part of the story because rural and urban lands are lumped together (see Box 1). In many of the 35 metro areas examined in this

Box 1: Metro Areas, Defined

In common parlance, "metro area" means a city and its surrounding suburbs. However, in this report we use the U.S. Census Bureau's definition, which includes cities, suburbs and sometimes farmlands, deserts, national forests, and other largely undeveloped areas.[6] Metro areas considered in this report range in size from Providence-New Bedford-Fall River, RI-MA (1,601 square miles) to Los Angeles-Long Beach-Riverside, CA (33,955 square miles).

study, the brunt of future growth will be borne by relatively few component counties. At densities of recent development, 18 counties are on a pace to use all of their remaining non-federal farmland and other natural areas to accommodate projected growth, and another 19 will consume more than one-half. In total, roughly 22,374 square miles (an area the size of West Virginia) of natural resource and habitat land in these 35 metro areas are projected to be lost to development over the next 25 years. This runaway land consumption can only be reduced if development is channeled into existing urban and suburban areas, new development is built to be more compact, and natural areas are protected from irresponsible development.

Loss of Wildlife Habitat in Metro Areas Threatens Many Imperiled Species

A new analysis of NatureServe's rare and endangered species data shows that three-fifths (60 percent) of the nation's rarest and most imperiled species are found within designated metropolitan areas, with the 35 fastest growing large metropolitan areas home to nearly one-third (29 percent) of these species.[7] In other words, rapid consumption of land could threaten the survival of nearly one out of every three imperiled species in the U.S., especially the highly localized ones. In some areas, existing parks and other public lands may help sustain these species and mitigate this loss of green space. However, species will not benefit unless those lands are managed specifically for wildlife protection. Further, the projected loss of natural lands may understate the actual impact on species because even where patches of habitat are left intact, they may be too small or fragmented to sustain imperiled species populations over the long term.

For example, the Charlotte, NC metropolitan area, home to 13 imperiled species, is projected to lose 35 percent of its remaining natural lands to development over the next 25 years. Similarly, development is likely to consume 17 percent of remaining natural lands in the Nashville, TN region where 43 imperiled species are found. In the Los Angeles metro area, which harbors an incredible 219 imperiled species, 12 percent of the remaining open space is projected to be lost to development. The Tampa-St. Petersburg-Clearwater metro area, home to 26 imperiled species is expected to lose 40 percent of its remaining natural lands. These figures are even more striking when examined at the county level. A total of 287 imperiled species are found in the 37 counties that will likely lose half or more of their available non-federal open space between 2000 and 2025. Among the many animal and plant species that this sprawling development puts at risk are the West Indian manatee in Florida, the arroyo toad in California, the mountain plover and alkali mariposa lily in Nevada, the Hine's emerald dragonfly in Illinois, and the Western prairie white-fringed orchid in Minnesota.

As this analysis shows, runaway development threatens the very survival of these national treasures and underscores the urgency for comprehensive habitat protection strategies and planning for green infrastructure.

Local Governments Should Do More to Protect Green Infrastructure

In the United States, local governments are responsible for most decisions regarding the location of buildings, roads, and other development projects.[8] Unfortunately, our survey of 15 metro areas (selected from the longer list of the 35 fastest growing large metro

areas) found that local governments generally have not done enough to ensure that wildlife habitats and other aspects of green infrastructure are adequately considered when land use decisions are made.

That said, the outlook is not hopeless. Across the country, voters have demonstrated a willingness to devote public funding to land conservation. In 2004, voters approved 162 state and local ballot measures to generate $4.1 billion for the protection of natural areas. The federal Endangered Species Act continues to provide a safety net for many species threatened with extinction, although it is seriously underfunded and is at risk of being ruther weakened in the coming months.

Some local governments in the 15 metro areas surveyed have been innovative with green infrastructure tools (see Box 2). Leaders of these local governments used computerized mapping technologies to inventory natural resources and set priorities for protection. They overcame narrow parochial interests and cooperated with nearby jurisdictions to develop regional solutions. They adopted visionary green infrastructure plans, and then implemented protection strategies ranging from zoning and other traditional land use regulations to purchases of development rights and other financial incentives that steered development away from valuable natural areas. And many secured the funding needed to make all of this possible. These local stories, featured in this report, provide models for the rest of the country as communities grapple with the impacts of sprawling development on precious natural resources.

Finally, the task of protecting our natural habitats also relies on our ability to create quality human habitats. Smart growth approaches to development prioritize the enhancement of community livability, the efficient use of land, and the creation and preservation of parks and natural areas. They respond to increasing market demand for more compact and convenient communities, and are gaining momentum in many communities across the nation.

Box 2: Key Findings and Tools for Protecting Green Infrastructure

Sprawling development poses one of the most serious threats to America's wildlife heritage. Left unmanaged, sprawl could consume significant portions of the remaining green space in the country's fastest growing large metro areas and counties, which are home to nearly one-third of imperiled species in the U.S. Despite the threat, most local governments have failed to protect their open space from sprawling development. However, there are several exceptions across the country. This report compiles models of green infrastructure protection, and identifies six tools for successful programs:

1. Create and maintain inventories of species and natural resources.
2. Establish regional cooperation to protect natural areas and species.
3. Develop green infrastructure protection plans, with performance goals and measurements.
4. Establish urban growth boundaries or urban service boundaries.
5. Protect critical natural habitats.
6. Build reliable local funding sources for green infrastructure and species protection.

The **expanding footprint of development** will put additional pressure on **diminishing wildlife resources** and their habitats, and has the potential to drive more plants and animals towards extinction. If the U.S. is to **protect** its current array of **plant and animal species** for future generations, the nation must plan carefully to guide development so that it leaves life-sustaining green infrastructure intact.

Risks to Wildlife and Natural Habitat

Our planet is now in the midst of a major extinction event—the first mass extinction since the age of the dinosaurs 65 million years ago.[9] Although many Americans are aware of the rapid loss of plant and animal species, much of the public debate has focused on resource extraction industries or farming and grazing operations in the world's remote landscapes.[10] In fact, the United States has a rich diversity of plants and animals, and is a world leader in the diversity of certain kinds of wildlife. Unfortunately, nearly one third of the nation's plant and animal species are at risk, and more than 500 U.S. species are missing or may already be extinct.[11] The extinction crisis is not just a distant problem; it is occurring close to home.

The primary threat to most of these species is the destruction or degradation of the habitats on which they depend. While many human activities—from agriculture to military training—can alter natural habitats, the conversion of green space to urban and suburban uses is the fastest growing threat to the nation's wild species. Nearly three quarters of Americans already live in urban or suburban areas, and the U.S. is projected to see continued growth in metropolitan area populations.[12] Urban and suburban areas now cover 64 million acres, having grown by nearly 300 percent since 1955, while population has risen by only 75 percent.[13]

The nation's wildlife heritage is not just restricted to the last remaining pristine habitats. Prime farmland, forests, wetlands, and prairie grasslands in and around cities and suburbs provide numerous ecological services, and are home to many imperiled species. These areas have enormous potential for species restoration as well, so long as they are protected from development. Even those lands that will never be restored to natural conditions often serve as essential buffers for nearby wildlife reserves or connecting corridors between reserves. For example, in south Florida cattle ranches with a mosaic of forest patches provide valuable habitat for the endangered Florida panther and the Florida black bear.

SFWMD

Loss of habitat to urbanization and agriculture are among the greatest threats to the Florida panther.

A new analysis of NatureServe's rare and endangered species data finds that three-fifths (60 percent) of the nation's rarest and most imperiled species occur in designated metropolitan areas (Table 2). Of particular importance are the 35 fastest growing large metro areas, which are home to nearly one-third (29 percent) of the nation's imperiled species, despite only comprising 8 percent of the total land area in the lower 48 states. The warm climates and varied topography in the western and southern United States have not only given rise to extremely diverse biological communities, including many localized and vulnerable species, but have also been attractive for human settlement. Consequently, many of the regions with the greatest number of imperiled species coincide with some of the largest and fastest growing population centers. This overlap is bad news for the survival of many species. For instance, a recent National Wildlife Federation (NWF) study of California's wildlife

found that sprawl is the leading cause of species imperilment in that state (Box 3: *Paving Paradise: Sprawl's Impact on Wildlife and Wild Places in California*).

The leading demographics and economic forecasting firm Woods & Poole Economics, Inc., estimates that America's metropolitan population will increase by 29 percent between 2000 and 2025. New buildings, roads, sewers, and water systems will be built to accommodate these growing human needs. And if development continues at prevailing densities, land will be consumed at an even faster rate than population grows. The expanding footprint of development will put additional pressure on diminishing wildlife resources and their habitats, and has the potential to drive more plants and animals toward extinction. If the U.S. is to protect its current array of plant and animal species for future generations, the nation must plan carefully to guide development so that it leaves life-sustaining green infrastructure intact. In addition, the U.S. must maintain and strengthen key safeguards such as the Endangered Species Act.

Box 3: *Paving Paradise: Sprawl's Impact on Wildlife and Wild Places in California* (February 2001)

In this report, the first quantitative assessment of the causes of species imperilment in California, the National Wildlife Federation (NWF) found that sprawl is the leading culprit. Outranking 17 other factors including road construction and outdoor recreation, sprawl threatens 188 of California's 286 federally listed species (66 percent). NWF also found that sprawl has the highest incidence of association with other harmful factors, suggesting that many causes of species imperilment are closely intertwined with sprawl.

Source: Doyle, K., J. Kostyack, B. McNitt, G. Sugameli, C. Whitaker, K. Whitcomb-Blaylock, J. Byrd, G. Stull, and B. Czech, *Paving Paradise: Sprawl's Impact on Wildlife and Wild Places in California*, Washington, D.C: National Wildlife Federation, 2001.

Why Should People Care?

Why should disappearing species and habitats concern everyday citizens? Because they literally cannot live without them. Composed of thousands of different species, forests, wetlands, grasslands and other natural habitats purify drinking water, recharge aquifers, help prevent droughts, protect against floods, and help maintain a stable climate. Each time a species is removed from a natural system, many other species in that system can be affected. This can lead to unpredictable chain reactions that can harm human health and economic viability.

To take just one example, pollinators such as bees generate enormous economic benefits, even as their numbers decline. Over 90 percent of all flowering plants and over 75 percent of the staple crop plants that feed humankind rely on pollinators.[14] Pollinators also fertilize plants from which many leading medicines, dyes, beverages and fibers are derived. In the year 2000 alone, the economic value of insect-pollinated crops in the United States was estimated to be between $20 and $40 billion.[15] Thus, the loss of pollinator species could lead to a series of devastating losses to our economy and food supply.

The loss of individual plant and animal species, both known and as-yet undiscovered, would also represent lost opportunities for future advances in medicine. A majority of today's most popular medicines were derived from wild plants, animals, or microorganisms.[16] For example, the treatment of ovarian, breast and lung cancer has benefited from the identification of a naturally occurring substance known as paclitaxel (commercially known as Taxol®).[17] Paclitaxel was first discovered in the Pacific yew, a slow-growing tree found in the Pacific Northwest, and once considered a "trash" tree that was burned after clearcutting forests.

BR. ALFRED BROUSSEAU, SAINT MARY'S COLLEGE

The Pacific yew, once considered a "trash tree," is the original source of a major new cancer treatment.

Beyond safeguarding individual species, protecting natural areas from over-development can generate major economic and environmental benefits, particularly with regard to protecting water quality.[18] Water agencies have learned that land conservation can help reduce the impacts of polluted runoff, which threatens both drinking water quality and the survival of aquatic habitats across the U.S.[19] New York City, for example, acquired watershed lands in the Catskill Mountains for $250 million in the 1990s, and avoided having to spend over $6 billion on new water filtration and treatment plants.[20] Other communities are achieving these goals by promoting "low impact development," as is being done in Prince George's County, MD, which educates and encourages builders to use design features and technology that minimize pollution and resource consumption.[21]

Coastal areas are especially vulnerable to flooding and stormwater runoff problems (see Box 4). According to the Pew Oceans Commission, watersheds that are over 10

ROBERT H. POS/USFWS

Admiring the catch of the day at Prince Georges County's Patuxent National Wildlife Refuge.

Beyond safeguarding individual species, protecting natural areas from overdevelopment can generate major economic and environmental benefits, particularly with regard to protecting wate....Land conservation can help reduce the impacts of polluted runoff, which threatens both drinking water quality and the survival of aquatic habitats across the U.S.

percent impervious (where water cannot penetrate the surface) will contribute to a dramatic degradation in the health of aquatic ecosystems. The best way to avoid such impacts is to steer development away from watersheds with little existing development (with more than 90 percent of the watershed's surface remaining permeable) and focus development into watersheds that are already degraded.[22]

Box 4: The Little Mouse that Could (and Did) Save a Community

In When Hurricane Ivan slammed into the Alabama coast in September 2004, entire beachfront communities were destroyed. However, the developments on the Fort Morgan peninsula were spared. Unlike everywhere else along the coast, the natural dune habitat on the peninsula had been protected from development and served as a vital buffer against floodwaters. Developers had undertaken this habitat conservation measure to protect the tiny Alabama beach mouse from extinction and thereby to fulfill their duties under the Endangered Species Act. The beach mouse not only helped save a community from a hurricane, but it also offered a timely lesson on how conserving healthy habitats for wildlife improves the quality of human habitats.

