5-2023

Investigating Consistency of Landscape-Scale Green Infrastructure in Local Government Policy

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INVESTIGATING CONSISTENCY OF LANDSCAPE-SCALE GREEN INFRASTRUCTURE IN LOCAL GOVERNMENT POLICY

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of City and Regional Planning

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by
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May 2023

Accepted by:
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ABSTRACT

Planning for Climate Change is multifaceted and requires effort across all scales. Green Infrastructure networks of green spaces, natural lands, reserves, working lands, core habitat, riparian corridors, parks, open spaces, private conservations lands, and other complementary land uses work together to support life on earth and human existence through the ecosystem services provided. Clean air, clean water, carbon sequestration, food production, recreation, pollination, and spiritual and cultural benefits are only a few of the services that natural lands provide society. With climate change occurring due to human actions such as land use, development, and energy use, to name a few, society must adopt adaptive measures and implement adaptive mechanisms in order to bolster and increase local community resilience. The benefits of Green Infrastructure provide communities with greater resilience to disturbances and climate risks.

This research looks at the consistency of GI-focused plans at the landscape scale and assesses the manifestation of consistency with local-level policy administered in comprehensive plans. The results of this study can give local governments a better understanding of where policy and implementation improvement can occur to create more robust communities facing climate changes, disturbances, and extremes that will occur in this century. Two different landscape-scale Green Infrastructure plans from different geographies, with different guiding landscape ecology principles, were used to closely investigate these concepts and better understand how local governments understand or acknowledge Green Infrastructure as a form of resilience to climate change.

DEDICATION

I could not have completed this thesis without the support of my mother, Christie; my father, Brad; and my brother, Jack. Their unwavering support, reassurance, encouragement, and consistently being my number one fans, no matter the circumstance, is something I am incredibly grateful for always. Additionally, I dedicate this thesis to my boyfriend, Drew. If anyone has been through this process second-hand, it is him. He supported me throughout pursuing a Master of City and Regional Planning here at Clemson, but most importantly, he picked me up each time the fear of such a large project got in my way. He continuously reminded me that we are all works in progress, but most importantly, he taught me that what I hope to be is already inside me. I want to thank my friends who constantly champion me, listen to my grad school complaints, encourage me to chase my inspirations and ideas, and remind me that this is only the beginning of my life.

Pursuing this degree would not have been possible without the love for learning my professors at Sewanee instilled in me. My Anthropology professors Dr. O'Connor, Dr. Ray, and Dr. Murdock, planted a seed in me of wanting to make sense of the world around me and understand how people exist differently everywhere. From them, I learned there is generally no right or wrong, only difference in perspective. In referencing a seminal piece by Anthropologist Clifford Geertz, I hope to continue "waddling in," making mistakes but also making new realizations and gaining new knowledge, constantly sharpening my outlook. I hope to recognize new understanding daily and not hold too tightly to ideas and thoughts in such an evolving world.

ACKNOWLEDGEMENTS

I would also like to thank my professors at Clemson for their support throughout this project and my graduate education. My committee chair, Dr. Dyckman, continuously reminded me of how capable I am, and I will always be thankful for her understanding and support during this time. Dr. Dyckman has also helped me realize how important each person is in the fight against human-induced climate change. She has inspired me and reminded me of the role I can play in making communities more equitable as we enter a future of uncertain risks. I want to thank Dr. Nocks for reminding me of why I wanted to study planning in the first place. He has encouraged me to always keep my values at the forefront of my mind and in all my actions professionally. His passion for the planning field inspires me, and I hope to find the same passions in my professional work while making a difference, just as he has in my life. I also want to thank Dr. Morris for supporting my efforts while studying at Clemson and always taking the time to catch up and check in on me. Lastly, I thank every professor I have had for helping me get to where I am today. My education is something I value greatly, and I am thankful for the opportunity to pursue a Master of City and Regional Planning degree. I will remember Dr. Dyckman saying, "Perfect is the enemy of the good," as I move through my professional career.

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CHAPTER ONE

INTRODUCTION

Relatively conceptually novel, over the past twenty years Green Infrastructure (GI) literature is consistently tied to human health, social, economic or political systems, ecosystem services, and resilience theory. It emphasizes multifunctionality, while also hoping to achieve multiple layered solutions by the means of an interdisciplinary approach (Hansen & Pauleit, 2014). At the same time, GI solutions are not actually new, as these systems and natural processes have been supporting humans for thousands of years. Concurrently, individual understanding of contemporary environments is almost entirely socially and culturally understood. The way society interacts with its supporting ecosystems depends upon how these natural communities and natural resources are viewed. Human society relies on natural resources, ecosystems, and habitats as life-supporting systems. With the onset of human caused climate changes, global warming, and the negative effects of our urban footprints and developments, strategies to protect and connect these multifunctional greenspaces are needed.

The effects of urbanism are significant, and a reorganization of our development priorities with relation to our natural resources and ecosystems are needed. Human actions and human development threaten species extinction globally; biological communities are becoming less diverse; and in the past 50 years, the human population has doubled, generating massive increases for energy and materials (IPBES, 2019, p.11-13). Simultaneously, by 2050, 68% of the global population is expected to live in urban areas (Woodruff et al., 2020, p. 1578, citing to United Nations 2019). Green infrastructure can serve as a framework for development, by prioritizing green spaces on the front end, guiding better suited locations for development in response.

Local governments will be expected to cope and handle unprecedented population pressures, accommodating and planning for large increases in city capacities. On top of this, we are living in a time of climate change, with effects already being felt through loss of species and increased urban heat island effects that cause increasing heat related deaths. Climate change is directly manifesting extreme weather events. These events create stormwater drainage problems due to outdated grey infrastructure and areas covered by impervious surfaces that lack the appropriate grey infrastructure. Connections of green spaces, natural areas, working lands, riparian corridors, and reserves, and creating GI networks can help urban areas address climate extremes in the context of a connected landscape.

Since the 2000s, recognition of GI has increased. The Intergovernmental Panel on Climate Change (IPCC) reports continually emphasize GI as viable adaptation for climate change (IPCC AR6 WGII SPM, 2022). In 2016, the American Planning Association held a Green Infrastructure symposium, pushing forward this agenda with planners across the U.S., confirming their role in local implementation (American Planning Association, 2017). More American Planning Association publications reference GI as a strategy for local resilience planning. While the EPA defines GI in relation to stormwater and site-specific manifestations, other organizations such as the Conservation Fund identify GI as a “strategically planned and managed network” (Environmental Protection Agency, 2022; 2022 The Conservation Fund, n.d.).

GI is tied to climate change, socio-ecologic resilience, sustainable land use theory and practice, and grounded in conservation science and ecological theory. GI is commonly defined as, “a strategically planned and managed network of wilderness, parks, greenways, conservation easements, and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life” (Rouse & Bunster-Ossa, 2013, p. 10 citing to Benedict & McMahon, 2006). GI responds to climate change and resilience as a manifestation to achieve climate resilience by recognizing the importance of natural ecosystem services and processes, biodiversity, and connectivity of landscapes at a regional rather than local scale. Randolph (2004) defines a landscape as “an area defined as having a repeated pattern of components, including both natural and human-altered areas” (p. 321 citing to FISRWG 1998). Similarly, The Chicago Wilderness Green Infrastructure Vision (2012) refers to the landscape scale as the functional connectivity of habitats, facilitating the movement and processes of organisms and wildlife (p. 33). This study will look at literature that helps give context to GI, its effectiveness, and its ability to provide benefits for Social-Ecological Systems (SESs).

The literature on climate change adaptation, resilience, and SESs and resilience frames the way GI is viewed as an effective planning strategy for climate change adaptation. The study then examined previously accepted GI plans. The plans were analyzed with a comparative GI plan quality evaluation, investigating whether GI principles and Social-Ecological Resilience (SER) principles manifested as a result of potentially successful plan quality. Next, to evaluate implementation at the local level, I conducted an iterative content analysis of policy adopted by the local jurisdictions in relation to the GI plan case studies and their assessed plan quality. This allowed me to evaluate whether policy documents at the local level supports GI connectivity manifestation and Social Ecological Resilience (SER) for communities in light of climate change risks. More specifically, this study examined how local governments within regional, landscape-scale GI plans, with different guiding landscape ecology principles (such as watershed boundaries or cores and hubs foci) are manifesting the advancement of GI connectivity and social-ecological resiliency.

CHAPTER TWO

LITERATURE REVIEW

Climate Change

While the threats of climate change are ever-increasing, it is most blatantly seen in the surge of references to it in the news after destructive events such as fires, hurricanes, and floods. With current warming at 1.09 degrees Celsius, compared to the 1850 to 1900 time period, the UN Climate Change Conference in 2015 set a goal to keep warming at no more than 1.5 Celsius during this century (IPCC AR6 WGII SPM, 2022; McKibben, 2018, p. 3). Climate change is already affecting humans, making it impossible to prevent at this point, but society can try to lessen its impacts, and implement adaptive measures. We know that climate change leads to extreme weather, and scientists have been publishing this fact for decades, but that is not the only harm it will cause to the planet. Those who are the most vulnerable and the poorest, lacking necessary resources, will face the biggest brunt of climate change's effects, and this is confirmed again and again by IPCC reports and other climate literature used to inform these reports (IPCC AR6 WGII SPM, 2022). In the past 30 years, humans have experienced the hottest 20 on record, 9 of the 10 deadliest heat waves in human history have occurred since 2000, and the percentage of habitable land is shrinking, creating less functional space for human existence in areas of high risk (IPCC AR6 WGII SPM; McKibben, 2018).

The Fifth Assessment Report (AR5) from the Intergovernmental Panel on Climate Change (IPCC), a body of the United Nations, reports that cities and urban areas are some of the most vulnerable to climate change risks, and the Sixth Assessment Report (AR6) continuously reiterates this reality (Jiang et al., 2017, p. 1; IPCC AR6 WGII SPM, 2022). As urbanization and sprawl trends continue, land use and land cover trends combined with climate change effects will affect watersheds with increasing amounts of nutrient and sediment pollution and runoff, calling for mitigation strategies for urban planning and environmental policy to intercept and address these problems (Alamdari et al., 2022). Speed et al. (2022) also notes the substantial impacts of the combined effects of land use and land cover change toward urbanization along with climate change. Temperatures are increasing globally, and in cities the urban heat island (UHI) effect, caused by the built environment and heat waste, in combination with climate change is causing higher heat risks (Keith et al., 2021, p. 1). Planners are increasingly addressing heat, climate risk, and environmental outcomes of these issues on local, county, regional, and state scales (p. 8). Vegetation and tree canopy mapping is one of the most popular sources of information planners are using to address climate risks, which helps jurisdictions understand their existing GI networks (Keith et al., 2021, p. 7).

Though a large amount of responsibility for climate action rests with world leaders, national governments, and collaborative climate agreements to influence emission reduction, there are actions that can be taken locally to better position communities for climate change effects. If we want to continue to rely on the environmental resources that support everyday life, human existence, health, and uphold the human economy, mitigation and adaptation for more climate resilient communities is needed in a connected fashion rather than locally isolated interventions. Increasing climate events such as stronger storms, higher rates of flooding, and more extremes in rainfall are hard to handle when urban areas and suburbs have high amounts of impervious surface covering the ground, limiting the filtration properties of nature. For local governments, risk reduction can coincide with adaptive climate change measures (Anguelovski et al., 2016, p. 334). There are different ways of framing climate strategy whether local, regional, national, or global, but many of the framing theories and concepts apply at all scales. This paper focuses on GI as a method of fostering climate change adaptation and resilience but must explain major factors of climate change in the context of societal and natural systems to which GI can respond, according to the IPCC.

Intergovernmental Panel on Climate Change and its Guiding Frameworks

In 1988, The World Meteorological Organization and the United Nations Environment Programme (UNEP) created the Intergovernmental Panel on Climate Change with the intention of gathering scientific information for informing climate policy and for global climate change negotiations (2022 IPCC). They create Working Group (WG) reports and a Task Force. WGI focuses on climate modeling with the basis of the physical science behind climate change, WGII focuses on projected impacts using the modeling scenarios, and WGIII creates strategy goals for climate change mitigation (2022 IPCC). The Task Force continuously develops and refines methods for calculating and reporting greenhouse gas (GHG) emissions and removals, to keep modeling up to date (2022 IPCC). The IPCC's newest Sixth Assessment reports were released beginning in 2021 with the remaining WG reports released in 2022, and shorter synthesis reports released in 2023, while still awaiting the full volume of the AR6 Synthesis Report.

This study will mostly use WGII and WGIII to inform importance of GI as a strategy for adaptation. The connections IPCC WGII makes on the interactions and relationships between human society, ecosystems, and the climate are integral for understanding the importance of GI. Each of these aspects interact and have the capability to affect one another, creating change in the current state. While humans cause climate change, this makes us intrinsically part of the solution, and the IPCC focuses on this heavily, as we are the ones to push forward an agenda to mitigate and adapt our world appropriately. According to the IPCC,

> "Human society causes climate change. Climate change, through hazards, exposure and vulnerability generates impacts and risks that can surpass limits to adaptation and result in losses and damages. Human society can adapt to, maladapt and mitigate climate change, ecosystems can adapt and mitigate within limits. Ecosystems and their biodiversity provision livelihoods and ecosystem services. Human society impacts ecosystems and can restore and conserve them. Meeting the objectives of climate resilient development thereby supporting human, ecosystem and planetary health, as well as human well-being, requires society and ecosystems to move over (transition) to a more resilient state. The recognition of climate risks can strengthen adaptation and mitigation actions and transitions that reduce risks. Transformation entails system transitions strengthening the resilience of ecosystems and society" (IPCC AR6 WGII SPM, 2022, p. 6).

The report focuses on concepts of risk, vulnerability, adaptation, and resilience as a framework for understanding the effects of climate change impacts, but also the framework for solutions. The IPCC defines risk as, "the potential for adverse consequences for human or ecological systems" in the WGII Technical Summary (Pörtner et al., 2022, p. 43). Risk of climate change impacts comes from exposure or vulnerability of climate hazard to humans and ecological systems, but risks regarding climate change responses can come from inability to achieve objectives, trade-offs that must be decided, or negative side effects of actions taken. The suggestions of the IPCC reports are essentially a form of risk management, addressing many possibilities based on climate data, modeling, and strategies used to move forward (Pörtner et al., 2022, p. 43).

Vulnerability is defined as the susceptibility to be adversely affected by risks, or other elements, climate induced or otherwise, including susceptivity to harm or damage and the potential for a reduced ability to cope or retain adaptive capacity (Pörtner et al., 2022, p. 43). Adaptation is an important concept in reducing exposure, reducing risk, vulnerability, and specifically climate related risk in this context. The AR6 WGII also describes it as:

> "Adaptation in ecological systems includes autonomous adjustments through ecological and evolutionary processes. In human systems, adaptation can be anticipatory or reactive, as well as incremental and/ or transformational…Adaptation is subject to hard and soft limits" (IPCC AR6 WGII SPM, 2022, p. 7).

Resilience is the structure used for organizing adaption according to concepts of WGII. Resilience focuses on bouncing back and recovering by returning to a previous state of being after a disturbance to the specified system. A key component according to WGII is maintenance of essential function, but also "identity, structure, and the capacity for transformation" (IPCC AR6 WGII SPM, 2022, p. 7; Walker & Salt, 2012). The IPCC Working group reports recommend certain levels of adaptation and mitigation, along with a percentage of reduced emissions, to stay within the goal of 1.5 degrees Celsius, and hopefully reduce risk with combined increase in resiliency.

Identification of Human-Ecosystem Relationships within the Context of Climate Change

This paper's conceptual theory depends heavily on the connections between humans and nature, otherwise known as a social-ecological system. The subsection on vulnerability in AR6

WGII highlights the ways ecosystems and human systems are inherently bound, and verified with high confidence by WGII, this connection is described as interdependent (IPCC AR6 WGII SPM, 2022, p. 12). Vulnerability of ecosystems directly impacts humans and vice versa. While this vulnerability varies from region to region, WGII also verifies with high confidence that "Development patterns are increasing exposure of ecosystems and people to climate hazards…Unsustainable use of natural resources, habitat fragmentation, and ecosystem damage by pollutants increases ecosystem vulnerability to climate change" (IPCC AR6 WGII SPM, 2022, p. 12). While the level of vulnerability shifts between and within regions, approximately 3.3 to 3.6 billion people live in places considered highly vulnerable to climate change, denoted by high confidence from the IPCC (IPCC AR6 WGII SPM, 2022, p. 12).

"Loss of ecosystems and their services has cascading and long-term impacts on people globally," and humans are the largest determinant of this ecosystem loss according to the IPCC (IPCC AR6 WGII SPM, 2022, p. 12). As human populations continue to grow, there is higher need for food, resources, water, and materials from the earth. The United States is already in a position of biodiversity vulnerability according to Dietz et al. (2020), indicating one third of species are vulnerable to extinction (p. 7). Only 11% of species of conservation concern are in highly protected areas in the U.S. (Dietz et al., 2020, p. 1). As humans continue to alter ecosystems at high rates, we will lose the ability to provide a society with goods and services to survive. The IPCC confirms this in saying, "unsustainable land-use and land cover change, unsustainable use of natural resources, deforestation, loss of biodiversity, pollution, and their interactions, adversely affect the capacities of ecosystems, societies, communities and individuals to adapt to climate change," (IPCC AR6 WGII SPM, 2022, p. 12).

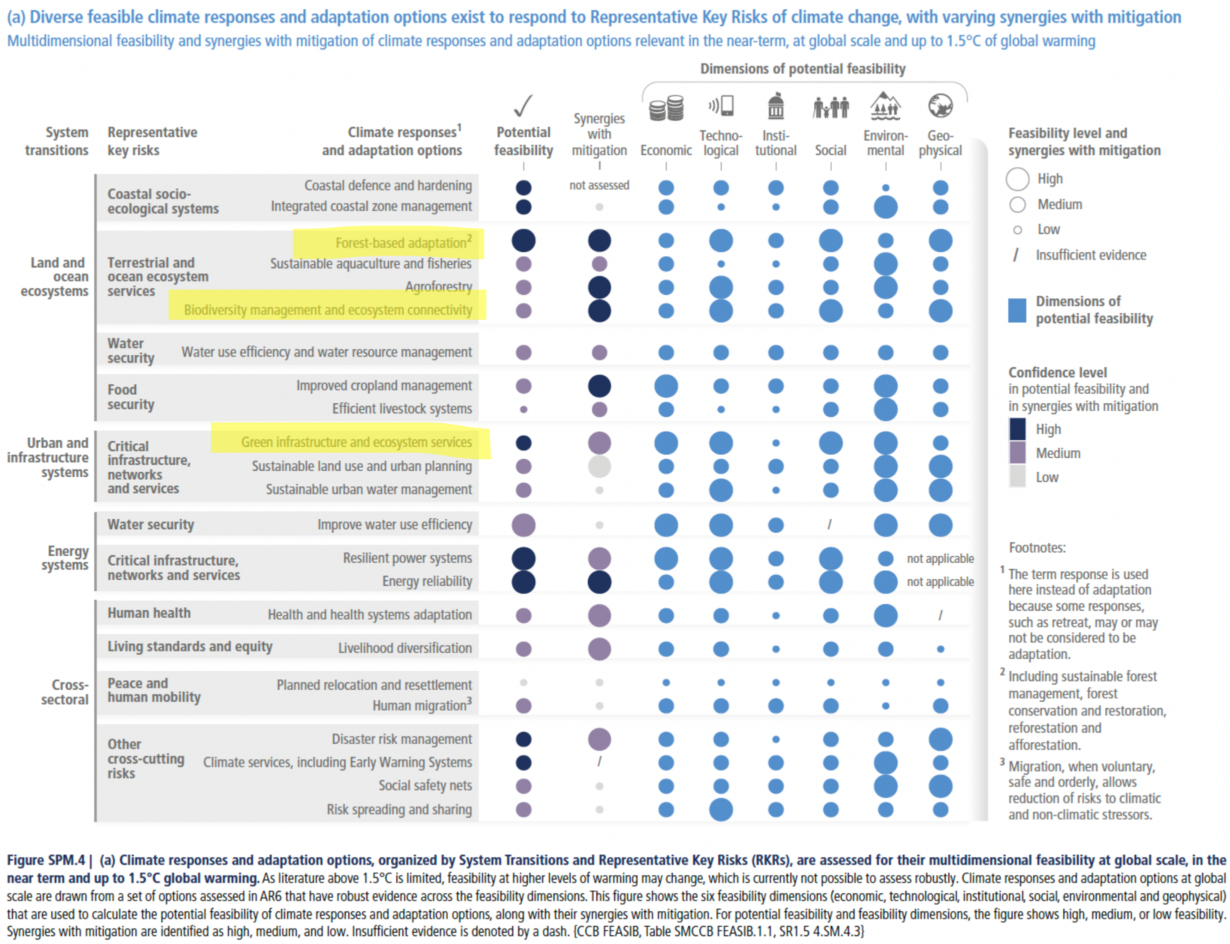

Figure 2.1: Graphic from IPCC AR6 WGII explaining feasible responses to "Representative Key Risks" of climate change (IPCC AR6 WGII SPM, 2022, p. 22).

Climate risk responses and adaptation such as forest-based adaptation, agroforestry, and biodiversity management and ecosystem connectivity have high and medium confidence levels in potential feasibility and synergy with mitigation in the near term (2021-2040) and up to 1.5 degree Celsius warming according to the WGII. GI and ecosystem services have a high confidence level in potential feasibility, and medium confidence level in synergies with mitigation on top of a high feasibility level when considering these synergies. Synergies with mitigation exist at high confidence levels across various dimensions of feasibility for all categories, and specifically with high confidence within technological dimensions of feasibility for each response/ adaptation option. Forest-based adaptation also has high predicted feasibility and synergy with mitigation within social and geophysical dimensions. Agroforestry has high confidence in feasibility and synergy with mitigation within environmental dimensions. Biodiversity management and ecosystem connectivity also has high confidence in feasibility within social and geophysical dimensions. Economic and institutional dimensions have medium confidence ratings in each climate and adaptation response (IPCC AR6 WGII SPM, 2022, p. 22).

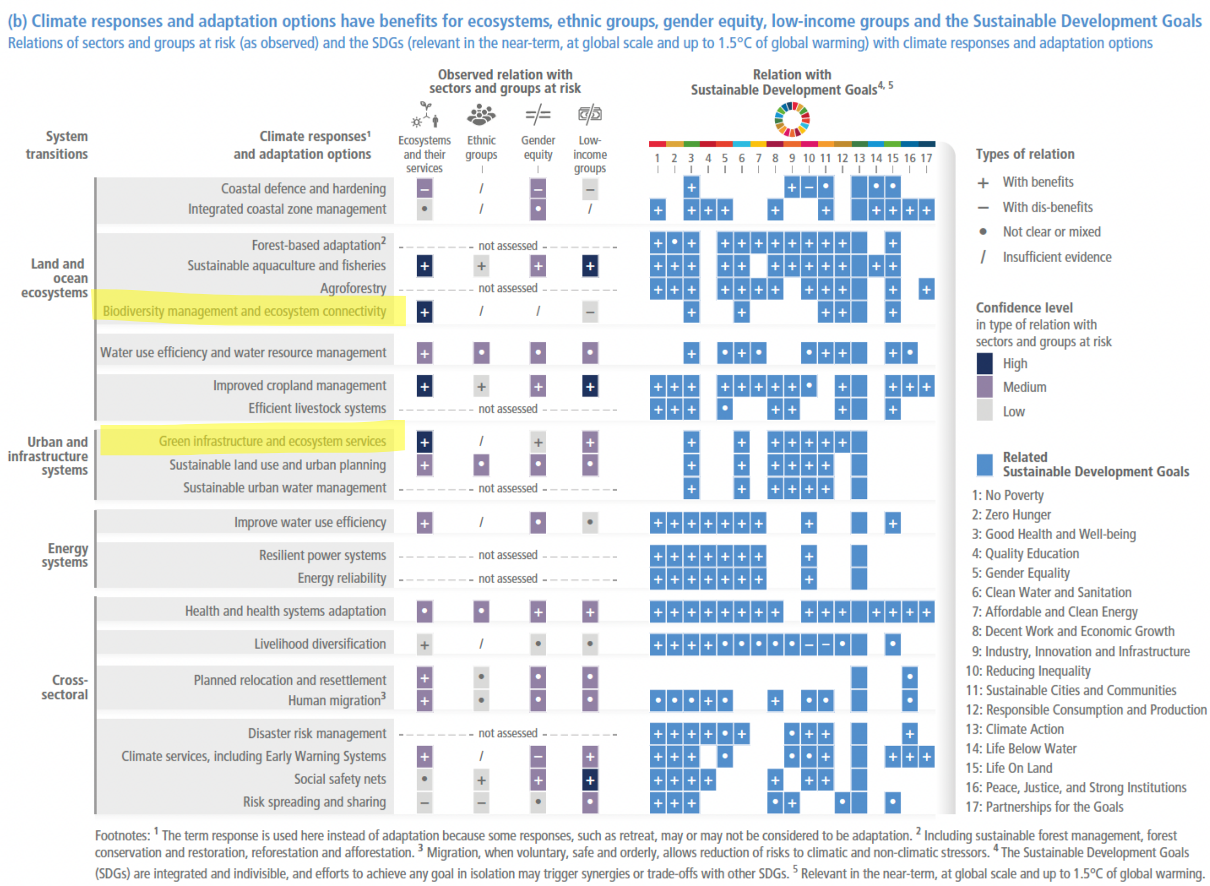

Figure 2.2: Graphic from AR6 WGII explaining climate responses and adaption options (IPCC AR6 WGII SPM, 2022, p. 23).

