

Working at the Nexus of Climate Justice and Nature-Inspired Solutions

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1. Abstract

This work represents a partnership between the Urban Sustainability Directors Network (USDN) and the University of Michigan’s School for Environment and Sustainability (UM-SEAS) as part of the requirements for the completion of graduate studies. *Working at the Nexus of Climate Justice and Nature-Based Solutions* focuses on significant modification of internal local government processes, including climate action, and provides guidance to center racial equity holistically throughout. The analyses conducted for this project, obtained through literature review and expert interviews, also consider how biomimicry—learning from and mimicking natural or ecological strategies and systems to more sustainably solve human-driven challenges—may enhance and support existing guidance on solutions that local governments can implement in the pursuit of centering racial equity. In addition, the project identifies deeper connections and opportunities for climate action and makes recommendations for establishing an awareness of power dynamics and a commitment to power shifting. The provided recommendations help delineate methods to embed and integrate biomimicry at all stages of decision-making processes. Particular focus is placed on the USDN Nexus framework because of its applicability to a variety of local governments and its grounding in fundamentally transforming traditional approaches to climate action planning. This project is rooted in the notion that human needs and quality of life must be at the forefront when attempting to address issues related to climate change. To make that a reality, those involved must be willing to come to terms with the fact that racial injustice and global climate change come from the same place. By reshaping how local government operates by embedding racial equity, climate justice, and biomimetic principles into the center of all planning processes, resulting in a comprehensive response, practitioners stand a chance at facilitating positive change for all involved. This work can surely be categorized as novel—most efforts to enact change do not prioritize these efforts at their core, choosing instead to work within existing frameworks—but the process and payoff of nature-inspired planning promise to be more rewarding and enduring should they prove successful.

2. Introduction

The global environment faces numerous challenges related to ecological degradation, biodiversity loss, and climate change (UN Environment Plan, 2021). Many of these challenges can be attributed to human-driven processes and activities that rely on extractive relationships toward natural environments and resources. Strict power structures, defined here as institutional and structural dynamics wherein White supremacist ideology and colonial pedagogy guide all aspects of decision-making, restrict holistic engagement with advancing climate goals to a just and livable climate future. Many lessons learned from cultural and land management practices from various Indigenous communities around the world, including mutual respect for nature, flexibility in planning, and reflectivity and introspection, suggest that developing collaborative relationships between ecological and human systems (Chisholm Hatfield, 2018) may aid in the reduction of a number of the aforementioned challenges. A partnered relationship that views human and biological ecosystems as interconnected and reciprocal, rather than linear and founded in strict power structures, is founded in respect, coalition, and flexibility. Highlighting these principles can aid the replenishment of natural ecosystems and drive improvements in

biodiversity. These shifts are important not only for the conservation of nonhuman actors but also for human communities (USDN, 2021). Humans are simultaneously the drivers and victims of climate collapse. Histories of colonialism, industrialization, and globalization have all contributed to current environmental problems. Placing an emphasis on climate and racial justice, two areas which intersect, is important in achieving the aims of a just, equitable, and sustainable climate future. Furthermore, environmental justice, an umbrella under which climate and racial justice as well as ecological conservation and restoration fall, is inextricably linked to the principles of respect, coalition-building, and flexibility in policies and programs that impact human and nonhuman communities. Therefore, it is both impossible to ignore and imperative to center the foundation of environmental change in these values.

The Urban Sustainability Directors Network (USDN) tackles some of these core issues (USDN, 2020). USDN has developed a novel approach to identify how to effectively manage environmental problems without disregard for the essential focus on justice implications (School for Environment and Sustainability, 2021). This approach, coined the Nexus, provides guidance “for local government practitioners to begin a new set of practices that will help them fundamentally transform traditional approaches to climate action planning” (USDN, 2021). One of the central questions that the USDN regularly confronts is addressing the “how” of change-making. There are a plethora of studies, reports, and other media that identify and catalog environmental problems. Similarly, a smaller but still significant body of literature exists on where socioeconomic and sociocultural factors interact with and influence environmental problems. However, moving beyond basic identification and analysis of these problems is a challenge that has not been addressed as widely (Powell et al., 2019). The Nexus, outlined in *Figure 1*, is not theory but rather is founded in real-world solutions to unique challenges that communities face in regard to climate change risks and existing problems. The Nexus proposes a non-linear six-part process which recognizes how power shows up, where local government practitioners have the opportunity to alter power, accountability and the ability to ensure that there is a real shift from engagement to ownership (USDN, 2021). Due to this grounding, the Nexus is able to be applied in different community settings without losing sight of the central issues that are common to most communities in post-colonial states. Some of the core issues include ecological degradation, biodiversity loss, and climate change, and all stem from a lack of reciprocity between human activities, infrastructure, and systems with the environments that those factors are reliant on. Existing attempts at addressing these issues can be effective to an extent, however many are unsuccessful in garnering lasting and sustainable change (Fixico, 2012). Well-intentioned attempts ultimately fail in this greater aim because they are founded in traditional mechanisms that are not developed to address diverse perspectives and experiences. By leaving no room for diversity, extractive systems are able to continually prevail and catapult disparate communities into environmental contexts that are unhealthy and unjust. The Nexus works to break down the structures and/or systems that are not working to serve the needs of a globalized community, and are, in turn, impelling harmful environmental and social externalities onto communities that have been marginalized through histories of similar extraction and violence (O’Brien, 2003).

This master’s project builds on, analyzes, and provides biomimicry connections and pathways for the Nexus guidance to further explicate the significance of nature-respected solutions, climate justice, and racial equity in order to speak to the scalability and flexibility of the Nexus guidance

in different communities. The following questions were inspired by introductory research in this area by the project team:

Research Questions:

- Which biomimetic principles and processes can be applied to policy and planning design?
- How can the mechanisms behind natural processes and patterns be applied to the Nexus process?
- How can natural processes and patterns guide community solutions at the nexus of racial equity and climate resilience?

In addressing these questions, the report attempts to synthesize environmental justice challenges and how to impart solutions to these problems in a flexible and non-extractive manner in communities across the United States. Central to our work is the linking of literature on racial equity, climate justice, and climate adaptation, which will be addressed below.

2.1 The Nexus

In determining a path forward for bridging racial equity and climate resilience, USDN developed its Nexus guidance, a set of pathways designed to be adaptable to each local government putting them into use (USDN, 2021). The Nexus focuses primarily on the centering of racial equity through local practitioners who are deconstructing racism and supporting change within their own communities; without this critical step, the secondary goal of incorporating climate resilience and mitigating greenhouse gas emissions will likely not be nearly as successful (USDN, 2021). To do this most effectively, the Nexus guidance first aids local governments in recognizing their biases, implicit biases, and the true history of racism in the United States, then builds in guidance for tackling inequitable power distribution through recognition as well as action (USDN, 2021).

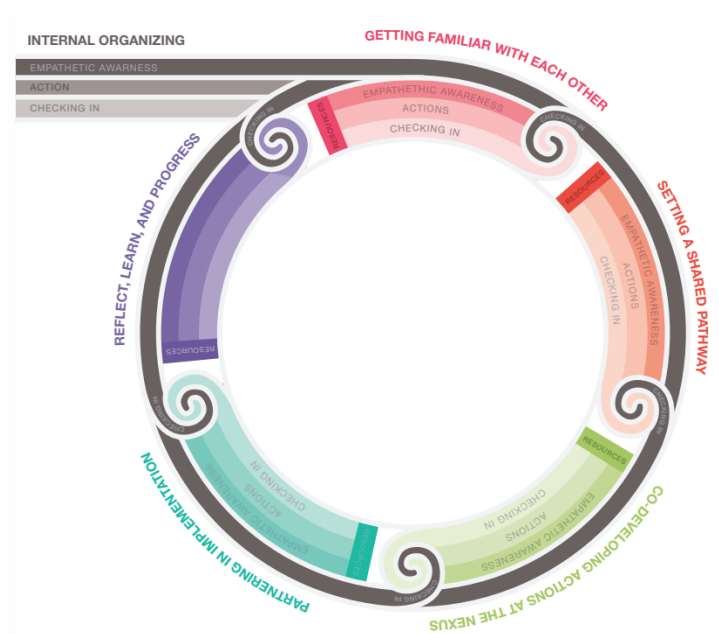
The Nexus is unique in that it takes a different approach from most other forms of climate resilience planning. In other realms, the goal of helping communities become more resilient in the face of climate change takes the form of attempting to limit temperature rise; any methods that can help keep the planet under 1.5°C of global temperature increase will largely be considered a success (IPCC, 2018). However, according to the Nexus guidance, the key to enacting real change in addition to meeting climate goals lies in the recognition of human needs and quality of life (USDN, 2021). In order to do that, there must be a collective willingness to accept that the root causes of racial injustice and global climate change come from the same place—and to act on that front (USDN, 2021). By centering those most impacted by racial injustice and climate change, communities can form the basis of a comprehensive response to the two critical issues and stand a better chance of enacting positive change for all involved.

Once local governments align their collective goals with a conjunctive plan targeting racial equity and climate resilience, they must recognize a few universal truths before diving in. One of these is the understanding that there are multiple paths for communities to travel down in order to arrive at a future of racial equity and climate resilience (USDN, 2021). This recognition is highlighted in the makeup of the Nexus; it is designed so that it can be adapted to fit the needs of

a specific community. Additionally, communities and local leadership must accept that change will take time, with the possibility that certain steps may have to be revisited and reworked in light of new developments (USDN, 2021). This may be due to the complexity of solving significant problems for a large group of people, as well as the recognition that goals and plans evolve over a period of time, and groups may realize that what they are working toward is not actually what they most want or need to accomplish with the Nexus. Further, those utilizing Nexus guidance must realize that their efforts must truly be collaborative. No single person can effectively transform the way a community functions; cooperation among individuals, community groups, and local governments must be of the utmost priority. As such, the Nexus process can be expected to be a multi-month/multi-year process; because it is organized in a cyclical manner with many opportunities for checking in and reassessments built in throughout, practitioners should not assume that the Nexus can function as merely a checklist to be completed in a timely and linear fashion (USDN, 2021).

The Nexus seeks to achieve racial equity and, by extension, climate resilience in a series of 6 steps: (1) internal organizing, (2) getting familiar with each other, (3) setting a shared pathway, (4) co-developing actions at the Nexus, (5) partnering in implementation, and (6) reflection, learning, and progress (USDN, 2021). Each of these steps are further broken down into stages of empathetic awareness, action, checking in, and resources. As stated above, a key to the Nexus that differentiates it from other climate adaptation work is its adaptability; as such, these different stages within each of the six steps help organizers and local governments in their progress to the next step by making full consideration of the many facets at the current step. To that end, if there is any feeling as though low or no progress is being made or community members and organizers are not feeling heard or included in the efforts being carried out, a stop should be put to the current work and time should be taken to reassess the situation at hand (USDN, 2021).

Figure 1. The Nexus diagram (USDN, 2021) illustrates the Nexus process. At its most basic, it is comprised of six cyclical stages: (1) internal organizing, (2) getting familiar with each other, (3) setting a shared pathway, (4) co-developing actions at the Nexus, (5) partnering in implementation, and (6) reflection, learning, and progress. A core element of the Nexus is it prioritizes adaptable pathways; USDN recognizes that no community will be starting from the same place or encounter the same experiences when going through the process and, as such, has structured the Nexus to be accessible from a variety of perspectives.



While the Nexus is a relatively new way to think about solving problems as they relate to centering racial equity and climate resilience, it is motivated by actions to shift power to participatory and community-based partners throughout all stages of program and policy creation and implementation. A likely failure of many previous plans was that they did not fully consider the human element in their planning. In going a step further and fusing climate change issues with human issues, there may be a greater chance of having success with these critical issues. Humans are *part* of the world ecosystem, and plans must be developed with that fact in mind.

2.2 Biomimetic Potential

One of the possible avenues for a successful highlighting of racial equity lies in a crossover of racial justice issues, climate action planning, and biomimicry, intertwined with a collective underlying respect for nature. In this case, biomimicry describes the practice of modeling systems after biological entities and processes to solve human design challenges (Biomimicry Institute, n.d.). While ascribing biomimicry to centering racial justice as a method of achieving more effective climate action planning may not seem like the most intuitive solution, we believe that, when considered and explained in full, the links among these categories will become apparent.

Think, for a moment, about the natural world. What immediately comes to mind? Probably a lot of greenery, maybe some trees, animals, or water. The mental images conjured by this prompt will be different for everyone, as would be expected. That's part of the beauty of diversity of thought and experience: every individual comes in with a distinct background and understands the world in a unique way. For every person who adds an anecdote about what nature evokes in them, the collective imagery becomes a bit sharper, a bit more well-defined. The more voices present, the more detailed the picture.

The same is true of including diversity of thought in climate action planning. While positions of power, in nearly every discipline, have historically been filled on the basis of racial prejudice, bringing a myriad of opinions to the table and installing BIPOC voices in leadership positions aids in addressing all necessary shortcomings when determining directionality for the future. Inclusivity sharpens the picture of where climate action planning will and should go next.

Still, the relationship of climate action planning to the natural world and biomimicry extends beyond a simple visualization exercise. Planning commissions may make efforts to become more diverse, include more voices, and have a strong vision of where they want to be 5, 10, or 20 years from now, but there is more to the story than just thinking about the end goal. The 2015 Paris Agreement aims to prevent global warming from rising by 2°C by 2100, but current probabilities suggest a five percent chance of staying below that threshold, as measured by countries' nationally determined contributions (NDCs) to reducing emissions (Liu & Raftery, 2021). If all countries meet their NDCs and continue to curb emissions at the same rate by 2030, the probability of successfully meeting the goal rises to 26 percent, a number heavily influenced by the United States, which is still relatively low (Liu & Raftery, 2021). Bearing these statistics in mind, shifting how we think about climate action planning may be the key to unlocking more durable success at a time when it is desperately needed.