Smarter Growth Can Generate Major Benefits

In addition to providing environmental benefits, farmland and other open spaces typically generate far more in taxes than they cost in public services. In contrast, the taxes generated by new residential development in outlying areas almost never are sufficient to cover the costs of extending roads, sewers, schools and other public services.[23]

Proximity to natural areas has also been linked to improved health and increased property values. According to a recent study, people living near parks and other natural areas live healthier lives with fewer hospital visits.[24] In a recent poll, the National Association of Realtors found that 57 percent of voters would be more likely to purchase a home close to green space, and fifty percent said they would be willing to pay ten percent more for a home located near a park or other protected natural area.[25]

Protecting green spaces can be aided by more compact development. Fortunately, demographic and industry trends indicate high consumer demand for the development of condos, townhomes and commercial districts that resemble traditional main streets and town squares, and other more walkable neighborhoods. For example, condo sales have broken volume records for eight years in a row, and 2003 was the best year ever with nearly a million existing units sold. Furthermore, prices for condo resales have risen

Proximity to natural areas has also been linked to improved health – and is something that people value when purchasing a home.

rapidly at 15.2 percent annually in recent years—double the rate of single-family homes. The increase has been so dramatic that the median condo price ($163,800) now rivals that for single-family homes ($169,900).[26]

This demand will likely continue to grow, as baby boomers become empty nesters and retire. According to a University of Southern California analysis published by the Fannie Mae Foundation, this large demographic group shows an increasing preference for more compact, walkable neighborhoods with a greater sense of community, such as developments reflecting the design principles of "the new urbanism."[27] Specifically, the study analyzes data from the National Association of Homebuilders and the National Association of Realtors and estimates that roughly one-third of the total market demand for new owner-occupied homes will be for higher-density neighborhoods, and that another sixth could be attracted to such homes when presented with choices regarding design quality, lifestyle and other advantages.[28]

Generation X (those born between the early 1960s and early '80s) may reinforce this trend. According to research by Yankelovich (a leading marketing services consultancy), Gen Xers demonstrate a stronger commitment to having traditional relationships with neighbors, and more highly value neighborhood characteristics such as sidewalks and nearby recreational facilities. Yankelovich's President, J. Walker Smith discussed these findings at the premier homebuilding conference PCBC in June 2004, noting that "planned communities that foster togetherness and neighborhood life will resonate with this generation."[29] Another industry analyst, Brent Harrington of DMB Associates, reports that Gen Xers are looking for more diverse and compact communities characterized by smaller but better-designed homes, shopping and schools in more central locations, reflecting an "extreme disillusionment with the bland, vanilla suburbs."[30] According to Virginia Tech professor Arthur C. Nelson, these changing preferences and demographic trends will increase the demand for higher-density housing to roughly 70 percent of the market by 2010, a nearly complete reversal of preferences from those seen in the 1970s.[31]

Loss of Natural Areas and Ecosystem Services Caused by Sprawling Development

What is Sprawl?

Despite these promising trends, sprawl remains the nation's dominant development pattern. Although definitions vary, sprawl is usually characterized by: (1) low-density residential development; (2) rigid and large-scale separation of homes, shops, and workplaces; (3) a lack of distinct, thriving activity centers, such as strong downtowns or suburban town centers; and (4) a network of roads marked by very large block size and poor pedestrian access from one place to another.[32] Compact development is the antithesis of sprawl, keeping complementary uses close to one another.

Recent studies have quantified the relationship between sprawl and a host of negative outcomes: high ozone levels, traffic fatalities, drive time to work, and even obesity.[33] This report relates sprawl (measured here as the drop in gross population density as rural lands are converted to development) to the loss of open space and natural habitats. The faster a metropolitan area or county grows in developed land area relative to population, the more sprawling the area becomes, and the more habitats on which rare species depend are consumed.

Runaway Development will Deplete Natural Lands in Metro Areas

In order to measure the potential impact of future development, we focused on the 35 large metropolitan areas (those with more than one million people in 2000) projected to grow the fastest between 2000 and 2025. Our basic units of analysis were Metropolitan Statistical Areas (MSA) and Combined Statistical Areas (CSA), as defined by the U.S. Census Bureau in December of 2003. We analyzed growth trends and rural-urban land conversion in these metropolitan and combined metropolitan areas and subsequently identified the constituent counties where open space is particularly threatened by the combination of high growth rates and low development densities.

Between 2000 and 2025, Woods & Poole Economics, Inc., projects population growth in these 35 metropolitan areas ranging from a low of 15 percent for Providence to a high of 86 percent for Las Vegas (see Table 1). For 31 of the 35 areas, urban land area expanded faster than population between 1982 and 1997, causing average population densities to decline. The estimated average density of new development during the period was less than 2,500 persons per square mile for all but seven metropolitan areas. This translates into *fewer than two dwellings per acre.* A few regions, including Las Vegas, Los Angeles, and Phoenix, experienced modest increases in density during this period. But even in those areas, development densities (around 5,000 to 6,000 persons per

PHOTO COURTESY OF THE FOREST PRESERVE DISTRICT OF DUPAGE COUNTY

Housing adjacent to a DuPage County, IL forest preserve.

TABLE 1: Projected Population Growth, Growth Rate, and Prevailing Development Densities in 35 Fastest Growing Large Metropolitan Areas

	Projected population growth (2000–2025)	Growth Rate (2000–2025)	Average population density of new development (persons per square mile, 1982–1997)
Atlanta-Sandy Springs-Marietta, GA MSA	2,074,226	48%	1,290
Austin-Round Rock, TX MSA	1,035,379	82%	2,122
Baltimore-Towson, MD MSA	689,103	27%	1,286
Birmingham-Hoover, AL MSA	250,546	24%	515
Charlotte-Gastonia-Concord, NC-SC MSA	708,334	53%	954
Chicago-Naperville-Michigan City, IL-IN-WI CSA	1,907,017	20%	1,309
Cincinnati-Middletown, OH-KY-IN MSA	458,265	23%	805
Columbus, OH MSA	567,698	35%	1,283
Dallas-Fort Worth-Arlington, TX MSA	2,723,075	52%	1,910
Denver-Aurora-Boulder, CO CSA	1,111,636	45%	1,878
Houston-Baytown-Sugar Land, TX MSA	2,121,049	45%	1,482
Indianapolis, IN MSA	544,262	36%	1,090
Jacksonville, FL MSA	526,147	47%	1,344
Kansas City, MO-KS MSA	517,494	28%	1,266
Las Vegas-Paradise, NV MSA	1,194,167	86%	6,163
Los Angeles-Long Beach-Riverside, CA CSA	4,355,506	26%	5,415
Louisville, KY-IN MSA	267,301	23%	329
Memphis, TN-MS-AR MSA	340,015	28%	625
Miami-Fort-Lauderdale-Miami Beach, FL MSA	2,234,207	44%	3,383
Minneapolis-St. Paul-Bloomington, MN-WI MSA	1,108,359	37%	1,197
Nashville-Davidson-Murfreesboro, TN MSA	608,015	46%	783
Oklahoma City, OK MSA	278,178	25%	607
Orlando, FL MSA	1,057,960	64%	1,684
Phoenix-Mesa-Scottsdale, AZ MSA	2,241,585	68%	4,982
Portland-Vancouver-Beaverton, OR-WA MSA	898,564	46%	2,282
Providence-New Bedford-Fall River, RI-MA MSA	245,209	15%	613
Richmond, VA MSA	361,564	33%	714
Sacramento-Arden-Arcade-Roseville, CA MSA	1,024,526	57%	3,054
San Antonio, TX MSA	780,968	45%	1,930
San Diego-Carlsbad-San Marcos, CA MSA	1,200,733	42%	4,336
San Jose-San Francisco-Oakland, CA CSA	2,036,375	29%	3,988
Seattle-Tacoma-Bellevue, WA MSA	1,098,893	36%	2,323
Tampa-St. Petersburg-Clearwater, FL MSA	931,915	39%	1,609
Virginia Beach-Norfolk-Newport News, VA-NC MSA	414,231	26%	1,360
Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	1,788,506	37%	2,089

square mile) are low by historical standards. The net effect of such densities is the loss of more land to accommodate fewer people (see Table 1).

To estimate land consumption over the 25-year period, we divided the projected increase in population by the net density of recent development for each metro area. These estimates were then compared to the amount of land available for development in each metropolitan area based on data from the 1997 Natural Resources Inventory (NRI) compiled by the U.S. Department of Agriculture. We identified as "green infrastructure" all non-federal land categorized by the NRI survey as cultivated and uncultivated cropland, pasture, rangeland, and forests.

Given projected population growth, the 35 metropolitan areas by 2005 will lose a total of 22,374 square miles of green space if land continues to be developed at recent prevailing densities. This amount of developed land would be approximately the size of West Virginia.[34] The most significant losses are slated for metropolitan areas that combine high growth rates with low densities: 1,608 square miles of open space potentially lost in Atlanta, 1,457 square miles in Chicago, 1,426 square miles in Dallas, 1,431 square miles in Houston, 926 square miles in Minneapolis-St. Paul, and 856 square miles in the Washington, DC region. These losses would absorb between 6 to 60 percent of the remaining developable land in the 35 metropolitan areas.

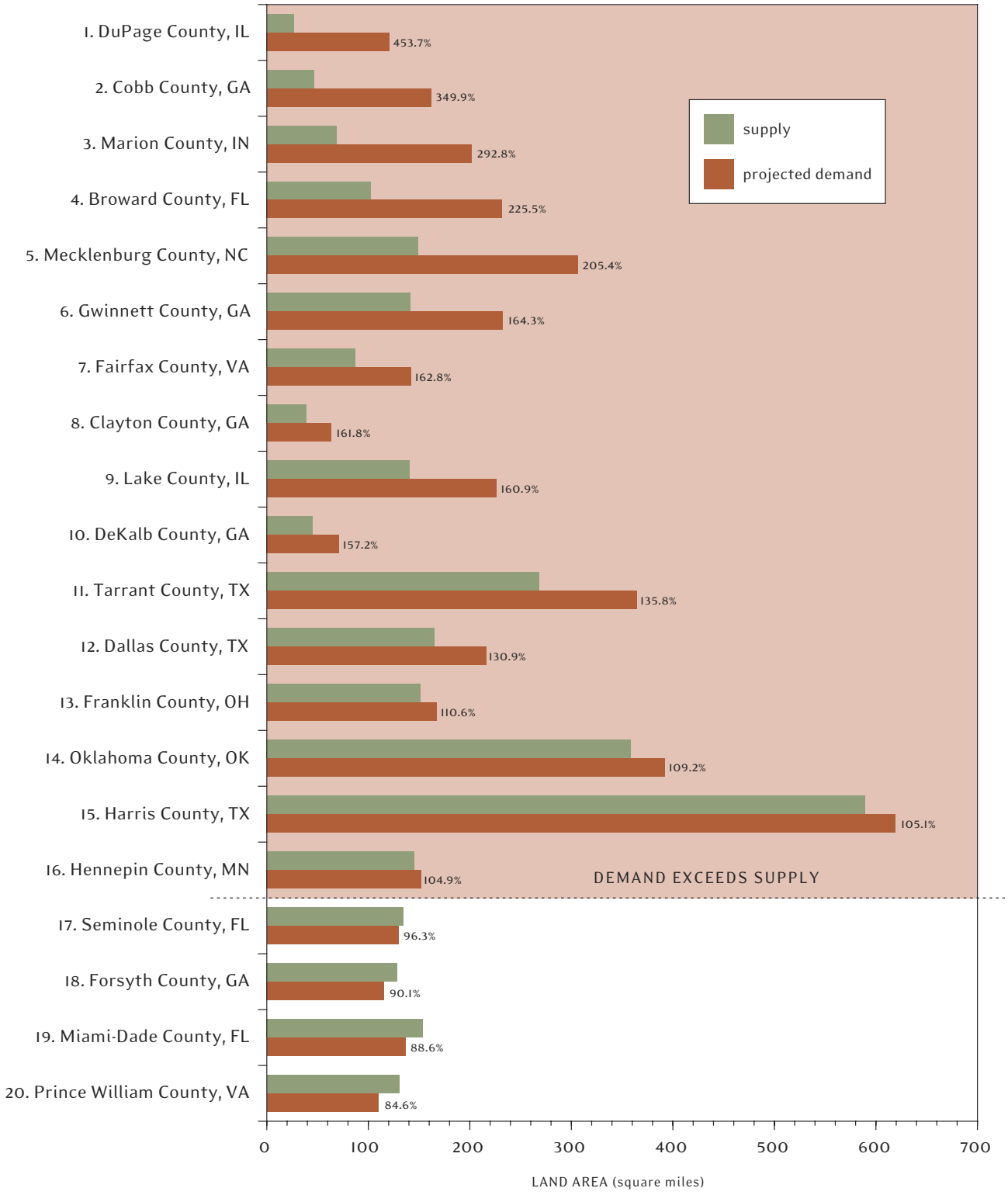
It is important to note that these projections are somewhat conservative. Though they are based on the best available data to conduct a nationwide analysis, the net density estimates are based on changes in population and urban land area between 1982 and 1997, a long period that most likely does not reflect recent density trends. Recent national and local studies suggest that the pace of sprawl is accelerating in the vast majority of places.[35]

The same methodology was applied to counties within these 35 metropolitan areas. Growth tends to be concentrated in a few suburban counties, rather than spread evenly across metropolitan areas. The Woods & Poole projections indicate that 11 of the counties in these metro areas will more than double in population between 2000 and 2025, with another 110 counties increasing in population by more than 50 percent. At prevailing densities of new development, the county-level analysis shows that accommodating projected population growth would consume all remaining space in 18 counties (see Figure 1; two counties have been dropped from the Figure because they had less than 20

TABLE 2: Imperiled Species and Population Occurrences Found in Metro Areas, and the 35 Fastest Growing Large Metro Areas