As seen in Figure 2.2, GI and ecosystem services have high confidence levels in the potential for feasibility with mitigation, but medium confidence in synergies with mitigation regarding implementation. Green infrastructure and ecosystem services responses and adaptation options have high feasibility levels for synergy with mitigation in economic, technological, social and environmental dimensions. This category also has medium feasibility and synergy with mitigation in the geophysical dimension. The categories of biodiversity and ecosystem connectivity and green infrastructure and ecosystem services also have relations to sectors and groups at risk including: ecosystems and their services, gender equity, low-income groups, and several Sustainable Development Goals, as defined by the UN (IPCC AR6 WGII SPM, 2022, p. 23).

Plant flowering phenology, bird breeding territory, and abundance of zooplankton are noted as a few of the significant changes due to climate change and increasing temperatures (Speed et al., 2022, p. 9). While Carroll and Noss (2021) suggest conserving land on elevational, latitudinal, and ecosystem gradients, as alpine and mountainous regions will become species migration destinations due to warming environments at lower altitudes, there are different levels of conservation and ecosystem protection needed. Lowland animals and plant species will shift upward as temperatures increase, so preserving these landscapes, and connecting them is important for species movement (Carroll & Noss, 2021). Some strategies of GI are explicitly mentioned in the AR6 WGII report as methods of ecosystem-based adaption that can help natural systems respond in the face of climate change but include co-benefits for society. These mentioned strategies include urban greening to induce cooling effects, and using natural river systems, wetlands, and forest ecosystem to reduce flooding effects (IPCC AR6 WGII SPM, 2022, p. 24). Each of these strategies, which fall under the GI umbrella, have high confidence in effectiveness, but the effectiveness declines with increased warming (IPCC AR6 WGII SPM, 2022, p. 24).

The IPCC emphasizes, “most observed adaptation is fragmented, small in scale, incremental, sector-specific, designed to respond to current impacts or near-term risks, and focused more on planning rather than implementation (high confidence)” (IPCC AR6 WGII SPM, 2022, p. 20). Planning for GI on a regional scale is well-positioned to have positive mitigation effect on climate change trends (IPCC AR6 WGII SPM, 2022 p. 20) Jiang et al. (2017) documents exponential increases in urban planning and climate adaptation literature after the year 2005, showing increased awareness and research highlighting the importance of strategies and that cities begin to plan for feasible and immediate adaptation strategies (p. 15). This positions city and regional planners to address local impacts of climate change through comprehensive plans and zoning, creating policy to help communities adapt. With GI concepts, I argue this needs to be done in a connected fashion across jurisdictional lines, but concepts of resilience are key to understanding planning for the climate change mitigation and adaptation called for in the IPCC AR6.

Resilience Literature: A Synopsis of Seminal Pieces

While the IPCC AR6 references and defines some resilience terms and concepts, these concepts are largely derived from resilience literature and resilience theory. The last major policy points for WGII include concepts of climate resilient development, its conditions, how to enable these conditions, the feasible windows of opportunity, its effects on natural and human systems, and how to achieve success within specified limitations (IPCC AR6 WGII SPM, 2022,). Resilience practice has been emphasized by the IPCC as a major factor for climate change solutions, while as a concept it has been identified and used in ecological fields for quite some time. Holling (1973) was the first to introduce the concept with reference to ecological ecosystem resilience in (Folke et al., 2010, p. 1). In the introduction to his paper, Holling (1973) identifies the perceived idea of resilience as paying attention to the degrees in constancy of organisms as opposed to presence or absence noted by death or extinction. Now, resilience is commonly used when referencing society's ability to withstand global pressures of climate change. Walker & Salt (2012) provide an interdisciplinary definition of resilience, as they identify resilience as an important theory for many fields including psychosocial, ecological, military, and disaster relief (p. 2). This paper focuses on resilience in the context of climate change and with relation to society and the environment as a combined system. After engaging resilience theory, I discuss the ways in which GI manifests resilience to climate change locally through improved physical ecosystem conditions and connections.

Holling's (1973) paper, "Resilience and Stability of Ecologic Systems," begins by explaining how properties and relationships within a system determine how that system is affected by outside forces. He takes an ecological perspective, and his theory moves ecological system studies towards a qualitative lens rather than counts of species before and after disturbance (Holling, 1973, pg. 1). Holling's (1973) ideas stand in opposition to previous notions of equilibrium of ecologic systems, and specifically extinction in relation to fecundity and mortality. Ecologic modeling predating Holling's (1973) findings do not provide accurate estimations, and do not represent the true complexity of these systems. Previous models often leave out concepts of lags, spatial elements, thresholds, limits, and nonlinearities (Holling, 1973, p. 5). Equilibrium was commonly understood along linear notions, with few models allowing for oscillations, realistic and natural behaviors, spatial heterogeneity, or an adequate number of dimensions and variables (Holling, 1973, p. 6). Gunderson (2000) cites Holling's (1973) explanation of resilience regarding equilibria. "Engineering resilience" considers the time it takes to return to a stable state as a measure of the system's stability, aka global equilibrium, which only allows for one state of equilibrium (Gunderson, 2000, p. 426) Multiple equilibria, noted by Holling's (1973) explanations of the complexity of ecological systems, acknowledges several stability states, and resilience is the measure of the ability to absorb disturbance without changing its original behavior, variables, or processes (Gunderson, 2000, p. 426). Concepts of stability are still important for understanding resilience, and while Holling's (1973) work makes stability a piece of defining the equilibrium state (p. 14), stability is not necessary for resilience manifestation or measurement. An important takeaway to identify is the difference between stability and resilience and understanding how resilience plays a role with highly unstable systems, showing a wider range of how ecologic systems persist.

Holling (1973) uses the term "domains of attraction" to signify thresholds, and if surpassed, the system can change entirely, entering a new domain (p. 13). Walker and Salt (2012) emphasize this in saying "there are limits to a system's self-organizing capacity" (p. 3). They build on Holling's (1973) findings by noting that thresholds can be hard to identify, but that resilience is typically defined as the distance the system is from its threshold, or from changing behavior (Walker & Salt, 2012, p. 7). Scheffer et al. (2001) citing to Hare and Mantura (2000) refers to this concept as a "regime shift." Natural systems generally have high levels of persistence, or "high capacity to absorb change without being dramatically altered" (Holling, 1973, p. 7). Highly unstable systems generally have higher resilience than extremely stable systems that are typically described as more homogenous, low fluctuating, or well-contained. High instability in a system could imply a more heterogeneous system with species diversity, “spatial patchiness,” flexibility, and capacity to absorb disturbance (Holling, 1973, p. 19). This absorption of disturbance can fluctuate greatly, but when the systems can return to the same relationships and interactive dynamics, the instability can be a strength reflecting high resilience. Holling (1973) uses this theory to conclude that because of qualitative variables previously unaccounted for, management of natural resources may be better approached from a resilience standpoint rather than the perspective of classic equilibrium (p. 21).

As previously mentioned, Walker and Salt (2012) provide an interdisciplinary definition of resilience, framing it in identifying that all resilience realms deal with how something or someone copes with effects or aftermath of shock or disturbance.

> “it is the capacity of a system to absorb disturbance and reorganize so as to retain essentially the same function, structure, and feedbacks – to have the same identity. Put more simply, resilience is the ability to cope with shocks and keep functioning in much the same kind of way” (Walker & Salt, 2012, p. 3).

A specific key point in understanding resilience has to do with the concept of identity, which emerged in both ecological and psychosocial resilience studies. Identity is important because the systems of examination within the context of resilience can all have variation, experience disturbance, cope in the aftermath, but also continue to retain the identity of the system without crossing a threshold hold or enduring regime shifts (Walker & Salt 2012, p. 3). Gunderson (2000) includes the concept of adaptive capacity, which can shift identity when humans influence a change of state (p. 428). Variables that make up stability domains can slowly shift over time, without human intervention (Gunderson, 2000, p. 428). Folke et al. (2010) elaborates that human action, on top of these slow shifts, are major external drivers of ecosystem dynamics and variability (p. 3). Folke et al. (2010) continues in describing that many issues with natural resource management traditions stem from the obscurity that ecosystems and social systems are interdependent, as humans rely heavily on natural resources, influencing the ways these ecologic systems function.

Walker and Salt (2012) summarize and aggregate concepts of resilience and provide ten components of resilience thinking and practice. Principles of resilience are as follows:

1. "The systems are self-organizing
2. There are limits to a system's self-organizing capacity
3. These systems have linked social, economic, and biophysical domains
4. Self-organizing systems move through adaptive cycles
5. Linked adaptive cycles function across multiple scales
6. There are three related dimensions to resilience: specified resilience, general resilience, and transformability
7. Working with resilience involves both adapting and transforming
8. Maintaining or building resilience comes with a cost
9. Resilience is not about perfect knowledge
10. Resilience is not about changing" (Walker & Salt, 2012, p. 3)

Each of these components are key to understanding how resilience works and how it can be achieved, planned for, or integrated into practice.

Social-Ecological Systems and Resilience Specifics

Resilience, in general, is about interdependent systems, but many of the fields that use resilience thinking and practice apply its concepts to coupled human and natural systems, or Social-Ecological Systems (SES) (Folke et al., 2010). Humans are linked to natural systems in every part of our lives, and the goods and services we use depend on earth's resources. As populations continue to grow, cities are continuously built out, and land cover and social change affect biophysical processes (Liu et al., 2007). In order to sustain life, humans need food, water, and shelter, all things that come from the earth. Society is endlessly linked to the earth and have impacts on the Earth System. As human life has become part of these systems, they impact each another, creating feedback loops between one another (Liu et al., 2007). Walker and Salt (2012) emphasize that different domains within a system include the social, economic, and biophysical, while changes within one domain affects the variables of another (p. 11). Many of these social-ecologic relationships are not linear, invoking the existence of thresholds that mark a system's identity and its limits for functioning in the same capacity (Folke et al., 2010; Liu et al., 2007; Walker et al., 2004). Adger (2000) identifies SESs through societal resource dependency exhibited through resource management and institutions that shape society.

Walker et al. (2004) argues that linked human and natural systems can remain stable due to concepts of "three complementary attributes: resilience, adaptability, and transformability" (p. 1). Other scholars continuously emphasize the importance of these attributes for SESs (Folke et al. 2010). While adaptability is "the capacity of actors in the system to influence resilience (and in an SES, the ability to manage)," transformability "is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable" (Walker et al., 2004, p. 2). Berks and Ross (2013) describe resilient change, adaptability, and transformation as a continuum, as transformation is dependent on the type of system (p. 17). SESs also function within adaptive cycles, including phases of growth, conservation, chaos/collapse, and release (Walker et al., 2004, p. 3; Walker & Salt, 2012). With the fluctuation that exists in SESs, these cycles are not fixed, and can jump from one point to another in any order and at any time. Scheffer et al. (2001) does not use the term adaptability but explains how traditional human control over ecosystems are unsuccessful due to the focus on prevention of disturbances, when in reality, society must understand disturbances are part of ecological systems and that preventing them can cause a change in system functioning (p. 596).

SESs are always changing and oscillating, rarely fixed on a certain attractor, so there is room for different basins to exist, and that is determined by the response of the variables in the systems to inner and outer factors (Walker et al., 2004, p. 4). In this case, a "basin of attraction" is where the system is inclined to exist with regard to the makeup of variables that define the system (Walker et al., 2004, p. 4). The "attractor" is commonly referred to as the equilibrium state, and systems that gravitate toward equilibrium can define their "basin of attraction" by the conditions of the variables when the system is leaning towards or at a state of equilibrium (Walker et al., 2004, p. 4). Multiple scales are always interacting with the focal scale (Figure 2.3), so while systems have different dimensions within them, these dimensions are also affected by the dimensions and scales above or below (Walker et al., 2004). Walker et al. (2004) calls this concept "panarchy." Similarly, Gunderson (2000) highlights that no single technique or procedure will guarantee resilience (p. 436). While understanding cross-scale interactions will help the big picture, institutions should focus on social learning and trust (Gunderson, 2000, p. 436). Olsson et al. (2004) incorporates adaptive capacity with facilitating flexible governance responding to environmental and ecosystem feedback (p. 75). Similarly, Walker et al. (2012) describes resilience approaches as strategies for increasing sustainable development goals. Berkes and Ross (2013) also emphasize adaptive capacity and agency through social learning as strengthening community systems and relationships (p. 17, citing to Brown & Westaway 2011; Goldstein 2008). Though these variables can help explain SES resilience more precisely, strategies will differ with different contexts. Resilience is not a one-size-fits-all solution, and each act of resilience thinking implementation requires local knowledge and context.

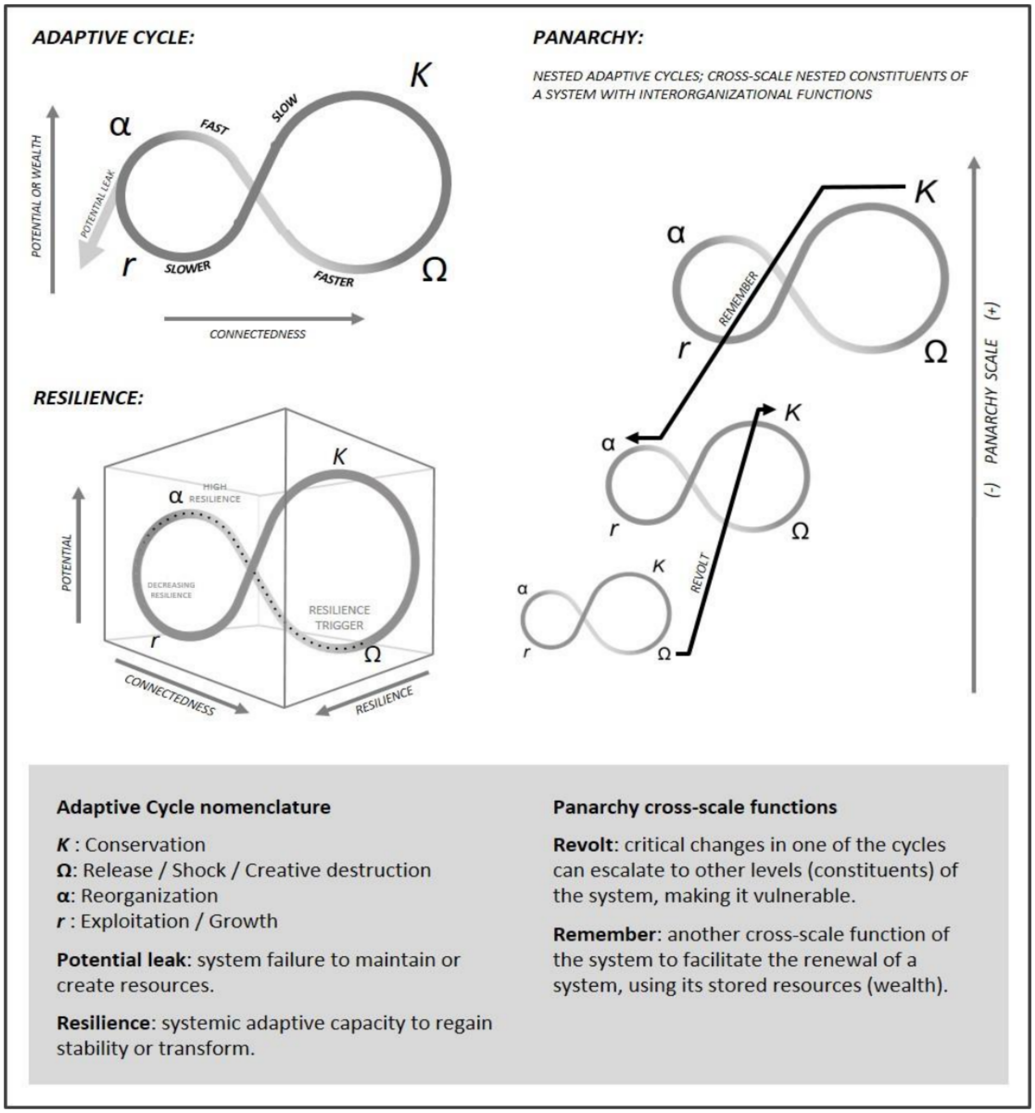

Figure 2.3: Resilience figures from Contardo & Figueroa (2021).

Folke et al. (2010) expands upon specifics from Walker et al. (2004), and explains how resilience can take on many scales, especially with the acceleration of human activity on earth, which expands the scales of SESs. Social change becomes an essential function of potential adaptability or transformation of systems, as SESs continue to grow together. Folke et al. (2010)

emphasizes the potential for transformation as a deliberate response in order to continuously support and promote various SESs. By promoting many small-scale transformation efforts, these could sequentially lead to larger scale transformation in a less stark and less undesirable way (Folke et al., 2010, p. 6). Transformation could become a key pathway to resilience for some systems,

> "Fruitful avenues of inquiry include the existence of potential thresholds and regime shifts in SESs and the challenges that this implies; adaptability of SESs to deal with such challenges, including uncertainty and surprise; and the ability to steer away from undesirable attractors, innovate and possibly transform SESs into trajectories that sustain and enhance ecosystem services, societal development and human well-being" (Folke et al., 2010, p. 7).

Folke et al. (2010) describe transformation as a growing part of resilience literature in response to changes in large scales of stability worldwide, when considering movement out of the Holocene, the stable climate humanity has existed within the last 10,000 years, and a need for flexible systems as a response. While highlighting transformability as an important tool, they also observe managed resilience or adaptability at small scales to contribute to large scale resilience (Folke et al., 2010).

As previously mentioned, climate change invokes the need for more SES resilience to sustain the current systems supporting human life. Society, governing bodies, institutions, and organizations will need to invoke concepts of resilience in their practices and decision-making strategies to sustain SESs. As mentioned in the IPCC AR6, understanding states of risk and vulnerability and methods of adaptation and resilience will be important organizing approaches in managing supporting systems, or responding to disturbances in society. Taking the parameters and understanding of resilience thinking and using it as a lens to view society can help us manage and work within unexpected events or disturbances and view resilience, adaptability, and transformation in a more regional context, existing at multiple scales (Holling, 1973, p. 21). New disturbances or unexpected occurrences within SESs will open possibility for social change, and in order to adapt or transform, social change will be needed, along with novelty and innovation in thought and method (Folke et al., 2010, p. 3).

Though adaptation planning has positive intentions for communities and ecosystems, like many other planning best practices, it has the potential to create unintentional consequences for minority communities. Scholars such as Anguelovski et al. (2016) and Shi et al. (2016) note similarities of the vulnerabilities of climate adaption concepts to environmental justice and green gentrification. If cities do not deliberately address “socio-spatial vulnerability” and disparity on the front end of adaptation measures, Anguelvoski et al. (2016) notes that injustices through land use plans and practices to historically marginalized residents will continue. These injustices will be exhibited in two ways: acts of commission and acts of omission (Anguelovski, 2016, pp. 333-334). Acts of commission occur when infrastructure investments, land regulations, or newly protected land affects disadvantaged groups through displacement or disproportionate measures (Anguelovski, 2016, p. 334). Acts of omission occur when economically valuable land and residents are protected over others. This could also happen through lack of participatory planning processes involving minorities and disadvantaged communities that will be affected or in emphasizing privatization of adaptation instead of framing it as a public good (Anguelovski et al., 2016, p. 334). Land use and development involves reallocations of financial, political, and human resources, usually leading to large investments repackaged for higher income groups. Cities need to intentionally plan and analyze how these new resources are distributed, who bears the brunt of the effects, and consider historic land use patterns that lead to risk and exacerbate socio-economic variability. Adaptation efforts must remain a public good that benefit all, or they will not be sustainable, as marginalized groups often witness a “double injustice” of contributing the least to climate issues but also being excluded from the benefits of adaptation (Anguelovski et al., 2016, p. 334).

While climate change adaptation seems mostly anticipatory, there are thresholds to avoid, and action is needed in the present to build greater resilience. Tompkins and Adger (2004) note that climate change is likely to manifest in four ways. These four main paths for manifestation are described as, “slow changes in mean climate conditions, increased interannual and seasonal variability, increased frequency of extreme events, and rapid climate changes causing catastrophic shifts in ecosystems” (para. 1). Citing to Kelly and Adger (2000) and Jones (2001), Tompkins and Adger (2004) explain that adaptation to present and future risks is a necessity to cope with extremes of gradual climate change. They also emphasize adaptive management, social learning, and community engagement in the present day as necessary factors for resilience to current and future climate change threats (Tompkins and Adger, 2004, para. 3). Society is positioned to play an integral role in supporting SES resilience, and resilient systems and institutions are needed to face threats and changes in our world due to climate change. Additionally, further climate adaptation scholarship would benefit from investigating intentional equity in climate adaptation plans and procedures. Social-ecological systems are not static, and humans have played a major role in the evolution of these systems, making it important to recognize the power of our impacts moving forward (Liu et al., 2007).

Framing Green Infrastructure

GI as a Part of the Multi-Scalar Urban System

Urban systems, and their included peri-urban fringe, do not operate in a state of equilibrium with combined elements of governance, material and energy flows, urban infrastructure and form, and socioeconomic variations (Meerow et al., 2016, p. 45). Denser and growing populations are changing land patterns in urban to peri-urban built forms. Cities are expected to support and provide services to increasing populations from infrastructure to food production to employment opportunities and medical services (Tyler & Moench, 2012, pp. 312-313). According to Tyler and Moench (2012), some of the critical support systems for urban populations are water, food supply, ecosystems that support these functions, energy, transport, shelter, and communications (p. 313). Tyler and Moench (2012) also engage the term "robust systems," or systems designed to emphasize functionality through the strength of the variables, ensuring resilience through disruption (p. 313). Functioning and resilient ecosystems are assets to communities, considered to advance general well-being through ecosystem services (Tyler & Moench, 2012). GI is widely recognized to provide stormwater benefits and potentially reduce long-term infrastructure costs, but it also can also improve water quality, air quality, mitigate urban heat, provide more access to green space, and increase ecosystem connectivity (Fu et al., 2021, p. 3, Meerow & Newell, 2017). Meerow and Newell (2017) recognize that scholars and practitioners assert GI's ability to promote resilience through "increasing diversity, flexibility, redundancy, modularization, and decentralization (p. 63, citing to Ahern, 2011; Godschalk, 2003; Wardekker, de Jong, Knoop & van der Sluijs, 2010; Wilkinson, 2011).

Landscape Scale and Potential for Regional Implementation

One of the previously mentioned ecosystem services, landscape connectivity, is a key component of GI at the landscape scale. Smaller parts of GI can be incorporated at various scales from regional to city-wide, down to neighborhoods and even at the site scale (APA, 2017, p. 2). At a 2016 Regional Green Infrastructure Symposium facilitated by the American Planning Association, it was determined that mismatched scale or, "aligning challenges and solutions at different scales of concern," was one of the challenges in GI implementation (APA, 2017, p. 4). Functions of GI go beyond political jurisdictions and boundaries, as do hazards and disturbances, explains the APA. Hazards are also typically managed at the regional level (APA, 2017, p. 7). Integrated approaches, in addition to stakeholder variability, and various professional and expert opinions are all key functions of making GI happen at the landscape scale.

The landscape scale emphasis is what drives connectivity of the larger GI system. Randolph (2004) cites to FISRWG (1998) in defining a landscape as "an area defined as having a repeated pattern of components, including both natural and human-altered areas" (p. 321). Similarly, The Chicago Wilderness Green Infrastructure Vision (2012) refers to the landscape scale as the functional connectivity of habitats, facilitating the movement and processes of organisms and wildlife (p. 33) According to Mell and Roe (2007), use of the landscape scale in planning dates back to Frederick Olmstead and his park planning in New York and Boston (p. 8). Olmstead emphasized landscape connectivity through the patch and corridor concepts, which are now integral components of GI (Mell & Roe, 2007, p. 8; Rouse & Bunster-Ossa, 2013).

Davies et al. (2006) explain the landscape scale as supporting biodiversity and habitat connectivity. Using principles of landscape ecology, Hilty et al. (2006) find that while organisms deal with fragmented habitats regularly, a changing climate makes it harder for them to adjust appropriately (p. 49). Subsequently, habitat fragmentation is a threat to biodiversity conservation (Hilty et al., 2006). Habitat patches contain high quality habitat and are differentiated from their surroundings (Hilty et al., 2006; Rouse & Bunster-Ossa, 2013). Between connected patches, species dispersal is common, but with fragmentation, the patterns change (Hilty et al., 2006, pp. 58-60). Hilty et al. (2006) describe corridors as the features that help achieve landscape connectivity, and they enhance natural habitat and species diversity (p. 90, 108). Landscapes facilitate viable species populations, and while different species require different amounts of habitat or space, providing these connections can support multiple species populations (Margules & Pressey, 2000, p. 247). Focal species need specific habitat features, which in turn support many other species populations within the landscape (Margules & Pressey, 2000, p. 247).

