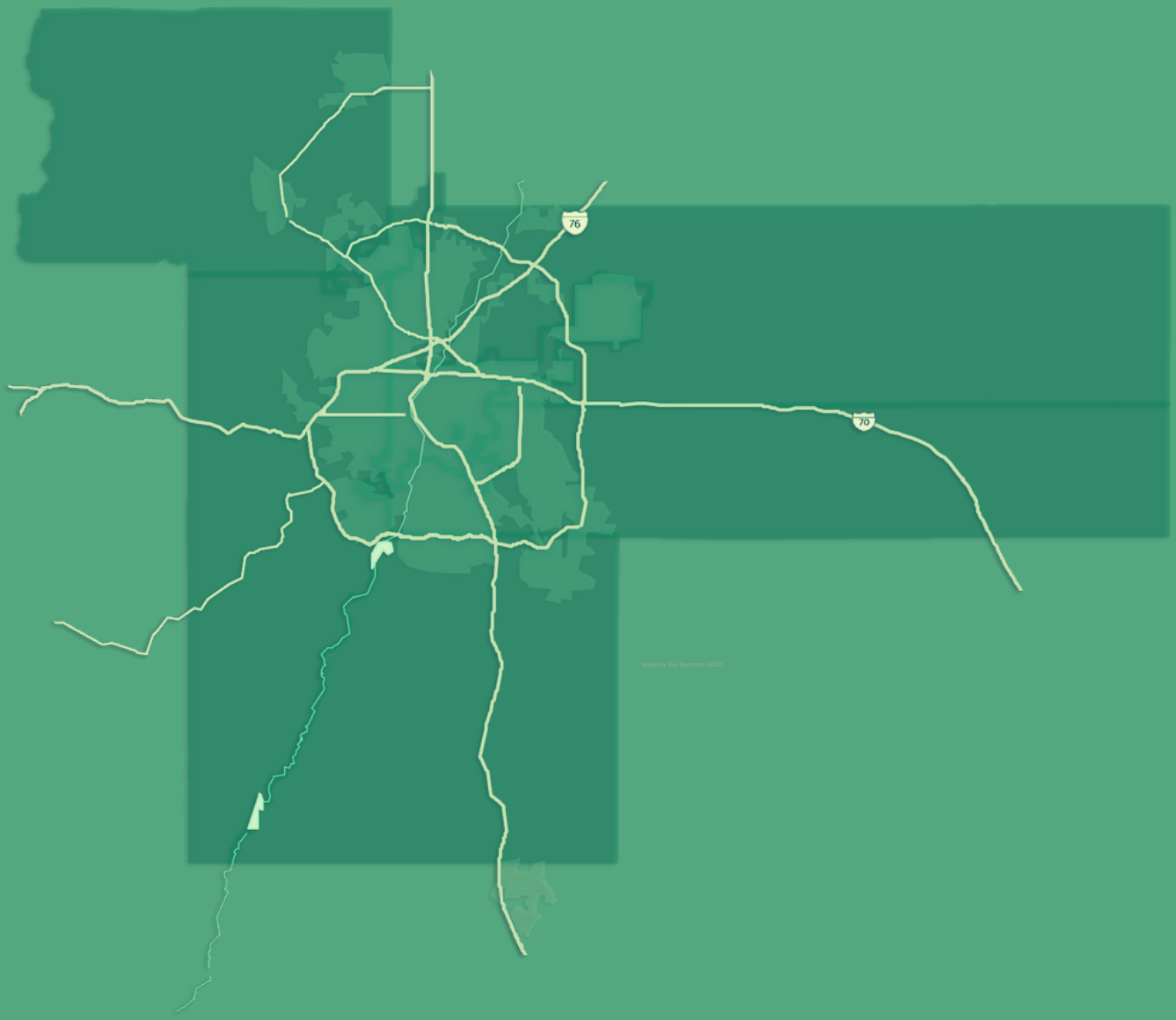
Review & Analysis:

Merging Ecology, Equity, & Resilience



A Review + Analysis of Existing Research & Case Studies for the Metro Denver Nature Alliance's *Regional Vision for People + Nature*

Prepared For:
The Metro Denver Nature Alliance

Masters of the Environment

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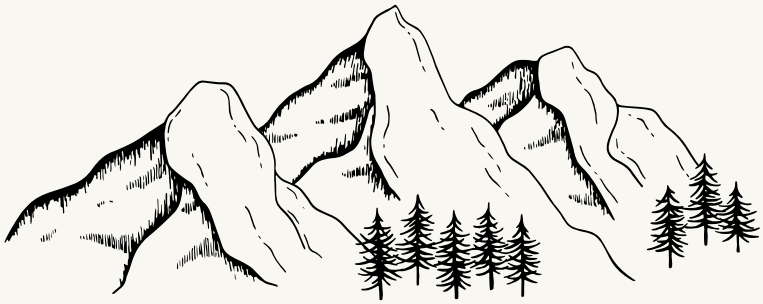


Masters of the Environment

OUR TEAM

Bay Burnham (primary author) is completing a Masters of the Environment degree in Urban Resilience and Sustainability at the University of Colorado Boulder. She has studied human-environment relationships in projects based in Southern Africa, Iceland, Southeast Asia, Central America and the United States. Bay is an experienced researcher pursuing a career in sustainable development, socio-ecological resilience, and land conservation. Her interests include research in vulnerable communities and natural design solutions.

Anna Perkins Buongiorno (secondary author) is a graduate student in the Masters of the Environment program at the University of Colorado at Boulder, focusing on Environmental and Natural Resources Policy. She is interested in addressing the climate crisis through policy, strategic planning, and stakeholder engagement. Anna has worked for the past eight years in renewable energy and environmental consulting, and she specializes in cross-functional collaboration, strategic negotiation, and project management.

Livia Spencer (contributor) is a graduate student in the Masters of the Environment program at the University of Colorado Boulder, focusing on Urban Resilience and Sustainability. Livia is interested in urban greening and conservation initiatives on a large community scale. Livia entered the masters program after receiving her B.A. in Environmental Studies and Atmospheric and Oceanic Sciences through the University of Colorado Boulder. Livia has worked as an environmental educator, ecological field research assistant, and outreach coordinator with CascadiaNow, a Seattle non-profit.

Autumn Panlilio (contributor) is a graduate student in the Masters of the Environment program at the University of Colorado Boulder focusing on Urban Resilience and Sustainability. She is interested in crafting urban planning projects centralized around green and natural infrastructure in order to sustain both human and natural communities. Autumn has conducted research on socio-ecological sustainability and ethical regenerative agricultural practices in Central America, South America, and the Eastern United States. She has worked for the Everglades Foundation, a non-profit, in environmental and ecological conservation, and has extensive experience as a sustainability coordinator through obtaining her B.A. in Environmental Studies and Ecology.

The University of Colorado Boulder Masters of the Environment (MENV) Program is a two-year immersive program that builds students into leaders in the conservation, consulting, energy, natural resources, planning, policy, and sustainability industries.

Masters of
the Environment

PROJECT **GOALS**

Establish a baseline knowledge of embedded systems in the Denver Metro Area

Review organizations implementing innovative projects in equitable access to nature, ecological health and connectivity, and climate resilience

Compile applicable resources for MetroDNA

Ecological Health & Connectivity

Equitable Access to Nature

Climate Resilience

KEY **TERMS**

Denver Metro Area	-	The seven counties that make up the Denver Metropolitan Area.
BIPOC	-	BIPOC stands for Black, Indigenous, and people of color.
Equitable Access to Nature	-	The ability for all groups to access green space regardless of race, income, ability, and other socio-economic identities.
Ecological Health	-	A measure of the health of an ecosystem that integrates environmental conditions with the impacts of anthropogenic activities in order to give information for a sustainable use and management of natural resources.
Climate Resilience	-	Climate resilience is the ability to anticipate, prepare for, and adapt to the impacts of climate change.
Marginalized Communities	-	Groups of people that experience discrimination based on unequal power dynamics across social, cultural, and economic dimensions. Examples of marginalized communities include groups excluded due to race, physical ability, age, gender, language, and/or immigration status.

LAND **ACKNOWLEDGEMENT**

As we engage in regional planning efforts for the seven-county region that makes up what is now called the Denver Metro area, we acknowledge that this area is located on the traditional land of Indigenous peoples including the Southern Ute Indian Tribe, the Ute Mountain Tribe, the Arapaho Tribe, and the Cheyenne. We honor with gratitude the land itself and these tribes, and acknowledge the stewardship and place-based knowledge of the peoples of these territories. We affirm Indigenous sovereignty, history, knowledge, and experiences, and we recognize that colonialism has displaced and killed Indigenous people across the globe. Colonialism is a current ongoing process, and we need to build our mindfulness of our present participation. Acknowledging the original peoples of this land and their forced removal is one step, but not the only step, in building relationships with the Indigenous communities in this region and highlighting the importance of actively working towards regional planning practices that benefit the original peoples of this land.

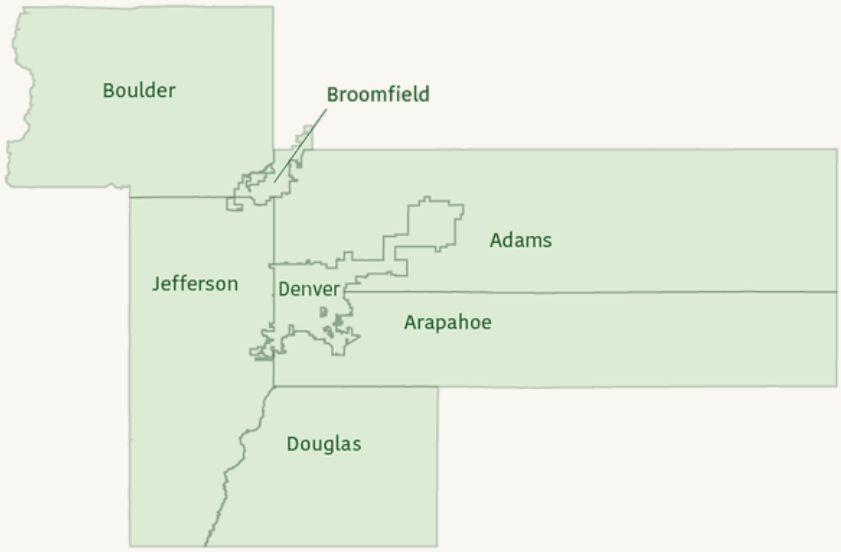
Additional Resources

Tribal Nations Maps, A Native American owned business, the most thorough map of Native America currently in existence

Invasion of America, GIS, US seizure of American Indigenous lands (1776 -1887)

The Decolonial Atlas, Collection of Global Maps for unlearning and rediscovering

PREFACE



The Denver Metro area includes Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties. Image created by Bay Burnham (2022).

The Metro Denver Nature Alliance (Metro DNA) convenes non-profit, government, research, and private sector members at a regional level to improve equitable access to nature and to promote healthy people, communities, and natural places. Metro DNA conducted research on ecological health and resilience in the seven-county Denver Metro area from 2020-2022 through a Regional Conservation Assessment (RCA).

From 2022-2023, Metro DNA will also research equitable access to nature in the Denver Metro area to create a Regional Equity Assessment, with the goal of combining the two assessments to create a Regional Vision for People + Nature. This vision will create a framework for a resilient future in the Denver Metro area through conservation and land use planning.

The University of Colorado Boulder Masters of the Environment (MENV) Capstone Team's task is to discover how to successfully link information gathered from these two assessments through researching and understanding the best practices of similar regional alliances.

This literature review will establish a baseline understanding of the barriers to equitable access to nature, ecological health, and climate resilience within the Denver Metro area. We discuss the historical and modern socio-economic systems that led to the current equity challenges in the region, including discriminatory land use planning, redlining, and environmental gentrification, and detail the contemporaneous ecology challenges brought about by changing land uses and climate change. However, this review is not intended to serve as a complete overview of the historic policies and practices that led to inequitable access to nature and decreased ecological health in the Denver Metro area. This knowledge will orient our research topic on how others have achieved or attempted to achieve greater equitable access to nature while also improving climate resilience and ecological quality and connectivity.

We will gather information from other organizations that have merged equity and ecology goals in urban areas to inform the efforts around equitable access to nature, climate resilience, and ecological health in the Denver Metro area. We will detail how similar organizations have advanced efforts to restore ecological health and access to nature in urban regions, and discuss emerging themes around best practices and challenges faced. The findings in this literature review will inform the MENV Capstone Team's Final Report for Metro DNA, where we will combine information from the literature review along with interviews of other nature alliances to synthesize the best practices and recommendations for how Metro DNA can merge their equity and ecology goals.

DENVER'S **HISTORY**

Equitable Access to Nature

Trust for Public Land Parkscore

Redlining

Environmental Gentrification

Transportation & Growth

Climate Resilience & Ecological Health

Climate Resilience & Ecological Health

Climate Change & Resilience

Historical Land Use of the Colorado Front Range

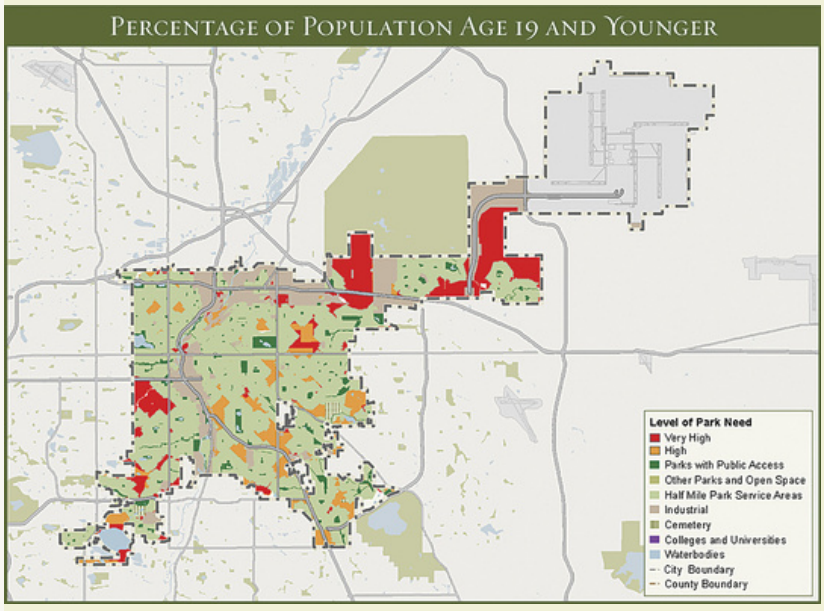
Water Rights

Natural Disasters

EQUITABLE ACCESS TO NATURE

8 Minute Read

In the Denver Metro area, many different identities are excluded from equitable and meaningful access to nature as a direct result of discriminatory land use planning, environmental gentrification, and spatial separation. Based on the 2022 Trust for Public Land ParkScore® Ranking, Denver scores a 67/100 in the equity category for green space. This ranking considers the ratio of nearby public park space between neighborhoods of color and white neighborhoods and the ratio of nearby public park space between low-income neighborhoods and high-income neighborhoods on a per person basis. Additionally, the analysis reviews the percentage of people of color and low-income households living within a 10-minute (half-mile) walk of a public park (Trust for Public Land, 2022). Lack of green space, poor ecological health, and insufficient infrastructure continue to hinder many marginalized communities today as a result of these historical inequities.



