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Harnessing Technology for Land Conservation: Reflections on the Evolving Role of Geographic Information Services and Technology in Advancing the Land for People Mission of The Trust for Public Land

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Will Rogers
The Trust for Public Land

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Abstract

By developing and using sophisticated mapping and spatial analysis tools, The Trust for Public Land (TPL) has been able to dramatically increase its effectiveness in delivering its land-for-people parks and conservation mission. Geographic Information Systems (GIS) and related analytical tools have not only enabled the organization to be more responsive to the communities it serves; these tools have also enabled the organization to play a stronger leadership role in advocating for parks and conservation and the ways in which parks can help address fundamental societal problems such as equity, community health and climate change. The following paper tracks the development and use of these tools at TPL since their introduction some two decades ago. It addresses their impact on The Trust for Public Land as well as on the people and communities it serves in its parks and conservation work, from inner cities to rural and remote wildlands. This paper is written from my perspective as: the organization's recently retired leader and champion of this technology from 1998-2018; and as the Kingsbury Browne Award Recipient and Fellow for 2017-2018. I conclude with thoughts about what other challenges these tools might help us tackle and what additional conservation opportunities they might open up. Maps and analyses provided throughout the paper illustrate TPL's GIS tools and the evolution of our GIS/Planning function.

About the Author

William ("Will") Rogers is President Emeritus of The Trust for Public Land (TPL), a national organization based in San Francisco, CA, which creates parks and protects land for people, ensuring healthy, livable communities for generations to come. Rogers was TPL's president from 1998 to 2018, having joined the organization in 1991 as the director of California, Hawaii, and Nevada operations. Prior to joining The Trust for Public Land, he managed urban projects for a Chicago-based real estate development company, managing both new construction and the rehabilitation of vacant industrial buildings for commercial, office, and residential use. Before that, he was a commercial beekeeper, founding and managing a honey production company in Bogotá, Colombia.

Rogers is a nationally recognized advocate for land conservation and has given major addresses or interviews to the Urban Land Institute, the National Smart Growth Conference, the National Brownfields Conference, and Talk of the Nation, among others.

Rogers is a graduate of Stanford University and received his MBA from Harvard University. He lives with his family in Kensington, California.

Will Rogers was assisted in the preparation of this paper by Breece Robertson, TPL Vice President and Director of Planning and Geographic Information Systems (GIS). For comments or questions regarding this paper, Breece can be reached at breece.robertson@tpl.org, by telephone at her office at (505) 988-5977, or by mail at The Trust for Public Land, 607 Cerrillos Road, Suite F-1, Santa Fe, New Mexico 87595.

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Executive Summary

By developing and using sophisticated mapping and spatial analysis tools, The Trust for Public Land (TPL) has been able to dramatically increase its effectiveness in delivering its land-for-people parks and conservation mission. Geographic Information Systems (GIS) and related analytical tools have not only enabled the organization to be more responsive to the communities it serves; these tools have also enabled the organization to play a stronger leadership role in advocating for parks and conservation and the ways in which parks can help address fundamental societal problems such as equity, community health and climate change. The following paper tracks the development and use of these tools at TPL since their introduction some two decades ago. It addresses their impact on The Trust for Public Land as well as on the people and communities it serves in its parks and conservation work, from inner cities to rural and remote wildlands. This paper is written from my perspective as: the organization's recently retired leader and champion of this technology from 1998-2018; and as the Kingsbury Browne Award Recipient and Fellow for 2017-2018.[1] I conclude with thoughts about what other challenges these tools might help us tackle and what additional conservation opportunities they might open up. Maps and analyses provided throughout the paper illustrate TPL's GIS tools and the evolution of our GIS/Planning function.

Mission and Strategies: The Early Days at TPL

At the heart of TPL's "land for people" mission is the belief that a connection with nature is a fundamental human need, and that access to nature, nearby and remote, should be a basic human right. Inherent in that mission is a commitment to equity and close-to-home access to nature for those without the resources or mobility to connect with places wild and remote. From day one, TPL's work encompassed both inner cities and wilderness and the lands between. Founded in 1972 at a time when conservation was heavily focused on habitat protection and protecting nature <u>from</u> people, TPL took a very different approach. A founding tenet of the organization was that people needed to connect with nature not only for their own health and well-being but, through their connection and appreciation of nature, to foster conservationism and a land ethic. Simply put, without that connection, there would be no constituency for wild nature or our fellow species.

Author Robert Michael Pyle in his book, *The Thunder Tree*, wrote about growing up in the suburbs on Denver's edge and discovering the wonder of nature while playing along the High Line irrigation ditch. Of the importance of our connection, he writes, "Those who care, conserve.

[1] The Kingsbury Browne Award and Fellowship was presented to Will Rogers in October 2017 at the Land Trust Rally in Denver, Colorado by the Land Trust Alliance and the Lincoln Institute of Land Policy

Those who don't know, don't care. What's the extinction of the condor to a child who has never known a wren?"

In The Trust for Public Land's early years, we were primarily a conservation land acquisition intermediary between willing-seller private landowners and the public agencies, communities and other non-profits who wanted to see those lands protected. The organization's focus on land for people, from urban to rural, was very responsive to agency and community agendas. We prioritized the lands the public cared about and wanted to protect, with public access being a strong element. Unlike the work of organizations like The Nature Conservancy, who used science-based analysis to identify and protect critical habitat for biodiversity, the Trust's land protection work was directed at "human habitat" and driven by the public's desire to see special places protected – or to prevent private inholdings within existing public lands from being developed. That approach was to expand over time, thanks in large part to the power of GIS and spatial analysis, allowing the Trust to be both responsive and proscriptive in its mission to create healthy human habitat. But early on what we had to tell our story were simple maps.

Maps

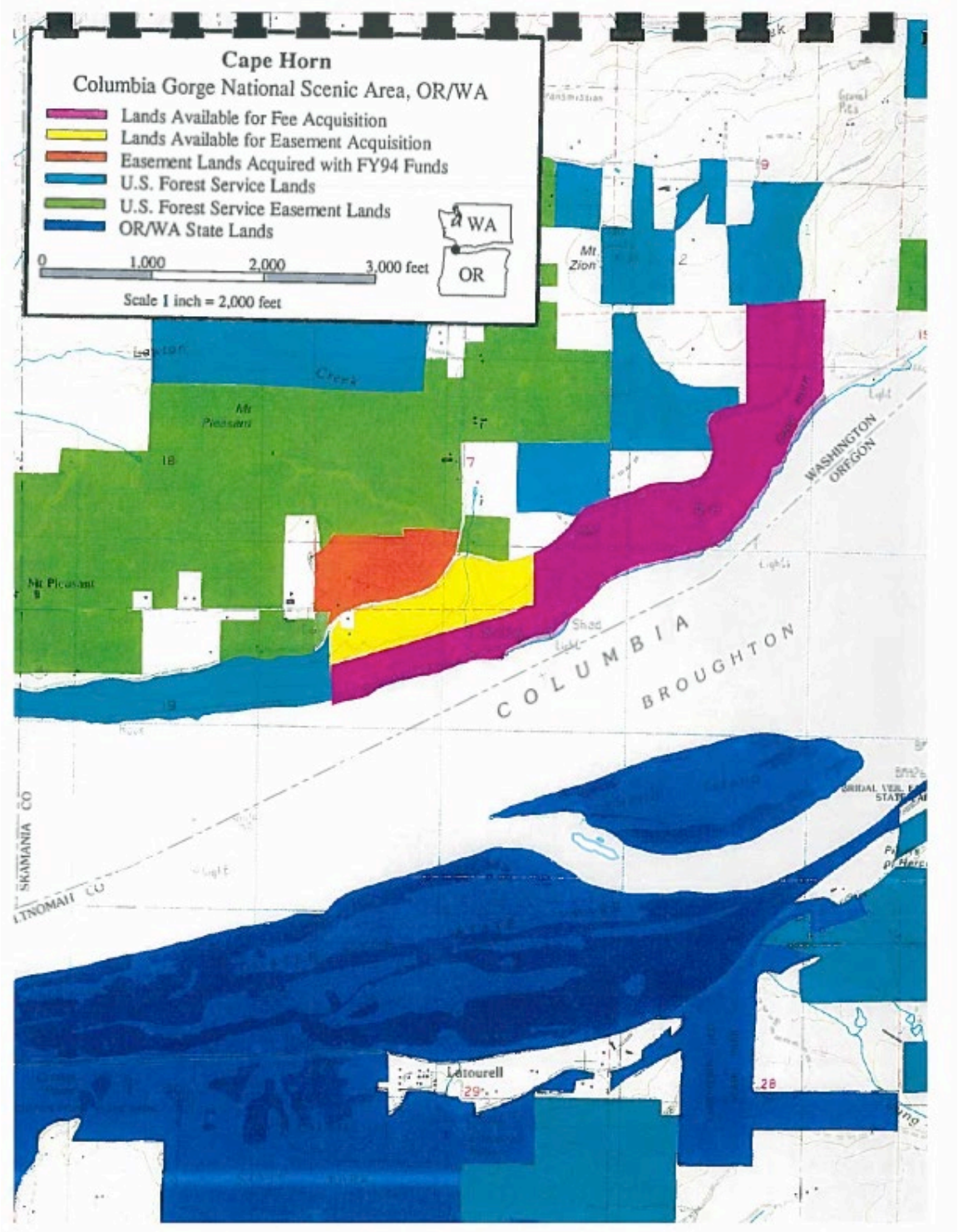
In the late 1980's maps were already a powerful conservation tool. They were essential in our efforts to identify critical habitat threatened by development, recreation lands and open space facing similar challenges, and to help the public know how and where to access public lands. Organizations from The Nature Conservancy to the Bay Area's Greenbelt Alliance – and later GreenInfo Network – were using maps to raise awareness about both threats and opportunities.

In those early days at TPL, maps served both for orientation and story-telling. With place-based work, it's essential to describe the place – it's location, geographic elements and other qualities. Maps – especially topographic maps – provided important information about both the location and basic geography of a property. When combined with photographs, increasingly sophisticated maps allowed us to make even stronger and more persuasive cases for conservation.

With some notable exceptions, most of the funding that goes into TPL's conservation acquisitions is public: federal, state or local – and often a combination of all three. Maps and accompanying photos were particularly useful when working with public land agencies or lobbying for federal, state and local public acquisition funding. It was very helpful to be able to show a federal appropriator where in her district a conservation property was located, show federal forest supervisors the private (and developable!) inholdings within their jurisdiction, or demonstrate to a parks director how a property could expand or improve access to an existing facility or neighborhood.

But mapping at that time, with the tools and technology available to TPL and other conservation organizations, was clunky (*Figure 1*). The maps were not easily formatted, manipulated or modified. Making them look good and adding captions and information was a labor of love. And there was a lot we wanted to know and show that was simply too difficult to capture with the existing technology. For example, showing the location of all of a region's (or the nation's) conservation easements, was (and is) critical to understanding local conservation needs and progress. That was something which, in TPL's early days, was very difficult to do.

Figure 1: Pre-GIS “Dumb Map”



Throughout the last three decades of the twentieth century, TPL was often able to capture in a spreadsheet format important conservation data at the parcel level. While that tabular format was useful to researchers studying state and local conservation funding measure successes, it was not a simple, compelling or easily searchable way to communicate results or tell the story of a powerful national movement to the broader public.

A Different Kind of Map – Parks Access in Los Angeles

It wasn't until 2001-2002 that TPL began to marry mapping/GIS with analysis and communication, and in the process began establishing a centralized mapping/GIS group. We called that early work "Conservation Vision." It combined community engagement with mapping and GIS, both as a way to communicate existing parks and conservation areas, and as a way to capture community priorities. An early example was our first parks access analysis for the City of Los Angeles.

Our LA office was trying to determine where it should work while, at the same time, raising awareness about the lack of parks access with our public partners in the Parks and Recreation Department and the Mayor's office. We did a simple analysis of both the City and County of Los Angeles (see *Figures 2 and 3*), with the goal of understanding who did and did not have a park within a half-mile radius of where they lived. We discovered that over 60% of Angelinos did not have close-to-home parks access. By adding demographic layers to our analysis, we became better able to visualize the on-the-ground distribution of income levels, population density and other factors. In effect, we used maps and GIS analysis to tell the story of park equity and help our partners understand where they needed to direct their park-making efforts.