Dealing with periods of transition is no easy feat. But biomimicry provides an example in this realm. Consider the role of ecotones, a transition zone in which two biological communities meet and integrate with one another (Delcourt & Delcourt, 1992). These ecotones provide great variation in how and where they occur. They can be narrow or wide, local or regional, distinct or meandering; each distinction is integral to the functionality and presentation of a certain area. How these ecotones come together determine how that area will operate. The same is true of determining the best paths forward in climate action planning. Practitioners must be willing to meet their constituents where they are and determine how best to proceed when accounting for a range of challenges, viewpoints, and needs. Whatever the plan evolves into must become a fusion of all of these different entities and provide a smooth transition from one mode of operation to another, a true bridging of community principles and values. If we fall short of recognizing the many connections that we have with the natural world, we risk failure on the climate action planning front, a luxury that continues to become progressively less viable as time passes.

It is also important to keep in mind that the Nexus process is constantly evolving; while much work has been completed in order to bring the Nexus to member communities, there is still more to be done as it relates to the later stages of the framework and determining how it can be most effective in communities.

3. Research and Analytics

3.1 Project Objectives and Scope

The present research intends to aid local governments in the creation of policies and programs that both address pressing climate needs and center broad social justice. Integration of ecological environmental systems and anthropogenic systems reduces the nature-culture dichotomy that is largely grounded in colonial ideologies that separate humans from natural systems (Matthews, 2003). Research herein is framed for use at the census-tract level (Council on Environmental Quality, 2022) and, as such, is generally applicable to many communities throughout North America. Biomimicry will be the primary vessel through which program implementation can happen as a result of this project. By delving into existing research surrounding racial justice and equity and biomimicry, our team elaborated on this area of study and implemented best-practice recommendations into this report. Findings may aid in implementation of collaborative efforts with local governments for centering racial equity in future processes and projects. Because we anticipate that many suggestions and program implementations will be modified, biomimicry is uniquely situated to serve project aims. Biomimicry targets the forefront of our methods, collaborative production efforts, while maintaining that the earth provides the best infrastructure design and capabilities for living organisms. By mimicking biological systems, anthropogenic systems are better able to serve not only themselves but also their ecological counterparts. In synthesis, biomimicry provides the solutions to practical human-driven issues that are further complicated by social categories of difference such as race, class, gender, and other dimensions. By drawing on advice from the fields of conservation ecology, environmental justice, and program evaluation, among others, while centering collaboration through biomimicry, the restructuring of government processes to value racial equity can be achieved.

3.2 Methods

This interdisciplinary research relied on a variety of mixed methods to progress toward the goal of incorporating biomimicry in sustainable design and shifting existing power structures and dynamics in North American government processes; collectively, these aims permit the recognition and reconciliation of histories of White supremacy that necessitate mass extraction of human and nonhuman resources from our shared environments. Furthermore, employed methods were to be in-line with goals to provide non-linear guidance to the aforementioned governments that center racial equity and respect for nature as inextricable to climate action. Methods included the following:

1. Conduct literature review

- a. Determine existing research and investigation in relevant academic and professional literature. Review historical and contemporary literature on topics such as biomimicry, climate change, equity and justice in order to add relevant commentary to the field and refrain from duplication of existing work.

2. Analyze Biomimicry Principles (Table 1)

- a. Use expert interviews to analyze the biomimicry principles and ideas to identify those most relevant and useful for the Nexus planning stages.

3. Interview biomimicry and city planning experts to determine which ideas resonate with or are most impactful among policy makers and community members (Appendix A)

- a. Discuss the planning process with experts in the field to identify what aspects of biomimicry resonate with policy makers and what techniques are not as powerful. This would enable the analysis to narrow down the principles or ideas that would be most effective.

4. Match those principles up with aspects of ecological systems or “champion” organisms

- a. As per guidance received in interviews, relate the principles to systems or examples in nature that planners can draw inspiration from. This is important because it grounds planning within nature by having community leaders and city officials view themselves within the model.
- b. Use ecological champions to analyze and interpret awareness and opportunities within each stage in the Nexus process and highlight ways to shift power to communities. (Table 3)

5. Summarize Content/Actions framework at the Nexus Mapping and demonstrate how ecological processes and patterns can inspire equitable solutions to community needs

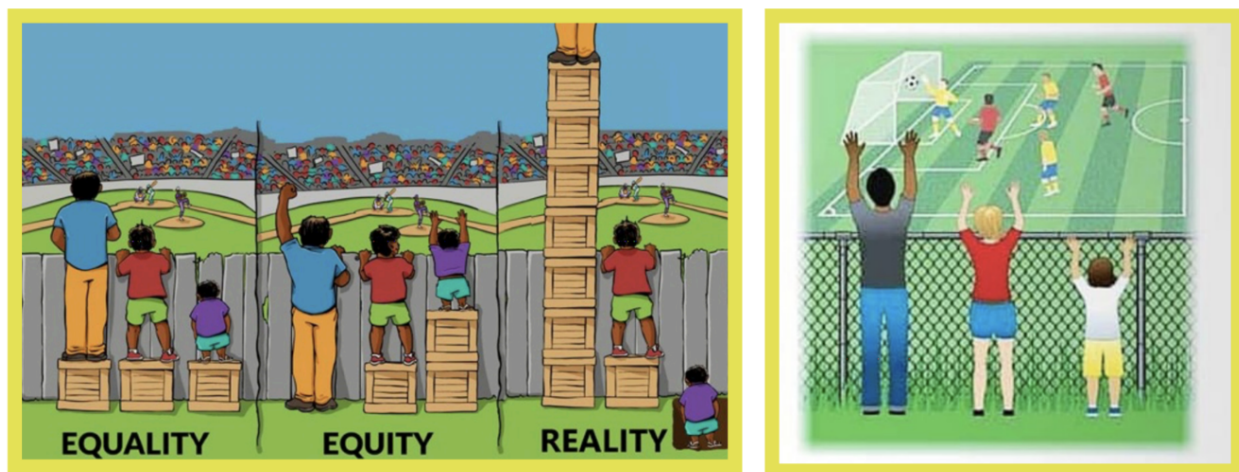
- a. Summary is completed by drawing out keywords from each category, such as respond, adapt, and improve. These keywords could be used as a basis for concrete suggested actions for the Nexus in learning from nature.
- b. Compile a set of specific “suggested actions” for the Nexus that use natural mechanisms to aid in designing effective policy for participating cities and communities.

4. Literature Review

4.1 Racial Equity, Climate Justice, and Adaptation

In 2015, the United Nations deemed climate change adaptation strategies an essential part of city governments' central processes and planning (Shi et al., 2016). As a part of this declaration, racial justice was highlighted as one of the key drivers of advancing social and environmental progress. Racial justice brings together many of the essential elements of environmental justice. These elements include, but are not limited to, conservation ecology, energy access, education, communication, and natural resource statistics. Racial justice is central to environmental justice and to the aforementioned elements of environmental justice because racial justice categorizes the undue environmental and social burdens that those members of marginalized groups bear (Shi et al., 2016). In the United States, race is among the greatest determinants of health outcomes, implying that race continues to determine the survivability of people of color (Smedley et al., 2003). The use of enslavement and colonialism firmly rooted the institution of slavery in the United States in order to drive the Industrial Revolution and Anthropocene (Jenkins, 2021). Although this report is focused on the United States, it is important to be reminded that many other areas of the world, particularly parts of Europe, also relied heavily on the enslavement of primarily peoples of African descent in order to promulgate their market goals. This reminder serves to acknowledge the resilience, determination, and power of communities within the African diaspora and other communities harmed by histories of colonialism and neocolonialism (Davis, 2005). Achieving racial justice, then, will broaden the scale of this acknowledgement.

Figure 2. This figure depicts a visualization of the differences between equality, equity, and reality (Powell et al., 2019).



Sources: Variations of these images have been created by Craig Froehle, Angus Maguire, the Center for Story-Based Strategy and the Interaction Institute for Social Change.

In building on the significance of racial justice, it is imperative to also consider racial equity and the important delineation between justice and equity; *Figure 2* helps make this delineation,

depicting a visualization of equality, equity, and reality. On the rightmost side of *Figure 2*, an uncaptioned depiction of justice is displayed. Justice connotes the removal of structural barriers which prevent access for all groups regardless of ability. Equity makes possible access, within the confines of structural barriers, and can be strategically used in progressing to achieve holistic justice. By making this distinction, climate adaptation plans can better evaluate their goals and implement strategies to move through equity towards justice. In many cases, climate resilience will require reconciling historical and contemporary harms through a variety of means such as reparations, land back programming, and dismantling of well established organizations and institutions (Davis, 2005).

Operationalizing holistic racial justice in city governments, as purported by the United Nations to be a crucial part of achieving effective climate change plans, poses a seemingly insurmountable challenge for U.S. cities to accomplish. In order to achieve these aims, it will be essential for cities and nations alike to address their histories and patterns of oppression, dispossession, and generalized harms which often have broader implications with global ramifications (Bulkeley et al., 2013). Centering racial equity at the core of city government processes, projects, and systems will aid in making this transition to developing a more just and equitable society. Therefore, the centering of racial equity is an indispensable part of the USDN Nexus guidance and so is it a part of this report. In their 2009 paper, Dodman and Satterthwaite, researchers at the United Kingdom's International Institute for Environment and Development, identified the capacity for institutions to capitalize on the unique capabilities for urban communities -particularly urban poor populations- to develop innovative climate adaptation strategies (Dodman et al., 2009). Their research suggests that urban contexts exemplify opportunities for innovative climate adaptation precisely because of their vulnerability to climate change risk factors. Importantly, between the cases studied, the need for local government intervention was common (Dodman et al., 2009). Other studies also identify this need (Torabi et al., 2015). Many people believe that this identification is one of the most important steps in addressing pressing climate change risks (Pauli, 2019). However, without the inclusion of racial equity in these addresses, plans developed to help are ill-fated in being sustainable (Fixico, 2012). Furthermore, as referenced in the Nexus, replacing systems of oppression with sustainable systems of support is the most appropriate and effective way to develop climate adaptation plans that include holistic racial justice.

Contemporarily, the lack of racial equity—an important foci for advancing racial and climate justice in local government projects and programs—contributes to a host of catastrophes that are simultaneously detrimental, violent, and deadly to those directly and tangentially impacted, as well as drivers for economic and social disparities. These include substandard infrastructure (American Society of Civil Engineers, 2021), public health crises (Pauli, 2019), and property default and seizure (Marohn, 2020). Giving appropriate resources and dedication to centering racial equity can, in partnership with other reparative strategies, improve the city's climate change adaptation and resilience plans and also have vibratory impacts on the greater national and global communities.

Racial equity is not only central to achieving climate justice, but also must be considered in climate adaptation strategies. In fact, racial equity has been an implicit part of recent federal policy, especially in regard to infrastructure and environmental improvements. The Biden Administration, in collaboration with the 117th Congress of the United States, has implemented a

series of Executive Orders, regulations, new legislation (in particular, the signed Infrastructure Bill, and the proposed Build Back Better bill), regulations, and initiatives relevant to climate justice (The White House, 2022).

Climate adaptation is a pressing issue for all countries and local communities to consider around the world; the pace and magnitude of climate change is increasing, causing massive disruptions to food, water, energy, and livelihoods. Communities with limited economic and social capital are most affected by climate change and least able to cope (Thomas et. al, 2019). The increase in frequency and intensity of some extreme events has also been linked to climate change, including extreme flooding, droughts, and heatwaves; such disasters displace some 20 million people annually (National Academies of Sciences, Engineering, and Medicine, 2016).

Climate adaptation is defined as “the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2014). The Intergovernmental Panel on Climate Change (IPCC) recently released “Climate Change 2022: Impacts, adaptation and vulnerability” (IPCC, 2022a). It has a strong focus on the need to reduce risks and protect especially vulnerable people. The report notes that because some people are suffering disproportionately, “equity and justice” are vital in decision-making and investment going forward. As well, no country is immune. Although developing countries are the most threatened, low-income communities are also vulnerable in wealthy countries such as the United States.

For example, the new IPCC North America fact sheet concludes that “fragmented responsibility for planning, disaster management, and mitigation and adaptation actions hinders the development of integrated and equitable policies (high confidence) and their implementation. While community-level planning tailors adaptation to the local context, misalignment of policies within and between levels of government can prevent implementation. Coordination, planning, and national support are needed as well as sufficient financial resources to implement climate-resilient policies and infrastructure (high confidence).”

Indeed, while many cities and states have developed climate mitigation plans (Hsu et al., 2019), fewer have developed adaptation plans (Georgetown Climate Center, n.d.). The U.S. National Climate Assessment (NCA), required by the Congress via the Global Change Research Act of 1990 (Global Change, n.d.), evaluates the planning and implementation of adaptation plans across the United States. In its most recent fourth quadrennial assessment from 2018, the NCA notes that three parts of the adaptation “cycle” are now active (awareness, assessment, and planning), which is an improvement from the previous 2014 assessment (USGCRP, 2018). However, there is still too little happening in the crucial phases of “implementation” and “monitoring and evaluation.” Indeed, those are the stages the Nexus seeks to rapidly achieve, to help cities respond equitably to climate change quickly enough to avoid the worst costs and impacts—which will be felt hardest by the poorest communities.

Figure 3. U.S. Global Change Research Program Figure on Five Adaptation Stages and Progress (USGCRP, 2018).



