THE USE OF BIOMIMICRY IN URBAN PLANNING AND DESIGN

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Urban Planning Using Biomimicry
Title: Planning with Physarum: Biology-Based Network Design

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1. BIOMIMICRY

Biomimicry in its simplest form is the method that takes design inspiration from biology. It entails the process of studying nature, extracting valuable principles from inspiring organisms or ecosystems, and subsequently incorporating these principles into our designs. It stems from the search for alternative solutions to our challenges and design limitations. The logic comes from the understanding that the biological world that surrounds us has had a significant amount of time to develop strategies to survive that can often apply to the problems we have today.

Inspiration from the natural world is virtually limitless. The shapes, behaviors, processes, materials, functions, and other attributes observed in the biological realm stand as potential solutions to our contemporary challenges. Biomimicry, therefore, offers an approach to design innovation by emulating nature's time-tested strategies. Life incorporates and refines various strategies to establish conditions that support its existence. By drawing insights from these profound design lessons, we can formulate innovative strategies, and evaluate our designs against sustainable benchmarks.
2. LIFE’S PRINCIPLES

Life’s principles come from the notion that there are numerous overarching patterns found amongst the species surviving and thriving on earth. Life has evolved a set of strategies that have sustained over 3.8 billion years. Life integrates and optimizes these strategies to create conditions conducive to life. By learning from these deep design lessons, we can model innovative strategies, measure our designs against these sustainable benchmarks, and allow ourselves to be mentored by nature’s genius using life principles as our aspirational ideals.

2.1 PRINCIPLES

**EVOLVE TO SURVIVE**

The principle of "Evolve to Survive" underscores the importance of continuous adaptation and resilience to ensure sustained effectiveness. This principle highlights the need for a dynamic and adaptable approach, where successful strategies are repeated, mistakes are leveraged for innovation, and information is constantly reshaped to create new opportunities.

**ADAPT TO CHANGING CONDITIONS**

The principle "Adapt to Changing Conditions" emphasizes the need for flexible responses to evolving environments or cities. This principle encompasses the importance of adaptability, resilience, and sustainability by embracing diversity, ensuring ongoing system renewal, and establishing redundant yet varied systems to effectively navigate changing conditions.

**BE LOCALLY ATTUNED AND RESPONSIVE**

The principle of "Being Locally Attuned and Responsive" underscores the importance of harmonious integration within the environment. It involves the significance of harmonizing with the environment by utilizing cyclic processes, readily available resources, feedback mechanisms, and collaborative relationships to ensure a symbiotic relationship with the surroundings.
INTEGRATE DEVELOPMENT WITH GROWTH

The principle of "Integrating Development with Growth" emphasizes the importance of investing in strategies that foster both advancement and expansion. It involves strategic investments that facilitate the evolution of systems by enabling self-organization, employing a bottom-up construction approach, and integrating modular components in a manner that supports both development and growth systematically and sustainably.

BE RESOURCE EFFICIENT (MATERIAL AND ENERGY)

The principle of "Resource Efficiency (Material and Energy)" focuses on astutely managing resources and opportunities. This principle underscores the importance of resource management by minimizing energy use, employing versatile designs to meet diverse needs, embracing closed-loop material recycling, and tailoring forms to align seamlessly with their intended functions, thereby promoting efficient resource utilization and reducing waste.
3. FUNDAMENTAL STEPS OF BIOMIMICRY UTILIZATION

The utilization of biomimicry typically involves a sequential progression through four fundamental steps, commonly encountered by most designers. These stages are the following, scoping, discovery, creation, and evaluation. These stages are useful in establishing a systematic approach to incorporating biomimicry principles in urban planning and design.

SCOPING:

Scoping serves as the exploratory phase, initiated when design ideas and concepts encounter limitations. At this juncture, designers look to their surroundings for inspiration, establishing a problem and discerning its essential requirements.