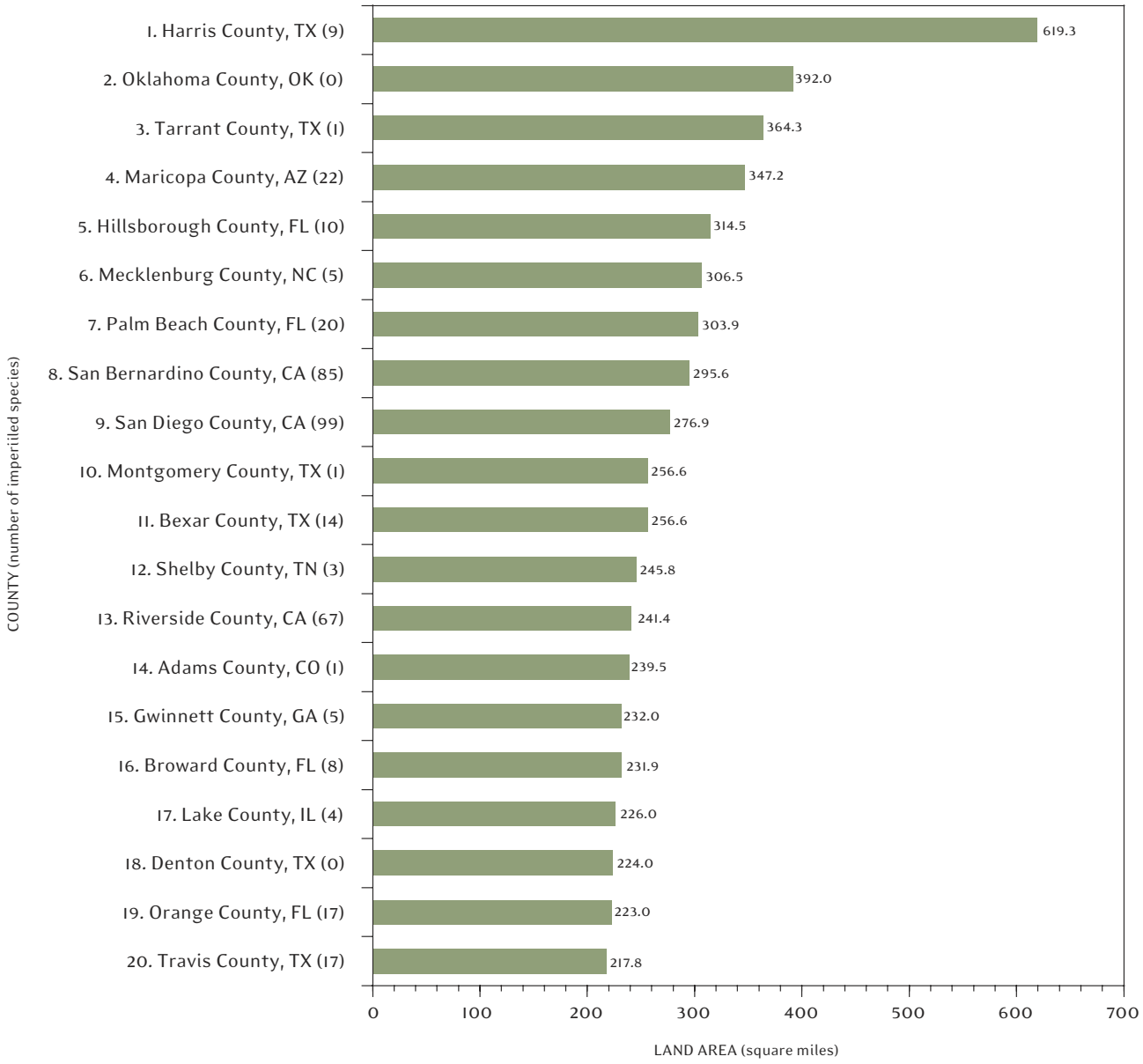
	SPECIES		POPULATIONS	
	COUNT	PERCENT	COUNT	PERCENT
Entire U.S.	4,173	100%	138,716	100%
All Metropolitan Areas				
Present	2,506	60%	63,282	46%
Exclusive	1,284	31%		
35 Fastest Growing Large Metropolitan Areas				
Present	1,196	29%	25,861	19%
Exclusive	553	13%		

FIGURE 1. Demand for Open Space is Quickly Outstripping Supply: *Counties with Greatest Ratio of Projected Demand to Available Supply*



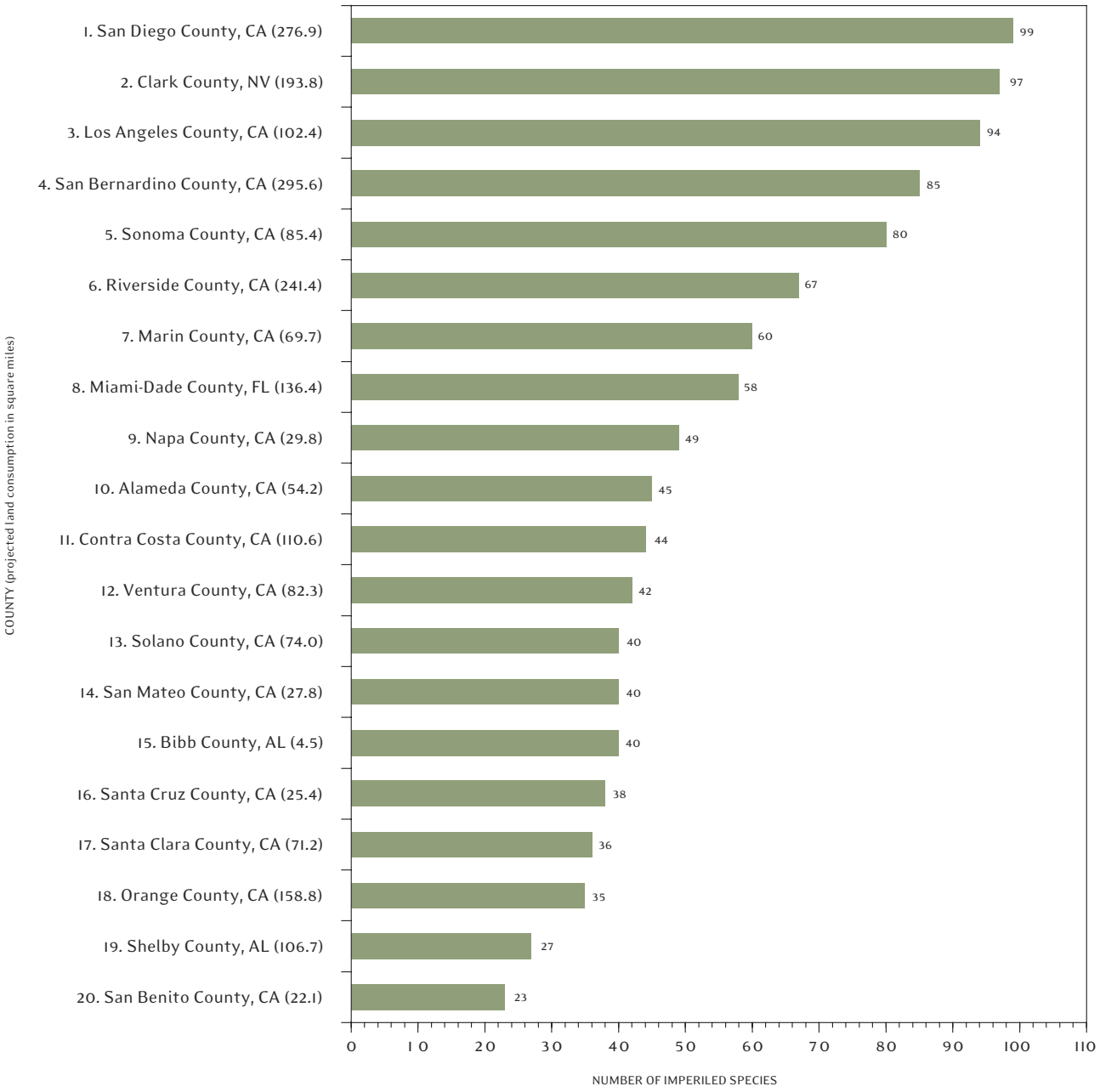
In America's 35 fastest growing large metro areas, these 20 counties are projected to develop the largest proportion of their remaining open space through 2025. Large metro areas are metro areas with over a million people in 2000. Metro areas with the fastest growth are those with population levels projected to grow at the highest rates between 2000 and 2025. Development projections are based on Woods & Poole population projections and recent development densities derived from U.S. Census population data and land use data from the U.S. Department of Agriculture's Natural Resources Inventory (NRI). Open space is defined to include the following NRI categories: cultivated and uncultivated cropland, pasture, rangeland and forestland. See Data Sources and Methodology, below. Counties with less than 20 square miles of remaining open space were excluded from this ranking.

FIGURE 2. Large Amounts of Open Space in the Path of Development: *Counties with the Largest Amount of Open Space Projected to be Developed through 2025 under Existing Sprawl Patterns*



These 20 counties in the nation's 35 fastest growing large metro areas are projected to lose the greatest amount of open space to development through 2025. Projections of future development are based on Woods & Poole population projections and recent development densities. See Data Sources and Methodology, below.

FIGURE 3. Large Numbers of Species at Risk of Extinction: *Counties in Fastest Growing Large Metro Areas with the Largest Number of Imperiled Species*



These 20 counties have the greatest number of imperiled species among all counties in the nation's 35 fastest growing large metro areas. Imperiled species are defined as species or subspecies with NatureServe global conservation status ranks of G1/T1 (critically imperiled) or G2/T2 (imperiled). See Data Sources and Methodology, below.

square miles of open space remaining). The degree to which demand outstrips supply is dramatically illustrated by the amount by which "projected demand" for land exceeds 100 percent of available land base in the 18 counties. Development pressure from these counties would likely spread into adjacent counties, which would also lose open space. Another 19 counties will lose half or more of their green infrastructure lands.

Viewing the county-level data another way, 20 counties in the 35 fastest growing large metropolitan areas will each lose more than 200 square miles of open space to development if growth proceeds at the low prevailing densities of recent years (see Figure 2). Leading the pack is Harris County, TX, part of the Houston metropolitan area, whose population growth between 2000 and 2025 would use up a staggering 619 square miles of open land at prevailing densities. In fact, Harris County will run out of open land before the demand is fully met. Six other high-growth counties are in this same position. Collectively, the top 20 counties have projected land consumption of 5,815 square miles.

Finally, viewing county-level data from a third perspective, 20 counties in the 35 fastest growing large metropolitan areas each harbor upwards of 20 imperiled species (see Figure 3). These counties are concentrated in the West, particularly the San Francisco and Los Angeles metropolitan areas, and the Southeast, with two from the Birmingham metropolitan area. Collectively, the top 20 counties harbor 718 imperiled species, with many species appearing in multiple counties and 438 species that are unique to these counties. Unless development can be channeled into existing developed places, or new development can be made more compact, these counties stand to lose much of their natural areas and wildlife habitat to sprawl. In some areas, existing parks and other public lands may help sustain these species and mitigate this loss of open space. However, species will not benefit unless those lands are managed intentionally for wildlife protection. Further, the projected loss of open space may understate the actual impact on species because even where patches of natural habitat are left intact, they may be too small or too fragmented to sustain imperiled species populations over the long term.

Loss of Wildlife Habitat in Metro Areas Threatens Many Imperiled Species

These development trends will have significant consequences for the survival of America's wildlife heritage. To better understand the potential magnitude of this threat, we analyzed the distribution of species classified by NatureServe as imperiled or critically imperiled relative to designated metropolitan areas. NatureServe and its network of state natural heritage programs have carried out scientific assessments of the conservation status for more than 35,000 U.S. species, and maintain databases documenting the precise location of those of greatest conservation concern. These assessments are widely regarded as providing a more comprehensive view of the extinction risk facing the nation's plants and animals than does the listing of species formally protected under the U.S. Endangered Species Act.[36] NatureServe currently categorizes approximately 6,400 U.S. species as imperiled or critically imperiled, compared with just 1,265 U.S. species that are federally listed as threatened or endangered. This study analyzes the distribution of 4,173 imperiled or critically imperiled species and subspecies occurring in the mainland United States.

Approximately 60 percent of imperiled species are found in one or more of the mainland metropolitan areas, with 31 percent found exclusively within metropolitan areas. At a more detailed level, conservation biologists are concerned not only with

TABLE 3: Imperiled Species within the 35 Fastest Growing Large Metropolitan Areas

	Projected % of Green Infrastructure Lands Consumed	Number of Imperiled Species	Sampling of Imperiled Species
Atlanta-Sandy Springs-Marietta, GA MSA	29%	35	White Fringeless Orchid, Cherokee Darter, Oval Pigtoe Mussel
Austin-Round Rock, TX MSA	14%	33	Jollyville Plateau Salamander, Golden-Cheeked Warbler, Texas Wild-Rice
Baltimore-Towson, MD MSA	34%	9	Torrey's Mountain Mint, Sandplain Gerardia, Dwarf Wedge Mussel
Birmingham-Hoover, AL MSA	11%	80	Alabama Snow-Wreath, Black Warrior Waterdog
Charlotte-Gastonia-Concord, NC-SC MSA	35%	13	Carolina Heelsplitter, Schweinitz's Sunflower, Carolina Creekshell
Chicago-Naperville-Michigan City, IL-IN-WI CSA	27%	15	Karner Blue Butterfly, Kirtland's Snake
Cincinnati-Middletown, OH-KY-IN MSA	17%	11	Virginia Mallow, Fanshell
Columbus, OH MSA	15%	4	Northern Riffleshell, Spotted Darter, Rayed Bean
Dallas-Fort Worth-Arlington, TX MSA	22%	9	Black-Capped Vireo, Comanche Peak Prairie Clover
Denver-Aurora-Boulder, CO CSA	10%	29	Preble's Meadow Jumping Mouse, Ute Ladies' Tresses, Colorado Butterfly Plant
Houston-Baytown-Sugar Land, TX MSA	23%	20	Prairie Dawn, Houston Toad, Texas Windmill Grass
Indianapolis, IN MSA	17%	7	Indiana Bat, Northern Riffleshell, Kirtland's Snake
Jacksonville, FL MSA	18%	30	Hartwrightia, Striped Newt
Kansas City, MO-KS MSA	6%	4	Indiana Bat, Mead's Milkweed
Las Vegas-Paradise, NV MSA	50%	97	Southwestern Willow Flycatcher, Relict Leopard Frog, Alkali Mariposa Lily
Los Angeles-Long Beach-Riverside, CA CSA	12%	219	Least Bell's Vireo, Laguna Beach Dudleya, Pacific Pocket Mouse
Louisville, KY-IN MSA	25%	33	Indiana Bat, Spotted Darter
Memphis, TN-MS-AR MSA	15%	5	Ovate Catchfly, Interior Least Tern
Miami-Fort-Lauderdale-Miami Beach, FL MSA	60%	68	Florida Panther, Johnson's Sea Grass, Florida Royal Palm
Minneapolis-St. Paul-Bloomington, MN-WI MSA	23%	10	Winged Mapleleaf, Karner Blue Butterfly
Nashville-Davidson-Murfreesboro, TN MSA	17%	43	Tennessee Coneflower, Tennessee Cave Salamandar, Braun's Rock-Cress
Oklahoma City, OK MSA	10%	4	Black-Capped Vireo, Arkansas River Shiner
Orlando, FL MSA	25%	34	Florida Sandhill Crane, Sand Skink, Orlando Cave Crayfish
Phoenix-Mesa-Scottsdale, AZ MSA	6%	32	Arizona Cliff Rose, Desert Pupfish, Nichol's Turk's-Head Cactus
Portland-Vancouver-Beaverton, OR-WA MSA	11%	45	Willamette Valley Daisy, Bradshaw's Lomatium, Oregon Spotted Frog
Providence-New Bedford-Fall River, RI-MA MSA	40%	6	Small Whorled Pogonia, Coastal Barrens Buckmoth
Richmond, VA MSA	11%	16	New Jersey Rush, Sensitive Joint-Vetch
Sacramento-Arden-Arcade-Roseville, CA MSA	12%	47	Sacramento Orcutt Grass, California Tiger Salamander, California Red-Legged Frog
San Antonio, TX MSA	6%	23	Golden-Cheeked Warbler, Comal Springs Riffle Beetle, Widemouth Blindcat
San Diego-Carlsbad-San Marcos, CA MSA	16%	99	Otay Mesa Mint, Arroyo Toad, Stephen's Kangaroo Rat
San Jose-San Francisco-Oakland, CA CSA	8%	257	Santa Cruz Long-Toed Salamander, Alameda Manzanita, Swamp Harebell
Seattle-Tacoma-Bellevue, WA MSA	17%	10	Water Howellia, Golden Paintbrush
Tampa-St. Petersburg-Clearwater, FL MSA	40%	26	Giant Orchid, Cooley's Water-Willow, Tampa Vervain
Virginia Beach-Norfolk-Newport News, VA-NC MSA	20%	13	Small Whorled Pogonia, Viginia Least Trillium
Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	23%	18	Torrey's Mountain Mint, Small-Whorled Pogonia

the total number of species in a region, but also with the number and condition of distinct populations of these species. Surprisingly, 46 percent of all known population occurrences of imperiled species are within the boundaries of metropolitan areas. These figures suggest that the future of many of the nation's rarest and most endangered species will depend not just on what occurs in remote rural landscapes, but will be directly related to growth patterns within metropolitan areas.