Randolph describes landscapes as "mosaics of patches that can range in size from a few to several thousand square miles" (Randolph, 2004, p. 321). The components of this mosaic include patches, corridors, and matrices. A patch is a "nonlinear polygon area less abundant than and different from a matrix," and a corridor "is a linear or elongated patch that links other patches in the matrix" (Randolph, 2004, p. 321). Here, a matrix represents the dominant land cover that makes up the majority of environment in a particular area such as forest, grassland, or urban land (Randolph, 2004, p. 321). Rouse and Bunster-Ossa (2013) describe a landscape as "the physical manifestation of processes that connect the built and natural environments, performing multiple functions and yielding associated benefits for the health and well-being of people and wildlife" (p. 11). According to Rouse and Bunster-Ossa (2013), this definition links an environment's physical form with beneficial anthropogenic outcomes, and further seeks to connect natural habitats and landscapes with built form and grey infrastructure, creating a more interdisciplinary approach (2013, p. 11).

When using a landscape scale perspective, patches and corridors are distinct ecosystems. Patches contain specific systems, conditions, and organisms, and landscape connectivity through corridors facilitates the flow of resources, energy, and organisms (Randolph, 2004, p. 322). The landscape scale elicits protection in the form of connections in contiguous lands, understanding the importance of ecological systems, and the risks and dangers of fragmenting them (McDonald et al., 2005, p. 7). Allen (2012) mentions how the landscape scale and region scale can overlap. Regional authority commonly presides within some sort of political boundary, but it can be helpful for regional land use goals (p. 21). Regional organizations are also well positioned to support specific open space planning, water supply and management, and connections through recreational corridors or greenways, all key pieces of the GI landscape (Allen. 2012, p. 21). Regional organizations or regional structures are positioned well to observe and act at the landscape scale, as this scale typically crosses political and municipal jurisdictions. Regionally, crucial landscapes and connections can be identified with better viewpoints for emphasized connections, as they are not bound by city limits.

Landscape Ecology and Conservation Biology Background

Green Infrastructure ideology is founded in the natural sciences, largely derived from concepts of landscape ecology and conservation biology, but also integrates the perspective with concepts of human development and urban planning. Breuste et al. (2008) describes urban green spaces as isolated habitat patches, referencing the concept of island biogeography theory, defined by MacArthur and Wilson (1987), as a way of understanding urban ecosystems within cities (p. 1139). This theory is summarized by Hilty et al. (2006) with four major components. The four components include larger islands with more topographic diversity existing with higher species diversity, islands closer to mainland's also have more species diversity than islands farther away, small islands support smaller species populations leading to higher extinction rates, and for the same reason, islands closer to mainlands will have lower extinction rates (p. 51). While "discontinuous habitats" and "changing needs over both short and long term" periods are not new for species on earth, the accelerated rate of habitat fragmentation due to human activity and population growth are novel (Hilty et al., 2006, p. 49). Citing to Klausnitzer (1993), Breuste et al. (2018) also describe positive correlations between patch size and species richness, with applications for urban areas, peri-urban, and more rural and natural areas (p. 1130-40).

Connectivity, an integral component of GI, is a determinant of species occurrence in the urban to peri-urban landscape. Connell (1978) suggests in his "intermediate disturbance hypothesis," that the higher the level of disturbance, the lower the amount of species richness, identifying intermediate levels of disturbance as the most optimal levels for species richness. This concept is identified in GI ideology when conservation spaces are identified ahead of new development, to place new built structures in appropriate locations, allowing for less disturbance in habitat areas. Noss (1993) identifies connectivity as key for species movement, but also emphasizes it should not substitute nature reserves or cores, which are needed to maintain populations of sensitive species. Hilty et al. (2006) defines connectivity as "the extent to which a species or population can move among landscape elements in a mosaic of habitats" (p. 90, citing to P. D. Taylor et al. 1993 & Tischendorf and Fahrig 2000). Landscape ecology correlates species distributions with likelihood of population extinction or survival, so prioritizing connection is important to keep the natural systems resilient, as biodiversity helps support human health and wellbeing (Stokstad 2020, p. 1418).

Conservation biology seeks to protect and maintain ecological systems, and Carroll and Noss (2020) suggest that this concept can address increasing threats of climate change and species extinction by increasing globally protected areas (p. 156). Major goals of conservation biology include maintaining biological diversity, ecological integrity through the "composition, structure, and function of those systems," and ecological health through "resiliency and systems' ability to endure over time" (Trombulak et al, 2004, p. 1181, citing to Callicott et al. 1999). Systematic conservation planning, according to Margules and Pressey (2000), includes "managing whole landscapes including areas allocated to both production and protection," which is an integral theme to GI networks (p. 243). Reserves, an important and widely understood function of conservation, serve to represent regional biodiversity, but also separate and protect this biodiversity from threats to its persistence (Margules & Pressey, 2000, p. 243). Trombulak et al. (2004) also mentions the relation to human well-being by touching on nature's intrinsic, instrumental, and psychological benefits, and that humans simultaneously bring about habitat destruction, modification, and overexploitation. Conservation is important in order to preserve these values of nature and ecological systems, while we know that humans are the major cause for nature's amplified destruction or loss of resilience.

Connected natural landscapes benefit humans through providing recreation opportunity when appropriate, limiting urban expansion, and aesthetic enjoyment (Hilty et al., 2006, p. 113). Futher, Hilty et al. (2006) explains the benefits of ecosystem services such as buffering hillsides to limit erosion and landslides, buffering creeks and wetlands to provide improved natural filtration, limiting soil loss of agricultural areas, reducing pollution from pesticides, and sustaining pollination systems (p. 115). Landscape ecology and conservation biology help to integrate ecology and social sciences as one framework, which can be highly effective for urban planning and management (Breuste et al., 2008, p. 1140, Trombulak et al. 2004). Many of these concepts are threaded into the GI principles and are the foundation of GI best practices.

Green Infrastructure: Manifestation of Climate Change Resilience Through Adaptation

GI is frequently mentioned as a response to climate change, and as a method to build SES resilience. Highlighted various times throughout the IPCC AR6, key principles of regional manifestation of GI help to protect biodiversity and ecosystem services, which is the intent of section D.3, "Climate Resilient Development for Natural and Human Systems," in the WGII Summary for Policymakers. In the same section, subsection D.4 states,

> "Safeguarding biodiversity and ecosystems is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation (very high confidence). Recent analyses, drawing on a range of lines of evidence, suggest that maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near-natural ecosystems (high confidence). {2.4, 2.5, 2.6, 3.4, 3.5, 3.6, Box 3.4, 12.5, 13.3, 13.4, 13.5, 13.10, CCB INDIG, CCB NATURAL}" (IPCC AR6 WGII SPM, 2022, p. 32)

Subsection D.4.1 summarizes some benefits of resilience of biodiversity in saying, "supporting ecosystem integrity can maintain benefits for people, including livelihoods, human health and well-being and the provision of food, fiber and water, as well as contributing to disaster risk reduction and climate change adaptation and mitigation" (IPCC AR6 WGII SPM, 2022, p. 32). Subsection D.4.2 states that loss of biodiversity and loss or degradation of ecosystems further contributes to greenhouse gas (GHG) emissions. This section elaborates on how ecosystems are at a greater extent of risk as climate change impacts strengthen and intensify. GI is confirmed as a climate mitigation option with feasibility if established in the present or near future and is described as increasingly cost efficient with general support from the public (IPCC AR6 WGIII SPM, 2022, p. 48). Since the IPCC's last report, AR5, there has been increased ecosystem degradation, subsequently increasing vulnerability of people with high confidence according to AR6 WGII (2022, p. 12). Concepts of Green Infrastructure are tied to climate change, socio-ecologic resilience, and sustainable land use theory and practice. Conservation, preservation, and land use planning are often looked at as separate goals and fields of practice, but the concept of GI builds upon the science of ecosystem protection highlighting the ways that sustainable land planning can incorporate protection of high-quality habitat, and plan for human development using better informed methods. GI also responds to climate change and resilience as a manifestation to achieve climate resilience by recognizing the importance of natural ecosystem services and processes, biodiversity, and connectivity of landscapes at the regional scale.

GI: Short Historic Background

Monteiro et al. (2020) credit the President's Commission on the American Outdoors for stirring up interest in GI in the US with their recommendation for a network of greenways in 1987 (p. 3). In the UK, Mell (2008) credits the President's Council on Sustainable Development when they noted that GI's intention is to "'promote place-based approaches to conserve, protect, restore, and manage local and regional networks of natural living, and environmental resources and amenities,'" in 1998 (p. 70). In urban planning, concepts of GI can be dated back to Frederick Olmsted and Ebenezer Howard. Olmsted understood the importance of connectivity early on, expressed through his design of Boston's Emerald Necklace (Mell, 2008, p.71). Mell explains the Boston Emerald Necklace park system was a reaction to flooding from the Charles River, but also provided social, economic, and ecological benefits for residents, visitors, and the environment, showcasing SER (p. 71). Olmsted emphasized landscape pedestrian corridors in many of his designs, and he emphasized greenspace and corridors at a regional scale (Rouse & Bunster-Ossa, 2013, pp. 40, 108). Ebenezer Howard is famously known for his concept of the Garden City, integrating greenspace into every part of the city and respecting the ecological co-benefits (Mell, 2008, p. 71). Howard promoted a design for sustainable communities dependent on their green spaces and ecosystems. Ian McHarg reshaped urban planning with regard to environmental context with his book, *Design With Nature*, released in 1969. McHarg's book played a role in advancing environmental legislation such as the National Environmental Policy Act, the Clean Water Act, and the Endangered Species Act, all formalized federally in the 70s (Fleming et al., 2019).

Green Infrastructure Literature

In literature, GI is frequently described as a method for climate change adaptation. With its basis in landscape ecology previously mentioned, GI's adaptive qualities are due to the promotion of biodiversity, ecosystem functions, and life-supporting services it offers. Grabowski et al. (2022) reviewed 122 plans from 20 different U.S. cities and found that GI is not commonly defined, and when it is, its stormwater benefits are highlighted most prominently (p. 152). While literature defines GI more broadly, the planning profession has not caught up to recognize its other benefits for communities. A commonly accepted definition for GI is, "a strategically planned and managed network of wilderness, parks, greenways, conservation easements, and working lands with conservation value that supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to the health and quality of life for America's communities and people" (Rouse & Bunster-Ossa, 2013, p. 10 citing to Benedict & McMahon, 2006).

Randolph (2012) describes GI as a method that integrates wildlife habitat and open space planning (p. 386). Randolph defines GI as, "an interconnected network of green space that conserves natural ecosystem values and functions, supports biodiversity and provides habitat for diverse communities of flora and fauna, and provides associated benefits to human populations" (2012, p. 386). Benedict and McMahon (2006) advance the idea of GI, inform a specific GI approach, describe its benefits, basics of network design, and go so far as to provide thoughts on implementation, management, stewardship, and support for GI. Their book, *Green Infrastructure: Linking Landscapes and Communities*, covers GI at length and serves as a manual, published by The Conservation Fund in 2006. Benedict and McMahon base this work in a need for a new outlook and approach to conservation and development, warning that "less than 10 percent of land in the United States remains in a wild state, and only 4 percent has been set aside for nature reserves" (2006, p. 5). "Between 1982 and 2001, about 34 million acres–an area the size of Illinois– were converted to developed uses," according to Benedict and McMahon (2006, p. 5). Conversion rates of forest land to developed uses has increased to about 1 million acres a year at the time of Benedict and McMahon's publication (2006, p. 5). Rouse and Bunster-Ossa (2013) published *Green Infrastructure: A Landscape Approach*, with the American Planning Association as a Planning Advisory Service Report, putting GI in a more official position as a land use strategy within the planning practice. Davies et al. (2006) published a GI planning guide with Newcastle University in order to provide a quick reference for GI planning.

Reasoning behind GI is rooted in land use planning, prioritizing conservation on the forefront of development, which has not been a common practice in the 20th century. Cities are growing larger, covering more land, and average single-family lot size has increased with time as well (Benedict & McMahon, 2006, p.8). As lot sizes grow larger and suburban sprawl increases, "the nation's largest and fastest growing metropolitan areas risk total eradication of their natural areas–except perhaps those owned by the government" (Benedict & McMahon, 2006, p.8). Natural communities of plants and animals, and natural system processes are affected by our development and sprawl land use patterns, and it is hard to make these changes without a mindset of resilience thinking. Economic factors push development further and further from city cores, taking over undisturbed lands, or old agricultural lands, as greenfield development is cheaper comparatively. These practices alter ecosystems and habitats extremely, impacting stability for many different variables in the system. At the same time, GI can be tool for development with relation to sustainable communities (Davies et al., 2006, p.3). Not only are economic factors structuring land use, but so do human health factors (Tzoulas et al., 2007). GI highlights the quantity and quality of green spaces available to benefit human society, its interconnections with ecosystems, but also its effects on public health (Tzoulas et al., 2007). Andersson (2017) emphasizes GI as a design structure that intends to incorporate the connections between green space, green infrastructure, the built environment, and formal and informal government arrangements (p. 193).

As an expression of "strategic conservation" and "smart growth," GI hopes to guide development and growth, planning for our natural and human systems simultaneously, and keeping natural, preserved, or open space land, preserved for the good of the community's SESs (Benedict & McMahon, 2006). Methods of greenspace conservation can affect the ways communities are structured and how community members interact with one another, facilitating attachments towards specific places and the community at large (Tzoulas et al., 2007, pp. 170-171). Rouse and Bunster-Ossa (2013) also emphasize the multifunctionality of GI, building on sustainability and the “triple bottom line–the environmental, economic, and community benefits” (p. 19). Rouse and Bunster-Ossa emphasize (2013) GI in practice as an integration of designers, planners, and other to achieve societal goals (p. 11, 19). Some of the societal goals for GI include human health and well-being. Tzoulas et al. (2007) formulated a framework linking ecosystem health and human health in support of the benefits provided to communities through GI.

Davies et al. (2006), Benedict and McMahon (2006), and Rouse and Bunster-Ossa (2013) all address basic concepts of GI in their work, include salient background information, but simultaneously provide a resource for framing and implementing GI in planning practice. These resources are especially helpful for understanding GI as a function of planning, and within the context of climate change, as a form of adaptation.

GI as a Network of Lands

By their nature, GI networks are SESs. They can and do typically include trails and recreation lands, farms, ranches, gardens, archeological sites, forests, which are all valued community resources with resource yields that are a part of economic systems (Benedict & McMahon, 2006, p. 14). Mell (2008) highlights the feature of connectivity as a function of applied landscape ecology, and the importance of connection of landscape features no matter the size or composition (p.70) Benedict and McMahon also use concepts of hubs, links, and sites to describe connection of these networks. Hubs are the anchors of the GI network. They provide ample space for plants animals, wildlife, and people, and are a sort of destination for facilitation for ecological processes (Benedict &McMahon, 2006, p. 13). Hubs can have different sizes, ranging from large reserves of protected land to private working lands to community parks or open spaces. Links function as corridors, facilitating health of ecosystems biodiversity, and natural ecological processes through connection of landscapes and ecosystems (Benedict &McMahon, 2006, p. 13). Others, such as The Conservation Fund, reference the same concept with terminology of cores, hubs, and corridors. With these terms, cores are the high quality habitat, while hubs are what surrounds this and interfaces with human development, and corridors connect hubs. Corridors can be solely for wildlife, and they can also exist as trails and greenways. GI networks and plans intend to connect natural assets in similar ways to design of grey infrastructure (Nolon, 2021, p. 47). Nolon (2021) extends this idea further, "water and wildlife, like vehicles and people, need to travel through connected paths and landscapes" (p. 47). Links can be used for recreation, they can be riparian corridors, floodplains, protection of historic sites, or greenways/ greenbelts (Benedict &McMahon, 2006, p. 13). Increased access for species mobility is the ultimate goal. In order to achieve connectivity, communities may need to incorporate lands that previously had other uses.

> "In addition to 'the ecologically based' green infrastructure hubs and links mentioned above, a green infrastructure network could include large tracts of public land, including land on military installations; large tracts of forested land, fallow land, desert, or other open land; riparian lands, including rivers streams creek corridors, and floodplains; fragile lands, including steep slopes, coastal areas, wetlands, and hydric soils; working lands, including lands used for agriculture, forestry, hunt clubs, and preserves; recreation lands, such as parks, golf courses, and hiking or walking trails; private lands; including corporate/ industrial properties, utility company rights-of-way, and railroad corridors,

abandoned or underutilized sites, including brownfields; or transportation corridors" (Benedict &McMahon, 2006, p. 15).

The strategies for GI networks can shift depending on the surrounding context and setting of the area. For example, in rural areas, GI can be used to ensure protection of ecologically sensitive and valuable areas, and it can function as a guideline to direct new development toward land better suited for human use, and more connected to other community resources (Benedict &McMahon, 2006, p. 15). In urban areas, this could mean street trees, pocket parks, or buffers along streams and riverine corridors.

The role of water is included in the typical green infrastructure network, making it a key feature of GI, and riparian corridors are commonly used for habitat linkages and connections between hubs or cores. Green stormwater infrastructure (GSI) is one of the largest and most recognizable functions of GI. The EPA solely describes GI through this definition on their website. While the EPA does address GI at the landscape or watershed scale, they open the GI learning page on their website talking about stormwater runoff, the pollutants stormwater carries, and damage that can be caused by flooding (2022 EPA). Mell (2008) citing to Kelly Cave's work explains the importance of reservoirs for storing, filtering, and releasing rain and excess stormwater in surges (p. 74). Surges, surplus water in areas of bad infiltration, can cause erosion and degradation of ecological resources if natural riparian and water systems and natural GI linkages are not implemented properly (Mell, 2008, p. 74). Using GSI interventions suggested by the EPA such as bioswales, permeable pavements, and emphasizing the urban tree canopy can help urban systems respond to water in more natural ways, but these methods are site-specific and implemented on a smaller scale.

GI Principles

Green Infrastructure Principles as stated by Benedict & McMahon, incorporated with Land Use Planning Concept,

1. “Connectivity is key
2. Context matters
3. Green infrastructure should be grounded in sound science and land-use planning, theory, and practice.
4. Green infrastructure can and should function as the framework for conservation and development.
5. Green infrastructure should be planned and protected *before* development.
6. Green infrastructure is a critical public investment that should be funded up front.
7. Green infrastructure affords benefits to nature and people.
8. Green infrastructure respects the needs and desires of landowners and other stakeholders.
9. Green infrastructure requires making connections to activities within and beyond the community.
10. Green infrastructure requires long-term commitment” (2006, p. 37).

Rouse and Bunster-Ossa also provide their own key principles for GI,

1. “Multifunctionality
2. Connectivity
3. Habitability
4. Resiliency
5. Identity
6. Return on Investment” (2013, p. 18).

While Benedict and McMahon (2006) emphasize a framework, Rouse and Bunster-Ossa (2013) emphasize collaboration in the professional practice. Benedict and McMahon (2006) structure GI and lay out its potential for success and various impacts, and Rouse and Bunster-Ossa (2013) address GI more practically with the descriptions of various case studies. Touching on notions of equity, Rouse and Bunster-Ossa (2013) also emphasize the need for community input, as the goal is to support and benefit members of the community. On the other hand, Tzoulas et al. (2007) highlights needed progress in research to address the interdisciplinary impacts of GI, ecosystem health, and community and human health further, to better address public health as a function of GI.

Ecosystem Services

One of the fundamental concepts and benefits of GI is the ecosystem services it provides, and the role these services play in supporting ecological and human life. Rouse & Bunster-Ossa (2013) identifies ecosystem services as "the benefits natural ecosystems provide for people" (p. 12). These services are further broken down into provisioning services such as food and water, regulating services such as improved water or air quality and carbon sequestration, supporting services such as nutrient cycling or crop pollination, and cultural services like recreation or spiritual inspiration (Rouse & Bunster-Ossa, 2013, p. 12). GI literature commonly brings up ecosystem services with the concept of multifunctionality because the benefits of GI serve many environmental, economic and community purposes at once. From hydrology to public health to transportation systems, outcomes of ecosystem products support life on earth.

These services can act as insurance for communities in disturbances or when unexpected hazards occur. Green et al. (2016) citing to Baumgartner and Strunz (2014), notes that investing in ecosystem service is like investing in ecosystem insurance, keeping ecosystems in desirable domains, preventing irreparable changes in the flow of these services and the stability and state of the system (p. 1052). GI's main goals of eliminating ecosystem fragmentation and restoring biodiversity strengthens potential outcomes of ecosystem services (Zoppi, 2020). Ecosystem services can also further highlight the social and ecological systems at play together (Hansen & Pauleit, 2014, p. 517). Bastian et al. (2012) cited by Hansen and Pauleit (2014) created a framework for assessing multifunctionality of ecosystem services from a social-ecological perspective (p. 520). This framework has contributed to ecosystem services literature, helping to further realize the benefits in analyzing the status quo of the system, both ecological and social perspectives through capacity data and demand data, and valuation measures which all contribute to priority actions and strategies (Hansen and Pauleit, 2014, p. 520). The ecological perspective looks at spatial and structural components to the environment in addition to its functions and services (p. 521). The spatial elements can be described as green and blue spaces including many of the types of landscapes previously mentioned in the GI sections, such as nature reserves, agricultural land, and water bodies, to name a few. The framework then assesses the supply of the services and the local demand with land cover and quantification indicators (pp. 520-521). Demand is usually measured by experts, or standards agreed upon politically, and can be quantified with statistical analysis, models, or interviews (Hansen & Pauleit, 2014, citing to Burkhard et al., 2012, p. 522). Davies et al. (2006) has developed a matrix to assist in determining quality of GI elements and GI network connectivity. This gives a valuation of the GI integrity, which can help determine the crucial functions and health of the ecosystems (Hansen and Pauleit, 2014, p. 523). Synergies and trade-offs are also included in the model (Hansen and Pauleit, 2014, p. 525).

While ecosystem service measurements and data are not required for GI plans, they can help assess the important services in an area, strengthening messaging of GI plans and emphasizing the importance of the services through the GI network in relation to a community and its values or needs. Explaining the importance of ecosystem functions with local examples and data would only help further the value and understanding of GI in an area, and help stakeholders come together to support, fund, and facilitate GI networks. Currently, cultural services such as recreation and health are the most recognized functions of GI (Andersson et al., 2005, p. 447). Provisioning services such as food production and biodiversity conservation are other commonly noted services, increasing in realization with GI plans. Regulating services such as seed dispersal, pest regulation, and pollination can be addressed by GI plans, and these services go beyond an area's limiting bounds, affecting surrounding landscapes, but still working together to facilitate local ecosystems (Andersson et al., 2005). Each of the types of ecosystem services are commonly linked to human well-being, confirming the importance of social-ecological system consideration, and GI plans.

Climate change has high potential to impact the functional delivery of ecosystem services in natural areas, with anticipated loss of ecosystems and species as greenhouse gas amounts continue to increase (Green et al., 2016). Disruptors expected to become more prevalent with increasing effects of climate change will increase risk related to ecosystem services, creating adaptation challenges if not addressed sooner than later (Green et al. 2016, p. 1052). Green et al. (2016) also examines an ecosystem resilience and economic model by Strunz and Baumgartner (2010), which finds that full costs of investing in resilience mitigation or adaptation measures are less than the overall potential loss of income if ecosystem services were to be eliminated (p. 1054).

The IPCC AR6 (2022) and National Climate Assessment (2018) both state that current actions are not enough to reduce risks of climate change, and more immediate and larger scale actions need to be taken. This drives the focus of this GI research in the context of a landscape scale, as a response to the need for regional adaptation that climate literature calls for. Using the frameworks and resources for GI planning, GI plans should address important features of resilience planning and exhibit SER benefits for communities. GI plans should address many of the components and principles featured in the literature.

Plan Quality and GI Plan Evaluation Literature

Plan quality relating to green infrastructure and social-ecological resilience is an evolving field. Professionals, practitioners, and academics would hope that GI Plans manifest an outcome of quality that addresses resilience of SESs, but there are varying frameworks and ideas of GI existing in literature. GI is a pathway for climate adaptation and mitigation, so the literature on plan quality will cover relevant existing literature. I suggest that GI plans should manifest SER qualities and principles, on top of integral GI principles from literature.

While Berke et al. (2006) does not cover GI plans or conservation-related plans in their discussion of plan quality with relation to plan typologies, their internal and external plan quality metrics are standard for land use and development plans (Dyckman & Conroy, 2020). Plans are long-range policy documents that provide background context such as legal and political context, in addition to logical reasoning of an area's development and settlement over a twenty or thirty-year timeline (Berke et al., 2006, p. 60). Berke et al. (2006) indicates the core purposes of a plan as: "a vision that inspires action for the future, consisting of goals and policies to inform the vision's physical development pattern, long and short-range actions and goals that encourage a future development pattern, and engage the 'big picture' of a community based on relevant trends and regional influences" (p. 60). "A high-quality plan helps inform debate and collaboration among competing interests through stakeholder participation in its preparation," (Berke et al., 2006, p. 60). Berke et al.'s (2006) plan quality metrics work to strengthen a plan's influence with determined crucial criteria (2006, pp. 69-70). Berke et al. (2015) argues that the typical "predict and plan" techniques that predict future trends do not indicate appropriate measures for disaster recovery planning (p. 311). Berke et al. (2015) also uses an anticipatory governance model for incorporating flexible policy into plans (p. 311). Combining plan quality literature with anticipatory governance helps to create a structure for adaptive plan quality aimed at addressing complex and uncertain problems that could arise in disaster recovery (Berke et al., 2015, p. 311). As Berke et al. (2006) mentions, "plans carry the weight of public responsibility," so plan quality evaluation is necessary and important, no matter the plan type (p.70).

