ABSTRACT

Title of Thesis:	DESIGNED WILD: CULTIVATING CONNECTIONS TO THE NATURAL WORLD THROUGH ARCHITECTURE
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The typology of visitor centers for state and national parks is long overdue for reinvention. These buildings often fail to truly integrate themselves into the environment that surrounds them. These places, despite being "natural," are often curated and cared for by humans in a highly complex relationship. This, however, is not to be scorned, but embraced and taught. Through immersive architecture, parks have the opportunity to create places which heighten people's environmental consciousness and create ecologies with the end goal of mutualism. Rather than acting to exclusively maintain the environment as it is, these parks can act with foresight to actively enrich the conditions for the flora and fauna that call these parks home and can do so while enriching the experience and knowledge of those who visit the park.

REARING CONNECTIONS: ENRICHING ECOLOGIES THROUGH AQUAPONICS AND ARCHITECTURE

by

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Chapter 1: Introduction

State Parks play a critical role in environmental conservation efforts in the United States. They take pieces of land and maintain them in a way that allows visitors to experience the environment around them in a convenient manner. Trails are maintained, camp sites provided, and often they provide facilities with water, electricity, and restrooms. These amenities make it easy for people to visit these parks and appreciate the wildlife, plants, and natural scenery of any given area. Many of these parks have a building that nearly every attendee visits: the visitor center. This is a building that most people share a common mental image of. A brown building, with a gabled roof, usually made of logs. With a typical brown sign with yellow sans serif lettering leading to it. We share this mental image because many of these visitor centers were established in the 1960s[1] and are still standing today.

Much has been learned about the natural world since the 1960s, and these park centers are becoming outdated and worn. This provides an opportunity for improvement in the next generation of park infrastructure. Visitor centers should integrate themselves with their unique contexts and provide rich opportunities for education, involvement, and harmonization with the environment. Parks are highly managed by humans, whether it is damming off rivers, introducing species, or clearing trails. These places, despite being "natural," are often curated and cared for

[1] Kyle Burns, "Re-Inventing the National Park Visitor Center" (University of Cincinnati, 2012), http://rave.ohiolink.edu/etdc/view?acc_num=ucin1337007451.

by humans in a highly complex relationship. This, however, is not to be scorned but embraced and taught. Through aquaponics, parks have the opportunity to create places which heighten people's environmental consciousness and create ecologies with the end goal of mutualism. Rather than acting to exclusively maintain the environment as it is, these parks can act with foresight to actively enrich the conditions for the flora and fauna that call these parks home and can do so while enriching the experience and knowledge of those who visit the park.

Humans have historically engaged with nature in a highly controlled manner. Ancient practices such as aquaponics have put humans in a management position over elements of the natural world for an intended result. This relationship has been practiced all over the world, from China to Mexico[2] and may be looked at as a tangible display of the practices that are occurring on a grand scale between humans and the natural world. Just like acting to maintain park trails or reforest an agricultural site, aquaponics is an act of humans taking control over the natural world. This provides an excellent chance to use this technology within managed natural areas to educate people on the natural systems of the world while working to produce plants and fish that can be used to restore and strengthen the existing environment within the park grounds. Acting in this proactive way also allows communities to engage with the environment in a meaningful way by directly taking part in the

[2] Michael Ezban, *Aquaculture Landscapes : Fish Farms and the Public Realm* (Milton Park, Abingdon, Oxon ; Routledge, 2020).

conservation effort and using the products of the aquaponics system to protect and improve the status of their natural areas.

This will allow for a built environment which is truly integrated into it's site. The project will be conscious of the fact that it will interact with plant and animal species, partake in the water cycle, and modify the landscape, but through the understanding of these (and more) cycles, this project will serve as a benevolent actor to both human and non-human processes on the site. This will serve as a space which not only fosters an appreciation for the natural world in its visitors, but also educates them, and reminds them that nature and man is not a binary separation, but rather an inseparable whole.

Chapter 2: Literature Review

Introduction

Aquaponics, despite being thousands of years old, has just begun its life as a subject of in-depth research. With this, there is a high level of potential for the discovery of new methods of improving aquaponics and incorporating it into systems that could greatly benefit from its involvement. Education, human well-being, and environmental restoration efforts can all see improvements in their fields through the involvement of aquaponics due to its hands-on nature, which combines aspects of engineering, environmental sciences, and agriculture.

Education

In Children

Much of the literature regarding aquaponics indicates a large potential for education in both children and adults. Aquaponics puts users in contact with both plants and animals to harness the power of a symbiotic relationships. This intersection allows for learning through many different lenses as it is at the crux of many different disciplines. The hands-on nature of the process allows people to interact with aspects of nature, agriculture, biology, and more while producing a tangible outcome reflected in the health of both the fish and the plants. This experience is deeply engaging as it allows people to see many systems working together, and the input of

their efforts directly translates into witnessing other living things to thrive in an environment created by the user.

Interest is at the center of getting children to learn, and at a young age, few things are as interesting as the natural world. Discovering that there are other living things besides humans on this planet can hold the interest of children, but direct interactions with the natural world are often not incorporated into the typical curriculum of many places, namely the United States. In a study done by Nicole M. Ardoin and Alison W. Bowers in 2020 titled "Early Childhood Environmental Education: A Systematic Review of the Research Literature." this exact idea is held within focus to see if incorporating learning time in nature has any positive effects on the minds of children and particularly their appreciation of the environment. The idea of Early Childhood Environmental Education (ECEE) takes many forms, ranging from "simply taking children outdoors to discover the beauty of nature and speaking about the natural environment"[3] to "appropriate and positive process whereby educators can start young children on their journey toward becoming environmentally responsive youth and adults"[4]. This shows that the method of *how* children are exposed to ECEE can take many forms, but ultimately leads to similar results. The study reviewed existing research into ECEE to see what results these educational practices were getting, and the results were strong. The study states that ECEE

[3] Nicole M. Ardoin and Alison W. Bowers, "Early Childhood Environmental Education: A Systematic Review of the Research Literature," *Educational Research Review* 31 (November 1, 2020): 100353, https://doi.org/10.1016/j.edurev.2020.100353.
[4] Nicole M. Ardoin and Alison W. Bowers, "Early Childhood Environmental Education: A Systematic Review of the Research Literature," *Educational Research Review* 31 (November 1, 2020): 100353, https://doi.org/10.1016/j.edurev.2020.100353.

effectively encourages children to explore the environment, boosts their confidence, bolsters their abilities to make social connections, develops cognitive frameworks for understanding the natural world, and lays groundwork for skills needed to take action to improve and protect the environment.[5] These results are promising as aquaponics creates the perfect environment for children to experience both nature and learning-oriented goals at the same time, suggesting that introducing young children to aquaponics may be a successful method of engaging them with ECEE. The coupling of childhood education and environmental education produces a result greater than the sum of its parts and therefore should be pursued and explored through new methods to further progress the capability of our society to provide this opportunity to the children of the world. This may be done in many capacities, ranging from exhibits, park centers, school programs, or privately at home.

Carrying forward with pairing childhood education with environmental education, a crucial part of this process is demonstrations. Whether that is demonstrating a live animal to children, showing them how the water cycle works, or any other visual learning opportunity, seeing is a critical part of believing. Aquaponics provides the opportunity to witness natural cycles taking place. The process puts plants and animals at the forefront of the system and allows for direct and indirect interaction with both. The exciting aspect for children may be being able to see fish up close, an atypical experience unless they have been afforded the

[5] Ardoin and Bowers, "Early Childhood Environmental Education: A Systematic Review of the Research Literature."

opportunity to go fishing, which, depending on the location, may be rare. In a study titled "The Implementation of Demonstration Method to Increase Learning Outcome in Natural Science Lessons", researchers sought to validate the ability of demonstrations to improve student comprehension of topics in science. The study was done with students in 2nd grade in a state elementary school. Separate groups of children were given a lesson on the same topic; one group was given a demonstration, where an activity was performed in the classroom, and another was not. Both groups were given post-lesson evaluations to gauge their learning. The findings suggested that the use of demonstrations improved student learning outcomes[6]. This is unsurprising given that at a second grade age, kids enjoy playing and doing activities. At this young age, children who may have a hard time asking questions, still enjoy doing activities, and often benefit from a hands-on activity.

This once again ties back to the success of education when it is paired with the natural world and shows the viability of aquaponics as an educational tool. Not only is the system a novel idea to them, but it is full of life and engaging content. Whether the system is located at a natural area or in the classroom, it can serve as a valuable tool to get children engaged with the content taught in a science classroom. The study emphasizes that children are the catalyst of change as they are the future decision makers of our societies, and if we wish to further our human progress and make meaningful changes in the world, education should be our top priority, and anything

[6] Bambang Wiranto Pangaribuan et al., "The Implementation of Demonstration Method to Increase Learning Outcome in Natural Science Lessons," *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini* 6, no. 4 (2022): 3680–92.

that may better the education of children should be acted upon[7]. The point of this research was to provide a reason to engage more often in demonstration methods within classrooms, and the findings of this study ought to be considered when questioning ways to improve the quality of education for our future generations.

As the world becomes more advanced and relies more heavily on technology, the ability to deal with complex systems becomes more and more important. Learning how changes in one system upstream may affect a different system downstream is becoming ever more critical because nothing acts in a vacuum. This idea can be difficult to demonstrate, and requires critical thinking, but through the use of aquaponics, the idea can be made clearer. Aquaponics is a system that engages with Science, Technology, Engineering, and Mathematics (STEM) in equal parts and provides a hands-on approach to enable experiential learning[8], which is many students' preferred method of learning. The system of aquaponics is also very adaptable, which makes it suitable for many ages and locations. The internet has countless resources on how these systems can be made, and they can be constructed at an inexpensive cost[9]. A problem with incorporating Aquaponics into the classroom at levels below university level is the preexisting curricula. Often, schools have

[7] Pangaribuan et al.

[8] "Chapter 24: Aquaponics and Social Enterprise," in *Aquaponics Food Production Systems : Combined Aquaculture and Hydroponic Production Technologies for the Future*, by Sarah. Milliken and Henk. Stander, 1st edition 2019. (Cham: Springer Nature, 2019), https://doi.org/10.1007/978-3-030-15943-6.

[9] "Chapter 4: Design of Aquaponic Units," in *Small-Scale Aquaponic Food Production : Integrated Fish and Plant Farming*, by Christopher Somerville and issuing body Food and Agriculture Organization of the United Nations publisher., FAO Fisheries and Aquaculture Technical Paper, 589 (Rome: Food and Agriculture Organization of the United Nations, 2015), 4.

learning objectives that they must accomplish, making aquaponics difficult to incorporate into the class schedule unless it is well-planned and executed. While it is not impossible, it is more difficult than university level, since upper-level classes tend to have more freedom in how they plan their schedules. An example of aquaponics being brought into a primary school can be seen at Alandsbro Skola, a primary school in Sweden. The school created two tabletop aquaponics systems to use with the students. 90-100 students (aged 9-12) participated, as well as several teachers, and the tanks were used for various lessons. A diary was kept for each tank, and the students

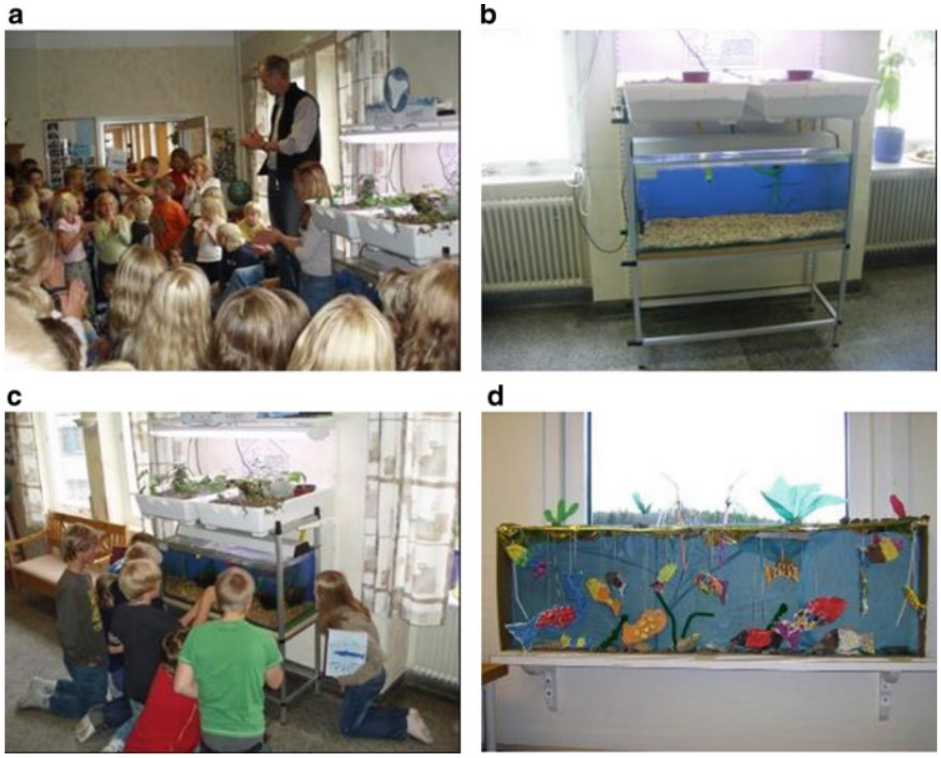

Figure 1: "(a) Opening ceremony in the school of Alandsbro, (b) The simple aquaponics at Alandsbro, (c) Older students making observations for the "Recirculation Book," (d) Model built by the younger students during an arts class" (Figure 1 and description provided by "Chapter 22: Aquaponics as an Educational Tool," in Aquaponics Food Production Systems : Combined Aquaculture and Hydroponic Production Technologies for the Future, by Ranka Junge et al., 1st edition 2019. (Cham: Springer Nature, 2019), https://doi.org/10.1007/978-3-030-15943-6.)