Figure 2: Early Park Equity Analysis – City of Los Angeles

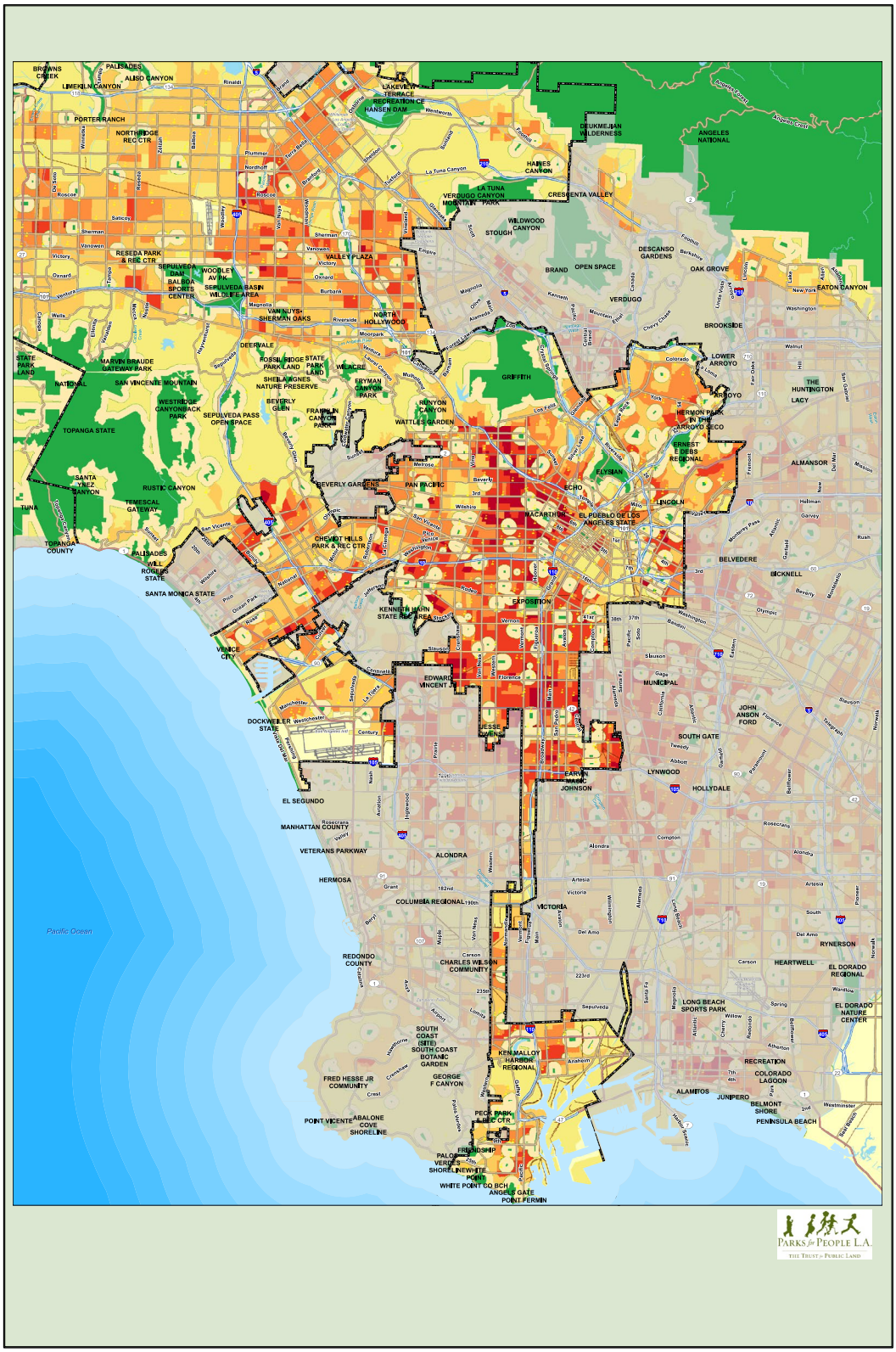
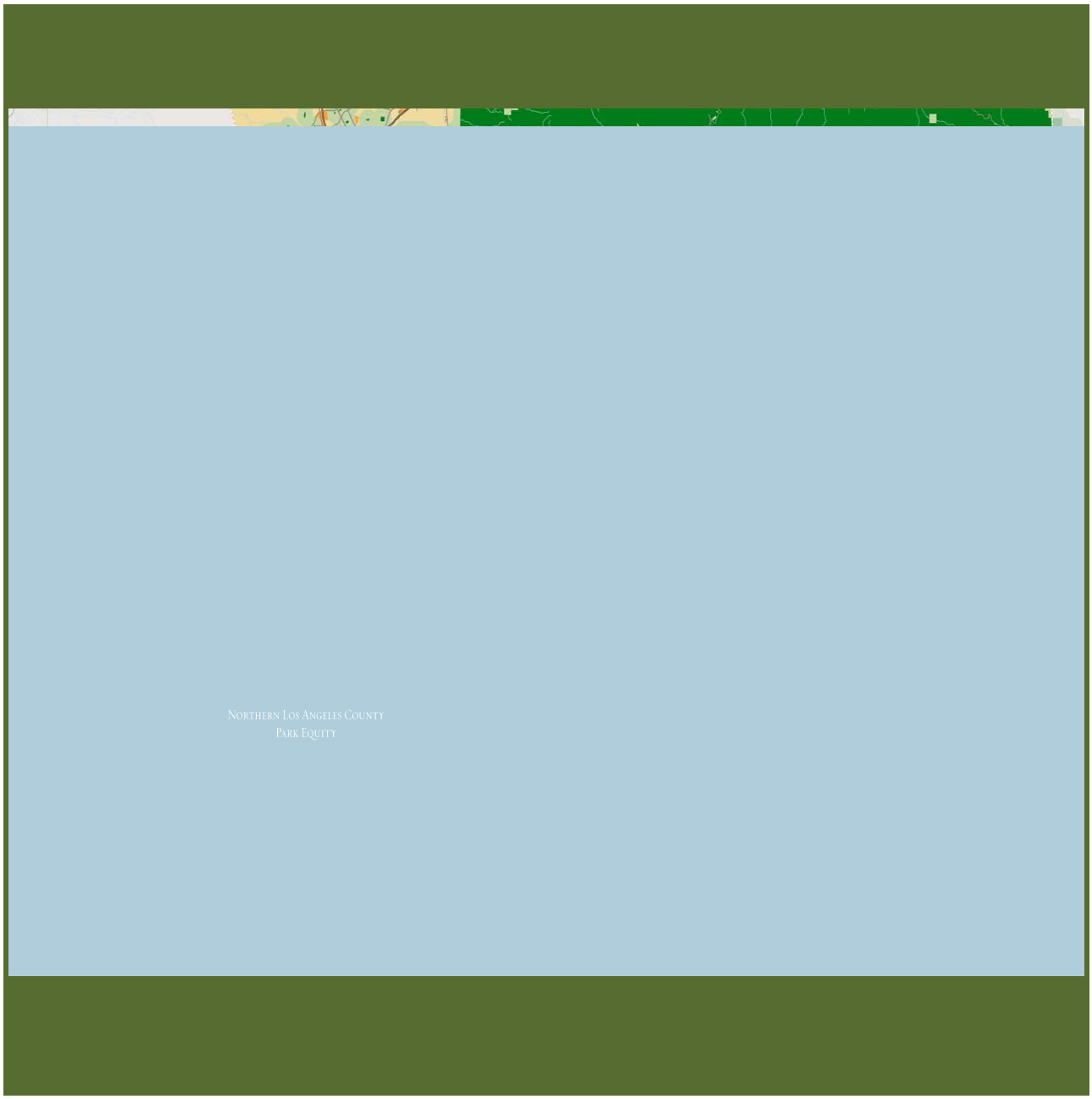


Figure 3: Early Park Equity Analysis – County of Los Angeles



The 10-minute walk analysis and a suite of related tools came into their own years later when we created a GIS model that calculated true walking distance to a given park's entrance. This novel analysis became the parks access cornerstone of our ParkScore urban parks rankings for America's 100 most populous cities, as well as the basis for our national "10-minute walk to a great park" standard and campaign.

While the Los Angeles work marked an important first step in our GIS work, it was with the Trust's planning work for King County, Washington, in 2003-04 that GIS really demonstrated to TPL and its clients its value as a key conservation tool and its potential to become one of TPL's core areas of expertise.

The King County Greenprint: Stepping into Our GIS Future

It seems fitting that our drive to be responsive to communities as they wrestled with their conservation vision and commitment led to our first in-depth and successful application of GIS technology. And it's not surprising that the opportunity arose due to concerns over limited conservation funding and how best to spend it.

Nine times out of ten, funding is the constraining factor for conservation. From the National Park Service to the local parks and recreation department, there is never enough funding to go around. And when some amount of funding does materialize, knowing where to spend it to get the most bang for one's conservation buck is always a challenge. That challenge is compounded by a wide range of public conservation values that might be addressed with the new money. Such conservation values include, among others: watershed protection; farmland protection; trail development; habitat protection; hunting, fishing and other recreational access; and shoreline access and protection.

This combination of scarce resources and conflicting public needs and values has always presented difficulties for conservation nonprofits trying to help and be responsive to state, county and municipal partners, and to the communities they serve. We were hungry for a better way to work with communities toward a shared conservation vision that could lead to public (or private) funding and ultimately to the acquisition of the properties that best meet that vision.

To try to meet this challenge, we jumped into GIS technology with both feet and, with key partners, developed the tools and process that we called "Greenprinting" or "Conservation Vision." Our experiment with King County would ultimately lead TPL to develop a professional GIS team that would go on to create a suite of GIS tools. Those tools in turn enabled TPL and its partners to bring increased focus and effectiveness to conservation.

The Trust for Public Land had long worked with King County on land acquisition from the outskirts of Seattle and beyond. The County Administrator, Ron Sims, was a strong advocate for parks, conservation, and habitat (especially salmon habitat!). When it came to parks, Ron, having grown up in a park-poor African American community on the south side of Seattle, was adamant about the need for all of the region's communities to have great park systems

Ron and his county departments were the ideal partners with which to experiment with both new tools and a participatory public process. Our shared goal was to come up with a map-based analysis and decision tool that would allow King County to: understand the priorities of its citizenry; leverage the county's limited financial resources to acquire the urban and rural properties that would best meet those priorities; and, ideally, satisfy multiple needs.

To accomplish our goal, we took on several additional partners. One, of particular importance, was to become essential to TPL's future GIS tool development – Esri (the initials for the Environmental Systems Research Institute, founded by Jack Dangermond in 1969). Esri, based in Redlands, California, is described by Wikipedia as "an international supplier of geographic information system (GIS) software, web GIS and geodatabase management application" (see https://en.wikipedia.org/wiki/Esri).

Esri was then, and remains today, the leader in GIS software development. Its tools are used by professionals and the public, alike, as the basis for analysis, planning and spatial communication. We took our partnership and idea to the county and secured their blessing and support.
The best way to describe the tool and process, and Greenprinting in general, is to offer here several passages from our final report to the county, simply called ***Greenprint for King County.***[2] The report accompanied the GIS database and tools that constituted the final work product for the TPL's Greenprint for King County initiative.

First, consider an excerpt from the report's Executive Summary. It emphasizes the need at the time to make a transition to a new, more comprehensive method of devising land conservation strategy – a method which, as is subsequently explained, was enabled by GIS technology that was emerging at the time.

> For over 40 years, the King County region has aggressively pursued land conservation in a forward-thinking manner, as evidenced by the Farmlands Preservation Program's protection of over 13,000 acres of productive farmlands, the creation of over 100 miles of regional trails, Water Ways 2000 protection of significant water resources, and the preservation of over 96,000 acres of forests. A variety of methods were used to achieve this protected network of open space and resource lands, including publicly voted bonds, dedicated revenues such as Conservation Futures Tax, transfer or purchase of development rights and other creative means.
>
> The County needs a comprehensive land conservation strategy, encompassing all of its programs, to address pressing resource conservation issues, such as: species becoming listed under the ESA; population increases; Growth Management Act requirements to reduce sprawl; and global warming induced climate change in the Pacific Northwest. At the same time, the County's financial resources have become increasingly constrained. Directing those limited resources towards the highest land conservation strategies has never been more essential. *The Greenprint for King County* is intended to do that, and to state the case for increasing the financial capacity to conserve critical lands.

[2] The Trust for Public Land, Northwest. *Greenprint for King County,* Prepared for the King County Department of Natural Resources and Parks, Water and Land Resources Division, March 2005. Available at : https://your.kingcounty.gov/dnrp/library/2005/KCR1856/0505_Greenprint.pdf .

The Executive Summary goes on to explain that, based on a series of meetings in 2004 which the Trust for Public Land had with the King County Department of Natural Resources and Parks [DNRP], staff, cities, state agencies, conservation organizations, and key political and community leaders, the Greenprint is based on a "regional conservation vision that reflects a core set of shared conservation values."

The values central to the Conservation Vision, as articulated in the Executive Summary, were: Ecological Health, cited as being "of paramount concern to the majority of the region's citizens and decision-makers"; Cultural and Economic Values, highlighted because "all these special places are part of the local and regional culture that is shared between generations..."; and Connectivity, emphasized because "the value of individual open space and resource land properties is dramatically enhanced when it is part of an interconnected system of trails, parks, greenways, farmland, forests, shorelines, and lands around lakes, rivers, and streams."

Finally, the Executive Summary focuses on "New Analytic Tools," explaining that the GIS model built for the Greenprinting effort served a key role in enabling the comprehensive visioning and analytical process, and that the use of this GIS model would continue to inform the work of the King County DNRP.

> A powerful geographic information systems (GIS) model was created to inform the development of the Greenprint for King County. This GIS model evaluates existing conservation values across the county landscape according to six King County program areas: ecological lands, farm, forest, flood protection, regional trails, and marine shorelines. All maps and statistics contained within the Greenprint for King County reflect a January 2005 GIS model run. It is possible to adjust the GIS model and incorporate different data sets and criteria weights as regional priorities, policies, and information emerges. King County DNRP continues to use this dynamic analytical tool to ensure that limited resources are directed to the highest value lands, so the county can continue to fulfill its mission to be the regional steward of the environment while strengthening sustainable communities.

The amount of time, effort and technological innovation that went into the creation of the new GIS model was remarkable. As noted in Chapter 1 of the report,

> With the introduction of a new GIS platform, ArcView 9, and ModelBuilder software by Esri, it was possible for TPL to build a complex new model to evaluate hundreds of criteria from several dozen data sets and analyze results at the parcel-level throughout King County...The King County Greenprint is one of the first instances in which ArcGIS 9 ModelBuilder has been used to model a landscape as large and complex as King County's greater than 500,000 property parcels.

Illustrations of Greenprint GIS output that show the level of detail we could generate at the time are available in Figures 4 and 5. For a more extensive explanation of the expertise that went into building the model, please see Appendix A to this paper.