McDonald et al. (2005) provide an overview of green infrastructure plans, best practices for GI planning, and an evaluation framework for GI at different local and regional scales (p. 7). Delineating GI plans from other conservation-focused plans, McDonald et al. (2005) specify primary GI plan objectives as identifying "suitable lands for conservation in the context of current and future development" (p. 8). McDonald et al. (2005) also identify essential GI plan elements; goal setting, analysis, synthesis, and implementation (p. 9-11). Woodruff et al. (2021) evaluate GI components of comprehensive plans from coastal cities in Texas, taking a slightly different approach than McDonald et al. (2005). Their plan evaluation framework includes general planning criteria largely derived from Lyles and Stevens (2014) and couples this with GI-specific criteria. Woodruff et al. (2021) find that GI elements are poorly integrated into comprehensive plans in the coastal Texan cities chosen for their study (p. 1592). Unfortunately, this is consistent with other studies of GI evaluation in other regions of the US (Woodruff et al., 2021 citing Brody, 2008; Lynch, 2016; Kim & Tran, 2018), but this leaves room for studying sole GI plans, their quality, and if this quality translates to a local level implementation.

According to McDonald et al. (2005), an advisory board or committee should direct the goal setting, incorporating diverse perspectives, and building public support for plan goals (McDonald et al., 2005, p. 9). Berke et al. (2006) identifies major limitations to plans. A poor fact base will hinder plans in influence and strategy. Without rationale behind priorities, the plan is unable to guide or suggest viable policies, making goal setting an extremely important function of any plan type (p. 75). Other important goals include protection of ecologic functions and space for the benefit of humans, and natural elements should be identified (McDonald et al., 2005, p. 9). As different landscapes have different goals, the landscape scale should be one of the driving forces, explaining how the study area is influenced by the area's resources and surrounding ecosystems (McDonald et al., 2005, p. 10). The analysis should include network design with linked ecosystem components and processes, restoration and ecologically valuable areas, distribution and change over time, and interactions with the built environment (McDonald et al., 2005, p. 10). The synthesis component suggests an analysis model to identify network gaps and a map of the final design (McDonald et al., 2005, p. 11). Lastly, implementation should include supporting tools and a system or structure to prioritize protection according to the plan elements (McDonald et al., 2005, pp. 11-12). Lack of monitoring solutions also causes a plan to be weak. Without measurable steps to take towards goals, or a way to track progress, there is no accountability for the plan to be used for its indicated purposes (Berke et al., 2006, pp. 75-77). A specific plan evaluation matrix from McDonald et al. (2005) is in Appendix A, with further application in the methodology.

The literature has confirmed GI as a supporting system of urban areas and society, meaning it is an SES. The literature also supports GI's multifunctionality and co-benefits, so GI planning should manifest the Social-Ecologic Resilience (SER) indicators from Dyckman & Conroy (2020). Reiterating the SES literature, SES resilience must be planned for as one, and not for separate social or ecologic variables. Dyckman and Conroy (2020) build on previous traditional plan quality to incorporate SER and Sustainable Commons Management (SCM) for assessment of resource management plan quality. Building on flexibility emphasized by Berke et al. (2015), this plan quality measure can assess a variety of planning processes for SER and SCM principles in light of climate change (Dyckman & Conroy, 2020, p. 4).

Plan Implementation Literature

Allen (2012) describes how the landscape scale of GI can overlap successfully with the regional scales of governments or institutions. At a regional scale, governmental organizations can introduce ordinances or invoke incentive programs through public processes (Allen, 2012, p. 22). Other pathways for implementation can include funding for land acquisition or conservation easements, policies located in comprehensive plans or stormwater management policies and standards, incentives for open space conservation in subdivisions, conservation subdivisions more specifically, and tax and valuation policies to encourage preservation of forests, farms, and wetlands (Allen. 2012, p. 22). Lastly, implementation efforts through incentives to protect floodplains, trees, landscaping, native ecology, slopes, surface waters, wetlands, and other vital natural resources are other avenues at the landscape scale suggested by Allen (2012) (p. 22).

The American Planning Association (APA) provides a variety of useful resources through their publications and have addressed GI plan implementation through PAS reports such as the Rouse and Bunster-Ossa (2013) report, and other reports that explicitly address the Wildland Urban Interface in partnership with the US Forest Service. Best practices by the APA suggest GI implementation in the form of local plans, regulatory tools, other policy tools, capital investments, and programmatic tools (APA, 2017). Laurian et al. (2004a) find that typically, the resources in planning agencies and the quality of the plans drive implementation, though the research is based in New Zealand.

Implementation should be consistent with the plan approaches and concepts, which are measured through the plan quality framework (Berke et al., 2006, p. 67). Laurian et al. (2004b) suggests a Plan Implementation Evaluation (PIE) methodology to identify strengths and weaknesses of plan implementation and resolve implementation difficulties or obstacles (p. 471). This piece informs the methodology, to be discussed further in the document, so it is briefly discussed here.

Laurian et al. (2004a) define plan implementation in performance-based and conformance-based language, which include different assumptions linked to plan implementation (p. 472). The conformance approach links plans to development, assuming a rational model according to Laurian et al. (2004a), as a direct approach for development (p.472). Assuming specificity and measurable monitored outcomes, as Berke et al. (2006) suggests, conformance-based implementation is qualitatively or quantitatively measured by outcomes such as policy (Laurian et al., 2004a, p. 472). Performance-based approaches consider plans as more of a guide than a directly read blueprint and is implemented “if it is used in decision-making processes” (Laurian et al., 2004a, p. 472). Laurian et al. (2004a) highlights the focus of planners to shape the physical environment through outcomes of development, assuming that planners lean more toward conformance-based implementation measures or approaches (p. 472). At the same time, “performance-based view of implementation correctly observes[s] that planning decisions often depart from the plan and yet implement its policies” (Laurian et al., 2004a, p. 472). Laurian et al. (2004a) claims to lean towards conformance in the PIE method, defining plan implementation as “the degree to which plan policies are implemented through the application of specified development techniques in planning practice,” but also noting that it does not assess outcomes as positive, negative, strong, or weak (pp. 472, 479).

Berke et al. (2006) also look at implementation in terms of conformance and performance. In terms of conformance, Berke et al. state that planners have significant influence over implementation efforts, but in terms of performance, they are less influential. Laurian et al. (2004a) notes that implementation is conditioned by four factors including: commitment of the agency, inclusion of implementation or management techniques, specification of related management in development permits, and use of techniques by developers (pp. 472-473)

In order to apply the PIE methodology, there are five requirements: “the identification of one or several issues of interest,” “the selection of plans or relevant sections of plans,” “the selection of permits,” “the evaluation of linkages between plan policies and permits,” and “the calculation of implementation indicators” (Laurian et al., 2004a, p. 473). This process can help the planner or researcher understand if plan objectives match with the techniques utilized by the municipality. In summary, the goal is to delineate the strengths of linkages “between plan policies and the techniques used in permits to implement these policies” (Laurian et al., 2004a, p. 477).

Literature Summary with Regard to the Methodology

GI links ideas of resilience, social-ecological systems, climate change adaptation and mitigation, and can be executed through the planning practice in the manifestation of GI plans or GI plan components. If included in city or county plans, GI can be held as an overarching policy for planning and development of a community's landscape, natural systems, and land use practice. Previous studies typically use plan evaluation in determining plan quality, but have not done so with specific GI intents in mind at the landscape scale. If GI is to represent resilience qualities and capabilities for the interconnected social and ecological realms, one would hope that these features can manifest in real communities as a result of GI policy exhibited in local comprehensive plans. This research asks if landscape-scale GI plans, with different guiding landscape ecology principles (i.e. watershed boundaries or cores and hubs foci) manifest consistency in advancement of social-ecological resiliency through connected GI networks at the local policy level.

CHAPTER THREE

METHODOLOGY

The intent of this research is to explore if GI plans at the landscape scale, with different guiding landscape ecology principles (watershed boundary versus cores and hubs bases) manifest GI connectivity and SER at the local government and local policy level. The landscape-scale, a commonly used concept in landscape ecology, refers to the functional connectivity of habitats, facilitating the movement and processes of organisms and wildlife (Chicago Wilderness, 2012, p. 33). I examined two GI plans for vertical consistency from the landscape scale down to the scale of local government policy and implementation in the form of comprehensive plans. I did so through two different analyses: including a comparative GI plan evaluation analysis and a local content analysis seeking manifestation of GI content.

Case Study Selection

I chose to analyze two GI plans from different regions of the United States, highlighting the nuance of the landscape scale and its ability to be realized across city, county, or state boundaries. I have only examined two GI plans due to the availability of truly focused landscape scale plans that included boundaries crossing jurisdictional lines, and was unable to find any other plans exhibiting this scale and specified qualities. I found GI plans through the Conservation Fund's website, an important actor in the creation and facilitation of GI plans in the United States. I intentionally used the website's resources to search for GI plans, knowing that they have has a tremendous impact on GI knowledge, plans, and research in the US. I hypothesized that plans produced with the help of the Conservation Fund are likely to be of higher quality than a straightforward Google search. Limiting my selection to this website created a pool of 32 plans and documents to further narrow. Each plan was to be based on the landscape scale, and not limited to city or country-wide designations. Eliminating city-wide and county-wide plans reduced the selection pool significantly because very few GI plans cross municipal and jurisdictional boundaries, as much of governmental policy is contained within these limits. Additionally, to provide a comparison of different GI plans, I intentionally pre-determined that the plans would have a basis of different geographies, different types of landscape scales, and would be adopted by different types of institutions. The plan selection was also further reduced to exhibit a sufficient timeline for manifested implementation, so I limited my search to GI plans created between the years 2000 and 2012. This allows at least ten years for implementation at the latest date. Limiting my selection of GI plans makes the case selection a purposeful and nonrandom sample.

The cases I selected are the “Chicago Wilderness Green Infrastructure Vision” and the “(Re) Connect Wasatch Front Green Infrastructure Plan.” They each fit the criteria described and have different defining features to allow for a comparison of GI plans. The Chicago Wilderness Green Infrastructure Vision was created by a nonprofit organization and is based on watershed boundaries. This GI plan is made for an area in the Great Lakes region that includes four states, 38 counties, and more than 500 cities. This plan was originally created in 2004 and was updated with an additional document created in 2012 (2023 The Conservation Fund, n.d.). The Chicago Wilderness Green Infrastructure Vision has aimed to show physical results of its work by the year 2025, making investigation of policy implementation in this region timely. The (Re)Connect Wasatch Front Green Infrastructure Plan was formally adopted through municipal processes by the Wasatch Front Association of Governments and the plan was created with the help of The

Conservation Fund. The Wasatch Front is the Association of Governments that captures the Salt Lake City region in Utah. This plan is based on the cores and hubs features of the landscape scale in the Intermountain West. The (Re)Connect GI plan includes 5 counties and 60 cities and was adopted in 2012 (Wasatch Front Regional Council, 2021).

Research Design

Analysis Approach, Phase 1: GI Plan Quality Evaluation

As described in the research design table located in Table 1, the first step of analysis performed was a qualitative comparative assessment of the two GI plans described in the case study selection. I completed this analysis using the structure of the plan evaluation frameworks from McDonald et al. (2005) and Dyckman and Conroy (2020) that were discussed in the literature review. Each of these frameworks, with their specified coding measures and material, are provided Appendix A. McDonald et al. (2005) applies a simple point system giving scores to each main element of the plan evaluation. These elements include goal setting, analysis, synthesis, and implementation (McDonald et al., 2005). Each main element contains listed criteria to rank and score the plans, and some criteria weighs more heavily with the potential for a higher number of points, depending on its pre-determined importance in strengthening a GI plan's overall quality (McDonald et al., 2005, p. 15.). Dyckman and Conroy's (2020) SER measures were also used to code each GI plan. This evaluation framework scored the plans for elements of Social-Ecological System Resilience and Sustainable Commons Management manifestation. This evaluation highlights components such as localism, trade-offs, sharing knowledge, and SES qualities (Dyckman & Conroy, 2020). The framework applies a 1-3 coding scale where a score of one equals "not mentioned in the plan," two equals "mentioned but not in detail," and three equals "a detailed description" (Dyckman & Conroy, 2020, p. 13). The analysis was performed to see whether GI principles and SER principles from the literature manifest in each of the GI Plan cases.

To perform this analysis, I read each GI plan thoroughly. Next, I scored both GI plans using the evaluation frameworks and their designated coding guidelines mentioned previously. This format allowed me to give each plan a score, in order to compare differences and similarities between each case, across the same form of measurement.

Analysis Approach, Phase 2: Creation of Local Content Analysis coding metrics

While reading the GI plans, I took extensive notes on important features, components, and strategies outlined or expressed for each case study, the Chicago Wilderness and the Wasatch Front. I used these notes to create a Local Content Analysis framework in order to investigate consistency of important themes and concepts from the case study GI Plans and their potential manifestation in local policy documents. This coding metric can be found in Appendix B. The goal in personally creating a new content analysis framework is to see whether the subject matter may occur in the local comprehensive plans as a form of implementation, and what pieces of this subject matter are emphasized in the different locations. This Local Content Analysis is the metric used in Phase 3 to analyze the local city and county comprehensive plans, along with a ten local GI plans from the Chicago Wilderness region discovered in the data collection process. The Local Content Analysis is based on the literature, each larger GI Plan's subject matter and plan quality evaluation results. This was an iterative process occurring while I performed the first phase of methodology, with incorporation of key aspects from the literature.

The framework includes key components that would be expected to translate for a true understanding of the benefits, functionality, and planning for local implementation of GI. This includes variety of integral components expressed in phase 1 of methodology. Each section of the metric has a different weighting in order to express the relevance and importance of the themes and concepts according to my personal perspective and the literature. I used the notes taken while performing the comparative GI plan quality evaluations to inform the most important and repetitive concepts with regard to both case study GI plans. For example, resiliency was an important piece of the literature review, but the GI plans did not reference resiliency with that level of emphasis in regard to GI concepts and planning. This Local Content Analysis will seek subject matter and relevance of GI regarding the fact base, specified goals, GI understanding, land use strategies, resilience indicators, and implementation goals. I chose for the Local Content Analysis to include a code of one to three, where a score of one equals “not mentioned,” two equals “mentioned but not in detail,” and three equals “a detailed description” (Dyckman & Conroy, 2020, p. 13).

Analysis Approach, Phase 3: Gathering local policy documents

I performed a rough count of all counties and cities within each of the cases in order to gauge the volume of data and jurisdictions for analysis. This count was not accurate and was only used to inform my process moving forward. To do this I used Google to search lists of cities within each county incorporated in both the Chicago Wilderness and the Wasatch Front GI Plans. This rough estimation led me to a number of about 500, but likely more, due to an inability to locate accurate verification lists in the plans. With this number in mind, and the time frame for my research, I decided to narrow the cities and counties examined to those explicitly listed in stakeholder lists within each of the landscape-scale GI plans.

Next, I began gathering data by creating a list of each county. Then, I went to each county's website and searched for a list of municipalities within the county's jurisdiction. I did this for each county, compiling a master list to guide my document collection process. In retrieving documents, I only included local Comprehensive and General Plans, as they are referred to in Utah, within the time frame of post 2012, and within the case study's described area. When I arrived at each municipality's website, I first tried to self-navigate to the Planning Department's webpage. If planning documents were located here, they were quite easy to find and assess for the appropriate time period. If there was no Comprehensive Plan located on this page, I would manually try to locate a document webpage. If a document webpage was not easy to locate, I finally referred to the municipality's search option, and typed "comprehensive plan," "plan," or "planning." If the document could be found and was created in the year 2012 or later, I saved it to my hard drive. I repeated this process for every single county and its respective cities that were explicitly listed as stakeholders in each of the GI Plans. Below is a final count of the documents that were to be examined in the next phase of the methodology.

Cases	City Comprehensive and General Plans	County Comprehensive Plans	Local Green Infrastructure Plans
Chicago Wilderness	112	5	10
Wasatch Front	40	3	0

Table 3.1: Total count of local plans fitting the selection criteria

Analysis Approach: Phase 4, Seeking Local Manifestation of GI & SER Principles

The next phase of analysis I performed included a qualitative investigation of local manifestation of the perceived GI and SER principles found through the previous GI and SER plan quality measures, using a variation of Laurien et al. (2004)'s PIE method. This was done through a Content Analysis of the local government policy documents retrieved, using the new framework known as the "Local Content Analysis" (found in Appendix B) devised from themes in the literature, the GI Plan Quality Evaluation, the SER Plan Quality Evaluation, and each of the case study GI Plans. The scoring metric I used was the same one to three scale expressed previously. About a quarter of the way through, I found a webpage linked to the Chicago Wilderness with separate specified GI plans adopted by a small amount of the cities and counties in the CW area. This prompted me to pay close attention to any mention of GI Plans in the local comprehensive plans already gathered. While working through the scoring of each plan according to the Local Content Analysis, I located one more locally specific GI plan mentioned in the city of Gary, Indiana's comprehensive plan. I added this local GI plan CW list. A short list of the included counties is below, and a list including all cities examined within the associated county jurisdictions is located in Appendix D.

Chicago Wilderness

Illinois

- Cook County
- Dupage County
- Kane County
- Kendall County
- Lake County
- McHenry County
- Will County

Indiana

- Lake County

Wisconsin

- Milwaukee County
- Walworth County

Wasatch Front

Utah

- Davis County
- Salt Lake County
- Tooele County
- Weber County

Figure 3.1: Case Study localities, by region and county

Research Intent

The results of the Local Content Analysis will show how GI is expressed and regulated locally, while the examined cities and counties simultaneously exist within an intentional GI network, according to the landscape scale GI Plans. This study shows how GI is addressed in local GI plans, and whether data on GI implementation converges or diverges between the chosen cases and different geographical areas. The content analysis uncovered various successes and gaps in implementation, and the multitude of techniques realized through the local policy documents (Gaber, 2020, pp. 112-3). Implementation strategies and actions reveal various similar or different outcomes, showing convergence or divergence in local strategy.

	Metrics		
Governing Documents	Phase 1: SER/SCM Plan Quality Evaluation	Green Infrastructure Plan Quality Evaluation Framework	Phase 3: New Local GI Content Analysis
Wasatch Front GI Plan	X	X	
Chicago Wilderness GI Plan	X	X	
Local Comprehensive/ General Plans			X
Local GI Plans			X

Table 3.2: Research design illustrating the qualitative research process, its metrics, and types of analyses.

Research Limitations

The analysis methods were all qualitative and performed by me, which allowed for biases. I have pursued this research with my own personal interests, but also with the hope that it will be of use to others researching GI plans, GI planning processes, or GI plan implementation. The comparative GI plan analysis produces a question of intercoder reliability, creating a threat to validity that much be considered when interpreting the results. I have personally conducted these analysis methods using the provided coding structures, which has created internal bias, as I am the only coder.

While the goal of this research was to investigate consistency between GI plans and implementation through policy outcomes at the local level, there was not any room for generalizing these observations to predict or assume outcomes in other locations not mentioned or researched. The results of this research were context specific to each of the geographical regions examined by the case selections of the Wasatch Front and the Chicago Wilderness. Thus, the outcome does not accurately represent the sample population of all GI plans, local comprehensive plans, or local city and county codes.

CHAPTER FOUR

DATA RESULTS AND DISCUSSION

Data Description and Restatement of Research Question

The resulting data includes scores from McDonald et al.'s (2005) Green Infrastructure Plan Evaluation Framework (Appendix A Figures A-2 through A-5) and Dyckman and Conroy's (2020) SER/SCM Plan Quality Evaluation (Appendix A, Figure A-1). These frameworks with specified scoring information can be found in Appendix A. Using my new Local Content Analysis (Appendix B) derived from the literature, the Chicago Green Infrastructure Vision, and the (Re)Connect Wasatch Front Green Infrastructure Plan, I coded all cities, counties, and a small batch of specific local GI plans found through the Chicago Wilderness website.

Results in the form of coding scores will help to answer how GI and SER principles found in the plan quality evaluations of each GI case study manifest at the local policy level through comprehensive and general plans. Using the Local Content Analysis (Appendix B), I measured themes and present quantitative totals, showing trends, similarities or differences between the Chicago Wilderness Green Infrastructure Vision's watershed-based plan and the (Re)Connect Wasatch Front Green Infrastructure Plan's cores and hubs landscape basis.

Plan Quality Evaluation Results: GI Plan Quality Evaluations

The McDonald et al. (2005) Green Infrastructure Plan Evaluation Framework was created to test GI Plans for criteria thought to be essential for plans of this nature. After reading and taking thorough notes on each case's document, I went through the framework evaluation, scoring each element according to my personal opinion of the document's success in manifestation of GI criteria. The Wasatch Front (WF) GI Plan produced a score of 140 points out of 210 possible points. The Chicago Wilderness (CW) produced a score of 153 points out of 210 possible points, seen in Table 4.1. The entire scored plan quality frameworks for each Case Study GI Plan can be found in Appendix C, figures C-3 through C-10.

It is important to note that the GI Plan Evaluation Framework was created using principles and approaches found in various green infrastructure plans observed by McDonald et al (2005, p. 13). While we can compare the scores of each case to one another, they both contained about 70 % (72.9 % for CW and 66.7 % for WF) of the suggested GI criteria. Specified in the framework, "required" criteria contained an asterisk (*) next to the description of possible points. The Wasatch Front received less than the maximum scores for seven different required criteria. These required criteria are below.

2.1.5 In the Network Design Criteria section, "Did network design criteria for hubs and corridors incorporate ecological thresholds and other conservation parameters? (ex. minimum dynamic areas, size of migration corridors, natural disturbance regimes, edge effects, important riparian zones, etc.)"

2.2.5 In the Network Suitability Analysis section, "Are specific hubs and corridors delineated in the plan?"

3.1.4 In the Network Design Model Enhancements section, "Was the protection status of green infrastructure network land identified and incorporated into the model?"

3.2.1 In the Identifying Priorities section, "Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?"

4.1.1 In the Decision-Support Tool section, “Did the plan include a decision-support tool (i.e., mechanism for quantifying ranking conservation opportunities based on the network design and other important factors)?”

4.1.3 In the Decision-Support Tool section, “Can the decision-support tool help guide local and site-level implementation efforts?”

4.3.1 In the Conservation Funding section, “Does the plan identify federal, state, local and/or private conservation funding opportunities?” (McDonald et al., 2005, pp. 16-19).

The Chicago Wilderness did not meet the maximum potential score of five required criteria. These required criteria are below.

3.2.1 In the Identifying Priorities section, “Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?”

4.1.1 In the Decision-Support Tool section, “Did the plan include a decision-support tool (i.e., mechanism for quantifying ranking conservation opportunities based on the network design and other important factors)?”

4.1.3 In the Decision-Support Tool section, “Can the decision-support tool help guide local and site-level implementation efforts?”

4.3.1 In the Conservation Funding section, “Does the plan identify federal, state, local and/or private conservation funding opportunities?”

4.4.2 In the Conservation Strategies section, “Does the plan outline specific implementation strategies for state and regional agencies?” (McDonald et al., 2005, pp. 16-19).

The main differences here show that the Wasatch Front's network design and suitability models are less sophisticated than the Chicago Wilderness. WF lost more points in these categories than CW, and a notable difference was the extensive ranking system in the CW analysis, while WF identified a list of network design criteria without rankings of importance or conservation need. Both plans were lacking in identifying and ranking vulnerability for corridors and hubs within the networks (Criteria 3.2.1, Appendix A, 4). They also were both lacking in providing a decision-support tool for users to rank the value of potential conservation lands. Federal, state, local, and private funding opportunities (Criteria 4.3.1, Appendix A, 5) were lacking in the CW GI Plan and were nonexistent in within the WF GI Plan. Finally, WF was much better at outlining implementation strategies at the state and regional level (though scatter-shot), while CW's suggestions for state and regional agency implementation was nonexistent (Criteria 4.4.2, Appendix A, 5).

McDonald et al. (2005) identify case studies in their article that met all plan criteria. While they do not disclose the actual scoring, this evaluation shows that both Chicago Wilderness and the Wasatch Front do not meet all plan criteria and would not be considered as high of quality according to this structure. Overall, the use of this plan quality evaluation is to strengthen plans and their criteria, and here, specifically their GI criteria, priorities, strategies, goals, and tools. These results conclude that the Chicago Wilderness addresses more GI criteria than the Wasatch Front, and I conclude it is because of the difference in their network design approaches, which can be seen in sections 2.1 and 2.2 of the McDonald et al. (2005) GI Evaluation Framework and in Appendix C, Figures C-4 and C-8.