made daily notes about the systems, including the PH, temperature, nitrate and nitrite levels, the lengths of the plants, the activity of the fish, and when they added food into the water[10]. The younger students learned about the process of recirculation by building models out of cardboard that demonstrated the process, and also worked with paintings, drama, and music to better understand the relationship between the plants and the fish[11]. Meanwhile, the older students took responsibility for recording the data within the tank, they learned of different themes such as the water cycle, the everyday use of water in a house, the different appearances of smells, tastes, and appearances of water, fish biology and ecology, other environmental recirculation systems, and the importance of water on a global scale. This process was managed by having various groups of students take responsibility for the tank for one week each so that every group got a meaningful amount of engagement with the systems.

This way of learning is promising for the proposition of incorporating one of these systems into a visitor center. Through active engagement with the tabletop aquaponics units, children appear to have learned quite a lot. Through a questionnaire about nutrient requirements of plants and fishes that was given at Alandsbro Skola, there was a 28% increase in correct answers after the unit on aquaponics was taught[12]. Overall, this study provides insightful knowledge about how aquaponics may be implemented into a classroom, but acknowledges that questionnaires may not

[10] "Chapter 22: Aquaponics as an Educational Tool," in *Aquaponics Food Production Systems : Combined Aquaculture and Hydroponic Production Technologies for the Future*, by Ranka Junge et al., 1st edition 2019. (Cham: Springer Nature, 2019), https://doi.org/10.1007/978-3-030-15943-6.
[11] "Chapter 22: Aquaponics as an Educational Tool."
[12] "Chapter 22: Aquaponics as an Educational Tool."

be the best way to gauge student learning. If the study were to be done again, a more useful question to ask instead of "what was the impact on the students: could be "How useful did the teachers perceive the material to be?".

Looking at these studies, it is clear that the current state of education should look towards incorporating more direct involvement in nature, as most studies agree that it has a positive impact on the learning of children, especially in early childhood. This age is crucial in creating adults who are environmentally conscious. Exposure to natural systems has been seen to allow for more self-expression, better comprehension, more engagement, and an amplified interest in the environment, according to the studies covered in this section. There is not much research on aquaponics being used in schools in the United States since the requirements of learning outcomes are quite rigid, and I believe this would be a great opportunity for further research in the field.

While most scholars agree that it would be beneficial to implement aquaponics into the classroom, an easier route may be to incorporate it into other public aspects of education. Parks and reserves often have summer camps which allow for childcare during the summer when parents are still working, but the children are on their breaks from school. Incorporating displays and systems that deal with aquaponics may be more appealing to places that already focus their children's education on the natural environment. It would take less effort to install a system such as this somewhere with less stringent requirements than a school, and I believe it

makes parks a prime candidate to enhance their ability to supplement ECEE. The incorporation of aquaponics exhibits into parks would provide a natural synergy at a location where providing an education about the environment is already the primary goal of the organization. Changing the trajectory of the entire educational system is a large challenge and would take some time to accomplish, so implementing the demonstration strategies into the alternative locations where students get their education may provide a stopgap between current practices and where education ends up. This would also provide an opportunity to do studies on the results of the incorporation with lower stakes than changing the education system. This would provide a chance for the system to prove itself on a larger scale incorporation while not impacting the whole of the education system if it is to fail.

In Adults

It is important to remember, however, that the future of the environment does not rest wholly on the shoulders of our successors. Adults, too, have a part to play, if not a more pressing one than our children. The time to fight for a healthier environment is now, and each moment we do not is a moment wasted. Most people do not actively despise the environment, yet perform actions that contribute to the detriment of ecosystems and our natural places. This may seem counterintuitive, but it may happen as a result of ignorance or a sense that one's actions do not matter to the bigger picture. This mindset, however, can be changed. In a study titled "A Meta-Analysis of the Effect of Visiting Zoos and Aquariums on Visitors' Conservation Knowledge, Beliefs, and Behavior," researchers investigated zoos and aquariums to

determine whether or not zoos held any influence over the knowledge, beliefs, and behaviors of visitors. Using the Theory of Planned Behavior as a theoretical lens, and identified that with 95% certainty, interactions with zoos had a small to medium positive impact on visitors being more knowledgeable about conservation issues, holding more favorable opinions on conservation, and were more likely to act for the benefit of biodiversity[13]. This result establishes zoos as promoters of knowledge and action and plays into the narrative that seeing is believing. Having up-close encounters with animals and plants that are affected by the results of your actions holds people accountable for their actions and may make them think twice about a questionable environmental choice. The results of this study are promising as they show that zoos may promote belief shifts and may contribute to achieving global targets[14]. Of the many ways that zoos influence visitors, the three that were most effective were increasing awareness of behaviors and their impacts, overcoming barriers to action, and delivering information from a trusted source. All of these things are relatively straightforward to do and can be incorporated into almost any system. Even more promising is that the study found "a visit or any form of engagement with a zoo or aquarium is likely to have positive effects on outcomes in visitors"[15]. This must be taken with a grain of salt, though, as the amount of impact each effect had was variable, and more study must be done to deem this claim completely true, but it is exciting nonetheless.

[13] Xavier McNally et al., "A Meta-Analysis of the Effect of Visiting Zoos and Aquariums on Visitors' Conservation Knowledge, Beliefs, and Behavior," *Conservation Biology* 39, no. 1 (February 1, 2025): e14237, https://doi.org/10.1111/cobi.14237.
[14] McNally et al.
[15] McNally et al.

Environmental Considerations

Brief

Aquaponics is often hailed as a sustainable alternative to traditional agriculture. Most often, it is cited that aquaponics systems produce more plants in less space, use less water, and create less waste; many of these claims make dangerous generalizations and rely on a lack of specificity. Largely, these claims are unverified due to the lack of commercial-scale aquaponics systems and the availability of data from commercial-sized units that do exist. This section will look at the available data to determine the true nature of aquaponics and how it can impact the environment.

Versus Traditional Agriculture

Current soil-based agriculture systems are contributing to the overexploitation of water, land, and nutrients. The popular agricultural method of planting and harvesting monocultures utilizes a large amount of pesticides and chemical fertilizers to provide bigger and better yields for farmers. These chemicals are frequently washed off the farms by rain and into the nearby waterways, which often leads to the pollution of the water sources and eutrophication of freshwater bodies[16]. With aquaponics, since the plant growth is primarily indoors, it uses far less pesticides and fertilizers[17] and heavily reduces the chances of any chemicals unintentionally being

[16] Sravani Pericherla, Manoj Kumar Karnena, and Saritha Vara, "A Review on Impacts of Agricultural Runoff on Freshwater Resources," *Int. J. Emerg. Technol* 11 (2020): 829–33.
[17] "Chapter 2: Aquaponics: Closing the Cycle on Limited Water, Land and Nutrient Resources," in *Aquaponics Food Production Systems : Combined Aquaculture and Hydroponic Production Technologies for the Future*, by Simon. Goddek et al., 1st edition 2019. (Cham: Springer Nature, 2019), https://doi.org/10.1007/978-3-030-15943-6.

washed into nearby water sources since the growing mediums are not open to the rainwater.

Regarding Invasive Species Vectors

In most instances, baitfish are collected from wild mixed species stocks, mostly through netting. This allows for a large amount of bycatch, which is the catching of species other than the intended target species. This inherently creates a risk of transporting unintentional species to different locations. Fish caught along with these baitfish often include game fish, imperiled, and invasive species. With this, combined with many angling trips and risky angler behavior, a high probability of introducing invasive species to new bodies of water increases greatly[18]. In an article titled "Ecological Risk of Live Bait Fisheries: A New Angle on Selective Fishing," there is a call for new methods of both legislation as well as bait harvesting. This article addresses the need for alternative methods of procuring bait and minimizing the use of potentially invasive species as baitfish. This would call for a substitution of non-native species for native species when angling. Through a study done by the Arizona-Nevada Academy of Science, they found that there is no difference in the persistence times of native vs non-native species when used as bait, meaning they both are viable options when fishing[19]. This study, combined with the fact that bluegill (a species native to most of North America) can be raised with great success

[18] D. Andrew R. Drake and Nicholas E. Mandrak, "Ecological Risk of Live Bait Fisheries: A New Angle on Selective Fishing," *Fisheries* 39, no. 5 (May 4, 2014): 201–11, https://doi.org/10.1080/03632415.2014.903835.
[19] Ethan Mower and Lorraine Avenetti, "A Comparison of Live-Hooked Persistence Time between Non-Native and Native Baitfish in Arizona," *Journal of the Arizona-Nevada Academy of Science* 48, no. 1–2 (October 1, 2019): 218–21, https://doi.org/10.2181/036.048.0204.

in an aquaponics system[20] means that aquaponics may provide a solution which allows anglers to still use live-bait, but to do so through the use of a native species. Aquaponics can raise these baitfish as a byproduct of growing a plant. Allowing for these species to be raised in isolation without the risk of bycatch, while performing a role to allow for more plant production. It is important to provide this option to anglers because, as shown in another study, 64% of anglers in the state of Maryland use live bait, and it is extremely likely that they are releasing unused bait into the water bodies they fish. The study showed that 65-69% of anglers will release aquatic bait into the environment[21]. Aquaponics can help put native species in bait shops and mitigate some of the impact of baitfish being released into the environment.

Human Well-being through Nature

Stress Reduction

This project seeks to improve the lives of those who attend the park by providing experiences that make people more aware of their connection to the natural world. There is much evidence suggesting that time spent in nature can improve mental health and well-being, and it is now becoming accepted in medical situations that spending time outdoors can be prescribed as a preventive measure for health issues[22]. Through medical trials and repeated exposure to the natural environment,

[20] "Chapter 7: Fish in Aquaponics," in *Small-Scale Aquaponic Food Production : Integrated Fish and Plant Farming*, by Christopher Somerville and issuing body Food and Agriculture Organization of the United Nations publisher., FAO Fisheries and Aquaculture Technical Paper, 589 (Rome: Food and Agriculture Organization of the United Nations, 2015), 7.
[21] Jay V. Kilian et al., "An Assessment of a Bait Industry and Angler Behavior as a Vector of Invasive Species," *Biological Invasions* 14, no. 7 (July 1, 2012): 1469–81, https://doi.org/10.1007/s10530-012-0173-5.
[22] ND Cyndi Gilbert and Katie Smith, "Nature Rx: Health Benefits of Spending Time in Nature," n.d.

patients in this study were found to have lower salivary cortisol and subjective stress levels than patients who were not exposed to the natural environment.[23] This has led to the implementation of a program called Nature RX, which allows doctors to prescribe time in nature as a preventative treatment for disease. However, this is not the only way that engaging with the natural world can promote good health in people. It has been shown that through the direct care of plants, a relationship between person and plant is created in which a direct relationship between the care given and the state of the plant can easily be seen. This creates personal agency and responsibility. Practicing horticulture in a group setting acts as a structure to acquire skills, improve self-worth, and provide a buffer to stressors.[24] Aquaponics can also provide an opportunity to connect with the community in a new way. For example, if the produce is provided to local restaurants, like with *Asociacion Huerto Lazo*, where the fish raised in aquaponics systems, cared for by young people from "troubled backgrounds," are sold to El Sollo restaurant in Fuengirola[25]. This creates a relationship between a community member and their community and allows for positive connections to be established between people through the vector of working with nature to provide a product.