Figure 4: Priority Map, King County Greenprint

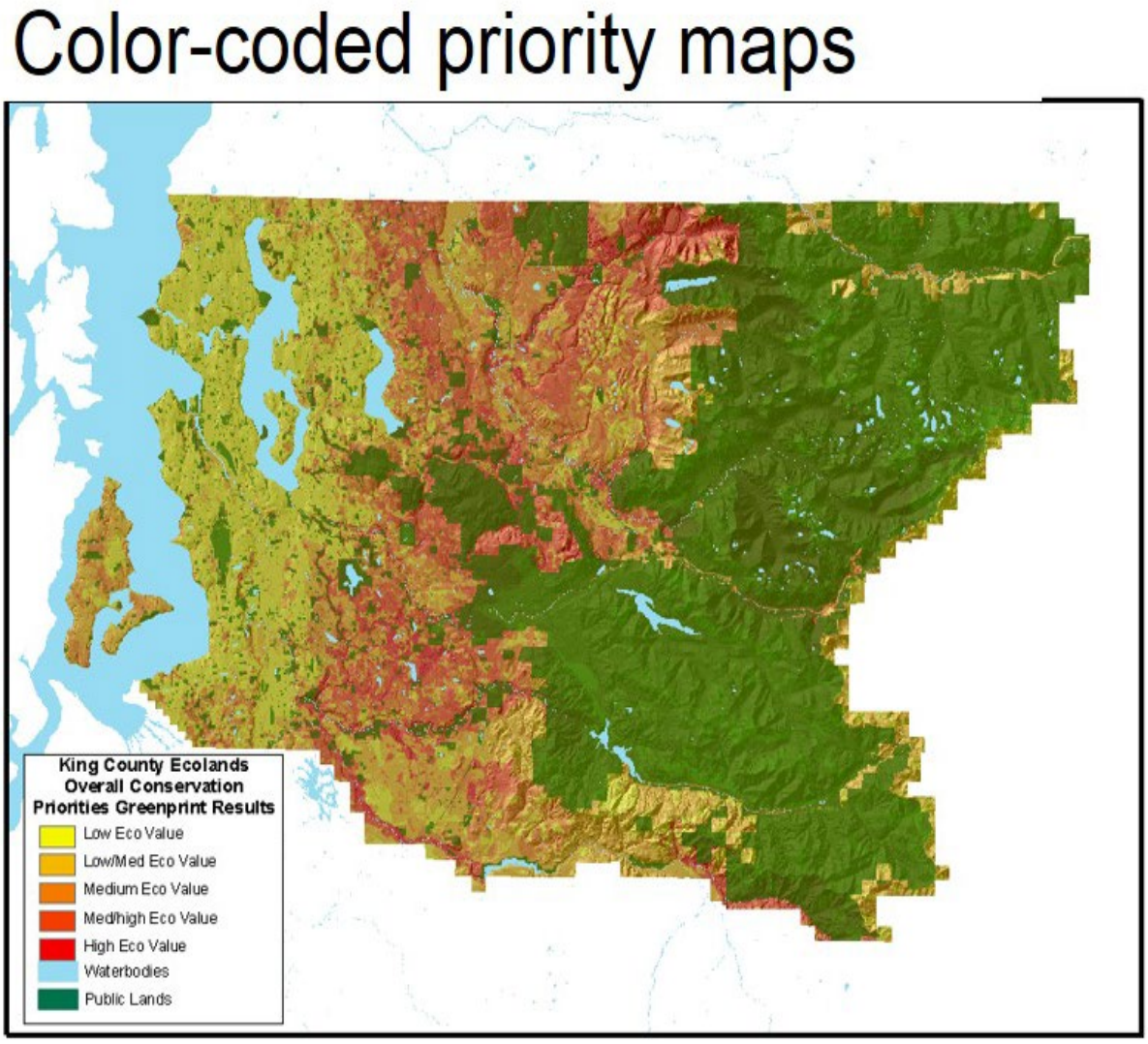
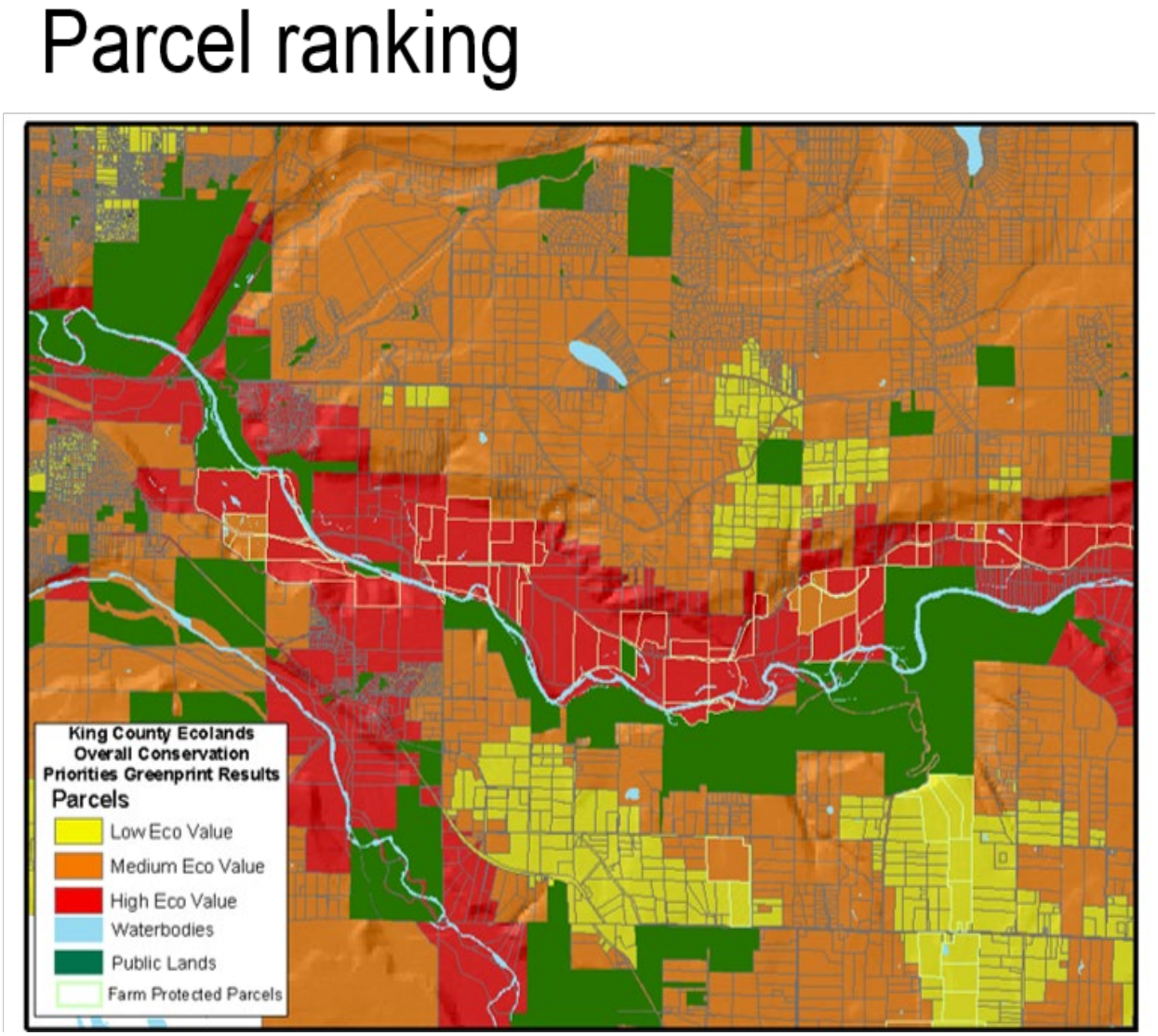


Figure 5: Parcel Priority Ranking, King County Greenprint



The impact of the analysis, and of the existence of the new model, was then, and continues to be, of considerable strategic significance to the professional staff of the King County DNRP. The Greenprint for King County report, published in the spring of 2005, reported that King County DNRP managers were then looking forward to making ongoing use of the model to continue analysis in several areas, including: Acquisition Strategy, Implementation of Salmon Recovery Plans, Maintenance and Operations, Capital Programs, Improving Regulatory Efficiency, and Growth Management.

In addition to its utility to staff, the power of the technology was explicitly recognized by King County political leaders as well. As reported in a contemporaneous TPL article titled "Conservation by Computer," King County Executive Ron Sims reported that previous to the Greenprint project, the county "had no sense of which pieces were the most critical. Now we can think parcel by parcel, from the highest peaks to the bottom of Puget Sound. It is absolutely key to have that capacity because we can answer questions such as 'What land do we need for salmon?' With this tool you can really see and understand the land.... " He went on to explain the decision-making context.

> Decisions have sometimes been made because a particular property had a gallant spokesperson who knew how to work the system and said, 'Save this!' With the Greenprint as a guide, King County will be able to respond appropriately. Sometimes the spokesperson's efforts will be rewarded and sometimes they are going to have to wait because we will be able to judge how the property fits in to the big picture.[3]

It is important to note that this effort in King County has had enduring value, as evidenced by its ongoing use. Nearly fifteen years after the conclusion of the first greenprinting process, King County continues to use some of the data generated by the Greenprint tool as an input in prioritizing and tracking conservation activity. According to Breece Robertson, the lead GIS system designer for the King County project, who now serves as National GIS Director for TPL, that data, as well as new inputs now available, are being used to advance the King County Open Space Initiative, launched in January 2018. The initiative seeks to add an additional 65,000 acres to the total of 190,000 acres protected in King County since 1970.[4]

It is also important to note that the King County greenprinting experience has been widely transferable. Subsequent to the King County experience, TPL has conducted an additional 44 Greenprint analyses in communities across the nation. The greenprints which followed benefitted from what we learned in King County, including the following.

- We learned that without getting the right people in the room (and listening to them!), the analysis and tool would get neither deep traction nor engaged use. We came to appreciate that the process -- in particular identifying a representative group of community leaders to help steer the project -- was every bit as important as the technology. For example, it

[3] Sandra Tassel, "Conservation by Computer," in "Land + People" circa 2005 available at https://www.tpl.org/magazine#sm.0000shya0x4rid23wa82om8ohgqrj.

[4] For more information on the King County Land Conservation Initiativie, see https://kingcounty.gov/services/environment/water-and-land/land-conservation.aspx

was important for us, early on in the process, to tease out key conservation values. We were able to use these values to guide a parcel-by-parcel analysis that was the basis of several public charrettes that relied heavily on the GIS technology itself.

- We learned that simple advances in the GIS software and its ability to allow rapid reiterations could significantly improve the public participation process and outcome. For example, the King County experience led us look for better ways to allow charrette participants to immediately see the significance of choices they were making. As a result, subsequent greenprinting efforts incorporated hand-held voting pads to participants allowing the GIS system to reflect and display, in real time, the evolution of group priorities, and how changing priorities changes the maps that identify conservation acquisition targets.

- We also learned that the output Greenprint was well-suited to be adapted over time. We had created a dynamic greenprinting tool and methodology that King County could share with community members. Together, they could generate ongoing analyses without the need for ongoing TPL support. The ability for our partners to own and use the tool to update data, measure progress and continue to define priorities without our involvement was an attractive feature that is consistent with TPL's long-standing commitment to develop and share new conservation tools. In sum, we learned from our first Greenprint effort that, enabled by new GIS technologies, we had created a tool that, with the right preparation, participants, political savvy, data and project management, could provide enormous benefit for the communities with whom we work. In combination, the people, the technology and the process led to a positive outcome for the entire process.

GIS Inside TPL: Developing Our Program

In hindsight, it is clear that the King County project helped kick TPL into a much higher gear with mapping and GIS. As noted above, we have done over 40 city, county and regional greenprints and hundreds of other more focused conservation analyses, effectively fusing strong data-based analysis and technology with a thoughtful and deliberate public participation process grounded in local politics and informed by local thought leaders.

These successes notwithstanding, it was not in 2004 a foregone conclusion that TPL would make GIS and spatial analysis and tools one of its conservation service pillars. We already had well-established land acquisition and public finance expertise and programs. Our National Board at that time expressed skepticism that TPL or any organization our size could add and successfully deliver a third conservation service. But when we presented the King County Greenprint to our Board, and when they heard from very enthusiastic King County officials, they became convinced that developing this technology complemented our other mission services and was worth our time and effort. They gave staff the green light to invest in a robust GIS team and service area.

Convincing the TPL Board was relatively simple compared with the challenge of rolling out and coordinating a new national service in a decentralized national organization of seven distinct

geographic regions and nearly 30 offices, each with significant autonomy. The King County Greenprint process had been driven by what was then our Northwest Region. To complete the job, it had become necessary at several points in the process to force collaboration with our small GIS and mapping team based in Santa Fe, New Mexico. The project was successful despite a sub-optimal internal process and imperfect communications. It became clear that without more centralized control and management, GIS at TPL would suffer real inefficiencies, including: a lack of consistency regarding process; difficulty in sharing data, knowledge and best practices; challenges in creating and maintaining partnerships with service providers; and friction in constantly advancing our technology. Indeed, our decentralized structure was holding TPL back, not only with regard to the use of GIS methodologies, but also in several other key organizational areas, including marketing and fundraising.

Despite these internal challenges, TPL was able, during the period from 2004 to 2009, to significantly expand our GIS staff and expertise. We were able to continue to develop our greenprinting and Conservation Vision portfolio, experiencing varying degrees of cooperation and collaboration from TPL offices around the country

That this effort paid off was underscored by the presentation in 2006 of a "Special Achievement in GIS" Award to TPL by Esri. Breece Robertson, accepting the award on behalf of TPL in front of some 10,000 GIS professionals gathered at the annual Esri users conference, recognized the significance of the award, saying, "the combination of our creative team, collaboration with partners and the use of GIS sets TPL apart in getting to conservation on the ground that reflects the inherent qualities of a place and is driven by community consensus. We are honored to be recognized by Esri and thank them for their ongoing commitment to making data come alive."[5] The significance of the influence and support we received from Esri and its CEO, Jack Dangermond, cannot be overstated. Jack is a dedicated conservationist in his own right. He recognized early on the importance of TPL's land for people mission as a complement to more traditional conservation.