This TPL ParkServe map represents park needs for Denver's children and youth by showing the areas of Denver with and without park access (Robertson, 2013).

TPL's Park Serve

To dive deeper into Trust for Public Land's (TPL) maps and rankings, **click this link** to view TPL's Interactive Map: Park Serve. The provided map is an example of the type of information that can be accessed.

The tool allows users to view park needs in relation to certain United States city demographics.

TRUST FOR PUBLIC LAND PARKSCORE: CITY OF DENVER

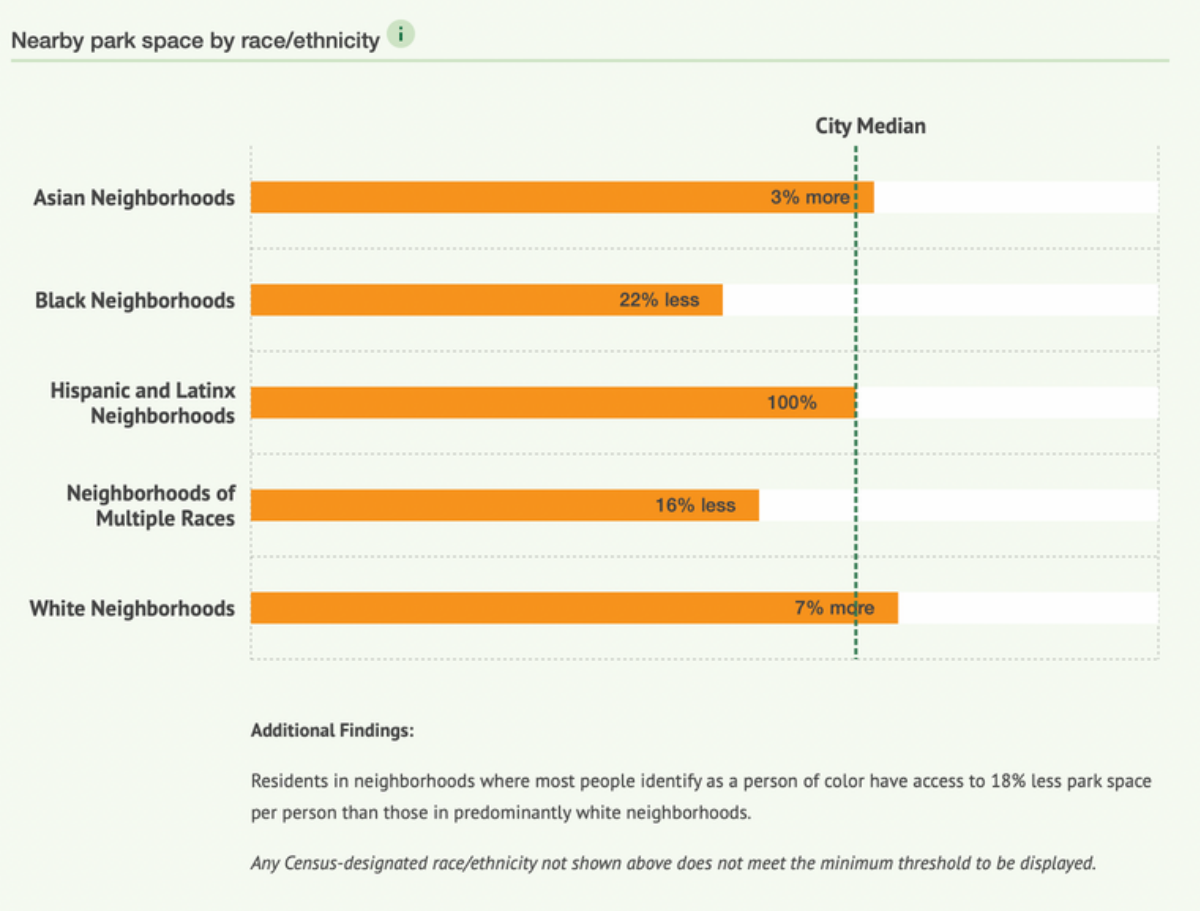
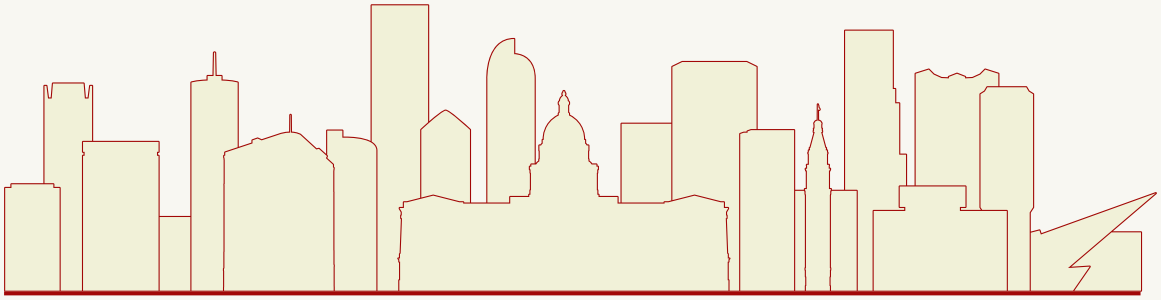


Figure 1 represents nearby park space by race/ethnicity in the City of Denver, Colorado. (Trust for Public Land, 2022)

(Trust for Public Land, 2022)

(Trust for Public Land, 2022)

REDLINING



Between 1938 and 2000, the Denver Metro area was steeped in a “redlining” culture and practice. “Redlining” includes discriminatory zoning and loaning practices that precluded Black, Indigenous and people of color (BIPOC) and low-income populations from homeownership and other services predominantly during the 20th century (Harris, 2022). Redlining concentrated BIPOC and low-income populations into specific neighborhoods across U.S. cities (Everson, 2021) (Cusick, 2020). Banks, mortgage lenders, and property insurance companies labeled BIPOC and low-income communities “hazardous” and “declining”, rejecting loans and other services “for creditworthy borrowers based strictly on their race or where they lived” (Brooks, 2020) (Townsley, et. al, 2021). In contrast, wealthy, White communities were labeled as “best” and “still desirable” for bank lending, leading to greater investment in parks and green spaces where those communities resided (Townsley, et. al, 2021).

People who lived in redlined areas were not more likely to default on loans or mortgages than those who lived outside redlined areas, but redlining made it almost impossible to buy or refinance (NPR, 2018). As a result, redlining perpetuated long-term segregation in areas like Denver by influencing which neighborhoods were concentrated with low income and BIPOC populations and which neighborhoods were concentrated with wealthy, White populations (Townsley, et. al, 2021). In redlined neighborhoods, landlords abandoned properties, city services became unreliable, crime usually increased, and property values dropped (NPR, 2018). Often in the Denver Metro area, city planners built highways through BIPOC and low-income communities and built green spaces and parks in wealthy, White neighborhoods (Abello, 2021) (Cernansky, 2019).

Satellite imagery shows tree canopy cover in Denver's Sun Valley (left) and West Highland neighborhoods (right)(USGS)(Fennell, 2021). Sun Valley is one of the lowest income neighborhoods in Denver, with 80% of residents living in poverty. The neighborhood's disconnected street grid and poverty prevent Sun Valley from economic opportunity and from accessing critical amenities (Sun Valley Redevelopment, n.d.). Three miles away, West Highland is a historically wealthy neighborhood that enjoys the perks of abundant green space like street trees (redT, 2022).

Decades later, redlining and segregation still have noticeable impacts – increased climate burdens, lower quality of living, poor ecological health, and significantly decreased green space in predominantly BIPOC and low-income areas (Townsley, et. al, 2021) (Cusick, 2020). These discriminatory practices defined the Denver Metro area's history and contribute to the problem that BIPOC and low income communities have less meaningful access to nature.

To access more information on redlining in Denver, click the **link for this interactive map** which shows redlining documented in Denver, Colorado in 1938.

Additional Resources:

University of Richmond's Digital Scholarship Lab (Mapping Inequality Red Lining in New Deal America)

NPR video (Racist Housing Practices From The 1930s Linked To Hotter Neighborhoods Today)

ENVIRONMENTAL GENTRIFICATION

Even though urban areas are becoming more green, urban greening is not making access to natural spaces more equitable. In fact, many urban greening efforts are a large driver of environmental gentrification. "Environmental gentrification" is broadly defined as the process where efforts to improve urban sustainability drive up property values and displace low-income residents (Patole, 2017). Many marginalized communities continue to resist the creation of new green spaces in low income areas, citing the concerns of environmental (or green) gentrification that could increase housing prices and force lower income communities to relocate (Rigolon, 2019). Gentrification, much like redlining, has expelled or excluded BIPOC and low-income populations from areas in the Denver Metro area that typically have greater access to nature in the form of parks, community gardens, and other green spaces. Members of BIPOC communities are also disproportionately negatively impacted by gentrification as they face additional challenges when relocating from an area that has been gentrified when compared to members of other communities. For example, Stanford researchers Hwang and Ding found that residents moving from historically Black neighborhoods experiencing gentrification tend to move to poorer non-gentrifying neighborhoods within a city, while non-Black residents moving from other gentrifying neighborhoods have a broader range of options and often move to wealthier neighborhoods within a city and its suburbs (Feder, 2020). Gentrification disproportionately impacts the BIPOC community, further exacerbating inequalities such as meaningful access to nature.

The provided images represent the challenges in the Denver Metro area when efforts to green urban areas and prevent gentrification of predominantly BIPOC areas collide. The City of Denver Parks and Recreation Office has identified areas that are predominately Hispanic or Latino and Black or African American as having greater park-need for potential future park planning projects. Though these neighborhoods deserve equitable and more meaningful access to parks and green space, green gentrification is a very real threat that could displace these marginalized communities if parks are not planned appropriately.

There is no mention of the threat of **green gentrification** nor potential mitigation efforts to prevent displacement caused by it on The Denver Parks and Recreation Office website or in its resources. There is, however, information on preventing displacement caused by gentrification which was published by the Denver Office of Economic Development. Based on these findings, it is reasonable to conclude that cities and academics are not collaborating enough on city park planning efforts to provide greater access to nature while protecting communities from green gentrification.

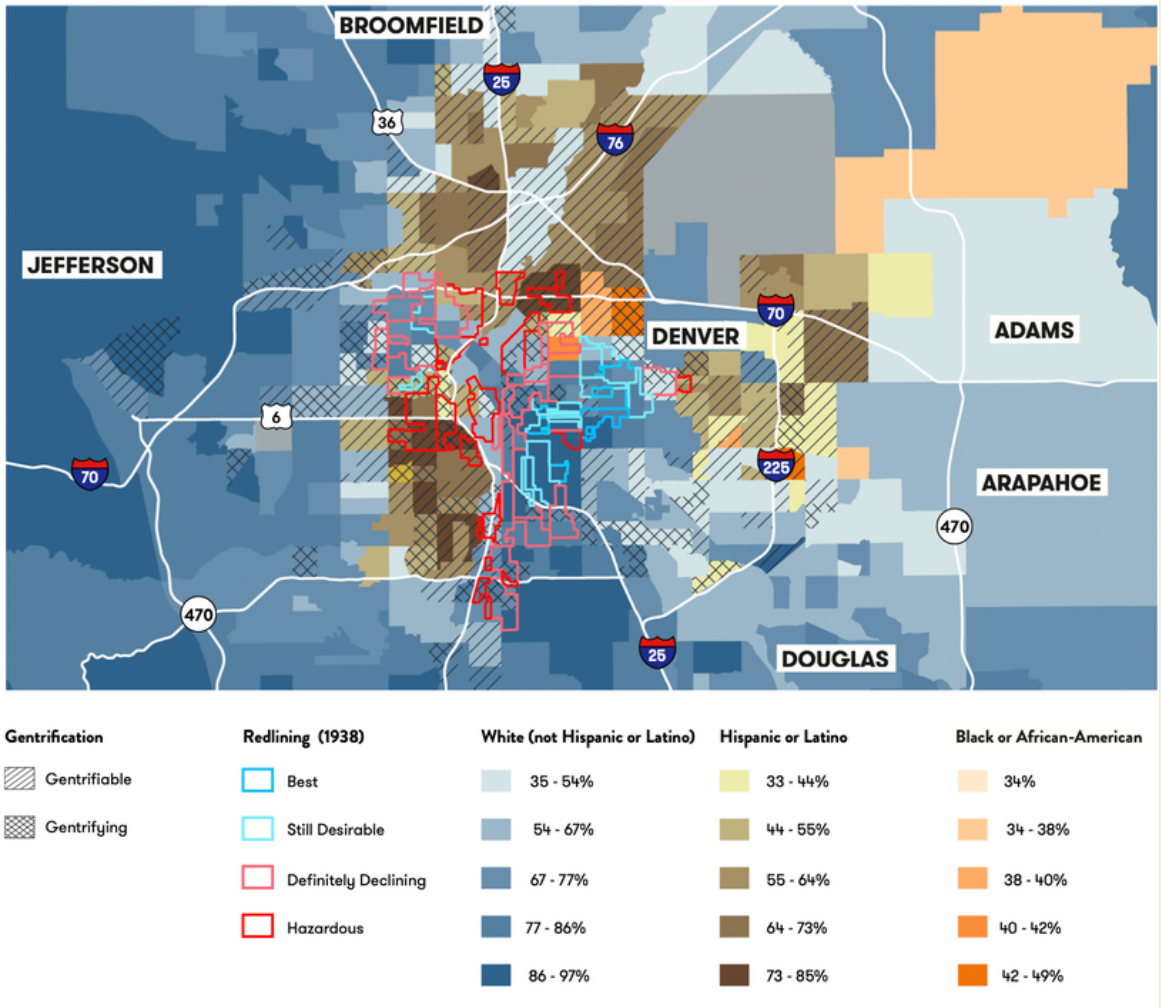


Figure 2 above is a map created by Shift Research Lab which shows gentrification trends and racial plurality in the Denver Metro Region in 2016. (Shift Research Lab, n.d.)