[23] Cyndi Gilbert and Smith.
[24] "Chapter 24: Aquaponics and Social Enterprise," in *Aquaponics Food Production Systems : Combined Aquaculture and Hydroponic Production Technologies for the Future*, by Sarah. Milliken and Henk. Stander, 1st edition 2019. (Cham: Springer Nature, 2019), https://doi.org/10.1007/978-3-030-15943-6.
[25] "Chapter 24: Aquaponics and Social Enterprise."

Representing Personal Beliefs

It has also been shown through the findings of UC Berkley's post-occupancy evaluation of the Philip J Merrill Center gives insight into how people feel when a building aligns with their personal goals. The survey recorded responses of inhabitants of the building, ranking their satisfaction in multiple categories four years after the building had been constructed. The building broke the record for user satisfaction of a LEED building, which houses the Chesapeake Bay Foundation[26]. This is critical as it is a building that fits the goals of the organization. The survey suggests that since the building practices what it preaches, it made the people working there happier and more satisfied with both the building and their work. This can be applied to the thesis at hand, as it shows a direct relationship between aligning a building to an end goal and the end-user satisfaction with the building.

Conclusion

This literature review has explored the many benefits and high potential of aquaponics, primarily in regards to education, environmental impact, and human well-being. From early childhood learning to adult education, aquaponics presents a less explored method of learning that can engage individuals through hands-on interaction with natural systems. Studies show that children respond positively to experiential learning experiences such as the ones in aquaponics systems. These

[26] J Heerwagon and Leah Zagreus, "The Human Factors of Sustainable Building Design: Post Occupancy Evaluation of the Philip Merrill Environmental Center. UC Berkeley: Center for the Built Environment," *UC Berkeley: Center for the Built Environment*, Indoor Environmental Quality (IEQ), April 1, 2005, https://escholarship.org/uc/item/67j1418w.

systems nurture curiosity, environmental stewardship, and systems thinking which are all critical skills for the next generation to have. Similarly, adults exposed to educational experiences focused on the natural world, such as those provided at zoos and aquariums, are more likely to adopt pro-environmental beliefs, which shows the potential of aquaponics as a tool for changing people's behavior as well as beliefs.

Despite aquaponics' reputation as a ultra-sustainable technology that will singlehandedly save humanity from the food problems it struggles with today, the current body of research has shown both promise and the need for greater scrutiny. Issues such as pesticide reduction, water conservation, and invasive species management show encouraging promise, but more data from large scale systems is necessary to confirm the long term sustainability claims.

Aquaponics can contribute positively to human well-being by serving as an outlet for stress relief, bringing forward community engagement, and building self-worth and confidence through care for living systems. Using aquaponics as a system to send a message that aligns with personal or organizational ideals can lead to a greater sense of fulfillment and purpose, as seen in the Phillip J. Merrill case study and the other aforementioned community focused aquaponics initiatives from *Aquaponics Food Production Systems.*

Overall, aquaponics is promising as a tool that bridges education, environmental health, and personal well-being, but to unlock its full potential, further

research, practical implementation, and public engagement will play large roles in determining its success. Aquaponics is not just a method of food production, but a greater, more powerful system, that serves as a metaphor for the interconnectedness that exists between all things which exist in nature, and this deserves continued exploration and interest.

Chapter 3: Methodologies

Introduction

This chapter will explore the methodologies of this thesis research topic. This passage relies heavily on the methods described by Ray Lucas's *Research Methods for Architecture*[27] and seeks to clarify the methods used to conduct the research for my thesis topic. Tuckahoe State Park is a complex ecosystem, so it is important to understand it at a variety of levels and through multiple lenses. To do this, a mix of qualitative, quantitative, design-based, theoretical, and visual methods will be used to obtain a deep understanding of the problem as well as the solution of this thesis. It is critical to conduct research through a variety of methods to have a more complete solution to the problem. These methods will allow for a variety of experiences to be measured and introduce new perspectives that may not have been considered if this research was done exclusively using only one or two of these methods, it is the net result of these methods compiled that will provide an accumulation of knowledge that can strengthen the end result of the project.

Methods

Qualitative Methods

This thesis places strong emphasis on understanding the lived experiences of park visitors, both human and non-human. Ethnographic research will be used to

[27] Ray. Lucas, *Research Methods for Architecture* (London: Laurence King, 2016).

observe the behaviors, routines, and interactions of a diverse range of park users. This will extend not only to people, but plants and animals as well as abiotic processes on the site. These observations will provide insight into how different actors engage with the site and will help ensure that the final design reflects the actual needs, patterns, and goals of its inhabitants. This is critical to designing a space that functions with the end goal of mutualism and deprioritizes the focus on the needs that are exclusive to humans.

Figure 2: Signs of Beaver Activity on Piney Branch Trail (Photo by author, 2024)

To supplement and contextualize these observations, unstructured interviews will be conducted with both visitors and park staff. The conversations with park visitors will explore motivations for visiting, perceived strengths and weaknesses of the current infrastructure, and ideas for improvement. Interviews with park staff will

include statuses of plant and animal species, perceived strengths and weaknesses of the park, and potential issues that architecture may play a role in solving. This qualitative data will deepen the project's understanding of user priorities and help shape a design that is responsive to the community.

Additionally, as a frequent visitor to Tuckahoe State Park, I will incorporate my own immersion into the research process. This first-hand engagement will provide an additional layer of insight into the everyday rhythms and functional challenges of the park, while being balanced with objective data and broader participant perspectives.

Quantitative Methods

This thesis also draws heavily on quantitative data, particularly through spatial analysis. Tools such as GIS (Geographic Information Systems) and Google Earth will be used to evaluate the physical characteristics of Tuckahoe State Park, including land allocation, topography, proximity to ecological features, and infrastructure access. These spatial insights will help identify potential sites for a new visitor center that are contextually appropriate and environmentally responsible.

In addition, statistical data such as annual visitor counts, seasonal usage patterns, and comparative metrics from similar parks will be analyzed to inform the functional requirements of the center, including its size and capacity. Quantitative

data will provide objective grounding for design decisions and may also reveal unexpected patterns that challenge initial assumptions. These findings will be cross-referenced with qualitative and visual data to ensure a holistic, data-informed approach to site planning and program development

Design Based Research

This thesis will conduct research through the method of design. Using design experiments through the method of physical models, digital models, and various forms of drafting will act as a form of questioning and allow many possible scenarios to be tested to objectively compare the products of different methods of design. These designs will be further criticized and improved upon to ensure that an ultimately strong design result is achieved. Similar to a design studio, the results of these design experiments will improve through iteration and critical thinking and push the research towards a solution that has been critiqued through many methods of exploratory design.

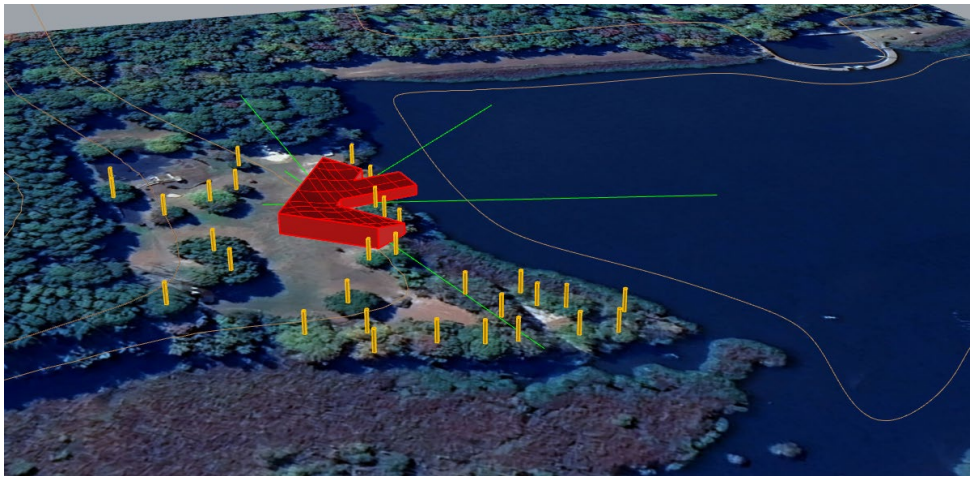

Figure 3: Digital Massing Model of a Proposed Design Concept (by author, 2025)

Theoretical Research

These methods will utilize existing literature and theory to achieve a better understanding of the baggage associated with the designs of visitor centers as well as aquaponics system and the relationships humans share with the natural world. Historical documentation will be analyzed to internalize the history of State Park visitor centers and to better understand the historical context of Tuckahoe State Park and understand it's original plans, goals, shortcomings and successes. A literature review will also be conducted to assess the current state of aquaponics, research into how humans benefit from time spent in nature, the ecosystem of the Delmarva peninsula, and the relationship between man and nature. This wide expanse of topics will help encompass not only the design of a visitor center, but a more comprehensive understanding of the adjacent fields and areas of importance that may tie back to the larger scope of the project.

Visual and Spatial Methods

Lastly, visual and spatial tools such as diagramming, mapping, and photography will support the research by communicating site conditions, relationships, and user experiences. Mapping techniques will allow for quick comprehension of patterns within the context, land use, spatial hierarchies, and relationships at multiple scales. While diagramming will serve as visual abstractions of the interplay between the many systems at work within the environment of Tuckahoe as well as the relationship Tuckahoe has to its adjacent land uses.

Diagramming and mapping will be crucial to the development of the thesis as they will allow for a wealth of accessible information the be available when making decisions in the design process. Diagrams of water flow, sun path, and visitor accessibility, for example can be useful when determining the most ideal site for the visitor center. Diagrams will also play a crucial role in understanding the systems and processes that connect different actors in the park together. Diagramming will serve as an easily digestible means for construing information about the seen and unseen relationships in the park. Photographs and recordings will assist in conveying the message of the qualities of the site as it stands. Through photo collage and sequenced photographs, the site will be better portrayed for an outsider to envision the experiences one would have within the park.

Figure 4: Visitor Activities within the Park (Photos by author, 2025)

Chapter 4: Precedent

Introduction

This thesis has studied five precedents with different intentions and insights being drawn from each of them. The first project studied was the Ise Shrine in Ise, Japan. This project was studied to understand the process of steeping visitors in a setting of serene natural qualities and having the architecture of the space contribute to the feelings of connection to the natural world. The next case study was The Farnsworth House by Mies Van Der Rohe, this project was looked at through the lens of understanding the importance of views, transparency, and control. The Kengo Kuma & associate project, The Portland Japanese Garden Cultural Village successfully creates interactions between people of diverse backgrounds and cultures through harnessing the great equalizer of natural beauty and was studied in order to understand why it is so successful in accomplishing this goal. The fourth building studied was Agape Productive Housing by Rama Estudio in Ecuador. This building was studied for its tectonics and successful use of natural materials such as timber and rammed earth which were used to connect the building back to the site and create a serene atmosphere both inside and outside the structure. Finally, the Little Leisure Lodge in Monferrato, Italy was studied to understand how to connect a place to it's environment. The intention for this process was to find projects which captured specific qualities of the space which I am envisioning and boiling away the rest of the

project to study more deeply how to obtain those specific qualities such as an aura of tranquility or an architecture which fosters an appreciation for the landscape.

Grand Ise Shrine

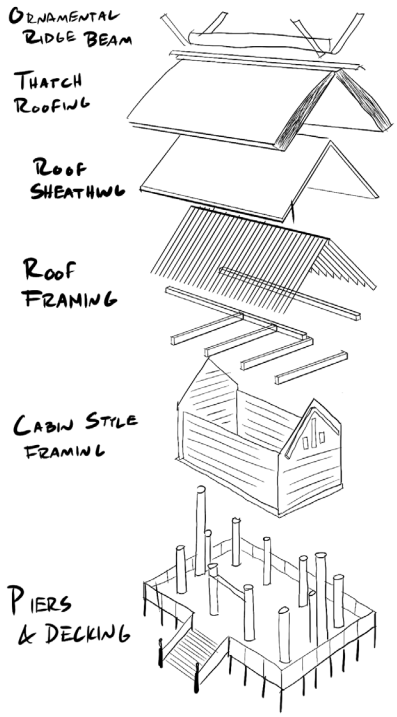

Figure 5: Grand Ise Shrine Exploded Assembly (Illustration by author, 2025)

The Grand Ise Shrine is an important location in Shinto religion, which focuses on the spiritual essence of things, beings, or actions[28]. This shrine showcases a place's ability to maintain identity despite being rebuilt every twenty years and questions the traditional western perspective on preservation. The place creates a serene atmosphere due to its location; nested within a dense, old, and spiritually significant forest and has a procession which slowly marches the visitors through a winding journey up to the shrine which washes the visitors over with the presence of nature. The path is an important aspect of the shrine itself as it allows the visitors time to adjust to the new scenery and feel steeped in nature. Taking this journey allows the mind frame of being in the natural world to set in, through the journey, one's mindset has time to transition from the bustle of life to a focus on the beauty of nature and the spiritual significance the shrine holds. The entire experience of this

[28] Miyaji Naokazu, "What Is Shinto?," *Contemporary Religions in Japan* 7, no. 1 (1966): 40–50.

shrine would be vastly different if visitors could drive directly to the shrine and park at its doorstep.

