The Future is Behind Us

Raising Indigenous Knowledge through Multifunctional Urban Agricultural Practices in Honolulu, HI

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Approval

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To my family and friends - thank you for always believing in me and showing me that with courage and determination I can achieve anything.

Dedicated to my grandparents -
Elisa Juanillo & Leon Juanillo

I ka wā ma mua, i ka wā ma hope

The future is secured by the past

- Hawaiian proverb

Image 1

Personal Statement

I would like to begin by acknowledging that although I was born and raised on the island of O'ahu, I am still, in many ways, learning about my cultural identity as a first-generation Filipino-American who calls Hawai'i my home. The shared values and beliefs of the Hawaiian culture have been instilled in me through my education and the community. Although I do not identify as Hawaiian, I consider myself a *kama'aina*, which translates to "a child of that which feeds me". In recognizing this I feel as though it is my responsbility to care for the land that raised me as it continues to sustain my community, my family, and myself.

My family currently lives in the Waipahu neighborhood, an area once home to Oahu Sugar Company, which brought a wave of laborers from the Philippines, Japan, China, Portugal, and Norway. In search for better opportunities, both my parents' families moved to Honolulu from the Philippines. Over the years, our neighborhood has seen many changes with the sugar cane plantation now owned by Monsanto, numerous fast-food chains, and new transportation corridors for the upcoming rapid transit line.

This project has become a reflection of my cultural identity and presents my hope for the islands and how we, as landscape designers and planners, should advocate for the recognition of indigenous wisdom.

Abstract

With the closest port of call approximately 2,400 miles away, the Hawaiian Islands are one of the most geographically isolated and food-import dependent populations in the world. The Hawaiian Islands imports approximately 90-percent of its food and energy making it vulnerable to any natural or human-caused disaster that could disrupt shipping and supplies. Urbanization practices in Honolulu allow for limited space for urban agricultural practices, higher concentrations of people, and an increase in high-rise condominiums and hotels. Most importantly, Honolulu faces an even greater loss in its historical agricultural identity. Understanding the indigenous agricultural practices of the Native Hawaiians along with what remains today is essential to charting a pathway forward.

The Native Hawaiians coevolved with their landscape and engineered a social-ecological system, called the *ahupua'a* unit, that maximized ecosystem services. The *ahupua'a* was a multifunctional land division that separated agroforestry practices in the forest zone, urban agricultural practices in the lowland or plains, and aquaculture practices in the coastal zone. Reflecting on the richness of this past system with the current design and planning of Honolulu's Ala Wai watershed challenges us to rethink new strategies of implementing urban agricultural practices that raise indigenous knowledge while enhancing Honolulu's resiliency.

This research project is motivated by the ahupua'a model due to its multifunctionality and importance within Traditional Ecological Knowledge. The three zones of the *ahupua'a* model are examined using four selected precedent studies, ranging within the Pacific Rim. Each precedent study is examined based on its use of Traditional Ecological Knowledge (TEK) composed of local knowledge, resource management, and worldview, and multifunctionality composed of production, ecological, and cultural functions. These studies will help formulate a design framework that can be applied towards spatial typologies within the Ala Wai watershed.

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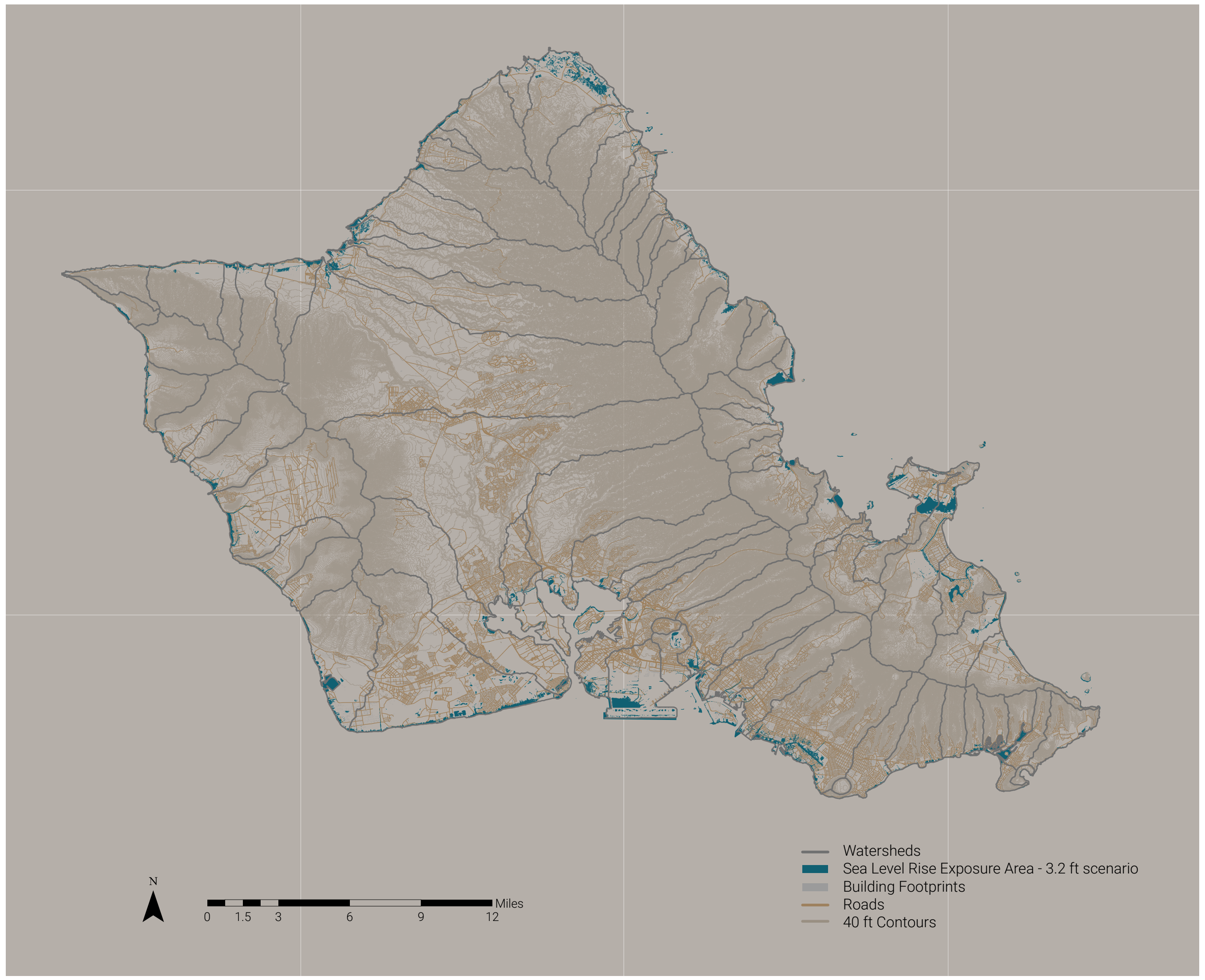
introduction