Nevertheless, even with this great progress and recognition, prior to 2009 people in both TPL's headquarters in San Francisco and in its field offices around the country did not fully embrace our GIS work or take full advantage of our growing GIS team.

Never Waste a Crisis!

It was the economic meltdown and great recession of 2009, with associated pressure to reduce costs and re-organize, that allowed TPL to centralize our core services, thereby eliminating the primary obstacle to creating consistent, efficient, effective and collaborative conservation services, including planning services that incorporate sophisticated GIS tools.

As of early 2009, most of the internal services which enabled TPL to do creative conservation deals were relatively decentralized, with the exception of our Conservation Finance services, which had been centralized since the early 1990s. We quickly transformed our structure, moving

[5] The Trust for Public Land. "TPL honored for exceptional work using GIS technology," Press Release, August 24, 2006, available at https://www.tpl.org/media-room/tpl-honored-exceptional-work-using-gis-technology#sm.000gek6gt1dykdj1ryq2crpp2rueb .

from a national-regional (and state office) organization with semi-autonomous local offices **to** a national – state organization with four centralized services designed to support state offices. In particular, we moved quickly to centralize our GIS/Conservation Vision services, our Conservation Transaction services, and our Park Design and Development services. What emerged was a set of four national teams, forming four national service centers, as follows.

1. PLAN: An internal TPL function that provides GIS/Conservation Vision services.

2. FUND: A team focused on providing Conservation Finance/Public Funding expertise at the federal, state and local level (for example, voter approved funding measures that TPL has helped pass since 1995 which have provided nearly $70 billion of funds).

3. PROTECT: This is the service that is focused on doing Conservation Transactions that protect open space from urban to wildlands

4. CREATE: The Park Design and Development service, which uses a community-based participatory design process and works in collaboration with local parks departments.

Our on-the-ground presence in states allowed us to continue being responsive and tailor our work to local conservation needs. But by bringing in national expertise and experience to help local offices, we were able to deliver a consistent, high quality product and achieve economies of scale, while continuing to develop our expertise.

That structural change created the opportunity and conditions under which our GIS program, with strong leadership from GIS and Planning Director, Breece Robertson, could really take off. Breece continued to build an excellent team of staff, consultants and partners, including Esri. Building on the organization's growing experience with and demand for Greenprints, the group went on to create a host of new tools and databases in service to the parks and conservation world. The power of our GIS tools was compelling. In short order, demand for GIS and analysis was permeating most -- and then virtually all -- of our parks and conservation activities.

One initially unexpected structural change that was enabled by the financial crisis was the emergence of centralized marketing and fundraising teams. These centralized teams, in turn, allowed us to dramatically and successfully change the organization's business model. Prior to the changes, TPL's work had been primarily dependent on financial support from the landowners with whom we did land protection deals, rather than traditional philanthropy. The structural change paved the way for growth in our non-transaction-related services like Conservation Funding and GIS. It also allowed us to significantly increase our parks creation work in cities, which relied much more heavily on philanthropic support.

Making Data Accessible

Even as we struggled through the layoffs and restructuring necessitated by the great recession, we continued to explore how to put our growing GIS capacity in service to our conservation work.

Internally we had always kept records of the more than 4,000 conservation projects we had done up until that time. With the establishment of a national GIS group, we began capturing GIS coordinates for all our work, mapping each land protection effort. We also began a retroactive effort to consolidate and centralize the map of all our past work, in order to have a complete database with GIS co-ordinates.
For example, our GIS and Conservation Finance group worked closely together on several outward facing projects, geo-enabling two long-time databases that we created and managed for the conservation movement:

- LandVote, which tracks voter-approved funding measures across the country regardless of TPL's engagement, and

- The Conservation Almanac, which is a database that captures conservation activity – including conservation easements – across the country.

These databases were already online and publicly accessible. However, putting them into a map format with searchable information made them far more useful and compelling, increasing site visits dramatically. The maps told an important story about the scope and extent of conservation activity and funding, while allowing the user to dig in on specific place-by-place information. These geo-enabled databases were the precursors to the "story maps" that we use today that can also layer photographs, videos and all kinds of other information.

Cities: Parks Access, Social Equity, Climate Adaptation, and Public Health

GIS also became a major factor in The Trust for Public Lands ability to carry out its longstanding commitment to cities, creating or restoring the parks and natural areas where people who live in urban settings can get outdoors and connect with nature and each other. The cornerstone of the Trust's work in cities has always been responsiveness to and engagement with communities. Beyond the simplistic concept that great cities need great park systems, we saw an opportunity for parks and nature in the city to help tackle some of the most challenging and persistent urban problems: parks access and social equity; the growing impact of climate change; and public health – particularly with respect to obesity and its related diseases.

<u>Access and Equity</u>

Having learned from our early access analysis in Los Angeles, we were already using a new and improved GIS model that measured actual walking distance to a park's entrance. In cities where we had urban programs, we used an access analysis that showed which areas benefit from a half-mile/10-minute walk to the park as a way to focus our work, helping to spark a conversation with the city about the accessibility of its park system. It was simple enough for us to add demographic data layers to address income and age levels, allowing us to highlight poor neighborhoods with higher numbers of youth. That analysis was the foundation for our green schoolyards work in New York City first with the Bloomberg administration and subsequently under Mayor DeBlasio.

Mayor Bloomberg adopted the 10-minute walk to a park standard as part of his green plan for the city – PlaNYC. However, his administration recognized the challenge of knowing where the park deserts were, and then how to give them new parks, given the cost and scarcity of available land. Our GIS parks access map for New York identified the gaps and we proposed that the city turn to its school playgrounds as a source of new neighborhood parks, open after school hours, on weekends and in the summer. Our plan was to work with the students to repurpose their school's asphalt-covered school playgrounds (where, more often than not, teachers parked their cars) into wonderful, green, multi-purpose parks. The results of that effort have been very rewarding –over the past 12 years, we have worked with the city, school principals and students to reimagine and recreate some 200 new green school playgrounds, thereby dramatically helping the city to improve its park access in some of the neediest and park-poor neighborhoods.

Similarly, analyses of access needs and opportunities enabled by GIS technologies led us to: create green alleys in Los Angeles, bring to life new park spaces at schools and recreation centers in Philadelphia; and renovate unsafe and decrepit playgrounds in San Francisco's Tenderloin and Bayview neighborhoods, to name just a few examples.

Adapting to Climate Change

At a time in 2010 when much of the climate conversation from the environmental community was about clean energy (a situation which is still true in 2018), and when there was a general unwillingness to talk about adapting to what seemed to The Trust for Public Land an inevitable increase in climate impacts, we began to explore how parks and open space could help cities deal with these climate change-related challenges. We focused on four challenges: managing storm water runoff from increasingly severe weather events; dealing with the urban heat island effect and its health impacts – particularly for low income neighborhoods with relatively less tree-cover; reducing carbon emissions (and increasing exercise opportunities) by providing for more non-motorized transit through trails and greenways; and buffering against storm surges coming in from the ocean and from higher elevation inland sources in coastal and waterfront communities. Using GIS for both analysis and to guide decisions, TPL developed its Climate-Smart Cities (CSC) program. The program had four elements: *Connect* (urban trails for non-motorized access), *Cool* (park creation, tree-planting and greening to lower the urban heat island effects), *Absorb* (capturing storm water runoff), and *Protect* (protecting and restoring wetlands as a buffer to shield uplands from storm surge). The arrival of superstorm Sandy added real momentum to the program and allowed us to secure funding and academic partners to underwrite research and GIS tool development.

The resulting tool, which identifies both climate challenges and mitigation opportunities, was incorporated into the Greenprinting process. This analytical methodology is based on a comprehensive parcel-by-parcel analysis that considers such information, which is mostly readily available, as: soil types and permeability, tree coverage as determined by satellite imagery, flood zones, trails and transit and demographics. The tool identifies those areas suffering – or most likely to suffer -- the greatest climate impacts, as well as the parcels that could be developed as parks or open space to help mitigate those impacts. The model was developed by the Trust's GIS team in collaboration with Esri. Thus far 30 cities have become TPL Climate-Smart Cities and the number is growing. After a thorough parcel-by-parcel analysis

of existing conditions, climate impacts and potential solutions, the city being analyzed is given the GIS decision tool to help it determine where and how to leverage parks and open space as green infrastructure climate solutions. Where we have an on-the-ground presence, we can also help implement plan recommendations.

The Trust's Green Alleys program in Los Angeles is a good example. It combines multiple climate benefits by working with communities – generally in poor neighborhoods – to reclaim and beautify trash-filled and unsafe alleys as safe alternative corridors connecting residences with schools and shopping. The alleys are well-lit, heavily planted, and surfaced with permeable material that allow storm water to be recaptured and returned to groundwater sources, including local aquifers. The alleys were chosen based on GIS analysis of potential storm water and heat island impacts.

Our CSC decision tool and the awareness it has created goes beyond TPL's CSC program – it has led TPL to assess the design and engineering of all parks that we are helping create or restore in order to evaluate potential climate impact benefits. For example, our New York City playgrounds now incorporate swales, rain gardens, and gravel retention beds beneath playing fields for storm water capture.

Where we have protected wetlands in coastal cities – New York and New Orleans being good examples – we have been able to use GIS analysis to demonstrate that uplands behind protected wetlands suffer less damage in major storm events. That was certainly the case in superstorm Sandy where uplands on Staten Island behind protected wetlands escaped damage.

Public Health

The Trust's New Orleans program benefitted from the versatility of GIS in allowing users to focus on particular geographies and particular impacts. Not only did our CSC decision tool enable the city to explore climate challenges and opportunities (primarily from storm water runoff and storm surge), we were also able to layer in, along with our usual access and demographic profiles, Center for Disease Control (CDC) data on obesity and other public health challenges (see *Figures 6 and 7*). Working with a group of stakeholders including public health agencies, we developed an analysis and tool for New Orleans, helping the city consider how best to tackle the multiple challenges of access, climate and health through parks creation and open space protection.

Figure 6: Climate Smart Cities Decision Tool Map for New Orleans: Overall Priorities