The 35 fastest growing large metropolitan areas collectively are home to nearly one third (29 percent) of all known imperiled species, and 13 percent apparently are restricted to these metro areas. These 35 areas, which are concentrated in the western and southern regions of the country, also harbor about 19 percent of all known population occurrences of imperiled species (see Table 2).

The number of imperiled species found within each of the 35 metropolitan areas is shown in Table 3, along with a sample of some of the specific species. The largest number of imperiled species is found in the San Francisco metropolitan area (257 species). Another western metropolitan area, the Los Angeles-Long Beach-Riverside CSA, is home to 219 imperiled species, including the Pacific pocket mouse. This region covers an area larger than the state of South Carolina, and is expected to lose 12 percent of its remaining open space to development by 2005. Regions not traditionally associated with endangered species conflicts also have significant biological resources that may be at risk. The Charlotte, NC metro area, which is projected to lose 35 percent of its remaining open space to sprawl, is home to 13 imperiled species, such as the Carolina creekshell mussel. The Nashville, TN region, where sprawl will likely consume 17 percent of remaining green infrastructure lands, is home to 43 imperiled species, including the Tennesee coneflower. And the Tampa-St. Petersburg-Clearwater metro area has 26 imperiled species, including the Tampa vervain flower, and is projected to lose 40 percent of its remaining open space to development. The figures are even more striking when examined at the county level. Indeed, a total of 287 imperiled species are found in the 37 counties projected to lose half or more of their green infrastructure between 2000 and 2025.

Nearly half of U.S. lands protected as of the late 1980s had been at **high elevations**, over 10,000 feet above sea level. Yet it is in the **lower elevations** where the most productive soils and the most **diverse array of species** are found and, not coincidentally, where most of the people in this country live.

Local Governments Should Do More to Protect Green Infrastructure

To a large extent, Americans seeking to protect green infrastructure are playing catch up. Land conservation efforts in the U.S. historically have focused outside of metropolitan areas. Nearly half of U.S. lands protected as of the late 1980s had been at high elevations, over 10,000 feet above sea level.[37] Yet it is in the lower elevations where the most productive soils and the most diverse array of species are found and, not coincidentally, where most of the people in this country live.

Fortunately, the focus of land conservation efforts has begun to shift. Increasing numbers of leaders in government and the nonprofit and private sectors have begun working to protect natural resources closer to home. For example, in the past decade, voters have repeatedly approved the investment of their tax dollars for local land conservation (see Table 4). In the same time period, federal, state and local officials in a wide array of metropolitan areas ranging from Austin, Texas to San Diego, California, have launched initiatives under the federal Endangered Species Act to conserve imperiled species threatened by sprawl. Everyday citizens have broadly supported these and other habitat protection measures. According to a January 2004 poll by Decision Research, 86 percent of voters nationwide supported maintaining a strong Endangered Species Act.

However, despite the promise of these local funding measures and Endangered Species Act initiatives, they are not sufficient to protect green infrastructure. In many cases, such efforts are undermined by local governments' piecemeal approaches to green infrastructure protection and the failure to ensure that local conservation funds are

TABLE 4: Local and State Ballot Measures for Land Conservation[38]

	MEASURES PASSED	MEASURES ON BALLOT	PASSAGE RATE	AMOUNT FOR CONSERVATION
1996	60	74	81%	$1.1 billion
1997	54	64	84%	$0.6 billion
1998	144	190	76%	$6.6 billion
1999	93	102	91%	$2.2 billion
2000	174	208	84%	$4.4 billion
2001	137	196	70%	$1.6 billion
2002	140	190	74%	$5.4 billion
2003	101	135	75%	$1.3 billion
2004	162	217	75%	$4.1 billion
Total	**1,065**	**1,376**	**77%**	**$27.3 billion**

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Second home construction along Great Lakes shorelines contributes to the decline of the dune thistle.

responsibly invested. To assess the extent and effectiveness of local government efforts to protect green infrastructure, we conducted extensive surveys of land use agency staff in 15 large metro areas. (See Box 5: Survey Methodology)

Our research reveals that only three of the fifteen metro areas (Portland, OR; Minneapolis-St. Paul, MN; and Riverside, CA) have regional bodies with broad power over land use; elsewhere, local governments have adopted a patchwork of land use policies, with no strategy for ensuring that one jurisdiction's policies do not undermine the green infrastructure protection efforts of a neighboring jurisdiction in the same ecosystem. Our research also reveals that only the regional bodies and a handful of the largest counties in the fifteen metro areas have inventoried their natural resources or are tracking species or habitat losses. Thus, it is impossible for most jurisdictions even to know what resources are being lost or to evaluate the success of their green infrastructure protection efforts.

The results of our survey highlight the significant number of local governments that have an open space program but lack a comprehensive green infrastructure protection program. If the latter program were put in place, the regional or local government would pay as much attention to issues of species, habitat loss and ecological integrity as it does to address open space for recreational, scenic or farmland protection purposes. Although there are important exceptions (discussed later in this report), far too many local governments have neglected this aspect of green infrastructure in designing their land conservation programs. Better performance goals and tracking mechanisms are needed to ensure that funds available for green infrastructure protection are helping to conserve imperiled species and habitat types.

Box 5: Survey Methodolgy

From April 2002 to March 2003, National Wildlife Federation staff performed extensive telephone and e-mail interviews with the staff of local and regional land use planning bodies in fifteen Metropolitan Statistical Areas and Consolidated Metropolitan Statistical Areas in the U.S.: Atlanta, Miami-Ft. Lauderdale, Tampa-St. Petersburg, Dallas-Ft. Worth, Houston, Denver-Boulder, Phoenix, San Diego, Los Angeles, San Francisco, Seattle, Portland, OR, Washington, DC-Baltimore, Chicago, and Minneapolis-St. Paul. These fifteen metro areas were selected for the survey because they are large population centers (each with populations greater than 2 million as of 2000) and they had the most rapid increases in population in the most recent decade covered by the U.S. Census (1990-2000).

All told, NWF staff interviewed land use planning staff from 160 counties, cities, metropolitan planning organizations, regional planning organizations, and regional governments. (See Appendix A for e-mail interview questions.) In addition, they interviewed roughly 75 experts on state and regional law and politics from the 15 metro areas, and gathered dozens of reports and downloaded materials from hundreds of web sites. As a result of these efforts, the authors of this report were able to draw upon an extensive green infrastructure database.

Tools Needed to Protect Green Infrastructure

The history of U.S. land use policy reveals that no single tool works to protect natural resources from overdevelopment. Furthermore, what works in one region may not necessarily work in another. Based upon the lessons of the 15 metro areas surveyed, a review of the academic literature, and the advice of experts, we recommend the use of the following tools as part of a comprehensive green infrastructure strategy:

1. Create and maintain inventories of species and natural resources.
2. Establish regional cooperation to protect natural areas and species.
3. Develop green infrastructure protection plans, with performance goals and measurements.
4. Establish urban growth boundaries or urban service boundaries.
5. Protect critical natural habitats.
6. Build reliable local funding sources for green infrastructure and species protection.

What follows is a description of these tools and their use within these 15 fast-growing large metropolitan areas in the country.

1. Natural Resource & Species Inventories

Reliable information about an area's biological and ecological resources is essential in the design of any green infrastructure strategy. Finding out where development would

Box 6: Additional Smart Growth Tools

Tools that can support smarter growth and capture growing consumer demand for more compact and neighborhood-friendly development can complement many green infrastructure protection strategies. For detailed information about these tools, see Smart Growth Online (www.smartgrowth.org) from the Smart Growth Network and the U.S. Environmental Protection Agency's web site, www.epa.gov/smartgrowth. Both offer numerous free publications such as *Getting to Smart Growth: 100 Policies for Implementation.*[39] Also, this report does not address rural growth management tools that are vitally important to habitat preservation and complement the metropolitan-oriented tools we cover in this report. For further information about rural strategies, see *Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land* and *Principles and Practice of Growth Management.*[40]

be helpful, and where it would be harmful to the public interest is a crucial role for local land use planners. Sensitive habitats are often highly localized, and can often be easily accommodated early in planning processes. Postponing consideration of these sensitive resources until late in the development process, on the other hand, often leads to increased conflicts, higher costs and poor environmental results.

Satellite imagery and accessible mapping technologies have greatly increased the types and amount of habitat information available to assist local governments to understand and map their significant biological resources. Of particular relevance are the state natural heritage programs, which are found in every state and together constitute the nationwide NatureServe network. Typically operated by state agencies, these programs maintain computer databases of all species and habitats of special concern in their state, together with detailed maps indicating their location and condition. A number of other state and federal programs also provide information on the location of species and habitat. Of help in the near future will be Comprehensive Wildlife Conservation Strategies, which each state must complete by October 2005 to qualify for federal wildlife conservation grants. (See Box 7: Biological and Ecological Inventory and Mapping Efforts)

Some excellent examples of cutting-edge inventory work are described below:

San Diego and Portland, Oregon

Driven in part by the Endangered Species Act (ESA) and other legal obligations, several regional and local governments have invested considerable resources into the development of detailed maps of sensitive species and habitat types within their jurisdictions. The habitat assessments and mapping performed by the San Diego Area Government (SANDAG) and Portland's regional government, Metro, represent some of the most comprehensive regional inventories in the country.[41]

Minneapolis-St. Paul

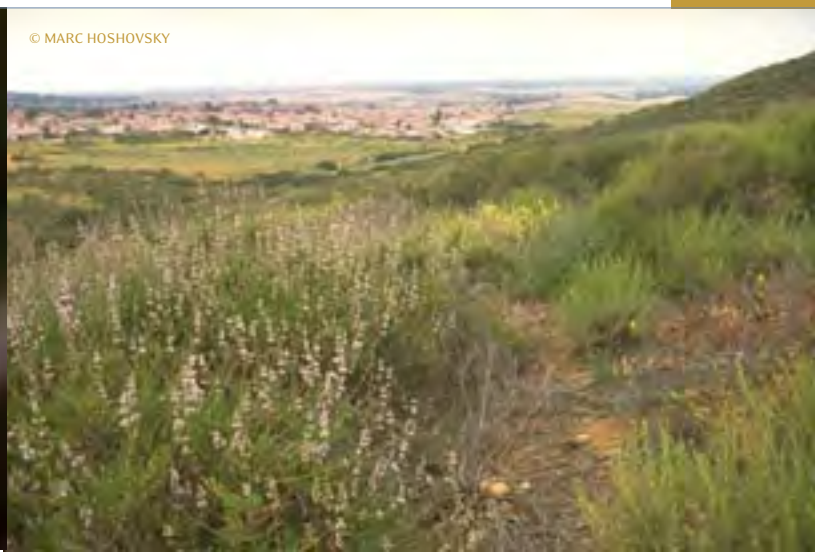
Several regional and local governments not directly affected by the ESA or other federal regulatory mandates have nonetheless undertaken ambitious efforts to inventory species and habitats. For example, in Minneapolis-St. Paul, the Metropolitan Council and the Minnesota Department of Natural Resources are using a Geographic Information System (GIS) model to identify significant natural resources in the seven-county metropolitan region. A primary goal of the assessment is to identify areas with a high likelihood of having intact native plant communities and/or high quality native animal habitats.

Chicago

In Chicago, two non-profits, the Openlands Project and the Center for Neighborhood Technology, have embarked upon a similar exercise. The goal is to create a database of the Chicago region's green infrastructure that will help local governments, land trusts and other organizations incorporate environmental considerations into their planning. The project will include several dozen data layers depicting different types of green infrastructure and will cover a 14-county region (extending into Wisconsin and Indiana). This effort may be expanded to cover approximately 30 counties.[42]

L:The endangered Karner blue butterfly is indirectly threatened by fire suppression efforts aimed at protecting encroaching developments; R: San Diego County sprawl is putting the squeeze on remaining wildlife habitat.

J & K HOLLINGSWORTH/ USFWS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Regional Cooperation

Most decision making on land use issues in the U.S. is made at the local level (i.e. town, village, township, city, etc.) or, for areas not incorporated into a city or town, at the county level. Neighboring governments typically do not coordinate their land use strategies, and often unwittingly undermine each other's efforts. Under such circumstances, it is extremely difficult to protect and restore habitats and natural areas that cross jurisdictional boundaries. It is also difficult for citizens concerned about green infrastructure to influence policy because it is difficult for them to appeal to decision makers in multiple jurisdictions and at different governmental levels.