DISCOVERY:

After scoping, the discovery phase establishes the link between the identified problem and its potential solution. In biomimicry, this connection is derived from the study of the shape, behavior, process, material, function, etc., inherent in biological entities that can address the identified problem. Solutions are found by emulating natural processes during this phase.

CREATION:

The creation phase marks the transition from design conceptualization to practical application. It involves translating the characteristics gleaned from biology into tangible forms and structures.

EVALUATION:

The evaluation phase represents the testing stage, where the designed solution undergoes scrutiny and is measured against predefined criteria. This step involves subjecting the inspired design to testing protocols and gauging its effectiveness against the parameters it was created to address.
This sequential progression can help when setting out to solve a design challenge. It outlines the essential elements of a design process that uses nature as a guide for creating solutions. It describes the four most important steps a design team should take when seeking biomimetic solutions to a design challenge. The steps are described sequentially as a starting point. However, moving back and forth between steps or repeating them is not uncommon, as each step often reveals new insights that can refine or challenge previous assumptions. In a further section, I will demonstrate the use of these steps.

4. WHAT BIOMIMICRY IS NOT

Understanding what biomimicry is not helps clarify its boundaries and distinctions from other concepts. These alternative concepts include:

**BIO-UTILIZATION:**

This refers to the direct exploitation or use of biological organisms or materials without necessarily imitating or learning from their natural functions or designs. Unlike biomimicry, which focuses on learning from nature's designs to solve human problems, bio-utilization often involves using biological resources for various purposes without imitating their inherent mechanisms or properties.

**BIOMECHANICS:**

Biomechanics involves the scientific study of the structure, function, and movement of mechanical aspects within biological systems. While it explores how biological systems work mechanically, it doesn't necessarily seek to imitate or apply those mechanisms directly into human-made designs or problem-solving.

**BIONICS:**

Bionics involves the application of knowledge about the functioning of biological systems to solve engineering problems. However, unlike biomimicry, which specifically aims to emulate nature's solutions, bionics is more concerned with using biological insights to inspire or guide engineering solutions without strictly replicating natural designs.
**BIOMORPHISM:**

Biomorphism involves the imitation or incorporation of natural shapes, forms, or aesthetics found in biology into art, design, or architecture. Unlike biomimicry, which focuses on functional emulation or learning from nature’s strategies to solve human challenges, biomorphism primarily concerns itself with the visual or aesthetic aspects of natural shapes without necessarily imitating their functionalities.

In summary, while these concepts share connections with biology or natural systems, they differ from biomimicry in their focus, approach, or scope. Biomimicry is distinct in its emphasis on learning and applying nature’s strategies, mechanisms, or designs to innovate solutions for human challenges.
5. KEY CONCEPTS APPLIED IN URBAN PLANNING

5.1 THE EAST GATE BUILDING IN HARARE, ZIMBABWE

The design of the Estate building in Harare, Zimbabwe, which was erected 26 years ago, drew inspiration from termite mounds. Specifically, the ventilation system of termites served as a model for creating a cooling mechanism within the construction. This bio-inspired approach has proven to be particularly advantageous for designers in Zimbabwe.

ARCHITECTURAL INNOVATION BY MICK PEARCE:

Mick Pearce spearheaded the implementation of low-tech architecture in the Estate building. The structure successfully maintains a temperature range of 21-25 degrees Celsius, even in an external environment with temperature extremes ranging from 5 to 33 degrees Celsius.
SIGNIFICANT ENERGY EFFICIENCY:

Notably, the building achieved a remarkable reduction of 35% in energy consumption compared to conventional structures in Harare. This accomplishment underscores the practical benefits of drawing inspiration from biological models, such as termite mounds, in architectural design.