Plan Quality Evaluation Results: SER / SCM Plan Quality Framework

Dyckman and Conroy's SER/SCM Plan Quality Framework produced similar results in terms of comparison between the two GI cases. The Chicago Wilderness received a score of 70 out of 120 (58.33%) possible points, and the Wasatch Front received a score of 77 out of 120 (64.2 %) possible points. Overall, WF tends to understand and manifest resilience qualities and indicators better than CW, but not by a significant extent. A notable difference includes the Chicago Wilderness' better understanding of goals within the context of SESs, while the Wasatch Front scores higher for every other section. The Wasatch Front scores higher by three points for understanding flexible policy and resource user coordination (Appendix C, Figure C-2).

With no additional plans for comparison, I conclude that the Wasatch Front is more aware of social-ecological resilience at the larger landscape scale. There is not a large difference in this scoring, similar to the findings of the GI Evaluation Framework.

		Scores	
GI Plans	Year Adopted	GI Plan Evaluation Framework	SER/ SCM Plan Quality Framework
(Re)Connect Wasatch Front GI Plan	2012	140/210	77/120
Chicago Wilderness Green Infrastructure Vision	2004 with an update in 2012	153/210	70/120

Table 4.1: GI and SER Plan Quality Evaluations Scores for each case study

Local Content Analysis Results

The next phase of research uses the content analysis coding framework derived from the GI and SER literature and the most frequently indicated factors of GI and SER in each of the landscape-scale GI Plans. This content analysis seeks GI and SER manifestation in local policy.

Various trends and patterns result from the coding framework expressing the frequency of the GI and SER indicators established at the local level. While quantity can be expressed, some findings express more specific quality indications according to grouped themes within the content analysis.

For comparison of total scores from each category (i.e. City Comprehensive Plans, County-wide Comprehensive Plans, and Local GI Plans), I have eliminated the three case-specific criteria to compare the coding scores from both regions across an identical framework. These criteria are located at numbers 3.d.i, 8.f, and 9.2 criteria (3.d.i For Chicago Wilderness region: Biodiversity Recovery Plan mentioned? 8.f Skiing (WF) 9.i.2 Scattershot, Wasatch Front). The full framework can be found in Appendix B. Eliminating these three elements does not take away from the quality of the framework, allowing all categories and cases to be compared with a maximum score of 168.

The plans examined are listed below and grouped into plan typology categories for a more approachable look at the results, though each city's individual score can be found in Appendix E. The category titled "WF County-wide Plans" includes all the individual County General Plans in the Wasatch Front region that met the sample selection criteria (adopted post 2012). The category titled "CW County-wide Comprehensive Plans" includes all the individual County Comprehensive Plans in the Chicago Wilderness region that met the sample selection criteria (post 2012).

The "City Comprehensive Plans" category includes all city plans meeting the requirements of the sample selection in the Chicago Wilderness case study. In Table 7, these cities are further divided into their respective counties. The same goes for the Wasatch Front, with each of the City General Plans divided into their respective county jurisdictions in Table 8.

Plan Typology Categories with Associated Mean Scores

Plan Category	Mean Scores, out of 168
WF City General Plans	104.6
CW City Comprehensive Plans	102.8
WF County-wide Plans	120
CW County-wide Plans	134.6
Local GI Plans	144.1

Table 4.2: All plan categories, mean total scores of the "New Local GI Content Analysis" from each plan typology category

County-wide Comprehensive Plan Scores

County-Wide Plans, Wasatch Front	Content Analysis Score, out of 168
Tooele County, UT	112
Ogden Valley, Weber County, UT	116
Western Weber County, UT	132

Table 4.3: Wasatch Front County Comprehensive plans and respective content analysis score results

County-Wide Plans, Chicago Wilderness	Content Analysis Score, out of 168
Walworth County, WI	116
Lake County, IN	120
Lake County, IL	136
Kane County, IL	149
McHenry County, IL	152

Table 4.4: Chicago Wilderness County Comprehensive plans and respective content analysis score results

City Comprehensive Plan Averages, Grouped by County Jurisdictions

The "Wasatch Front City General Plans" category includes all cities meeting the requirements of the sample selection, grouped by the county jurisdiction they belong to (Table 7). The mean scores are averages of each grouping of cities, within their respective county, not to be confused with the previously mentioned County-wide category. The same explanation goes for the Chicago Wilderness City Comprehensive Plans and mean scores. Table 7 and 8 are both organized from lowest to highest mean score.

Wasatch Front City General Plans	**Mean Scores, out of 168**
Davis County	99.8
Weber County	101.7
Salt Lake County	107.7
Tooele County	116.5

Table 4.5: Mean total scores of WF's City General Plans, separated by County

Chicago Wilderness City Comprehensive Plans	**Mean Scores, out of 168**
Lake County, IN	86.8
DuPage County, IL	91.6
Cook County, IL	93.7
Kendall County, IL	105.5
Milwaukee county, WI	105.8
Lake County, IL	106.0
Will County, IL	108.3
McHenry County, IL	112.3
Kane County, IL	113.1
Walworth County, WI	122.0

Table 4.6: Mean total scores of CW's City Comprehensive Plans, separated by county

Local GI Plans

Lastly, the Local GI Plans category is reduced to the individual plans and their total scores from the Local Content Analysis. The Local GI plans average was indicated in Table 3, and is 144.1 points.

Local GI Plan	**Content Analysis Score, out of 168**
Midlothonian Creek GI Plan (IL)	137
Bannock/Lincolnshire/Mettawa GI Plan (IL)	140
Crystal Lake GI Plan (IL)	140
Woodstock GI Plan (IL)	143
Des Plaines River Communities GI Plan (IL)	143
Gary GI Plan (IN)	144
McHenry County GI Plan (IL)	146
Kishwaukee River Corridor GI Plan (IL)	147
South Cook County/ Millenium Reserve GI Plan (IL)	148
Kane County GI Plan (IL)	153

Table 4.7: Local GI Plans and their Local Content Analysis scores

Green Infrastructure Indicators from Content Analysis Compared

While quality of the plans can be expressed by mean scores for each region, some findings express more specific quality indications according to grouped themes within the Content Analysis. Each of the designated themes are compared across the cities from each case study (WF and CW), and their designated County groupings. The Local GI Plans clearly have a higher level of quality in comparison to the County-wide Plans and City General and Comprehensive Plan groupings. The GI Plans will be left out of the following tables and comparisons, but may be mentioned to caveat the expressed data.

GI- Specific Indicators

The tables below describe the average total coding scores for section 3, which focuses on the integral GI components expected to manifest in City Comprehensive and General Plans. Each county is given an average score, and the third column shows the average scores of all City Plans within the CW and WF cases. For this specific section the maximum score is 44. The County Categories separating scores of City Comprehensive Plans have been listed from lowest to highest score.

CW	**GI Indicators Averages, out of 44**	**Case Study Average**
Lake County, IN	21.5	29.3
DuPage County, IL	26.8	
Cook County, IL	28.1	
Kendall County, IL	28.3	
Lake County, IL	30	
Milwaukee County, WI	30.3	
Will County, IL	30.5	
McHenry County, IL	31.9	
Kane County, IL	32.4	
Walworth County, WI	32.5	

Table 4.8: Average scores for GI Indicators in the CW, or section 3 of the Local Content Analysis

WF	**GI Indicators Averages, out of 44**	**Case Study Average**
Davis County, UT	25	27.1
Weber County, UT	27	
Tooele County, UT	27.5	
Salt Lake County, UT	28	

Table 4.9: Average scores for GI Indicators in the WF, or section 3 of the Local Content Analysis

The tables below describe the average total coding scores for section 3.g, which focuses on the water planning components that are an important piece of GI benefits. Each county is given an average score, and the third column shows the average scores of all City Plans within the CW and WF cases. For this specific section the maximum score is 18. The County Categories separating scores of City Comprehensive Plans have been listed from lowest to highest score. The criteria in this section is looking for understanding of watershed planning, water planning, awareness of flooding or water quantity problems such as drought, and water quality problems generated by stormwater and runoff.

CW	**Water Planning Indicators Averages, out of 18**	**Case Study Average**
Lake County, IN	10.3	13.8
Cook County, IL	12.7	
McHenry County, IL	13.7	
Lake County, IL	13.8	
DuPage County, IL	13.8	
Kendall County, IL	14.0	
Kane County, IL	14.8	
Milwaukee County, WI	15.2	
Will County, IL	15.3	
Walworth County, WI	15.8	

Table 4.10: CW average scores for Water Planning Indicators, or section 3g of the Local Content Analysis

WF	**Water Planning Indicators Averages, out of 18**	**Case Study Average**
Davis County, UT	10.4	12.2
Tooele County, UT	11.5	
Salt Lake County, UT	12.6	
Weber County, UT	12.8	

Table 4.11: WF average scores for Water Planning Indicators, or section 3g of the Local Content Analysis

The Tables below show the frequency of City Comprehensive and General Plans addressing the larger GI plans (Chicago Wilderness Green Infrastructure Visions and (Re)Connect Wasatch Front Green Infrastructure Plan) from each case study. This effectively shows that only 11 of the 112 of local comprehensive plans in the Chicago Wilderness reference the Chicago Wilderness Green Infrastructure Vision as a source or as a tool. For the Wasatch Front region, none of the local plans mention the (Re)Connect Wasatch Front Green Infrastructure Plan.

	1, Does not reference larger GI plan	2, Does reference larger GI plan
CW	101	11
%	90.18%	9.82%

Table 4.12: Percentage of cities that reference the Chicago Wilderness Green Infrastructure Vision in their Comprehensive Plans

	1, Does not reference larger GI plan	2, Does reference larger GI plan
WF	40	0
%	1.00%	0.00%

Table 4.13: Percentage of cities that reference the Wasatch Front (Re)Connect Green Infrastructure Plan in their General Plans

Resilience indicators

The tables below describe the average total coding scores for section 7, which focuses on the SER indicators that are an important piece in understanding GI as a resilience and climate adaptation strategy. Each county is given an average score, and the third column shows the average scores of all City Plans within the CW and WF cases. For this specific section the maximum score is 17. The County Categories separating scores of City Comprehensive Plans have been listed from lowest to highest score.

CW	SER Indicator Averages, out of 17	Case Study Average
Lake County, IN	6	8
Milwaukee County, WI	6.8	
McHenry County, IL	7	
Kendall County, IL	7	
DuPage County, IL	7.3	
Kane County, IL	7.4	
Lake County, IL	8.0	
Cook County, IL	8.4	
Will County, IL	8.6	
Walworth County, WI	10.3	

Table 4.14: Chicago Wilderness SER Indicators and average score results

WF	SER Indicator Averages, out of 17	Case Study Average
Tooele County, UT	7.5	9.6
Davis County, UT	7.6	
Weber County, UT	8.2	
Salt Lake County, UT	11.9	

Table 4.15: Wasatch Front SER Indicators and average score results

The tables below show frequency in occurrence of specific SER components within the Local Content Analysis section 7. To reiterate, a score of 1 equals not present, a score of 2 equals present and not detailed, and a score of 3 equals present and detailed. Table 4.16 shows frequency of addressing criteria 7.a, identifying a resilient perspective with reference to GI (linking social/ economic and environmental benefits). This criterion shows plan understanding of a resilient perspective associated with GI benefits. In scoring this section, it does not mean that resilience is specifically mentioned in the GI section of the plan, but it means that throughout the entire plan document, social, economic, environmental or sustainability benefits are identified with regard to green spaces, GI, or natural resources. For the Chicago Wilderness, there is a present and detailed explanation of these resilient benefits for 22.32 % of the plans and 18.75% of the plans mention resilient benefits, but not in detail. Over 50% of these plans in the CW region do not identify resilience benefits at all (Table 4.16). The WF region has a present and detailed understanding of resilient benefits for 42.50% of its local plans, and it is not mentioned in 47.50% of its local plans.

Table 4.17 shows the frequency of addressing criteria 7.d, awareness of climate change or biome shifts. This table shows that both regions have a very low awareness of climate change or biome shifts due to climate change. For each case study region, 80% or more of the local plans do not address climate change or biome shifts.

Table 4.18 shows the frequency of addressing criteria 7.e, understanding GI as a climate adaptation mechanism. In both case study regions, a total of eight plans address GI as a climate adaptation strategy in detail, and ten plans mention it without a detailed explanation. For both regions, 85% or more of the localities do not mention GI as a climate adaptation mechanism at all in their comprehensive plans.

These data help us conclude that understanding of major SER components with relation to GI is low overall, but not impossible, and not entirely absent. There is a greater awareness of resilience when it is looked at from various elements such as social, economic, and environmental benefits combined. When it comes to climate change specifics, the plans indicate much lower overall awareness. Each table includes the mean score for City Plans by their county jurisdictions, and each coding score is given a frequency percentage for all cities in each case study. The mean scores show the difference in understanding of the criterion by county.

CW	1	2	3	Mean Score
Cook County, IL	13	11	10	1.9
Lake County, IL	14	3	4	1.5
McHenry County, IL	5	2	0	1.3
DuPage County, IL	7	1	2	1.5
Will County, IL	5	2	1	1.5
Kane County, IL	5	1	2	1.6
Kendall County, IL	3	0	1	1.5
Lake County, IN	4	0	0	1
Walworth County, WI	4	1	5	2.1
Milwaukee County, WI	6	0	0	1
%	58.93%	18.75%	22.32%	

WF	1	2	3	Mean Score
Davis County, UT	4	2	2	1.8
Salt Lake County, UT	3	1	13	2.6
Weber County, UT	11	0	2	1.3
Tooele County, UT	1	1	0	1.5
%	47.50%	10.00%	42.50%	

Table 4.16: Frequency of criteria 7.a, along with mean scores for all cities

CW	1	2	3	Mean Score
Cook County, IL	27	5	2	1.3
Lake County, IL	17	2	2	1.3
McHenry County, IL	7	0	0	1
DuPage County, IL	9	1	0	1.1
Will County, IL	7	0	1	1.3
Kane County, IL	7	1	0	1.1
Kendall County, IL	4	0	0	1
Lake County, IN	4	0	0	1
Walworth County, WI	6	0	4	1.8
Milwaukee County, WI	6	0	0	1
Total	83.93%	8.04%	8.04%	

WF	1	2	3	Mean Score
Davis County, UT	8	0	0	1
Salt Lake County, UT	9	2	6	1.8
Weber County, UT	13	0	0	1
Tooele County, UT	2	0	0	1
Total	80.00%	5.00%	15.00%	

Table 4.17: Frequency of criteria 7.d, along with mean scores for all cities

CW	1	2	3	Mean Score
Cook County, IL	30	2	2	1.2
Lake County, IL	21	0	0	1
McHenry County, IL	7	0	0	1
DuPage County, IL	9	1	0	1.1
Will County, IL	7	1	0	1.1
Kane County, IL	7	1	0	1.1
Kendall County, IL	4	0	0	1
Lake County, IN	4	0	0	1
Walworth County, WI	5	2	3	1.8
Milwaukee County, WI	6	0	0	1
Total	89.29%	6.25%	4.46%	

WF	1	2	3	Mean Score
Davis County, UT	8	0	0	1
Salt Lake County, UT	11	3	3	1.5
Weber County, UT	13	0	0	1
Tooele County, UT	2	0	0	1
Total	85.00%	7.50%	7.50%	1

Table 4.18: Frequency of criteria 7.e, along with mean scores for all cities

Implementation Approaches and Strategies

The tables below describe the average total coding scores for section 9.a and 9.b, which focus on the adaptive management approaches and explicit implementation strategies expressed in City Comprehensive and General Plans. Tables 4.19 and 4.20 reference criteria 9.a, describing the frequency of adaptive management approaches. Tables 4.21 and 4.22 reference criteria 9.b, giving each county a mean score for expression of implementation strategies. The maximum score for 9.b is 24. Tables 4.21 and 4.22 also includes a mean score for all City Plans within each case study.

Tables 4.19 and 4.20 show the distribution of adaptive management approaches organized by each specified method. For the CW region, acquisition is the most frequently mentioned approach, with greenway connections following as the second most popular mentioned strategy. For the WF region, it shows conservation development as the most frequently specified approach, with acquisition as the second most popular approach mentioned in the local plans.

Tables 4.21 and 4.22 show the scoring for implementation strategies specific to GI. This implementation criteria corresponds to section 9b of the Local Content Analysis seeking ordinance recommendations, site specific details, development strategies, restoration, conservation, and preservation strategies. With a maximum score of 24, the CW region meets about 66.67% of this criterion, and the WF region meets 62.1% of the criteria. The mean scores show that the CW identifies some specifics of implementation strategies slightly more explicitly than the WF. Both regions have a score of over 50% meaning that they each do specify some specific implementation strategies that are essential to GI connectivity or enhancement.

CW	1	2, 3	Mean Scores
Acquisition	31	81	2.2
%	27.68%	72.32%	
Conservation Easements	77	35	1.5
%	68.75%	31.25%	
Restoration	50	62	1.8
%	44.64%	55.36%	
Greenway Connections	38	74	2.0
%	33.93%	66.07%	
Conservation Development	59	53	1.8
%	52.68%	47.32%	

Table 4.19: Frequency of adaptive management approaches, Chicago Wilderness cities

WF	1	2, 3	Mean Scores
Acquisition	23	17	1.7
%	57.50%	42.50%	
Conservation Easements	24	16	1.6
%	60.00%	40.00%	
Restoration	27	13	1.4
%	67.50%	32.50%	
Greenway Connections	28	12	1.4
%	70.00%	30.00%	
Conservation Development	13	27	2.1
%	32.50%	67.50%	

Table 4.20: Frequency of adaptive management approaches, Wasatch Front cities

CW	Average Scores, out of 24	Case Study Average
DuPage County, IL	13.6	16
Cook County, IL	13.6	
Lake County, IN	14.3	
Lake County, IL	16.2	
Kendall County, IL	16.5	
Milwaukee County, WI	16.8	
Will County, IL	17.9	
McHenry County, IL	18.7	
Walworth County, WI	19.3	
Kane County, IL	19.5	

Table 4.21: Average scores for Local Content Analysis section 9.b: Description of Implementation Strategies, Chicago Wilderness

WF	Average Scores, out of 24	Case Study Average
Davis County, UT	13.4	14.9
Weber County, UT	14.4	
Salt Lake County, UT	15.5	
Tooele County, UT	18.5	

Table 4.22: Average scores for Local Content Analysis section 9.b: Description of Implementation Strategies, Wasatch Front

Local Content Analysis Criteria Compared Between City Plans in Each Case Study

Additionally, Table 4.23 refers to the average scores for each specific criterion in the Local Content Analysis. For the implementation criterion enumerated in section 10, both regions have low average scores, with a 1.12 for CW and a 1.63 for WF. Very few plans explicitly indicated impediments to implementation, though implementation is challenging and requires support, funding, and often needs public backing. The breakdown of each specific criterion's average score across city plans from each region also shows which specific implementation strategies are most and least common. Restoration strategies are listed at a slightly higher average in CW than in WF, and preservation strategies are frequently listed for both case study regions with an average score of 2.39 for CW and 2.5 for WF. A couple of other notable findings from this table are worth mentioning. There is low identification of the landscape ecology core/hub/corridor principle (3.f.i), with a score of 1.22 for CW and 1.05 for WF. There is also relatively low identification of the various scales of GI (3h), such as referencing community, regional, or landscape scales. CW received a score of 1.22 and WF received a score of 1.10 for identifying GI scales. The ranking approaches for network design of GI (4b) scored extremely low for both regions with a score of 1.04 for CW and a score of 1 for WF. A score of 1 indicates that zero examined plans specified this component. Preventing sprawl (5f) ranked low compared to other land use designation criteria, and variety of stakeholder expertise (6b) also ranked low. In the SER section, identification of nested systems (7b) scored low for each case study region. For this criterion (7b) CW had an average score of 1.12 and WF had an average score of 1.28. Criterion 7d and 7e also have low average scores, which is previously discussed in tables 4.17 and 4.18. Finally, specifying site locations for restoration (9.b.4.a), conservation (9.b.5.a), and preservation (9.b.6.a) all scored relatively low, and was uncommon throughout both case study regions.

For both regions, identification of parks (8a) and trails (8b) both scored very high, showing consistent understanding of recreational benefits for communities. While CW had an average score of 2.30 for site specific implementation strategies (9.b.3), WF received a score of 2.20 for development strategy suggestions in the context of GI (9.b.4). Identification of hazard mitigation (7c) was one of the highest scoring SER elements for WF with an average score of

2.15. Land use identification of future protection (5a), preservation (5b), and conservation (5c) scored well for each region. Many of the local plans included maps showing network connection (4a), with CW receiving a score of 1.55 out of 2 and WF receiving a score of 1.45 out of 2 for this criterion. The most widely recognized GI indicators include water planning (3g), water quality/pollution (3.g.i), identification of GI benefits or ecosystem services (3e), and specified GI goals (3b, max score of 2).

Local Content Analysis	CW Cities	WF Cities
1	1.86	1.88
1a	1.82	1.85
2	2.14	2.40
2a	1.83	2.00
3		
3.a	1.80	1.68
3.b	1.73	1.70
3.c	1.21	1.15
3.d	1.10	1.00
3.e	2.36	2.25
3.f	1.61	1.45
3.f.i	1.22	1.05
3.f.ii	1.24	1.33
3.g	2.73	2.40
3.g.i	2.43	2.08
3.g.i.1	2.69	1.90
3.g.ii	2.16	2.03
3.g.ii.1	2.55	2.18
3.g.ii.2	1.19	1.58
3.h	1.22	1.10
3.i	2.07	2.20
4		
4.a	1.55	1.45
4.b	1.04	1.00

5		
5.a	2.01	2.28
5.b	2.43	2.23
5.c	2.15	2.15
5.d	1.66	2.08
5.e	1.44	1.88
5.f	1.42	1.40
5.g	1.87	1.90
6		
6.a	1.43	1.13
6.b	1.01	1.03
6.c	1.13	1.38
7		
7.a	1.63	1.95
7.b	1.12	1.28
7.c	1.44	2.15
7.d	1.24	1.35
7.e	1.15	1.23
7.f	1.44	1.68
8		
8.a	2.88	3.00
8.b	2.80	3.00
8.b.i	1.59	1.83
8.b.ii	1.04	1.58
8.c	1.16	1.28
8.d	1.13	1.18
8.e	1.51	1.60
9		
9.a		
9.a.1	2.15	1.73
9.a.2	1.49	1.60
9.a.3	1.84	1.38
9.a.4	1.99	1.43
9.a.5	1.77	2.13
9.b		
9.b.1	1.88	2.03
9.b.2	2.30	1.28

9.b.3	1.88	2.20
9.b.4	1.76	1.38
9.b.4.a	1.32	1.13
9.b.5	1.94	2.00
9.b.5.a	1.13	1.03
9.b.6	2.39	2.50
9.b.6.a	1.36	1.35
10	1.12	1.63
Total	102.8	104.6

Table 4.23: City Comprehensive and General Plan mean scores for each indicated criterion within the Local Content Analysis, compared between each case study area

Discussion

Though these findings do not discern causality, they do show trends, realities of comprehensive plan contents, and frequency of occurrence of the major theories discussed in this paper's literature review. While acknowledging that each Plan Category Typology observed using the Local Content Analysis has a different number of cases within it, trends in the form of mean scores and percentages help show the frequency of Green Infrastructure criteria found in the various governing policy documents. These criteria were derived from the first phase of the GI/ SER/ SCM Plan Quality Evaluations.

Discussion: GI Plan Evaluation Framework Scores

The GI plan quality evaluation used a detailed framework developed by McDonald et al. (2005) along with the support of the Conservation Fund. This evaluation framework is the most detailed part in the methods of this research. As previously stated in Table 4.1, both case study GI Plans scored similarly, with WF receiving a score of 140 out of 210, and CW receiving a score of 150 out of 210. These scores can be differentiated when comparing the detail of the GI plans' network design and suitability analyses. A suitability analyses was absent from the Wasatch Front GI Plan. This ultimately means that each plan created maps with a connected network of GI, but the Chicago Wilderness provided rankings to delineate lands with more urgent need for preservation.

The GI plans scored quite similarly throughout the rest of the McDonald et al. (2005) evaluation framework aside from a few other points. The Wasatch Front did a better job of providing implementation suggestions for various levels of government, while the Chicago Wilderness lacked these concepts, aside from expressing the need for GI to be a part of local comprehensive plans. Though the Wasatch Front provided detailed implementation suggestions, they were scattershot and disorganized, without a defined strategy, leaving specifics to the local entities to figure out among themselves. The Chicago Wilderness expressed an emphasis on five adaptation methods for implementation: Acquisition, Conservation Easements, Restoration, Greenways, and Conservation Development. These approaches were used as a part of the following Local Content Analysis (found in Appendix B).