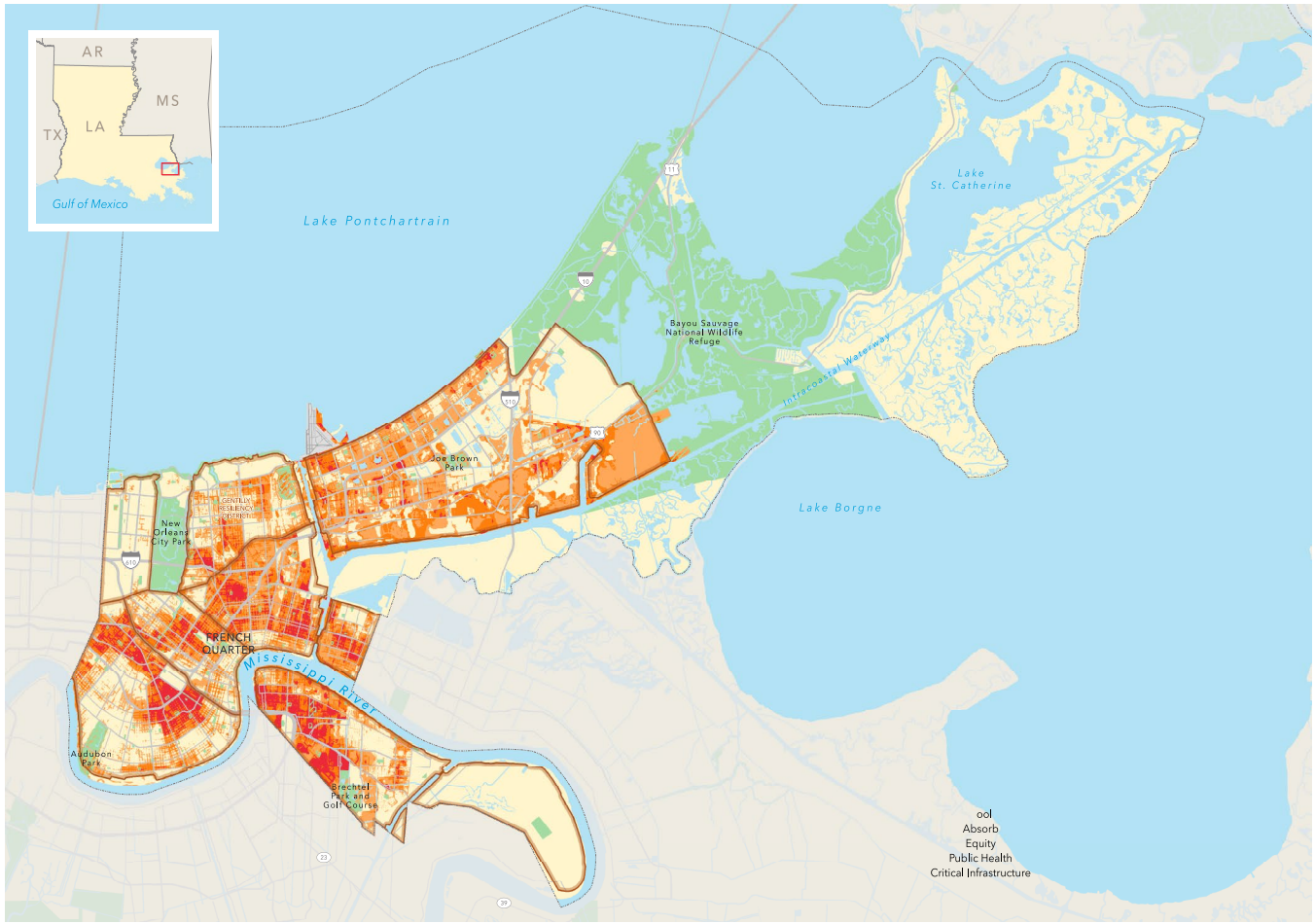
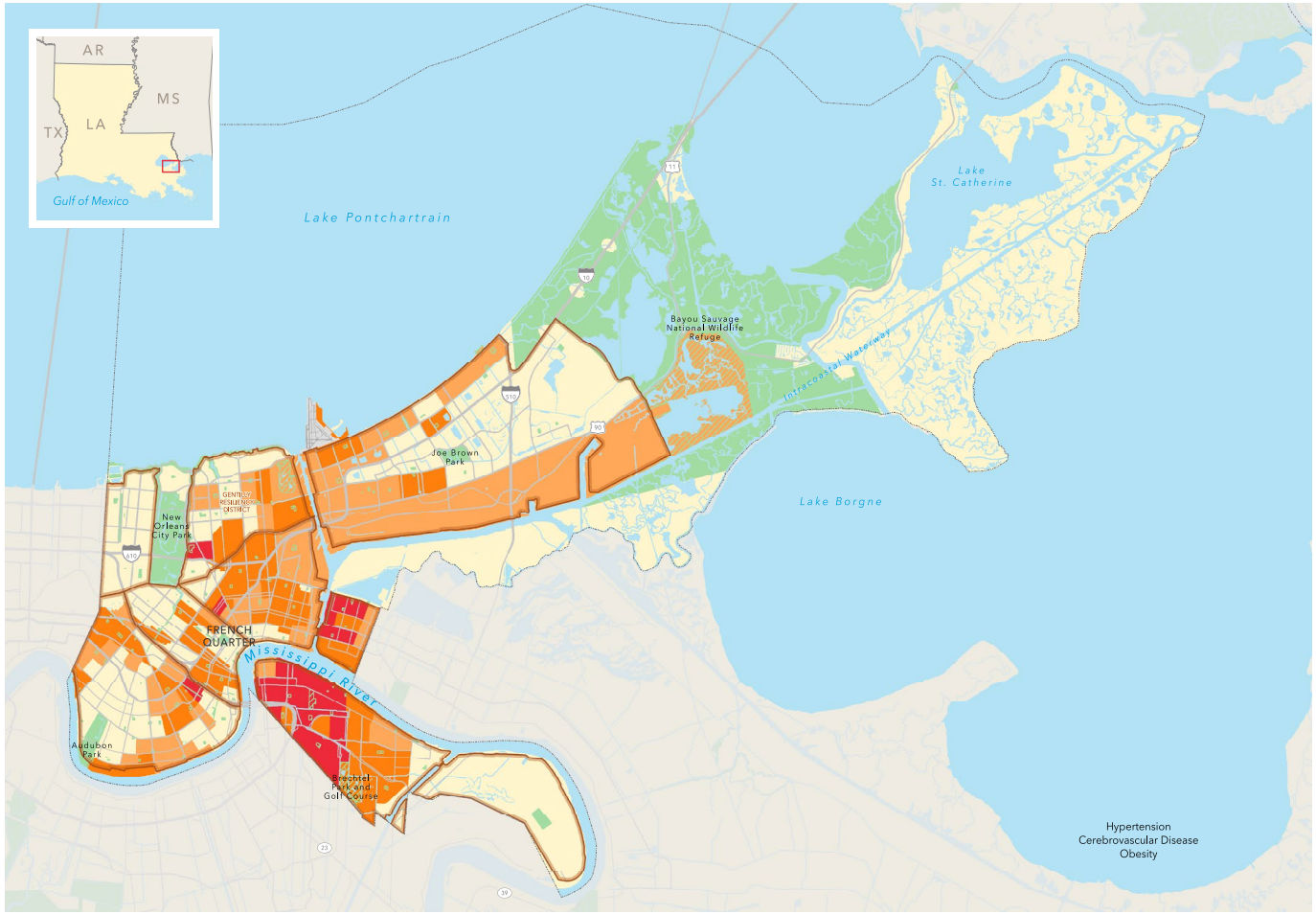


Figure 7: Climate Smart Cities Decision Tool Map for New Orleans: Health Focus



That was before the creation of TPL's new Community Health program, now in its pilot stage and rolling out in three cities across the country. GIS is already playing a key role in identifying communities at risk that could be assisted by new or restored parks and park programming. Because linking health outcomes to any one factor is difficult at best, we expect GIS and other analysis to play an important role as we work to demonstrate the efficacy of parks and programming in tackling key public health challenges, including obesity and heat related impacts. This program is still in its infancy, but its success will depend heavily on our ability to demonstrate to hospitals and other health providers/funders that parks make a measurable difference.

The prestigious "Making a Difference" award we received from Jack Dangermond at the Esri International Users Conference in July 2012 is a powerful testament to the innovation, creativity and impact of our GIS team's work on the Climate Smart Cities GIS decision tool and our work on ParkScore and the 10-minute walk parks access analysis.

From Reactive to Proactive: How GIS is Helping TPL Lean into Leadership

Early in my career with The Trust for Public Land, when we were less well known, I was often asked how we were different from The Nature Conservancy. My simple answer was that we focused on people rather than other species. I went on to explain that difference showed up in how the two organizations chose where to work. The Nature Conservancy turned to its scientists who could prescribe what land needed to be protected in order to protect a given endangered species: a very proactive, prescriptive, science-based approach. In contrast, The Trust for Public Land would go to communities or to public land agencies and ask them what lands they cared about and wanted to see protected. This more reactive model forced us to work in close partnerships and on the agendas of others. As a result, we developed a culture focused on implementation rather than policy. We generally did not take on the role of telling people what they should want to protect. We saw ourselves as a conservation facilitator rather than as a leader.

Over decades – and after completing thousands of land protection projects and hundreds of urban park efforts – our position and culture began to change. In a sense, we backed into leadership – particularly in cities where we were the only national organization doing parks and conservation work. Our record of success with parks and conservation funding measures in and around cities raised our profile and expectations about what we could provide. Communities and other non-profits began to turn to TPL for information about parks, funding and other conservation tools – information that wasn't otherwise available. We established The Center for City Parks Excellence and conducted an annual survey of key park system data for America's 100 largest cities. We co-wrote *The Conservation Easement Handbook*. We published, under our Center for Land and People, books about the importance the human connection with land and nature – *Our Land Ourselves, The Story Handbook,* and *The Great Remembering*. And we established the LandVote website to track voter-approved funding measures and the Conservation Almanac. In spite of this work, we still thought of ourselves more as facilitators and implementers rather than leaders. It wasn't until we began to use GIS to talk about and define healthy human habitat and

what people need – in the same way that TNC talked about the habitat needs of other species – that we had the tools to step into a more proactive leadership role.

Developing the "10-minute walk" or "one-half mile to a great park" access standard allowed TPL to push cities to create better and more equitable park systems, so that they could offer a larger portion of their citizens with all the benefits parks provide. GIS enabled us to identify parks gaps and how and where those gaps could be filled. We turned up the volume in 2012, with the public release of our first ParkScore national urban parks ranking (*Figures 8-10*). We began by evaluating and ranking the parks systems of America's 50 largest cities. Using both GIS and data from our annual City Parks Facts survey, we gave each city a score based on park access, area, amenities and park spending. We then posted the results online in a searchable web site. A national press release and stories in many of the ParkScore cities significantly raised awareness. Lists and rankings generally get good media attention and ParkScore was able to focus that attention to get cities to focus on the shortcomings of their park systems.

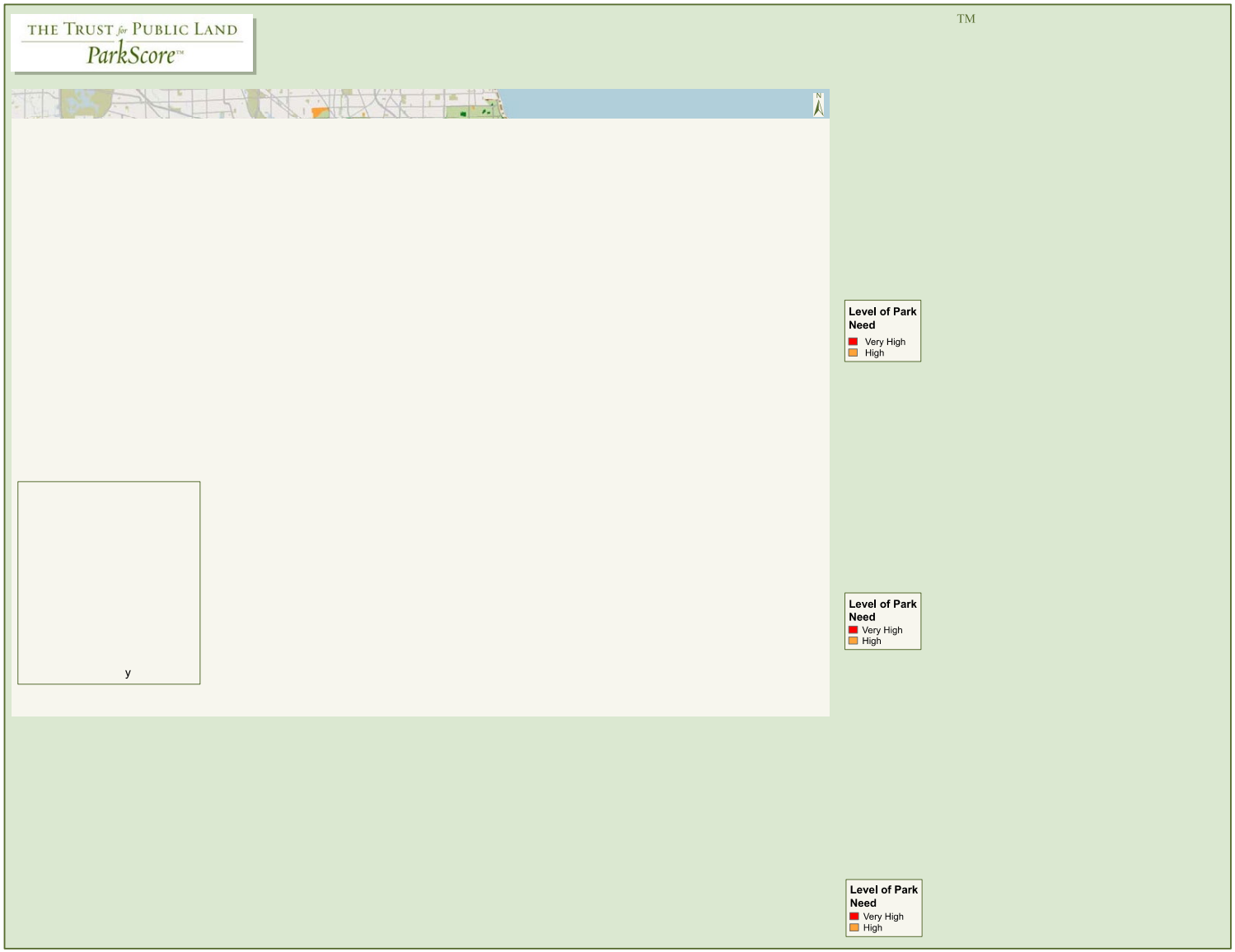
ParkScore grew to include the 100 largest cities in America. TPL continues to update and release ParkScore rankings annually, allowing cities to use the tool to set their own goals and measure progress against those goals. For example, the City of Houston, low in the ParkScore rankings with only 45% of its residents having a park within a 10-minute walk, has committed to creating the parks that will get the city to 75% by 2040.

Along with the ParkScore data, TPL's GIS team also created a "Park Locator" app to support new park implementation. The app allowed our partners and other users to identify potential park sites, sketch them in, and determine the population and demographic profile of the individuals who would be served by the park. With those results, they could then see how that new park would impact the city's ParkScore access ranking.

The publishing and promotion of the ParkScore rankings marked a milestone in TPL's parks and conservation leadership. By setting a standard for parks access and having that standard be adopted by a number of cities – New York City was among the first – we had created a platform from which TPL could promote the importance and benefits of parks and its land for people mission. Having a broad and easily communicated vision for parks along with the data and analytical tools to identify gaps and track progress allowed TPL to take on a greater leadership role and has led to a shift in organizational culture. TPL is today definitely leaning into leadership!