The procession is critical in understanding this place and is something often overlooked in western architecture. Another feature of this space which is critical to understanding its significance is the connection it establishes between the people and the site. The building is reconstructed on alternating sites which are adjacent to each other every twenty years[29] using trees from the surrounding area. The act of reconstructing this building establishes many connections back to the site as well as to traditional Japanese construction techniques. The Logs are rolled down the hill and into the river. The logs are fished out further downriver and picked up by craftsmen. These people practice ancient techniques of Japanese joinery[30] and other construction methods to prepare the pieces to be transported back to the site and reconstructed the same way it has been since the seventh century. This practice connects not only the structure to the site, but the people as well. The heritage of the people of Japan is embodied within the shrine and provides a valuable lesson about how to connect culture back to a building. This process emphasizes that responsibility fosters ownership and pride, a critical aspect that is intended to be included in the thesis of this project. Through the act of utilizing the visitor center's productive capacities members of the community can aid in the effort of strengthening the environment and through this act gain a sense of ownership

[29] Jordan Sand, "Japan's Monument Problem: Ise Shrine as Metaphor," *Past & Present* 226, no. suppl_10 (January 1, 2015): 126–52, https://doi.org/10.1093/pastj/gtu018.
[30] Florian Coulmas, "Eternal Change at the Grand Shrine of Ise," *Japan Quarterly* 1, no. 3 (1994): 1–10.

Edith Farnsworth House

The Edith Farnsworth House by Mies Van Der Rohe sits along the banks of the Fox River in Plano Illinois. The house puts the occupant face-to-face with their surroundings, the only thing separating them being a few white columns and a thin layer of glass. The house plays into the landscape which it is situated on. The flatness of Illinois is reinforced through site moves such as clear cutting a path of trees from the forest and establishing a lawn. The manicured grass reinforces the connection to the structure as the level surface of the grass resembles the flat planes which make up the building's floors and roof. This is an easy detail to take for granted, but reminds the designer to take ownership of not only the building, but the landscape as well. Buildings do not exist in a vacuum, but interact fundamentally at a high level with their site. Though the site resembles the building itself, the fact that this building does a horrible job at being resilient to its site is one of the biggest critiques of this building. Having been built in the floodplain[31], and not being built above the flood height, this building fails dramatically at being conscious of all of the environmental conditions of its location. There is a dichotomy between the inside of this building and it's exterior. From the outside, the building harmonizes with its surroundings, but stands out greatly. The stark white paint pops this building out of the landscape immediately, but from the inside of the building the landscape is brought inside and the surrounding environment seems to blend seamlessly into the ambiance of the structure. There are no interruptions in the view of the landscape except for the sparse

[31] James J Williams, "Living with Nature the Farnsworth House and the Environmental Successes and Failures of Modernist Architecture" (University of Cincinnati, 2015), http://rave.ohiolink.edu/etdc/view?acc_num=ucin1445342413.

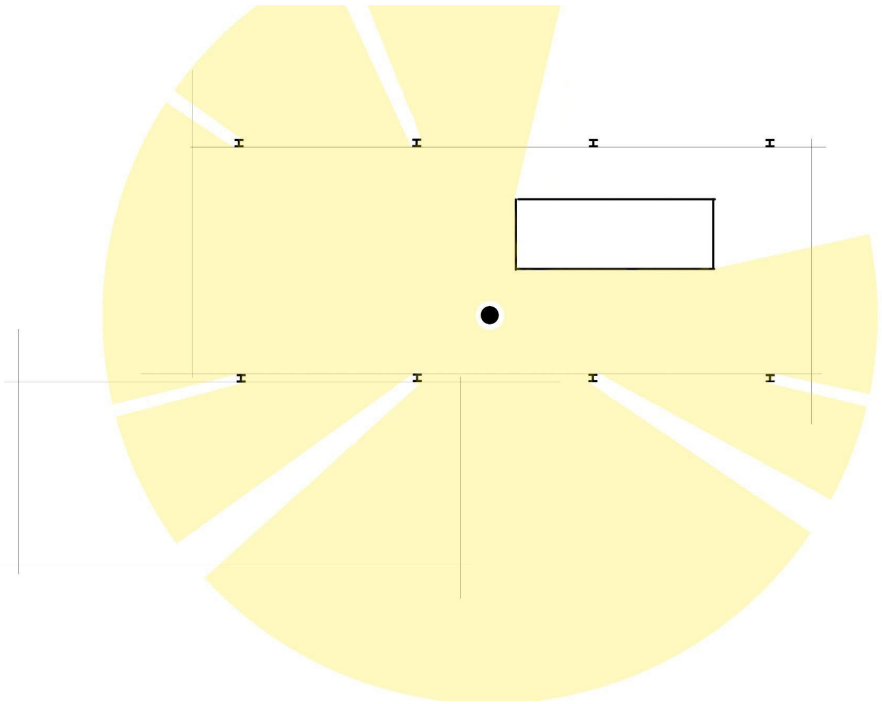

Figure 6: View Shed Diagram from Center Point of the House (Illustration by author, 2025)

interruptions from the columns which have a minimal impact on the inhabitant's field of view. This lack of interruptions makes the indoctrination into the environment come more easily emphasizing the importance of control. If these columns were larger, they would greatly eat into the view path of the inhabitant, creating disharmony between the inside and outside, and making the large panes of glass feel more like windows than an invisible boundary between inside and outside. The study of this building will take shape in my thesis through taking great care to prepare the site for the building and having them work together instead of against each other. This means considering environmental attributes such as flood planes, cut and fill amounts, tree removal, and more to get a full understanding of what to expect in terms of environmental impact and looking to minimize disturbance.

Portland Japanese Gardens Cultural Village

The Cultural Village is a project which deals with landscape and harmony in nature through utilizing tools derived from a traditional style of Japanese residential architecture called "monzenmachi"[32]. This style lends itself highly to the site by creating a central courtyard space framed by the three buildings while also appealing

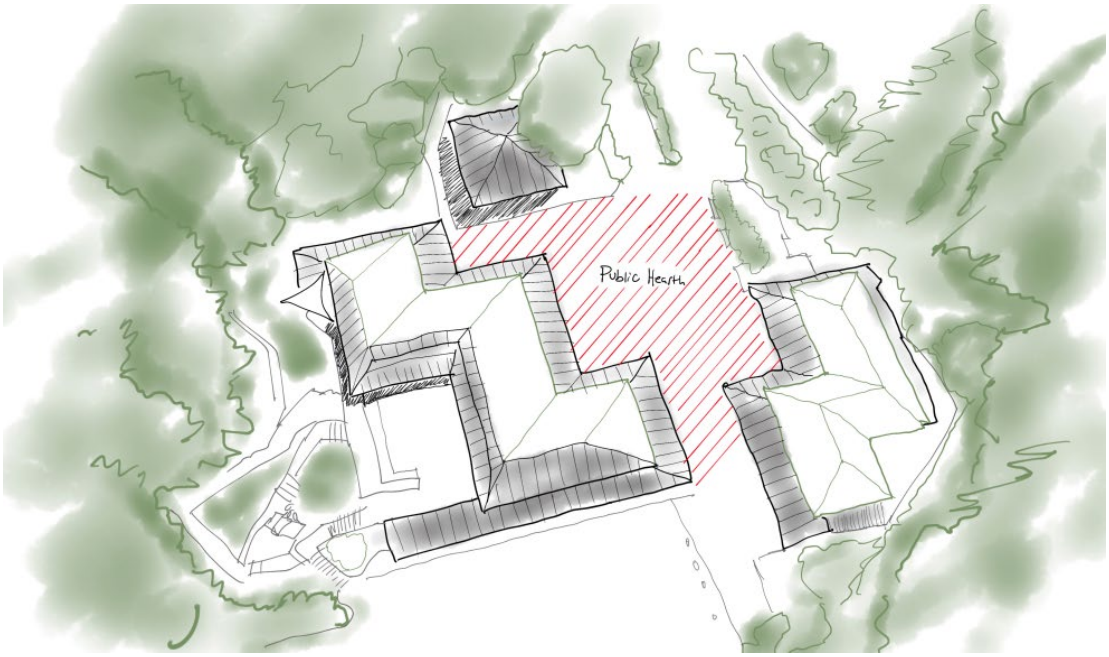

Figure 7:Aerial View Highlighting the Public Hearth as Framed by the Buildings(Illustration by author, 2024)

to traditional Japanese architecture, However, the system used to construct the buildings is anything but traditional. The entirety of the building's structure is steel and it allows for cantilevers and overhangs unachievable by the traditional architecture methods. This results in a sharp look and the ability to open more walls up to the outside - a critical element to the success this project sees in creating flexible, inviting, and low-stress spaces. The entirety of the ground floor can be

[32] Kengo Kuma and Associates, "Portland Japanese Garden Cultural Village," Architect's Website, accessed May 19, 2025, https://kkaa.co.jp/en/project/portland-japanese-garden-cultural-village/.

opened up as the exterior walls are all sliding glass doors, this blends the threshold between the plaza and interior shop spaces. Despite being only 3 buildings, the courtyard is washed in the feeling of a small village bustling with life and providing opportunities for exchange between the patrons of the gardens. The project gives a place for people to exchange cultures with many opportunities for hands-on learning throughout the cultural village. The environment is highly natural and it makes a welcoming place for anyone no matter race, religion, or sex. The lesson to be derived from this project is that space carries a social weight. Creating a place which suggests peaceful behavior has a real influence and can set the expected behaviors of visitors to align with the vision of the organization.

Agape Productive Housing

Agape Productive Housing is a yoga studio and a residence, but mostly it is a meditative space. The clean finishes consist of textures one would expect to find in nature. Exposed wood grain, earth tones within the walls, and the greenery provided by the curtain wall's view out into the green courtyard simulate the feeling of taking a

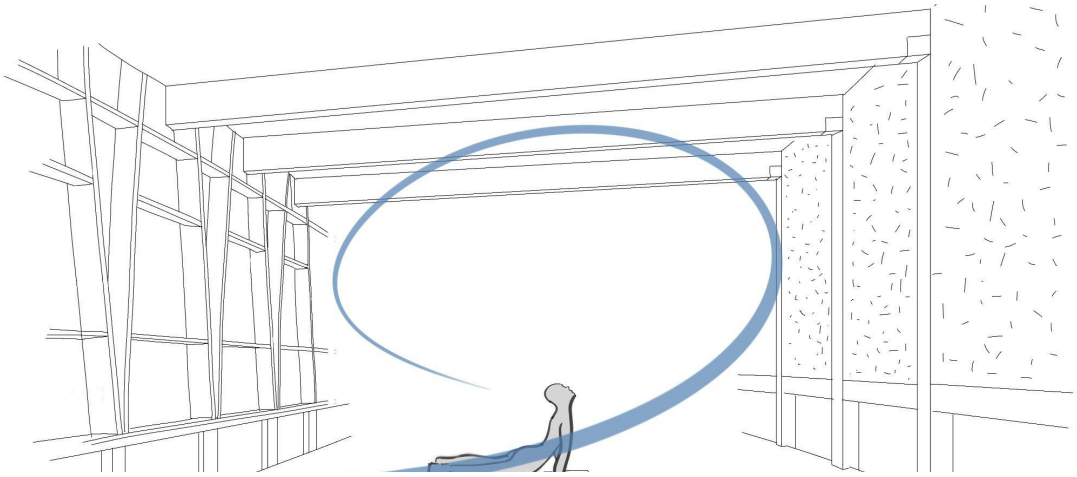

Figure 8: Person Performing Yoga in the Central Yoga Studio(Illustration by author, 2025)

walk out in nature. The mind and body feel at peace when comforted by the presence of nature and this studio successfully draws those qualities indoors. The open plan allows for a clean and meditative space for the yoga studio. With focus drawn to the wooden beams and the rammed earth walls, one feels tranquil. The simple repeated module reinforces the feeling of predictability and allows one to focus on their thoughts and feelings. The crescent shape focuses the view on the courtyard and allows one to appreciate the natural elements of both the courtyard and the building itself. The module for each bay is seemingly complex, but really focuses on a few key connections where wood meets steel. Simple buckets and exposed plates are used to hold the beams together and give an accent to the finishes on the interior. The rammed earth walls are an adaptation of a traditional Ecuadorian rammed earth technique called "bahareque"[33]. The rammed earth is now filled with a modern spray gun which allows the pressurized earth to be painted into the cavity of the walls and then ground down to provide a smooth finish. This project emphasizes the importance of tectonics and materiality. Through the use of textures and qualities found in nature, this building brings the therapeutic qualities of the outdoors into the building. This is important to consider when designing a visitor center as it is of the upmost importance to connect the building back to it's environment and to distill an appreciation for the beauty and healthful qualities of spending time outdoors.