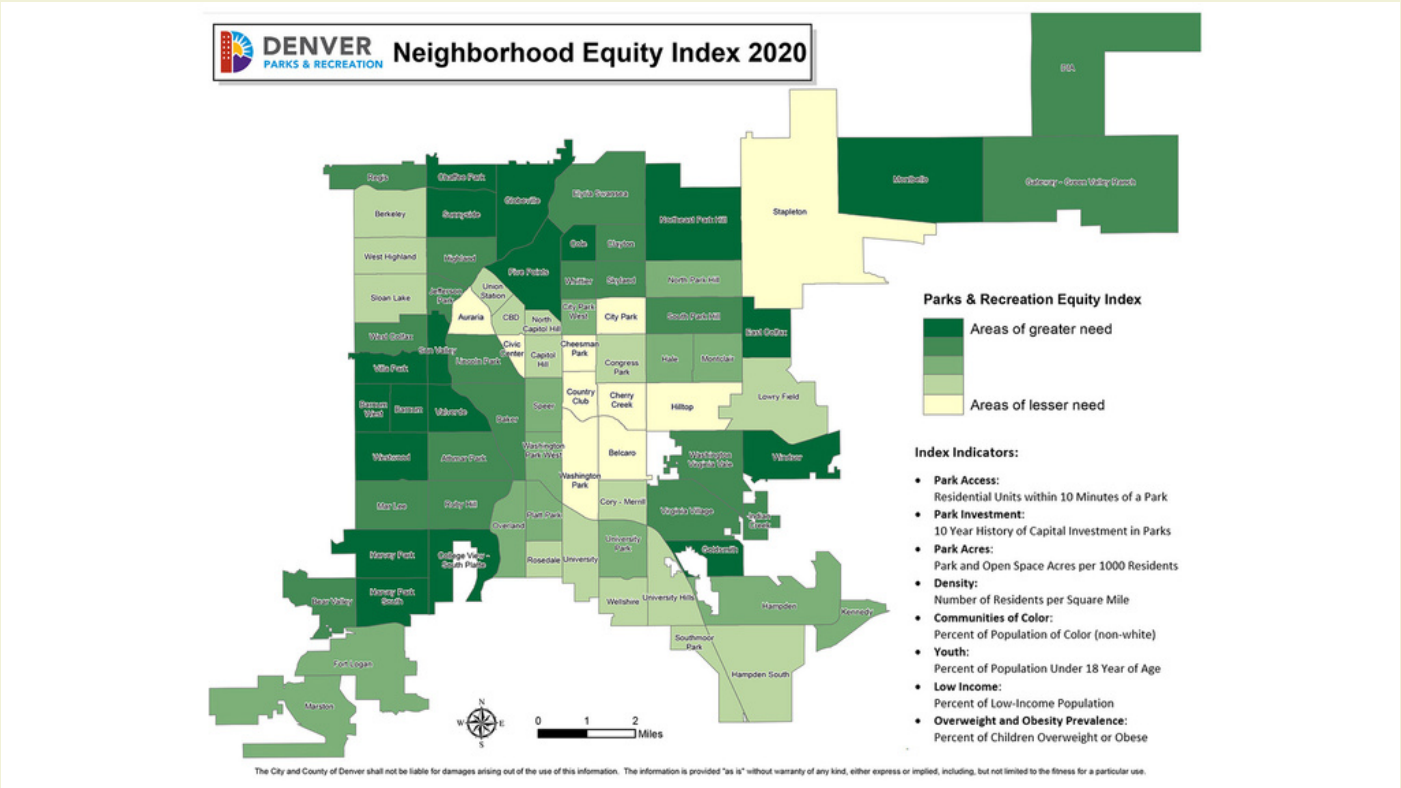


Figure 3 above is a map created in 2020 by the City of Denver Parks and Recreation Office which shows which Denver neighborhoods are areas of greatest access-to-park need. (Beaty, 2020)

Additional resources to learn more about environmental gentrification:

- Shift Research Lab (*Undesign the Redline*, "Gentrification: A Recent History in Metro Denver")
- Alessandro Rigolon & Jeremy Németh (Green gentrification or 'just green enough': Do park location, size and function affect whether a place gentrifies or not?)
- Eco Justice Radio (Greening Without Gentrification: Expanding Parks and Protecting Communities-Ep. 119)

TRANSPORTATION & GROWTH

The Denver Metro area has grown substantially in the past decades. The region is consistently ranked as one of the fastest growing areas in the United States (Metro Denver EDC, 2022). In 1950, about half a million people lived in the Denver Metro area. Today, the region's population is around 2.9 million (MacroTrends, 2022). Rapid urbanization has led to increasing spatial separation, or "sprawl", between people's homes, their jobs, businesses, and recreational activities (Rusk, 2003). In the Denver Metro area, sprawl has increased the space between the physical places people occupy most and local green spaces. Sprawl has made it more time consuming and costly for Denver Metro area residents to access nature, especially for historically marginalized groups who may be located farther from green spaces or have less infrastructure to support their transportation needs (Gosalvez, 2020).

The Denver Metro area is known for failing to get the basics of public transportation right across the region (Bosselman, 2019) (Spieler, 2018). Congested primary access routes and parking areas limit the ease of arriving at commonly trafficked areas such as trailheads, parks, local green spaces and other outdoor spaces. The lack of efficient connectivity within the Denver Metro area's transportation system is the primary fault within its development. Equitable access to efficient public transportation is another major concern within the region. For those who don't have cars or licenses, public transportation is essential for accessing local green space that is too far or inaccessible to walk to. With limited coverage, the Denver regional transportation system does not provide adequate service to individuals residing in lower income or BIPOC predominant communities (Sen, 2022). This fault in the system limits marginalized groups' easy access to affordable and reliable transportation, a service essential for accessing nature outside one's community.

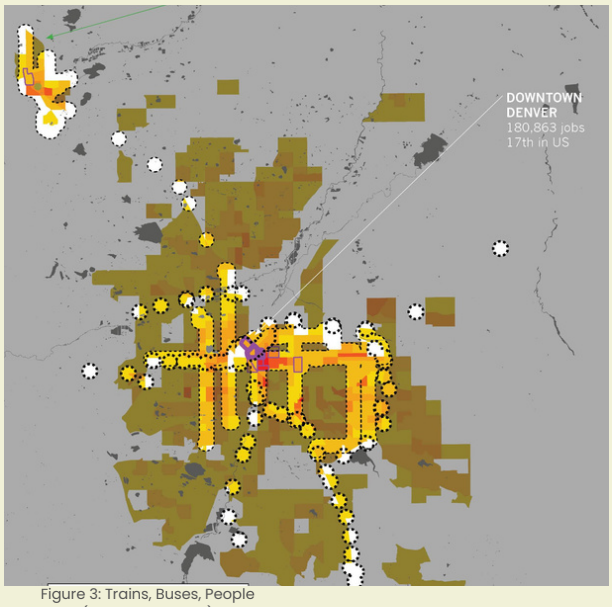


Figure 3: Trains, Buses, People (Bosselman, 2019)

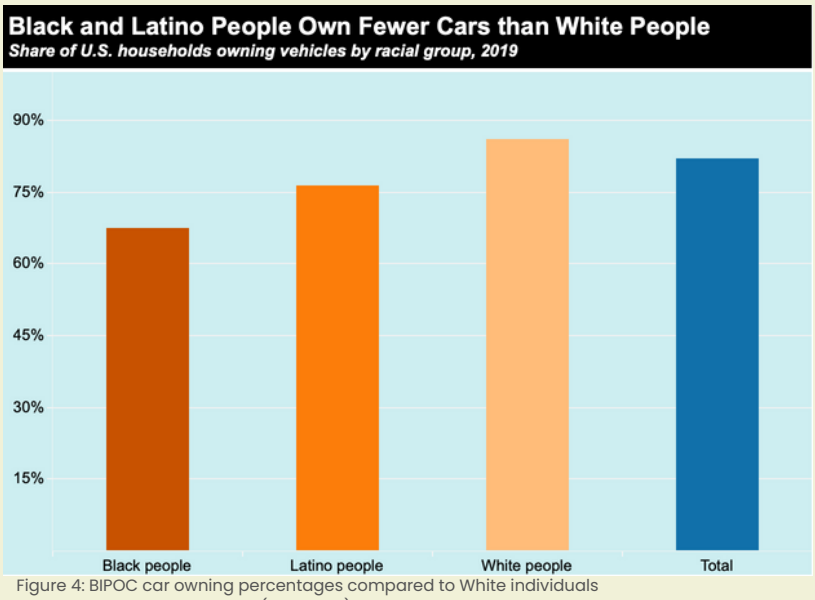


Figure 4: BIPOC car owning percentages compared to White individuals (Sen, 2022).

Figure 3 showcases the contrast between population density (colored blocks: yellow, orange, purple red; the darkest colors signify the greatest density--e.g. red + purple) to public transportation (the circles and rounded, clear lines) within the Denver Metro area. In this figure, there is a strong contrast between where a majority of individuals are residing to where the access to public transportation begins. Figure 4 shows the average percentage of BIPOC vehicle owners compared to white individuals according to a 2019 census report. This factor is a key attribute to the inequitable distribution of transportation access for the BIPOC communities within large urban areas.

The RTD Bus Transit Study Equity Analysis created an interactive map in 2019 to learn about where future bus routes, known as Bus Rapid Transit (BRT) corridors, are likely to "enhance mobility and equity for a wide range of people" in the Denver Metro area (Headwaters Economics, 2019). The map allows users to identify potential Bus Rapid Transit corridors and associated impacts on vulnerable populations, such as people who are low-income, people who don't have cars, and people with disabilities (Hernandez Gude, 2019).

The current DR COG Plan to address issues can be accessed through clicking this link (DRCOG, 2022).

SECTION SUMMARY

Many of the historical and modern inequities related to accessing nature were caused by exclusionary land use regulations and the long-term impacts of discriminatory housing and lending policies that segregated low-income people of color into overcrowded and nature-poor neighborhoods (Rigolon, 2019). Discriminatory land use policies, redlining, gentrification, rapid urbanization, and inequitable transportation options have further exacerbated the issue of meaningful access to nature across marginalized communities within the Denver Metro area. To adequately address the problems caused by redlining and gentrification, those working to create equitable access to nature within the Denver Metro area need to fully understand their histories and modern implications. Additionally, it will be vital for practitioners to obtain a deep understanding of modern issues that continue to perpetuate inequitable access to nature, such as disproportionate transportation options and park planning efforts.

CLIMATE RESILIENCE & ECOLOGICAL HEALTH

6 Minute Read

Just as equitable access to nature is a human right, so is a healthy and safe environment (United Nations, 2021) (Louv, 2021). Often, those who contribute the least to climate change and have the fewest resources to be resilient against it are disproportionately impacted. Climate resilience and ecological health is an environmental justice issue (Cho, 2020). In order to achieve Metro DNA's goal of building climate resilience and ecological health and connectivity in the Denver Metro Area, practitioners must understand the history of ecosystems in the Colorado Front Range. The Colorado Front Range has seen generations of development and changing land-use patterns. Recognizing this rich landscape history is a crucial step to establishing an understanding of modern issues' roots and their dynamic impacts on life in the Front Range today.

The Denver Metro area sits on the Colorado Front Range, an area that has changed significantly as the region's population has grown. These changes include the development of natural land cover like coniferous forests and grassland plains, and the creation of agricultural lands (**Figure 5**).

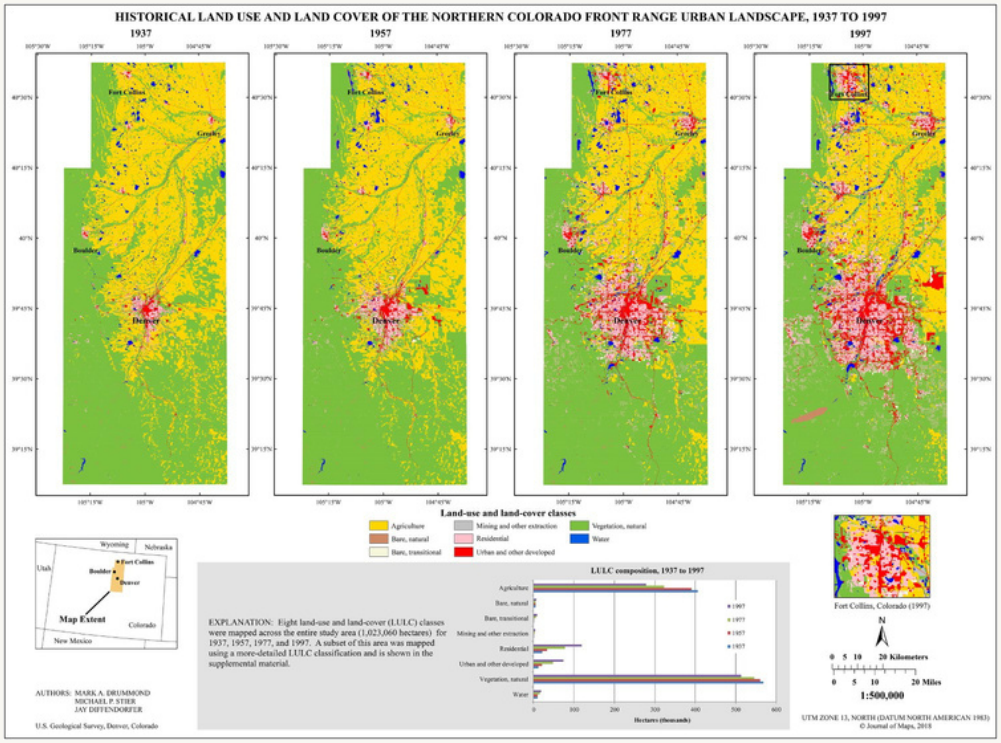
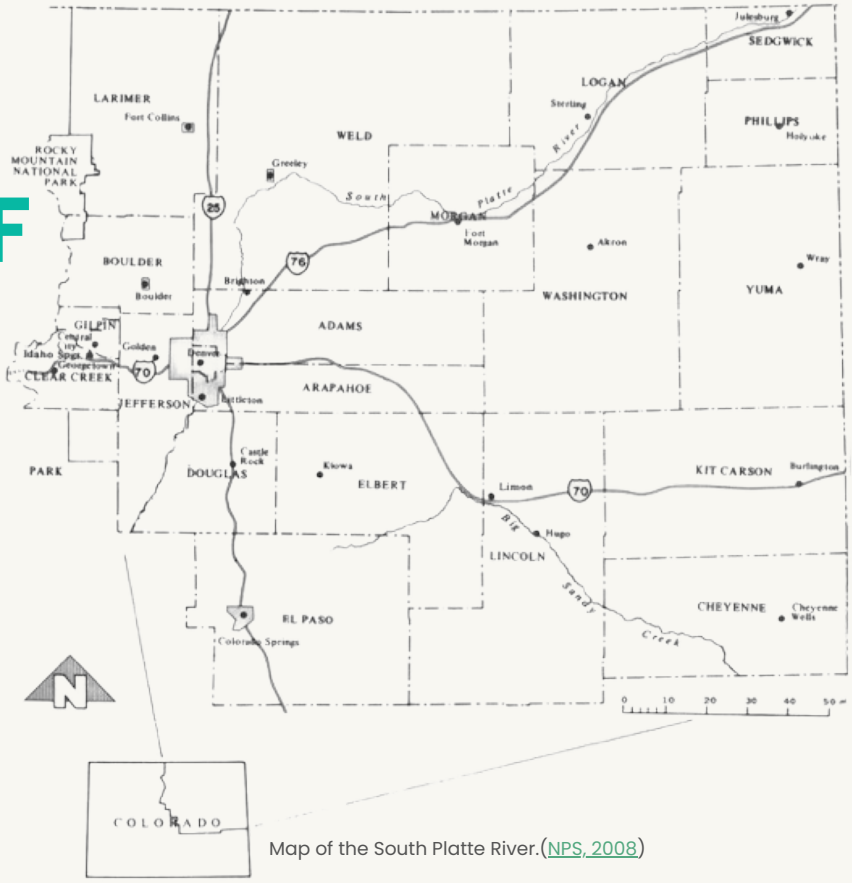