Figure 8: ParkScore 2018: Cover

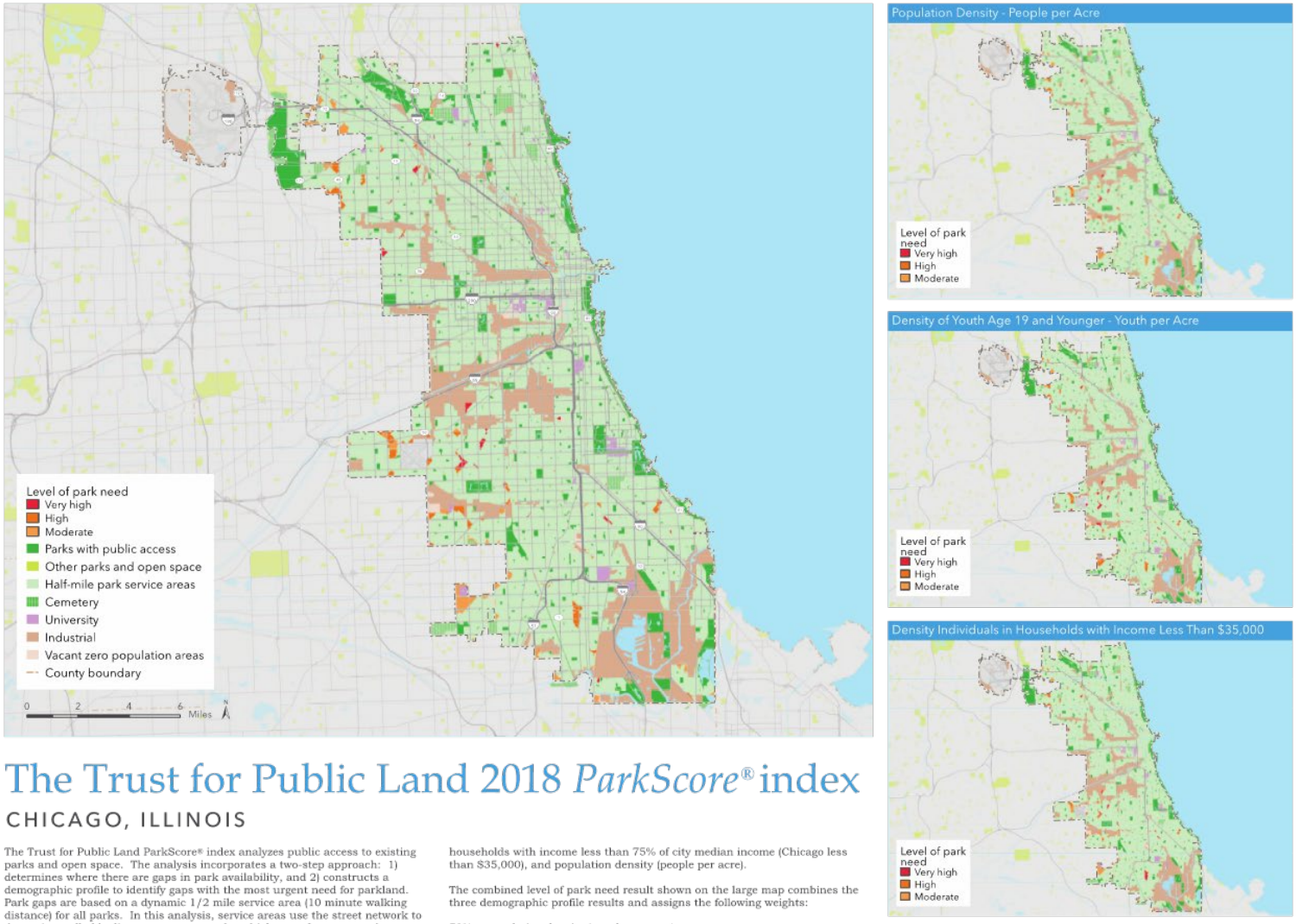
Figure 9: ParkScore 2012: Chicago Park Access Map



That leadership role and the importance of GIS in getting us there is best demonstrated by the project which followed our roll-out of ParkScore: TPL's national "10-Minute Walk to a Great Park" campaign, announced on October 10, 2017. The campaign engaged over 150 mayors from cities large and small; each one signed on to the 10-minute walk vision for their cities. True to form, TPL had key partners in the campaign – The Urban Land Institute and the National Recreation and Parks Association. With key support from The JPB Foundation, the campaign seeks to create a national movement that will encourage cities to invest in their parks systems, bringing the benefits of parks to those who do not currently have close to home access. The campaign includes grants to support cities in their efforts and a menu of actions cities can take to further their progress toward a 10-minute walk for all citizens. At the heart of the campaign is the GIS and technological platform that backs up the 10-minute walk standard and allows progress to be measured.

Bigger Data: The challenge facing a campaign promoting a national standard like the 10-minute walk is having baseline data for every city – data which simply did not exist. Once again TPL relied on its GIS group, with critical financial support from The JPB Foundation, to fill that information gap. For the first time, we have been able to map local and urban parks in cities and towns in America where more than 80% of the US population resides. TPL has posted a national database called ParkServe (*Figures 11 and 12*) that includes parks and analyzes a 10-minute walk access for over 14,000 communities, nationwide. At this time, TPL estimates that nearly 100 million Americans do not live within a 10-minute walk of a park. That translates to 1 in 3 people living in America that don't have access to a park within a 10-minute walk. Now that the baseline is established and providing funding can be secured, the access data will need to be updated every few years to measure progress.

Figure 10: ParkScore 2018 Chicago Park Access Map



The Trust for Public Land 2018 *ParkScore*® index

CHICAGO, ILLINOIS

The Trust for Public Land ParkScore® index analyzes public access to existing parks and open space. The analysis incorporates a two-step approach: 1) determines where there are gaps in park availability, and 2) constructs a demographic profile to identify gaps with the most urgent need for parkland. Park gaps are based on a dynamic 1/2 mile service area (10 minute walking distance) for all parks. In this analysis, service areas use the street network to determine walkable distance - streets such as highways, freeways, and interstates are considered barriers.

Demographic profiles are based on 2017 Forecast block groups provided by Esri to determine park need for density of youth, density of individuals in households with income less than 75% of city median income (Chicago less than $35,000), and population density (people per acre).

The combined level of park need result shown on the large map combines the three demographic profile results and assigns the following weights:

50% = population density (people per acre)
25% = density of youth age 19 and younger
25% = density of individuals in households with income less than $35,000

Areas in dark red show a very high need for parks.

Special thanks to the following data providers: Chicago, Esri.

Figure 11: ParkServe National Parks Access Analysis

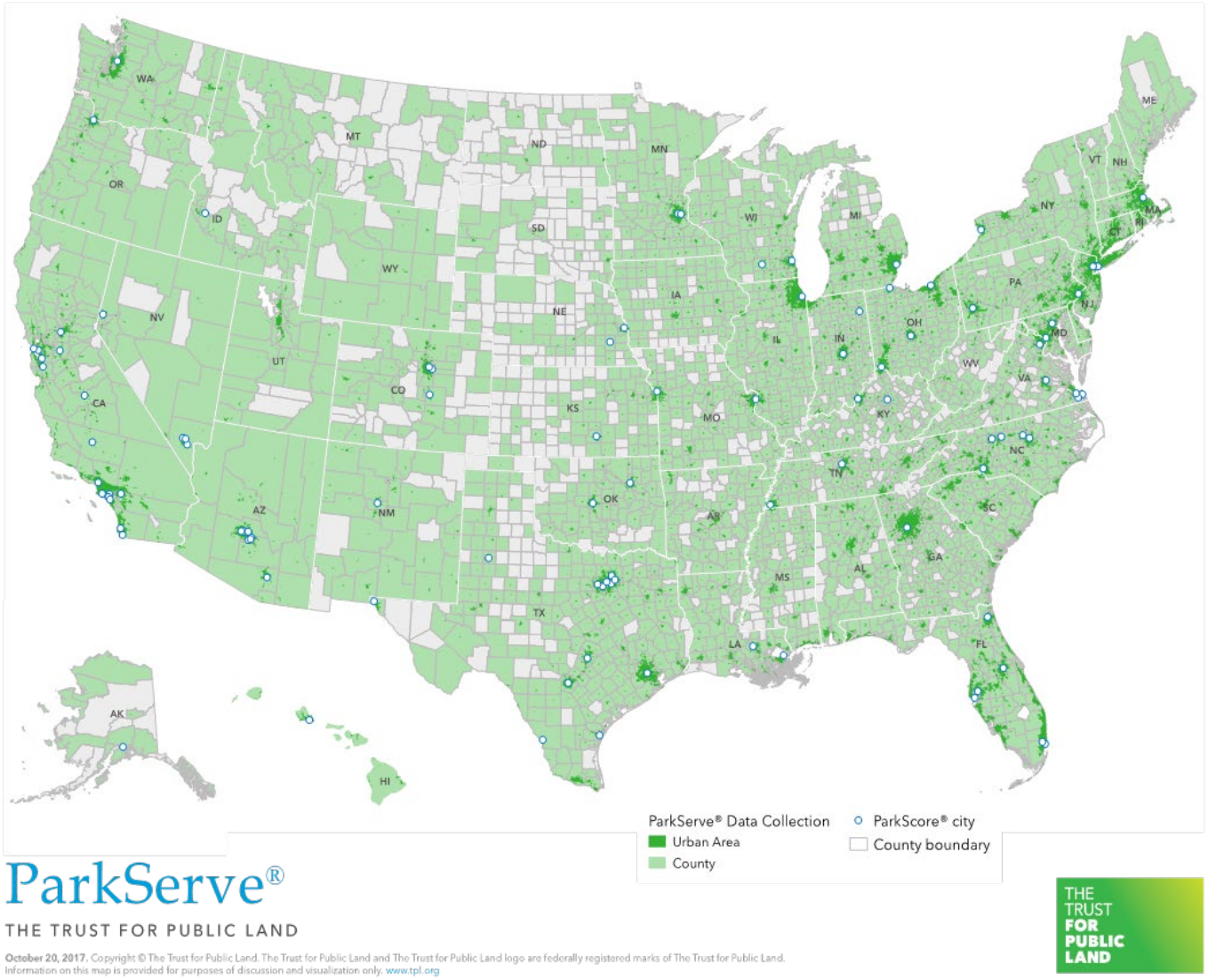
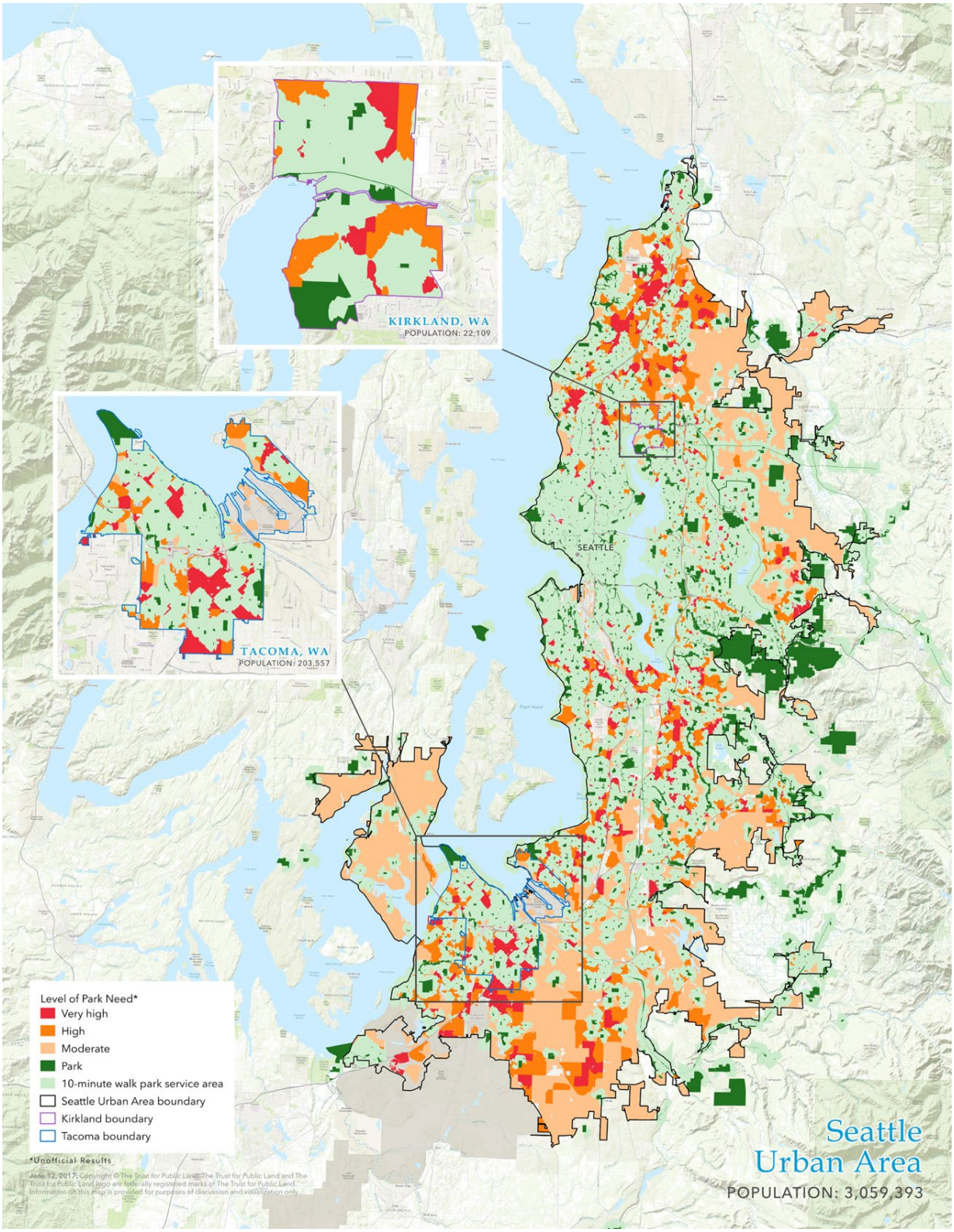


Figure 12: ParkServe Parks Access Analysis: Seattle Urban Area



What Next?

Technology - and particularly GIS, has insinuated itself into virtually everything TPL does. Internally, our GIS capacity – staff, knowledge and experience – has grown significantly as the organization has invested in this line of work. One good example of TPL's commitment is the endowment of the GIS Director's position – a recognition of the need to bring more financial stability to this important function. TPL's GIS tools have allowed the organization to be both more responsive to our clients and more pro-active in helping them adopt and implement the vision for healthier human habitat that is at the heart of TPL's mission.

There is plenty of opportunity for greater GIS impact in both of TPL's continued two major mission strategy areas – urban (Parks for People) and rural and wild lands (Our Land).

Parks for People

Thus far GIS has had its greatest impact on our urban work through being able to map, analyze, promote and implement equitable access, climate solutions and, just beginning, a focused effort to use parks to support individual and community health.
There is still much to be done to support the organization's urban Parks for People strategy that will rely on GIS and other technology tools:

- Completing and updating the ParkServe national parks access database
- Capturing meaningful data on how parks impact public health
- Evaluating the efficacy of park design and engineering in addressing climate impacts like storm water capture and reducing the urban heat island effect
- Assessing park usage, to better understand: the extent to which parks getting used, from where users are coming, and which aspects of parks are or are not attractive and/or meeting expectations.
- Assessing park quality, to better understand whether or not parks are well-designed, safe and well-maintained; this is a key challenge if we are to support a vision of a 10-minute walk to a **great** park.