Finally, the IPCC report highlights how using nature-based solutions can enhance resilience of people and ecosystems to climate change. For example, having healthy forests, wetlands, and mangroves can reduce flood risk by storing water and slowing the flow (IPCC, 2022b). The press release notes, “Together, growing urbanization and climate change create complex risks, especially for those cities that already experience poorly planned urban growth, high levels of poverty and unemployment, and a lack of basic services. But cities also provide opportunities for climate action – green buildings, reliable supplies of clean water and renewable energy, and sustainable transport systems that connect urban and rural areas can all lead to a more inclusive, fairer society.” In short, reconceptualizing our cities, not only as a place of people, but a place of nature can enhance livability, climate resilience and racial equity. Achieving this is a goal of the Nexus process but requires the inclusion of not just science and policy, but equally important the local knowledge, customs, and practices. The IPCC Biodiversity Fact sheet notes, “Potential benefits and avoidance of harm are maximized when Nature-based Solutions with safeguards are deployed in the right places and with the right approaches for that area, with inclusive governance (high confidence). Taking account of interdisciplinary scientific information, Indigenous knowledge and local knowledge and practical expertise is essential to effective Ecosystem-based Adaptation (high confidence)” (IPCC, n.d.).

The confluence of concerns about racial equity, climate justice, and climate adaptation make it imperative to advance climate-positive, equity-positive and nature-positive solutions at the local level.

4.2 Biomimicry

Biomimicry is a nature-inspired method of design that learns from natural systems in solving problems by mimicking natural form, process or systems structure in order to address human design challenges (Brown, 2017). The idea behind this form of design is that the ecological systems that have evolved for 3.8 billion years to be self-sufficient could provide a blueprint for human systems to do the same (Biomimicry Institute, n.d.). However, since the Industrial Revolution, Western ideas on dominance over nature have prevailed (Tulloch, 2015) in both developed and developing nations, especially in the areas of technology and innovation. This has led to a rise in automation and engines powered by the use of oil and gas, which are carbon sources that are naturally stored deep underground to be sequestered, as well as the prevalence of plastics and chemical pollutants, among other man-made materials. These practices have disrupted natural cycles, thrown them off balance, and have massive energetic and monetary costs. According to the Lancet Commission on Pollution and Health report on the global impact of environmental pollution, 9 million premature deaths, 92% of which occurred in poor countries, were the results of diseases from pollution in air, soil and water. This is a greater proportion of people than smoking, war, AIDS, natural disasters, hunger, or malaria (Cohen, 2017).

The potential of biomimicry in the design of social systems and policy is significant because, similar to human political systems, natural systems have various forms of governance, laws and power structures to maintain a steady state. For example, communities of insects use self-organizing social practices (Holbrook et al., 2010) to select nest-sites through the use of independent assessment, signaling and collective decision making through response to signals (Franks et al., 2002). Similar to human needs, natural systems embody resilience, power balances, and self-sufficiency. Additionally, natural systems address human needs sustainability, such as producing energy, breaking down materials, providing shelter and cleaning water, by utilizing mechanisms like feedback loops, signaling and by navigating trade-offs. For example, algae facilitate water treatment and filtration naturally by producing oxygen gas, which creates an environment suitable for aerobic bacteria (Olson, 2015). These bacteria degrade toxins and regulate nutrient levels in the process of creating the energy needed for growth (AOS Treatment Solutions, 2018). Wetlands also host several species of plants and animals that assist in water filtration. Nitrogen is a vital component in fertilizers used in farming, but using synthetic forms of fertilizer with nitrogen can release dangerous ammonia fumes (Kent, 2016). This is because nitrogen cannot be directly taken from the air and must be converted to a form that is available to plants (Johnson et al., 2005). This conversion occurs in natural systems through mutualistic relationships between plants like Lupine and nitrogen-fixing bacteria (Sanders, 2005). These nitrogen “fixing” plants act as a source of nitrogen for the wider ecosystem. Circular economy techniques can be seen in this process when microbes mineralize nitrogen from organic matter like manure, a result of the digestion of plants, which can then provide nutrition for additional plant growth. What is more, biomimicry is practiced by nature itself as organisms adapt and evolve traits and practices that can enhance survival (Pickering, 2019). This can be seen in *Hymenopus coronatus*, or the orchid mantis, which takes on the same color of the flower and can maneuver its body to take on the shape as well. The orchid mantis can use this disguise to attract and attack prey, like butterflies, and also hide from predators (LiveScience Staff, 2013).

But, natural ecosystems don't just demonstrate how a single system can be sustainable and equitable, they also demonstrate the benefits of connections and diversity. A prime example for this can be observed in Mycorrhizal networks, which establish connections with various different organisms, including other mycelium and various plants, that serve all parties involved. The carbon in plants feeds the network and the nutrients within the network nurture the plants. This process is facilitated through smaller feedback loops and mutualistic relationships between species (Hahs, 2017). Human governance systems also contain elements of give and take that are not always as equitably beneficial as mycorrhizal networks. But the structuring of checks and balances within the networks can help bridge the gaps within human systems. Plant's and many other organisms, including the human nervous system, use signaling to trigger the check points that restore equilibrium. An example of this is Melatonin, which, when released by the Pineal gland at night time, triggers relaxation and sleep (Johns Hopkins Medicine, n.d.). Importantly, these hormones are balanced by other hormones that have the opposite function, thereby regulating the cycle. In general, nature emphasizes diversity as key to resilience within systems in that the roles of organisms within ecosystems support those of others (Farnsworth, 2013). For example, biodiversity is a vital element of forest resilience after disturbances. After a forest fire, various plants, like Lupine, establish adequate levels of nitrogen in the soil, creating ecological conditions optimal for the next level of succession. Some plants, like Ponderosa pine, have seeds that activate from high temperatures of a fire, and thus, thrive in environments that get fires more regularly. The diversity of characteristics present in the forest help support the resilience and productivity of that environment after disturbance. The mechanisms used by ecological organisms and structures aid the regenerative nature of these systems and can inspire the design of sustainable planning processes, such as navigating the six Nexus stages to shift power and implement climate solutions. This analysis aims to learn from nature by walking through the Nexus stages and asking "How would nature do this?" with a focus on racial equity and climate resilience.

Although biomimicry has not been actively practiced by the Western world despite having been used by indigenous communities around the world (Brown, 2017), in recent history it has been used in examples such as airplanes, which have wings inspired by those of birds since the 1970s (Defosse, 2018). However, airplanes use and release a significant amount of pollution and are an example of the need to maintain the concept of self-sufficiency when attempting to use biomimicry for sustainable and environmentally friendly solutions. Fortunately, there have been many examples of innovation using biomimicry in areas like architecture, such as in the Eastgate Center in Zimbabwe that modeled its design and ventilation system around that of termite mounds (Fehrenbacher, 2012), technology, such as cooling systems created at MIT that run on no energy through the use of evaporation-insulation cooling design inspired by the insulation in camel fur, medical devices storing carbon (AskNature, 2020), vaccine storage, and many more things. However, although there have been examples of biomimicry discussed in relation to stress and discussed in the design of social movements (Brown, 2017), there are few examples of the application of biomimicry to policy design.

5. Findings

5.1 Deliverables

Table 1. Biomimicry Principles & Patterns in Natural Systems

When conducting preliminary research, a key to understanding how biomimicry could best be applied to local government processes came by way of exploring biomimicry principles and patterns in natural systems. Several studies outline systems that speak to the potential for incorporating both a respect for nature and a respect for humanity that allow for greater harmony between the two. In establishing how these principles and patterns work, determinations can be made regarding how they pair with the larger goal of recalibrating local government operations and how they can become foundational pieces of climate solutions.

Principles of Design	Explanation/Context
<p>5 Ecological Design Principles: Van der Ryn & Cowan 1996</p> <ol style="list-style-type: none"> 1. Solutions Grow From Place 2. Ecological Accounting Informs Design 3. Design With Nature 4. Everyone is a Designer 5. Make Nature Visible 	<p>This 1996 publication lays the foundation of contemporary studies of biomimicry in planning theory. Advancing through five series, the text focuses on building a “sustainable world” through localized design that is inspired by natural systems and an intimate understanding of the surrounding environments. Linearity is favored second to circular or systems designs that build on reciprocity (Van der Ryn, 2007).</p>
<p>The Hannover Principles: William McDonough Architects and Dr. Michael Braungart</p> <ol style="list-style-type: none"> 1. Insist on rights of humanity and nature to co-exist 2. Recognize interdependence 3. Respect relationships between spirit and matter 4. Accept responsibility for the consequences of design 5. Create safe objects of long-term value 6. Eliminate the concept of waste 7. Rely on natural energy flows 8. Understand the limitations of design 9. Seek constant improvement by the sharing of knowledge 	<p>The Hannover Principles are a set of 9 flexible principles that aim to structure design around an interconnectedness with nature, rather than an independence from it. Principles range from centering of human experiences to acknowledgement and responsibility for design decisions to waste and pollution reduction and a variety of others. Use of the principles by government practitioners and city planners necessitates local community input and whole-systems thinking, making these principles of particular relevance to the Nexus (McDonough, n.d.).</p>

<p>Checks and Balances: C.A. Brebbia, S. Hernandez, and E. Tiezzi</p> <ul style="list-style-type: none"> • A variety of tools are essential for urban sustainability • Systems are interconnected • Communities have unique needs 	<p>Checks and balances at integral steps between the inputs and outputs of a system, could accelerate the rate of change. Understanding limitations through holistic comprehension of natural systems, is useful “balances” an anthropogenic system. Innovative strategies that learn from nature are imperative in solving problems in contemporary cities with high levels of complexity. Existing research emphasizes the importance of knowing the connections between subjects and understanding why/how they have been shaped, this way adaptation can effectively target the whole system (Brebbia et al. (Eds.), 2010).</p>
<p>Circular Systems: C.A. Brebbia, S. Hernandez, and E. Tiezzi</p> <ul style="list-style-type: none"> • Recycling and reevaluating progresses social and environmental justice • Development requires reduced resource extraction 	<p>Circular systems are generally about inputs, outputs and feedback loops that represent the transition process from input to output. Therefore, the inputs and outputs of a system sustain the system. That independence, or, a system that “feeds” itself may be applied to adaptation policy, and the smaller feedback loops could act to enforce racial equity. This general principle may aid in shifting existing power structures in unique local communities (Brebbia et al. (Eds.), 2010).</p>
<p>Categorizing design: A. Gamage and R. Hyde</p> <ul style="list-style-type: none"> • Design by understanding natural processes and form in the environment 	<p>Integration of ecological sustainability through biomimicry to architectural design builds out sustainable development theories. The ecological model, when applied, suggests direct and indirect application of biomimetics in anthropogenic development. Direct application refers to the use of ecological theories to specific communities and entities, and is relevant at the micro scale. Indirect application refers to applying the biological concepts more widely, for a greater community. When used strategically, appropriately categorized design not only helps to understand the form of natural systems, but also helps sustainable development processes and programs (Gamage, A.,& Hyde, R., 2012).</p>
<p>4 types of Biomimetic Transition Systems</p> <ol style="list-style-type: none"> 1. Bio- TRIZ (BFT or BT): methodology to solve technology and environment discrepancies 	<p>Biomimetic transition systems, as described by Gamage and Hyde here, are various systems and functions that learn from nature in order to aid societies transitions to reduced extraction of natural</p>

<ol style="list-style-type: none"> 2. Design Spiral (DS): identify, translate, observe, abstract, apply, evaluate 3. Typological Analysis (TA): breaks down into organism, behavior and ecosystem, and then each of these is broken down into: form, material construction, process and function to find which aspects of design to be "mimicked." 4. Nature Studies Analysis (NSA): looks at adaptation to understand reasoning behind form and function. 	<p>resources. BioTriz is a mechanism that identifies disparities between biological and technological systems, and uses eco-innovation to innovate solutions. Biodesign spiral highlights key elements of ecologically-cognizant design strategies that can be particularly useful in urban planning. Typological analysis builds further on the biodesign spiral to reveal the various stages and functions of natural systems or organisms to learn from in anthropogenic development and sustainable growth. Nature studies analysis comprehends not only the systems-wide operations of ecological communities, but also the form of individual actors in those communities. This is uniquely applicable to holistic architectural design (Gamage, A., & Hyde, R., 2011).</p>
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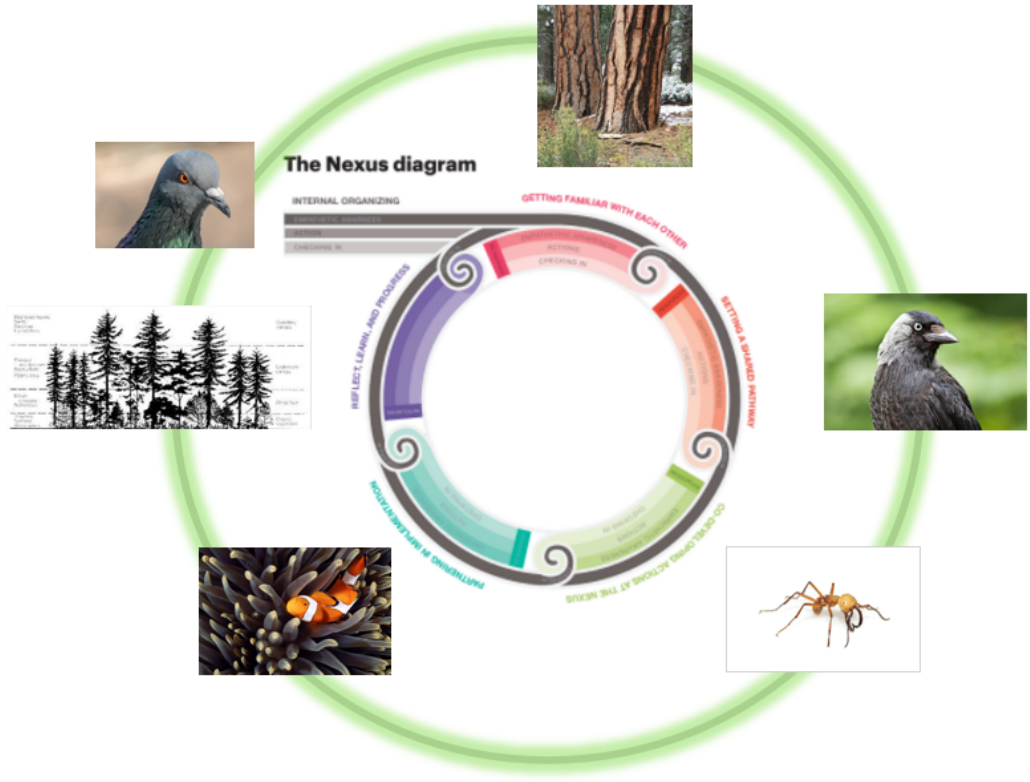
Table 2. Key Principles to Action

Ensuring that the developed guidance is poised to bolster existing USDN work requires identifying a number of foundational principles. Collectively, the following principles represent the fundamentals recommended for practitioners to follow to successfully incorporate elements of biomimicry into local government planning.