5.2 THE BULLITT CENTER - BIOLOGICAL MODEL

A groundbreaking project completed in 2013 in Seattle, Washington, stands as a pinnacle of high-tech innovation in sustainable architecture. Drawing inspiration from the Douglas pine tree, this architectural marvel is meticulously designed to adapt to its environment over decades, showcasing a commitment to long-term sustainability and self-sufficiency in energy consumption. Key features of the Bullitt Center include:

BIOLOGICAL MODEL - DOUGLAS PINE TREE:

The building's design is intricately linked to the Douglas pine tree, serving as a biological model. This inspiration translates into an architectural approach that mimics the resilience and adaptability observed in nature.

ADAPTABILITY OVER DECADES:

The Bullitt Center is engineered to adapt seamlessly to its surroundings over the course of decades. This forward-thinking design ensures that the building remains relevant and responsive to evolving environmental conditions, contributing to its long-term sustainability.

LIVING BUILDING CHALLENGE CERTIFICATION:

The Bullitt Center has achieved the prestigious Living Building Challenge certification, which is recognized as one of the most demanding labels in the field of construction. This certification, even more stringent than LEED (Leadership in Energy and Environmental Design), signifies the building's commitment to the highest standards of sustainability and its aspiration for a regenerative impact on the environment.
By seamlessly integrating cutting-edge technology with lessons from the natural world, the Bullitt Center sets a new standard for environmentally conscious construction. Its commitment to the Living Building Challenge certification exemplifies a dedication to not merely meeting sustainability benchmarks but actively contributing to the regeneration of the surrounding environment. The Bullitt Center serves as a beacon of inspiration for future high-tech, ecologically sound architectural endeavors.

In both instances, these buildings exemplify the potential of biomimicry to not only enhance the efficiency and sustainability of architectural design but also to contribute positively to the broader environmental and energy conservation goals. The successful application of nature-inspired principles in these buildings serves as a testament to the potential of biomimicry in shaping the future of sustainable and resilient architecture.

Bullitt Center across Madison Street Seattle, WA.

(Source: https://prismpub.com/biomimicry-in-architectural-design-the-bullitt-center/)

5.3 THE LLOYD CROSSING PROJECT: EXEMPLIFYING SUSTAINABLE URBAN DESIGN

The Lloyd Crossing Project, recognized in the AIA Top Ten, stands as a model of sustainable urban design that transcends conventional practices. Executed in Oregon, USA, in 2004, this visionary project was a collaborative effort between Mithun Architects and GreenWorks, demonstrating a profound commitment to ecological performance objectives and innovative urban development planning.
The Lloyd Crossing Sustainable Urban Design Plan represents a comprehensive initiative integrating diverse sustainable strategies focusing on energy, water, and habitat enhancement to reimagine and rejuvenate a 35-block commercial area within Portland’s urban landscape. This forward-looking plan aims to introduce a new identity while significantly enhancing the district’s environmental performance. Over a span of 45 years, the proposal envisions the addition of 8 million square feet of development, presenting an innovative blueprint for transformative growth.

The Lloyd Crossing Sustainable Urban Design Plan, championed by the Portland Development Commission and designed by Mithun Architects + Designers + Planners, is poised to redefine the urban landscape by seamlessly blending innovation, sustainability, and transformative development within Portland’s vibrant Lloyd District.

ENVIRONMENTAL STRATEGIES:

All core environmental strategies within the Plan align with the Predevelopment Metrics Goals, specifically focusing on habitat, water, and energy. These goals serve as the basis for evaluating and comprehending the systemic nature of interconnected design strategies.