Figure 1.1.
Distance of nearest port to Honolulu

Current Issues & Challenges

Food Insecurity and Public Health in Hawaii

The ongoing spread of the coronavirus and the resultant COVID-19 disease pandemic have exposed many systemic vulnerabilities to health care, the economy, and the normal functioning of society world-wide (Miles, 2020). For Hawaii, critical systems like our food supply, are also vulnerable to natural and human-caused disasters. With the closest port of call approximately 2,400 miles away in Oakland, CA, (Figure 1.1) the Hawaiian Islands are home to one of the most geographically isolated and food-import dependent populations in the world (Miles, 2020). The island's critical infrastructure lies along a 12-mile stretch of low-elevation coastline on the south shore of Oahu. If a natural disaster were to hit the islands, the state would have a five to seven-day supply of food (Miles, 2020). The food system is also the number one driver of



global environmental change and the primary cause of chronic diseases, such as diabetes, heart disease, and obesity (Miles, 2020). Social and health inequities parallel each other, and certain ethnic groups in Hawaii bear a disproportionate burden of these inequities (Kaholokula, 2014). Native Hawaiians, Pacific Islanders, and Filipinos are more likely to be undereducated, to be working in low paying jobs, to be incarcerated, and to be living in poorer conditions than other ethnic groups (Kaholokula, 2014). They are also the highest-ranking ethnic groups in terms of obesity, diabetes, cardiovascular disease, and certain cancers (Kaholokula, 2014). There is more than biology, such as poor eating and exercise habits at play. The length and quality of Hawaii resident's lives has a lot to do with social conditions – where one lives, works, and goes to school, and the distribution of wealth and resources in society (Kaholokula, 2014). These forces are referred to as social determinants of health and are vital in how we plan our cities and communities. Environments that promote unhealthy patterns of eating and sedentary lifestyles pose more stressors and health risks (Kaholokula, 2014). Areas that are near fast food restaurants and liquor stores, have less access to fresh fruits and vegetables, offer few walking and bicycle trails and poorly maintained public parks promote unhealthy patterns as well (Kaholokula, 2014).

With rapid urbanization on the rise in downtown Honolulu, space for urban agriculture is becoming limited, there are higher concentrations of people, and open spaces that are vital to the community's health and well-being are being taken away to make way for high-rise condominiums and hotels (Figure 1.2). On top of that, indigenous methods of land governance have been disappearing and have not been fully visible in urban cities. Property shapes how a city functions, how it looks and how people live. Property also fragments our urban environments and disconnects us from the natural landscape.