Action	Explanation
<p>Respect for Nature: R.B. MacKinnon, J. Oomen, & M.P. Zari</p> <ul style="list-style-type: none"> ● Biomimicry realizes its full potential when accompanied by respectful engagement with nature ● Reliance on a “bio-inclusive ethic” ● Insists that living things have a right to exist not because of their potential value to humanity but simply because they do exist 	<p>Along with systematic policy change, there is a need to incorporate respect for nature into the human mindset, and that humans must integrate and align their lifestyles into the natural world (MacKinnon et al., 2020). One paper suggested doing this by using system design that aligned with different human desires, like the desire to belong, or network (Waddock, S., & Kuenkel, P., 2019). This could be a way to foster co-benefits (multifunctionality) and promote new pathways to promote engagement (Gamage, A., & Hyde, R., 2012).</p>
<p>Ask the Right Questions When Planning: S. Waddock & P. Kuenkel</p> <ul style="list-style-type: none"> ● Determining what “gives life” to systems and how readily they allow for inputs and outputs 	<p>A strong sense of knowing what questions to ask during the planning process precedes the construction of a sturdy foundation for the process as a whole. A key component of this lies in recognizing the role of dynamic change</p>

<ul style="list-style-type: none"> ● Finding solutions that prioritize intentional generativity, the urge of living systems to continue into the future ● Identifying points of connection and possible disconnects that better allow living systems to thrive 	<p>and how living things interact with one another, thus forming the basis for life’s patterns. In doing so, practitioners can attempt to mimic the “vitality of socio-ecological systems” and initiate transformative change on the sustainability front (Waddock, S., & Kuenkel, P., 2019).</p>
<p>Designing Signals: Signals are mechanisms that can trigger positive and negative feedback loops within a broader system that work to keep the system in an equilibrium or steady state.</p>	<p>Signals are processes that can be set by a planning group using metrics that address community needs or targeted issues. For example, boundaries could be set for specific issues, beyond which a certain feedback loop would be triggered to bring the system into a steady state.</p>
<p>Walk the Talk: Reduction of the colonial, nature-culture dichotomy, aids sustainable and just anthropogenic development. Appreciation, respect, and involvement for and with natural spaces begins with accessible and equitable access to these spaces. Walk the talk helps get community members, including but not limited to, government practitioners involved in ecological environments to learn with.</p>	<p>Direct and immediate involvement in natural ecosystems grows respect and interest in ecological environments. Incorporation with natural spaces not only grows respect and interest in these areas, but it also helps to identify common natural themes that are conceptually presented in biomimetic and ecological design planning theory. Accessible and equitable access to the environment is central to ensuring that key decisions incorporate concerns and needs of all members of a community, and are not reliant on furthering racial capitalism and mass extraction of natural resources. Disruption, recovery, and power shifting, as modeled in Table 3, provide further examples of this accessible and equitable access.</p>
<p>Visualize the System: Use of experiences that may be common within a group helps build connection with the environment, even from an introductory level. Setting a shared pathway, module 3, is particularly bolstered by shared visualization of systems.</p>	<p>Relate community ideas to a natural system, such as a forest system or tree canopy to help decision makers see themselves within nature, and understand why biological systems are efficient.</p>

Figure 4. Ecological champions that could represent processes within each stage of the Nexus (Dinchev, 2022; Ponderosa Pine Lassen National Forest, California, 2017; Marshall, n.d.; Campbell, 2021; Hall, 2019; USDA Forest Service PNW Region, 1985).



The Nexus process contains six stages that guide planning groups through (1) internal organizing, (2) getting familiar with the historical and social context of the community, (3) setting a shared pathway and goals, (4) co-developing actions at the Nexus of racial justice and climate resilience, (5) partnering in implementation and shifting power to the community, and (6) reflection, learning, and progress. Encompassing this process is respect for nature and the idea that nature’s regenerative, restorative and self-sustaining processes can be used to reconstruct historically inequitable governance systems affecting communities.

Table 3. Biomimicry in the Nexus Process (Urban Sustainability Directors Network, 2021)

The following table reads as an exercise in choosing ecological champions for each of the six Nexus stages. Additionally, it explains the process behind each stage and highlights the roles of awareness and shifting power in each. This table is a key component of the present research, exemplifying how biomimicry can be readily applied to the Nexus guidance that has already been developed and providing usable information that practitioners can look to when taking an approach that seeks to have respect for nature built in at its core.

Stage 1 *Internal Organizing*

Process: The initial stage of the Nexus mandates that every member of a community, practitioner teams, and the larger local government involved in the process must be committed to internal organizing and be prepared to return to this stage time and time again. Emphasis should be placed on ensuring that all parties involved have the shared analysis and skills necessary to succeed in the Nexus process, including an understanding of how power has been misused for centuries and a willingness to shift away from a typical planning approach.

Awareness: The “awareness” piece of the *Internal Organizing* puzzle comes about in regard to how involved parties understand the power dynamics in their situation. A core tenet of this stage revolves around being able to recognize the various inequitable power structures that are so pervasive in government work and working to dismantle them. At the root of this awareness is a foundation of communication and knowledge-sharing among the group. An awareness at large translates into teams being able to shift to a focus that centers racial equity at its core.

Ecological Champions:

- Move like a homing pigeon, and be prepared to come back to certain stages of the Nexus process time and time again. Homing pigeons have the ability to return home after prolonged absences and can retain knowledge related to the beginning of a process (Sasaki & Biro, 2017). This ability also suggests a reliance on cyclical processes and a preference for returning to a point of origin, a key part of this first stage.
- Mycorrhizal fungi networks mirror the awareness component of the first stage of the Nexus. These networks are able to thrive on the basis of resource- (“knowledge”) sharing and connection along different parts of the chain. The positive attributes showcase the importance of prioritizing communication and awareness among the group and creating different pathways for knowledge to be the foundational basis of a critical system.
- Biological self-assembly, such as that of a spider constructing its web, ties into the shifting of power components in this first stage, exemplified in building a strong foundation before being able to move onto later stages of the process.

	<p>Shifting Power: Shifting power can come about in this stage after a thorough amount of time spent dedicated to process and awareness, especially in the first stage. Although this stage is early on in the Nexus process, it is important to continue to recognize the importance of building a strong foundation. If that is valued throughout the process, there will be a greater likelihood of achieving a true power shift in the later stages as well. By working incrementally, one step at a time, it is less likely to skip any steps in an attempt to arrive at a conclusion in a shortened time frame. Only after the necessary steps have been taken can a mission continue to advance. However, this process does leave room for modifying pieces of the puzzle as they are in progress—reiterating the key aspect of Stage 1 of continuing to check in and referring back to internal organizing.</p>
<p><i>Stage 2 Getting Familiar with Each Other</i></p>	<p>Process: This stage is focused on creating meaningful and transparent relationships by listening, building trust and understanding the historical dynamics between the community and local government. Specifically, it is focused on recognizing the power dynamics between BIPOC, working class and frontline communities and the local government. This process is focused on creating a shared vision, which also includes awareness of areas of possibility and sources of limitation in working with partners and local government. It also involves sharing knowledge and transparency with the community on the processes of governance that affect planning and with the government on community needs. Setting groundwork includes coalition building and identifying roles and opportunities for community members and partners to create change independent of local government, as well as ensuring access to training and compensation for the work. This work serves to create a structure to have clear visions/plans, make decisions, bridge gaps, and assess progress to ensure equity goals can be achieved. This includes conducting a power analysis, listening sessions, and placing community members on the hiring committee and in other positions of power in the process.</p> <p>Awareness:</p> <ul style="list-style-type: none"> • Nature Studies Analysis design tool (Table 1) can direct communities to analyze how the form and function of local systems have been affected by, or adapted to, major barriers. Alternatively, planning can analyze the ways in which local systems have

adapted, and the effect on the form and function of the community in order to identify specific root causes. This can help direct discussions between local government and community leaders on historical racism and community needs. It can also help highlight where governance practices have gone right and wrong.

- Using resources efficiently by establishing inventory of existing structures or resources available locally and prioritizing them in planning. For example, in addressing food security, the focus could be on empowering local food banks, farms and businesses. This also promotes ideas of a circular economy, where funding is invested back into the local community equitably (Biomimicry 3.8, n.d.).
- Within this stage, planning teams could look to incorporate a specific set of mechanisms that “signal” the systematic “limit”. This limit could be set by community needs. This incorporates the idea of checks and balances and alternative pathways to restore equilibrium. During discussions of historical injustice, communities should note which mechanisms could act as “signals,” and how these signals can be used to restore power balances. For example, “when electricity bills go over x limit, a y amount of resources should be given to assist with energy retrofits.”
- Many times, government focus is narrowed from a large agenda due to funding (among other factors), but nature shows us that true resilience lies in diversity. Rather than ranking issues by hierarchy, planners could approach planning by visualizing the interconnections between issues important to the community and move through implementation more efficiently. This could look like identifying co-benefits, sharing of resources between projects, or allocating funding in a way that focuses on the *spread* of impact in addition to the height of impact.

Ecological Champions:

- Think like a seed, which uses hormonal signals to begin the process of germination. These signals respond to environmental triggers that convey the optimal conditions for growth. The types of optimal conditions depend on the needs of the seed.

	<p>Groups can think about each category in the table as a seed. Then they can break down what environment that “seed” thrives in and doesn’t thrive in and identify what nurtures and doesn’t nurture the seed and what types of “signals” demonstrate that. The answers will likely be different based on the perspectives of parties involved (Daley, 2017).</p> <ul style="list-style-type: none"> ● The <u>muzzle of a giraffe</u> has evolved to be narrow, which enables it to get through branches. Thinking about what aspects have improved equity in the past can help guide future success. Likewise, unhealthy practices in the past can be highlighted by analyzing where the form and function of old practices has been unhelpful (Pacey, 2020). ● <u>Birds</u> often make nests from nearby twigs, leaves and branches (MacKinnon, 2021). ● In nature <u>mutualistic relationships</u> work harmoniously because they provide spaces for the needs of each organism. Although this is a dependent relationship, nature emphasizes the power of that relationship being mutual. Identifying mutualistic relationships between areas of importance could reduce spending and improve time efficiently as well. Additionally, mutualistic relationships between community groups could help local governments shift their practices to nurture that relationship. <p>Shifting Power:</p> <ul style="list-style-type: none"> ● The power shift in this stage starts by identifying where power is concentrated and where it is not/ has not been present. ● The recentering of focus on interconnections rather than a hierarchy between issues could help re-establish priority of local government. ● The bond between community partners and local leaders can help feed and empower the local community by making use of local resources efficiently. This coordination and community planning will place decisions in the hands of local leaders and potentially increase collaboration with local government.
<p>Stage 3: <i>Setting a Shared Pathway</i></p>	<p>Process: Stage 3 builds on points referenced in prior modules. <i>Setting a Shared Pathway</i> focuses on the <i>why</i> and <i>how</i> of work in the hopes of generating common goals in</p>

the workplace. These goals are centered around the acknowledgment and critique of White Supremacy in existing government practices and structural programs. Goals also highlight the institutionalized ways in which White Supremacist ideologies and pedagogies continue to drive our influential governing systems. By shifting towards collaborative planning efforts between government institutions and community organizations, Module 3 offers an alternative to the extractive and dominating systems that presently contribute to negative local, national, and global climate change implications. Furthermore, Module 3 is a step away from top-down approaches that insist on federally-driven government programming. In order to achieve goals of *Setting a Shared Pathway*, organizations must be internally knowledgeable about the ways in which power operates within their own systems, as well as familiar with or understanding of their inter and intra organizational peers. These aims are addressed in modules 1 and 2.

Awareness: Nature-respected solutions to GHG mitigation and adaptation to climate driven risks help to build community resilience. To set a shared pathway in local government processes and programs, centering those plans around an intrinsic respect for nature and a commitment to racial equity can help to achieve shared aims. Awareness (knowledge or perception of a situation or fact) in the Nexus, and in this module, helps to identify solutions that are grounded in principles of generosity, reciprocity, and equity. Biomimetic solutions such as these are accessible, hopeful, and restorative. Applying these principles to setting a shared pathway in policy making and organizational thinking helps shift existing power dynamics that necessitate racial capitalism. Therein, racial equity is achievable and a holistic approach to climate resilience and adaptation is possible. Without this approach, impassable faltering in plans will continue to hinder meaningful progress.