- **Habitat Improvement**: Enhancing habitat quantity, quality, and connections by restoring habitat "patches" in the streetscape, facilitating connectivity to existing habitat corridors. Tree cover is projected to increase from 14.5% in 2004 to 30% by 2050.
- **Water Conservation**: Reducing potable water use by 62% and lowering annual fees by 89% through an integrated water system. This includes stormwater management and treatment, along with graywater and blackwater treatment for non-potable purposes.
- **Energy Efficiency**: Curtailing energy demand while maximizing onsite renewable resources like daylighting, wind power, photovoltaic systems, and biogas generation. A shared "thermal loop" will balance heating demands among complementary uses. Solar utilization is anticipated to rise from 2% to 13.7% by 2050, surpassing the pre-development utilization of 5%. The carbon balance is expected to decrease significantly from 29,000 tons per year to 2,000 tons per year, even after the addition of 8 million ft² of new buildings. Close to 90% of power is projected to come from renewable sources in 2050, and carbon neutrality will be attained via the acquisition of carbon credits.

LAND USE & COMMUNITY DEVELOPMENT
This district possesses a unique blend of existing transportation systems, robust utility infrastructure, and the promise of both residential and commercial growth, making it an ideal location to establish a sustainable urban community.

TRANSPORTATION

Situated at the convergence point of Portland's light-rail, bus, and upcoming streetcar networks, the area presents an exceptional opportunity to leverage mass transit, thereby minimizing local air pollution and greenhouse gas emissions. Plans involve repurposing surface parking spaces for future building developments and open spaces, while also integrating stormwater management, streetscape enhancements, and habitat strategies to replace certain street parking areas.

The district's Transportation Management Association is actively engaged in enhancing public transit, promoting ride-sharing, implementing alternative work-hour initiatives, and advocating for effective parking management, as well as measures to support bicycling and pedestrian activities.

UTILITY INFRASTRUCTURE

The neighborhood benefits from well-established water, sewer, gas, and power infrastructure. However, there is a need to optimize electrical infrastructure due to its proximity to transmission limits, aiming to reduce overall power consumption. The area, covering 35 blocks, falls under the Central Commercial zoning with a Design Overlay Zone (CXd) and is part of the Oregon Convention Center Urban Renewal Area, qualifying for a tax-increment financing (TIF) program administered by the Portland Development Commission (PDC). These TIF funds could prove crucial in establishing sustainable urban infrastructure.

PRESERVING URBAN DENSITY AND PLACEMAKING

The Sustainable Design Plan envisions preserving all potential development areas within the neighborhood, thereby alleviating development pressures outside Portland's urban growth boundary. This approach safeguards sites with less established infrastructure and higher environmental sensitivity. Additionally, the plan proposes a mix of strategies encompassing street-level and upper-level land use, street hierarchy enhancements, open space creation, landscaping, habitat preservation, ground-level building aesthetics, and tower setback requirements. These initiatives aim to shape a vibrant and appealing urban neighborhood.
KEY FEATURES OF THE PROJECT

1. ECOLOGICAL PERFORMANCE OBJECTIVES AND URBAN DEVELOPMENT PLAN:
   - The project's foundation lies in a meticulous analysis of 'present vs. predevelopment' conditions.
   - Predevelopment metrics are organized around critical elements such as habitat, water, energy, and carbon use.

2. BIOLOGICAL MODEL - LOCAL MIXED CONIFER FORESTS:
   - The project draws inspiration from the resilient local mixed conifer forests, particularly focusing on the predevelopment habitat.
   - Restoration of habitat and tree cover is a primary objective.
   - The project aims to rely solely on on-site energy sources and utilize only locally available water, ensuring a harmonious relationship with the natural surroundings.
   - Emphasis on maintaining safe urban density integrates seamlessly with the ecological goals.

3. RESOURCE EFFICIENCY METRICS:
• Solar energy usage by the native ecosystem (forest) serves as a benchmark for resource efficiency.
• The project adopts this energy level as a baseline for its own energy consumption, ensuring a harmonious balance with the predevelopment habitat.
• Similar guidelines are applied to water usage, aligning with the principles of efficient resource utilization.

4. PERFORMANCE GOALS:
• The project's overarching performance goal is to replicate the energy and carbon usage levels of the native forest before development.
• Aligning with water usage guidelines, the project aspires to maintain resource efficiency and ecological balance.