[33] S. Kaminski, A. Lawrence, and David Trujillo, "Design Guide for Engineered Bahareque Housing," *INBAR–International Network for Bamboo and Rattan: Beijing, China*, 2016.

LILELO – Little Leisure Lodge

The scale at which they are built allows for an intimate human connection and the orientation of the multiple cabins along with the odd one out which acts as a community center allows for a sense of comradery and connection between the structures in a makeshift village.

The Simplicity of the form allows the busy facades to read as harmonious with the landscape and allow this pseudo-village to read as if they are pop-up tents on a campground site, further reinforcing the idea of harmony with the landscape. The article talks about the project's ambitions to create a retreat that exemplifies the qualities of northwestern Italy. The form is allegedly drawn from the hay bales commonly found in the area, and uses wood as a "sustainable" material with a finish that will darken over time to show the age of the wood. Searching for little connections like these are critical to tying back the place to the project and bring the user a sense of familiarity and appreciation to the site specific callback.

Conclusion

Together, these five precedents illustrate an approach to designing architecture that deepens the human connection to nature, fosters an appreciation of the natural world, and reinforces a sense of place. From the Grand Ise Shrine, the importance of procession, ritual, and material continuity teaches how architecture can embody cultural memory and spiritual connection. The Farnsworth House offers lessons in visual transparency and the harmony and disharmony between building and site,

reminding us of the critical balance between aesthetic control and environmental responsiveness. The Portland Japanese Garden Cultural Village demonstrates how spatial openness, cultural exchange, and social intention can be guided through the use of architecture to promote inclusivity and tranquility. Agape Productive Housing shows how the careful selection of natural materials and tectonic clarity can create meditative, healing environments that echo the outdoors. Finally, LILELO emphasizes how small, site-specific interventions can deepen one's appreciation for the landscape through context-sensitive design. Each precedent contributes a key ingredient—ritual, transparency, sociability, materiality, and site-specificity—that collectively inform the thesis' overarching goal: to create an architecture that not only connects people to nature but empowers them to participate in the stewardship of place through spaces that are serene, purposeful, and deeply rooted in context.

Chapter 5: Zones and Program

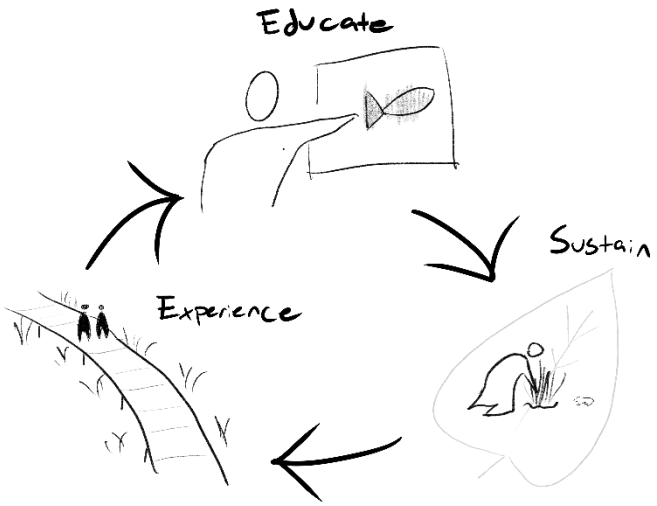

Figure 9: Thesis Drivers Leading to the Three Zone Types (Illustration by author, 2025)

Program Abstract

The program of this thesis project looks to reimagine the typical state park visitor center to create a more meaningful engagement between the visitor and the site. The program is organized into three main zones: Immersion zones, Informing zones, and Involving zones. This is intended to clarify the intended outcomes for those who occupy the spaces of the visitor center. Immersion zones seek to steep the visitor in the qualities of the site. This process is very focused on the experimental aspects of the user. These zones may include places to sit outdoors and listen to the sounds, locations to observe the birds and fish, or locations that mark the start of nearby trails. These spaces intend to acclimate the visitor to the site and allow them to

appreciate the beauty of the surrounding ecology. Inform zones seek to educate visitors through active and passive means. The goal of this is to instill a sense of responsibility and respect that comes with knowledge and to assist in creating a population that is knowledgeable about their local environment. This may take the form of a self-guided tour through the exhibit spaces, or a class taught in a classroom or around the park. Finally, Involve spaces seek to actively engage visitors with the park. This is critical in the scope of this project, as it aims to create a sense of personal ownership of the site for the visitors. Through actively engaging in replanting native plants, kayaking on the lake, or fishing at a location, the program will encourage people to be personally connected to the place and create a deeper appreciation for the ecosystem and its functions. As part of this exercise, the level of enclosure for each element of the program was notated, as for a project like this, it is important to understand the space's relationship to the outdoors. The levels of enclosure in order of least enclosed to most enclosed are as follows: Exposed (EX), Covered (CV), Screened (SC), and Contained (CT). This classification system is intended to encourage thinking about typical programs and how they can be challenged to utilize a connection to the outdoors.

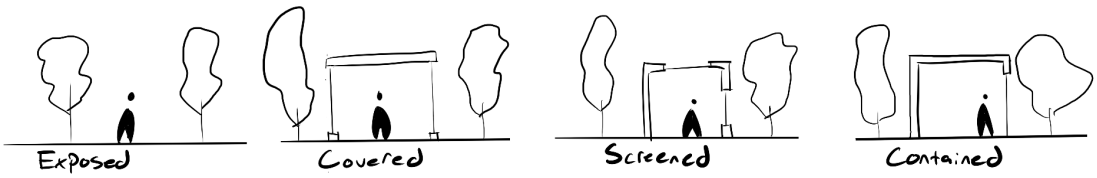

Figure 10: Level of Enclosure Diagram (Illustration by author, 2025)

Program Elements

Immersion Zones

Immersion zones are spaces that strive to connect people to the environment. Immersion zones can be thought of in terms of outdoor spaces as hiking trails, camp sites, or any other place that allows a person to foster an appreciation for the outdoors. For the program of the visitor center itself, these places take the shape of an observation tower, a viewing area for the lake, and an outdoor picnic area. The spaces will have varying degrees of enclosure to allow for a variety of levels of engagement with the outdoors, allowing people to locate themselves in a place that feels most comfortable.

These spaces traditionally happen out in the park, not inside the visitor center, but bringing more of the outdoor experience into the visitor center will drive home the idea that this building is part of the fabric of the park. Having spaces that provide the opportunity to engage with nature in a more comfortable setting may help people warm up to doing activities in nature, and a transition space very well may be what determines whether a person ends up coming back to the park.

Table 1: Immersion Zone Program Breakdown

ZONE 1: Immerse

These spaces are intended to steep visitors in the natural elements of the site.

PRIMARY INTERIOR SPACE(S)	Sub-Spaces	Degree of Enclosure	SQ. FT. (approx.)
Observation Tower			
A space for people to climb up and observe the surrounding area. May be freestanding or within the building. Degree of enclosure may vary	Staircase	CT	
	Observation Deck	CV	
	Elevator	CT	
Aquaponics Pond Deck			
A space for people to observe the fish while also creating a place to relax	Deck	CV	
	Walkway	EX	
Outdoor Meal Space			
A location that alllows people to eat together. Either food that they brought or food purchased on site.	Café	CT	
	Picnic Area	CV	
	Restrooms	CT	

Information Zones

Information zones are categorized by a desire to teach people something about the environment. Much of the program is devoted to these spaces, since giving people a space to learn about the environment is an overarching goal of this project, and part of what makes a visitor center successful. Information zones take place mostly within the walls of the visitor center as they focus mainly on objective learning. The exhibit spaces within the building are a good example of this. Here, there would be displays that have text descriptions, which can educate visitors about various aspects of the park and the processes that it contains. The classrooms are also a good example of this since they serve to educate visitors through lessons or activities that can be conducted indoors.

These spaces are welcoming for new visitors and immediately allow for a transfer of information. This can quickly allow visitors to feel a bit of comfort in their surroundings as they are informed about what to expect around them. These places can also teach seasoned visitors new facts about the location and the creatures which inhabit it, not just through the exhibit, but through classes which may specialize in different topics.

Table 2: Inform Zone Program Breakdown

ZONE 2: Inform

Spaces that serve an educational purpose. Allow visitors to learn actively through classes or passively through exhibits or signage.

PRIMARY INTERIOR SPACE(S)	Sub-Spaces	Degree of Enclosure	SQ. FT. (approx.)
Aquaponics Spaces			
These spaces are tied to the aquaponics system. They make up all the required spaces for both back-end and front end work and enjoyment	Pond Viewing Room (subsurface)	CT	
	Aquaponics Mech Room	CT	
	Grow Room	SC	
	Storage	CT	
	Isolation/Care Room (Fish&Plants)	CT	
Exhibit Spaces			
Spaces to learn passively through signage, written text, and self-lead exhibits	Aquaponics Exhibit	SC	
	Native Species Exhibit (Plants)	SC	
	Native Species Exhibit (Animals)	SC	
	Storage		
Take-Home Learning Resources			
A place for visitors to acquire additional learning resources, childrens books, guides, etc.	Gift Shop	CT	
	Register	CT	
Lesson Spaces			
Spaces which can be used for lessons, group learning, activities	Community (Class)room	SC	
	Outdoor Classroom	CV	

Involve Zones

Involve zones overlap with Inform zones in the sense that they teach people new information or skills, except involve zones call for active learning, or learning through doing. These spaces may function more like the outdoor classroom where people can learn skills like fire starting or bird call identification. Involve spaces seek

to bring people into the outdoors and get them to participate in an activity that they wouldn't be able to do elsewhere. This is done with the hopes of connecting a person to a space. For people to take ownership of a space, it is important to put them in direct interaction with the area.

A critical goal of this building is to aid the existing landscape, and the key way this is done is through having visitors plant native species, which are grown using the aquaponics system within the building, out in the park. This strategy can be used to repair damaged wetland areas, restore wildflower populations, grow new saplings, or restore habitat. This action, while not done within the building completely, is a core component of the involved zone.

Table 3: Involve Zone Program Breakdown

ZONE 3: Involve

Spaces that engage the community with the site through actions and activities.

PRIMARY INTERIOR SPACE(S)	Sub-Spaces	Degree of Enclosure	SQ. FT. (approx.)
Water Recreation			
Spaces for people to engage with the lake.	Kayak Launch	EX	
	Fishing Pier	EX	
	Watercraft Storage	CT	
	Dip-Net Area	EX	
Group Spaces			
Spaces for group gatherings and activities.	Ampitheatre	CV	
	Replanting Areas	EX	
	Equipment Rental	CT	
	Community Room	CT	
Ranger Resources			
Places for the park staff to stage their operations and conducty daily activities	Park Offices	CT	
	Staff Room	CT	
	Garage	CT	
	Equipment Storage	CT	

Chapter 6: Site Analysis and Selection

Introduction

The site has played a major role in the inspiration for my thesis, as my thesis had a site selected from early days. This has positively impacted my research as I have been able to research the flora and fauna local to my thesis to indoctrinate myself with the importance of the organisms that call Tuckahoe State Park home. Remembering the importance of these living things is a critical step in my design process, as one of the ultimate goals of my thesis is to pass along an appreciation of these plants and animals to others.

The site is significant to my thesis because this location acts as a vessel for people to partake in recreation and appreciation of the natural world. People come to this place to indulge in the beauty of nature and put themselves back into a position of appreciation with their environment. This site brings people out of their homes and displays to them the beauty of nature, which cannot be found within their homes. The place offers unique experiences and puts people into contact with like-minded individuals as well as the flora and fauna that take refuge in the park. When people are allowed to connect with these organisms, even if it is just through sight, it sparks excitement and creates a memorable moment and deepens one's experience with the environment.

Intervention Concerns and Site Selection

Taking these factors into account when designing is critical to my thesis, as anything constructed on the site is going to change this environment in some way, and it is of the utmost importance that the consequences of these actions are anticipated and executed in a way that results in a net positive change in the ecosystem. It is also critical to the design process that the exact location of the site is chosen with care to best serve the park, its visitors, and the various species that live in the park.