Figure 5 Land-use and land-cover classification of the northern Colorado Front Range urban study area for 1937, 1957, 1977, and 1997. (Drummond et. al, 2019) (NRCS and USGS)

HISTORICAL LAND USE OF THE COLORADO FRONT RANGE



Map of the South Platte River.(NPS, 2008)

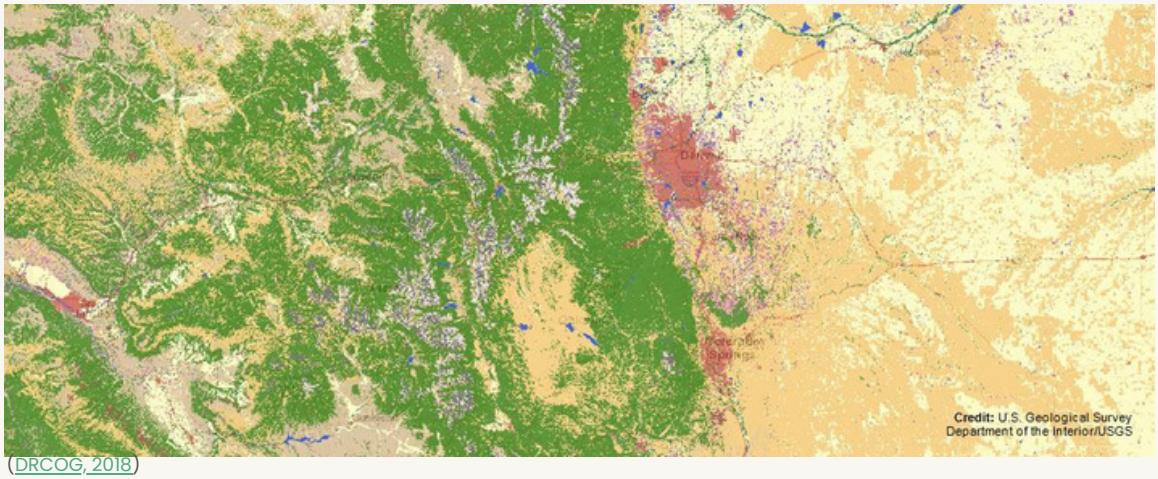
Land use change is the conversion of land from one purpose to another. These changes affect social, economic, and ecological processes throughout a region. As cities and suburbs expand, often the surrounding landscape undergoes changes that can affect wildlife habitat, hydrology, biogeochemical cycles, weather and climate (Biggs, Atkinson, Powell, & Ojeda-Revah, 2010) (Drummond et. al, 2019).

In the early 20th century, farmers across the northern Colorado Front Range tilled thousands of acres of grassland into wheatfields and other agricultural projects (University of Northern Colorado, 2022). During the 1990s, about 36,000 ha of agricultural land was converted to urban land per year. Around this time water was also consistently distributed away from agricultural use and towards urban areas to meet urban and industrial demands (Smith et al., 1996) (Drummond et. al, 2019). The Denver Metro Area sits on the South Platte Watershed which in 1999 had around 15 interbasin diversions that added water from the West Slopes, 500 irrigation ditches, and 100 reservoirs to remove water for agricultural and urban demands (Strange et. al, 1999). The South Platte Watershed was one of the primary reasons for development along the Front Range during the period of European colonization of North America. Streams and rivers brought life to the Front Range. The Colorado Front Range landscape was also an area with abundant natural resources like timber and precious minerals,

the landscape's natural resources drew more people to the area and encouraged them to develop. Gold and silver were found in the late 1800s throughout Clear Creek, Gilpin, Jefferson and Boulder Counties–the abundance of these minerals played a key role in the region's development and mining operations were started across the landscape (NPS, 2008) (Daniel, 2017).

In 1899, farmers began planting beet crops and in 1909 the state of Colorado became the largest producer of beets in the nation. Converting cereal-grain fields to beet and other vegetable fields was water intensive and it put a strain on the region's water supply (Daniel, 2017). After almost a decade of worsening drought and acres of farmland receiving half their water needs or no water at all, the Colorado–Big Thompson project was developed. The project brought water from the Western Slope to the Front Range. It provided water for farmers growing water-intensive crops and drinking water for the region's expanding urban population (Daniel, 2017).

There was a rich variety of species in the Rocky Mountains and in the Colorado Front Range during early settlement. However, many colonists over hunted the local species--including deer, elk, bears, and buffalo (Grizzly Rose, 2019). Colonists over hunted so much buffalo that the species began disappearing from the landscape. Buffalo were eventually replaced with longhorn cattle and other domesticated, roaming species (Daniel, 2017).



(DRCOG, 2018)

This section only covers a small part of the Colorado Front Range's complex history. Take a look at the following resources to learn more.

Additional Resources:

Colorado Gold Rush (Colorado Encyclopedia)

The New Empire of the Rockies: A History of Northeast Colorado (NPS.gov)

Front Range (Colorado Encyclopedia)

CLIMATE CHANGE & RESILIENCE

According to multiple independent measurements, Colorado average temperatures have increased by approximately two degrees (F) between 1977 and 2006. The Colorado Health Institute determined that this increase ranks Colorado as the 20th fastest-warming state since 1970. The Denver Metro area is projected to experience decreased snowpack and water supply, and higher temperatures and drought are likely to increase the severity, frequency, and the extent of wildfires. These wildfires have the potential to cause destruction to property, livelihoods, and human health (350colorado, 2021). The smoke created by wildfires can reduce air quality and trigger a range of symptoms for anyone including difficulty breathing, wheezing, and burning eyes (CDPHE, n.d.) (United States Environmental Protection Agency, 2021).

The Denver Metro area recently experienced unusually hot and dry conditions, severe wildfires and floods, and widespread infestations of tree-killing beetles (Riebsame, et al., 2017). The threats climate change poses for the Denver Metro area include urban heat island effect, infrastructure damage from severe storms, drought, loss of biodiversity, and ecosystem failure. In addition to increasing population pressure, the management of urban green spaces is further exacerbated by climate change. Changes in precipitation patterns, changes in the timing of seasons, and increased frequency and severity of extreme events (e.g. storms, floods, droughts) are among many climate related changes that land use planners will need to consider in order to safeguard the integrity of urban green space and associated ecosystem services (Stott, 2016) (Reynolds et al., 2020).

A growing number of government and scientific reports link project even greater climate change impacts in the future, making climate resilience infrastructure vital for sustaining quality of life in the Denver Metro area (The Report of The Colorado Local Resilience Project, 2015). Urban planning for climate change adaptation is critical, and studies have shown that urban green spaces can promote climate change resilience in cities (Cheng, 2021).

WATER RIGHTS

The environmental history of Colorado and the Front Range are intertwined with water rights, usage, and policy. Water is considered scarce for much of the Denver Metro area, and drought intensity and duration will continue to be exacerbated by the rising temperatures, decreased rainfall, and shrinking snowpack caused by climate change. As populations continue to grow, water availability will continue to shrink and there will be greater competition for water resources (Donahue, 2021).

Given the value of water in Colorado, water laws and rights are particularly sensitive. The primary law governing water distribution in Colorado is the Prior Appropriation Doctrine, created in 1973. The Prior Appropriation Doctrine established that water rights are determined by priority of beneficial use - meaning that the first person to use water for a "beneficial purpose" can acquire rights to the water. Beneficial purposes often meant agricultural, recreational, municipal, industrial, or mining uses (University of Nevada, n.d.). This antiquated system was designed in a time of unfettered development, and prioritized original water users while excluding many new water users, regardless of whoever might have the most beneficial, sustainable, or efficient use of those water rights. Currently, much of Colorado operates in a state of over-appropriation, and areas with significant rainfall continue to experience dwindling availability for new rights applicants (Schilling, 2018). Today, the Prior Appropriation system doesn't allow for full access to water as a human right. There is broad recognition that this priority system must change to allow the growing population to have adequate and full access to water (Schilling, 2018).

Colorado is currently in the process of updating their State Water Plan, a preliminary version of the plan calls for fewer grassy lawns, but many Coloradans argue that water should still be used for green spaces like parks, gardens and stream corridors that have health benefits for people and animals (Runyon and Hager, 2022). Much of the water supply for the Denver Metro area comes from tributaries of the Colorado River. However, as the Colorado River basin has experienced a megadrought for the last two decades - water managers are preparing for a water scarce future by attempting to diversify water sources and enhance water conservation and efficiency (Baltz et. al, 2021).

NATURAL DISASTERS

(Boulder County, 2022)

(NOAA Climate.gov, 2022)(WXChasing)

As climate change leads to higher average temperatures across Colorado and prolonged periods of drought, municipalities have increasing exposure to wildfire risk (Huber, 2018). The year 2020 shattered wildfire records across Colorado, burning 667,000 acres statewide and producing three of the largest wildfires in the state's recorded history (Finley, 2021). The Marshall Fire in 2021 demonstrated there is high vulnerability to wildfire in both open spaces and urban areas. Popular understanding has historically been that wildfires mainly threaten forested ecosystems, not grassland ecosystems. However, the Marshall Fire has indicated that municipalities must rethink mitigation and preparedness planning, especially in cases of historically low-risk areas like grassland ecosystems. In fact, a recent study conducted in 2017 on wildfires in the Great Plains revealed the number of acres burned each year increased by 400% on the Great Plains' western boundaries, an area which covers nearly half of the state of Colorado (Ufheil, 2022) (Donovan et. al, 2017).

These natural disasters are pressing threats to communities in the Denver Metro area, and regional planners have a responsibility to prepare communities to both minimize and face these disasters.

SECTION SUMMARY

Land use change and climate change have had significant impacts on the ecosystems in the Denver Metro area - affecting wildlife habitats and connectivity, air quality, water quality, public health, and resilience to climate change. As these changes continue to have an impact on the Denver Metro area, appropriate urban planning will be necessary to safeguard ecosystems and advance climate resilience while promoting sustainable growth.

EQUITABLE
ACCESS TO NATURE

14 Minute Read

Access to nature is a human right (United Nations, 2021) (Louv, 2021). However, not all people have access to nature, especially in the Denver Metro area. Equitable access to nature is the ability for all groups to access green space regardless of race, income, ability, and other socio-economic identities. Beyond equitable access to nature, meaningful access to nature means a person can safely and freely immerse themselves in a natural space and receive inherent benefits like improved mental and physical health, relaxation, and joy. Creating meaningful access to nature can be a complex challenge in historically underrepresented communities; institutional barriers (like green gentrification) continuously threaten successful efforts. The following section considers best practices of how organizations across the United States have created and sustained long-term, equitable and meaningful access to nature within their own communities.

Watch

Here We Stand #AnEveryoneOutside Film

Listen to

Nature is for Everyone: Equity in the Outdoors (Arielle King)

Case Studies

- 11th Street Bridge Park
- Clear Creek County
- Wild Diversity
- Vienna, Austria
- Confluence
- Transit Projects (3)
- The Intertwine Alliance

11TH STREET BRIDGE PARK

Key Takeways

When working in vulnerable communities, it is imperative to bring all diverse voices into all stages of the planning process. To ensure that a design will work for a community long into the future, planners must come back again and again to engage community members. Budget can be a major constraint to this strategy. Community engagement can be expensive and time consuming; planners must account for these costs and budget appropriately. Additionally, holding hundreds of meetings can slow a project down long into the future.

(District of Columbia, 2022)

The Trust for Public Land's Parkscore tool assesses residents' abilities to access green space within a 10-minute walk from their residence in the United States' largest 100 cities. Washington D.C. scored #1 for access to green space. Washington D.C.'s **11th Street Bridge Park** project is scheduled for completion by Building Bridges Across the River (BBAR) in 2024. The park will connect two communities, Anacostia and Capitol Hill, neighborhoods that were historically divided by the Anacostia River. The neighborhoods differ greatly in terms of socio-economic status, largely due to decades of disinvestment and segregation in the Anacostia neighborhood (Kratz, 2019). There are large disparities in health, wealth, and economic opportunity between the two neighborhoods that border the river.

Important goals of the project include (1) physically connecting residents of each neighborhood and (2) that historically disinvested residents and small businesses continue to benefit from the park's creation long into the future. To make this happen, the park's design is being driven by community members from both neighborhoods. Planners and architects held hundreds of meetings with community members over the span of two years to gather input on key concepts to incorporate into the park's design. As the implementation phase is carried out, park designers will continue to gather community input to figure out what does and does not work for neighboring residents. The project's Equitable Development Plan includes the following process recommendations:

Start the project early

Learn from experts in the field

Make data informed decisions

Engage diverse stakeholders

Diversify the project team to reflect values and identities of project location

Take an interdisciplinary approach

Develop measurable and attainable goals for each recommendation made

Obtain community input through all stages of the project process

CLEAR CREEK COUNTY

Key Takeways

Expand outdoor adventure programs and green spaces to fit Universal Design Principles to improve the experience of all users. A vital part of being able to access nature is creating accessible routes for all people to travel to and within a natural space. This strategy can create challenges and controversy over human impact on ecosystem health. In Desert Solitaire by Edward Abbey, Abbey brings up the argument that environmentally-valuable areas should limit human access to prevent environmental degradation. Unchecked tourism has harmed the environmental quality in protected natural areas, like National Parks (Finnessey, 2012). A balance must be struck. Promoting new, equitable, meaningful access pathways must also include strategies to combat over tourism and ecosystem degradation.