These last two challenges are huge. Park equity is often as much an issue of park maintenance and safety as of accessibility. Lower income communities often have adequate parks – but parks that are dangerous and poorly cared for. A single city can spend significant amounts on simply monitoring maintenance and safety issues. Using technology to find a universal and cost-effective way to assess park quality is an even greater challenge that simply mapping parks access. There is a huge need, whether through crowd-sourced data, anonymized cell phone data, or other means to offer ongoing assessments of park system maintenance, safety, amenity and quality. That is one of the next big technological challenges in the urban parks world (see *Figures 13 and 14*).

Figure 13: Anonymized Cell Phone Data

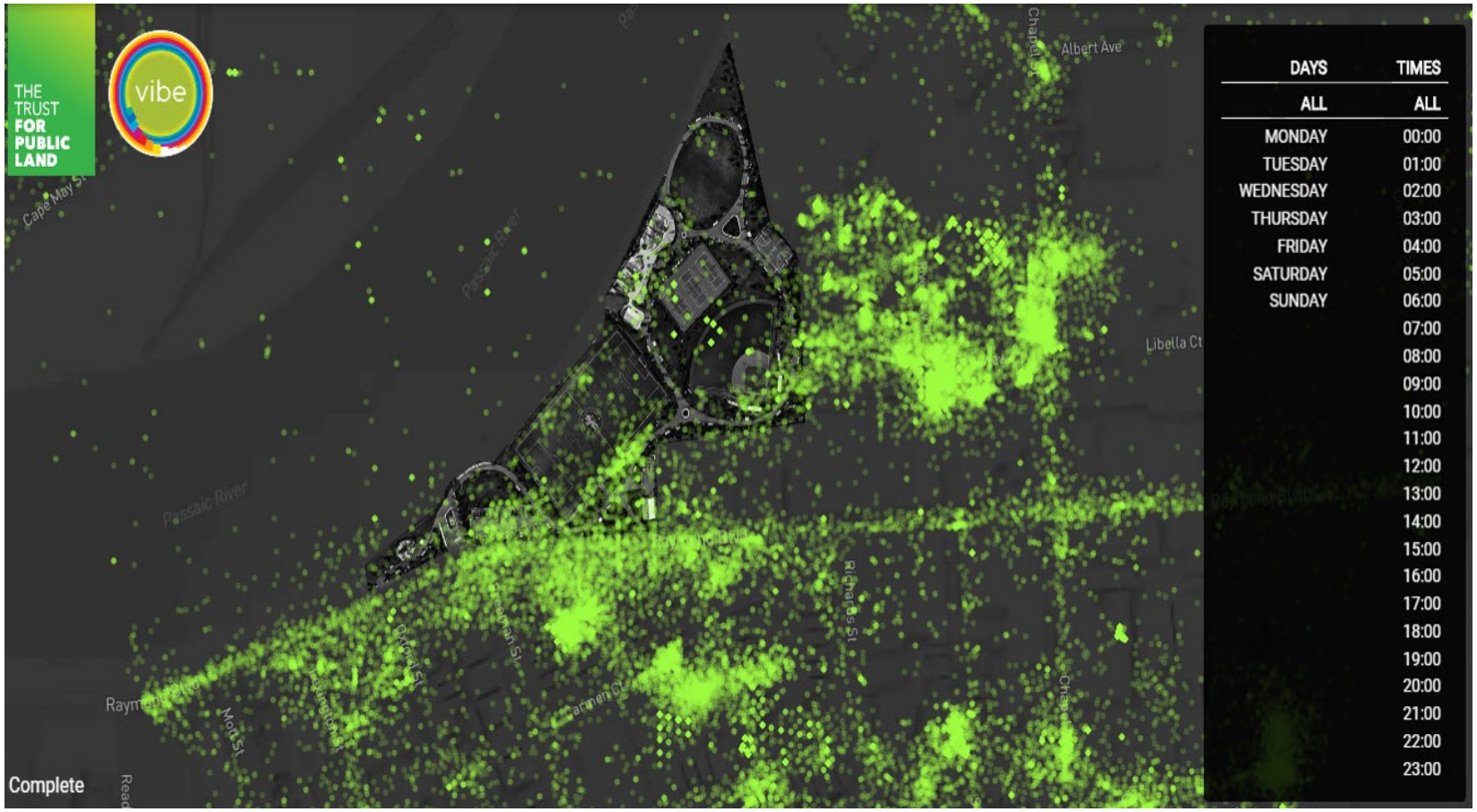
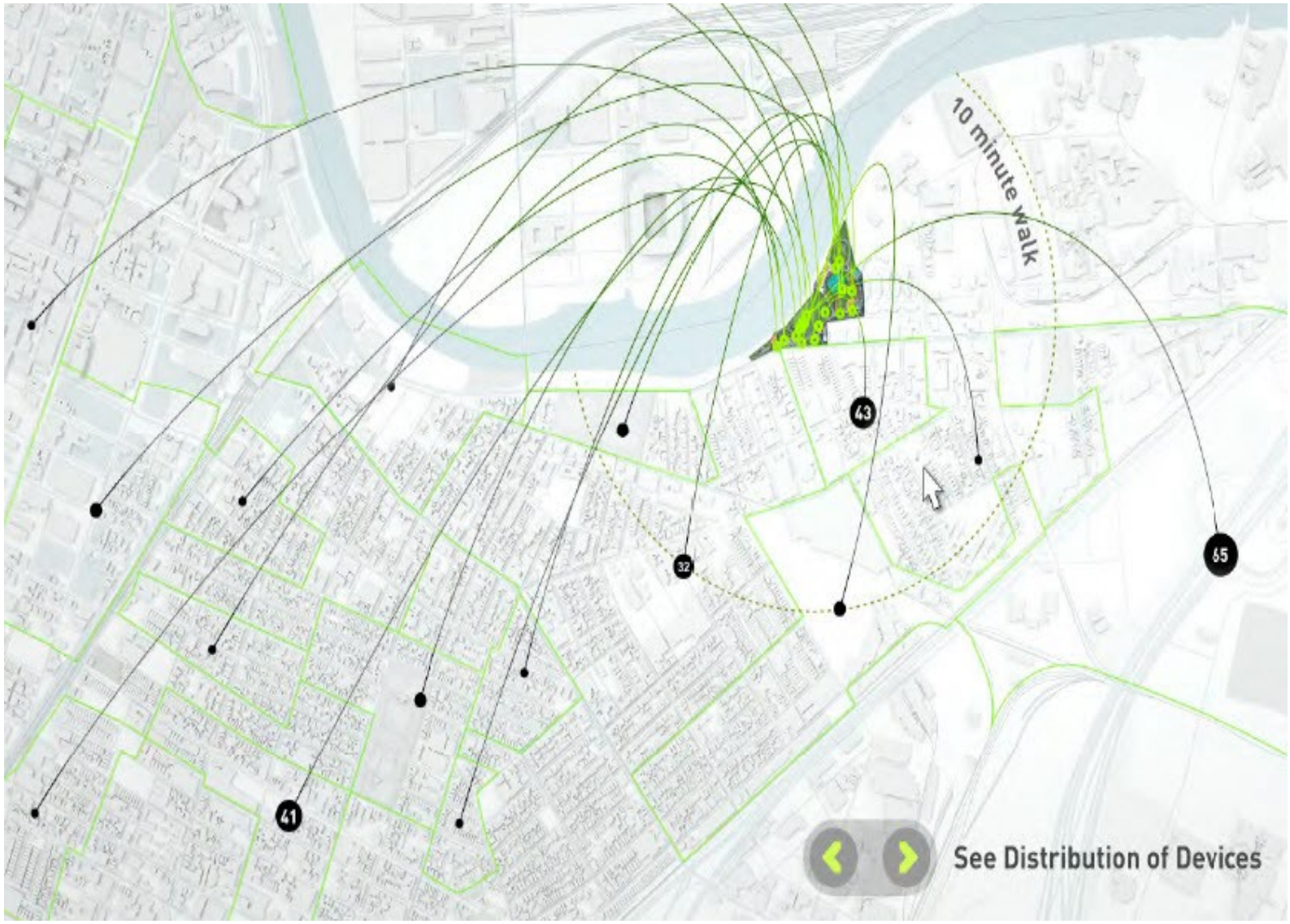


Figure 14: Source of Park Visitors Based on Cell Phone Data: Passaic River Greenway, Newark, NJ



Our Land

When it comes to wild lands work, there is already plenty of information on habitat value and growing knowledge about the importance of our wild lands to water supply and quality. We certainly need to know more and get better at valuing the ecological services and benefits of protected open space.

TPL has already completed many Greenprints for rural areas, balancing watershed protection, forestry, habitat, and recreation of all kinds. But the organization has long been searching for a simple vision, similar to the 10-minute walk, that puts front and center recreation and the human connection with nature and the great outdoors. Thus far TPL has not been able to come up with a simple and compelling metric for rural America. However, the organization does believe that GIS and other technologies can help us understand, analyze and identify gaps and solutions when it comes to accessing wild nature.

TPL's GIS team is currently embarked on a pilot project it calls Access Impact Mapping (AIM), using GIS and available public data to explore both the supply and demand of recreational access. Using, for example, localized data for subscriptions to fly fishing, hunting, birdwatching, snowmobiling or other publications can serve as a proxy or indicator for the size of interest groups and the local or regional demand for certain kinds of recreational access (*Figures 15-17*). That can be matched against the proximity, nature and accessibility of public lands with the goal of identifying gaps between demand and supply – gaps that can be filled by land acquisition, access or trail development, or changing public lands management policies.

It is by no means certain that what will emerge from TPL's exploration will be useful. However, this work has not been done before in this way. We are using whatever tools technology can provide. If successful, this form of analysis could reshape the priorities and work of public land agencies and non-profits, alike.

As access and the ability to cost effectively analyze big data sets improves, The Trust for Public Land hopes to be able to better leverage information to support and implement its land for people mission. This is an exciting time. More than ever before, technology, GIS and the availability to efficiently and cost-effectively process ever larger amounts of data is supporting the organization's ability to prioritize and carry out the work that will have the greatest impact in creating healthy human habitat from the hearts of our cities to the remote and inspirational wilderness.