When the lack of coordination between jurisdictions is recognized, the most common solution is to form a regional council of governments.[43] These bodies typically play an important role by facilitating information-sharing, providing a forum for debate, and making policy recommendations to member governments. However, their greatest weakness is that they are often merely advisory bodies. Because of this, regional councils often find that their recommendations are ignored.

Three of the 15 metro areas surveyed, including Portland, OR, Minneapolis-St. Paul and a sizable portion of the Los Angeles metro area (Riverside County), have boldly addressed this problem by establishing regional governments with real decision-making power. Elsewhere in the country, there is little movement toward the establishment of regional governments with broad authority over land use.[44] Yet, despite the perceived barriers, regional governance is still one of the most effective tools available for the protection of green infrastructure.

Portland, Oregon

The Portland area's regional government, known as Metro, covers 24 cities (including the City of Portland) across a three-county area. Metro has received praise by land use policy experts for successfully addressing problems that would otherwise have to be dealt with

Box 7: Biological and Ecological Inventory and Mapping Efforts

State Natural Heritage Programs: These programs are run by state agencies and are coordinated by the non-profit organization NatureServe. They are a leading source of scientific information about rare and endangered species and threatened ecosystems. Each program maintains computerized databases detailing their state's flora, fauna, and ecological communities, together with detailed locality maps for those species that are at greatest risk of extinction.

Gap Analysis Program (GAP): A program of the U.S. Geological Survey, GAP is an effort to identify those species and habitats not adequately represented within existing conservation areas. This program emphasizes work with state-level collaborators on the production of land cover and habitat maps that can be used for a variety of conservation planning purposes. GAP mapping efforts are now underway in 33 states with more than 200 cooperating organizations.

NatureServe Vista: This tool is a new computer-assisted decision support system designed to help local planners incorporate biological considerations into land use planning and green infrastructure development. NatureServe Vista represents a structured way for planners to understand and map existing wildlife habitat and their significance relative to other physical and economic attributes. It will help in the identification of sites with the greatest conservation potential, or the greatest sensitivity to development.

State Wildlife Grants: Under this formula grant administered by the U.S. Fish and Wildlife Service, each state fish and wildlife agency must develop a Comprehensive Wildlife Conservation Strategy by October 2005. These plans provide valuable ecological information to proactively address concerns and allow land development stakeholders to be partners in conservation. For example, these plans must provide information about the state's most imperiled wildlife and describe the location and condition of the key habitats upon which these species depend. The plans must also identify the primary threats to these species and habitats, as well as the conservation actions needed to address them. The fish and wildlife agency must also involve the public and all affected state, tribal, local, and federal agencies as partners in the plan's development and implementation.

by 27 different local governments.[45] These include the construction of a regional light rail line and an open space program that purchases parks, trails, and fish and wildlife habitat throughout the region.

Minneapolis-St. Paul

While establishing a regional government with decision-making power is an accomplishment in and of itself, it does not ensure effective protection of a region's green infrastructure. The experiences of the regional government in Minneapolis-St. Paul provide us with a lesson on that score. According to local experts, the Met Council (the name given to the regional government) has not effectively managed its growth or conserved green infrastructure. The Twin Cities area is developing its natural areas at a density comparable to sprawling Atlanta and Houston, and the Met Council's green infrastructure work has been narrowly focused on certain regional parks and trails. However, the basic structure of the Met Council as defined by state statute is sound. With the authority to review and modify local comprehensive plans to ensure

consistency with regional goals, the Met Council is well positioned to reorient the region toward improved green infrastructure protection. New initiatives such as a regional inventory of at-risk species and habitats suggest that the Met Council is beginning to realize its potential.

Los Angeles (Riverside County)

Metropolitan Planning Organizations (MPOs) offer another opportunity to promote regional, ecosystem-oriented decision making. Under federal transportation law, MPOs have been designated in every urbanized area with over 50,000 people.[46] (See Box 8: An Opportunity for Congress to Help Protect Green Infrastructure in the Federal Transportation Bill.) Riverside County, California is roughly the size of New Jersey. Transportation, housing, and habitat needs are considered through the joint efforts of the County of Riverside, the Riverside County Transportation Commission, and the Western Riverside Council of Governments (WRCOG, the MPO) through a single "Integrated Project." Revenues from a transportation sales tax measure, Measure A, are shared with municipalities in the county only on the condition that they participate in the county's regional habitat plan. Although the outcome of this Integrated Project includes controversial proposals for road-building and other development in some endangered species habitat, the debate over Riverside County's green infrastructure planning has been enhanced by linking transportation, housing, and habitat needs at the regional level. An integrated approach to regional government does not guarantee that sensitive lands will be protected, but it improves the chances for protection by focusing the debate on the cumulative loss of habitat across the region.[47]

Box 8: An Opportunity for Congress to Help Protect Green Infrastructure in the Federal Transportation Bill

A significant opportunity has emerged to ensure that Metropolitan Planning Organizations (MPOs) address green infrastructure concerns. Federal surface transportation law (known as TEA-21) requires, as a condition of eligibility for federal transportation funds, that local governments in urbanized areas with a population greater than 50,000 establish MPOs to make decisions on regional transportation priorities and to address the environmental consequences of those priorities. To date, MPOs have largely focused on the air quality impacts of various transportation plan options. When TEA-21 is updated by Congress in the coming months, conservationists should insist that MPOs be required to address impacts to green infrastructure before approving any regional transportation plan.

Clarifying that this is part of the MPO's responsibility would be highly appropriate considering the enormous impacts that transportation decisions have on green infrastructure. Roads destroy and fragment habitat, and they degrade habitats with polluted runoff and noise. Moreover, public subsidies for roads make sprawl development feasible. Without these subsidies, the cost of roads would make much of this type of development prohibitively expensive.

San Diego

In San Diego, the San Diego Association of Governments (SANDAG) plays the more typical MPO role for the region: its transportation plans strongly influence the actions of local governments, but its views on green infrastructure and other non-transportation issues are frequently disregarded. The result is fragmented land use decisions that fail to add up to any kind of regional green infrastructure strategy. Meanwhile, the Quality of Life Coalition, a group comprised of environmentalists and economic development and business agencies, is working on an initiative that would require SANDAG to change this by making its distribution of transportation funds conditional upon satisfaction of certain green infrastructure criteria such as habitat protection and water availability.

Green Infrastructure Plans

To succeed in protecting green infrastructure, local governments must first have a plan. In some states, such as Washington, Oregon, California, Maryland, and Florida, a comprehensive plan is required by state law, and that plan must address open space. Local governments in these states typically perform far better in planning for green infrastructure than in other states, such as Texas, where open space planning is purely voluntary.

As discussed earlier, an open space plan by itself will not necessarily succeed in conserving habitats without coordination with neighboring jurisdictions. Other pitfalls that could befall an open space plan are the failure to address habitat needs as distinct from recreational, farmland and other open spaces needs; reliance on the "wish list" approach (merely laying out recommendations, rather than assigning clear responsibilities and priorities); and the failure to adopt specific goals and performance measures for tracking progress.

CLAIRE DOBERT/USFWS

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L: Fragmentation of California gnatcatcher habitat has led to the federal listing of this diminutive bird; R:The Arroyo toad has lost much of its habitat—typically streams and adjacent sandy terraces—to sprawl and other disturbances.

Los Angeles and San Diego (Riverside, Orange, and San Diego Counties)

In the 15 metro areas surveyed, the best green infrastructure plans were those that avoided most or all of the pitfalls described above. In southern California, the federal Endangered Species Act has led San Diego, Orange, and Riverside counties, as well as several city governments, to prepare regional habitat conservation plans (HCPs) with clear performance goals and measures for tracking progress. Performance is defined in terms of total acres of habitat types conserved versus acres developed; annual reports show where progress is being made. Great controversy remains over the amount, quality and configuration of targeted habitats. Unfortunately, the ultimate test—the long-term survival of endangered species such as the coastal California gnatcatcher and the arroyo toad—cannot be measured for many years. In the meantime, these jurisdictions have created a model for other jurisdictions in the country for regional-scale planning, binding commitments (despite some loopholes), meaningful goals, and performance measures for tracking progress.

BOX 9: The Sonoran Desert Conservation Plan

At six million acres, the Sonoran Desert in Pima County, Arizona is one of the largest stretches of protected arid ecosystems in the world. This unique and delicate ecosystem is home to an incredible array of cultures (such as the Tohono O'odham Native American Nation), plants (including California palm oases) and animals such as the endangered Cactus ferruginous pygmy owl. However, like many areas of the southwest, Pima County is undergoing tremendous development, losing seven to ten square miles of habitat each year.

In response to these development pressures (especially the threat to the endangered pygmy owl), Pima County established the Sonoran Desert Conservation Plan (SDCP). In developing the SDCP, Pima County employed natural resource assessment and planning techniques, or "bio-planning," in order to determine where future development should occur. Essentially, bio-planning is land use planning taking into account the unique natural, cultural, and historic areas that must be protected, and directing growth to areas with the least natural, historic, and cultural resource values.

Wildflowers in the Sonoran desert habitat

The SDCP identifies biological corridors and sensitive habitats for the 39 plants and animals (excluding numerous invertebrates) that are in need of protection. Future urban growth and infrastructure development is steered toward existing urbanized areas. Meanwhile, future habitat loss or fragmentation is minimized through the acquisition of lands or conservation easements.

The SDCP has gained national attention for its effort to integrate natural, cultural, and historical resource protection with urban growth. In 2002, the American Planning Association selected the SDCP as winner of the national Outstanding Planning Award for a Plan.

For more information, see **http://www.co.pima.az.us/cmo/sdcp/**

Portland, Oregon

In Portland, Metro's Greenspaces Master Plan goes even farther than the southern California HCPs in terms of breadth and accountability. Unlike in southern California, the Greenspaces Master Plan addresses more than just species and habitats. It also identifies a regional system of parks, natural areas, wildlife corridors and trails to address the full range of habitat and open space needs. In addition, while the HCPs in southern California bind only certain county and city permit holders, the Metro Greenspaces plan covers all 3 counties and 24 cities of greater metropolitan Portland.[48]

Chicago

The Chicago Wilderness coalition is an excellent example of green infrastructure planning that involves close collaboration between governments and the private and nonprofit sectors. Comprising more than 160 public and private organizations, the coalition created the Biodiversity Recovery Plan to guide their work in sustainability, science, land management and other projects. The plan has won awards from the American Planning Association as well as from the National Association of Regional Councils.[49]

Phoenix (Maricopa County)

Regional open space planning efforts in metropolitan Phoenix have been led by its MPO, the Maricopa Association of Governments (MAG). While MAG is primarily concerned with transportation planning, its Regional Council did adopt the Desert Spaces Plan in 1995. The Desert Spaces Plan guides members of MAG on protecting sensitive open spaces while allowing future growth and development. It also aims to protect natural areas that support valuable wildlife habitat and allow wildlife to move freely between the larger preserves. Unfortunately, the plan is only an advisory document, to be used as a framework for developing policy and legislation in the 25 jurisdictions in Maricopa County (including the county).

Any regional or local green infrastructure planning effort should benefit from, and be consistent with, broader-scale planning that is done at the state level. As states develop and implement their Comprehensive Wildlife Conservation Strategies and move forward with conservation planning to take advantage of new federal funding and other incentives, local governments will have a major opportunity to tap into state-level expertise and resources for their own green infrastructure planning efforts.

Urban Growth Boundaries and Urban Services Boundaries

In implementing green infrastructure strategies, governments can play a vital role in deciding where development is appropriate and where it is not. In making this decision, a local government will sometimes protect very specific areas (e.g., wetlands and stream banks) that are especially environmentally sensitive. In such circumstances, it is appropriate to adopt critical and sensitive area protections (discussed below).

In some cases, large swaths of land are deemed inappropriate for development, such as when land is needed to sustain local farming or forestry, for scenic vistas, protecting wildlife migration corridors, or for limiting runoff from impervious surfaces. In such

circumstances, local governments typically rely on one of two tools to maintain a "greenbelt" of undeveloped land: urban growth boundaries (UGBs) and urban service boundaries (USBs).

UGBs are a regulatory tool in which local governments, exercising their zoning authority, declare a specified area off-limits to development in excess of a certain density. In designing UGBs, governments typically provide a long-term supply of developable land within the boundary to ensure that the demand for new homes can be met. USBs are financial tools in which governments withhold development subsidies in areas deemed inappropriate for development. Both tools can help protect green infrastructure because they greatly dampen developer speculation on rural properties, keeping property values manageable for rural landowners and redirecting developer investments toward already settled areas.

USFWS

The Oaks Bottom Wildlife Refuge provides wetland habitat in the heart of Portland, Oregon.

Oregon

Oregon is the leader in UGB implementation. The Oregon Land Conservation and Development Act of 1973 requires an urban growth boundary around each city in the state, as well as around the Portland metropolitan region. There are approximately 254,600 acres contained within the Metro UGB surrounding the Portland metropolitan area, and according to the 2000 Census, about 1.3 million people reside inside this boundary. The Metro UGB was approved in 1980 and has been amended periodically since that time with the last significant amendment occurring in December 2002, expanding the boundary to include 18,638 additional acres. Metro regional government is responsible for conducting a review every five years to ensure a 20-year supply of residential land for homebuilding and other development.[50]

Washington

The State of Washington's Growth Management Act requires that certain counties designate urban growth areas. Urban growth areas protect wildlife habitats and resource lands of long-term commercial significance (e.g., forests) from development. As one court explained, "'[T]he land speaks first.' Only after a county's agricultural, forestry and mineral resource lands have been identified and actions taken to conserve them, and its critical areas, including aquifers, are identified and protected, is it then possible and appropriate to determine where, on the remaining land, urban growth should be directed."[51]

Denver

The Denver Regional Council of Governments (DRCOG) adopted Metro Vision 2020 in 1997 as a long-range plan for dealing with growth. As part of this plan, DRCOG sets an overall urban growth boundary at 731 square miles and, using transportation funds, encourages local governments to establish an urban growth boundary. Thirty-one of DRCOG's 50 member cities and counties have signed the Mile High Compact, committing themselves to implement the urban growth boundary and other elements of Metro Vision 2020 through comprehensive or master plans. The square mileage of the land targeted

USFWS

Rapid development along Colorado's front range has contributed to a decline in the Preble's meadow jumping mouse.

for urbanization is allocated among these cities and counties. Unfortunately, the Denver area's UGB has already expanded beyond the initial targets. One of the current problems is the proliferation of large lot developments, which are quickly spreading in the rural lands outside the growth boundary. Nevertheless, Metro Vision 2020 and the Mile High Compact should be credited for promoting discussion about where future development will occur.