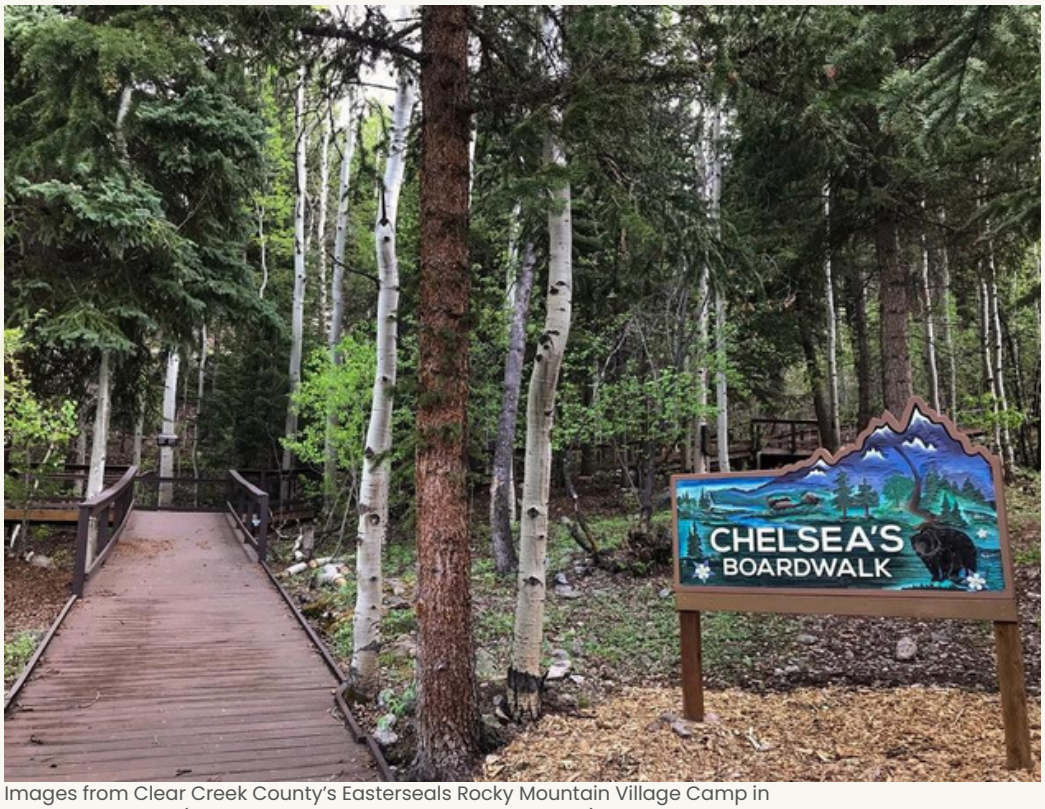
Images from Clear Creek County's Accessibility Colorado Initiative. (Clear Creek County Tourism Bureau, 2022)

Clear Creek County in Colorado has improved access to nature for people with disabilities by implementing Universal Design Principles in their parks and outdoor programs. Clear Creek County features popular destinations like Idaho Springs and Mount Evans. Clear Creek County has worked with Partners for

Access to the Woods (PAW) to build an accessible hiking route in Empire, Colorado. The PAW trail gives visitors the opportunity to experience and explore the history of the wagon road over Berthoud Pass. The trail is walker and wheelchair accessible, and designed to fulfill the needs of those with hearing and vision impairments.The 481 foot long trail features interpretive signage and gravel sections with few steep grades (Clear Creek County Tourism Bureau, 2022).

Clear Creek County also offers accessible camping at the Easterseals Camp in Empire, Colorado. The camp is fully accessible and used by more than 1,000 children and adults with disabilities every year. Additionally, Clear Creek County offers accessible ziplining, rafting, mountain getaways, luxury lodging, and historic sites.

An example of a Universal Design strategy is placing and expanding ADA parking in areas where popular activities are. This creates different access points that can be used by all visitors and facilitates inclusivity. Additionally, widening pathways beyond required ADA widths can improve the experience of all visitors and suit the needs of wheeled devices such as wheelchairs or strollers (Kanics, 2015).



Images from Clear Creek County's Easterseals Rocky Mountain Village Camp in Empire, Colorado. (Clear Creek County Tourism Bureau, 2022)

WILD DIVERSITY

Key Takeaways

Create programs that are geared toward marginalized groups and specifically designed to meet the needs of communities and close the access to nature gap. Given the history of exclusion for many groups in outdoor recreation, there may be many unforeseen and deeply embedded institutional barriers that can take time to dismantle and resolve. This process can be time-consuming and costly, especially in communities that have limited capacities. Additionally, these programs must be led by trusted community members and it may be time-intensive to find staff that fit the role and are able to commit long-term to a program's development.

Wild Diversity is a nonprofit organization based in Portland, Oregon that improves access to nature for the LGBTQ+ communities and people of color by building community, facilitating community workshops, offering outdoor education, and hosting adventure opportunities. Wild Diversity runs day and weekend-long adventure trips, has built robust community partnerships and held conferences, provides outdoor skills workshops, creates access to a gear library, and works to decolonize outdoor space by providing diverse leadership training. One of the many opportunities the nonprofit offers is backpacking adventure trips for LGBTQ+ communities and people of color. Backpacking trips are held in a variety of natural spaces in Oregon, including a trip to explore Mount Rainier's alpine meadows, Mt. Hood's old growth forest and creeks, and a 4-day 18 mile backpacking trip to the Hoh Rainforest. Wild Diversity provides gear and transportation for all participants.

VIENNA, AUSTRIA

Key Takeways

Having access to nature does not ensure meaningful interaction with nature. Nature spaces must be designed for marginalized groups, to encourage interaction with nature in ways that make marginalized groups feel safe and seen. The more groups that are considered in the design and engagement process, the better a space can serve a larger diversity of people. A challenge to this is engaging appropriately with community members in ways that ensure they feel heard and safe. Additionally, designers should remember that this type of communication process is an exchange, not a "gift" or a form of data-mining. Another challenge to this approach is finding ways to manage these projects so that their benefits last long into the future, and do not end up harming marginalized groups down the line.

In **Vienna, Austria** the city is working towards making urban spaces more inclusive for women, girls, and gender minorities. The design strategies that Vienna implemented have had noticeable impacts on access to nature for not just women, girls, and gender minorities but other marginalized groups as well. For example, park designs that feature enclosed spaces, better street lights, more visible paths, and wider and more entrances and exits have improved access to nature for the LGBTQ+ community in Vienna (Catterall & Azzouz, 2021). The Einsiedler Park was designed to provide meaningful access to minorities living in diverse, surrounding neighborhoods in Vienna. Some of the main problems park designers looked to address included: girls' feelings that nothing in the park was built for them, fear of entering spaces designed for and dominated by boys and

(Stadt Wien, n.d.)

men, and expectations to care for younger siblings.

Park designers built platforms and installed hammocks and seats to provide spaces for girls, women, and gender minorities while walking around the community. Wider pathways with better lighting and visible footpaths were installed to improve comfort levels and safety within the park. Entrances to sports areas were increased and widened, game areas were separated into different sections, and a sitting area was installed in the middle of the games area. Seats and benches were installed in the infant playground so girls and parents could sit and socialize while also watching younger children (source). Successful design strategies discovered from this project are:

Install shelter

Widen entrances and exits

Divide spaces into sub-zones

Diversify game activities

Make paths visible and clear to see where they lead

Provide areas for sitting and loitering

Install good lighting

Install more swings and equipment for climbing and balancing

Have functioning, quality toilet areas

The Gender Mainstreaming in Urban Planning and Urban Development guide published by Urban Development Vienna is a fantastic resource for those looking to identify and obtain a systematic understanding of the needs of different users in public spaces. This manual specifically looks at how public spaces meet the needs of different genders.

CONFLUENCE

Key Takeways

Equity valuation and scoring systems can be embedded into park funding processes and design strategies in your region. However, a potential challenge to this is that public equity valuation and scoring systems that help governments track project prioritization may contribute to issues like gentrification when additional funding is allocated towards park improvements without also ensuring adequate protection for community members to prevent subsequent displacement.

Confluence is a landscape design, planning, and urban design firm that built a framework for equity into park systems. Confluence addressed ways to fairly prioritize investments to ensure a park's design or redesign advances equity goals within a region (Minirik & Aldrich, 2022). Confluence collaborated with the Minneapolis Park and Recreation Board (MPRB) to create a 23-point system to score parks by demographics and park characteristics. The evaluation system informs park prioritization in order to support greater equity in park investments.

Confluence now uses the evaluation system in other designs to address equity issues in parks. The Minneapolis park system completed comprehensive assessments of all MPRB centers and their specific needs, created a publicly available online chart comparing MPRB facilities, land acquisition, and annual park investments, continually updates the region's Racial Equity Action Plan, and involves diverse voices and groups into engagement, accountability, and implementation efforts. Confluence adapted the model that they used with the MPRB to advance racial and economic equity in Bloomington, Minnesota, through the Bloomington Park System Master Plan. Bloomington's Forward 2040 Comprehensive Plan provides guidance on infrastructure investment within the community to advance their racial and economic equity goals.

TRANSIT PROJECTS

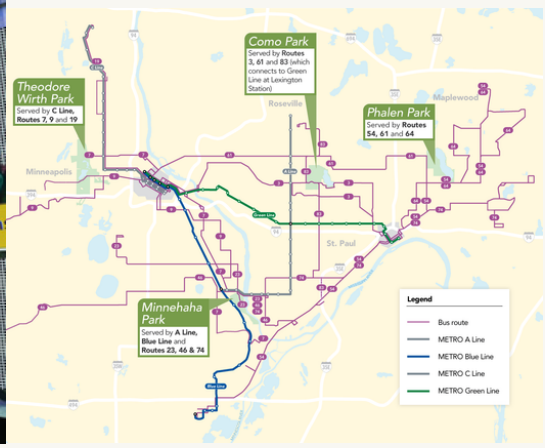
Key Takeways

Design and create transit routes to natural areas throughout a metropolitan region. Collaborating with and gathering input from local organizations about where transit routes should be can improve ridership and reduce the access to nature gap. Organizations can take advantage of grant programs like The Transit to Trails Act, the Environmental Justice for All Act, and the Invest in America Act to improve equitable and meaningful access to nature. Given power dynamics in local politics, more privileged communities may advocate for bus systems more than historically disadvantaged communities. This could be due to a number of factors including having more time, resources, or awareness of the program.

(Issaquah Alps Trails Club, 2019)

Trailhead Direct is a shuttle service that formed in 2017 in the Seattle area. The service run by King County Parks and King County Metro originally formed to reduce trail traffic congestion. However, many have come to recognize the service as key to improving access to nature in the Seattle area. Trailhead Direct offers shuttle service to over 150 trails in the surrounding region. In 2019, Trailhead Direct collaborated with The Wilderness Society and the Environmental Coalition of South Seattle to close the nature gap for people of color in the Seattle area. In order to reach a broader audience and improve access to nature for those who most need it, Trailhead Direct launched a new shuttle line for the Southern Seattle area. The new shuttle line led to a 75% increase in shuttle ridership to regional trails (Johnson, 2021).

(Metro Transit, 2019)



(Metro Transit, 2019)

Metro Transit has created a transit system to connect residents of the Minneapolis and St. Paul, Minnesota areas to local parks. Metro Transit decorated regional buses with nature imagery to signal to riders about the bus' park access. Buses, called "Nature Connectors", connect people of urban areas to local parks and show people where they can hop on a bus with monarch butterfly art on sidewalks near bus stops.

The Transit to Trails Act, established in 2021, will help build a grant program for organizations and governments looking to improve transportation opportunities for accessing public lands. The Transit to Trail Act can provide up to $500,000 for projects. The Environmental Justice for All Act and Invest in America Act provide funding for projects seeking to improve infrastructure and improve transportation access to nature in urban areas (Kerr, 2019).

Together for Brothers (T4B) is an organization seeking to, in part, create transportation sovereignty in New Mexico. The nonprofit worked with a variety of organizations to help establish a program that provides free youth bus passes for five years in the City of Albuquerque. The program started in 2021 and is expected to continue through 2026 (T4B, n.d.).