Ecological Champions:

- There are many opportunities in setting a shared pathway for reaching shared goals, including jackdaws' highly social behavior and inter-group communication. Jackdaws are birds that are strongly influenced by their environment and rely on partnership and neighbors instinctually for species sustenance. In this module, pathways are determined based on significantly modifying the

	<p>existing environment, based on the needs of the group. In this case, the group may be considered our shared global community.</p> <ul style="list-style-type: none"> ● It is essential to communicate with all members, coordinate plans, and react according to shared goals. <u>Ocean currents</u>, among many other ecological systems, rely on re-circulation of key nutrients, for example, to sustain many basic functions. Mimicking this kind of systems-level operation in setting a shared pathway for governments can help to fill the gaps between seemingly disparate areas of concern. Ocean currents highlight the reality that few systems are ever truly independent, and that without acknowledgment and cohesion with this reality, systems will ultimately fail. <p>Shifting Power:</p> <ul style="list-style-type: none"> ● The structure of <i>Setting a Shared Pathway</i> is such that power structures must be addressed and complicated. Acknowledgement of the existing structures of power that govern decision making processes and outcomes is made in order to critique said structures. ● To set a comprehensive plan that accounts for perspectives from various members of the community, learning from existing power structures and dynamics is needed. Advancing from those structures which disproportionately harm historically marginalized and otherwise vulnerable groups to climate hazards is grounded in shifting power through racial equity awareness and implementation of biomimetic practices. To shift power, at stage 3, work through previous stages and continue to build on lessons learned. Continued reflection and revision is part of the process.
<p>Stage 4: <i>Co-developing Actions at the Nexus</i></p>	<p>Process: This stage takes the shared goals, priorities and plans developed in the first 3 stages and co-develops actions that are targeted and centered on empowering the community and addressing community needs, while also increasing climate resilience. This involves ensuring that the members and partners have the capacity to act as collaborators and planners alongside local government. It also means anticipating roadblocks and questions and continuing to build relationships that are supportive for the community. Importantly, this stage is focused on making</p>

direct shifts away from traditional mechanisms of decision making within local government and makes space for collaboration with the community. Building capacity to shift power includes building wider networks of support within local government for community leadership. This includes greater commitment and endorsement from departments and decision makers to include community leaders, assesses areas needing improvement and works with community partners to broaden community impact against constraints. This stage also includes identifying the equity implications of alternatives, identifying short- and long-term actions needed and installing measures of accountability within the team to maintain awareness of the historical context of the work. This work emphasizes strategic collaboration and respect-based, holistic, bottom-up decision making that is centered on racial equity and works to shift power in the hands of the community, emphasizing human needs, health and climate resilience.

Awareness: This stage is about making direct shifts of power and cementing those shifts in the future with transparency and empathy, keeping on track with the shared vision created in the earlier three stages. But what does Power mean in this stage? Among other things, power can be thought to focus on three concepts: autonomy, opportunity and support.

Autonomy

- Community has a role in decision making.
- Structures for collaboration are established in the long run.
- Access to pipelines of support and resources is in the community's hands, empowering local communities and businesses.
- Community partners and members have established a bond independent of local government.
- Access to accurate information on possibilities and constraints in real time. Structures have been set up to provide transparency to community leaders.
- Community leaders have a broader political backing in their participation in decision making.

Opportunity

- Equitable compensation is provided to community leaders and members to allow continued participation in the long term.

- Rules and positions have been established for community leaders, and they are integrated in the decision making process.

Support

- A border network of support has been established between community and local government
- Relationships with community partners are productive and supportive
- A respect-based process is established between all parties that acknowledges the historical context of racial inequality throughout the planning and implementation stages
- The process is centered on racial equity and human needs targeted toward the identity of the community.

Ecological Champions:

- Symbiotic relationships between animals like Clownfish and sea anemone demonstrate the equitable and supportive roles between internal and peripheral actors (Bailey, 2019).
- Army ants follow a “golden seven-rule set” which involve positive and negative feedback loops that can guide ants in making decisions. Importantly the guidelines should be comprehensive, but simple to understand (Fewell, 2015).
- In temperate forest succession after a disturbance, nitrogen-fixing plants like lupine thrive in a niche within the ecosystem that is vital to the creation of a new forest. These plants establish nitrogen in the soil to support a more diverse community of plants. These niches demonstrate that the roles and diversity within these stages of succession are catered to benefit the community as a whole, despite disturbances, and do not ignore them. Recognition of the disturbance is critical in every step toward long term growth, as it reveals opportunities for growth.

Shifting Power:

- Provides community leaders more stability and security in their hand in decision making.
- Ensures the community is informed.
- Formal recognition of history and racial inequity, specifically within local governance creates drive to move forward towards racial equity and community centered decision making.

	<ul style="list-style-type: none"> ● Sets precedent of community centered decision making as a long-term solution.
<p>Stage 5: <i>Partnering in Implementation</i></p>	<p>Process: The key to this stage is continuing to build on the progress cultivated in the previous four stages, arriving at a place in which BIPOC and frontline community leaders share power equitably with local government practitioners. Further, this stage exemplifies collaborative implementation: bringing to fruition the necessary changes to funding, team structuring, and visions and goals. At this stage in the process, practitioners should be acutely aware of the challenges associated with restructuring power dynamics and what strategies are most effective in their communities. This implementation stage will continue to bring partners closer to realizing a more just and equitable power framework, as the stages before it have progressively worked to accomplish.</p> <p>Awareness: The awareness component of Stage 5 comes about both as a continuation of prioritizing the shifting of power dynamics and as a reassessment of the strategies needed for each implementation partner to be most effective. Playing to the strength of each individual in a given community is key. Doing so points not only to a sense of strong collaboration among the group but also a willingness to find and maintain individual niches. In finding the most effective roles for team members and continuing to check in with one another regarding how well the group is functioning, community leaders and government practitioners alike stand a better chance of accomplishing enduring success.</p> <p>Ecological Champions:</p> <ul style="list-style-type: none"> ● Partnering in implementation suggests a mutual collaboration between parties, much like a <u>mutualistic partnership</u> between organisms. In this instance, consider the relationship between clownfish and sea anemones. This interaction demonstrates an absence of competition that allows both parties to enjoy benefits: the clownfish has a stable home that cannot be infiltrated by other fish, and the clownfish protects the anemone from its other natural predators. The success of the clownfish does not in any way diminish the success of the anemone, and vice versa. The collaboration between the two ultimately strengthens both and allows them to focus on various other pressing matters. The same could be true of BIPOC and

	<p>frontline community leaders when working in collaboration with local government practitioners—the more focus there is on work that can be mutually beneficial, the greater potential for sustainable success, and more of it.</p> <ul style="list-style-type: none"> ● <u>Honey bees</u> are an often-cited example of collaboration rooted in awareness. In the hive, bees must delegate a whole host of roles, including queen, drone, worker, cleaner, undertaker, nurse, builder, temperature-controller, guard, and forager (Hertzberg, 2019). Each of these roles is interdependent on one another in order for the hive to survive. By doing these roles well and ensuring that the needs of the hive are met consistently, the colony can continue. ● <u>Altruistic behaviors in certain animal species</u>, such as dolphins, point to a natural phenomenon in which the creatures sacrifice their own well-being to help one of their own, a value that likely has to take hold in government structures for racial equity to see the greatest level of parity. Dolphins have at times been recorded as exhibiting reciprocal altruism (Connor & Norris, 1982), such as through caregiving, in order to protect a member of their pack. By demonstrating a willingness to uplift other members of their species with no apparent immediate benefit to the individual, these dolphins show the importance of prioritizing group success over individual success. Additionally, this phenomenon suggests that providing assistance in times of need and uplifting members of the pack to be on equal footing is a preferred method of group management. <p>Shifting Power: Shifting power in this stage can be achieved through a number of outlets, including putting community partners in formal positions of power, prioritizing implementation and funding in BIPOC and frontline communities, and highlighting transparency, accountability, and recognition, among others. Doing so contributes to fundamentally changing the narrative around what climate planning and solutions can look like, bridging the gap between where planning is coming from and where it is headed.</p>
<p>Stage 6: <i>Reflect, Learn and Progress</i></p>	<p>Process: Stage 6 bolsters learnings from each module. Herein, the relevance of systems-wide interconnection is</p>

	<p>demonstrated. Collaborative work on identifying need, project development, implementation, and affecting change is helped by continual reflection and flexibility in management and development practices. Module 6 learns from the successes and failures of process and outcomes in order to continue progress towards sustainable climate outcomes through reevaluation. Additional lessons are exposed in this module due to the critical reflection that is central. Working with community members allows for identification of wins in plans and continual improvement within an always-connected system. Respect for a circular and regenerative economy is crucial here, as reflecting to learn and advance can only happen within a broader systems context. Learning from nature is a useful tactic for moving forward sustainably. Natural systems continually demonstrate reflective action based on environmental conditions and community needs. Highlighting these lessons is applicable to human systems that are hindered by extraction-dominant culture which is not in accordance with the biological systems that govern ecosystems. Module 6 reinforces the importance of racial equity in all levels of government processes and programming. Without achieving racial equity, holistic systems development is not possible. The subjugation of certain groups based on a socially constructed concept such as race reinforces a nature-culture dichotomy that separates humans from ecological ecosystems. This kind of separation perpetuates and necessitates damaging the Earth for unrestricted capital growth and consumption. Being reflective of iterative processes of climate solutions development with the goal of learning more and progressing better, starts with recognizing the significance of racial equity and working towards achieving continual justice. To reflect, learn, and progress is to identify lessons from a community perspective and determine the successes and failures of development strategies and be flexible in generating changes to move forward sustainably.</p> <p>Awareness:</p> <ul style="list-style-type: none">● Biomimicry or ecosystem services can, and must, be incorporated into this module through use of the following strategies. At the reflection stage, first consider the input of all community members. Garnering a sense of community experience, perception, and outcomes from a variety of inputs is an essential first step in meaningful reflection. We notice this kind of temperature check in natural
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systems ranging from migratory populations to forest understory. Being cognizant of the needs and experiences of the broader community allows the greater economy and ecosystem of the group to learn from existing strategies through reflection.

- Reflection also highlights the susceptibility and risk of environmental hazard on native communities. Taking the lessons learned and adapting to changing conditions with the needs of all community members at the forefront generates substantial progress. Progress is also sustainable given the genuine commitment to learning from all community members in the reflective stage. Module 6 is an opportunity for learning and self-evaluation. Highlighting collaborative efforts within this stage further supports continued improvement and progress towards shared goals set earlier on. Identifying how and why this stage was achieved can be an impetus for self assessment and learning through collaboration of government and community partners, including acknowledgment of intersecting identities.

Ecological Champions:

- Migratory animals (Berdahl et al., 2016) demonstrate behaviors relevant to Module 6. Because community participation is an essential consideration to Reflect, Learn and Progress, learnings from migratory animals are particularly relevant. Collective behavior in migratory species have varying impacts. One useful takeaway, however, is that the behavior itself is common across a variety of species. Rather than adopt hyper-individualistic patterns of behavior, migratory species tend to coordinate with one another and act as a group. These behaviors are not only typical of the populations, but are also, in many cases, necessary for species reproduction.
- Similarly, forest understories (Rooney et al., 2004) help to explicate the importance of diversity in ecosystems, human or otherwise. Module 6 is about working together with the community and monitoring success. Gathering diversity of perspective in earlier stages allows for meaningful reflection and progression at stage six. It is also an opportunity to identify when and where diversity began to fall off, if at all, and rectify that metric. In

	<p>a forest understory, keystone species, and others, can be used as measures of success. The presence, or lack thereof, of diversity in understory communities nearly always signifies a deeper issue with the broader ecological context. Reflection on changing conditions can help human and nonhuman partners learn from changing conditions and progress forward to recover important diversity.</p> <p>Shifting Power:</p> <ul style="list-style-type: none"> ● Module 6 builds upon the former stages of the Nexus that identify deeper connections and opportunities for holistic climate action. Shifting power at this stage begins with critical reflection. ● Identifying areas of oversights, eliciting additional perspectives, and considering new factors that may be in flux, are important steps in reflecting on completed areas of work. ● Reflecting for critique is the first step in learning from reflections. Learning helps to shift power because it grows from addressing historic and contemporary realities of institutions and systems that structure power to be reciprocal in who controls power. In learning from these realities, progress can be made using the aforementioned and other ecological champions and biomimetic strategies for processes and programs.
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Biomimicry within the Nexus Content and Action

As stated above, the Nexus is a multi-stage adaptable series of pathways that support local governments in recognizing their bias, implicit biases, and the true history of racism in the United States. It provides ways to not only recognize inequitable power distribution, but also actions to shift power to communities and community partners at every stage of a project, plan or policy. The Nexus centers racial equity and then builds in opportunities to work at the intersection of climate resilience and greenhouse gas (GHG) mitigation. The content of the Nexus planning work is centered around human needs and ties to equity, resilience and shifting power. Our project adds an ecological component to this planning that ties actions to nature. This project analyzed biomimicry in the context of the Nexus process (Table 3) to highlight ecological “champions” and processes that could be used to bring more awareness to opportunities within the planning process that learn from nature, and the potential to shift power within each stage. In the three introductory stages, internal organizing, getting familiar with each other, and setting a shared pathway, research and development teams focus on building cohesive and meaningful relationships both with each other and with community partners. These three stages are an integral starting point in order to advance holistically, considering the wants, needs, and cultural relevancy of anticipated projects. Moving forward to stage 4, actions at the Nexus, process

planning groups formulate actions that are targeted towards the context and needs of the community, before moving into the implementation and reflection in stages 5 and 6.