Figure 1.2. (opposite)
Map of O'ahu showcasing SLR
and urbanization

The Past

Hawaii Pre-Settlement/Settlement History

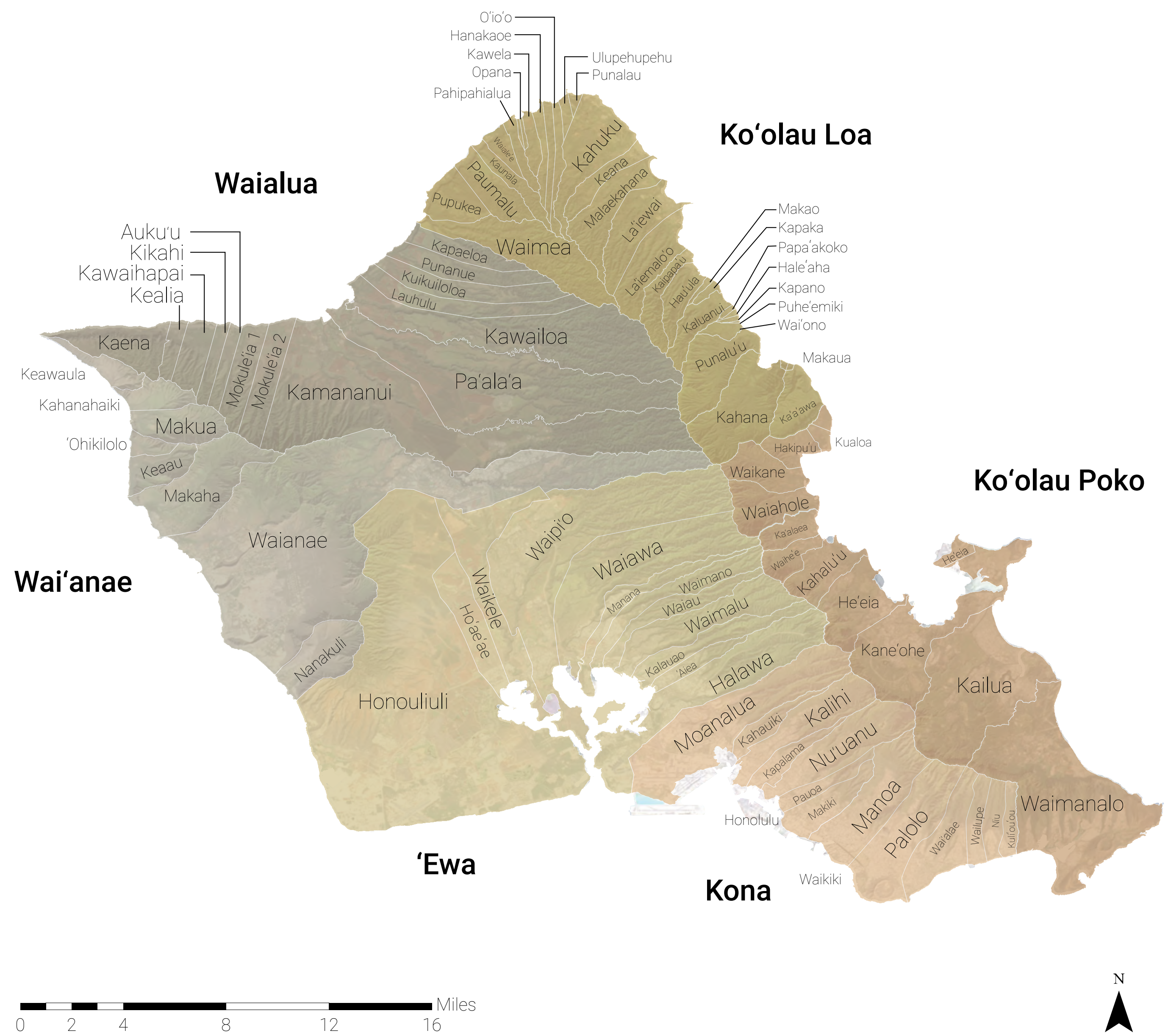
Prior to any contact with human settlement, the island chain was first home to unique life forms due to its ecological diversity. However, over time and due to human presence, on the island of Oahu, 85 percent of the land that was once home to a diverse endemic set of ecosystems had been entirely lost (Gon and Winter, 2019). However, even with this loss the Hawaiian Islands remain one of the most diverse places on the planet. Understanding the history of those losses and what remains is essential to charting a pathway forward (Gon and Winter, 2019).

Agricultural History

The Native Hawaiian society coevolved with their landscape and engineered a social-ecological system that maximized ecosystem services and the abundance of key resource species (Gon and Winter, 2019). They not only recognized the value of the forests in producing ecosystem services but honored its intrinsic value and associated biodiversity (Gon and Winter, 2019). The resource management strategies they employed included designing food systems that could sustainably feed over a million people with no external inputs (Gon and Winter, 2019). The system recognized biogeographic patterns, noting that different living elements are found from summit to coast and that they extend from nearshore to reef to the edge of the pelagic (Gon and Winter, 2019). This resulted in the formation of land-sea geographic units called ***ahupua'a*** (Figure 1.3).

According to Winter, a more holistic understanding of the ***ahupua'a***'s structure and function includes first understanding the ***moku system*** (Figure 1.4) which divided large islands into social-ecological regions and into interrelated social-ecological communities (Winter, 2018). The moku system had several social-ecological zones running horizontally across each region and divided individual communities vertically while connecting them to adjacent communities horizontally (Winter, 2018). This mosaic contained forested landscapes, cultural landscapes, and seascapes which harnessed a diversity of ecosystem services to facilitate an abundance of biocultural resources (Winter, 2018). Oahu is comprised of 6 mokus – Waialua, Ko'olau Loa, Ko'olau Poko, Kona, 'Ewa, and Wai'anae (Figure 1.3).