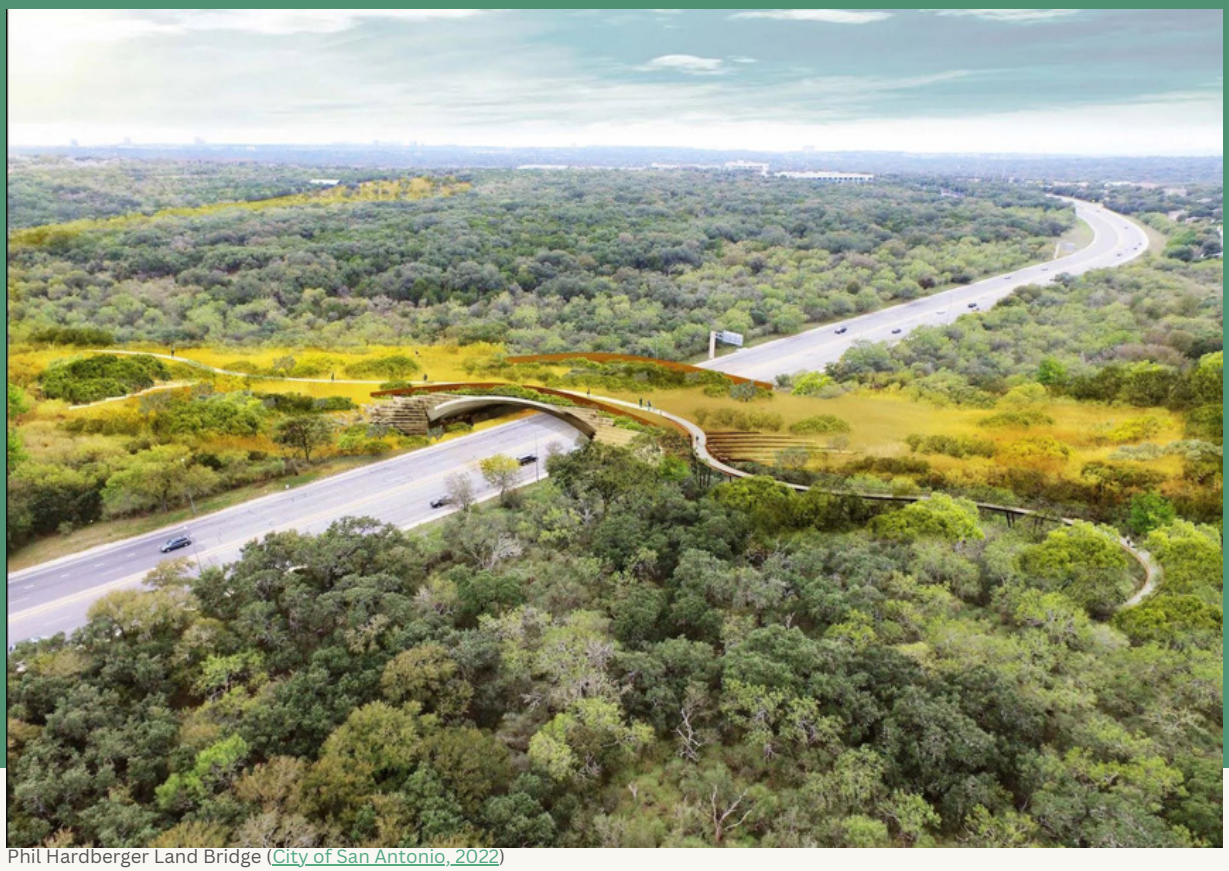
THE INTERTWINE ALLIANCE

Key Takeways

Get creative and utilize children's programs to promote meaningful access to nature through interactive educational opportunities. Create opportunities for meaningful interaction with nature with local species and in local community spaces like in parks and playgrounds.
Educators would need to put in additional time and resources to create a truly meaningful interaction with childrens' local environments. Field trips may not be feasible for some communities, or easily accessible nature may not be close to where children's programs are held. These programs might need outside funding from nonprofit organizations, government grants, or some other funding resource.

The Intertwine Alliance's Greening of Schoolyards Collective focuses on improving outdoor learning spaces and greening schoolyards to improve children's access to nature and providing a way for them to interact with green spaces in a comfortable, familiar and safe setting, particularly in low-income communities. The Greening of Schoolyards Collective provides resources, best practices, and a platform for collaboration while connecting a diverse range of stakeholders who are working toward improving the state of children's health, ability to succeed and overall school experience. The collective's focus is on finding funding for members' work, assuring they are building the best and most sustainable projects possible, and providing proper support for teachers.

The **Intertwine Alliance's RxPlay project**, while currently on pause due to the COVID-19 pandemic, is a program that leverages patient and clinician connections to use nature and physical activity as a key component for mental, physical, and spiritual health. The prescription play program is utilized as a primary-care solution for dealing with a range of health ailments. The program is currently undergoing an expansion that will help RxPlay reach more participants by expanding the number of partners and stakeholders while reaching underserved communities and increasing access.



Phil Hardberger Land Bridge (City of San Antonio, 2022)

BIODIVERSITY CORRIDORS

14 Minute Read

A biodiversity corridor is any feature in the landscape surrounded by cultivated or fragmented land which can be used as a method of transit or habitat for local species (Sprlyan, 2019). This section provides an overview of what communities and organizations have done to promote biodiversity within their own regions. As Metro DNA searches for new ways to support ecological health and connectivity within the Denver Metro Region, it will be crucial to learn from and potentially replicate strategies of what other organizations have implemented successfully.

Case Studies

Al Fay Park
The Wallis Annenberg Wildlife Crossing
All-Ireland Pollinator Plan
Wild West End
U.S. Highway 93
Bangalow Koalas
The Rewild London Fund & Rewild My Street

Watch

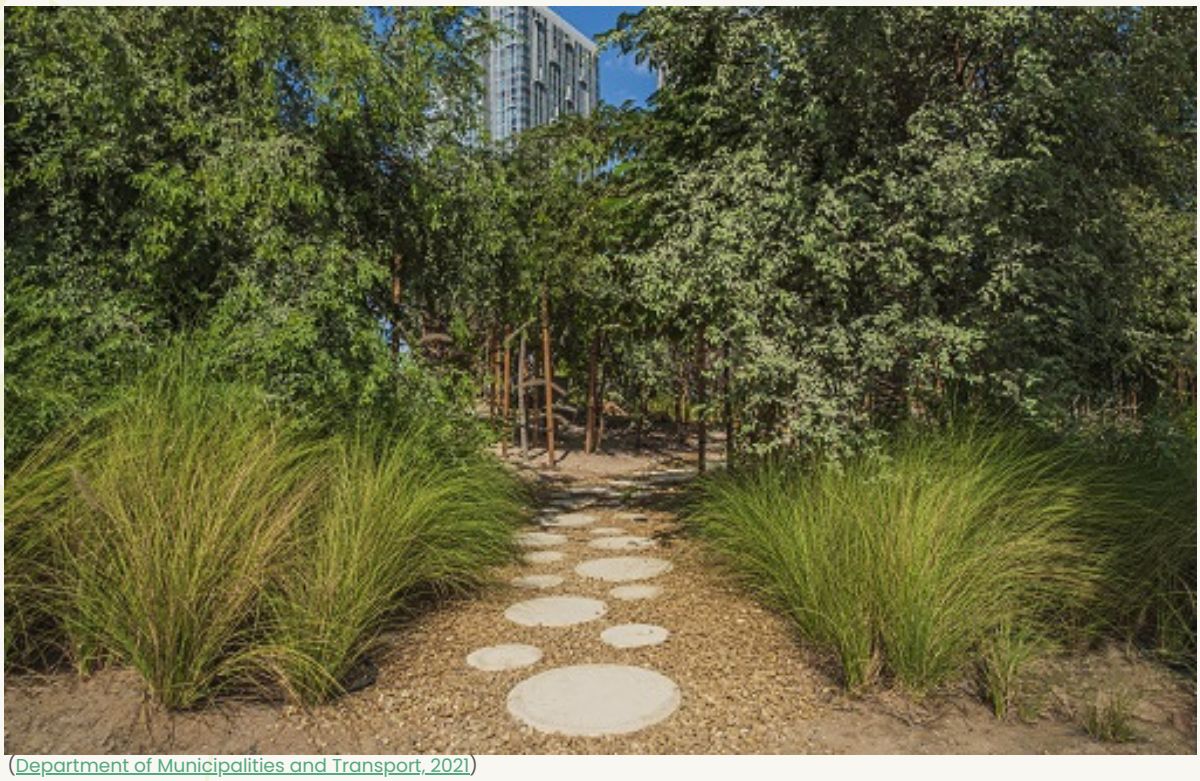
Wildlife Use Wildlife Crossing Structures US 93 N, Montana

AL FAY PARK

Key Takeways

Conduct in-depth research on the region's ecology to inform the design of a wildlife corridor that has minimal environmental impacts and provides multiple socio-ecological benefits to the region.

The process is time consuming, requires a rich network of diverse stakeholders, and can add expenses to a project. Additionally, there are still many gaps in the world's current understanding of how to balance human-use and well-being with a self-sustaining ecosystem.

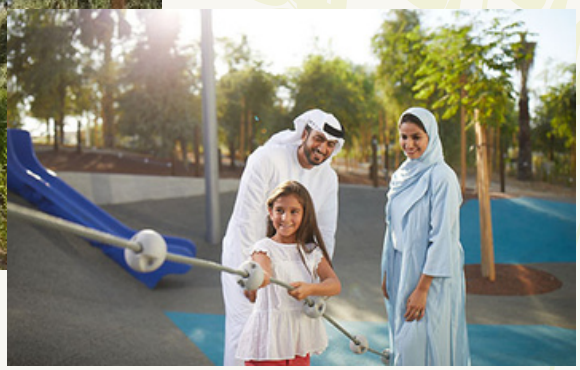


(Department of Municipalities and Transport, 2021)

Al Fay Park is Abu Dhabi's first biodiversity park. The park was designed by the Danish landscape architecture firm, **SLA**. The park's design is driven by inclusive nature, a strategy which recognizes and addresses inequalities associated with access to nature (Tozer, et. al, 2020). Al Fay Park represents a new paradigm of designing urban space in the UAE, leading the charge on replacing skyscrapers and over-watered landscapes that have traditionally occupied much of the city's area with more sustainable, holistic alternatives. Al Fay Park is the first park in the UAE that uses biodiversity to improve social and ecological issues.

Each aspect of Al Fay Park was carefully considered and researched to make the space into a successful biodiversity hub. Species that were eventually chosen for the park design were thoroughly researched before planted. SLA completed a yearlong research project on the species native to the UAE, the ecosystem services of those particular species, and compiled technical information like species' growing requirements before making any choices (Holmes, 2021) (Landezine, 2022).

(Department of Municipalities and Transport, 2021)



The park features many of those native plant species researched, including 2,000 native tree and bush species. The species chosen for the design thrive in the local climate of Abu Dhabi and require little maintenance or water. The forested park spans just over six and a half acres and provides abundant wildlife habitat, reduces traffic noise, cools down the urban environment, and lowers air pollution.

The park uses 40% less water than conventional parks, this is because the design features native plant species and 100% of the park's irrigation is recirculated. The park was designed to provide habitat for local wildlife, as well as to create spaces for all humans to enjoy. The park features playgrounds, climbing walls, fitness areas, multiple sports areas, food trucks, and outdoor seating. The park acts as a biodiversity hub and wildlife corridor, providing space for birds, pollinator insects, and animals inside a bustling metropolis (Holmes, 2021) (Landezine, 2022).

THE WALLIS ANNENBERG WILDLIFE CROSSING

Key Takeways

Gain diverse community buy-in by providing hands-on educational and volunteer opportunities, community design workshops, and information sessions that include stakeholders in multiple phases of the development and management of the project. Analyze your region's connectivity and wildlife movement patterns to identify major corridor barriers and opportunities for redevelopment. Consistent human development and disruption may make it increasingly difficult to track and analyze wildlife movement patterns. Engaging and collaborating with a community takes time and resources. Additionally, wildlife may take time to find wildlife crossing structures and recognize them as safe and reliable.

Colorado Wildlife & Transportation Alliance

(Zach Key, 2019)

The Wallis Annenberg Wildlife Crossing is set to become California's first freeway wildlife crossing near the Santa Monica mountains and LA metropolitan area. The wildlife crossing will connect one of the last undeveloped plots of land in the area to the Santa Monica mountains, to support mountain lions–a species most immediately at risk–and other important species survive in the urban environment. The project was driven by the dwindling number of regional mountain lions and increasing frequency of lions being killed on freeways. The project is part of a thirty year effort to link and preserve habitat corridors in the region. Multiple research studies and planning projects have identified the 101 Freeway as the "most significant barrier to the ecological health of the region, and a possible extinction vortex" (National Wildlife Federation, 2019). The Wallis Annenberg Wildlife Crossing will connect 1,600 feet of open space on either side of the 101 Freeway.

ALL-IRELAND POLLINATOR PLAN

Key Takeways

Set measurable goals with ways to track implementation and accountability. In order to ensure implementation of goals, give funding partners big roles and responsibility. To reach overarching goals, create diverse resources for multiple sectors to implement small-scale projects across your region. Create strong allyships with diverse partners across your region, ask them to do their part in implementation efforts. Organization is key to the success of this strategy. It can be time-consuming and very difficult to create a strong communication structure between multiple participating stakeholders. Additionally, commitments for time and resources initially made by partners can be depleted and it may be challenging to find additional resources if unexpected events occur.

(Proinsias Mac an Bheatha, 2020)

The National Biodiversity Data Center's **All-Ireland Pollinator Plan** (AIPP) is an action plan to improve pollinator habitat throughout Ireland, supported by more than 80 governmental and nongovernmental organizations. The plan connects with a variety of partners, including the EPA, golf courses, schools, county councils, The National Parks and Wildlife Service (NPWS), and the National Trust, among many others. The All-Ireland Pollinator Plan is funded by The Heritage Council, NPWS, Bord Bia and the Department of Agriculture, Food, and the Marine (DAFM). The first All-Ireland Pollinator Plan (2015-2020) was led by two individuals and further developed by a 15-person steering group. The plan also went through a consultation phase with stakeholders and the general public. The Steering Group is made up of a diversity of members, including individuals working on county councils, in the transportation industry, in environmental agencies, and within universities.

According to the AIPP 2021-2025, the previous AIPP of 2015-2021 has been successful in:

- Creating Actions for Pollinators: A publicly available GIS mapping system to track what actions are being implemented across sectors to improve pollinator biodiversity in Ireland. More than 1,600 individuals have input their 4,400 pollinator friendly actions into the database.
- Developing evidence-based how-to-guides that explain how people can support pollinators across different sectors including farmers, local communities, businesses, residential gardens, and schools. Recommended actions in the guides have proven to have a positive impact on native bee species.
- Creating the Tiny Towns Competition: A pollinator award program that has helped see more than 160 communities make their landscapes more pollinator friendly
- Documenting a significant increase in people utilizing pollinator identification resources and submitting data on native pollinator species in Ireland.

If you are interested in learning more, Working Together for Biodiversity is a booklet that documents all of the successful efforts completed through the AIPP 2015-2021.

The most recent plan (AIPP 2021-2025) will build upon the 81 actions successfully implemented in the AIPP 2015-2020. The AIPP 2021-2025 has outlined the 186 actions necessary to reverse pollinator decline in Ireland, and has translated these actions into "clear and creative ways that enable all sectors of society–schools, communities, farmers, businesses, gardeners, local authorities, etc. – to get involved in pollinator conservation" (National Biodiversity Data Centre, 2021). The plan has a clear implementation strategy, much of which funding partners are responsible for. For example, DAFM is funding the employment of a full-time farmland officer who will support implementation of the plan by working to make farmland more pollinator friendly. The tables included in the 2021-2025 outline implementable actions to help AIPP reach their broad goals. The table includes the action, the progress measure, and information about who is responsible for completing the action.

Thanks to **Dublin's Biodiversity Action Plan** 2015-2020, nearly 80% of the city's green space is pollinator friendly. The city has replaced heavy-chemical, monoculture lawns with native species that provide habitat for pollinators. Overall, more than 95% of the actions laid out in the Biodiversity Action Plan have been implemented. Additionally, Dublin's most recent Biodiversity Action Plan 2021-2025 will continue the work of the previous plan. Dublin has also laid out a Technical Guidance Note on Biodiversity for Development Management In Dublin City which helps promote and support biodiversity at every stage of a development's process in the region.