Reflecting on the literature reviewed, I was not surprised by the lack of specificity in network design. This concept was not covered extensively by the literature reviewed in this paper, which was reflected in the WF GI plan. The CW GI plan contained an extensive network design and analysis, likely due to the amplitude of funding from private organizations long involved with the Chicago Wilderness nonprofit. While network design is important, it is not entirely necessary to such an extent as in CW. The WF region was still able to identify weaknesses in its network connectivity, and areas of key importance for strengthening reserves or core habitat. Due to the emphasis on stormwater and GI as a flood mitigation technique, it is not surprising that each plan has its own unique focus on water. CW has an emphasis on protecting high quality streams and riparian corridors, and WF has a network design map devoted to water resources. With network connectivity as one of the most important and highlighted features in the literature (APA, 2017; Benedict & McMahon, 2006; Davies et al., 2006; Hilty et al., 2006; IPCC AR6 WGII SPM, 2022; Margules & Pressey, 2000; Meerow & Newell, 2017; Mell, 2008; Mell & Roe, 2007; Nolon, 2021; Randolph, 2004; Rouse & Bunster-Ossa, 2013), it is a positive conclusion to see this reflected with a similar emphasis in each of the GI plans. Implementation suggestions mostly aligned with the literature, but there could be more emphasis on funding in order to follow through with the landscape scale GI intents at the local level.

Discussion: SER/SCM Plan Quality Evaluation Scores

Based on the results of the SER/ SCM Plan Quality Evaluation, the GI plans produced another set of scores that are not very starkly different. With WF scoring 77 out of 120, and CW scoring 72 out of 120, the Wasatch Front showed to have a relatively better understanding and expression for Social Ecological Resilience and Sustainable Commons Management. Both GI plans scored low in the Implementation and Monitoring and Resource User Coordination sections of the SER Plan Quality Evaluation, but they each scored higher in the Policies and Participations sections. The conclusion drawn from this evaluation is that the Wasatch Front has more awareness for resilience principles within the context of GI.

While both GI plans emphasized different indications of resilience, the concepts were not always directly referenced or obvious. There is room for sufficient improvement on this front. Each of the GI plans can improve in basic concepts of identifying the systems, their bounds, and how these elements directly impact disturbance and the potential subsequent return to the existing state. While nested systems or processes may have been identified, these nested systems were not always identified with relation to adaptive cycles across scales.

Resilience concepts will help guide organizations and local governments through a changing climate and in turn, a changing environment. One of the most referenced resilient features in the case study GI plans was deference to local knowledge. Though this is specified, there was no subsequent instruction on how to incorporate this knowledge or emphasize it as an important strategy. It will be increasingly important to understand the role of local context moving forward in the context of climate change, since there will be less room for standardized processes, emphasizing the need for and understanding of local context (Dyckman & Conroy, 2020; Meerow & Newell, 2017; Olsson et al., 2004). Similarly, monitoring is an important piece of dealing with resources, natural or not. Monitoring responses to sanctioned events and disturbances will help communities and governments better understand the variety of resilience responses, and how to move forward using newly acquired knowledge. Additionally, if resources, such as GI, are going to be regulated, restored, or maintained, users may need to be regulated in their use of the resources. Without clear understanding of resource demand or threshold awareness, systems risk degradation or overuse on top of the stress of a changing climate.

Local Content Analysis Scores and Discussion

The tables shown in the Results sections break down the large amount of data derived from the Local Content Analysis into more relative and potent comparisons with regard to seeking the consistency of SER and GI principles from the GI Plan Case Studies.

The "Big Picture" and Comparing Plan Typology Categories

Table 4.2 shown in the Local Content Analysis results provides a comparison of the varying categories of City Plans, County-wide Plans, and specified Local GI Plans. This data helps to frame the findings at the largest scale, to show how the groups differ in assessment using the specified Local Content Analysis criteria. The criteria within the Local Content Analysis were developed to seek out the more basic, yet essential components from each of the larger GI Plan case studies, in addition to basic concepts in the literature.

At this wider scale, it is shown the Local GI Plans scored the highest collectively using the content analysis. This expresses the Local GI Plans have a stronger level of consistency with the larger GI case studies, this also confirms success for more specificity if a locality has the opportunity and means to create a local GI plan separate from a City's Comprehensive Plan. Due to the nature of comprehensive plans, and the variety of important community-related topics they must address in a single document, this is to be expected. The mean scores of the county plans are behind the GI Plans by about 10 points, and the city plans scored the lowest with Chicago Wilderness cities receiving a mean score of 102.8 out of 168 (61.2%), and the Wasatch Front receiving a mean score of 104.6 out of 168 (62.3%). These results make sense for the most part, but one may assume city plans to receive a higher score in comparison, with the opportunity to get more specific in a smaller area. The results show that county plans are able to be more specific about their integral green spaces and natural resources, which can be helpful for GI connectivity and implementation, as counties cover large areas and impact larger populations.

While the number of County-wide plans is significantly less than the number of City Plans, they receive a higher score of GI manifestation, which is interesting when considering the importance placed on the landscape scale in the original CW and WF Case study GI Plans. A county-wide scale has more opportunity to engage the wider landscape scale, as it covers more ground, literally. Given the results and higher level of consistency at the County-wide scale, county jurisdictions are positioned to make a positive impact in each case study area.

County-wide Comprehensive Plans

It is important to note that the county plans within the selection criteria in the Wasatch Front are all defined by a consistently more rural landscape. The area covered by the counties included is well suited for an impact on the larger GI network as the more urban Salt Lake, Davis, and Morgan Counties' general plans do not fit the selection criteria. These plans collectively scored 120 out of 168, meeting 71.3% of the criteria. A map of the counties and spatial makeup of the Wasatch Front can be found in Figure 4.1.

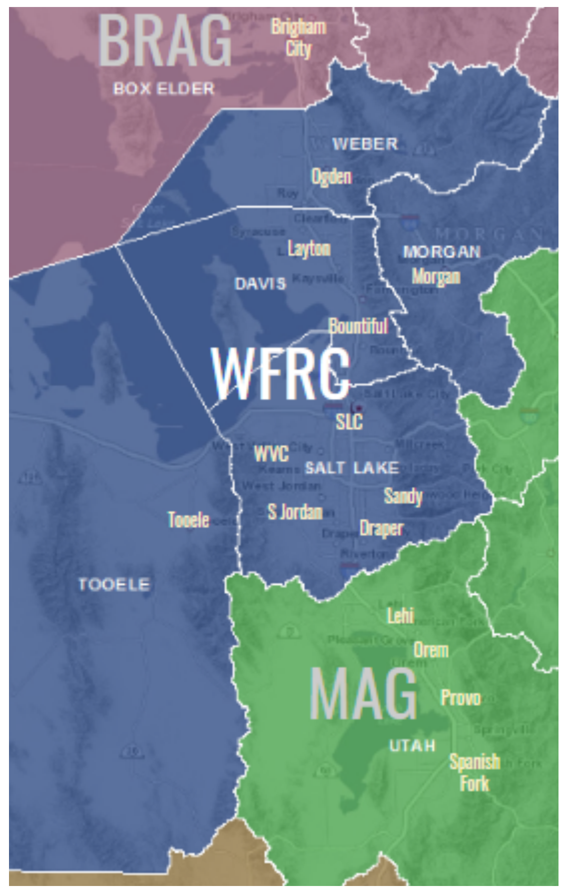

Figure 4.1: Wasatch Front Regional Council area map (www.WFRC.org)

The County-wide Plans included in the Chicago Wilderness show an even higher level of consistency in regard to case study GI Plans, with a collective score of 134.6 out of 168, which equals 84.1% of the content analysis criteria. The counties included in this grouping are also slightly less urban and more rural than the county encapsulating the City of Chicago, Cook County. The Chicago Wilderness case study spatial makeup is exhibited in Figure 4.2. The highest reflection of consistency is in McHenry County's Comprehensive Plan, which also has a Local GI plan that is scored within this study, signifying a large effort to focus on GI in this jurisdiction. The Chicago Wilderness County-wide Plans scored slightly higher with regard to the Local Content Analysis, which is consistent with the McDonald et al. (2005) GI Plan Evaluation Framework scores.

Figure 4.2: Chicago Wilderness area map, figure retrieved from ResearchGate (https://www.researchgate.net/figure/Chicago-Wilderness-map-The-Chicago-Wilderness-region_fig1_283844284)

The City Comprehensive and General Plans scored lower relatively, but also have a greater number of plans included, 40 in the Wasatch Front, and 112 in the Chicago Wilderness. Salt Lake County and Tooele County had the highest average scores, with SLC cities meeting 64.1% of the content analysis criteria and Tooele meeting 69.3% of the criteria. In Salt Lake County the most commonly met criteria include acknowledging strategies of preservation, parks and trails as justification for GI, identifying GI benefits with a resilient perspective, and identifying water planning as an important piece of GI. Tooele County only contains 2 cities, which is likely why is scored this high.

In the Chicago Wilderness, the highest scoring counties include Walworth County, WI and Kane County, IL. Walworth met 72.6 % of the content analysis criteria, and Kane met 67.3% of the criteria. The cities in Walworth County commonly indicated watershed planning, water quality and pollution, and stormwater with regard to GI. Walworth also commonly addressed land use with regard to future protection, conservation, and preservation, and incorporated preservation as a significant strategy with future desired locations listed. Kane County commonly addressed criteria such as the benefits of GI, preservation and conservation in the context of land use, acquisition of GI land, and GI specific ordinance recommendations. Identification of parks, trails, and open space as an important benefit to communities was also addressed by every city plan included in each of these counties.

Kane County also has a Local GI Plan that was evaluated with the Local Content Analysis, scoring the highest of all plans across every typology. The Kane County GI Plan received a 153 out of 168, meeting 91.1% of the content analysis criteria.

Green Infrastructure Indicators

Getting into more specific indicators within the Local Content Analysis, the themes are compared across the variety of city plans to address trends more effectively. While GI has a number of important components, it is necessary for this paper to take a closer look at the GI indicators in section 3 of the Local Content Analysis. This section has a maximum score of 44, and CW cities met 66.6% of the criteria, while WF cities met 61.6% of the criteria. Salt Lake County and Tooele County scored the highest for WF again (see Table 4.9), as did Kane County and Walworth County for CW cities (see Table 4.8). One county within the CW area scored lower than 50%, with Lake County, IN meeting 48.9% of the GI criteria (see Table 4.8).

Specifically, CW addresses GI indicators of water planning and stormwater the most, and indicators of drought and different scales of GI the least. WF addresses GI benefits and water quantity issues of flooding the most, and indicators of structural elements of GI (core/hub/corridor), and scales of GI the least. Interesting to note, while only 9.82% and 11 of the Chicago Wilderness city comprehensive plans reference the larger GI case study, none of the cities in the Wasatch Front mention the (Re)Connect Wasatch Front Green Infrastructure Plan (Tables 14 and 15). This shows a large disconnect from the landscape scale to the local scale, making consistent efforts of implementation challenging, and also indicating a need for better collaboration across scales of governance.

While water and watershed planning is a major component of GI, this paper focuses on the average scores in addressing water related GI content in the city comprehensive plans. On the whole, the Chicago Wilderness addresses water with an average score of 13.8 out of 18 points (76.7%). The Wasatch Front addresses 67.7% of the water criteria with an average score of 12.2 out of 18. For each region drought received the lowest average scores within the water planning criteria.

Resilience Indicators

The resilience criteria are some of the lowest indicated criteria for city plans in each case study area. To examine these trends more specifically, I broke down the criteria in the Local Content Analysis most connected to the overall intent of the study; benefits recognized through a resilience perspective (7a), climate change impacts and biome shifts (7d), and GI as a climate adaptation mechanism (7e). This section also looked at the SER category as a whole, showing each case study area's awareness of these concepts.

The Wasatch Front obtained a mean score of 9.6 out of 17 possible points, while the Chicago Wilderness obtained a mean score of 8 out of 17 possible points. WF cities address 56.5% of the SER indicators and CW cities address 47.1% of the SER indicators. Examining Tables 4.16, 4.17, and 4.18 show the percentage of a score of 1, 2, or 3 for each of the previously specified SER components in the Local Content Analysis. A score of 1 is overwhelmingly the most common for 7a, 7d, and 7e. These Tables show WF more commonly expressing each concept or expressing them with greater detail. Though not included in my content analysis, due to a lack of emphasis in the larger Case Study GI Plans, WF had a number of cities with plan components devoted to resilience in the community, and various ways to strengthen and implement this. Since it was not a part of my content analysis, there are no numerical details, but CW cities addressed sustainability as a concept using some resiliency language.

Implementation Strategy Indicators

Comprehensive and General plans serve as city and county policy, thus making strong implementation plans and strategies a real possibility for the community. I want to emphasize the aspect of *strong* implementation plans and strategies, because without specification, many of these approaches may not get implemented at all. Tables 4.19 and 4.20 highlight the frequency of each adaptive management strategy specifically delineated in the CW GI Plan. The Chicago Wilderness mentions each approach more frequently than the Wasatch front except for the strategy of conservation development, which is mentioned more frequently than the other approaches in the WF cities. CW most frequently references greenway connection and acquisition as approaches for improve GI networks. These indicators are found in section 9a of the Local Content Analysis (Appendix B).

Tables 4.21 and 4.22 observe section 9.b, addressing implementation strategies expressed in comprehensive plans. Again, CW cities produce a higher average score out of a maximum of 24 possible points. CW City Comprehensive Plans address 66.67% of the suggested implementation criteria, while WF City General Plans address 62.1% of the implementation criteria. These score averages are about the same as the GI section criteria percentages for CW, but slightly higher than the GI indicator section for WF cities. This expresses a slightly better acknowledgement of implementing positive GI mechanisms than of the GI fact base and knowledge in general.

CHAPTER FIVE

CONCLUSION AND FUTURE RESEARCH RECOMMENDATIONS

Various Weak and Strong Trends

Overall, the Chicago Wilderness cities scored the highest collectively in addressing parks and trails, preservation as an implementation strategy, identifying site specific GI interventions, addressing GI connectivity, and water quality and stormwater as a feature of GI. Chicago Wilderness cities scored the lowest in addressing the network design approach, expressing a variety of stakeholder expertise with regard to GI, identifying the linkage of nested systems (SER), and identifying GI as a climate change adaptation mechanism.

The Wasatch Front cities scored the highest in addressing parks and trails, future preservation and conservation with regard to land use, flooding, conservation development strategies, and ordinance recommendations. Wasatch Front scored the lowest in referencing the (Re)Connect GI Plan, identifying structural concepts of GI (cores, hubs, corridors), expressing variety of stakeholder expertise with regard to GI, explaining network design criteria, and identifying restoration and conservation sites.

This is consistent with existing GI literature, as GI is very commonly perceived for its recreation benefits for humans, and at a regional level, trails are emphasized as viable key connections for GI (Allen, 2012). Stormwater, water quality, and GI connectivity are consistently emphasized in the literature, so the high scores reflect local understanding of these integral concepts (Benedict & McMahon, 2006; Davies et al., 2006; EPA, 2022; Fu et al., 2021; Grabowski et al., 2022; IPCC AR6 WGII SPM, 2022; Meerow & Newell, 2017). Stakeholder participation is an important piece of any plan type (Berke et al., 2006), but with regard to GI, professional and expert opinion, along with stakeholder variability is key. While locals may have knowledge on what resources and species are important to a community, the expert opinion can help better guide methods and strategies on how to deal with these indispensable organisms. Also key to GI is the respect of needs and desires of all landowners and stakeholders, again emphasizing the importance of collaborative measures when planning for GI networks (Benedict & McMahon, 2006, p. 37).

The implications of not addressing SER elements and climate change concepts could be grave for the future of natural communities, green spaces, open spaces, and GI in general, in turn affecting the health and wellness of society. The IPCC has concluded that current actions are not sufficient to reduce climate change risks, and ecosystem degradation continues every year, while human population continues to increase, densifying cities, and rapidly covering the earth with development and pavement. These trends continue to heighten the vulnerability of people, making cities some of the most vulnerable locations (IPPC AR6 WGII SPM, 2022). Increased disturbances and natural disasters continue to wear down localities that do not. have enough capacity or funding to continuously rebuild. Without the appropriate perspective to address potential risks on the front end, local governments cyclically deal with flooding and disasters in the same manners. When utilized strategically, green infrastructure sustains communities, increasing localized resilience to flooding events, natural disasters, increased urban heat, and other climate induced events and risks. Nature naturally adjusts, and delivers resilient benefits of clean air and water, while it costs infrastructure rebuilding and adjustments millions or billions of dollars. Without acknowledging the negative effects of human land use trends, societal habits at the urban scale, and their ripple effects, how can localities begin to recognize needs for resilience, let alone solutions to increase resilience? Understanding the interconnection between society and supporting ecological systems is one of the first steps to understanding climate risks and vulnerabilities.

Concluding Remarks

The Chicago Wilderness Green Infrastructure Vision, a non-profit organization, consistently scored higher across city plans, while the Wasatch Front, an initiative backed by a Regional Council of Governments in Utah, scored lower in most categories except for SER indicators and awareness of climate change. SER as a concept is not well-addressed by City or County-wide Comprehensive Plans, though this concept has a lot to offer about the understanding of a community in light of climate changes. Average scores for SER criteria are higher among the small number of local GI Plans within the CW region. The results also show a striking need for more awareness and planning for future impacts of climate change to local communities. With loss of ecosystems to the combination of development patterns and climate change, GI networks as an adaptation strategy has the ability to not only assist natural systems in responding to climate changes, but also have positive impacts on low-income groups positioned for the highest risks of climate change, and society at large.

The regions are very geographically different, retrospectively, it may be more fruitful to compare regions of similar geography, cultures, and needs. The difference in guiding landscape principles did not seem to have much of an influence on the results, other than the confirmation of better understanding of water planning objectives within the Chicago Wilderness. The Wasatch Front has a better understanding of redirecting development, and seemingly buying into conservation development strategies, but this could also be due to its geography of the

Intermountain West. This causes a need to understand optimizing density in the right areas, with less buildable land for development, and less available water supply for that development.

In conclusion, results are similarly consistent with the larger GI plans. The Wasatch Front consistently scored higher in addressing components of resilience, while the Chicago Wilderness generally scored higher on general GI criteria. With such low mention of the larger GI plans in these documents, lack of collaboration could be a factor in addressing the consistency between landscape- scale GI Plans and GI subject matter in local comprehensive plans. This study does not show or prove any causation but does suggest a further look into the interaction of various levels of government in implementing large scale projects, such as a Green Infrastructure network. The majority of plans observed met over 50% of the Local Content Analysis Criteria, suggesting a significant amount of trickle down from the larger GI Plan initiatives, though very infrequently overtly referenced or mentioned.

Suggestions for Future Research

The case study GI plans, (Re)Connect and Chicago Wilderness, do not emphasize monitoring as a form of implementation, which is why this is left off of the Local Content Analysis. Monitoring and physical efforts toward GI Implementation on the ground need to be observed to fully understand the influence and effects of these initiative and policy documents. In addition to realized physical change on the ground, an exploration of the resulting ordinances addressing protection of GI should be further examined. While it was an initial goal in this study, time limitations precluded the ordinance assessment as another extension of the GI plan implementation. Ordinances govern land use through zoning, development regulations, and stormwater management, which are all areas of potential for GI protection to be codified.

While this study takes a broader and more expansive perspective, specific conclusions as to why certain concepts do not translate or show up in local policy documents cannot be discerned. It would be interesting to further look at the understanding of resilience in combination with GI in communities in each of these regions. Some of the comprehensive plans, such as Crystal Lake, IL; Gary, IN; McHenry County, IL; Kane County, IL; and Brighton and Bluffdale, UT show wonderful understanding of the linkages between GI, SER, and climate change. Future research should involve interviews with the planners at each scale.

Ultimately, this research found that landscape-scale governing GI plans in the Wasatch Front and Chicago Wilderness areas did not manifest a collective consistency at the local policy level through comprehensive plans. This research found a major gap in acknowledging the larger governing plans at the local level, which likely contributed to the variability in GI and SER understanding in comprehensive plans. While some cities excelled in either GI or SER understanding, others did not, and results of this study cannot explain causation. Plans that did reference the landscape-scale plans excelled in GI awareness, while SER acknowledgement and awareness was much more dissonant. When localities are given the funding and opportunity o have a more focused policy document, such as a city-wide GI plan, many of the important concepts and indicators come through in the plan, giving the community a better handbook on tackling these issues and implementing multi-functional solutions. Perhaps the timeline of GI Case Study plans from the year 2012 inhibited the percolation of climate-awareness that is more widely acknowledged today in 2023. Additional research previously recommended could help fill in gaps of understanding and causation that this research raises, furthering overall comprehension on the roles and frequency of GI awareness and Gi implementation at the local level as a form of climate resilience for localities in the United States.

APPENDICES

Appendix A

GI Plan Quality Evaluation Framework and SER/ SCM Plan Quality Evaluation Framework

Table 4. New Resource Plan Quality Framework.

DIRECTION-SETTING PRINCIPLES	ACTION-ORIENTED PRINCIPLES
I. **Goals:** A State in which the SES Deliberately Exists (Social, Ecological, and Social-Ecological System)	IV. Resource User **Coordination**, Powers & Polycentricity
1. Maintaining SER/SCM in the resource use: • **Reducing physical externalities (pollutant load, poverty, species loss, etc.)** • **Restoring ecological systems** • **Identification of target areas (where intervention is needed)** • **Withstanding disturbance events and returning to the existing state or deliberately transforming**** **2. Tailored connection to the local context and resource needs** **3. Balancing human and ecological needs****	**1. Collective-choice arrangements**** **2. Minimal recognition of rights to organize**** **3. Nested/scalar processes (polycentricity)**** **4. Acknowledging adaptive cycles across multiple scales and their relation to internal adaptive cycles**** **5. Establishing social-ecological rules**
II. **Fact Base:** Environmental and Social Quality Indicators that lead to SER & SCM	V. **Participation:** Accommodating and Fostering Local and User Engagement in the SES

1. Resource system indicators:
• **Clearly defined boundaries and definitions (maps, political boundaries, etc.)**
• **Threshold awareness:**
  o **Identification of externalities, their sources, causes****
• **Disturbance indicators**
2. Social system indicators:
• **Clearly defined boundaries (of users, political system, etc.)****
• **Number of users**
• **Inclusionary processes with the users**
• **Threshold awareness (economic and social context)**
• **Governance system typology:**
  o **Constitutional choice rules**
  o **Collective choice rules**
  o **Government organizations**
  o **Nongovernmental organizations**
  o **Operational rules**
  o **Network structure**
  o **Property rights systems**
  o **Constitutional rules**
  o **Monitoring and sanctioning process**
3. Linked resource and social system indicators:
• **Threshold awareness****
• **Linked social, economic, and biophysical domains**
• **User-group and resource overlaps**
• **Levels of resource demand**
	1. Allowing traditional ecological knowledge (and linkage with science)
	2. Social learning**
	3. Accommodation of norms/building social capital
	4. Ability to self-organize into collaborative groups***
	5. Outreach to impacted parties
	6. Public education**
	
	VI. **Implementation & Monitoring** for the SES
	
	1. Monitoring:
	• **Milestones**
	• **Strategy**
	• **Evaluation**
	2. Graduated sanctions
	3. Conflict resolution mechanisms
	4. Assessing resilience dimensions:
	• **Specified resilience**
	• **General resilience**
	• **Transformability**
	5. Management measures tied to local conditions

III. **Policies**: Maintaining flexibility and adaptability to adjust to events and disturbances, as well as internal adaptive cycling	
1. Proportional equivalence between benefits and costs** **2. Self-organizing systems** **3. Informed tradeoffs (ecological, economic) at the local level** **4. Deference to local knowledge** **5. Financial assistance** **6. Technical assistance**	

Note: Text in blue indicates that it is an SCM principle from Table 1; text in green indicates that it is an SER principle from Table 1; text in red indicates that it is one of the emerging concepts from the meta-ethnography needed for sustainable and resilient outcomes from Table 2; text in orange is from Brody (2003); and text in purple is from Berke et al. (2014). Coding: 1 = not present; 2 = noted but not described; 3 = carefully described not mentioned; SER = social-ecological resilience; SCM = sustainable commons management; SES = social-ecological system.
*Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified by the SER or SCM literatures, Brody (2003) or Berke et al. (2014) and color-coded accordingly.
**Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified in a combination of the SER and SCM literatures.