Figure 1.3. (opposite)
Ahupua'a land divisions

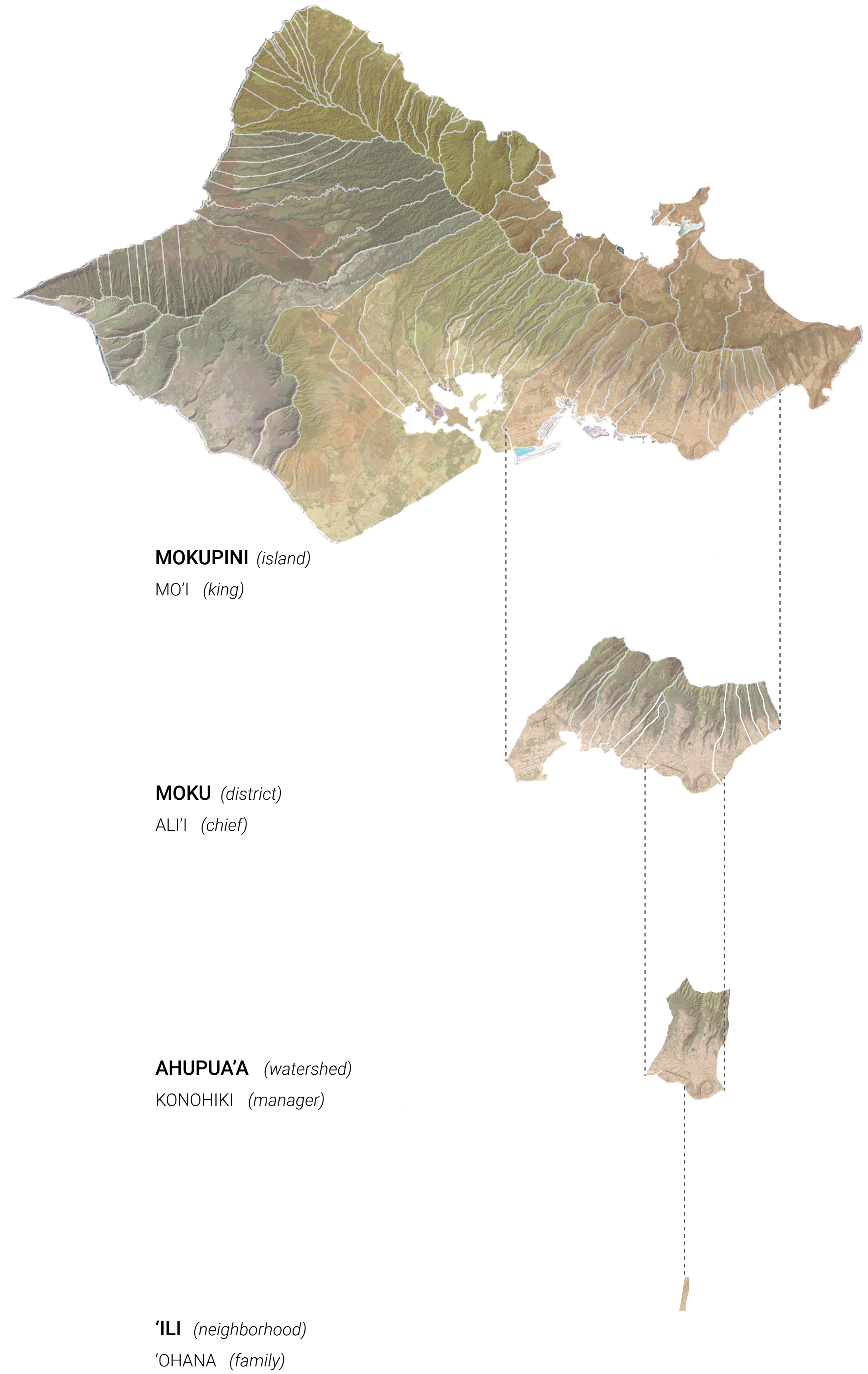


The land was divided into various scales – ***mokupini, moku, ahupua'a, 'ili*** and further into various types of agricultural plots (Winter, 2018) (Figure 1.4). Of these land divisions, the ***moku*** and ***ahupua'a*** were key political boundaries in the pre-contact system of governance, managed by positions in the ruling class known as ***ali'i'ai moku*** and ***ali'i 'ai ahupua'a*** respectively (Winter, 2018). Land divisions below the ***ahupua'a*** – ***'ili*** and others – were derived through kinship and cared for by specific extended families (Winter, 2018). These land divisions were made to manage biocultural resources due to a growing human population and were able to sustain an abundance of resources for more than a millennium (Winter, 2018).

The ***ahupua'a***, which makes up only part of the Hawaiian land division, is the focus of this research due to its ability in maximizing resources, productivity, and its complex design. The ***ahupua'a*** worked to connect people and their social systems to place and were administered by ***konihiki***, resource managers appointed by the ruler of large districts or entire islands (Gonschor, 2014). Within each ***ahupua'a***, varying in size from as small as 100-acres to over 100,00 acres (Levy and Chernisky, 2020), members viewed the land as a sacred home of the ancestral gods that cared for all people. This view inspired people to care for the land in turn which resulted in 100-percent self-sufficiency in a small but intensively worked space.
Each ***ahupua'a*** is comprised of five terrestrial social-ecological zones, ***wao*** (Figure 1.5).
Wao akua, or sacred forest, was a restricted forest zone for native plant communities and accessed only under strict protocols. ***Wao kele***, or wet forest, was an untended forest zone and left as a native-dominant plant community zone whose primary function is to maximize aquifer recharge. ***Wao nahele***, or remote forest, was minimally tended and whose function was to maximize habitat for native birds.

The ***wao la'au***, or agroforest, primary function was to maximize the availability of timber and non-timber forest products. A zone allowing for the management of a highly tended forest via an integrated agroforestry (native and introduced plants) regime. This zone comprised native and introduced hardwood timber, food trees, native and introduced biofuel sources, cordage and weaving material, medicine and dyes, and ceremonial and adornment plants.