WILD WEST END

Key Takeways

Market wildlife corridors as desirable design components on major real estate developer's projects. Create a mutually-beneficial relationship with developers in your region. Strategically link wildlife corridor habitats to create diverse networks for pollinator species. If not monitored correctly, these programs could lead to unintended consequences, such as green gentrification. Additionally, program managers should ensure that participating stakeholders understand and agree to guidelines and best management tactics, to prevent failure or greenwashing.

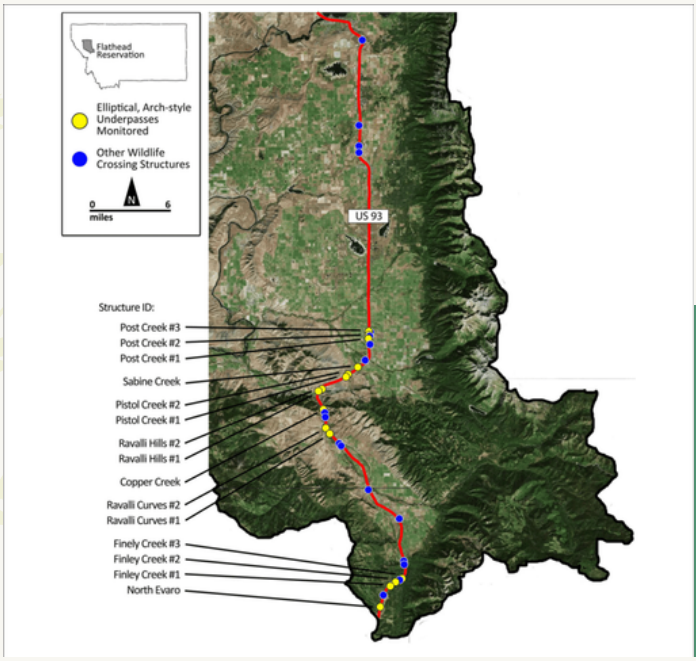
(Adam Rhodes, 2022)

Wild West End is a coalition of London's largest property owners working to develop new design and building strategies to create corridors for pollinator species in the city of London. The organization is made up of partners like Capital and Counties, Church Commissioners for England, and The Crown Estate. Wild West End creates green roofs and walls for pollinator species like bats, birds, and insects throughout the City of London. The coalition has worked to build free residential gardening areas, green roof pollinator gardens, and green walls on buildings. These green spaces act as stepping stones for species between habitat areas in the dense urban environment. In order to continue to build lasting habitat connections through London, Wild West End seeks to assist partner-led community greening projects, promote access to local green space by improving walking and cycling connections through way-finding, locate areas with potential for new green space development, maintain a minimum dual-functional value of each green space, track local species populations, and provide public access to the coalition's green space data (Wild West End, n.d.) (Peters, 2022).

U.S. HIGHWAY 93

Key Takeways

Change the framework, make transportation routes and other man-made structures into "respectful visitors to the land." Use the landscape and people who inhabit the landscape to guide design. A challenge to this approach is creating one definition of "respectful visitors to the land" that all stakeholders can agree with. Additionally, some influential stakeholders may not agree to creating a framework. It will be a time-consuming process to work with stakeholders to ensure their needs are met and to facilitate collaboration between stakeholders.



This map shows the location of wildlife crossing structures along US Highway 93 on the Flathead Indian Reservation in western Montana, USA. This image does not show all of the existing wildlife crossing structures along US Highway 93. Yellow circles indicate structures monitored in a research study, and blue circles represent other wildlife passage structures not included in the study. US Highway 93 is shown as a red line. (Flathead Indian Reservation, 2016)

U.S. Highway 93 is a 55 mile long wildlife-sensitive highway project in Montana (Jones et. al, 2019). The corridor includes 81 fish and wildlife crossing structures, seven miles of exclusion fencing on both sides of the road, and 1.5 miles of wing fencing at nine different wildlife crossing structures. The wildlife corridor is the largest wildlife sensitive highway design project in the United States (Montana.gov, n.d.). The corridor design was led by the values of local Indigenous Peoples. The Salish, Kootenai, and Pend d'Orielle consider protecting wildlife and their local environment as an important part of safeguarding Native American cultures. The Confederated Salish and Kootenai tribes (CSKT) opposed plans of expanding Highway 93 into a four-lane highway in 1989. Much of the highway goes through the Flathead Indian Reservation and, at the time, an expansion would have greatly disturbed the area. The expansion would have likely also led to higher vehicle speeds and an increased wildlife-vehicle collision rate (Jones et. al, 2019).

In order to resolve disputes about the future of the highway between stakeholders, local Indigenous groups brought in Jones & Jones Architects, Landscape Architects, and Planners of Seattle, Washington to create new concept design plans for the highway. Jones & Jones proposed the idea of designing based on a new framework, to reconstruct the highway as a "respectful visitor to the land", as opposed to a traditionally built structure that meets one human service and cuts through the land. The “road as a visitor” and “land comes first” design approaches took cues from the areas surrounding US Highway 93, in order to blend with the culture and nature of the landscape. Tribal staff with experience in wildlife biology, wetlands, and native plants designed the wildlife crossing structures that go over and under the highway (Jones et. al, 2019).

Wildlife corridors are supported by other built elements in the landscape, like protected riparian corridors. Riparian corridors are visible from the highway and provide additional protection for wildlife traveling through the valley and near surrounding farm fields. Designers analyzed watersheds, the unique species communities that existed within them, their geology, their historic settlement patterns, and their land uses. This is what stakeholders of the project eventually called the “‘spirit of place,’ representing the intrinsic patterns and complex dynamics of a landscape the tribes hold sacred” (Jones et. al, 2019). The project eventually incorporated the following elements:

(Yale School of the Environment, 2021)

- Small box culverts (to promote the movement of rodents, amphibians, and some deer): 4’h x 6’w, concrete
- Large arch culverts (to promote the movement of deer, elk, bears): 10’h x 22’w, steel and concrete
- Open span bridges (to promote the movement of deer, elk, bears, moose): used existing bridges or replaced large culverts
- Wildlife over-crossings (to promote the movement of deer, elk, bears): vegetated lid over a highway
- 8’ Stock Fencing
- Highway built to gently curve and conform to the landscape, horizontal and vertical alignments were tweaked to reduce cuts and fills

(Jones et. al, 2019)

BANGALOW KOALAS

Key Takeways

Provide educational opportunities for landholders and other community members to teach them how to improve wildlife corridors on their land and in their communities. Facilitate community volunteer events to encourage long-term support and to further spread your mission. Creating an active volunteer network can take time and resources. Enthusiasm and support for volunteering may not last long into the future, and quick turn-over of volunteer management positions further exacerbate challenges.

Bangalow Koalas is a community group located in Bangalow, Australia working to establish a wildlife corridor for koalas through their urbanized environment. Through educational programs and volunteer opportunities, Bangalow Koalas has been hugely successful in garnering support for establishing koala wildlife corridors in its community. The goal of the Koala Wildlife Corridor is to help lead koalas out of urban areas and into habitats with less threats and greater food sources. Volunteer projects like mass tree plantings and educational workshops help inform the public about wildlife coexistence and encourage the long-term support of and community involvement with establishing and maintaining koala wildlife corridors. Bangalow Koalas hosts educational workshops like Landholder Workshops, Koala Health and Habitat Workshops, and Kiddy Workshops for young children. Bangalow Koalas has planted 157,000 trees over the span of three years, and its community group is made up of more than 120 members.

URBAN CORRIDORS

Key Takeways

Create or advocate for a fund that will cover restoration costs for sites across your region. Connect diverse stakeholders in the effort, such as park managers, state and local government, wildlife biologists, and individual land owners. If local governments are leading these efforts, they may not have the capacity or resources to create and manage a program like this. Additionally, restoring sites could cause gentrification or worsen contentions between stakeholders. Local governments will need to build strong, trust-based relationships with its citizens in order to be successful.

The Rewild London Fund has committed about $750,000 to the restoration of 20-30 sites across London. The Rewild Fund has established Sites of Importance for Nature Conservation (SINCs) to make up London's core wildlife network. This project will support individual landowners and managers and ensure that each site is resilient to future challenges (Peters, 2022).

Rewild My Street is an organization dedicated toward building neighborhood pocket parks and micro forests. Rewild My Street works with residents by giving them tips on how to support wildlife in their own residential spaces. With increasing numbers of workers working from home, many office spaces and buildings are becoming available for new uses. Rewild My Streets explains the potential of transforming these spaces' plots and walls into pocket parks to improve biodiversity (Moxon 2022).

Additional Resources:

Gardens By The Bay Supertree Grove, Singapore
Gemini Solar Project: Massive Desert Solar Project 'Experiment' in Tortoise Survival, Bobby Magill
WWF Case Studies of Connectivity Conservation
Eco-Link @BKE, Singapore
Yellowstone to Yukon Wildlife Corridor, North America
Going wild? A radical green plan for Nottingham's unloved shopping centre
The Transformed Stormwater Park: Qunli National Urban Wetland, China
Jack's Solar Garden

(The Nature Conservancy, 2021)

CLIMATE **RESILIENCE**

11 Minute Read

Climate resilience is the ability to prepare for and adapt to climate change through planning, policy, and other localized efforts (Center for Climate and Energy Solutions, 2019). By 2080, the Denver metropolitan area is expected to have a climate much more similar to Texas. According to a study by Dunn and Fitzpatrick in Nature Communications, Denver's climate will be seven degrees warmer and about one and a half percent drier—much like the town of Borger, Texas (Hood, 2019) (2019). The Denver Metropolitan area will face flooding, extreme storms, wildfires, drought, displacement, health impacts, and a number of other climate related threats in the coming future. In order to prepare for these impacts, the Denver Metro area must adapt to climatic changes and learn from other projects and organizations successful in climate resilience adaptation.

Case Studies

The Sponge City
Cooling Singapore
Brace for Heat
CFMC
Humbolt County
California Natural Resources
LEO

Rainwater Harvesting for Drylands and Beyond (Brad Lancaster)

THE SPONGE CITY- WUHAN, CHINA

Key Takeways

Think about the built environment differently. Be creative in implementing new strategies and rely on nature-based solutions. Build green space sponges that dually conserve water for use during drought and act as flood control. Varying climates and ecosystem requirements may restrict the effectiveness of implementing nature-based solutions, especially green space sponges. Building a sponge in dense, metropolitan areas would be costly, time-consuming, take up a lot of land, and require substantial community support. Additionally, "nature" can become very constructed, management and infrastructure must be in balance with ecosystem benefits.

World Economic Forum video on Sponge Cities

The **Sponge City Programme** is a Chinese planning design policy aimed to reduce the impacts of extreme flooding in dense urban areas using nature-based solutions. The Sponge City Programme implements nature-based flood designs throughout cities by building "sponges", vegetated areas that can absorb flood waters. The sponges work as a network to provide city-wide flood control. Sponge projects absorb excess stormwater during flooding events, and then hold onto and reuse that water in times of drought. The Sponge City Programme's first set of pilot cities were chosen in 2015 and 2016 (Qi et. al, 2021). Wuhan, China was one of the pilot cities, along with 15 other Chinese urban metropolises.

Wuhan suffered extreme floods in 2016, resulting in the death of 14 people and the loss of $326 million. Wuhan's flooding disproportionately impacted those who live in poorly managed areas of urban expansion with complex social, economic, and environmental problems. In response to the 2016 floods, The City of Wuhan implemented 389 separate sponge city projects over a distance of 25 miles (Oates et. al, n.d.) (Nature4Climate, 2022). The city incorporated the Sponge City Programme into its entire city planning framework (Interesting Engineering, 2021). Some of the nature-based designs Wuhan built include absorptive roads, permeable surfaces, rain gardens, grass swales, parks, greenroofs, greenwalls, rainwater reuse facilities, wetlands and low elevation green belts (Oates et. al, n.d.) (Nature4Climate, 2022). Xinyuexie Park was created from an old drainage ditch and turned into an expansive green space with rain gardens, permeable pavements, and storage ponds for stormwater for reuse throughout the city (Interesting Engineering, 2021). The first stages of the Sponge City Programme were implemented in pilot cities from 2015 to 2020 (Qi et. al, 2021).

Wuhan discovered that the sponge approach ended up being far cheaper than implementing traditional gray infrastructure to address flooding problems. The sponge approach saved the city a total of $600 million (Oates et. al, n.d.). The Sponge City design concept was found to additionally reduce carbon emissions, improve public health, enhance natural cooling effects, and improve regional biodiversity in Wuhan. China dedicated about $3 billion to the entire Sponge City Programme, which aims to transform 20% of each pilot city's land according to sponge city standards. Notable features in other cities involved in the program include creating artificial lakes that draw water away from densely populated, flood prone areas into water channels that can handle large flood waters and building multi-functional parks that change form with dry and rainy seasons (Oates et. al, n.d.).

COOLING SINGAPORE

Key Takeways

Create new tools to track urban heat across entire cities and visualize future scenarios. Use these tools to inform future decision making and mitigation efforts. If green gentrification mitigation tactics are not properly understood or implemented in a region, this strategy could be used for perpetuating gentrification.

The **Cooling Singapore** 2.0 research project is working with ETH-Zurich to develop a Digital Urban Climate Twin (DUCT). A DUCT compiles all relevant computational models (like environmental, land surface, and industrial models), and regional and micro-scale climate models to map and visualize climate impact and heat patterns of a city (Eidgenössische Technische Hochschule Zürich, 2022) (Ramboll, n.d.). DUCTs allow users to identify urban heat islands (UHI), which are locations in a region that experience disproportionate heat due to the surrounding environment. Often, urban heat islands are caused by hard surfaces (concrete, asphalt) which absorb and re-emit heat into the surrounding environment and the lack of vegetated surfaces (trees, parks) which cool local surface temperatures through various measures (EPA, 2022). DUCTs help users visualize future scenarios and identify the most impactful locations to focus mitigation efforts. The Cooling Singapore 2.0 research is based on previous research projects (Cooling Singapore 1.0, Cooling Singapore 1.5), which sought to select metrics to assess UTI and OTC, develop mitigation efforts, identify gaps, create decision support systems, and develop "climate-responsive urban design guidelines for Singapore" (Eidgenössische Technische Hochschule Zürich, 2022). Along with the development of a DUCT, the expected outcomes of the project are to develop climate-responsive design guidelines and potential what-if scenarios for future UHI and OTC study (Eidgenössische Technische Hochschule Zürich, 2022).