The Lloyd Crossing Project demonstrates the high-level use of bio-inspired urban development, showcasing how analysis, inspiration from natural ecosystems, and resource efficiency metrics can inform sustainable design. By intertwining human habitats with nature-inspired solutions, the project stands as a testament to the possibilities of harmonious coexistence between urban environments and the ecosystems they inhabit.

5.4 DHAKA STUDY - USING BIOMIMICRY FOR TRANSPORTATION EFFICIENCY

In response to escalating environmental concerns, increased traffic, and lack of infrastructure, cities are actively exploring innovative strategies to promote eco-friendly mobility alternatives, to mitigate the detrimental environmental effects of transportation, including greenhouse gas emissions, air pollution, and noise. Among the realm of non-motorized transportation options, bicycles emerge as a popular and pragmatic choice, notably in regions like Europe and Japan, where urban planning seamlessly integrates extensive cycling infrastructure with major road networks. Cities are changing from sprawl and car dependency to transit and more compact urban forms, and so are their streets. The focus of urban streets is changing from ensuring traffic movement efficiency to a more people-centered design that puts pedestrians first, then cyclists and transit, and lastly private motorized vehicles.

In a case study conducted by a team of researchers, a nature-inspired network design methodology employing Physarum polycephalum, a brainless, giant multi-nucleated, single-celled slime mold organism, as an innovative approach to crafting Bicycle Lane Networks (BLNs). The team developed a mathematical model inspired by the foraging behavior of Physarum and adapted it to address various constraints relevant to urban environments.

Urban Planning Using Biomimicry
The group established a mathematical model based on the Physarum’s foraging behavior and adapted it to maneuver various constraints. They presented a BLN design to promote green mobility in a congested megacity, employing a bioinspired Physarum method. Taking into consideration existing local routes and avoiding main roads as much as possible in the design of the BLN, the mathematical model of Physarum was adapted for the case of a congested megacity. The proposed model was applied in creating two BLNs for Dhaka, which is considered a very congested city. The first BLN was designed for the most congested and busy central city area. The second BLN was designed for the entire Dhaka city, suitable for electronic bikes given longer travel distances.
The effectiveness of the resulting BLNs was evaluated by comparing the available routes between different locations using the BLNs versus existing vehicle routes within the city. This assessment considered factors such as distance and travel times at various times of the day. The analysis conclusively demonstrated that BLN routes offered viable alternatives to congested main roads, thereby presenting a promising solution to enhance mobility while concurrently reducing congestion and environmental impact. This case study emphasized the potential of nature-inspired approaches in Physarum and eco-friendly urban transport networks.
6. FROM THEORY TO PRACTICE - SPRINGVILLE, CA

6.1 BIO-INSPIRED WATER COLLECTION - SPRINGVILLE, CA

Between September 2021 and December 2021, my classmates and I interacted with the community of Springville, CA as well as County staff in a series of public meetings and surveys to generate a Background Report on existing conditions. The 2021 Background Report served as a supplemental informational document to the Community Plan. This Community Plan represented the official goals and policies that would serve the next 40 years.

Our class was split up into groups that corresponded with certain elements that made up the Community Plan. These elements identify specific issues such as housing, circulation, safety, and more. I was part of the group that identified certain issues and established goals and policies for Public Facilities. A component of this element dealt with water distribution facilities for the area.

In this section, I will practice using a portion of the four fundamental steps to biomimicry utilization mentioned in section 3 of this report. For this exercise, I will only be using the Scoping and Discovery from that section since both the Creation and Evaluation steps are “post-design”.

6.2 SCOPING: WATER DISTRIBUTION IN SPRINGVILLE

Springville’s water supply is strained, meaning any future growth will increase the demand for water in the community. The Springville Public Utilities Department (PUD) currently has water rights that allow the entity to draw water from the Tule River. Residents outside of the PUD service area rely on groundwater.