Figure 1.4. (opposite)
The Moku System



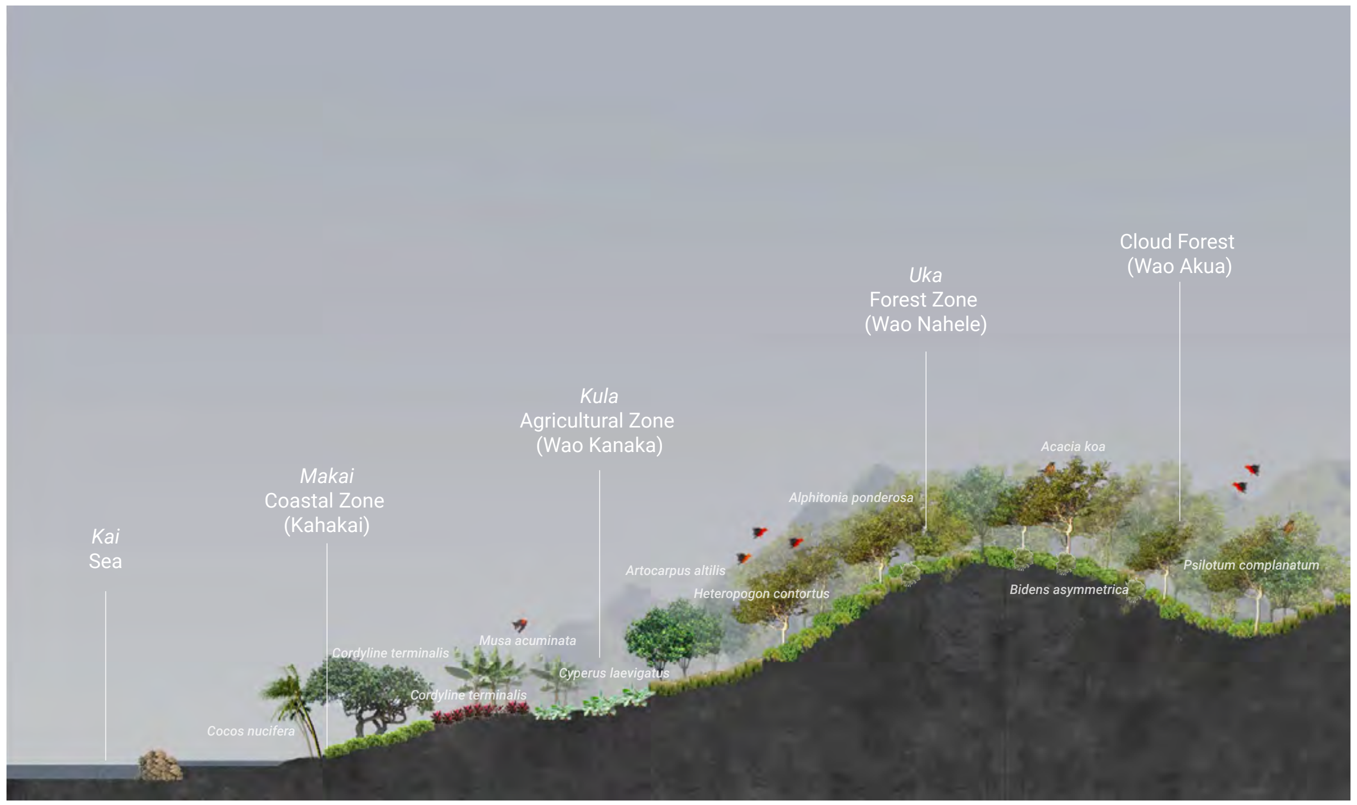


Figure 1.5.
Zones of the ahupua'a

The ***wao kanaka***, habitation zone, primary function was to maximize the availability of food, medicine, and housing. This zone allowed for the conversion of forest to field agriculture, aquaculture, habitation, recreation, and/or temple worship.

Native and introduced trees tended, individually or in groves, for regular and specific cultural services (Winter, 2018).

The coastal zone provided most of the protein in fish, shellfish, shrimp, crab and lobster using fishponds. Flooded field and rainfed agriculture provided a cornucopia of vegetable foods such as taro, sweet potato, bananas, breadfruit, yams, arrowroot and others. Nearshore edible algal diversity provided vital minerals and other nutrients (Gon and Winter, 2019).

The land was abundant and traditionally described as ***'aina momona***, meaning "fat lands". Through skillful, intensive uses of the land and sea, the Hawaiians were able to keep their footprint small (Gon and Winter, 2019).

The ***ahupua'a*** model promoted self-sufficiency through the exchange of fish, wood, poi, and other goods between those living in mountainous regions and coastal residents. An informal system of ***mauka-makai***, meaning mountain to ocean, gift exchange allowed a high degree of self-sufficiency for the community (Levy, 2005).

The resource management strategies the Native Hawaiians employed included designing food systems that could sustainably feed over a million people with no external inputs, a population that is comparable to today (Gon and Winter, 2019). The Native Hawaiians were greatly connected to the land – multi-generational recipes were shared, the community knew where their food was being grown, and they cultivated their own food (Figure 1.6).