Actions are centered on human needs, which are outlined in [Table 5](#) (see: Appendix B). The actions are related to health and wellbeing, leadership and economy, buildings and infrastructure, and land and natural systems. They further relate back to one another and are similarly connected to the cyclical process of the Nexus. Each category corresponds to aspects of achieving climate justice through use of essential principles such as racial equity and life's six principles (Biomimicry 3.8). Moving through each category, actions are summarized based on existing circumstances, a projected disruption, and recovery from disruption. They are sorted further to determine how power shows up and where it can be shifted within the relevant sector. Accompanying each sector are also ecological considerations that include examples of biomimetic solutions to some of the associated challenges.

For example, clean water as a human centered experience has many environmental justice implications. These categories help in thinking through solutions to environmental justice considerations by identifying areas in which relevant actions for holistic and equitable climate action can be taken. To achieve equity, everyone should have access to clean water. Currently, public facilities, private homes, and water infrastructure needs to be improved. A disruption to achieve equity would be providing locations for people to access clean water including bottled water distribution, water filtration at community sites, and treatment tablets. In recovery, potable water would continue to be provided, while new criteria for water reuse and water filtration in buildings was developed and implemented. These are the steps to building an equitable and resilient community with access to clean water. Further considerations for GHG mitigation, power considerations, and a biomimetic component for clean water are also laid out with examples in Table 5.

Table 5 is a go-to resource for providing helpful insight into how to move through the stages. The Nexus suggests various stages, and actions determined in stage 4, and demonstrated in Table 5, can be applied, as appropriate, as practitioners and partners work through each stage. The actions rely on foundational principles of racial equity and justice, and biomimicry, especially mutual respect between peoples and environments. Engagement with critical environmental justice, climate resilience, and biomimicry literature inform suggested actions and are bolstered by contributions from practitioners and community partners in the space. Table 5, is primarily informational, leaving flexibility for the unique considerations that each community has.

Table 4. Keyword Summary Table for Actions at the Nexus Mapping

Human Centered Experience	<i>Equity - who is impacted</i>	<i>Resilience - ability to adapt</i>	<i>GHG Mitigation - pollution reduction</i>	<i>Power Connections - who is in control</i>	<i>Ecological Component - where can we learn</i>
Health & Well-Being	Access to clean and healthy resources, influence	Anticipate, accommodate & adapt	Access & prevention/ mitigation	Support & sense of belonging	Mangroves
Leadership & Economy	Opportunity & Resources	Prioritize vulnerable communities & Facilitated training/ pipelines	Prioritize by burden, provide education & training	Equitable resource allocation & representative leadership	Lion pride
Buildings	Affordable, safe, relationship building	Advance, protect, healthy	Efficiency, Finance, Retrofits, Codes, Assessments	Unity with natural ecosystem	Beehive design
Infrastructure	Access/ stability, conservation/ management, affordable	Stability	Reduce, Alternate technology, Enhance	Multiple co-benefits & integrated	Ocean currents
Land & Natural Systems	Access, resource management	Green space, green infrastructure	Reduction, conservation, incentives	Reduced extraction and pollution, respect	Wildfire regeneration

Below are selected examples of how communities could learn from nature to formulate specific actions. Further exploration of examples can be found in Table 5, located in the Appendix.

Health and Well-Being

- Safety: Safety means that communities, including children and other vulnerable groups, are safe from bodily, social, or spiritual harm in all of their environments. Normally, federally sponsored pathway homes such as foster care and reintroduction spaces are

critically underfunded and not maintained. Those with socially vulnerable identities must make additional considerations for safety in daily activities, and cultural values and practices are disregarded or devalued in popular culture. In disruption mode, communities and residents are supported in positive adaptations to safety in the face of climate change. The use of nature-based design influences infrastructure and development, and cultural competency is highlighted in order to enhance quality of life (Maslow). As disruption transitions to recovery, societies move beyond anarchy to resilience and flexibility in adaptation. Biomimicry guides ecological design and planning theory in urban and nonurban settings. Inclusion from a place of genuine commitment sustains mutual respect, as power has shifted, between human and nonhuman environmental actors.

- Shelter: Reliable shelter is a critical component to any individual's livelihood. Challenges associated with a lack of readily available housing include difficulty maintaining employment, sleep inconsistencies, and a near-impossible opportunity to form a sense of community within a given place. These shelter components most often refer to permanent housing, but, in the face of a climate crisis, temporary and emergency shelter areas become necessities as well. Further, those who do not have sufficient access to housing are more immediately faced with environmental hazards and are less likely to have appropriate insurance measures in place. Looking at this challenge with a nature-centered eye, it bears mentioning that many organisms, such as snails, retain shelter possibilities wherever they are. Showcasing preparedness in this way suggests an avenue to prioritize mobile, easily accessible shelter in case of emergency/temporary housing necessities. An example of a solution in this vein that has explored this type of shelter includes a biomimicry-based system in which shelter structures are able to shape themselves, a feat of engineering created from one thin sheet of metal and able to be assembled in less than a minute (InHabitat, 2017).

Leadership and Economy

- Democracy: Similar to behavior observed in honeybees, increasing opportunities for collective decision making could empower local communities and better relations between local government and communities. The mechanism behind this approach could involve establishing smaller positive and negative feedback loops that are time efficient and encourage participation. For example, if energy bills in a community are greater than a set value, perhaps compared to a national average, plans could be set to subsidize retrofits or energy audits. To increase climate resilience and greenhouse gas mitigation efforts, collective decision making could mean more transparency and information sharing with the community on where energy comes from, what options are available for mitigation and any limitations.
- Community: Realizing the significance that community plays in making holistic and sustainable decisions begins with the centering of racial equity and the environment. Community development must happen with these core values in order to be sustained and relevant to changing needs and demands over time. Communities can mimic natural systems to build necessary flexibility that highlights the importance of equity in a community. For example, spider webs are strategically and carefully designed given the existing circumstances and anticipated needs of the spider. The web itself is flexible and

sticky, yet slick and nearly invisible. This malleable and flexible nature of the spider web provides an example of the importance of assessing need and responding with openness to achieve goals. Community preparedness and resilience assessments can benefit from this kind of example.

Buildings

- **Affordable Housing:** Natural ecosystems contain niches that can host specific groups of organisms. This includes resource access as well as shelter. Thus, affordable housing strategies could mean both the cost of the housing, as well as that affordability of living in that house or area, such as grocery prices or transportation costs, which heavily influences the affordability of housing (Keatts, 2016). Working with local governments, planning groups can work to increase transportation access to communities or lower the cost of transportation. Work can be done with community partners to conduct retrofits or audits that lower costs of living for occupants. Additionally, protections around the affordability of housing can be set to provide security for those who are renting or owning homes in higher demand neighborhoods. This could look like economic incentives for landlords to keep rents affordable for the community and prevent gentrification. Essentially, these strategies can help create a niche for the local community.
- **Safe Places:** Learning from nature informs and restates the importance of safe places. Basic cyclical processes of nutrient recycling that are common in soil ecosystems, ocean ecosystems, and others maintain the health and quality of the environment such that they cultivate a safe space for the organisms that are reliant on those places. Use and reuse of key nutrients provide safe spaces because they define sustainability. Circular systems are sustainable systems, and are mimicked even in the design of the Nexus. Safe places include healthy spaces, and also cultivate social infrastructure. People are able to build meaningful relationships and community cohesion because they are safe and stable. Healthy living conditions and places encourage safety.

Infrastructure

- **Clean Water:** Natural ecosystems filter water passively using several layers of permeable and semi permeable surfaces. The importance of passive filtration and a multi-layered approach could help inspire communities to analyze their water systems to be more efficient. A key aspect of this multi-layer approach is that each step of water filtration plays a useful role for the system, like how erosion of sediment creates landforms. Planning committees could identify the co-benefits at each step of the water “cycle” relevant to the community and utilize them to conserve potable water. For example, rainwater collection systems that water lawns and gardens.
- **Transportation:** Structural design is crucial to developing sustainable transportation that manages the inequities that are present in contemporary transportation systems. Innovative transportation strategies, such as incorporating spheres and domes into transit systems more broadly can be applied to reduce transportation inequities. Spheres are particularly useful to incorporate because they accommodate greater space. Birds and reptiles have rounded eggs not only to accommodate space for a growing body, but also

to withstand exposure to elements. Transportation systems can use similar principles to include space for alternative transit styles such as bikes and trains, and also be better suited infrastructurally to withstand infrastructure demands.

Land and Natural Systems

- **Urban Heat:** As climate changes grow more extreme, issues like urban heat islands increase the demand on land and resources to provide additional cooling. Many places have community cooling centers to provide crucial services to communities during heat waves. However, nature balances the needs of different plants, such as sunlight and water using several mechanisms we can draw inspiration from. One example is tree canopy or forest trophic levels. Taller trees provide shade for understory plants that need less sunlight. Multiple kinds of habitats are created with each canopy layer. This layered approach could assist in the design of buildings, as well as policy to reduce heat island effects by directing an approach where community prioritizes act as layers. Additionally, plants use several mechanisms to protect themselves from heat. Full-sun plants often have whiter colored leaves that reflect back more sunlight than those that are greener. Learning from nature can help construct climate adaption or urban design plans that reduce burden on natural systems, such as through less need for fossil fuels.
- **Resource Management:** Equity is an important component of resource management that can be addressed by learning from how natural systems support plant and animal species with resource flows. There are many aspects of these flows that can provide strategies to planners, but a key one of those is the idea of zero waste or circular systems. It is not simply that the resource is reused, recycled or remanufactured for other uses at several steps of the material flow, but also that systems are designed to be multi-purpose. This means co-benefits are not just discovered, but designed for. In a planning process, this could look like examining a particularly limited resource for the community, such as potable water, tracking its uses throughout the community boundary and outside of it, and finding pathways that reuse and recycle gray water where possible, use rainwater where possible, and re-direct flows more efficiently. The integrative planning groups involved in the Nexus planning process are already set up for this by bringing local government, affected communities and community partners to the same table.

5.2 Impact

The most significant impact of this work will likely be the crafted additions of biomimicry to local government processes through the USDN Nexus process. In providing further avenues for practitioners to explore how they can better center racial equity while cultivating and maintaining a respect for nature, there exists the potential for a larger network of public servants who are better equipped to handle social, economic, and environmental challenges in their respective communities.

5.3 Areas for Future Research

This project emphasizes the need for both the decolonization of city governance overall and the embedding of equity and adaptation within the fabric of governance structures across the

country. Further, it speaks to the broad goal of expanding the use of biomimicry as a means of using examples from nature to improve the human condition. We hope that the exploration of the intersection of these issues will contribute to more research into these expanding areas. Too, we hope that the “best practices” and “lessons learned” from local communities involved in restructuring processes such as these can be valuable additions to both practitioner-led and academic circles.

Future work could critically analyze how community planning groups, including local governments, resonate and interact with nature-inspired planning processes. This could mean qualitative research on how it supports planning efforts and comparative studies with conventional Nexus planning processes. These comparative studies could focus on several aspects of the process, such as timeframe, participation levels, implementation of plans and shifting power to the community after standardizing for funding levels, initial participation and other context-specific factors that could affect city progress.

5.4 Limitations

This project was limited in part due to unforeseen factors out of the immediate control of the research team. Research commenced in February of 2021, following the onset of the COVID-19 pandemic. For the US-based subject matter, complications due to the pandemic limited the scope of research that was possible for this project. Academic regulations, travel restrictions, safety, and ethical considerations of travel during the pandemic made interacting directly with local partners nonviable. Lack of direct interaction also contributed to reduced ability to discuss sensitive matters of interest with local governments and community members in typical interview formats. As we continue to learn and live with COVID-19, research will continue to expand on the present study and explore aforementioned and other areas for future research.

In addition to restrictions due to the COVID-19 pandemic, prolonged successful completion of the application for approved research by the University of Michigan’s Internal Review Board (IRB) further limited research opportunities for this project; justification for virtual interviews and comprehensive informed consent disclosures faced multiple iterations of review. The expedited process for both research and analysis, found in any master’s project, also played a role in limiting the attempted and final scope of the project.

Integration of various related literatures into the project proved complex. This is complicated across all disciplines of interdisciplinary research, but it required additional time on behalf of the project team to ensure that written aspects of the project maintained a solid flow and were easily communicable to various audiences. A secondary challenge on this front was that academic literature primarily comes from institutions that are grappling with their own colonial pedagogies (Held, 2019), limiting the perspectives from which the research team was able to draw on.

6. About the Team

Thea Louis is an MS candidate concentrating in Environmental Justice at the University of Michigan School for Environment and Sustainability. Louis obtained her Bachelor’s degree in Environmental Studies with a minor in Public Health from Wellesley College in 2020. Her

research interests surround the equity implications of climate change risk factors and how public policy can address those inequalities. This interest drives motivation for partnership with USDN. Looking ahead, Thea will continue working on advocacy efforts in environmental policy decision-making.

Kristen Buchler is an MS candidate at the University of Michigan School for Environment and Sustainability with a focus in behavior, education, and communication. Prior to her studies at UM, Buchler completed a bachelor's degree in English with a minor in environmental science at the University of Toledo, graduating in 2020. She is particularly interested in the use of environmental communication as a tool for action in addressing the many ecological crises the world faces.

Jyoti Bodas is an MS candidate in the School for Environment and Sustainability in the Environmental Policy and Planning, as well as Sustainable Systems track. She will also be completing a dual degree in Applied Economics. After completing her undergraduate degree in environmental science and resource management she hopes to promote large-scale systematic change in her work that ensures equity and furthers climate solutions. Specifically, she hopes to combine practical application and creativity to promote long term environmental sustainability, including new systems and norms. She is also very passionate about biomimicry and hopes to apply this lens to her future policy and analysis work.