To be minimally invasive, though, is not the primary concern of the project. If larger changes are needed to positively affect the park, I would not want to shy away from that. For example, the park currently has a lot of agricultural land within it. If it is in the best interest of the park to reclaim this land, which has been cleared and tilled, then that action should be taken. Since the damage has already been done, it would make this location an ideal spot for rejuvenation and

Figure 11: An Image of Turtles Sunbathing on Submerged Wood at Tuckahoe State Park (Photo by Byron De La Cruz, Research Partner, 2025)

improvement. Part of this site may be used for an education center, while the remainder of the field would begin on a path to wetland or forest restoration. In this case, the process would be highly invasive, but in a positive direction, as it is reversing a previous negative impact and overall improving the health of the site.

The criteria that were important to me when selecting this site were a.) a place which preserved a natural ecosystem b.) a place which has a history of connecting the public to nature c.) a place which I understood with a high level of intimacy d.) a place that may be in need of repair or rejuvenation e.) Somewhere that would serve a community that may not have access to many forms of education. These things made Tuckahoe State Park stand out in my mind because each time I traveled to it, I wondered how it remained such a hidden gem. However, when fishing there, I also noticed all of the trash and traces of humanity carelessly using this beautiful space.

Figure 12: Garbage Found at Tuckahoe State Park (Photos by author, 2024)

This spurred a desire to help the people help the park, which was important to the surrounding community, but somehow fell below the radar of people just an hour's drive away. If people understood the importance of this park, then perhaps they would treat it with higher levels of care and respect. That if these people saw more of the creatures that reside in the park and learned that they too have lives as important as ours, and that they are what makes the beauty of this place possible, that the park would remain in better condition longer and would be able to be so healthy, that it could have a positive impact not only on the park, but on the lives of the people who attend it.

Site Documentation

Key Locations

A trip to the site was taken to record observations about the ethnographic and phenomenological conditions of the site. Documentation was recorded regarding things like activities of visitors, favored locations to do these activities, notable plant species, wildlife species, and initial perceptions of the site. Since I have been to the site, all conclusions regarding initial perceptions are drawn from my research partner.

Upon an investigation of the site, a few hotspots of activity were identified, with the location that had the highest concentration of people being the dam at the

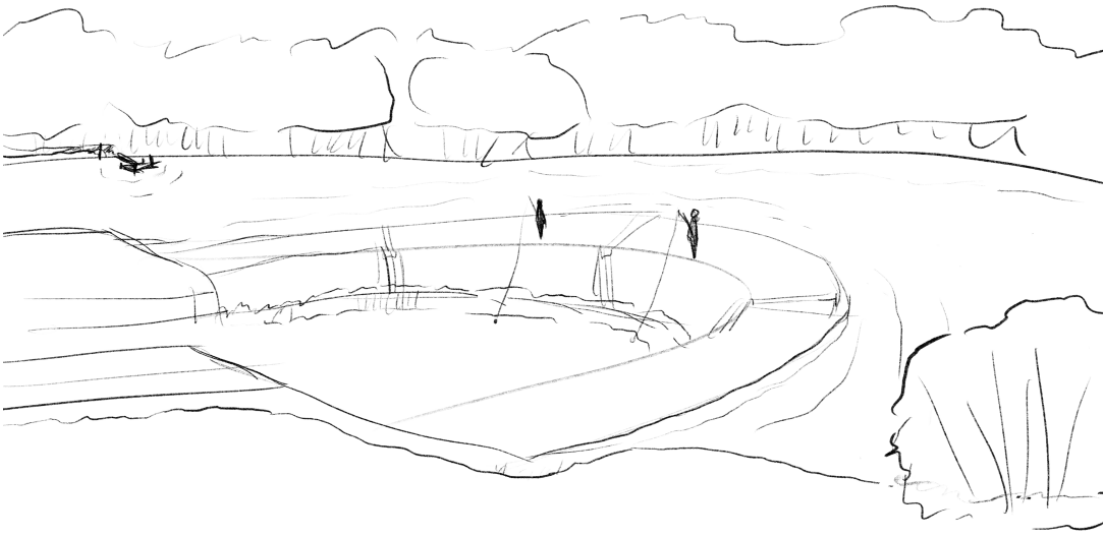

Figure 13:Sketch of Tuckahoe State Park Visitors Fishing from the Dam (Illustration by author, 2025)

southern side of Tuckahoe Lake. People clustered around this area to fish the tailwaters of the dam and seemed to be enjoying themselves. The people upon the dam varied from lone individuals, mostly male, to families fishing together. This location is rather beginner-friendly for new anglers as there is a low risk of snagged lines and very few things that could obstruct a cast. The family of four, which was

fishing, caught two fish in the fifteen minutes this location was observed, making its population understandable, as it is seemingly a prolific location to catch fish. In this instance, the caught species was a type of Bullhead Catfish. This location features a fish ladder, which is used for migratory fish to be able to navigate upstream and reach their spawning grounds.

Another popular location was the pavilion near the fitness trail. Here, people seemed to be setting up for an event. The event seemed domestic in nature and was not being set up by a member of the park staff, but rather a group of individuals who were taking ownership of the space for the afternoon. This shady location was sheltered by loblolly pine trees and was situated near the large playground on the east side of the lake. This would make an excellent location for a gathering, especially with young kids, as the location is located slightly uphill from the lake, providing a great vantage point to keep watch of any children playing by the lake or at the park located below. This space was simply sheltered by a shingled roof supported by columns, the pavilion featured a grill and a cluster of picnic tables suitable for seating about two-dozen seated guests.

Near this location was a shelter where visitors could rent kayaks and canoes. Five people (in sight from the shores) were partaking in water recreation. A canoe was launched containing two people, a woman in a kayak was accompanying them, and a paddleboard with a man and child occupying it was cruising the shores. Overall the water recreation seems to rarely get motorized traffic, but it is an option and there

is a boat launch on the western side of the lake which would allow one to launch a larger watercraft, however, the water in the lake maxes out at roughly six feet so the size of watercraft must not be excessive.

Figure 14: Sketch of Visitors Horseback riding Besides the Road at Tuckahoe State Park (Illustration by author, 2025)

A final notable location was the trailhead, which connects Adkins Arboretum to Tuckahoe State Park. Many people were parked here, and this trail seemed to be popular with the equestrian community in this area. Roughly two dozen horses and riders were seen within three hours of site observation.

Perceptions

Tuckahoe State Park is a large park on the Eastern Shore of Maryland, but would be passed over by most as it is in an area that lies between the popular tourist

locations of Kent Island and Ocean City. Despite this, my research partner enjoyed the experience of the park and found the site to be a place that does a good job of putting people in a natural environment and giving them a place to partake in hobbies that revolve around the outdoors. The park has a lot of life, but is not bustling with people. An observation from my research partner is that the park is slightly disorienting as there is no indication of a clear entrance to the park, and no designated visitor area. The signage for vehicular traffic is largely missing, making the location harder to navigate for first-time visitors.

Incorporation into Thesis

The park serves many unique activities, which range from aquatic activities such as fishing and using water crafts to terrestrial activities such as mountain biking, trail hiking, and horse riding. Ideally, a visitor center would consider these aspects in its design, allowing for the facilitation of these activities for new visitors to the park. The park seems to be most visited by locals, but Adkins Arboretum pulls more visitors, likely due to their frequent community-engaging activities, such as identification classes, children's programs, and other nature activities like nature journaling. I believe that Tuckahoe could have an easier time attracting new people if it had a visitor center to house community activities and put the park staff in contact with the attendees. This center would also make it less intimidating for newcomers to navigate the park. Having a designated location to host events, educate visitors, and act as a staging ground for park activities would greatly benefit the area both in terms of user experience and park management.

Chapter 7: Conceptual Testing

Introduction

The goal of this thesis focuses on cycles and the cyclical processes of nature, and how they could be considered through an architecture that facilitates processes. Cycles such as evaporation and condensation, decomposition and regrowth, and migration and return are natural phenomena that occur regardless of human presence, yet architecture has rarely engaged directly with these flows. To develop this, there must be a rich understanding of these processes as they happen on the site. This requires an immersive and investigative approach to the environment, one that goes beyond typical site analysis and delves deeply into the temporal and spatial rhythms of the place. This relates to the animals, the plants, and the nonliving things, such as the sun, water, and air, as they all relate to each other and come together to formulate the "place". Each of these agents, both biotic and abiotic, plays a role in shaping the identity and functions of the site, and their interactions form the foundation for a living, dynamic landscape. To design a concept, then, for this site requires a non-traditional approach to design. Rather than imposing form upon the land, the design must emerge from the land, co-evolving with the site's systems and feeding into their natural intelligence. The idea of massing an object and placing it on the site must be forgotten to truly integrate an installation of architecture into the processes of the site. Instead, design should take the form of an agent that participates, amplifies, and responds to the systems it inhabits.

Early Process and Theory

To begin this process, there is a heavy reliance on the earlier methodology of diagramming. Diagramming acts as a tool for discovery, enabling the invisible to become visible and the intangible to take on shape and meaning. The only way to bring these vast cycles, which are typically invisible to most people, is through drawing. If done correctly, the drawings will begin to reveal the interconnectivity and hidden dimensions of the processes that happen on site. Many of these processes happen in obscure places, or are hidden behind time-scales which people aren't around long enough to witness, but these processes are always constantly ongoing. For example, soil regeneration may take decades, and the shifting edge of a wetland might appear static unless charted over seasons or years.

Designing based on these diagrams will require a new convention of drawing. A drawing convention that is not static or object-oriented but rather narrative, process-based, and rooted in reality. These visualizations must work both as analytical tools and as frameworks for design, allowing cycles to inform form, space, and function. These cycles are to serve as the core drivers of the design. Whether this is a cycle of water retention and treatment, wetland regeneration and the restoration of habitat, or a focus on raising healthier fish in the lake, it should be included graphically in the drawing. These cyclical systems are not merely background conditions, they are the infrastructural and conceptual basis for the design decisions. Each of these cycles is complex and interwoven with other cycles, so this building cannot operate in a vacuum and is likely to span across much of the site. It is through

this embeddedness and its reach across different ecologies that the architecture gains meaning and a sense of belonging.

The site is to be understood, not just as a plot of land, but as a series of ecosystems and relationships. It is a living, breathing entity composed of physical terrain, microclimates, symbiotic interactions, and historical trajectories. The site consists of many sub-regions ranging from lake, to beach, to meadow, to forest, to paved lot. Each sub-region contributes unique ecological functions and presents different opportunities for engagement and intervention. It is paramount to understand the relationship these subregions have with each other, and equally important to expose visitors to this relationship. By recognizing how water flows from forest to meadow to lake, or how wind patterns shift across open and wooded areas, a deeper architectural response can emerge. Through having the building (or buildings) span across multiple sub-regions, the building is contributing to a vast array of ecosystems and truly integrating itself into the site. This integration challenges traditional boundaries and allows the architecture to act as connective tissue rather than an isolated object. This will also allow visitors to be exposed to a range of conditions on the site. Experiencing the sensory transitions, such as the smell of a pine forest to the smell of water by the lake, from a shaded grove to a sunlit clearing, will foster a greater awareness of ecological diversity. As they pass through the different regions, they will be made aware of the unique aspects of each region. These idiosyncrasies will act as identifiers for the region and allow for learning opportunities that answer the question as to why these regions function differently from each other. The

architecture thus becomes not only a facilitator of experience but also a teacher, inviting inquiry, observation, and reflection about the natural world.

Figure 15: Site Plan of the Omega Center for Sustainable Living (Image credits: "Omega Center for Sustainable Living | AIA Top Ten." https://www.aiatopten.org/node/109.)

To better understand how a building may relate to its environment at a core level of processes, one may look at the Omega Center for Sustainable Living. This building in Rhinebeck, New York, leverages many sustainable systems in order to produce architecture that is ingrained in the site. It stands as a precedent for buildings

that are not merely efficient but are regenerative, as in buildings that give back to their surroundings rather than extract from them. It utilizes the solar cycle through photovoltaic panels on the roof, plants grown in the sun, and a 98% daylighting factor[34].

The building is oriented and detailed to maximize solar gain in winter and minimize it in summer, showcasing a deep integration with the solar rhythm. It utilizes the water cycle by using plants to dehumidify the indoor rooms, filter waste on site, and restore the wetlands that used to be present on the site. This closed-loop water system redefines waste as a resource and returns clean water to the environment, promoting resilience and self-sufficiency. Those wetlands serve as more water purification site and foster insect and bird species, acting as if they were the original ecosystem. They provide habitat, support biodiversity, and act as living proof that architecture can catalyze ecological repair. This building is largely successful in implementing many systems to bring together a cohesive unit that functions through the processes on the site, not in isolation from them. Its performance is not static; rather, it adapts, reacts, and evolves in tandem with the living systems it supports. If the ecosystem were to dramatically change, this building would also need to, a good indicator that it is not an independent factor on the site it is placed on. This interdependence is a key principle of ecological design and a goal for this thesis

[34] American Institute of Architects, "Omega Center for Sustainable Living | AIA Top Ten," *AIA Top Ten*, n.d., https://www.aiatopten.org/node/109.

project.