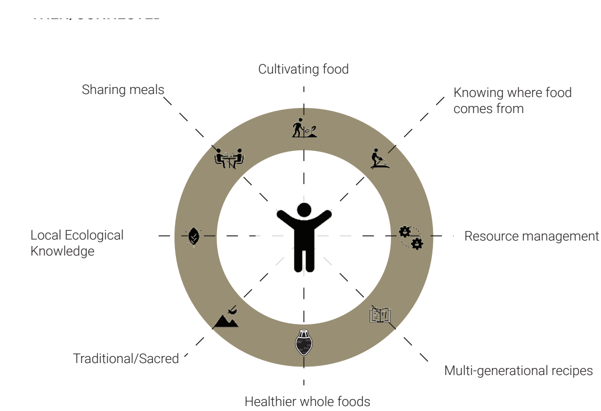


Figure 1.6.
Diagram showcasing connection between food, land, and self

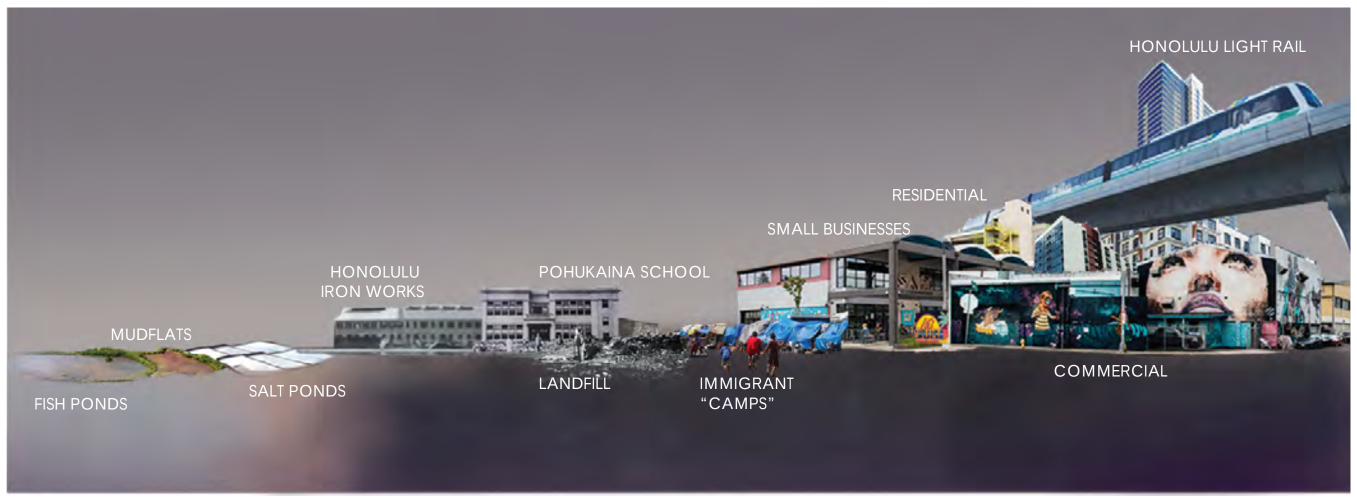


Figure 1.7.
The disappearance of the ahupua'a system due to the impacts of colonization

Post-Colonization

In 1776, cultural impacts of colonization following European contact resulted in massive habitat losses. The imposition of anthropocentric technological solutions in transforming the landscape; the degradation of ecosystems by fire, overgrazing, monocropping of sugar and pineapple plantations; and urbanization led to the decline of the ***ahupua'a*** system (Levy and Chernisky, 2020).

Hawaii was a once self-sustaining system prior to colonization, but later devoted much of its land to producing and exporting food products. The 20th century ushered in the modern era that swept up Hawaii into the rest of the Western world (Gon and Winter, 2019).

Wetlands were drained to develop Honolulu, and agricultural lands and forests were destroyed to build suburbs to accommodate a post-statehood population explosion (Gon and Winter, 2019) (Figure 1.7). Trees found in forest lands were cut for both export and as fuel for trains and ships, and these deforested lands eventually made room for cattle and sheep pastures.

As the Hawaiian ecosystems disintegrated, so did Native Hawaiian society as the United States government overthrew the Hawaiian monarchy by the end of the 19th century, and imprisoned Hawaii's last monarch, Queen Lili'uokalani. By the end of the 20th century, Hawaii's population surpassed 1 million people, but now heavily depends on imports to provide 90 percent of its food and energy (Gon and Winter, 2019). A community that was once connected to its land, has now become largely disconnected (Figure 1.8).

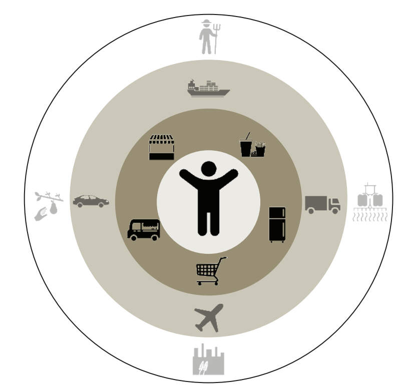


Figure 1.8.
Diagram showing disconnection between self and production of food

__Current Agricultural Practices__

With the decline of the sugar industry, current agricultural lands are returning to a new era of small farms growing diversified agricultural products. There are currently over 5,500 farms in Hawaii and 40 crops grown commercially (DOA, 2020). Agricultural crops such as fruits, coffee, macadamia nuts, flowers and foliage provide produce and flowers to Hawaii markets, but also have become major exports to places around the world. Some small farms are also taking more sustainable approaches, and early fishponds have evolved into high-tech aquaculture ventures (DOA, 2020). Current non-profit organizations (Figure 1.9) continue to honor indigenous knowledge and work to restore degraded lands into productive landscapes.