Figure A-1: SER/ SCM Plan Quality Framework from Dyckman and Conroy (2020, p. 12)

TABLE 2 Regional/Local Plan Element 1 — Goal Setting

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

1.1	Plan Foundations	Possible Points	Applicable Plan
1.1.1	Were plan parameters identified geographically, temporally and/or other?	1	R,L
1.1.2	Were the planning area's comprehensive "green infrastructure" components and threats to those components documented?	3	R,L
1.1.3	Did the plan call for coordination with adjacent areas regarding efforts that extended beyond jurisdictional boundaries?	3	R,L
1.1.4	Was the plan based on an integrated landscape analysis that focused on the protection of functional landscape components?	5*	R,L
1.1.5	Were federal, state, county or local planning mandates or policy recommendations addressed and incorporated into the plan?	1	R,L
1.1.6	Was the plan supported by a legislative body or executive office by means of a formal resolution?	1	R,L
1.1.7	Did the plan incorporate results from a statewide or regional green infrastructure plan?	3	L
1.1.8	Was the plan led by a vision, formal plan goals, and strategies for guiding plan development?	5*	R,L
1.2	**Stakeholder Involvement**		
1.2.1	Did a leadership forum or advisory committee provide leadership and generate momentum for the planning effort?	5*	R,L
1.2.2	Did the leadership forum/advisory committee include a diversity of professional disciplines and represent multiple sectors?	3	R,L
1.2.3	Did the plan include documentation of a stakeholder analysis to identify stakeholders included within the plan parameters?	1	R,L
1.2.4	Did the planning process include an "adequate" public engagement process that provided stakeholders with ample opportunities to weigh in on plan development?	3	R,L
1.2.5	Were county and local governments engaged in plan development?	1	R,L
1.2.6	Were federal or state agencies engaged in plan development?	1	R,L
1.2.7	Were area non-governmental organizations, land trusts or other conservation organizations engaged in plan development?	1	R,L
1.3	**Conservation Vision**		
1.3.1	Was plan development led by goal(s) to protect ecological processes and functions?	5*	R,L
1.3.2	Did the plan include goal(s) for working lands protection (i.e. farming, forestry, ranching)?	3	R,L
1.3.3	Did the plan include goal(s) for hazard mitigation?	3	R,L
1.3.4	Did the plan include goal(s) for watershed protection?	3	R,L
1.3.5	Did the plan include goal(s) for open space and its associated human benefits (i.e. passive recreation, aesthetic quality)?	3	R,L
1.3.6	Did the plan include goal(s) for the preservation of cultural and historic resources?	1	R,L
1.3.7	Did the plan include goal(s) for eco-tourism and other economic development activities that utilize conservation lands?	1	R,L
1.3.8	Did the plan include goal(s) for growth management?	1	R,L
1.3.9	Did the plan include other conservation-related goals?	1	R,L

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Figure A-2: McDonald et al. GI (2005) plan evaluation framework, part 1 (p. 16)

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TABLE 3 Regional/Local Plan Element 2 — Analysis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

2.1	**Network Design Criteria**	**Possible Points**	**Applicable Plan**
2.1.1	Did the plan include a comprehensive assessment of landscapes and landscape features within plan parameters? (e.g. biological, hydrological, geological, human-dominated)	3	R,L
2.1.2	Were spatially explicit data sets that contain attribute information for landscape features, gathered and compiled?	3	R,L
2.1.3	Did data sets include information for human-dominated landscape features (agriculture, development, etc.), as well as natural landscape features?	1	R,L
2.1.4	Were baseline maps prepared to identify individual green infrastructure components (i.e. forestlands, working lands, wildlife habitat, parklands, etc.)	1	R,L
2.1.5	Did network design criteria for hubs and corridors incorporate ecological thresholds and other conservation parameters? (ex. minimum dynamic areas, size of migration corridors, natural disturbance regimes, edge effects, important riparian zones, etc.)	5*	R,L
2.1.6	Were corridors identified using least-cost path analysis or a similar methodology?	3	R,L
2.1.7	Were network design criteria documented?	1	R,L
2.1.8	Were ecologists and other natural areas specialists involved in producing the network design criteria and weighting systems?	3	R,L
2.1.9	Were network design criteria based on current biological and ecological theories and best practices? (i.e. hubs/corridors, contiguous lands, connectivity, etc.)	5*	R,L
2.1.10	Do the network design criteria incorporate all of the plan's goals?	3	R,L
2.2	**Network Suitability Analysis**		
2.2.1	Was a suitability analysis or similar land suitability method (that incorporated the network design criteria) utilized to calculate and classify the range of conservation values for the study area?	5*	R,L
2.2.2	Were conservation values assessed for a range of spatial scales, including smaller parcel-level analysis?	1	R,L
2.2.3	Did the final network design (i.e. results from suitability analysis) result in an ecologically connected framework?	5*	R,L
2.2.4	Did the network design incorporate a diversity of land uses (i.e. working lands, open space, parklands, habitat)?	5*	R,L
2.2.5	Are specific hubs and corridors delineated in the plan?	3	R,L
2.2.6	If a regional plan was developed, were new target hubs and corridors revealed at the local-scale analysis?	1	L
2.2.7	Were gaps in the network (both in hubs and corridors) identified?	5*	R,L
2.2.8	Did the plan include a clear and coherent graphic representation of the final network design?	5*	R,L
2.2.9	Was the suitability analysis model (or similar model) replicable?	1	R,L

Figure A-3: McDonald et al. (2005) GI plan evaluation framework, part 2 (p. 17)

TABLE 4 Regional/Local Plan Element 3 — Synthesis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

3.1	**Network Design Model Enhancements**	**Possible Points**	**Applicable Plan**
3.1.1	Was feedback from a stakeholder assessment of the network design incorporated into the model?	1	R,L
3.1.2	Was an ecological "ground-truthing" assessment of the network design incorporated into the model?	3	R,L
3.1.3	Were risk and vulnerability factors (i.e. risk for development or fragmentation) for network segments assessed and incorporated into the model?	3	R,L
3.1.4	Was the protection status of green infrastructure network lands identified and incorporated into the model?	5*	R,L
3.1.5	If it is not feasible to connect hubs using the corridors identified in the original network design, are alternative corridors identified?	3	L
3.2	**Identifying Priorities**		
3.2.1	Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?	5*	R,L
3.2.2	Were hubs and corridors ranked within each different type of landscape?	1	R,L
3.2.3	Were hubs and corridors ranked at a coarse, regional scale?	1	R
3.2.4	Were hubs and corridors ranked at a finer, local scale?	1	R,L
3.2.5	Was a system for prioritizing restoration and enhancement opportunities developed?	3	R,L
3.2.6	Were specific priorities identified in this plan?	5*	R,L
3.2.7	Were ranking systems combined to create a comprehensive system for ranking lands within the green infrastructure network?	3	R,L
3.3	**Relationship to Plan Goals**		
3.3.1	Were the final conservation priorities evaluated against the original design criteria?	1	R,L
3.3.2	Did the final conservation priorities meet plan goals?	1	R,L
3.3.3	Does the local plan integrate the network design into a larger, regional network design?	3	L

Figure A-4: McDonald et al. (2005) GI plan evaluation framework, part 3 (p. 18)

TABLE 5 Regional/Local Plan Element 4 — Implementation

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

4.1	Decision-Support Tool	Potential Points	Applicable Plan
4.1.1	Did the plan include a decision-support tool (i.e. mechanism for quantitatively ranking conservation opportunities based on the network design and other important factors)?	5*	R,L
4.1.2	Does the decision-support tool allow for the incorporation of new data as it becomes available?	3	R,L
4.1.3	Can the decision-support tool help guide local and site-level implementation efforts?	5*	R,L
4.1.4	Was the methodology for developing the decision-support tool documented?	1	R,L
4.2	**Implementation Tools**		
4.2.1	Does the plan identify available mechanisms and tools for land protection (i.e. acquisition, easement, TDR, other)?	5*	R,L
4.2.2	Does the plan assess the feasibility and effectiveness of utilizing available tools for land protection?	1	R,L
4.2.3	Does the plan recommend new conservation tools?	1	R,L
4.2.4	Were implementation tools matched with sites based on their ability to handle the threats that were identified in those areas?	3	R,L
4.2.5	Did the plan provide useful and effective ways to integrate the green infrastructure network implementation efforts into county/city regulation, planning, capital improvement programs, and/or development review procedures?	1	L
4.2.6	Did the plan call for specific "small area plans" or similar small-scale plans to guide the conservation of target areas?	1	L
4.3	**Conservation Funding**		
4.3.1	Does the plan identify federal, state, local and/or private conservation funding opportunities?	5*	R,L
4.3.2	Did the plan document strategies for leveraging existing funding sources to generate new sources?	1	R,L
4.3.3	Does the plan document the need for a recurring or revolving funding source?	1	R,L
4.4	**Conservation Strategies**		
4.4.1	Was information pertaining to related environmental protection, natural resource conservation, green space planning and other similar efforts assessed in terms of implementation opportunities?	3	R,L
4.4.2	Does the plan outline specific implementation strategies for state and regional agencies?	5*	R
4.4.3	Does the plan outline specific implementation strategies for county, local governments and private landowners?	3	R,L
4.4.4	Does the plan identify relative priorities for implementation strategies?	3	R,L
4.4.5	Does the combination of all identified implementation strategies encompass a diversity of land uses?	5*	R,L
4.4.6	Are implementation strategies spatially matched to create an "implementation quilt" across the network?	3	R,L
4.4.7	Was a coordinating body or task force established to oversee and coordinate implementation efforts?	1	R,L
4.4.8	Does the plan identify necessary stewardship and management activities to restore, monitor and maintain green infrastructure network resources over time?	3	R,L
4.4.9	Does the plan outline a marketing and public outreach strategy to garner further support for plan goals?	1	R,L
4.5	**Defining Development Opportunities**		
4.5.1	Did the plan discuss opportunities for development within the context of the green infrastructure network?	1	R,L
4.5.2	Did the plan identify a range of land uses to buffer priority protection areas from current or future development?	1	R,L
4.5.3	Did the plan recommend the use of conservation development or limited development for developing lands within the context of the green infrastructure network?	1	R,L
4.5.4	Were implementation strategies coordinated with state or local growth management efforts?	3	R,L

Figure A-5: McDonald et al. (2005) GI plan evaluation framework, part 4 (p. 19)

Appendix B

New Local Content Analysis

1. Is GI a major goal of the Comprehensive plan (1- no, 2- yes)
    a. Indirectly or directly referencing GI intent (1- not referenced/ indirect, 2- direct)

2. GI fact base/ background info
    a. Ecological processes or reference to area's ecology/ natural systems

3. Green Infrastructure (GI)
    a. GI/ Environmental/ Natural resources component (1- no, 2- yes)
    b. Specified GI Goals (1- no, 2- yes)
    c. Definition for GI
    d. Larger GI plan mentioned? (1- no, 2- yes)
        i. For Chicago Wilderness region: Biodiversity Recovery plan mentioned (1- no, 2- yes)
    e. Purpose/ benefits/ ecosystem services
    f. Elements of GI specified? (i.e. connected landscape)
        i. Core/hub/corridor concept identified (1- no, 2- yes)
        ii. Regional connections
    g. Water planning/ watershed planning
        i. Water quality/ pollution
            1. Stormwater
        ii. Water quantity
            1. Flooding
            2. drought
    h. Scales of GI mentioned? (i.e. site/ local, community, landscape, regional)
    i. Types of land coverage examined/protected/conserved/planned for

4. Network design
    a. Maps mentioned or shown to give context to network? (1- no, 2- yes)
    b. Importance ranking approach described: traditional vs localized determination

5. Land use, Designation of:
    a. Future protection
    b. Preservation
    c. Conservation
    d. Preventative land development/ Redirected growth (in context of GI)
    e. Increasing density/ receiving areas for development
    f. Preventing sprawl (i.e. urban growth boundaries, greenbelt, etc.)
    g. Indirectly or directly referencing GI intent (1- not referenced/ indirect, 2- direct)

6. Stakeholder engagement with GI
    a. Collaboration outside of local gov- public, organizations, federal, state
    b. Variety of stakeholder expertise
    c. Public representation in network design

7. Resilience indicators
    a. benefits identified with resilience perspective (linking social/ environmental/ economic)
    b. Are nested systems identified within network?
    c. Hazard mitigation
    d. Climate change impacts/ biome shifts identified?
    e. GI as climate adaption mechanism
    f. Indirectly or directly referencing GI intent (1- not referenced/ indirect, 2- direct)

8. Recreation as justification for GI
    a. Parks
    b. Trails
        i. Hiking
        ii. Mountain biking
    c. Camping
    d. Hunting (access given)
    e. Fishing (access given)
    f. Skiing (WF)

9. Implementation goals
   Adaptive Management approaches
        i. Scattershot adaptive management vs focused
            1. Focused (CW)
                a. Acquisition
                b. Conservation easements
                c. Restoration
                d. greenway connections
                e. Conservation development
            2. Scattershot (Wasatch Front)
   Strategies for municipal implementation
        ii. Specific ordinance recommendations?
        iii. Site specific details such as: rain catchment, green roofs, rain barrels, GSI
        iv. Development strategy suggestions in context of GI (i.e. conservation development, GI overlay)
        v. Restoration strategies
            1. Sites identified? (1- no, 2- yes)
        vi. Conservation
            1. Sites listed? (1- no, 2- yes)
        vii. Preservation
            1. Locations for future preservation? (1- no, 2- yes)

10. Identified impediments to GI implementation?

Figure B-1: Local Content Analysis evaluation framework

Appendix C

GI Plan Quality Evaluation and SER/ SCM Plan Quality Evaluation with Case Study Scores

Table 4. New Resource Plan Quality Framework.

Chicago Wilderness Total: 70/120

DIRECTION-SETTING PRINCIPLES

I. Goals: A State in which the SES Deliberately Exists (Social, Ecological, and Social-Ecological System)

1. **Maintaining SER/SCM in the resource use:**
   - Reducing physical externalities (pollutant load, poverty, species loss, etc.) 3
   - Restoring ecological systems 3
   - Identification of target areas (where intervention is needed) 3
   - Withstanding disturbance events and returning to the existing state or deliberately transforming** 1
2. Tailored connection to the local context and resource needs 3
3. Balancing human and ecological needs** 3

Total: 16

II. Fact Base: Environmental and Social Quality Indicators that lead to SER & SCM

1. **Resource system indicators:**
   - Clearly defined boundaries and definitions (maps, political boundaries, etc.) 2
   - Threshold awareness:
     - Identification of externalities, their sources, causes** 2
   - Disturbance indicators 1
2. **Social system indicators:**
   - Clearly defined boundaries (of users, political system, etc.)** 2
   - Number of users 1
   - Inclusionary processes with the users 2
   - Threshold awareness (economic and social context) 1
   - Governance system typology: 2
     - Constitutional choice rules
     - Collective choice rules
     - Government organizations
     - Nongovernmental organizations
     - Operational rules
     - Network structure
     - Property rights systems
     - Constitutional rules
     - Monitoring and sanctioning process
3. **Linked resource and social system indicators:**
   - Threshold awareness** 3
   - Linked social, economic, and biophysical domains 2
   - User-group and resource overlaps 2
   - Levels of resource demand 1

Total: 21

III. Policies: Maintaining flexibility and adaptability to adjust to events and disturbances, as well as internal adaptive cycling

1. Proportional equivalence between benefits and costs** 1
2. Self-organizing systems 2
3. Informed tradeoffs (ecological, economic) at the local level 1
4. Deference to local knowledge 2
5. Financial assistance 1
6. Technical assistance 2

Total: 9

ACTION-ORIENTED PRINCIPLES

IV. Resource User Coordination, Powers & Polycentricity

1. Collective-choice arrangements** 1
2. Minimal recognition of rights to organize** 1
3. Nested/scalar processes (polycentricity)** 1
4. Acknowledging adaptive cycles across multiple scales and their relation to internal adaptive cycles** 1
5. Establishing social-ecological rules 1

Total: 5

V. Participation: Accommodating and Fostering Local and User Engagement in the SES

1. Allowing traditional ecological knowledge (and linkage with science) 1
2. Social learning** 2
3. Accommodation of norms/building social capital 1
4. Ability to self-organize into collaborative groups*** 3
5. Outreach to impacted parties 2
6. Public education** 1

Total: 10

VI. Implementation & Monitoring for the SES

1. Monitoring: 1
   - Milestones
   - Strategy
   - Evaluation
2. Graduated sanctions 1
3. Conflict resolution mechanisms 1
4. Assessing resilience dimensions: 3
   - Specified resilience
   - General resilience
   - Transformability
5. Management measures tied to local conditions 3

Total: 9

Note: Text in blue indicates that it is an SCM principle from Table 1; text in green indicates that it is an SER principle from Table 1; text in red indicates that it is one of the emerging concepts from the meta-ethnography needed for sustainable and resilient outcomes from Table 2; text in orange is from Brody (2003); and text in purple is from Berke et al. (2014). Coding: 1 = not present; 2 = noted but not described; 3 = carefully described not mentioned; SER = social-ecological resilience; SCM = sustainable commons management; SES = social-ecological system.

*Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified by the SER or SCM literatures, Brody (2003) or Berke et al. (2014) and color-coded accordingly.

**Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified in a combination of the SER and SCM literatures.

Figure C-1: Chicago Wilderness SER/SCM Plan Evaluation Scoring

Wasatch Front Total: 77/120

Table 4. New Resource Plan Quality Framework.

DIRECTION-SETTING PRINCIPLES

I. Goals: A State in which the SES Deliberately Exists (Social, Ecological, and Social-Ecological System)

1. Maintaining SER/SCM in the resource use:
   - Reducing physical externalities (pollutant load, poverty, species loss, etc.) 1
   - Restoring ecological systems 2
   - Identification of target areas (where intervention is needed) 2
   - Withstanding disturbance events and returning to the existing state or deliberately transforming** 1
2. Tailored connection to the local context and resource needs 3
3. Balancing human and ecological needs** 3

Total: 12

II. Fact Base: Environmental and Social Quality Indicators that lead to SER & SCM

1. Resource system indicators:
   - Clearly defined boundaries and definitions (maps, political boundaries, etc.) 3
   - Threshold awareness:
     - Identification of externalities, their sources, causes** 2
   - Disturbance indicators 1
2. Social system indicators:
   - Clearly defined boundaries (of users, political system, etc.)** 3
   - Number of users 3
   - Inclusionary processes with the users 2
   - Threshold awareness (economic and social context) 1
   - Governance system typology: 3
     - Constitutional choice rules
     - Collective choice rules
     - Government organizations
     - Nongovernmental organizations
     - Operational rules
     - Network structure
     - Property rights systems
     - Constitutional rules
     - Monitoring and sanctioning process
3. Linked resource and social system indicators:
   - Threshold awareness** 2
   - Linked social, economic, and biophysical domains 2
   - User-group and resource overlaps 3
   - Levels of resource demand 1

Total: 26

III. Policies: Maintaining flexibility and adaptability to adjust to events and disturbances, as well as internal adaptive cycling

1. Proportional equivalence between benefits and costs** 1
2. Self-organizing systems 2
3. Informed tradeoffs (ecological, economic) at the local level 2
4. Deference to local knowledge 3
5. Financial assistance 2
6. Technical assistance 2

Total: 12

ACTION-ORIENTED PRINCIPLES

IV. Resource User Coordination, Powers & Polycentricity

1. Collective-choice arrangements** 2
2. Minimal recognition of rights to organize** 1
3. Nested/scalar processes (polycentricity)** 2
4. Acknowledging adaptive cycles across multiple scales and their relation to internal adaptive cycles** 2
5. Establishing social-ecological rules 1

Total: 8

V. Participation: Accommodating and Fostering Local and User Engagement in the SES

1. Allowing traditional ecological knowledge (and linkage with science) 1
2. Social learning** 3
3. Accommodation of norms/building social capital 1
4. Ability to self-organize into collaborative groups*** 2
5. Outreach to impacted parties 2
6. Public education** 3

Total: 12

VI. Implementation & Monitoring for the SES

1. Monitoring: 1
   - Milestones
   - Strategy
   - Evaluation
2. Graduated sanctions 1
3. Conflict resolution mechanisms 1
4. Assessing resilience dimensions: 1
   - Specified resilience
   - General resilience
   - Transformability
5. Management measures tied to local conditions 3

Total: 7

Note: Text in blue indicates that it is an SCM principle from Table 1; text in green indicates that it is an SER principle from Table 1; text in red indicates that it is one of the emerging concepts from the meta-ethnography needed for sustainable and resilient outcomes from Table 2; text in orange is from Brody (2003); and text in purple is from Berke et al. (2014). Coding: 1 = not present; 2 = noted but not described; 3 = carefully described not mentioned; SER = social-ecological resilience; SCM = sustainable commons management; SES = social-ecological system.

*Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified by the SER or SCM literatures, Brody (2003) or Berke et al. (2014) and color-coded accordingly.

**Indicates that this principle was also revealed through the meta-ethnographic open-ended results but was originally identified in a combination of the SER and SCM literatures.

Figure C-2: Wasatch Front SER/SCM Plan Evaluation Scoring

Chicago Wilderness Total: 153/210

TABLE 2 Regional/Local Plan Element 1 — Goal Setting

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

1.1	**Plan Foundations**	**Possible Points**	**Applicable Plan**
1.1.1	Were plan parameters identified geographically, temporally and/or other?	1 **1**	R,L
1.1.2	Were the planning area's comprehensive "green infrastructure" components and threats to those components documented?	3 **3**	R,L
1.1.3	Did the plan call for coordination with adjacent areas regarding efforts that extended beyond jurisdictional boundaries?	3 **2**	R,L
1.1.4	Was the plan based on an integrated landscape analysis that focused on the protection of functional landscape components?	5* **5**	R,L
1.1.5	Were federal, state, county or local planning mandates or policy recommendations addressed and incorporated into the plan?	1 **1**	R,L
1.1.6	Was the plan supported by a legislative body or executive office by means of a formal resolution?	1 **0**	R,L
1.1.7	Did the plan incorporate results from a statewide or regional green infrastructure plan?	3	L
1.1.8	Was the plan led by a vision, formal plan goals, and strategies for guiding plan development?	5* **5**	R,L
1.2	**Stakeholder Involvement**		
1.2.1	Did a leadership forum or advisory committee provide leadership and generate momentum for the planning effort?	5* **5**	R,L
1.2.2	Did the leadership forum/advisory committee include a diversity of professional disciplines and represent multiple sectors?	3 **3**	R,L
1.2.3	Did the plan include documentation of a stakeholder analysis to identify stakeholders included within the plan parameters?	1 **1**	R,L
1.2.4	Did the planning process include an "adequate" public engagement process that provided stakeholders with ample opportunities to weigh in on plan development?	3 **3**	R,L
1.2.5	Were county and local governments engaged in plan development?	1 **1**	R,L
1.2.6	Were federal or state agencies engaged in plan development?	1 **1**	R,L
1.2.7	Were area non-governmental organizations, land trusts or other conservation organizations engaged in plan development?	1 **1**	R,L
1.3	**Conservation Vision**		
1.3.1	Was plan development led by goal(s) to protect ecological processes and functions?	5* **5**	R,L
1.3.2	Did the plan include goal(s) for working lands protection (i.e. farming, forestry, ranching)?	3 **2**	R,L
1.3.3	Did the plan include goal(s) for hazard mitigation?	3 **0**	R,L
1.3.4	Did the plan include goal(s) for watershed protection?	3 **3**	R,L
1.3.5	Did the plan include goal(s) for open space and its associated human benefits (i.e. passive recreation, aesthetic quality)?	3 **2**	R,L
1.3.6	Did the plan include goal(s) for the preservation of cultural and historic resources?	1 **0**	R,L
1.3.7	Did the plan include goal(s) for eco-tourism and other economic development activities that utilize conservation lands?	1 **0**	R,L
1.3.8	Did the plan include goal(s) for growth management?	1 **1**	R,L
1.3.9	Did the plan include other conservation-related goals?	1 **1**	R,L

Figure C-3: Chicago Wilderness GI Plan Evaluation Scoring part 1, total score included

TABLE 3 Regional/Local Plan Element 2 — Analysis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

2.1	Network Design Criteria	Possible Points	Applicable Plan
2.1.1	Did the plan include a comprehensive assessment of landscapes and landscape features within plan parameters? (e.g. biological, hydrological, geological, human-dominated)	3 3	R,L
2.1.2	Were spatially explicit data sets that contain attribute information for landscape features, gathered and compiled?	3 3	R,L
2.1.3	Did data sets include information for human-dominated landscape features (agriculture, development, etc.), as well as natural landscape features?	1 0	R,L
2.1.4	Were baseline maps prepared to identify individual green infrastructure components (i.e. forestlands, working lands, wildlife habitat, parklands, etc.)	1 1	R,L
2.1.5	Did network design criteria for hubs and corridors incorporate ecological thresholds and other conservation parameters? (ex. minimum dynamic areas, size of migration corridors, natural disturbance regimes, edge effects, important riparian zones, etc.)	5* 5	R,L
2.1.6	Were corridors identified using least-cost path analysis or a similar methodology?	3 3	R,L
2.1.7	Were network design criteria documented?	1 1	R,L
2.1.8	Were ecologists and other natural areas specialists involved in producing the network design criteria and weighting systems?	3 3	R,L
2.1.9	Were network design criteria based on current biological and ecological theories and best practices? (i.e. hubs/corridors, contiguous lands, connectivity, etc.)	5* 5	R,L
2.1.10	Do the network design criteria incorporate all of the plan's goals?	3 3	R,L
2.2	**Network Suitability Analysis**		
2.2.1	Was a suitability analysis or similar land suitability method (that incorporated the network design criteria) utilized to calculate and classify the range of conservation values for the study area?	5* 5	R,L
2.2.2	Were conservation values assessed for a range of spatial scales, including smaller parcel-level analysis?	1 1	R,L
2.2.3	Did the final network design (i.e. results from suitability analysis) result in an ecologically connected framework?	5* 5	R,L
2.2.4	Did the network design incorporate a diversity of land uses (i.e. working lands, open space, parklands, habitat)?	5* 5	R,L
2.2.5	Are specific hubs and corridors delineated in the plan?	3 3	R,L
2.2.6	If a regional plan was developed, were new target hubs and corridors revealed at the local-scale analysis?	1	L
2.2.7	Were gaps in the network (both in hubs and corridors) identified?	5* 5	R,L
2.2.8	Did the plan include a clear and coherent graphic representation of the final network design?	5* 5	R,L
2.2.9	Was the suitability analysis model (or similar model) replicable?	1 0	R,L