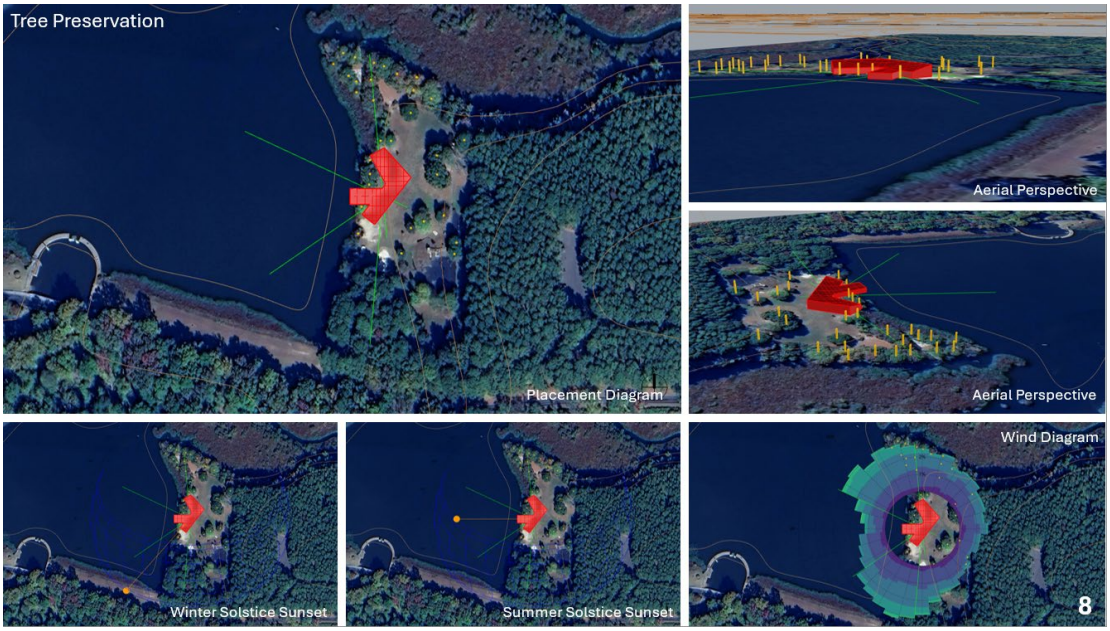

Figure 16: Early Design Concept 1 (Image by author, 2025)

The initial concepts I have created focus primarily on three systems: Wind, water, and sun. These are three things that can contribute greatly to a building's relationship with the site, but the concepts are not yet rooted in the site enough to truly integrate with these things. There is a gap between conceptual responsiveness and ecological participation, and bridging this gap was the next challenge. Meaning that the initial process of making a mass that is shaped while thinking about these things is not enough to fundamentally integrate them into these processes. Shaping the form must be the outcome of ecological research, not just the gesture of design intent.

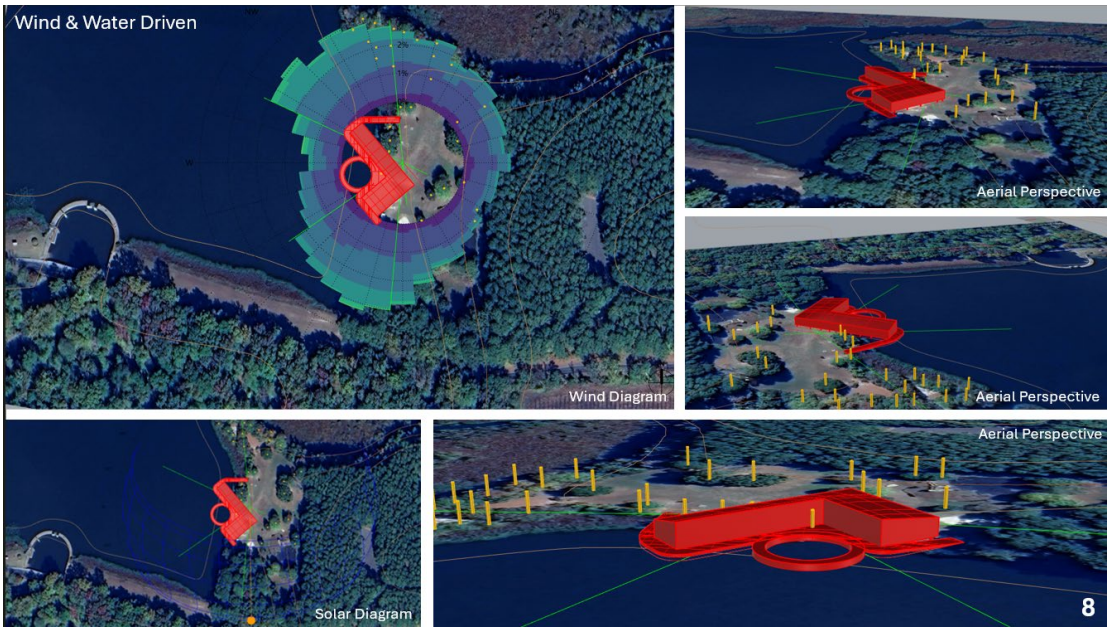

Figure 17: Early Design Concept 2 (Image by author, 2025)

The next step in the design process was to design in section, as it is here that most processes exist. Sectional design allows for the tracing of water paths, solar penetration, and habitat layers, revealing opportunities for intervention that plan views may obscure. Through visualization of topography, solar angles, and exploring the species that exist in what I've been calling subregions. This visual exploration will include diagrams of seasonal wind patterns, sun angles at solstices, species migration routes, and soil profiles, among others. A pattern will be revealed, and design can be done more intuitively through the lens of cycles. Ultimately, the architecture that emerges will be a product of this pattern. A spatial and material response to the rhythm of nature, rather than a "mass" imposed upon it.

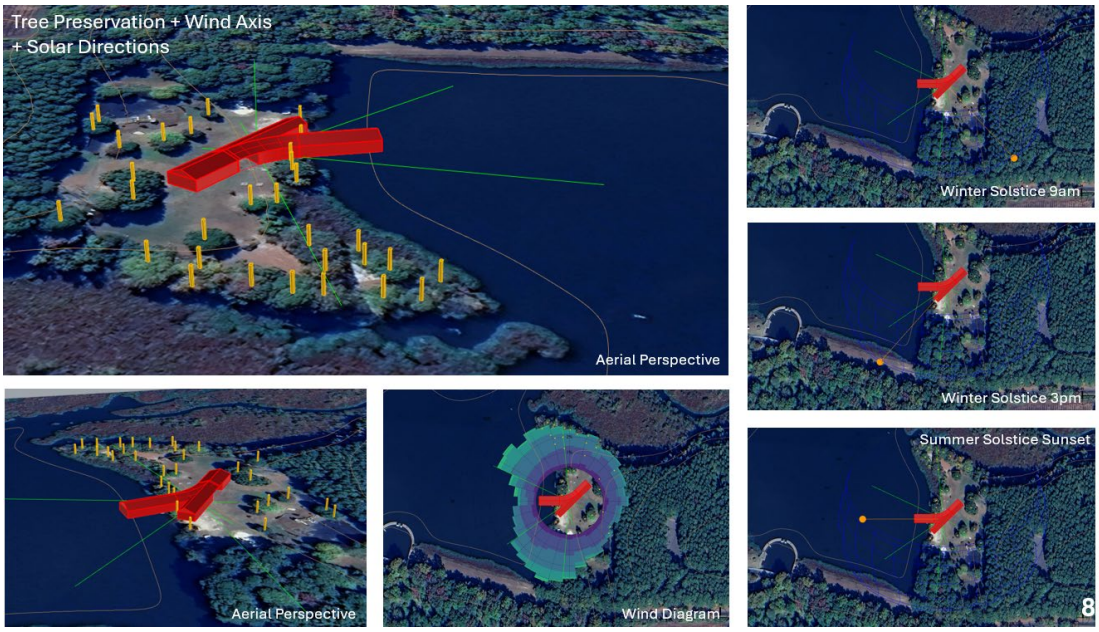

Figure 18: Early Design Concept 3 (Image by author, 2025)

Late Process and Theory. Completion of the Thesis and Findings

Through the later process of design, the focus of this thesis shifted dramatically. While trying to work within the system of aquaponics, it was found to be less interactive than was ideal for the connection that was trying to be formed. Aquaponics is largely a scientific system of measured conditions that need to be maintained to specific levels, which is a big deterrent for public engagement and presents problems with allowing multiple groups of visitors to do something such as feeding the fish. The thesis shifted to using the site itself to engage visitors with the natural world. As previously discussed in earlier sections, there are many promising interaction opportunities on the site and this was taken advantage of through the development of a tail with seven stations distributed across seven different zones identified within the site.

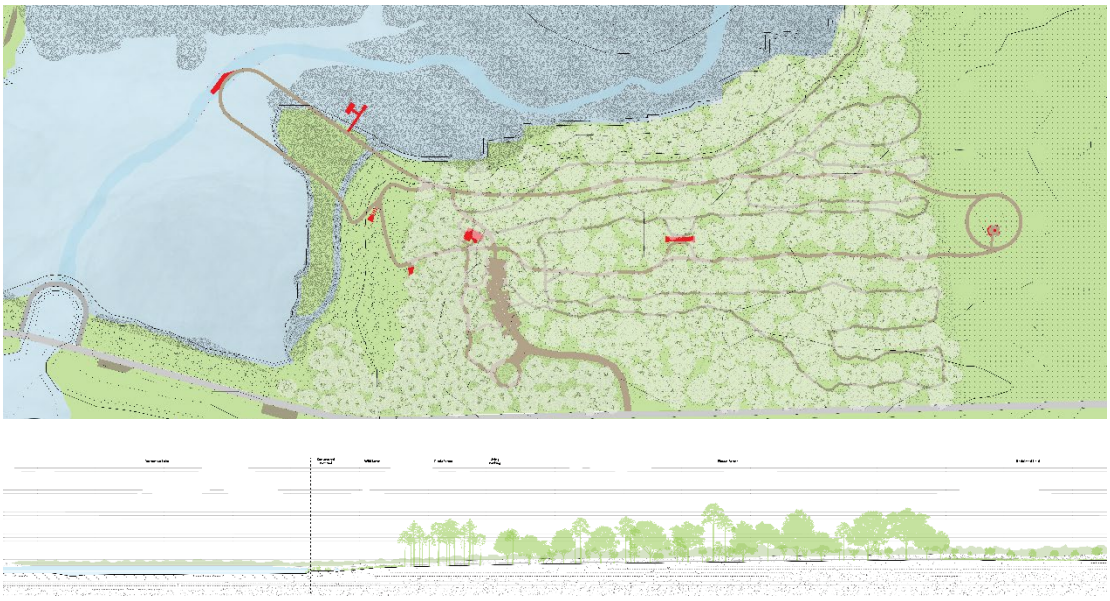

Figure 19: A Site Plan Identifying the Seven Stations in Red and Section Calling Out the Seven Zones Identified on the Site (Image by Author, 2025)

These stations are each intended to bring the visitors into unique experiences where they can perceive the site, its plant, and animal life in new lights. Visitors can travel along this trail in any which way they decide, and each station allows time to bask in the experience of a new ecosystem. The designs seek to stand apart from, but also within the sites. Each of the stations is rather small, rarely exceeding the dimension of 10 ft x 10 ft, which reduces impact on the site and allows these stations to be discovered along the way rather than acting as beacons or landmarks.

Station 1 projects out into Recreation Lake 1 as a boardwalk and directs the visitors' view out towards the dam. With columns flanking it on either side, emerging up from the water, this framework indicates the path on which the now dammed creek once ran. The station affords an opportunity for visitors to suspend themselves out over the lake and take in the sight of how beautiful the ecosystem of the lake is and ponder how much the area has changed since the construction of the dam. For this purpose, there is a QR code on the dam which allows visitors to see through

augmented reality on their phones a rendering of the site conditions in 1950. Through their screen they would see a creek valley with a small stream running through it and wildflowers ang grasses growing all around until they hit the forest's edge. A dramatic difference from the lake they see today.