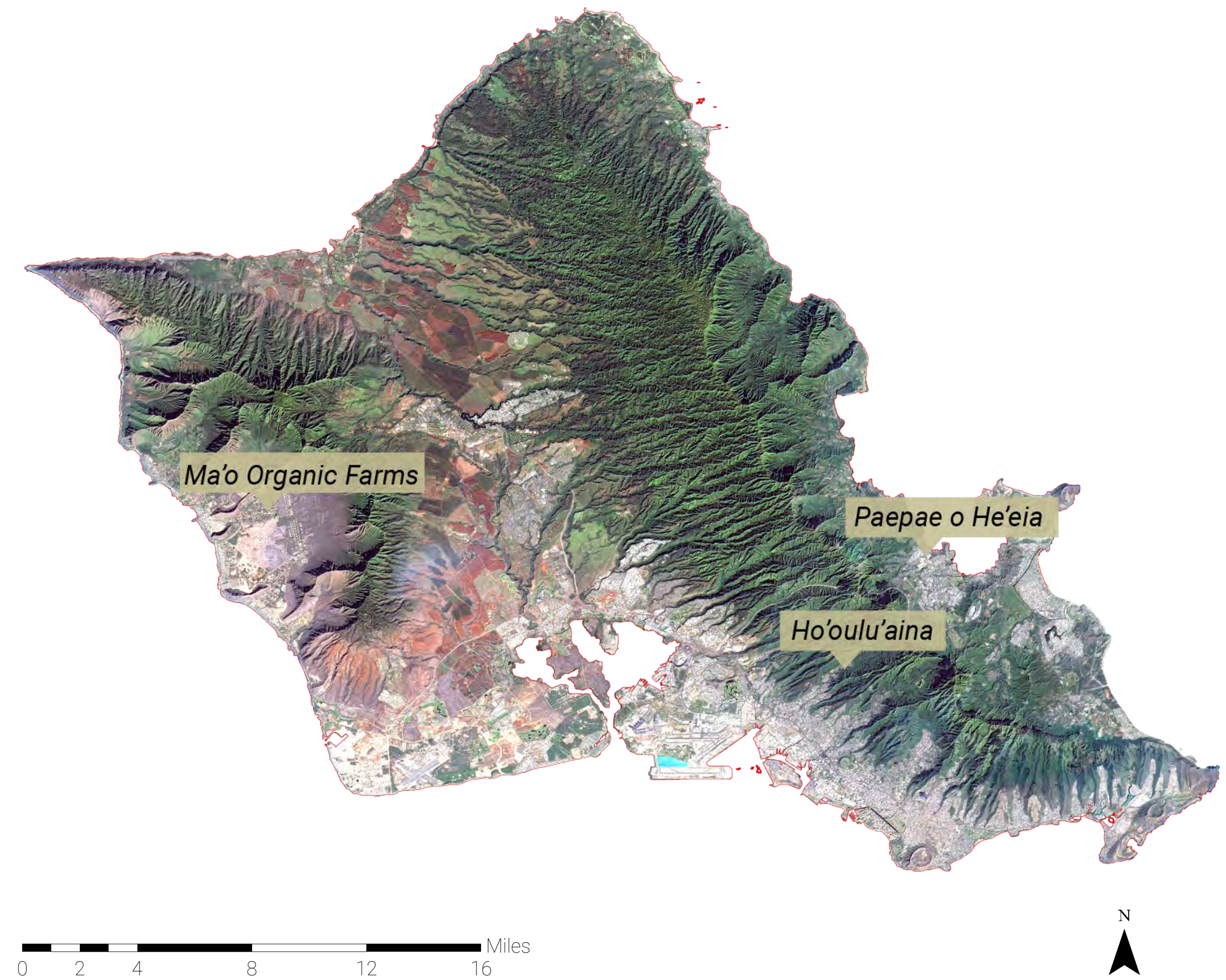
In 2000 a group of community members founded the Wai'anae Community Redevelopment Corporation to grow two of the community's greatest assets: the rich food producing traditions of the region and youth who were not achieving their academic potential (Ma'o, 2020). WCRC then created a social enterprise called Ma'o Organic Farms (MA'O) and developed programming geared towards mentorship, education, and empowering youth. Ma'o is an acronym for ***Mala'Ai'Opio***, which translates to youth food garden. It is an affirmation of their belief that "when we restore the relationship between youth and ***'aina*** (land), we restore our ancestral connection to the land and foster an interdependence that returns abundance and prosperity to the community" (Ma'o, 2020).

Paepae o He'eia, located in Ko'olau Poko is a non-profit organization established in 2001 dedicated to caring for the He'eia fishpond. Their program aims to restore the fertility and lushness of the fishpond and share its bounty with the community. The pond maintains a brackish water environment, ideal for algae, which helps raise herbivorous fish.

Kōkua Kalihi Valley Comprehensive Family Services (KKV) has provided innovative programs that directly address the needs and aspirations of Kalihi Valley's families (Ho'oulu'aina, 2020). In 2005, KKV was granted a 20-year lease from the Hawai'i Department of Land and Natural Resources to steward and sustainably develop 100 acres in the back of the Valley (Ho'oulu'aina, 2020). Ho'oulu'aina, meaning "to grow the land" and "to grow because of the land", is based on the value that the health of the land and the health of the people are one (Hooulu'aina, 2020).

Ho'oulu'aina dedicates multiple programs in the restoration of ancient sites and sacred places, reforestation, agroforestry, and a community garden that provides Kalihi residents with vegetables and revitalize the dormant farm-to-table culture of the Native Hawaiian's ancestors.

Figure 1.9. (opposite)
Current non-profit organizations on Oahu, HI




Ma'o Organic Farms
source: https://www.maoorganicfarms.org/


Paepae o He'eia
source: https://paepaeoheeia.org/


Ho'oulu'aina
source: https://www.hoouluaina.com/

Reclaim Public Space and Amplify Indigenous Voices through Multifunctional Food Forests

Reflecting on Hawaii's agricultural past and present has shown how humans have transformed the environment to support production and cultural functions for thousands of years. Reflecting on the issues of Honolulu's food insecurity, health, and indigenous knowledge also raises the question of:

How can multifunctional urban agriculture contribute to restoring indigenous knowledge and ecosystem services that we had lost while enhancing Honolulu's resiliency?

How can we create an alliance to advocate this landscape?

In designing Oahu's future agricultural landscapes, we must gain knowledge from Indigenous voices as Hawaiians are masterful ecologists, naturalists, landscape engineers, and resource managers (Gon and Winter, 2019). According to Gon and Winter,

"If we choose to live in a world where indigenous cultures not only survive but thrive, and their perspectives on resource management are honored and embraced, we can couple that with the best that Western science can offer, reestablish caring reciprocal relationships between people and nature, and remain hopeful for the future of our grandchildren's grandchildren."

While urban agriculture efforts continue to multiply, food production in cities is still often viewed as problematic (Lovell, 2010). The most common urban agriculture typologies are not valued because they rarely produce food and provide beneficial social and ecological services to the entire surrounding system and ecosystem (Lovell, 2010). The introduction of an ***ahupua'a*** based model that integrates a multifunctional food forest could provide a new approach in responding to food production while enhancing social and ecological services.