San Francisco

UGBs have also been successful where civic leadership has been lacking. In the San Francisco metro area, Greenbelt Alliance and other advocacy groups have promoted a vision of greenbelts in a series of citizen initiatives and county/city council votes across the region.[57] In the past decade, roughly 700,000 acres have been protected from development as a result of newly-enacted UGBs promoted by Greenbelt Alliance.[53]

Baltimore

Baltimore County, Maryland's Urban-Rural Demarcation Line (URDL) was established in 1967. With the help of strong low-density zoning beyond the line, it has largely prevented development from sprawling within the county.[54]

For governments seeking to protect large areas of land without zoning or other regulation, Urban Services Boundaries (USBs) provide an attractive alternative. Implementation of USBs requires a government to prioritize where it invests its existing infrastructure subsidies, such as for schools, roads, and utilities. For example, pursuant to the Coastal Barrier Resources Act (CBRA), the federal government has drawn a USB around sensitive coastal lands prone to flooding. Federal flood insurance subsidies are not available in these areas. Maryland enacted the Smart Growth Priority Funding Areas Act of 1997, which directs state money to priority funding areas. Priority Funding Areas are existing communities and places where local governments want state investment to support future growth.[55]

Minneapolis-St. Paul

In the Minneapolis-St. Paul region, the Metropolitan Council established the Metropolitan Urban Service Area (MUSA) in 1975. Since then it has been amended numerous times and has generally been unable to curb sprawl in the region. Part of the problem may be attributable to the Council's inability to exert its authority (see section on Regional Government).[56]

Chicago

The Northeastern Illinois Planning Commission (NIPC) and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in the Chicago region use different forms of urban service areas. In Illinois, a facility planning area is where a community may offer

centralized sewer service. Communities wishing to extend sewer service must submit an application to the Illinois Environmental Protection Agency or to one of the regional planning agencies such as NIPC in Chicago. NIPC reviews applications to ensure plans meet water quality standards and growth forecasts, and they encourage the preservation of farmland and natural areas.[57]

JIM P. REID/USFWS

Waterfront developments and associated boat traffic take a major toll on Florida's manatees.

Wisconsin

The Wisconsin Department of Natural Resources also uses sewer service to direct development by delineating sanitary sewer service areas, with the help of regional planning agencies such as the SEWRPC. Wisconsin excludes environmentally sensitive areas such as wetlands and floodplains from these service areas to avoid harming water quality. The delineation process also considers local land use plans and the need to protect farmland and natural areas.[58]

Tampa-St. Petersburg-Clearwater (Hillsborough County)

Hillsborough County in the Tampa-St. Petersburg-Clearwater metropolitan area delineates an Urban Service Area in the Future Land Use Element of their comprehensive plan, encouraging new development around existing facilities and development.[59]

Critical Area Protections

In seeking to protect critical and sensitive areas from development, governments have two complementary tools at their disposal: investing money (e.g., for fee acquisitions, purchase of development rights, and other conservation incentives for landowners), and enacting and enforcing regulations (e.g., zoning, land development regulations such as riparian buffers, wetland protections, and endangered species protections). Here we discuss critical area protections; the investment approach is discussed as part of tool six (Reliable funding).

Local governments typically enact critical and sensitive area protections through zoning ordinances. Zoning is a tool that divides a community into districts (zones) and imposes different land use controls on each district. It specifies the allowed uses of land and buildings, the intensity or density of such uses, and the bulk of buildings on the land.[60] Many local governments have inherent police power to protect critical and sensitive areas through ordinances.

Critical and sensitive areas are also protected by the Endangered Species Act in places where listed species are found.

Washington

The most serious efforts at critical area protection have been undertaken by local governments with a clear mandate from the state or federal government. In addition to

being the locus of important habitat protection initiatives under the federal Endangered Species Act, Washington State provides one of the strongest state mandates for regulatory protection of critical and sensitive areas in the country. According to the state Growth Management Act (GMA), all cities and counties in the state must designate and protect critical areas, including fish and wildlife habitat, through development regulations. Critical areas are defined as wetlands, fish and wildlife habitat conservation areas, areas with a critical recharging effect on aquifers used for potable water, frequently flooded areas, and geologically hazardous areas. The GMA does not allow exemptions that would leave some critical areas unprotected, though it allows critical areas to be protected with differing strategies and to differing degrees. The state's Office of Community Development monitors GMA compliance by local governments. Additionally, the 1995 amendments to the Growth Management Act require all counties and cities to revise their critical areas ordinances using "best available science" by 2007.[61]

DR. LLOYD GLENN INGLES © CALIFORNIA ACADEMY OF SCIENCES

Reduced water quality from sprawl is contributing to the decline of the Pugent Sound chinook salmon.

The Growth Management Act originally required critical area ordinances to be adopted by 1992 and 1993. This powerful mandate has led King County (in the Seattle metro area) and a few other counties to adopt some of the most ambitious critical area ordinances in the country.[62] Currently, relatively few county ordinances meet the standard of best available science but major efforts are underway to update the ordinances to meet these requirements.[63]

Often, critical and sensitive area ordinances do not prohibit all development on a parcel of land, but instead require establishment of buffer zones around the wetland, stream, or other important natural resource. In cases where development is foreclosed altogether, many local governments are turning to transfer of development rights ordinances, or TDRs, as a means of addressing landowner concerns. TDRs are a market-based technique that encourages the voluntary transfer of growth from places where a community would like to see less development (called sending areas) to places where a community would like to see more development (called receiving areas). The sending areas are typically environmentally-sensitive properties, open space, agricultural land, wildlife habitat, or historic landmarks. The receiving areas are places that are well-suited for additional development because they are close to jobs, shopping, schools, transportation and other urban services.[64]

Montgomery County, MD

Montgomery County, Maryland provides a fine example of a TDR program. Located in the Washington DC metro area, Montgomery County established its program in 1980. By the end of fiscal year 2003, the TDR program had put 43,195 acres (out of a total sending area of 93,000 acres) under protective easement. Prior to 1980, the county lost an average of 3,500 acres of farmland per year to development. In the first ten years of the TDR program, the county lost only 3,000 acres to development, a drop of approximately 92 percent.[65]

EYEWIRE

Funding sources such as the Forest Legacy Program can be crucial to the survival of species such as the Canada lynx, which need large tracts of undeveloped forest.

San Diego

In southern California and a handful of other metro areas in the country, the Endangered Species Act mandates that local governments take action to protect critical areas. To avoid liability for facilitating the illegal taking of listed species, San Diego County and other nearby jurisdictions have developed Habitat Conservation Plans that call for the establishment of wildlife reserves in parts of the endangered species habitats in the region, using mitigation fees paid by developers seeking permission to develop on other endangered species habitats (see also, "Green Infrastructure Plans" above). HCPs are essentially a political compromise; it remains to be seen whether the critical areas sacrificed to make the deal go forward were truly expendable, or whether the extinction process has simply been slowed for a period. As a backstop for their HCP, activists in San Diego are busily trying to secure critical areas provisions in a new comprehensive plan for the region.

Reliable Funding

Virtually every level of government—local, state and federal—is currently suffering through a fiscal crisis. To remedy shortfalls of revenue and pay for defense and homeland security programs, legislators and executive branch officials are targeting environmental and other domestic programs for cuts. In this context, some may wonder whether government support for protecting green infrastructure can be justified.

To some extent, green infrastructure protection is being led by the private and nonprofit sectors, which have ratcheted up their involvement in this area in recent years and will continue to do so.[66] Private land trusts, in particular, are playing a crucial role in prioritizing and funding land conservation. The Nature Conservancy's ecoregional planning efforts, for example, have helped to ensure that private acquisition dollars are targeted to areas with the important concentrations of imperiled species and habitat types.[67]

Nevertheless, substantial public support remains critical to green infrastructure protection, especially as private and nonprofit efforts are vulnerable to uncoordinated private development activity, as well as the vagaries of private funding. Significant funding is necessary to design a network of habitats and open spaces, acquire or otherwise protect this network from development, and manage these lands for conservation and other public purposes.

To overcome the funding hurdle, communities must rely upon a diverse array of funding sources: federal, state, regional and local government funds from tax revenues and bond issuances; local land trusts; private donations; and mitigation payments from private developers.

LOCAL RESOURCES

Long-term planning for green infrastructure protection depends on the ability to rely on future funding. By far the most popular and reliable mechanisms for achieving

TABLE 5: Local Reliable Funding Streams for Green Infrastructure[68]

LOCAL GOVERNMENT, MSA	AMOUNT	MECHANISM
Metro Regional Parks and Greenspaces, Portland-Salem, OR CMSA	$135.6 milion	Open spaces, parks and streams bond measure in 1995[69]
Hillsborough County, Tampa-St. Petersburg-Clearwater, FL MSA	$121 million over 25 years (1987-2001)	Environmental Lands Acquisition and Protection Program: 0.25 mil tax in 1987, ad valorem tax <0.25 mil in 1990 to retire $100 million bond referendum[70]
Pinellas County, Tampa-St. Petersburg-Clearwater, FL MSA	$72 million over 10 years (2000-2009)	Endangered Lands Account funded by Penny for Pinellas $.01 sales tax (1990-1999), extended in Extended Penny (2000-2009). Also includes matching grant funds from Florida Forever and Land and Water Conservation Fund
Boulder County, Denver-Boulder-Greeley, CO CMSA	$35 million / year since 1993	Series of voter approved initiatives: sales tax, bond money, property tax
Adams County, Denver-Boulder-Greeley, CO CMSA	$6 million / year since 1999	County passed 0.2% sales tax
Jefferson County, Denver-Boulder-Greeley, CO CMSA	$10 million - $20 million / year, depending on availability	0.5% sales tax non-sunsetted started in 1972. $160 million in bond money in 1998.
Forest Preserve Districts of Chicago-Gary-Kenosha, IL-IN CMSA	Varies by county: Will County $51 million over 10 years; DuPage County $75 million (1997 referendum); Lake County $125 million (several bond referenda), McHenry County $100,000 / year + $40 million of bond funds	Downstate Forest Preserve District Act, 1913 gives power to Forest Preserve Districts to create forest preserves
Pierce County, Minneapolis-St. Paul, MN MSA	Varies by year	
Marin County, San Francisco-Oakland-San Jose, CA CMSA	Varies year to year, $1 million per year last 2 years	State bond measures, Property tax, funds for stewardship of existing public lands
Sonoma County, San Francisco-Oakland-San Jose, CA CMSA	$16 million - $17 million per year	0.25% sales tax over 20 years (since 1990)
Riverside County, Los Angeles-Riverside-Orange, CA CMSA	$3.5 million in 2002	Interim Open Space Mitigation Fee, first adopted in 2001[71]
San Diego, San Diego, CA MSA	$10 million (also receive federal support in association with MSCP)	Multiple Species Conservation Program (MSCP)
Miami-Dade County, Miami-Fort Lauderdale, FL CMSA	$80 million ($2-$8 million /year)	Environmentally Endangered Lands Program – 2 yr. Property tax increase 1990-1992
Broward County, Miami-Fort Lauderdale, FL CMSA	$200 million	Part of Safe Parks and Land Preservation Bond Program 2000
DeKalb County, Atlanta, GA MSA	$90 million	Part of $125 million parks and greenspace bond referendum, repaid by ad valorem property tax over 15 years
Chattahoochee River Protection Campaign, Atlanta, GA MSA	Over $140 million	Coalition effort: Public/private agency, foundation, corporate and individually funded
Evergreen Forest Trust, Seattle-Tacoma-Bremerton, WA CMSA	$185 million for 100,000 acres	Plans to finance through Community Forestry Bonds™ (tax-exempt revenue bonds)[72]
Scottsdale, Phoenix-Mesa, AZ MSA	$500 million over 30 years for 19,000 acres	0.15% sales tax over 30 years to pay off bonds used to purchase land for the McDowell Sonoran Preserve

local, long-term funding support for green infrastructure protection is through bond issuances and dedicated taxes. These funding initiatives have the distinct advantage of providing a reliable stream of money to conservation programs on a long-term basis, rather than forcing governments to rely on an unpredictable annual appropriations process. Other mechanisms include development mitigation fees and private donations. Table 5 provides a list of some of the local funding streams for green infrastructure in the 15 metro areas surveyed.

STATE RESOURCES

Alabama

The Alabama Forever Wild Land Trust, a dedicated source of funding for land acquisition, was established by voter referendum in 1992. The program was passed with support from 83 percent of the voters, the highest margin ever for a conservation measures in any southeastern state. The funding is generated from a percentage of the interest income earned from the oil and gas severance tax, which includes offshore drilling. The percentage dedicated to the Forever Wild Program increases annually by one percent until it reaches a maximum of $15 million per year.[73]

The vernal pool habitats of the Sacramento Orcutt grass are being degraded and replaced by housing developments.

Arizona

Proposition 303, passed by Arizona voters in 1998, represents a key component of the state's Growing Smarter Act. Under Proposition 303, the State or any of its political subdivisions and certain non-profit organizations may apply to Arizona State Parks for 50/50 matching grants to purchase or lease reclassified State Trust Land, or to purchase the development rights of any State Trust Land. These grants are known as Growing Smarter Grants.

The grants are also available to landowners or lessees to implement conservation-based agricultural management alternatives that provide wildlife habitat or other public benefits that preserve open space. (The administration of these grants to ranchers is currently being challenged under the premise that they are illegal gifts. Many have been issued to ranchers who have reduced their herds because of drought, rather than as a conservation measure.) The $20 million annual appropriation began in fiscal year 2001 and will continue through fiscal year 2011. No more than 50 percent of grant monies per year will be available for projects in any one county. While Phoenix and Scottsdale use sales tax money to meet the required match for Growing Smarter Grants, many Arizona jurisdictions are unable to take advantage of the grants because they do not have a pool of money they can tap into for the purposes of land conservation and they do not have enough bonding capacity. As a result, much of the money set aside by Proposition 303 has not been spent.