Figure C-4: Chicago Wilderness GI Plan Evaluation Scoring part 2

TABLE 4 Regional/Local Plan Element 3 — Synthesis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

3.1	**Network Design Model Enhancements**	**Possible Points**	**Applicable Plan**
3.1.1	Was feedback from a stakeholder assessment of the network design incorporated into the model?	1 1	R,L
3.1.2	Was an ecological "ground-truthing" assessment of the network design incorporated into the model?	3 0	R,L
3.1.3	Were risk and vulnerability factors (i.e. risk for development or fragmentation) for network segments assessed and incorporated into the model?	3 1	R,L
3.1.4	Was the protection status of green infrastructure network lands identified and incorporated into the model?	5* 5	R,L
3.1.5	If it is not feasible to connect hubs using the corridors identified in the original network design, are alternative corridors identified?	3	L
3.2	**Identifying Priorities**		
3.2.1	Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?	5* 3	R,L
3.2.2	Were hubs and corridors ranked within each different type of landscape?	1 1	R,L
3.2.3	Were hubs and corridors ranked at a coarse, regional scale?	1 1	R
3.2.4	Were hubs and corridors ranked at a finer, local scale?	1 0	R,L
3.2.5	Was a system for prioritizing restoration and enhancement opportunities developed?	3 2	R,L
3.2.6	Were specific priorities identified in this plan?	5* 5	R,L
3.2.7	Were ranking systems combined to create a comprehensive system for ranking lands within the green infrastructure network?	3 3	R,L
3.3	**Relationship to Plan Goals**		
3.3.1	Were the final conservation priorities evaluated against the original design criteria?	1 0	R,L
3.3.2	Did the final conservation priorities meet plan goals?	1 1	R,L
3.3.3	Does the local plan integrate the network design into a larger, regional network design?	3	L

Figure C-5: Chicago Wilderness GI Plan Evaluation Scoring part 3

TABLE 5 Regional/Local Plan Element 4 — Implementation

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

4.1	Decision-Support Tool	Potential Points	Applicable Plan
4.1.1	Did the plan include a decision-support tool (i.e. mechanism for quantitatively ranking conservation opportunities based on the network design and other important factors)?	5* 0	R,L
4.1.2	Does the decision-support tool allow for the incorporation of new data as it becomes available?	3 0	R,L
4.1.3	Can the decision-support tool help guide local and site-level implementation efforts?	5* 0	R,L
4.1.4	Was the methodology for developing the decision-support tool documented?	1 0	R,L
4.2	**Implementation Tools**		
4.2.1	Does the plan identify available mechanisms and tools for land protection (i.e. acquisition, easement, TDR, other)?	5* 5	R,L
4.2.2	Does the plan assess the feasibility and effectiveness of utilizing available tools for land protection?	1 0	R,L
4.2.3	Does the plan recommend new conservation tools?	1 0	R,L
4.2.4	Were implementation tools matched with sites based on their ability to handle the threats that were identified in those areas?	3 3	R,L
4.2.5	Did the plan provide useful and effective ways to integrate the green infrastructure network implementation efforts into county/city regulation, planning, capital improvement programs, and/or development review procedures?	1	L
4.2.6	Did the plan call for specific “small area plans” or similar small-scale plans to guide the conservation of target areas?	1	L
4.3	**Conservation Funding**		
4.3.1	Does the plan identify federal, state, local and/or private conservation funding opportunities?	5* 2	R,L
4.3.2	Did the plan document strategies for leveraging existing funding sources to generate new sources?	1 0	R,L
4.3.3	Does the plan document the need for a recurring or revolving funding source?	1 0	R,L
4.4	**Conservation Strategies**		
4.4.1	Was information pertaining to related environmental protection, natural resource conservation, green space planning and other similar efforts assessed in terms of implementation opportunities?	3 3	R,L
4.4.2	Does the plan outline specific implementation strategies for state and regional agencies?	5* 3	R
4.4.3	Does the plan outline specific implementation strategies for county, local governments and private landowners?	3 2	R,L
4.4.4	Does the plan identify relative priorities for implementation strategies?	3 3	R,L
4.4.5	Does the combination of all identified implementation strategies encompass a diversity of land uses?	5*5	R,L
4.4.6	Are implementation strategies spatially matched to create an “implementation quilt” across the network?	3 0	R,L
4.4.7	Was a coordinating body or task force established to oversee and coordinate implementation efforts?	1 0	R,L
4.4.8	Does the plan identify necessary stewardship and management activities to restore, monitor and maintain green infrastructure network resources over time?	3 0	R,L
4.4.9	Does the plan outline a marketing and public outreach strategy to garner further support for plan goals?	1 0	R,L
4.5	**Defining Development Opportunities**		
4.5.1	Did the plan discuss opportunities for development within the context of the green infrastructure network?	1 1	R,L
4.5.2	Did the plan identify a range of land uses to buffer priority protection areas from current or future development?	1 1	R,L
4.5.3	Did the plan recommend the use of conservation development or limited development for developing lands within the context of the green infrastructure network?	1 1	R,L
4.5.4	Were implementation strategies coordinated with state or local growth management efforts?	3 0	R,L

Figure C-6: Chicago Wilderness GI Plan Evaluation Scoring part 4

Wasatch Front Total: 140/210

TABLE 2 Regional/Local Plan Element 1 — Goal Setting

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

1.1	**Plan Foundations**	**Possible Points**	**Applicable Plan**
1.1.1	Were plan parameters identified geographically, temporally and/or other?	1 1	R,L
1.1.2	Were the planning area's comprehensive "green infrastructure" components and threats to those components documented?	3 3	R,L
1.1.3	Did the plan call for coordination with adjacent areas regarding efforts that extended beyond jurisdictional boundaries?	3 2	R,L
1.1.4	Was the plan based on an integrated landscape analysis that focused on the protection of functional landscape components?	5* 5	R,L
1.1.5	Were federal, state, county or local planning mandates or policy recommendations addressed and incorporated into the plan?	1 1	R,L
1.1.6	Was the plan supported by a legislative body or executive office by means of a formal resolution?	1 1	R,L
1.1.7	Did the plan incorporate results from a statewide or regional green infrastructure plan?	3	L
1.1.8	Was the plan led by a vision, formal plan goals, and strategies for guiding plan development?	5* 5	R,L
1.2	**Stakeholder Involvement**		
1.2.1	Did a leadership forum or advisory committee provide leadership and generate momentum for the planning effort?	5* 5	R,L
1.2.2	Did the leadership forum/advisory committee include a diversity of professional disciplines and represent multiple sectors?	3 2	R,L
1.2.3	Did the plan include documentation of a stakeholder analysis to identify stakeholders included within the plan parameters?	1 1	R,L
1.2.4	Did the planning process include an "adequate" public engagement process that provided stakeholders with ample opportunities to weigh in on plan development?	3 2	R,L
1.2.5	Were county and local governments engaged in plan development?	1 1	R,L
1.2.6	Were federal or state agencies engaged in plan development?	1 1	R,L
1.2.7	Were area non-governmental organizations, land trusts or other conservation organizations engaged in plan development?	1 1	R,L
1.3	**Conservation Vision**		
1.3.1	Was plan development led by goal(s) to protect ecological processes and functions?	5* 5	R,L
1.3.2	Did the plan include goal(s) for working lands protection (i.e. farming, forestry, ranching)?	3 3	R,L
1.3.3	Did the plan include goal(s) for hazard mitigation?	3 1	R,L
1.3.4	Did the plan include goal(s) for watershed protection?	3 3	R,L
1.3.5	Did the plan include goal(s) for open space and its associated human benefits (i.e. passive recreation, aesthetic quality)?	3 1	R,L
1.3.6	Did the plan include goal(s) for the preservation of cultural and historic resources?	1 1	R,L
1.3.7	Did the plan include goal(s) for eco-tourism and other economic development activities that utilize conservation lands?	1 1	R,L
1.3.8	Did the plan include goal(s) for growth management?	1 1	R,L
1.3.9	Did the plan include other conservation-related goals?	1 1	R,L

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Figure C-7: Wasatch Front GI Plan Evaluation Scoring, part 1, total score included

TABLE 3 Regional/Local Plan Element 2 — Analysis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

2.1	**Network Design Criteria**	**Possible Points**	**Applicable Plan**
2.1.1	Did the plan include a comprehensive assessment of landscapes and landscape features within plan parameters? (e.g. biological, hydrological, geological, human-dominated)	3 3	R,L
2.1.2	Were spatially explicit data sets that contain attribute information for landscape features, gathered and compiled?	3 2	R,L
2.1.3	Did data sets include information for human-dominated landscape features (agriculture, development, etc.), as well as natural landscape features?	1 1	R,L
2.1.4	Were baseline maps prepared to identify individual green infrastructure components (i.e. forestlands, working lands, wildlife habitat, parklands, etc.)	1 1	R,L
2.1.5	Did network design criteria for hubs and corridors incorporate ecological thresholds and other conservation parameters? (ex. minimum dynamic areas, size of migration corridors, natural disturbance regimes, edge effects, important riparian zones, etc.)	5*3	R,L
2.1.6	Were corridors identified using least-cost path analysis or a similar methodology?	3 3	R,L
2.1.7	Were network design criteria documented?	1 1	R,L
2.1.8	Were ecologists and other natural areas specialists involved in producing the network design criteria and weighting systems?	3 1	R,L
2.1.9	Were network design criteria based on current biological and ecological theories and best practices? (i.e. hubs/corridors, contiguous lands, connectivity, etc.)	5*5	R,L
2.1.10	Do the network design criteria incorporate all of the plan's goals?	3 3	R,L
2.2	**Network Suitability Analysis**		
2.2.1	Was a suitability analysis or similar land suitability method (that incorporated the network design criteria) utilized to calculate and classify the range of conservation values for the study area?	5* 5	R,L
2.2.2	Were conservation values assessed for a range of spatial scales, including smaller parcel-level analysis?	1 0	R,L
2.2.3	Did the final network design (i.e. results from suitability analysis) result in an ecologically connected framework?	5* 5	R,L
2.2.4	Did the network design incorporate a diversity of land uses (i.e. working lands, open space, parklands, habitat)?	5* 5	R,L
2.2.5	Are specific hubs and corridors delineated in the plan?	3 2	R,L
2.2.6	If a regional plan was developed, were new target hubs and corridors revealed at the local-scale analysis?	1	L
2.2.7	Were gaps in the network (both in hubs and corridors) identified?	5* 3	R,L
2.2.8	Did the plan include a clear and coherent graphic representation of the final network design?	5* 5	R,L
2.2.9	Was the suitability analysis model (or similar model) replicable?	1 1	R,L

Figure C-8: Wasatch Front GI Plan Evaluation Scoring, part 2

TABLE 4 Regional/Local Plan Element 3 — Synthesis

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

3.1	**Network Design Model Enhancements**	**Possible Points**	**Applicable Plan**
3.1.1	Was feedback from a stakeholder assessment of the network design incorporated into the model?	1 **1**	R,L
3.1.2	Was an ecological "ground-truthing" assessment of the network design incorporated into the model?	3 **0**	R,L
3.1.3	Were risk and vulnerability factors (i.e. risk for development or fragmentation) for network segments assessed and incorporated into the model?	3 **3**	R,L
3.1.4	Was the protection status of green infrastructure network lands identified and incorporated into the model?	5* **0**	R,L
3.1.5	If it is not feasible to connect hubs using the corridors identified in the original network design, are alternative corridors identified?	3	L
3.2	**Identifying Priorities**		
3.2.1	Were the systems for prioritizing and ranking hubs and corridors based on the results of the suitability analysis, vulnerability factors and status of land protection?	5* **0**	R,L
3.2.2	Were hubs and corridors ranked within each different type of landscape?	1 **0**	R,L
3.2.3	Were hubs and corridors ranked at a coarse, regional scale?	1 **0**	R
3.2.4	Were hubs and corridors ranked at a finer, local scale?	1 **0**	R,L
3.2.5	Was a system for prioritizing restoration and enhancement opportunities developed?	3 **0**	R,L
3.2.6	Were specific priorities identified in this plan?	5* **5**	R,L
3.2.7	Were ranking systems combined to create a comprehensive system for ranking lands within the green infrastructure network?	3 **0**	R,L
3.3	**Relationship to Plan Goals**		
3.3.1	Were the final conservation priorities evaluated against the original design criteria?	1 **1**	R,L
3.3.2	Did the final conservation priorities meet plan goals?	1 **1**	R,L
3.3.3	Does the local plan integrate the network design into a larger, regional network design?	3	L

Figure C-9: Wasatch Front GI Plan Evaluation Scoring, part 3

TABLE 5 Regional/Local Plan Element 4 — Implementation

R=Regional Plan and L=Local Plan **Denotes a required criteria that plans must include.*

4.1	Decision-Support Tool	Potential Points	Applicable Plan
4.1.1	Did the plan include a decision-support tool (i.e. mechanism for quantitatively ranking conservation opportunities based on the network design and other important factors)?	5* 0	R,L
4.1.2	Does the decision-support tool allow for the incorporation of new data as it becomes available?	3 0	R,L
4.1.3	Can the decision-support tool help guide local and site-level implementation efforts?	5* 0	R,L
4.1.4	Was the methodology for developing the decision-support tool documented?	1 0	R,L
4.2	**Implementation Tools**		
4.2.1	Does the plan identify available mechanisms and tools for land protection (i.e. acquisition, easement, TDR, other)?	5* 5	R,L
4.2.2	Does the plan assess the feasibility and effectiveness of utilizing available tools for land protection?	1 0	R,L
4.2.3	Does the plan recommend new conservation tools?	1 1	R,L
4.2.4	Were implementation tools matched with sites based on their ability to handle the threats that were identified in those areas?	3 0	R,L
4.2.5	Did the plan provide useful and effective ways to integrate the green infrastructure network implementation efforts into county/city regulation, planning, capital improvement programs, and/or development review procedures?	1	L
4.2.6	Did the plan call for specific "small area plans" or similar small-scale plans to guide the conservation of target areas?	1	L
4.3	**Conservation Funding**		
4.3.1	Does the plan identify federal, state, local and/or private conservation funding opportunities?	5* 0	R,L
4.3.2	Did the plan document strategies for leveraging existing funding sources to generate new sources?	1 1	R,L
4.3.3	Does the plan document the need for a recurring or revolving funding source?	1 1	R,L
4.4	**Conservation Strategies**		
4.4.1	Was information pertaining to related environmental protection, natural resource conservation, green space planning and other similar efforts assessed in terms of implementation opportunities?	3 3	R,L
4.4.2	Does the plan outline specific implementation strategies for state and regional agencies?	5* 5	R
4.4.3	Does the plan outline specific implementation strategies for county, local governments and private landowners?	3 3	R,L
4.4.4	Does the plan identify relative priorities for implementation strategies?	3 1	R,L
4.4.5	Does the combination of all identified implementation strategies encompass a diversity of land uses?	5* 5	R,L
4.4.6	Are implementation strategies spatially matched to create an "implementation quilt" across the network?	3 0	R,L
4.4.7	Was a coordinating body or task force established to oversee and coordinate implementation efforts?	1 0	R,L
4.4.8	Does the plan identify necessary stewardship and management activities to restore, monitor and maintain green infrastructure network resources over time?	3 3	R,L
4.4.9	Does the plan outline a marketing and public outreach strategy to garner further support for plan goals?	1 0	R,L
4.5	**Defining Development Opportunities**		
4.5.1	Did the plan discuss opportunities for development within the context of the green infrastructure network?	1 1	R,L
4.5.2	Did the plan identify a range of land uses to buffer priority protection areas from current or future development?	1 0	R,L
4.5.3	Did the plan recommend the use of conservation development or limited development for developing lands within the context of the green infrastructure network?	1 1	R,L
4.5.4	Were implementation strategies coordinated with state or local growth management efforts?	3 2	R,L

Figure C-10: Wasatch Front GI Plan Evaluation Scoring, part 4

Appendix D

All Examined City and County Plans listed

Wasatch Front

- Davis County
  - Clinton City
  - Kaysville City
  - Layton City
  - North Salt Lake City
  - South Weber
  - Sunset City
  - Syracuse
  - Woods Cross City
- Salt Lake County
  - Bluffdale
  - Brighton
  - Copperton
  - Draper
  - Herrimen
  - Holladay
  - Kearns
  - Magna
  - Midvale
  - Millcreek
  - Murray
  - Riverton
  - Salt Lake City
  - Sandy
  - South Jordan
  - South Salt Lake
  - West Jordan
  - West Valley
  - White City
- Tooele County
  - Erda City
  - Tooele City
- Weber County
  - Farr West
  - Harrisville
  - Hooper
  - Huntsville
  - Marriot-Slaterville
  - North Ogden
  - Plain City
  - Pleasant View
  - Riverdale
  - Roy
  - Uintah
  - Washington Terrace
  - West Haven
- WF County-wide Plans
  - Tooele County
  - Western Weber County
  - Ogden Valley (Weber County)

Chicago Wilderness Illinois

- Cook County
  - Alsip
  - Arlington Heights
  - Barrington
  - Bensenville
  - Blue Island
  - Brookfield
  - Calumet City
  - Chicago
  - Chicago Heights
  - Chicago Ridge
  - Cicero
  - Deer Park
  - Des Plaines
  - Elgin
  - Elmwood Park
  - Glenview
  - Indian Head Park
  - Lansing
  - Lemont
  - Lincolnwood
  - Markham
  - Mount Prospect
  - Northfield
  - Oak Park
  - Orland Park
  - Palos Heights
  - Park Forest
  - Prospect Heights
  - Richton Park
  - River Forest
  - Rolling Meadows
  - Roselle
  - South Holland
- Dupage County
  - City of Naperville
  - City of West Chicago
  - City of Westmont
  - City of Wood Dale
  - Village of Addison
  - Village of Bensenville
  - Village of Carol Stream
  - Village of Itasca
  - Village of Lombard
  - Village of Winfield
- Kane County
  - City of Batavia
  - City of Elgin
  - City of St Charles
  - Village of Burlington

- Village of Campton Hills
  - Village of Elburn
  - Village of Montgomery
  - Village of North Aurora

- Kendall County
  - City of Plano
  - City of Yorkville
  - Village of Minooka
  - Village of Plainfield
- Lake County
  - Antioch
  - Bannockburn
  - Barrington
  - Beach Park
  - Deer Park
  - Deerfield
  - Green Oak
  - Gurnee
  - Hawthorn Woods
  - Highwood
  - Lake Barrington
  - Lake Villa
  - Lakemoor
  - Libertyville
  - Long Grove
  - Mettawa
  - Mundelein
  - North Barrington
  - North Chicago
  - Round Lake
  - Vernon Hills
  - Village of Round Lake Heights
  - Wadsworth
  - Waukegan
  - Winthrop Harber
  - Zion
- McHenry County
  - Algonquin
  - Barrington Hills
  - Cary
  - Crystal Lake
  - Fox River Grove
  - Lakemoor
  - Village of Lake in the Hills
- Will County
  - Channahon
  - City of Crest Hill
  - City of Lockport
  - Diamond
  - Frankfort
  - Romeoville
  - University Park
  - Village of Monee

Indiana
- Lake County
  - City of Cedar Lake
  - City of Crown Point
  - City of Gary
  - Town of Lowell
  - Town of St. John

Wisconsin
- Milwaukee County
  - City of Oak Creek
  - Cudahy
  - Greendale
  - Greenfield
  - South Milwaukee
  - St Francis
- Walworth County
  - Burlington
  - Delavan
  - Elk Horn
  - Lake Geneva
  - Town of Linn
  - Village of Darien
  - Village of East Troy
  - Village of Fontana
  - Village of Walworth
  - Whitewater
- CW County-wide Plans
  - Kane County, IL
  - McHenry County, IL
  - Lake County, IN
  - Walworth County, WI
- Local GI Plans
  - McHenry County
  - Kane County
  - Gary, IN
  - Crystal Lake, IL
  - Woodstock, IL
  - Midlothonian Creek (IL)
  - Kishwaukee River Corridor (IL)
  - Des Plaines River Communities (IL)
  - South Cook County/ Millenium Reserve (IL)
  - Bannock/ Lincolnshire/ Mettawa (IL)

Appendix E

Local Content Analysis scores listed

County	City/ Village	Local Content Analysis, score out of 168
Cook County, IL	Village of Alsip	76
	Arlington Heights	73
	Barrington	96
	Bensenville	84
	Blue Island	79
	Brookfield	108
	Calumet City	85
	Chicago	89
	Chicago heights	118
	Chicago Ridge	71
	Cicero	79
	Deer Park	95
	Des Plaines	100
	Elgin	107
	Elmwood Park	99
	Glenview	117
	Indian Head Park	65
	Lansing	86
	Lemont	123
	Lincolnwood	84
	Markham	86
	Mount Prospect	117
	Village of North field	92
	Oak Park	103
	Orland Park	120
	Palos Heights	77
	Park Forest	96
	Prospect heights	97
	Richton Park	109
	River Forest	103
	Rolling Meadows	94
	Roselle	84
	South Holland	93
	Streamwood	81

Table E-1: Local Content Analysis scores for city plans in Cook County, Illinois.

County	City/ Village	Local Content Analysis, score out of 168
Lake County, IL	Antioch	100
	Bannockburn	104
	Green Oak	105
	Gurnee	102
	Hawthorne Woods	108
	Highland	85
	Lake Villa	88
	Lakemoor	141
	Libertyville	98
	Long Grove	127
	Mettawa	109
	Mundelein	95
	North Barrington	116
	North Chicago	96
	Round Lake	79
	Vernon Hills	89
	Round Lake Heights	106
	wadsworth	100
	winthrop harbor	123
	Waukegan	135
	Zion	121

Table E-2: Local Content Analysis scores for city plans Lake County, Illinois.

County	City/ Village	Local Content Analysis, score out of 168
McHenry County, IL	Algonquin	108
	Barrington Hills	102
	Cary	117
	Crystal Lake	132
	Fox River Grove	93
	Lakemoor	131
	Lake in the Hills	103

Table E-3: Local Content Analysis scores for city plans in McHenry County, Illinois.

County	City/ Village	Local Content Analysis, score out of 168
Will County, IL	Channahon	114
	Crest Hill	110
	Lockport	97
	Diamond	86
	Frankfort	125
	Romeoville	104
	University Park	101
	Village of Monee	129

Table E-4: Local Content Analysis scores for city plans in Will County, Illinois.

County	City/ Village	Local Content Analysis, score out of 168
Kendall County, IL	Plano	114
	Yorkville	105
	Village of Minooka	107
	Village of Plainfield	96

Table E-5: Local Content Analysis scores for city plans in Kendall County, Illinois.

County	City/ Town	Local Content Analysis, score out of 168
Lake County, IN	City of Cedar Lake	73
	City of Crown Point	83
	Town of Lowell	92
	Town of St John	99

Table E-6: Local Content Analysis scores for city plans in Lake County, Indiana.

County	City/ Village	Local Content Analysis, score out of 168
Walworth County, WI	Burlington	130
	Delavan	125
	Elk Horn	114
	Lake Geneva	141
	Town of Linn	123
	Village of Darien	121
	East Troy	104
	Village of Fontana	138
	Walworth Village	105
	Whitewater	119

Table E- 7: Local Content Analysis scores for city plans in Walworth County, Wisconsin.

County	City	Local Content Analysis, score out of 168
Milwaukee County, WI	City of Oak Creek	114
	Cudahy	106
	Greendale	104
	Greenfield	109
	South Milwaukee	116
	St. Francis	86

Table E-8: Local Content Analysis scores for city plans in Milwaukee County, Wisconsin.

County	City	Local Content Analysis, score out of 168
Davis County, Utah	Davis	
	Clinton City	116
	Kaysville City	123
	Layton City	125
	North Salt Lake City	86
	South Weber	91
	Sunset City	79
	Syracuse City	88
	Woods Cross City	90

Table E-9: Local Content Analysis scores for city plans in Davis County, Utah.

County	City	Local Content Analysis, score out of 168
Salt Lake County, Utah	Bluffdale	134
	Brighton	134
	Copperton	91
	Draper	104
	Herrimen	97
	Holladay	104
	Kearns	95
	Magna	107
	Midvale	69
	Millcreek	124
	Murray	104
	SLC	135
	South Jordan	105
	South Salt Lake	105
	West Jordan	125
	West Valley	94
	White City	104

Table E-10: Local Content Analysis scores for city plans in Salt Lake County, Utah.

County	City	Local Content Analysis, score out of 168
Weber County, Utah	Farr West	71
	Harrisville	99
	Hooper City	114
	Huntsville Town	95
	Marriott-Slaterville	111
	North Ogden	122
	Ogden	112
	Plain City	97
	Pleasant View	108
	Riverdale	107
	Roy	106
	Washington Terrace	91
	West Haven	89

Table E-11: Local Content Analysis scores for city plans in Weber County, Utah.

County	City	Local Content Analysis, score out of 168
Tooele County, Utah	Erda City	111
	Tooele City	122

Table E-12: Local Content Analysis scores for city plans in Tooele County, Utah.

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