The low-residential rural areas of the community rely heavily on groundwater. The quality of water pumped from hard rock wells is generally suitable for domestic use. The Tule River is a perennial surface watercourse and is a source of domestic water for the Springville Public Utility District and other private uses. Groundwater, however, is not always a reliable source. Many of the members who attended the community meetings expressed that water is often unreliable and can shut down for days at a time. Further questioning during the community meetings indicated that a majority of proposed low-density residential is outside of the service area.

Based on the Consolidated Water Quality ArcGIS and CalEPA CalEnviroScreen OEHHA map provided by Tulare County, Springville is considered a Disadvantaged Community or DAC. This means Springville is
under a certain level of environmental vulnerability. In water distribution terms, this means that there is a deficit of equal water distribution from the Tule River to facilities.

<table>
<thead>
<tr>
<th>PWID</th>
<th>Water System Name</th>
<th>Regulating Agency</th>
<th>County</th>
<th>Total Weighted Risk Score</th>
<th>Risk Assessment Result</th>
<th>Excluded HR2W List Systema (as of 08.31.2021)</th>
<th>Final At-Risk List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA5410011</td>
<td>SPRINGVILLE PUD</td>
<td>DISTRICT 12 - VISALIA</td>
<td>TULARE</td>
<td>1.05</td>
<td>At-Risk</td>
<td>Non-HR2W</td>
<td>At-Risk</td>
</tr>
</tbody>
</table>

The screen capture above was taken from the information used in the Tulare County Consolidated Water Quality ArcGIS Map data. This data set rates all cities in California on water distribution and access to drinking water. From this information, we can see that the Springville Public Utilities Department is listed as “At-Risk”.

When the facilities for Springville’s rural areas that utilize groundwater from the PUD fail or shut off, there appear to be little to no “backup options”. During our community meetings in 2022, the residents who emphasized the need for a reliable water source emphasized that there are large periods the water is completely shut off in rural residential areas. Many of the residents rely on their private or shared rainwater collectors during those periods of outages.

6.3 DISCOVERY: FOGQUEST NETTING SYSTEM

One of the goals we established in the community plan was to provide a potable water supply to all residents. As it stands, Springville does not have a system to collect data and share and receive information on the state of groundwater supply. One of the suggested solutions to establishing a reliable water source for all residents was to expand the current facilities to the rural areas that solely rely on groundwater. However, Springville is a census-designated place (CDP) in Tulare County. Springville Public Utilities Department is already struggling to meet the needs of the current population. They, unfortunately, have limited resources and funding to make significant infrastructure changes.

To increase the accessibility of water during the PUD groundwater facility outages in rural areas, a possible solution needs to be cost-effective, easy to establish, and require few resources. Through my research of bio-inspired urban planning, I came across an innovative water collection system for rural areas that may help. It’s a system that uses fog to collect water. Fog is the accumulation of micrometer-sized water droplets resulting from the saturation of air with water vapor. Due to their small size, these
droplets remain suspended in the air and are capable of depositing onto surfaces through settling or interception mechanisms. In regions with minimal rainfall, particularly arid areas, fog serves as a crucial source of water replenishment. Although Tulare County is not exactly “arid” and regularly receives rainfall for more than half of the year, there are periods of the year that rarely have rainfall (May-Sep). During this time, there is likely little availability for rainwater collectors to sustain large outages for the groundwater supply from the PUD.

The system collects water from fog using a netting which is inspired by arid-region animals. These include the Namib Desert beetles, several lizard species, spider webs, and various types of cacti, grasses, and other plants. These organisms, including the spider webs which are external structures constructed by spiders, commonly possess specific regions where fog droplets can accumulate and grow before being subsequently directed either towards the mouths of animals or towards water-absorbing regions, such as plant roots.