SCOTT A. SMITH, MD DNR

Development has destroyed and fragmented most of the bog turtle wetlands in Maryland, making it more dangerous for the turtle to travel between habitats.

California

As a result of two bond referenda passed in 2002, California has the best-funded state programs for green infrastructure protection in the country. These referenda, known as Proposition 40 and Proposition 50, will provide $3.44 billion and $2.6 billion, respectively, for wetlands, habitat, and parks acquisition.[74] California also has several programs, such as the Natural Heritage Preservation Tax Credit, that rely on tax incentives to support conservation.[75]

Colorado

In 1992, Colorado voters approved the creation of the *Great Outdoors Colorado* (*GOCO*) Trust Fund, to be funded by proceeds from the Colorado Lottery. The Fund receives 50 percent of lottery proceeds with a $35 million cap (adjusted for inflation). Since its creation, the fund has distributed almost $290 million for 1,700 projects. Almost 390,000 acres are being preserved in perpetuity; 47,401 acres have been acquired for future state parks and a state wildlife area. Forty-three threatened or endangered wildlife species are the focus of protection efforts though grants awarded to the Colorado Division of Wildlife.[76]

Florida

The Florida Forever land acquisition program is continuing the enormous success of the Preservation 2000 program. Florida Forever has acquired more than 1 million acres in the last 5 years, making it the world's largest conservation land buying program. This program receives about $105 million annually from the sale of Florida Forever bonds. Future funding from the sale of bonds depends on legislative action, but the Florida Forever Program is scheduled to last through 2010.[77]

NATURESERVE

Declines in water quality from urbanization and other land uses are affecting the imperiled Blue Shiner in the Southeastern U.S.

Georgia

In 2003, Governor Sonny Perdue created the Georgia Land Conservation Partnership Advisory Council, which by August 2004 produced a Land Conservation Partnership Plan to address the state's relatively low level of land conservation funds and policies.[78] The Partnership recognizes that Georgia is the fifth richest state in terms of species diversity, including second for number of amphibians, third for freshwater fishes and crayfishes, and seventh for reptiles and vascular plants. However, it is also the fifth fastest growing state in the nation, and from 1992 to 1997, lost over 1 million acres of natural areas and farmland to development.

The Plan aims to increase land conservation efforts through private/public partnerships, with a focus on benefits such as clean and abundant water, clean air, species diversity, cultural identity, and outdoor recreation and education.[79] Recommendations include a wide range of strategies, such as providing conservation incentives to farmers and other stewards of private open space, mitigating wetland loss from highway construction, and increasing funding for high-priority natural areas.[80]

Illinois

The Illinois Department of Natural Resources uses the Natural Areas Acquisition Fund to purchase high quality natural areas and endangered species habitat. Established in 1989 and funded by real estate transfer tax, all sites acquired with the NAAF are listed on the Illinois Natural Areas Inventory. As of 2003, a total of approximately 18,000 acres have been acquired.[81] Also, the Illinois Open Land Trust Act which was enacted in 1999 and ended with the fiscal year 2003, dedicated $40 million annually for purchasing and preserving lands for open space and conservation purposes. Both local governments and the state Department of Natural Resources use the funds to acquire lands, and protected almost 50,000 acres in just four years.[82]

CHICAGO WILDERNESS COALITION

A student examines plants growing in a natural area near Chicago.

Maryland

Maryland has implemented several land acquisition programs, including *Program Open Space*. The program was established in 1969 and has acquired more than 265,000 acres of open space for state parks, local parks, and natural resource areas by using real estate transfer taxes.[83] Other programs include the *Rural Legacy* program, which has a goal of protecting up to 200,000 acres by 2011, and the *GreenPrint* program, which was established in 2001 to identify and conserve the state's green infrastructure.[84] Maryland also has an *Agricultural Land Preservation* program that purchases development rights. The program has protected over 200,000 acres since it began in 1977. It is funded primarily through agricultural land transfer taxes and property transfer taxes, with a portion ($7.5 million) coming from the *Rural Legacy* funds.[85] Despite the success of Maryland's programs, they have been decimated by the current administration, which lacks a commitment to these programs. Over 75 percent of dedicated funds have been diverted to other budget items, grinding land preservation in Maryland to a halt.

Minnesota

Created in 1963, the Legislative Commission on Minnesota Resources (LCMR) makes conservation funding recommendations to the full legislature. Four conservation funding sources include the Minnesota Environment and Natural Resources Trust Fund, the Minnesota Future Resources Fund, the Oil Overcharge Money and the Great Lakes Protection Account.[86] The Reinvest in Minnesota (RIM) Critical Habitat Match Program, established in 1986, is also funded by the Environment and Natural Resources Trust Fund and the Minnesota Conservation License Plate program. It encourages acquisition and development of fish and wildlife habitat by matching donations of land or cash from private citizens and organizations.[87]

Washington

The Open Space and Conservation Future Levy is used across the State of Washington. Under this program, a county legislative authority may impose a countywide property tax levy of up to 6.25 cents per thousand dollars assessed value in the county for the purpose of purchasing open space and future development rights. It is collected from all property in the county, both inside and outside cities and towns. Many counties have adopted this levy.[88]

FEDERAL RESOURCES

The Land and Water Conservation Fund (LWCF) is a federal program created in 1964. Congress is authorized to appropriate up to $900 million per year for acquisition of park land and outdoor recreational facilities, with most of these funds coming from royalties paid by companies drilling offshore for oil and gas. Unfortunately, actual appropriations have never come close to reaching the $900 million authorized. In 2004, for example, appropriations for the program were just over one-tenth of the authorized amount ($91.36 million).[89] Nevertheless, over the history of the program, four federal agencies have awarded grants totaling $3.3 billion, and state and local governments have matched these grants on a dollar-for-dollar basis. This total LWCF investment of $6.6 billion has led to the acquisition of 2.3 million acres of park land and 27,000 outdoor recreation facilities.[90]

The goal of the Forest Legacy Program (FLP) is to conserve forestland through acquisition of private land or through the purchase of conservation easements that restrict development but allow forest practices. The landowner retains ownership of the land, and although land enrolled in the program can never be developed, the landowner can continue to manage the forest for timber production and other such income generating uses. In addition, FLP conserves open space, scenic lands, wildlife habitat and clean water. It also ensures continued opportunities for outdoor recreational activities such as hunting, fishing, and hiking. The program has conserved over 600,000 acres of environmentally important, working forestland. With its requirement of 25 percent non-federal matching funds, the program leverages state and private dollars to complement federal money.[91]

JOHN AND KAREN HOLLINGSWORTH/ USFWS

Federal Land and Water Conservation Funds have helped make possible projects like this national wildlife refuge outside Philadelphia.

One of the most significant laws for wildlife conservation is the Federal Aid in Wildlife Restoration Act, known as the Pittman-Robertson Act. This landmark legislation, adopted in 1934, established an 11 percent excise tax on manufacturers of sporting arms and ammunition. These revenues are distributed to states to implement wildlife conservation programs ranging from management of hunting and fishing programs to habitat protection and restoration.[92] A subsequent law (known as Dingell-Johnson) added excise taxes on sport-fishing equipment for sport fishery conservation.[93] States collectively receive approximately $200 million annually through Pittman-Robertson and another $240 million from Dingell-Johnson.

There are several conservation programs within the 2002 Farm Bill, including the Farmland Protection Program, Wetlands Reserve Program, and the Wildlife Habitat Incentives Program, that help private landowners protect and enhance their natural lands.[94] In addition, other federal grants from the U.S. Fish and Wildlife Service are available to states, local governments, and private landowners. Examples include the Habitat Conservation Planning Land Acquisition and Recovery Land Acquisition grants for state governments wishing to protect endangered species, Private Stewardship Grants for private landowners wishing to benefit endangered species, the North American Wetlands Conservation Fund to protect wetlands and habitat for migratory bird species, and State Wildlife Grants which help states develop and implement Comprehensive Wildlife Conservation Strategies (see Box 4: Biological and Ecological Inventory and Mapping Efforts).[95]

Recommendations for Preserving Green Infrastructure

Our research finds that continued runaway sprawl development threatens many of America's most vulnerable plant and animal species with extinction. However, these losses can largely be avoided if communities take steps to plan for a healthy future. To help with that goal, this report identifies six tools that local governments can employ to develop and implement a comprehensive green infrastructure strategy. These should be used in conjunction with other principles and techniques for wise planning of metropolitan growth:[96]

1. Create and maintain inventories of species and natural resources.
2. Establish regional cooperation to protect natural areas and species.
3. Develop green infrastructure protection plans, with performance goals and measurements.
4. Establish urban growth boundaries or urban service boundaries.
5. Protect critical natural habitats.
6. Build reliable local funding sources for green infrastructure and species protection.
7. To ensure that land designated for development provides the best possible habitat for people, involve citizens in applying the principles of smart growth.
8. Meet the increased market demand for more compact, mixed-use development and walkable communities.
9. Inventory underutilized land (e.g., parking lots, vacant properties, brownfields, low-density commercial development) and target them for redevelopment.

Beyond these nine tools for local governments, we have identified steps that citizens, as well as local, state, and federal governments can take to protect the nation's natural areas:

For Citizens:

- Build diverse coalitions to promote better land use practices and a better quality of life in your region. Agree upon a common set of objectives and a campaign plan.
- Help educate government officials and fellow citizens about your region's native species and habitats and the benefits they provide.
- Work to elect government officials who have demonstrated a commitment to protecting green infrastructure.
- Work on campaign finance reform to ensure that developers and road builders do not exert undue influence on the political process.

- Participate in the transportation planning process through the Metropolitan Planning Organization (MPO) and assert that future transportation projects are planned with adequate consideration for native species and habitat preservation.
- Participate in land use planning processes and insist that habitat and open space needs be addressed for all communities.
- Defend habitat protection laws such as the Endangered Species Act when they are debated in federal and state legislatures.

For Local Governments:

- Ensure that the green infrastructure strategy is well integrated with transportation, housing and other elements of the region's land use plans.
- Partner with your state and federal fish and wildlife agencies in developing and implementing regional and statewide conservation strategies.
- Support early and meaningful citizen participation in planning and development decisions, such as through architectural design charrettes and regional visioning.
- Conduct inventories of vacant and underutilized lands and properties; develop strategies to redevelop these to meet demands for growth.

For State Governments:

- Update the state growth management law to encourage the use of statewide Comprehensive Wildlife Conservation Strategies in local land use and transportation planning.
- Ensure that state wetlands law and other natural resource protection laws are enforced to protect critical and sensitive areas.
- Incorporate state natural heritage data into infrastructure and resource planning efforts, and ensure adequate support for these biological inventory efforts.
- Assist regional and local governments with the mapping of natural resources and setting priorities for protection.
- Provide funding for regional green infrastructure planning and protection.
- Enact policies to at least level the playing field for smart growth approaches for a wide range of development opportunities.

For Federal Government:

- Ensure that the Endangered Species Act and Clean Water Act are fully funded and enforced to protect critical species and sensitive areas threatened by sprawl.
- Increase funding for State Wildlife Grants, so states can develop and implement effectively their Comprehensive Wildlife Conservation Strategies, and provide funding for regional and local governments to protect green infrastructure.
- Update the federal surface transportation law to require that metropolitan planning organizations integrate transportation planning with green infrastructure planning.
- Update the Census of Local Governments to include data gathering on green infrastructure protection efforts.

Data Sources and Methodology

To assess the extent to which sprawling development threatens the nation's wildlife heritage, this study relies on several data sources:

1. Population data from the U.S. Census and land use data from the Natural Resources Inventory (NRI) of the U.S. Department of Agriculture (USDA), together are used to estimate the density of recent development for each U.S. county and metropolitan area.

2. Population projections from Woods & Poole Economics, Inc., which when combined with estimates of recent development density, give us the amount of land that would be consumed by development through 2025 for each U.S. county and metropolitan area.

3. Rare and endangered species data from NatureServe and its natural heritage member programs, which along with projections of land conversion to urban uses, tell us how many imperiled species are potentially threatened by development within metropolitan areas and their constituent counties.

Data Sources

USDA's Natural Resources Inventory

The U.S. Department of Agriculture's Natural Resources Inventory (NRI) is a spatial survey conducted every five years. It includes data on major categories of land use for non-federally owned lands, some 75 percent of the country's land base. NRI captures data from statistically sampled locations on land use, land cover, soils, water bodies, and other natural features.

Samples are taken for all counties and parishes of the 50 states. Data for the 1997 NRI were collected for about 800,000 sample points, using photo-interpretation and other remote sensing methods. The 1997 NRI database contains data for four points in time (1982, 1987, 1992, and 1997) that are comparable and consistent, and that can be used in year-to-year comparisons.

In the NRI, lands are assigned to the urban and built-up category if they have the following land uses or land covers: residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; small parks (less than 10 acres) within urban and built-up areas; and highways, railroads, and other transportation facilities if they are surrounded by urban areas. Also included are tracts of less than 10 acres that do not meet the above definition but are completely surrounded by urban and built-up land.

Washington, DC and many independent cities (most in Virginia) are incorporated into the NRI county totals. Certain urban counties (e.g., Denver County, CO) are combined with neighboring suburban counties (e.g., Adams County, CO). Data from other sources had to be aggregated for these counties and county equivalents to produce a consistent dataset.

Woods & Poole's Population Projections

The Woods & Poole Economics, Inc. database contains more than 900 economic and demographic variables for every county in the United States. The database includes detailed population data by age, sex, and race; employment and earnings by major industry; personal income by source of income; retail sales by type of business; and data on the number of households, their size, and their income. All of these variables are projected for each year through 2025.

The projection method used by Woods & Poole avoids a common pitfall. City or county growth projections are often made without regard for potential growth in surrounding areas or other areas of the U.S. Woods & Poole links counties together to capture regional flows and constrains the results to previously determined U.S. totals.

The method used by Woods & Poole to generate county projections proceeds in four steps. First, forecasts are made of total U.S. personal income, earnings by industry, employment by industry, population, inflation, and other variables. Then, the country is divided into 172 Economic Areas (EAs) as defined by the U.S. Department of Commerce, Bureau of Economic Analysis, and for each EA, a projection is made of employment, using an "export-base" method; in some cases, employment projections are adjusted to reflect the results of individual EA models or exogenous information about the EA economy. Next, the employment projection for each EA is used to estimate earnings, and employment and earnings together become the principal explanatory variables used to project population and number of households for each EA. For steps two and three, the U.S. projection is the control total for the EA projections. The fourth step replicates steps two and three except that it is performed at the county level, using EA projections as the control totals for the county projections.