7. Sources

American Society of Civil Engineers (2021, March 17). ASCE's 2021 American Infrastructure Report Card: GPA: C-. Retrieved April 21, 2021, from <https://infrastructurereportcard.org/>

AOS Treatment Solutions. (2018, July 23). Role of Microorganisms & Microbes Used in Wastewater Treatment. AOS Treatment Solutions. <https://aosts.com/role-microbes-microorganisms-used-wastewater-sewage-treatment/>

AskNature. (2020). Passive cooling system inspired by camels - innovation - asknature. Retrieved April 23, 2021, from <https://asknature.org/innovation/passive-cooling-system-inspired-by-camels/>

Bailey, R. (2019, July 10). When Both Benefit: Mutualism Explained. ThoughtCo. <https://www.thoughtco.com/mutualism-symbiotic-relationships-4109634>

Berdahl, A., van Leeuwen, A., Levin, S.A. *et al.* Collective behavior as a driver of critical transitions in migratory populations. *Mov Ecol* 4, 18 (2016). <https://doi.org/10.1186/s40462-016-0083-8>

Biomimicry 3.8. (n.d.). DesignLens: Life's Principles. Biomimicry 3.8. <https://biomimicry.net/the-buzz/resources/designlens-lifes-principles/>

Biomimicry Institute. (n.d.). *Biomimicry is a practice that learns from and mimics the strategies found in nature to solve human design challenges—and find hope.* <https://biomimicry.org/what-is-biomimicry/>

- Brebbia, C. A., Hernández, S., & Tiezzi, E. (Eds.). (2010). *The Sustainable City VI Urban Regeneration and Sustainability*.
https://books.google.com/books?hl=en&lr=&id=3jEDKS-xonsC&oi=fnd&pg=PA215&dq=biomimicry+in+policy&ots=f3oJbhmggV&sig=zbAYRWe3rOT6BWeu_G5cCs9Yy-0#v=onepage&q=biomimicry&f=false
- Brown, A. M. (2017). *Emergent strategy: Shaping change, changing worlds*. Chico, CA: AK Press.
- Bulkeley, H., Carmin, J., Castán Broto, V., Edwards, G. A., & Fuller, S. (2013). Climate justice and global cities: Mapping the emerging discourses. *Global Environmental Change*, 23(5), 914-925. doi:10.1016/j.gloenvcha.2013.05.010
- Campbell, P. K. (2021). Army Ant [Photograph].
<https://www.discovermagazine.com/planet-earth/how-army-ants-build-city-like-nests-using-their-own-bodies>
- Chisholm Hatfield, S., Marino, E., Whyte, K. P., Dello, K. D., & Mote, P. W. (2018). Indian time: Time, Seasonality, and Culture in Traditional Ecological Knowledge of Climate Change. *Ecological Processes*, 7(1). doi:10.1186/s13717-018-0136-6
- Cohen, S. (2017, October 23). The human and financial cost of pollution. Retrieved April 23, 2021, from
<https://news.climate.columbia.edu/2017/10/23/the-human-and-financial-cost-of-pollution/#:~:text=Last%20week%2C%20the%20Lancet%20Commission,The%20results%20are%20straightforward%3A&text=According%20to%20this%20Commission%2C%20the,%25%20of%20global%20economic%20output%E2%80%9D>
- Connor, R. C., & Norris, K. S. (1982). Are Dolphins Reciprocal Altruists? *The American Naturalist*, 119(3), 358–374. <http://www.jstor.org/stable/2460934>
- Council on Environmental Quality. (2022). *Climate and Economic Justice Screening Tool*. Screeningtool.geoplatform.gov. Retrieved April 28, 2022, from
<https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5>
- Daley, J. (2017, June 9). Seeds May Use Tiny “Brains” to Decide When to Germinate | Smart News| Smithsonian Magazine [Online Magazine]. Smithsonian Magazine.
<https://www.smithsonianmag.com/smart-news/seeds-use-tiny-brains-decide-when-germinate-180963625/>
- Davis, A. Y. (2005). *Abolition Democracy: Beyond Empire, Prisons, and Torture*. New York, NY: Seven Stories Press.
- Defosse, M. (2018, May 28). When birds inspire the shape of planes' wings – agora paris. Retrieved April 23, 2021, from
<https://www.agora.universite-paris-saclay.fr/birds-inspire-shape-planes-wings/>
- Delcourt, P.A. & Delcourt, H.R. (1992). Ecotone Dynamics in Space and Time. In: Hansen, A.J., di Castri, F. (eds) *Landscape Boundaries*. Ecological Studies, vol 92. Springer, New York, NY. https://doi.org/10.1007/978-1-4612-2804-2_2

- Dinchev, T. (2022). Homing Pigeon [Photograph].
<https://doi.org/10.1038/scientificamerican0322-14>
- Dodman, D., & Satterthwaite, D. (2009). Institutional Capacity, Climate Change Adaptation and the Urban Poor. *IDS Bulletin*, 39(4), 67-74. doi:10.1111/j.1759-5436.2008.tb00478.x
- Farnsworth, M. (2013, October 14). Biomimicry and Gentrification. Center for Humans and Nature. <https://humansandnature.org/biomimicry-gentrification/>
- Fehrenbacher, J. (2012, November 29). BIOMIMETIC architecture: Green building in ZIMBABWE modeled AFTER termite mounds. Retrieved April 23, 2021, from <https://inhabitat.com/building-modelled-on-termites-eastgate-centre-in-zimbabwe/>
- Fewell, J. H. (2015). Social Biomimicry: What do ants and bees tell us about organization in the natural world? *Journal of Bioeconomics*, 17(3), 207–216.
<https://doi.org/10.1007/s10818-015-9207-2>
- Fixico, D. (2012). Struggle for Pueblo Water Rights in the Southwest. In D. L. Fixico (Author), *The Invasion of Indian Country in the Twentieth Century American Capitalism and Tribal Natural Resources, Second Edition* (pp. 55-77). Boulder, CO: University Press of Colorado.
- Fontenelle Forest. (2019, July 17). What’s in a Wetland? : Fontenelle. Fontenelle Forest.
<https://fontenelleforest.org/whats-in-a-wetland/>
- Franks, N. R., Pratt, S. C., Mallon, E. B., Britton, N. F. & Sumpter, D. J. T. (2002). Information flow, opinion polling and collective intelligence in house-hunting social insects. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 357(1427), 1567–1583. <https://doi.org/10.1098/rstb.2002.1066>
- Gamage, A., & Hyde, R. (2012). A model based on Biomimicry to enhance ecologically sustainable design. *Architectural Science Review*, 55(3), 224–235.
<https://doi.org/10.1080/00038628.2012.709406>
- Gamage, A., & Hyde, R. (2011, November 16). Can Biomimicry, as an approach, enhance Ecologically Sustainable Design (ESD)? 45th Annual Conference of Architectural Science Association, Sydney, Australia.
- Georgetown Climate Center. (n.d.). *State adaptation progress tracker*.
<https://www.georgetownclimate.org/adaptation/plans.html>
- Global Change. (n.d.). *About USGCRP: Legal mandate*.
<https://www.globalchange.gov/about/legal-mandate>
- Hahs, R. (n.d.). Looking for Inspiration? Biomimicry Global Design Challenge: Climate Change [February 17, 2017]. Think Biomimicry. Retrieved April 10, 2022, from <https://www.thinkbiomimicry.com/tag/mycorrhizal-network/>
- Hall, D. (2019). Clownfish and anemone [Photograph].
<http://www.nationalgeographic.org/article/symbiosis-art-living-together/>
- Held, M. B. E. (2019). Decolonizing Research Paradigms in the Context of Settler Colonialism: An Unsettling, Mutual, and Collaborative Effort. *International Journal of Qualitative Methods*. <https://doi.org/10.1177/1609406918821574>

- Hertzberg, R. (2019, March 22). *Every bee in a hive has a job. Here's how they get them.*
<https://www.nationalgeographic.com/animals/article/honey-bee-job-queen-hive-animals>.
- Holbrook, C. T., Clark, R. M., Moore, D., Overson, R. P., Penick, C. A., & Smith, A. A. (2010). Social insects inspire human design. *Biology Letters*, 6(4), 431–433.
<https://doi.org/10.1098/rsbl.2010.0270>
- Hsu, A., Höhne, N., Kuramochi, T., Roelfsema, M., Weinfurter, A., Xie, Y., Lütkehermöller, K., Chan, S., Coffee-Morlot, J., Drost, P., Faria, P., Gardiner, A., Gordon, D.J., Hale, T., Hultman, N.E., Moorhead, J., Reuvers, S., Setzer, J., Singh, N., Weber, C., & Widerberg, O. (2019). A research roadmap for quantifying non-state and subnational climate mitigation action. *Nature Climate Change*, 9, 11–17.
<https://doi.org/10.1038/s41558-018-0338-z>
- InHabitat. (2017, February 16). *Self-shaping shelters that could revolutionize emergency housing.*
<https://inhabitat.com/self-assembling-shelters-that-could-revolutionize-emergency-housing/>
- IPCC. (2014). Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, 117-130.
- IPCC. (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.
- IPCC. (2022a). *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.
- IPCC. (2022b). *Climate change: A threat to human wellbeing and health of the planet.*
<https://www.ipcc.ch/report/ar6/wg2/resources/press/press-release/>
- IPCC. (n.d.). *Fact sheet–Biodiversity: Climate change impacts and risks.*
https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FactSheet_Biodiversity.pdf
- Jenkins, G. (2021, April 18). *Climate Justice: Current and Future Challenges*. Lecture presented at New Horizons Conference in CT, New Haven.
- Johns Hopkins Medicine. (n.d.). Hormones and the Endocrine System. Johns Hopkins Medicine.
<https://www.hopkinsmedicine.org/health/conditions-and-diseases/hormones-and-the-endocrine-system>.

- Johnson, C., Albrecht, G., Ketterings, Q., Beckman, J., & Stockin, K. (2005). Nitrogen Basics – The Nitrogen Cycle (Fact Sheet No. 2; Agronomy Fact Sheet Series, p. 2). Cornell University. <http://cceonondaga.org/resources/nitrogen-basics-the-nitrogen-cycle>
- Keatts, A. (2016, May 23). *Where Transportation Makes Affordable Housing Unaffordable* [Urban Edge Blog]. The Kinder Institute for Urban Research. <https://kinder.rice.edu/2016/05/23/where-transportation-makes-affordable-housing-unaffordable>
- Kent, A. (2016, April 19). Nitrogen Fertilizer, a Comparison—Peas & Hoppiness by Ann Kent. Peas & Hoppiness. <https://peasandhoppiness.com/musings/2016/2/22/nitrogen-finding-the-source-of-all-that-we-are>
- Ling, H., Mclvor, G.E., Westley, J. *et al.* Behavioural plasticity and the transition to order in jackdaw flocks. *Nat Commun* 10, 5174 (2019). <https://doi.org/10.1038/s41467-019-13281-4>
- Liu, P.R. & Raftery, A.E. (2021). Country-based rate of emissions reductions should increase by 80% beyond nationally determined contributions to meet the 2 °C target. *Communications Earth and Environment*, 2(29), 1-10. <https://www.nature.com/articles/s43247-021-00097-8.pdf>
- LiveScience Staff. (2013, November 30). In Photos: Animals That Mimic Plants. Livescience.Com. <https://www.livescience.com/41604-animals-that-mimic-plants-photos.html>
- MacKinnon, R. (2021, July 29). An Introduction to Life's Principles. Biomimicry Institute. <https://biomimicry.org/an-introduction-to-lifes-principles/>
- MacKinnon, R. B., Oomen, J., & Pedersen Zari, M. (2020). Promises and Presuppositions of Biomimicry. *Biomimetics*, 5(3), 33. <https://doi.org/10.3390/biomimetics5030033>
- Matthews, A. S., (2003). Suppressing Fire and Memory: Environmental Degradation and Political Restoration in the Sierra Juárez of Oaxaca, 1887-2001. *Environmental History*, 8(1), 77–108. <https://doi.org/10.2307/3985973>
- Marohn, C. (2020, October 01). The local case for reparations. Retrieved April 21, 2021, from <https://www.resilience.org/stories/2020-10-01/the-local-case-for-reparations/>.
- Marshall, K. (n.d.). 7 amazing jackdaw facts [Photograph]. <https://www.discoverwildlife.com/animal-facts/birds/facts-about-jackdaws/>
- McDonough, W. (n.d.). The Hannover Principles: Design for Sustainability (1992). William McDonough. <https://mcdonough.com/writings/the-hannover-principles/>
- National Academies of Sciences, Engineering, and Medicine. (2016). *Attribution of Extreme Weather Events in the Context of Climate Change*. The National Academies Press. <https://doi.org/10.17226/21852>.
- O'Brien, J. (2003). Prologue and Peoples, Land and Social Order. In J. M. O'Brien (Author), *Dispossession by degrees: Indian Land and Identity in Natick, Massachusetts, 1650-1790* (pp. 1-30). Lincoln, NE: University of Nebraska Press.
- Olson, G. (2015, November 5). Cleaning up wastewater through algae [Arizona State University Julie Ann Wrigley Global Futures Laboratory]. Sustainability News. <https://sustainability-innovation.asu.edu/news/archive/11515-2>