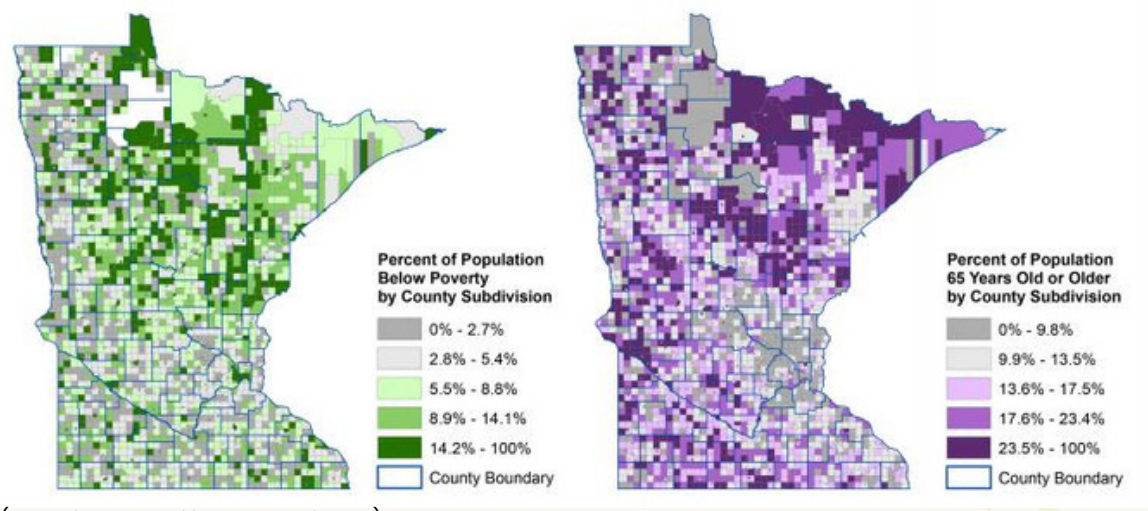
A DUCT developed to study Copenhagen. Click this link to learn more about the Copenhagen DUCT and how DUCTs can be used to fight urban heat islands. (Ramboll, n.d.)

BRACE FOR HEAT

Key Takeways

Map extreme heat and those most vulnerable to high temperatures. Use this to inform decision making around cooling centers, emergency announcements, and future planning. Prepare sample response strategies and save time for emergency teams during extreme heat emergencies. Mapping may not influence policy on its own. This strategy will likely be a tool in a suite of tactics used to influence local policy and implement change. Creating this tool will take time, cross-community collaboration, and resources.

BRACE for Heat video



(U.S. Climate Resilience Toolkit, n.d.)

The Minnesota Department of Health has created a Minnesota Extreme Heat Toolkit called **BRACE for Heat** to help reduce heat-related climate change impacts in Minnesota communities. The toolkit provides strategies for public health departments and emergency managers to prepare and adapt to situations of extreme heat. The toolkit also provides multiple sample response strategies in the event of extreme heat, which allows response teams to quickly pick and choose which option works the best for them in times of emergencies. The toolkit provides a set of maps that identify vulnerable populations throughout the state and other maps that show cooling areas. These maps allow users like emergency managers, planners, and citizens to determine where vulnerable populations exist in relation to cooling areas in their communities. During NOAA excessive heat warnings, Minnesota counties also issue public service announcements on radios, television stations, and through physical flyers recommending residents who do not have air conditioning to head to cooling locations that do (like libraries, schools, shopping centers, or senior centers) (U.S. Climate Resilience Toolkit, n.d.).

CULTURAL FIRE MANAGEMENT COUNCIL (CFMC)

Key Takeways

Work with Indigenous groups that have been practicing sustainable fire management for centuries in your own region. Elect, hire, advocate for these groups to be put into positions of power to establish new ways of interacting sustainably with the land. Some communities may not have strong, mutually-beneficial relationships with Indigenous groups or there may be a lack of trust between Indigenous groups and local governments. Additionally, this process could further exacerbate tensions between stakeholders.

Confederated Salish + Kootenai Tribes "Fire on the Land" website

The Cultural Fire Management Council (**CFMC**) is a collective of Indigenous tribes in Northern California that lead cultural burnings on their lands to promote ecological health and climate resilience. CFMC works with individual families and private landowners to conduct cultural burns and teaches best fire management strategies through the TREX program. The TREX program teaches experienced fire practitioners how to manage land with prescribed burns while sharing their knowledge and passion for the work. CFMC also partners with other organizations, agencies, tribes, and groups to conduct prescribed burns throughout the Klamath and Trinity watersheds (Cultural Fire Management Council, 2022).

HUMBOLDT COUNTY PRESCRIBED BURN ASSOCIATION

Key Takeways

Inclusive, community-based networks spread education, expand resources, build public participation in proper fire management on private lands, and establish important social and cultural norms around fire. If these programs are not managed by employees, then community members will need to spend their own time and money to create and manage networks. Additionally, important stakeholders may not be included if they do not have access to community-based networks.

August 2022
Fire Adapted
Network

(Humboldt County Prescribed Burn Association, n.d.)

In 2016, Lenya Quinn-Davidson and Jeremy Bailey met in California with prescribed burn association (PBA) leaders from around the Great Plains. At this meeting, leaders shared their stories and experiences with PBAs, major threats, and wildfires. Out of this networking event, the Humboldt County Prescribed Burn Association was formed in 2018 (Fire Adapted Network, 2020). The Humboldt County Prescribed Burn Association is the first PBA in the Pacific West, and it is a network of landowners, community members, fire departments, the UC Cooperative Extension, and others interested in using prescribed burns as an effective management tool. Trained and experienced volunteers help each other conduct burns on private lands. The Humboldt County Prescribed Burn Association inspired the creation of 15 other PBA-style groups across California. These PBAs facilitate an inclusive and community-based model for prescribed burns and fire management (Fire Adapted Network, 2020) (Humboldt County Prescribed Burn Association, n.d.).

NATURAL + WORKING LANDS CLIMATE SMART STRATEGY

Key Takeways

Create a how-to guide for strategic actions across multiple sectors in your region working to implement diverse, nature-based solutions. A detailed strategic action plan creates large systems change by providing specific resources and opportunities to those most interested in improving regional climate resilience. Some important stakeholders may be missed during this process, meaning they might be left out of important resources that others get access to. Additionally, creating a plan like this for a large region may not be entirely applicable to every portion of the region.

The **California Natural Resources Agency** has developed its first ever nature based solutions strategic actions document, which has been out for public comment since October of 2021. The Natural and Working Lands Climate Smart Strategy is a comprehensive document that looks at how nature based solutions can help address climate change impacts in California and create resilience within the state's communities. The strategy report includes information about California's ongoing projects, best practices for nature based solutions, methods to track project progress and measure outcomes, California's regional profiles, and helpful resources to improve project outcomes. Communities, businesses, governments, or individuals can use the information outlined in the draft report to help guide future projects focused on using nature based solutions to create climate resilience (The California Natural Resources Agency, 2021).

THE LOCAL ENVIRONMENTAL OBSERVER (LEO)

Key Takeways

Utilize community scientists as a resource. Use your diverse, expansive networks to gain deeper knowledge of the systems of the landscape, and make informed decisions off of these findings. Link environmental quality with human health, focus on those whose health is most impacted by poor environmental quality. Quality of information may be difficult to manage. Additionally, many problems may be left unidentified if tactics like these are solely depended on.

In 2011, the Alaska Native Tribal Health Consortium (ANTHC) created the Local Environmental Observer (**LEO**) Network with funding from the U.S. EPA. The LEO Network raises awareness of climate change and other environmental changes and connects local communities with technical resources. LEO connects networks of people like local and traditional knowledge keepers, scientists, agencies, and other experts to document extreme weather, changing plants and wildlife, and other major events that impact community health through an interactive tool. The tool was developed to help the tribal health system and local observers share information about climate change and the environment. LEOs are local observers who document their observations on the interactive tool, helping Alaskan Natives document environmental impacts, identify emerging threats, and plan responses with a network of topic experts (U.S. Climate Resilience Toolkit, 2021) (LEO Network, 2021).

Additional Resources:

Urban Nature Based Solutions (WWF)
Nonprofits Supporting Wildfire Aid and Long-term Solutions
Cool Policies for Cool Cities
Case Study of Denver Flood and Fire Resilience
U.S. Climate Resilience Toolkit
FEMA' Building Community Resilience with Nature-Based Solutions
Documentary - Thank you for the Rain

PROJECT **FUNDING**

Funding structures for ecology and equity initiatives in a given region can impact how those initiatives are carried out. Often the primary source of funding may be grant applications, financial support from partnering organizations, local or state taxes, and fundraising initiatives. Appropriate distribution of funding can increase efficiency on implementation of project components.

The Transit to Trails Act

Department of Transportation has established a grant program to provide up to $500,000 for governmental and private entity projects that increase public transportation access to public lands for critically underserved communities (Johnson, 2021).

INVEST in America Act

This program has established a grant program to provide up to $500,000 for projects that increase public transportation access to public lands for critically underserved communities (Johnson, 2021).

Environmental Justice for All Act

The Environmental Justice for All Act has established environmental justice requirements, advisory bodies, and programs to address disproportionate environmental harm faced by communities of color, low-income communities, or tribal and indigenous communities (Library of Congress, 2021). The same text in the Transit to Trails Act is incorporated into the Environmental Justice for All Act (Johnson, 2021).

GOCO

Great Outdoors Colorado (GOCO) is a leading organization that aims to assist in funding initiatives that promote sustainable community resilience plans. GOCO is a current partner with Metro DNA on the Regional Vision for People + Nature, and funding for future projects could be pursued through various grant opportunities that GOCO hosts. Currently, GOCO has two grant categories - The Land Acquisition Program and The Community Impact Program. Both are structured to fund projects that promote the goals of increasing equitable and sustainable access to green spaces and the outdoors for large communities.

Other states that have implemented green initiatives in hopes of improving equitable access to nature have primarily utilized grant initiatives. The Prevention Institute has currently structured a supporting initiative for organizations all across the United States who are aiming to increase park equity and sustainability. This supporting plan is titled as the People, Parks, and Power initiative. This initiative is a collaborative effort between the Robert Wood Johnson Foundation and the Dorris Duke Charitable Foundation. These foundations are supporting community-based organizations and base-building groups working in urban, low-income communities of color across the United States to increase park equity through local policy and systems change. These two foundations are holders of charitable grants that can be issued to any organization that applies and has an active initiative that falls within these frameworks (Fabian, 2020).

When funding is obtained through grants, governmental taxation initiatives, or stakeholder involvement; allocation of funds is the primary stressor that follows. Many companies such as iLead Strategies have example strategies for efficient and effective allocation of funding for sustainability efforts. iLead breaks down example suggestions for environmental organizations that are aiming to allocate funding through pooling funds across agency and program lines or improving coordination of existing funding streams. By prioritizing components of initiatives that are in need of greater funding, organizations can plan for timeline predictability of reaching individual goals (Jakopic, 2012). Also, many organizations such as the Greater Baltimore Wilderness Coalition, have maintained an active presence with stakeholder engagement and their partnering organizations. By upholding a well respected relationship with those who are partnered on an initiative, there gains an increase in involvement on a long term scale.

Organizations Creating Helpful Resources

The Safe Zone Project	LGBTQ+ allyship	Created a free online tool that provides people with the resources to improve LGBTQ+ experiences in parks and to increase inclusivity in public spaces. The Safe Zone Project's training programs can help organizations better understand how their company can facilitate safe and inclusive outdoor public spaces. The Safe Zone Project offers a free training facilitator guide that can be downloaded from the organization's website (Roemersberger, 2022)
The Outdoor Alliance	outdoor recreation & access to nature	The Outdoor Alliance created a story map on How The Outdoor Alliance Transforms Data into Advocacy. The Alliance has also created a suggested forest planning map for Western Colorado to help improve outdoor recreation opportunities and ecological health. Additionally, the Outdoor Alliance's Policy Library provides information on national and state-wide policies that help protect opportunities for accessing nature. The Alliance also provides resources for how individuals can take action against policies that reduce access to nature (Outdoor Alliance, 2021).
Every Kid Outdoors	children	EKO pass gives free national park access to all children in 4th grade and their families. The Outdoor Alliance for Kids (OAK) is working on a campaign to give free state park access to all children in the coming years (Every Kid Outdoors, n.d.).
The Emerald Alliance	trees, equity, & human health	Worked with the City of Tacoma to release a new Tacoma Community Forestry Map that explores the intersection of trees, equity, and human health. The map was developed in order to help determine where tree planting and preservation can make the greatest impact, specifically from an environmental justice perspective (City of Tacoma, 2021).
Children and Nature	children	Works to improve children's access to nature. Children and Nature has developed a planning guide for implementing strategies for improving children's connections with nature. The guide includes resources for how to conduct research in your region and begin implementing action (Cities Connecting Children to Nature, 2017).

Organizations Creating Helpful Resources

Houston Wilderness	children	Developed the Wilderness Passport program which acts as a guide to the 10 ecoregions of the Houston region. Houston Wilderness has also created the Great Green Quest program which distributes wilderness passport guides to over 35,000 schools, YMCA centers, park community centers, and region-wide libraries and interested community groups (Houston Wilderness, n.d.).
Greater Baltimore Wilderness Coalition	wildlife corridor & access to nature	Currently working on a landscape analysis for the Baltimore region that will result in a green infrastructure plan that identifies and prioritizes new areas for public access and wildlife habitat. The coalition has developed a Biodiversity Toolkit with a map of key focus areas for corridor restoration and protection (Greater Baltimore Wilderness Coalition, n.d.).
The Intertwine Alliance	mapping & wildlife corridors	Mapped important habitat areas, corridors, and routes linking wildlife to areas outside of the Portland urban metro area (The Intertwine Alliance, 2012). A Habitat Connectivity Toolkit that provides information on modeling, habitat assessments, permeability assessments, and individual species scorecards (The Intertwine Alliance, 2016). Outlined strategic actions at the end of the Regional Conservation Strategy document (The Intertwine Alliance, 2012).
The Chicago Region Trees Initiative's	plant corridors	Oak Ecosystems Recovery Project website maps oak corridors throughout the Chicago Region and informs citizens on how they can successfully add to the growing oak corridor initiative. The interactive map highlights core areas that need to be protected and potential new corridors that could be established through plantings (CRTI, 2022).

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