Figure 20:A pair of renderings showing the proposed state of Station 1 (left), and the concept of the augmented reality interactive experience showing the previous conditions of the site (right). (Image by Author, 2025)

Station 2 is a small extension from this boardwalk which projects users out into the wetlands area. It features a small station with a bird-blind type opening which allows users to see a wide panoramic view of the area without disturbing the wildlife. Inside this small hut there is an educational tidbit engraved into the wood of the structure, allowing visitors to learn more about some flora and fauna which they may see while occupying this space. The station also features a small platform which can be used for dip-netting or simply further observing the landscape.

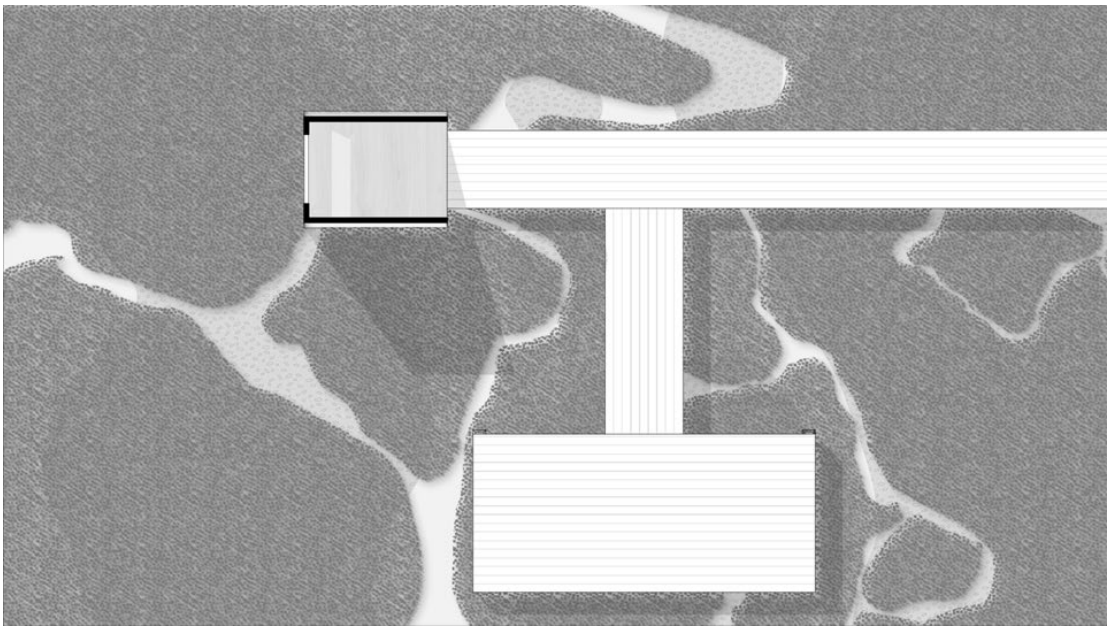

Figure 21: A floor plan of Station 2 showing the main station and the multi-purpose platform. (Image by Author, 2025)

Station 3 exists in the newly created wild meadow in the space which previously was a manicured lawn area. This station scoops out the soil, bringing its visitors eye-level with the top-soil layer. With a window butted up against roughly 5 feet of soil, this allows visitors to see into something which usually is not thought about. It is rare that people get to see below the ground we walk on and this station affords an opportunity to ponder what life occurs under our feet.

Figure 22: A pair of renderings showing the external conditions of Station 3 (left) and the user experience once they are inside the station, viewing the stratification of the soil layers (right). (Image by Author, 2025)

Station 4 is a viewing tower which blends into the loblolly pines which are situated around it by sharing the language of tall straight columns about 2 feet in diameter which extend upwards to a maximum height of 80 feet. The viewing platform does not bring visitors above the canopy like most observation decks would, but instead places the visitor inside of the canopy, making a great opportunity to see life which occurs within the treetops, something often occurring far above our heads and beyond our sight.

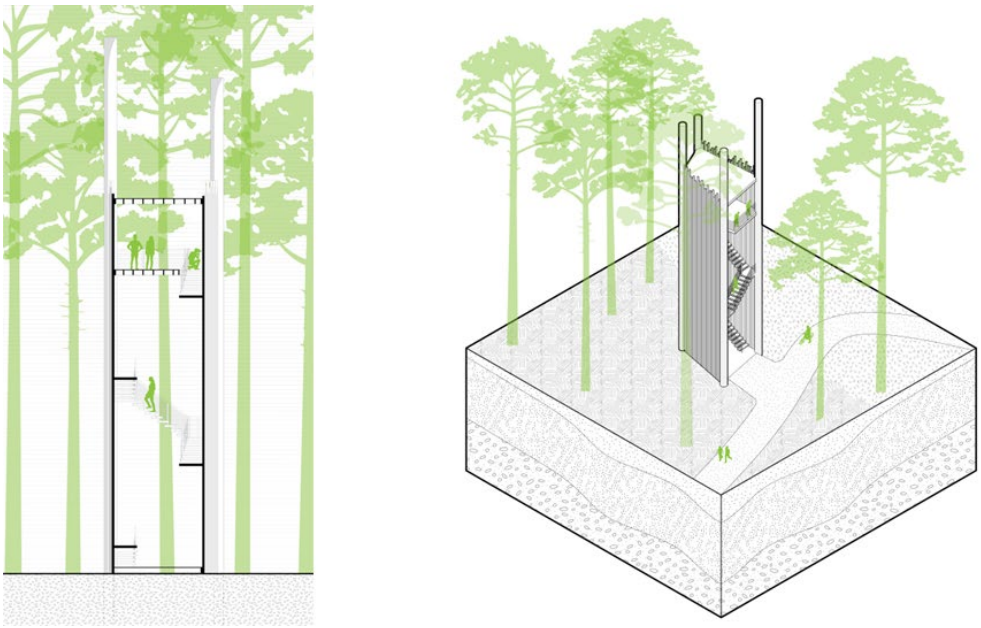

Figure 23: A Section (left) of Station 4 showing the height in which visitors view the canopy, and an isometric drawing of how Station 4 exists within it's ecosystem (right). (Image by Author, 2025)

Station 5 is the station closest to the parking lot which is proposed to become a green parking area which sacrifices some parking area to improve pedestrian access and allow for the planting of native species which can mitigate runoff and protect the downstream water from the runoff pollutants which occur where cars exist. This station serves as an extension of the tree canopy by allowing its curved CLT structure to swoop down and support itself in select locations which allow existing trees on the site to grow through the building unbothered by the new station. This station is designed in 8 ff modules to allow it to be shipped to site on semi-trucks and assembled around the existing trees. This station creates modules for the park's accessible restrooms as well as their main reception area and provides an outdoor covered area for larger groups such as school groups to gather before exploring the park. This station acts as the staging grounds for any visitors before they set off within the park.

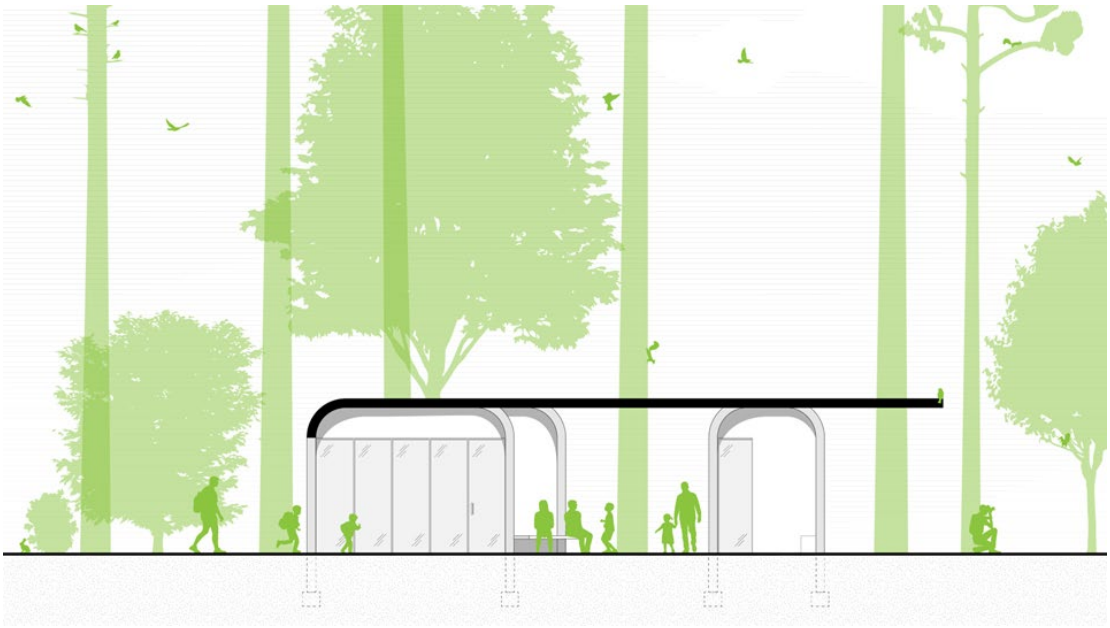

Figure 24: A section depicting how Station 5 forms space out of its curved structure and how visitors interact with the space. (Image by Author, 2025)

Station 6 sits between the existing site's fitness trail and the newly constructed trail which contains the new stations acting as the bridge between the two trails. This station splits into two levels each bringing the user either two feet upwards or two feet downwards from the trail's elevation and frames a view of the landscape in either direction, forcing once again, a new perspective on a landscape which may have become familiar as the visitors navigated their way through the environment to arrive at this place.

Figure 25: A section drawing of Station 7's split-level construction allowing visitors different perspectives of the Fitness Forest. (Image by Author, 2025)

Station 7 is the most modest and unintrusive of all the stations because it is situated in an area which is being reclaimed from an existing agricultural field. This landscape has been replanted in a dense pattern with native saplings to restore a native Maryland forest. Because of this tight grouping many of the saplings will naturally die off as the trees compete for resources. This station therefore is constructed of simple sawn logs to create simple seating and stage areas which can be easily manipulated to whatever shape the forest decides to take. The simple materials make it a low cost, low risk method of placemaking as the materials are easy to source and simple to manipulate according to visitors' needs. As people gather in this space over time it will grow and transform over time. Being moldable to the resulting forest structure which will develop over time.

Figure 26: A pair of renderings showing the approach to Station 7 (left) and a view from the sawn log stage area (right). (Image by Author, 2025)

Overall, these stations aim to bring people closer to the natural world and serve as the hosts for new memories and experiences which strengthen visitors' connections to this place and the greater experience of the natural landscape in an effort to strengthen people's love and concern for the outdoors.

Chapter 8: Conclusion

Conclusion

This thesis has set out to question what Visitor centers can become in the twenty first century. The typology of the buildings that sit on these managed natural areas have lacked real innovation in modern times and this thesis has pushed to transform them into a deliberate and functional pieces of ecological infrastructure. Using investigations consisting of environmental science, educational psychology, architectural precedent, and site research, it has been demonstrated that the visitor center is uniquely positioned to become a major player in the interface between people, place, and planet. This thesis demonstrates the ability for architecture to involve a diverse range of people with the natural world and heighten people's environmental consciousness.

This thesis started with a critique of the historical State-park visitor centers that exist today. Most of these were constructed in the 1960's when ecology was not a public concern and parks focused mostly on tourism and heavily leaned on a rustic camp aesthetic. Those buildings could not have foreseen today's environmental challenges of climate change, biodiversity loss, or a mental health pandemic, and often function as an isolated box that observes nature rather than participating in it. Reworking this typology therefore needed a new program brief. On top of passively dispensing pamphlets, the future visitor center must create immersive experiences, bring information to attendees through a wide variety of methods that suite a range of individuals, and serve as a hub for the ethical stance it is taking to allow others the

opportunity to embrace that narrative. Overall, the architecture must perform as ecosystem, classroom, community hub, and a cultural marker simultaneously to break down the divide between a human creation and a natural environment.

The literature review first considered education of children and pooled information gathered from studies on children's engagement with the environment. These studies showed that early, multisensory exposure to the living ecosystems creates an environmental literacy, empathy, and an agency to act for the benefit of the outdoors. Aquaponics amplifies this effect because it is inherently involved across many disciplines. Biology, chemistry, engineering, and mathematics all come together in a single system. The study by Ardoin & Bowers(2020) confirmed that Early Childhood Environmental Education (ECEE) boosts children's confidence and problem solving ability. When children participate in the care of an aquaponics system by testing PH, observing the fishes' behavior, and adjusting water levels, they are practicing skills that involve systems thinking that future challenges in the world will thrust upon them. Despite aquaponics not making it into the final design concepts, the ideas of seeing, and participating with the natural world across ages through the decentralized park visitor center will put these benefits into reach for children outside the classroom and brings this opportunity to families who may not have access otherwise attempted to be involved with nature.

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