- Pacey, P. (2020, October 14). Giraffe: Part 1, Physical Adaptation to their Environment. Whole Earth. <https://wholeeartheducation.com/giraffe-physical-adaptation/>
- Pauli, B. J. (2019). *Flint Fights Back: Environmental Justice and Democracy in the Flint Water Crisis*. Cambridge, MA: MIT Press.
- Pickering, J. (2019). Natural, Un-Natural and Detached Mimicry. *Biosemiotics*, 12(1), 115–130. <https://doi.org/10.1007/s12304-018-9335-x>
- Ponderosa Pine, Lassen National Forest, California. (2017). [Photograph]. <https://www.nationalforests.org/our-forests/your-national-forests-magazine/how-trees-survive-and-thrive-after-a-fire>
- Powell, J. A., Menendian, S., & Ake, W. (2019). *Targeted Universalism Policy and Practice* (pp. 5-44, Rep.). Berkley, CA: Hass Institute.
- Rooney, T., Wiegmann, S., Rodgers, D. A., & Waller, D.M. (2004). Biotic Impoverishment and Homogenization in Unfragmented Forest Understory Communities. *Conservation Biology*, 18(3), 7870798. <https://doi.org/10.1111/j.1523-1739.2004.00515.x>
- Samuels, S. (n.d.). Riverbank lupine in the Bald Hills [Photograph]. <https://www.nps.gov/articles/riverbank-lupine.htm>
- Sanders, R. (2005, December 7). Plants, too, have ways to manage freeloaders [Press Release]. UC Berkeley News. https://www.berkeley.edu/news/media/releases/2005/12/07_mutualism.shtml
- Sasaki, T., & Biro, D. (2017). Cumulative culture can emerge from collective intelligence in animal groups. *Nature communications*, 8, 15049. <https://doi.org/10.1038/ncomms15049>
- Shi, L., Chu, E., Anguelovski, I., Aylett, A., Debats, J., Goh, K., VanDeveer, S. D. (2016). Roadmap towards justice in urban climate adaptation research. *Nature Climate Change*, 6(2), 131-137. doi:10.1038/nclimate2841
- Smedley, B. D., Stith, A. Y., & Nelson, A. R. (2003). *Unequal treatment: Confronting racial and ethnic disparities in health care*. Washington, DC: National Academies Press.
- The White House. (2022, January 26). Fact Sheet: A Year Advancing Environmental Justice. The White House. <https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/26/fact-sheet-a-year-advancing-environmental-justice/>
- Thomas, K., Hardy, R.D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J.T., Rockman, M., Warner, B.P., & Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *WIREs Climate Change*, 10(2). <https://doi.org/10.1002/wcc.565>
- Torabi, E., Dedekorkut-Howes, A., & Howes, M. (2017). Not waving, drowning: Can Local Government Policies on Climate Change Adaptation and Disaster Resilience Make a Difference? *Urban Policy and Research*, 35(3), 312-332. doi:10.1080/08111146.2017.1294538
- Tulloch, L. (2015). Is Emile in the Garden of Eden? Western ideologies of nature. *Policy Futures in Education*. Retrieved from 2021. <https://journals.sagepub.com/doi/pdf/10.1177/1478210314566729>.
- UN Environment Plan. (2021). Making peace with nature. Retrieved from <https://www.unep.org/resources/making-peace-nature>

- Urban Sustainability Directors Network. (2020). High Impact Practices. Retrieved from <https://www.usdn.org/high-impact-practices.html>
- Urban Sustainability Directors Network. (2021, March). *The Nexus* [Scholarly project]. In *Usdn.org*. Retrieved from https://www.usdn.org/uploads/cms/documents/_usdn_nexus_document_draft_wm_3-26-21.pdf
- USDA Forest Service, Pacific Northwest Region. (1985). Different layers of a forest canopy. [Photograph]. <https://climate-woodlands.extension.org/diversity-in-the-forest-understory/>
- USGCRP. (2018). Figure 28.1: Five Adaptation Stages and Progress [Fourth National Climate Assessment, Chapter 28: Reducing Risks Through Adaptation Actions]. <https://nca2018.globalchange.gov><https://nca2018.globalchange.gov/chapter/28>
- USGCRP. (2018). *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, 1515. doi: 10.7930/NCA4.2018.
- Van der Ryn, S., & Cowan, S. (2007). *Ecological Design Tenth Anniversary Edition* (10th ed.). Island Press. http://dev.ecoguineafoundation.com/uploads/5/4/1/5/5415260/ecological_design_10th_edition.pdf
- Waddock, S., & Kuenkel, P. (2020). What Gives Life to Large System Change? *Organization & Environment*, 33(3), 342–358. <https://doi.org/10.1177/1086026619842482>

8. Appendices

8.1 Appendix A: Interview Summaries

In an attempt to tie theory and literature with practice, three interviews were conducted with experts who represented different aspects of planning. First, Carol Thaler and Trisha Brown, who are co-directors of Great Lakes Biomimicry, were interviewed to improve the teams understanding of how to incorporate learning from nature into planning processes in a way that resonates with individuals who may not be directly familiar with ecological systems, such as local government practitioners. Next, Dr. Tim Beatley, who is a professor at the University of Virginia and an expert on sustainability within cities, was interviewed to understand how relationships with nature are maintained throughout and beyond the planning process. Finally, Galen Hardy, who is the community engagement specialist in the Ann Arbor Office of Sustainability and Innovations was interviewed to provide the team an understanding of current practices of sustainability in local government. This background highlighted barriers and nuances in sustainability planning and views within one city. This city is not involved with the Nexus, but it does have higher levels of community engagement within sustainability planning, and these aspects of the interview identify ways to improve equity and access to benefits within participants involved in the planning process (Appendix A).

Summarized Content from Interviews with subject-matter experts

Interview 1: Carol Thaler and Trisha Brown

About: This interview was conducted with Carol Thaler and Trisha Brown. They are co-directors of Great Lakes Biomimicry. The team interviewed them to get more information on how biomimicry is incorporated into the process and content of project planning and problem solving. The following is a summary of the interview, with the questions, followed by answers given verbally by the interviewee, translated in the words of the team members.

This summary has been reviewed and edited by the interviewees and is presented with their permission.

How can we resonate with city officials?

- Officials make decisions based on the development code and the current rules, and when they run into new ideas, they feel they have no choice in the matter. There is a creative element to this project that is special that could support officials with the “why” development codes need to change but public safety considerations must remain.
Biomimicry checklist: Idea of presenting a list of components/ targets that are worth a certain number of points, similar to LEED. This would introduce people to the concepts but be similar enough to what they know to make it digestible. It would also allow them to experiment with resource and opportunity trade-offs.
- *Genius of place:* Using the natural limit of the ecosystem as a benchmark, which mimics the ecosystem constraints of natural systems in a way that people can understand. This is a way of living within your means but the "you[r]" is the community and the "means" are defined by nature. Importantly, this would allow communities to see themselves as a part of the natural system, which could help promote respect for nature.
 - Are there equity implications to these benchmarks? Will it increase taxes etc. This could tie into Stage 2, where the community discusses zones of possibility with local government and can weigh tradeoffs.
- Make it personal, relatable (use examples they will be able to visualize and understand), something that relates to their experiences.

Places that have made progress:

- Cleveland
- Ohio

Introducing biomimicry: Who? How?

- Why not start in nature? Have a naturalist or biologist explain in a structured way that gets people thinking creatively. This could also help get people out of the boxes of "codes, laws, budgets" and focus on the big picture.
- With local officials: use personal examples

Themes we could use:

- 2 major themes discussed:
 - Diversity

- Diversity is a strength, whether with species, strategies, etc. It can promote the centering of racial equity.
 - *Ecotones*, or transition areas between two ecosystems can be important here. How do they blend together? How do they work with each other?
 - Communication in nature (signaling)
 - Many ecosystems make decisions based on signaling, which can be a result of environmental triggers, shocks, etc.
 - Many systems, even natural systems operate with patterns. But those patterns can change depending on signaling from other components of the system. Patterns are easy to follow and make things scale-able, but ensuring conditionality can promote a sustainable system (if ___ happens, then our plan is ____). Having the planning work this way (Stage 4) could bring in biomimicry and potentially help with implementation.
 - Can weave this in with our other examples (fungal networks, resiliency, circular economy, intact ecosystems)?

Potential framework for bringing in biomimicry:

- Start with the big picture - get them to visualize it
 - Create a basic understanding of how and why a forest (or other ecosystem) is resilient/ efficient in the face of shocks
 - Introduce the city as the ecosystem, explain in the context of problems they can relate to
- Then get into specifics, champion organisms, principles, etc.
 - fungal networks, herd mentality, etc.

Final thoughts:

- Don't make it too long and complicated
- Generate support from smaller groups before approaching city officials
- Perhaps part of Stage 3's common vision could be respect for nature

Interview 2: Tim Beatley

About: This interview was conducted with Dr. Timothy Beatley. He is an expert on sustainable cities and professor at the University of Virginia. The team interviewed Dr. Beatley to understand how to develop a biophilic city, and what challenges may be anticipated. Furthermore, Dr. Beatley's experience collaborating with city officials for the purposes of creating publications and advising on city planning projects, was invaluable insight into the complexities of biophilia at the metropolitan scale. The following is a summary of the interview, with the questions, followed by answers given verbally by the interviewee, translated in the words of the team members.

This summary has been reviewed by the interviewee and is presented with his permission.

Objective:

- Understand what academia and city officials face when conveying the concept of biophilia to peers

- Learn about relationships with nature and affinity to nature
 - Question what constitutes conceptions of nature and natural
- Define biophilia and biophilic cities
 - Immersive natural system
- Identify partners in urban planning and advocates for nature-based solutions in urban development
 - Biomimicry Institute
 - Emory University sociologists

How can city planners enact environmentally-conscious change in their cities?

- Use of political activism, efforts from grass-roots organizers, and environmental advocacy is useful in enacting changes that are good for the environment
- Community activities and participation in challenges, such as CityNature, encourage local participation in environmental decision making
- Designating points of leverage and other metrics such as minimum tree canopy targets
 - Benchmarks often look like comparisons to other places, in order to define the realm of feasibility
 - The Nexus provides a chance to learn from others growth in a creative way

What is unknown about this process?

- There are unintended consequences to greening a space
 - Increase in property value can displace communities
 - Gentrification
 - Accounting for externalities in developing biophilic cities has important equity and justice implications
 - Structuring a community for the community, specifically including protections for displacement
 - Example: 11th Street Bridge Park

What gets the local government engaged in incorporating nature?

- Basic examples that practitioners and community members can mutually relate to, such as birds and trees, are effective
- Terminology such as biophilic and biomimetic is not immediately accessible
- Unknown aspects of nature and geopolitical constructions of the wild hinder perceptions of the applicability and usefulness of biomimicry

Are there particular implementation instruments that are most effective?

- Metrics and indicators that can be used to monitor or track changes over time are useful
 - A mixture of qualitative and quantitative creative measures are always welcome
 - Use of benchmarks to monitor progress
- Make nature visible and enjoyable

How are distinctions between urban environments and wild environments conveyed while embedding urbanity in nature?

- Cues to care are used as a broader signal to maintain space

- Ecological design and planning theory highlights the strategic use of nature to reduce the growing nature-culture dichotomy

Interview 3: Galen Hardy

About: Galen Hardy is the community engagement specialist in the Ann Arbor Office of Sustainability and Innovations, working specifically with residents and traditionally underserved populations in the city in order to be better equipped to facilitate sustainability strategies. The following is a summary of the interview, with the questions, followed by answers given verbally by the interviewee, translated in the words of the team members.

This summary has been presented in the words and interpretation of the interview team and has not been reviewed by the interviewee.

Objective: To learn more about Galen’s government work with the city of Ann Arbor and how the city generates funding and interest for sustainability. We also want to see where there may be potential connections between their work and the Nexus framework to see where we can modify the Nexus process for USDN’s partner cities.

Your role in the city:

- Community engagement specialist, program manager, outreach (neighborhood association), under-served communities
- Partnerships/relationships between offices

How do you maintain levels of engagement with community members?

- Be respectful of their time!
- Ann Arbor citizens are pretty eager to be involved- associated with the level of education in the city and mix of retirees

In terms of working with the local legislature, what are some of the biggest points of hindrances, and where have you seen support for sustainability measures?

- Political will is so important, don't get too detailed or the politics gets too involved in the breakdown
- Much of work here is done in/between cities, but not in/with residences

A20 Plan

- Frontline, fenceline communities, engage first
- How did the Office gather information from community members?
 - Surveys, online, different forms, through partner platforms, worked by creating a sort of *organism-like structure* for info gathering.

Equitable Engagement

- 30 person steering committee (relationship-building challenges over Zoom)
 - Sometimes conversation steered away from sustainability because they had other things on their minds

- Have the community define what equity is to them, or as Galen put it, in the "language of the people"
 - Build relationships though spending time in the field or in a specific and related area

How do you take appropriate time while trying to meet a deadline?

- Set flexibility into the project, or, add check and balance points within the process where the plan can adapt and create the most relevant signals
 - This allows progress to be made while maintaining equity in a dynamic community/ environment

Has there been any corporate pushback? For example, what if the equity issue is outside of community control (as it often is) through a factory?

- Not many factories in Ann Arbor, but there is development pushback
- UMich does not pay taxes, and their new buildings hurt the city financially
- Struggle with how to influence your partners, while maintaining partnership
- Many boundaries define their Office’s sphere of control: State laws/codes, business concerns, political-will (county, state, etc.), etc.

Why not part of Nexus when goals are so related?

- Did not know, but the Office is involved in some shape or form

Is Ann Arbor working with other cities like Detroit, or, what other communities has the Office worked with?

- Worked with Washtenaw County, which is working on a climate action plan. This would help Ann Arbor Sustainability’s impact branch out, because it is limited by county and state action.
- The solarized plan now gone statewide (Great Lakes Renewable Energy Association)

Who else can we talk to?

- Focus Hope
- Michigan Environmental Council
- Detroit Environmental Justice
- East Michigan Environmental Action Coalition
- Great Lakes Law Environmental Law Center–Nicholas Leonard
- City of Detroit–Office of Sustainability

8.2 Appendix B: Table 5: Please be directed to the [following hyperlink](#) to access Table 5.