NatureServe's Rare and Endangered Species Data

NatureServe and its network of cooperating organizations are the nation's leading source of information about rare and endangered species and threatened ecosystems. The NatureServe network includes 74 independent natural heritage programs and conservation data centers throughout the Western Hemisphere staffed by more than 800 scientists, and information specialists. The scientific information compiled by NatureServe is used by conservation groups, government agencies, corporations, and academia to make decisions about managing natural resources.

NatureServe maintains conservation- relevant data on more than 50,000 plants and animals in the United States and Canada. This includes all vascular plants, all vertebrate animals, and selected groups of invertebrates. Searchable databases with information on the taxonomy, distribution, status, and conservation requirements of these species are available online at www.natureserve.org.

NatureServe scientists, with the assistance of cooperating organizations, assess the conservation status of these plants and animals to determine their relative vulnerability to extinction. These assessments result in the assignment of a global conservation status rank (G rank or T rank). Species and subspecies with rankings G1/T1 (critically imperiled) or G2/T2 (imperiled) are the focus of this study.

State natural heritage programs in turn develop precisely geo-referenced data on the location, extent, and condition of the population occurrences of these imperiled species, which can in turn be analyzed relative to any size geographic unit. For this study,

NatureServe analyzed its spatial database to generate county FIPS codes for all mainland imperiled (G1 and G2) species and subspecies (T1 and T2), allowing the study to relate land consumption data to species imperilment data.

Methodology

To assess the extent to which sprawling development threatens biodiversity in the U.S., the aforementioned data were analyzed as follows. We focused on the 35 large metropolitan areas (1 million-plus population in 2000) projected to grow the fastest between 2000 and 2025.

Projecting Population Growth

County population projections for 2025 (the latest year in the Woods & Poole series) were aggregated to obtain metropolitan totals. In the period between 2000 and 2025, Woods & Poole projects population growth ranging from 15 percent for Providence (the slowest growing of the 35 metropolitan areas) to 86 percent for Las Vegas (the fastest growing) (see Table 1). These projections apply to Metropolitan Statistical Areas (MSAs) as defined in December 2003 by the U.S. Census Bureau, and to Combined Statistical Areas (CSAs) as defined in December 2003, if made up exclusively of Metropolitan Statistical Areas. CSAs are the closest equivalent of what were formerly called Consolidated Metropolitan Statistical Areas (CMSAs) prior to the 2000 Census.

Deriving Density Measures

Population data from the U.S. Census and land use data from the Natural Resources Inventory were combined to estimate the density of recent development for each county and metropolitan area in the United States (see Table 1). Population densities in 1982 (beginning of the NRI series) and 1997 (latest year in the series) were computed by dividing estimated county and metropolitan populations by NRI estimates of land in the "urban and built-up" category. The density of new development between 1982 and 1997 was computed by dividing the growth of population during the period by the growth of urban and built-up land area

Projecting Land Consumption

The projected increase in population between 2000 and 2025 was divided by the net density of recent development to project an estimate of land area that could be consumed by development between 2000 and 2025 in each of the 35 fastest growing large metropolitan areas and each component county.

These estimates were then compared to the amount of land available for development in each metropolitan area from the 1997 NRI. Land in the following NRI categories was considered available for development: cultivated cropland, uncultivated cropland, pasture, rangeland, and forested land. The same type of analysis of land available versus projected land consumed was undertaken for counties making up the 35 featured metropolitan areas.

Assessing the Threat to Biodiversity

NatureServe's rare and endangered species database was used to identity U.S. species potentially threatened by metropolitan growth. For this study, we extracted distributional data for 4,173 imperiled species or subspecies. Only species occurring on the mainland United States were included in this dataset, excluding the large number of rare and imperiled species unique to Hawaii.

Since the database reports the FIPS codes of each county in which a species has been found, plus the number of occurrences of the particular species in that county, the prevalence of species within metropolitan areas can be assessed by aggregating counties into metropolitan areas. The prevalence of species outside metropolitan areas can be assessed in a like manner. All imperiled species in the NatureServe database were thereby grouped into three classes:

1. found only in metropolitan areas
2. found only in non-metropolitan areas
3. found in both metropolitan and non-metropolitan areas

For the purposes of this report, we looked at the number of species found exclusively in metropolitan areas, as well as those present in both metropolitan and non-metropolitan areas. Sixty percent of all imperiled species are found in one or more U.S. metropolitan areas, and 31 percent are found exclusively within metropolitan areas.

The same kind of sorting process was performed for the 35 featured metropolitan areas and their component counties. These metropolitan areas collectively have 29 percent of all imperiled species within their boundaries, and 13 percent are found exclusively within their boundaries.

APPENDIX A: Survey Questions

1. **What planning functions are performed by your organization?**
   a. Transportation-only
   b. Other planning elements related to green infrastructure

2. **Amount of open space within the county (complete as many as you can):**
   a. Total open space acreage
   b. Percent of total county acreage
   c. Per capita in acres
   d. Amount designated as "natural areas"
   e. Amount designated as parks and recreation

3. **Has the county designated any new natural areas where habitat protection is a purpose within the last 5 years?**

4. **Do you have an existing inventory of natural resources?**

5. **Does your organization have a Geographic Information System "GIS" or similar mapping software allowing evaluation of green infrastructure?**
   a. If so, how is it used?
   b. If not, is this technology available at the local level or through a different regional entity?

6. **Please identify which of the following habitat protection tools, if any, are implemented by your jurisdiction:**

   ___Urban growth boundary/ Urban services boundary.

   ___Zoning or subdivision regulations requiring open space protection in new developments (If so, what percentage of land must be protected? _____ %)

   ___Mandatory cluster development

   ___Prohibitions against development or setbacks in wetlands, floodplains, or riparian zones (in addition to any federal or state prohibitions)

   ___Prohibitions against development in wildlife corridors or other environmentally sensitive lands (in addition to any federal or state prohibitions)

   ___Transfer of development rights to protect environmentally sensitive lands

   ___Other. Please describe:

7. **Does your jurisdiction have dedicated funding (e.g., sales tax, bond money, real estate transfer tax funds, or mandatory developer impact fee) earmarked for purchases of environmentally sensitive land, either fee simple title or conservation easements?**

___**Yes.** Local government's own sources of dedicated funds

___**Yes.** Dedicated state funds passed through to local government

___**No**

___If yes, approximately how much dedicated $ is earmarked each year for purchases of environmentally sensitive land? _____

APPENDIX B: Metropolitan Area Data

Metropolitan area	Projected population growth (2000-2025)	Growth rate (2000-2025)	Average population density of new development (persons per sq. mile, 1982-1997)	Green infrastructure lands (sq. miles, 1997)	Estimated land consumed by future development (sq. miles, 2025)	Projected % of green infrastructure lands consumed by future development	Number of imperiled species	Sampling of imperiled species
Atlanta-Sandy Springs-Marietta, GA MSA	2,074,226	48%	1,290	5,545	1,608	29%	35	White Fringeless Orchid, Amber Darter, Oval Pigtoe Mussel
Austin-Round Rock, TX MSA	1,035,379	82%	2,122	3,410	488	14%	33	Jollyville Plateau Salamander, Golden-cheeked Warbler, Texas Wild-rice
Baltimore-Towson, MD MSA	689,103	27%	1,286	1,563	536	34%	9	Torrey's Mountain Mint, Sandplain Gerardia, Dwarf Wedgemussel
Birmingham-Hoover, AL MSA	250,546	24%	515	4,370	487	11%	80	Alabama Snow-wreath, Black Warrior Waterdog, Alabama Canebrake Pitcher-plant
Charlotte-Gastonia-Concord, NC-SC MSA	708,334	53%	954	2,128	743	35%	13	Dwarf Aster, Schweinitz's Sunflower, Carolina Creekshell
Chicago-Naperville-Michigan City, IL-IN-WI CSA	1,907,017	20%	1,309	5,475	1,457	27%	15	Karner Blue Butterfly, Lakeside Daisy, Kirtland's Snake
Cincinnati-Middletown, OH-KY-IN MSA	458,265	23%	805	3,310	569	17%	11	Clubshell, Fanshell, Virginia Mallow
Columbus, OH MSA	567,698	35%	1,283	2,987	442	15%	4	Northern Riffleshell, Spotted Darter, Rayed Bean
Dallas-Fort Worth-Arlington, TX MSA	2,723,075	52%	1,910	6,389	1,426	22%	9	Black-Capped Vireo, Interior Least Tern, Brazos River Yucca
Denver-Aurora-Boulder, CO CSA	1,111,636	45%	1,878	5,656	592	10%	29	Preble's Meadow Jumping Mouse, Ute Ladies' Tresses, Greenback Cutthroat Trout
Houston-Baytown-Sugar Land, TX MSA	2,121,049	45%	1,482	6,148	1,431	23%	20	Attwater's Greater Prairie Chicken, Houston Toad, Texas Windmill Grass
Indianapolis, IN MSA	544,262	36%	1,090	2,932	499	17%	7	Indiana Bat, Northern Riffleshell, Kirtland's Snake
Jacksonville, FL MSA	526,147	47%	1,344	2,179	391	18%	30	Leatherback Turtle, Red-cockaded Woodpecker, Chapman Rhododendron
Kansas City, MO-KS MSA	517,494	28%	1,266	6,324	409	6%	4	Pallid Sturgeon, Mead's Milkweed, Western Prairie White-fringed Orchid
Las Vegas-Paradise, NV MSA	1,194,167	86%	6,163	391	194	50%	97	Southwestern Willow Flycatcher, Devil's Hole Pupfish, Alkali Mariposa Lily
Los Angeles-Long Beach-Riverside, CA CSA	4,355,506	26%	5,415	6,732	804	12%	219	Least Bell's Vireo, Laguna Beach Dudleya, Pacific Pocket Mouse
Louisville, KY-IN MSA	267,301	23%	329	3,232	813	25%	33	Illinois Woodsorrel, Indiana Bat, Spotted Darter

APPENDIX B: Metropolitan area data (continued)

Metropolitan area	Projected population growth (2000-2025)	Growth rate (2000-2025)	Average population density of new development (persons per sq. mile, 1982-1997)	Green infrastructure lands (sq. miles, 1997)	Estimated land consumed by future development (sq. miles, 2025)	Projected % of green infrastructure lands consumed by future development	Number of imperiled species	Sampling of imperiled species
Memphis, TN-MS-AR MSA	340,015	28%	625	3,567	544	15%	5	Ovate Catchfly, Interior Least Tern, Southern Hickorynut
Miami-Fort Lauderdale-Miami Beach, FL MSA	2,234,207	44%	3,383	1,104	660	60%	68	Florida Panther, Johnson's Sea Grass, Florida Royal Palm
Minneapolis-St. Paul-Bloomington, MN-WI MSA	1,108,359	37%	1,197	4,032	926	23%	10	Higgins Eye Mussel, Red Veined Prairie Leafhopper, Karner Blue Butterfly
Nashville-Davidson--Murfreesboro, TN MSA	608,015	46%	783	4,661	776	17%	43	Nashville Crayfish, Tennessee Coneflower, Smallscale Darter
Oklahoma City, OK MSA	278,178	25%	607	4,698	458	10%	4	Black-capped Vireo, Arkansas River Shiner, Arkansas River Speckled Chub
Orlando, FL MSA	1,057,960	64%	1,684	2,548	628	25%	34	Florida Sanhill Crane, Florida Black Bear, West Indian Manatee
Phoenix-Mesa-Scottsdale, AZ MSA	2,241,585	68%	4,982	7,165	450	6%	32	Arizona Cliff Rose, Desert Pupfish, Sonoran Pronghorn
Portland-Vancouver-Beaverton, OR-WA MSA	898,564	46%	2,282	3,433	394	11%	45	Willamette Valley Daisy, Oregon Chub, Oregon Spotted Frog
Providence-New Bedford-Fall River, RI-MA MSA	245,209	15%	613	995	400	40%	6	Small Whorled Pogonia, White-bracted Boneset, Coastal Barrens Buckmoth
Richmond, VA MSA	361,564	33%	714	4,587	507	11%	16	Virginia Quillwort, Yellow Lance, Sensitive Joint-vetch
Sacramento--Arden-Arcade--Roseville, CA MSA	1,024,526	57%	3,054	2,830	336	12%	47	Sacramento Orcutt Grass, California Tiger Salamander, California Red-legged Frog
San Antonio, TX MSA	780,968	45%	1,930	6,381	405	6%	23	Concho Water Snake, Comal Springs Riffle Beetle, Big Red Sage
San Diego-Carlsbad-San Marcos, CA MSA	1,200,733	42%	4,336	1,757	277	16%	99	Otay Mesa Mint, Arroyo Toad, Light-Footed Clapper Rail
San Jose-San Francisco-Oakland, CA CSA	2,036,375	29%	3,988	6,393	511	8%	257	Santa Cruz Long-Toed Salamander, Presidio Manzanita, Mission Blue Butterfly
Seattle-Tacoma-Bellevue, WA MSA	1,098,893	36%	2,323	2,721	473	17%	10	Stalked Moonwort, Salish Sucker, Golden Paintbrush
Tampa-St. Petersburg-Clearwater, FL MSA	931,915	39%	1,609	1,445	579	40%	26	Gulf Sturgeon, Florida Golden Aster, Tampa Vervain
Virginia Beach-Norfolk-Newport News, VA-NC MSA	414,231	26%	1,360	1,528	305	20%	13	Harper's Fimbristylis, Viginia Least Trillium, Schweinitz's Sunflower
Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	1,788,506	37%	2,089	3,712	856	23%	18	Dwarf Wedgemussel, Small-Whorled Pogonia, Northeastern Beach Tiger Beetle

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[7] Imperiled species are those with a global conservation status rank of G1 (at very high risk of extinction due to extreme rarity—often 5 or fewer populations, very steep declines, or other factors) or G2 (at high risk of extinction due to very restricted range, very few populations—often 20 or fewer, steep declines, or other factors).
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