**FOGQUEST NETTING SYSTEM**

The system I want to highlight in this practice utilizes this biological collection method. It is a net-based water collector currently available from *FogQuest*, a non-profit registered charity dedicated to planning and implementing water projects for rural communities in developing countries. Although they primarily offer volunteer services, they offer a commercial netting system on their website.

The system is made of a polymer mesh made of polyethylene or polypropylene specifically chosen to be efficient at capturing wind-blown fog. This mesh mimics the same principle of arid-region animals by using gravity to force collected water droplets from fog down into a tank.
A fog collector, boasting a 40 m² collection surface area, can potentially yield an average of 200 liters per day consistently over the course of a year. However, production can fluctuate significantly, with days yielding no water at all while others may generate up to 1000 liters. The extent of this variability is contingent upon the location and weather conditions. Notably, fog-water production exhibits both daily fluctuations and seasonal variations, akin to the patterns observed in rainfall.

Costs are variable depending on location and access. The small fog collectors for the evaluation cost $75 to $200 US each to build. The large 40 m² fog collectors cost about $1000 to $1500 US each and can last 10 years. A larger project producing about 2000 L a day will cost about $15,000 US.

**APPLICABILITY**

To determine where these systems would be most needed and which areas face water outages most frequently, further data would be needed. However, a number of these fog-collecting netting systems could be set up strategically in Springville’s rural areas to help supplement the emergency water supply.
when the PUD groundwater facilities are temporarily out of service. The water collected from the nets could be stored in a public use tank to be used during long periods of outages.

Unfortunately, there is currently no information on the location or number of rural residents that utilize the PUD groundwater system in Springville, CA. The only information available is annual water usage provided by the City of Porterville, Urban Waste Management Plan section from the Porterville General Plan which encompasses Springville in the estimation.

<table>
<thead>
<tr>
<th>Table 8-1: Current and Planned Water Supplies (AF/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td>Total City Demands&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Supplier Produced Groundwater&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Supplier Surface Diversions&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Surface Water Purchases&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Total demands based on assumed per capita use of 250 gallons/day from 2001 Porterville Water System Master Plan.
<sup>2</sup> The aquifer safe yield is assumed to be 1.0 acre-feet/acre. This value is approximate and needs to be verified with a detailed water balance study.
<sup>3</sup> Includes water rights on the Tule River with the Pioneer Ditch Company and Porter Slough Ditch Company.
<sup>4</sup> Surface water sellers are likely to include Porterville Irrigation District and other local irrigation and water districts.


For the sake of this practice, I wanted to highlight the potential of a simple bio-inspired design and its potential to help facilitate changes at a small urban scale. The netting systems are relatively cheap and easy to set up and maintain as they are commonly seen in rural areas in disadvantaged countries. It utilizes a naturally occurring weather condition, fog, as its source meaning it would not cause a significant environmental footprint. Again, since there is no estimation of the number of people who use groundwater facilities in these low-residential rural areas, it’s hard to determine its utilization. However, this could be an effective method to help supplement rain-water collectors used by the residents during dry-periods of the year.

Source: https://fogquest.org/f-a-q/
7. KEY FINDINGS

Biomimicry, when applied to urban planning, serves as a remarkable source of inspiration for innovative and sustainable solutions. Biomimicry serves as a compelling catalyst for the adoption of ecologically conscious design, presenting a unique approach that draws inspiration from nature's time-tested solutions. The inherently sustainable nature of biomimetic design acts as a powerful incentive for developers to embrace practices that not only harmonize with the environment but also contribute to regenerative urban design.

The Fundamental Steps of Biomimicry Utilization can serve as an excellent starting point for any level of urban design or planning. Planners everywhere can look to the natural world around us for inspiration in solving today's problems. Below I will link a helpful set of guides to applying nature’s lessons to design challenges.

Link:

*Biomimicry Toolbox*- [https://toolbox.biomimicry.org/](https://toolbox.biomimicry.org/)
WORKS CITED