Figure 15: Using Big Data on Expenditures as a Proxy for Demand

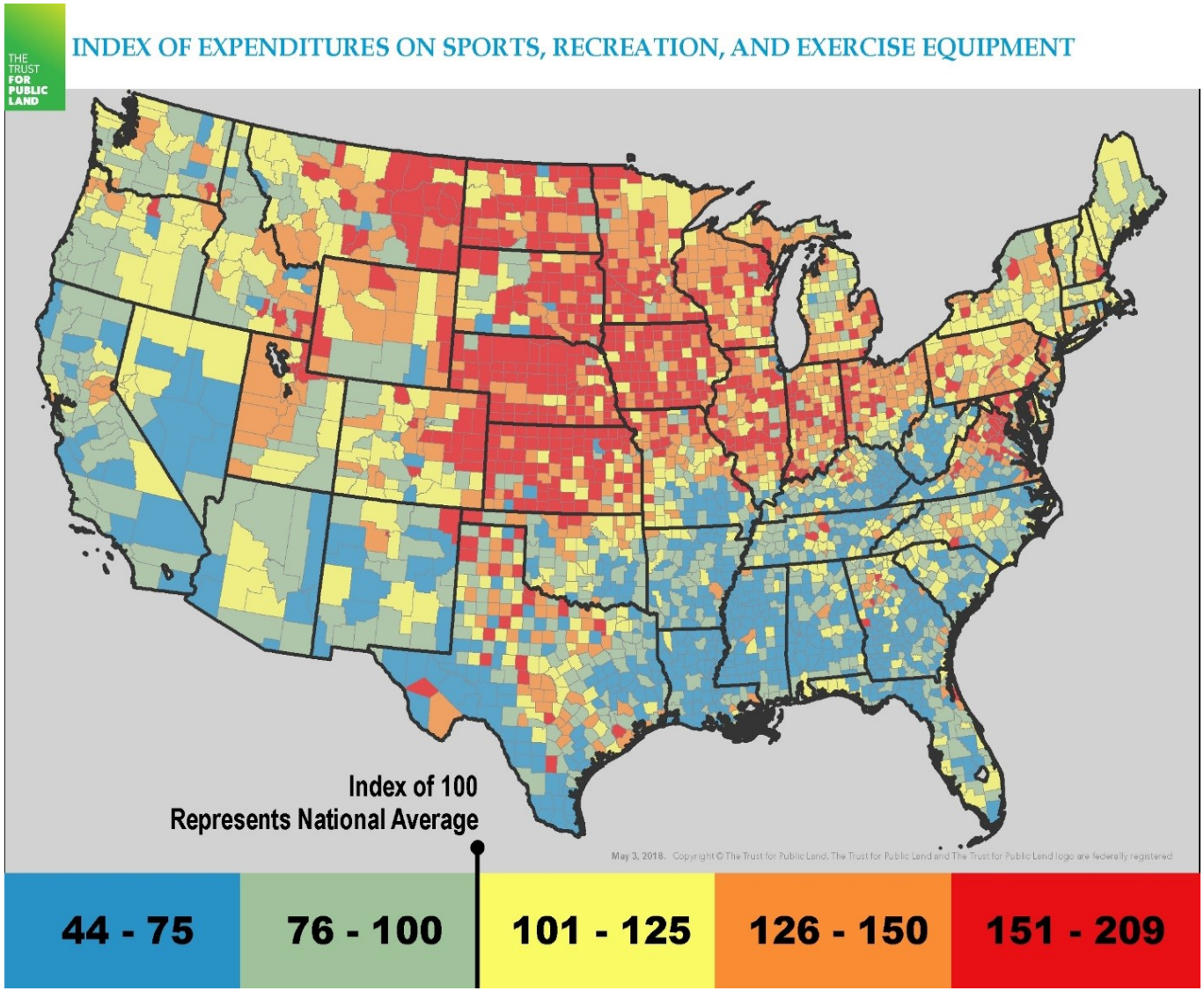
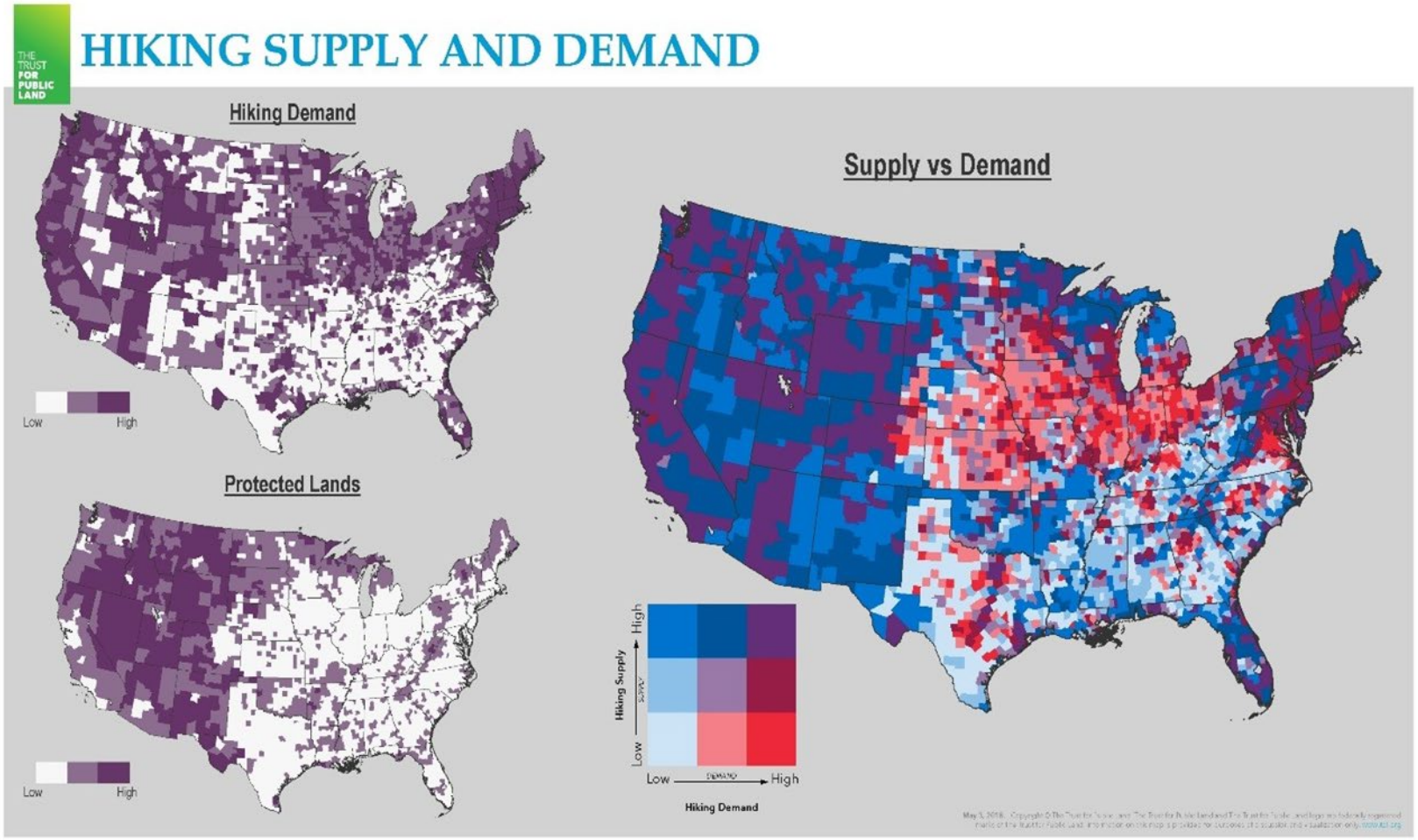
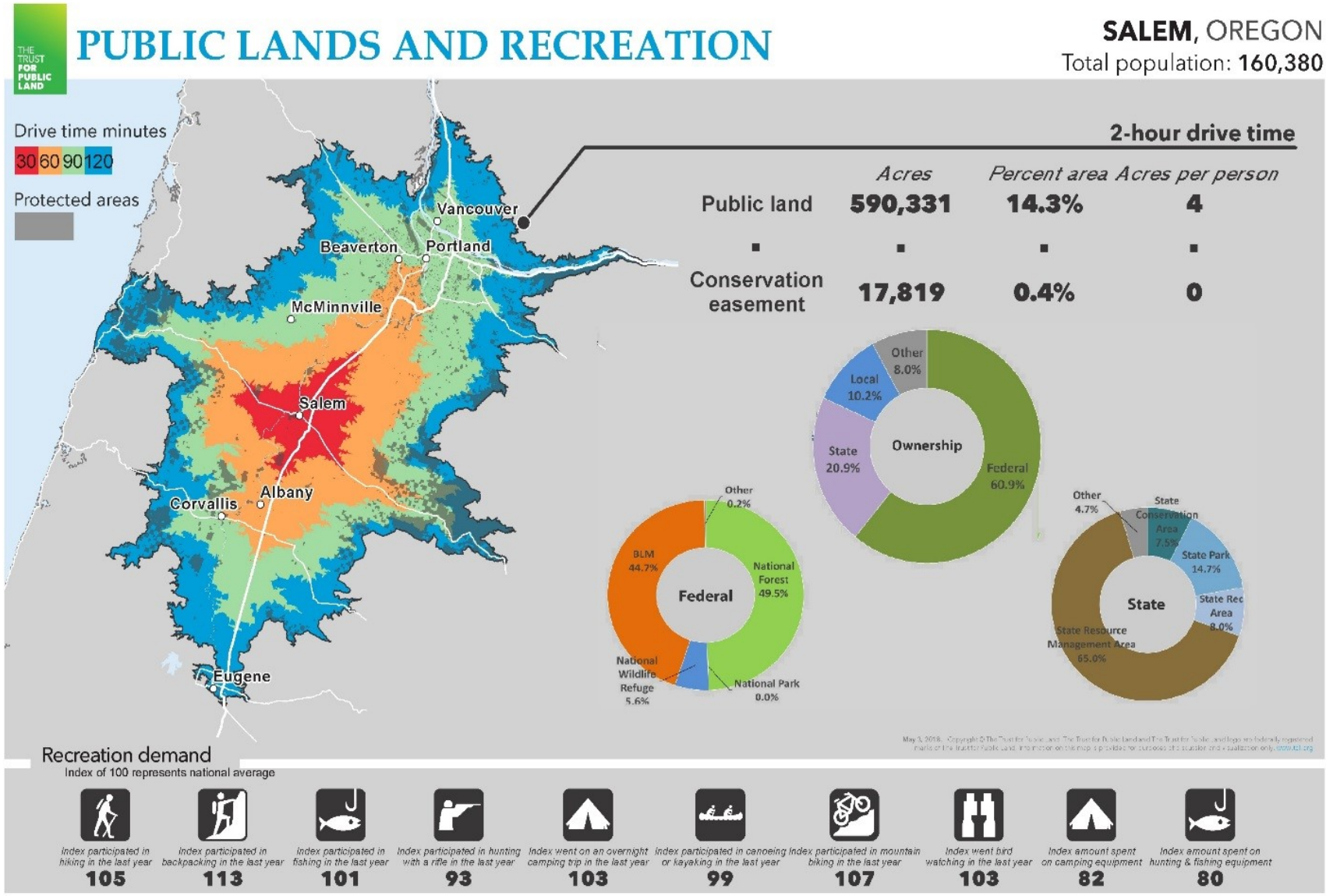


Figure 16: Hiking Supply and Demand Estimate



This map was created by calculating a hiking supply versus demand index. The hiking population (demand) was determined by the number of people who have self-reported hiking within the last year. The supply was calculated by the amount of public land per person in each county. Both supply and demand were then divided into 3 equal intervals representing high, medium, and low. The nine possible combinations of these intervals became the nine possible hiking index classes.

Figure 17: Public Land Availability Based on Drive Times: Salem, Oregon



Appendix A

Narrative regarding King County GIS Model, from Chapter 1 of Greenprint for King County

"…. Over time, King County DNRP has compiled a tremendous library of data related to parks and natural resources around the county. The county has utilized GIS to assess acquisition priorities in the past, and also had created an impressive online GIS Center for the public to access on the internet at http://www.metrokc.gov/gis. With the introduction of a new GIS platform, ArcView 9, and ModelBuilder software by ESRI, it was possible for TPL to build a complex new model to evaluate hundreds of criteria from several dozen data sets and analyze results at the parcel-level throughout King County. TPL's GIS model will help DNRP identify the quantity and location of existing high value conservation parcels that meet the criteria of individual county programs, as well as indicating where acquisitions would meet multiple program goals.

TPL, in collaboration with ESRI, King County staff, Foresite, Earth Analytic, and Jones & Jones created a raster-based GIS landscape characterization model. This model incorporated over 60 thematic data sets and analyzed the data using as many as 50 sub-models. This process involved selecting which data categories it was important to analyze, the exact scope of some of the data elements to be analyzed, and how data should be ranked and weighted. (see *Figures 4 and 5*) King County staff from each of the DNRP programs provided land/water conservation criteria, as well as how to weight the importance of each criteria to reflect the priorities of each program. Once the program specific, sub-models were run, a new county-wide raster layer was created that highlighted existing high conservation value areas for that program. All program-specific sub-models were then linked to create a composite 'conservation priorities' model run. The Greenprint GIS model can be expanded and updated, as needed, to reflect new data sets, policy shifts, and priorities associated with land conservation in King County. Representative data sets included in the model:

- Natural resource data, including endangered species habitat;
- Water quality, floodplain, and hydrological data;
- Landscape integrity data, such as wildlife migration networks and forest fragmentation;
- Demographic and socio-economic data (to help identify population centers with little access to parks);
- Regulatory data sets, such as zoning layers;
- Proposed trail linkages; needed to connect local and regional trails and greenways.

Each program-specific sub-model included customized analysis designed to capture the conservation strategies associated with that program. Some of the analytic processes assessed the following criteria classes:

- Resource values for wildlife, vegetation composition, and priority species habitat;
- Gaps in existing parkland;
- Land development risk;
- Proposed regional trail corridor connections;
- Hydrology, topography, and soils considerations.

A final objective was to overlay the model generated, conservation values raster layer with the King County Assessor's Office parcel data layer to identify parcel-specific conservation value information. Using zonal statistics, each parcel was scored based on a scale of 0-5 with '0' meaning no conservation value and 5 meaning the highest conservation value.[6] Parcel specific conservation values associated with each open space protection program, as well as a composite conservation value across programs, are available for mapping and analytic purposes.

TPL undertook this analysis to identify portions of the King County landscape that currently have high conservation values and are not presently protected with any kind of publicly retained property interest. Therefore, the county-wide GIS model results do not include analysis of existing parks and other public lands, as well private land with conservation restrictions.[7] The tables generated for each model run provide a breakdown of results by: 1) the conservation value identified by the model for all land across the county, 2) how much of the first column's land falls into the "already protected" category of parks, public land, and private protected lands, 3) the remaining unprotected private land identified for each score, and 4) how much of those remaining unprotected priority are vacant (no record of buildings or improved land value). In addition, the number of unprotected and vacant parcels/acreage in the 100-year floodplain was computed for the flood hazard reduction GIS analysis. Finally, the number of unprotected and vacant parcels/acreage in the Forest Protection District (FPD) and the Rural Forest Focus Areas (RFFA) were computed for the Forest Lands GIS analysis.

The King County Greenprint is one of the first instances in which ArcGIS 9 Model Builder has been used to model a landscape as large and complex as King County's greater than 500,000 property parcels. For this reason, and because ModelBuilder supports great model flexibility, including the ability to add additional model components, change the ranking and weighting factor of data elements, and implement completely new datasets, King County staff will be using TPL's model for additional analysis beyond what was prepared for this report.

King County DNRP managers anticipate incorporating TPL's GIS model into programs in the following ways:

- Acquisition Strategy – Focus Funds on Highest Priorities
    - Identify specific parcels of most value to purchase.
    - Common database to evaluate purchases across all programs.
- WRIA Salmon Recovery – Implementing the Plans
    - Model can be updated to include any new direction, information, criteria by WRIA.
    - Ability to focus on specific parcels identified by problem reaches.
- Maintenance and Operations

[6] The results for the rankings from 0-5 are not cumulative - each parcel is counted in the score for only one ranking (i.e. results with a score of 5 include only those properties with a score of 5, results with a score of 4 include only those properties with a score of 4, etc.).

[7] There is a broad spectrum of management on public lands and private lands with conservation easements that results in a range of protection for conservation values. However, given the limitations of existing data for public and private conservation lands in King County, a guiding assumption for this study was to treat all known public properties and private lands with conservation restrictions as equals in a single "protected" lands class. This class of lands is not statistically included in the GIS model results.

    - Focus limited resources.
    - Possibly use in stewardship and management of protected lands.
- Capital Program – Upgrade Degrading Basins
    - Possibly shift focus of restoration projects.
- Regulations – Improve Efficiency
    - Mitigation reserves program in CAO.
    - Federal and state level coordination.
- Growth Management Act – Urban Growth Boundary (UGB) Protection
    - Targeted acquisitions and land conservation actions on the rural side of the Urban Growth Boundary to help direct urban development into cities and protect rural character."