Significance

This would contribute to the development of new strategies of action that allow not only the strengthening of today's localized agri-food systems but also the revaluation of food systems forgotten or guarded by the indigenous populations that remain present.

As part of Oahu's Resilience Strategy, the island hopes to "Promote New Agricultural Models for Economic and Food Security" (Ola, 2020). Oahu's current resilience strategy recognizes that O'ahu must return to our traditional values of equity and responsible stewardship (Ola, 2020). According to Action 10 in the O'ahu Resilience Strategy, the following recommended actions are introduced:

1) Engage an "Oahu Food Policy Council", made up of local food policy and farming leaders to guide and advise the City on best practices to ignite a more robust local food and urban farming industry in Honolulu

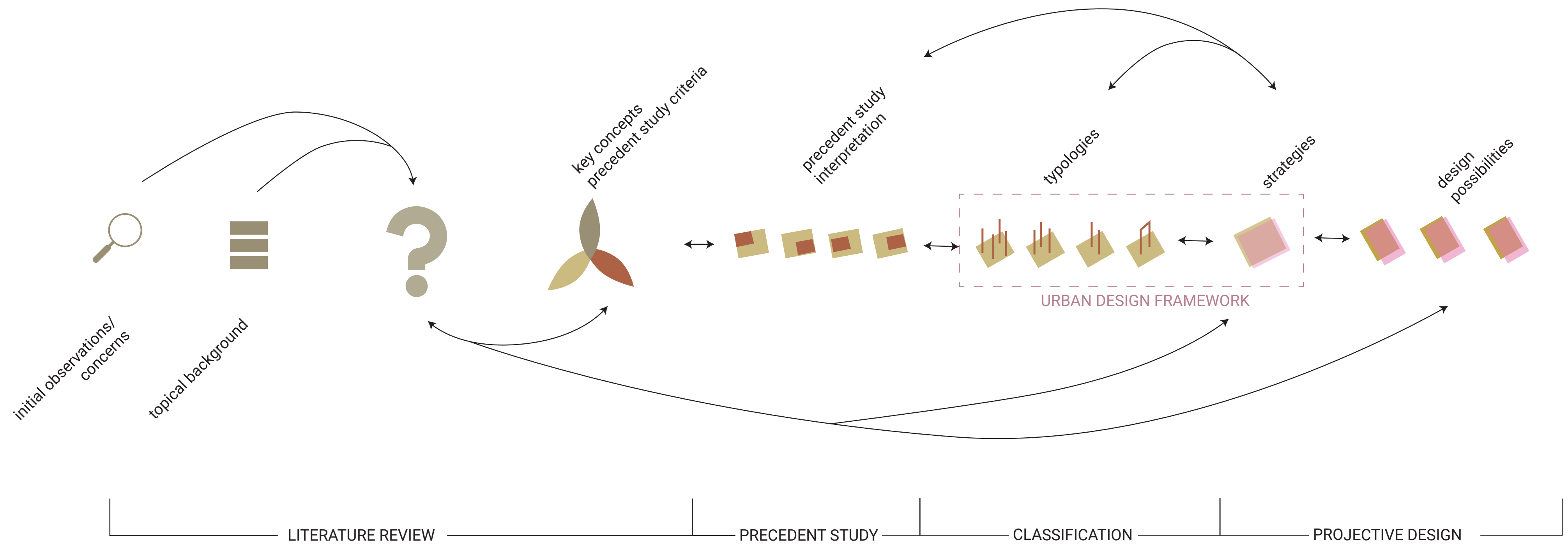
2) Create an "Urban Farming Roadmap" and partner with nonprofits to pilot projects to support struggling farmers and showcase container farming in the urban-core to test potential to scale more broadly on island

Agricultural sustainability should be encouraged by producing more agricultural inputs on-island an encouraging small-scale backyard farming through programs and policy (Ola, 2020).

However, there is currently no design framework within landscape design and planning that is focused on the importance of integrating food systems into urban areas in Honolulu, HI. This research explores the role landscape architecture has in empowering indigenous voices through the creation of a sustainable, multifunctional food production system.

In the past, the ***ahupua'a*** system provided a self-sufficient landscape while the current Hawaii landscape poses a challenging condition with larger population sizes, higher population density, and limited available spaces. This research places emphasis in the dense urban core of the island, as it faces future additions of condominiums and industrial buildings. Urban agriculture may also reduce the Urban Heat Island effect and contribute to building more resilient communities and sustainable cities (Tidball and Krasny, 2007). Introducing urban agriculture into open space areas can be a cornerstone to turn derelict lands into urban amenities and can bring people together and ignite social innovation (Mancebo, 2018).

Incorporating the ***ahupua'a*** concept with current plans from the Ola Oahu Resilience Strategy in design typologies would be beneficial to the culture, history, and sustainability of Honolulu's urban neighborhood. It could improve Hawaiian ecosystems and formulate strategies at various scales and spatial typologies. This research hopes to provide a pathway for landscape architecture and how it could respond to the importance of indigenous knowledge and cultural landscapes. This research responds to a needed conversation of how landscape designers should raise indigenous knowledge and wisdom into their practice.



Methodology

Each zone within the *ahupua'a* will be further analyzed through literature review, typologies and case studies pertaining to food forests (forest zone), urban agriculture (agricultural zone), and aquaculture practices (coastal zone). Precedent studies have been selected for their usage of traditional ecological knowledge and incorporation of urban agriculture, food forests, or aquaponics.

As shown in Figure 1.10, ***Literature Review*** is used to establish a baseline for available knowledge on any given topic and can be a useful strategy for initializing new inquiries or theory (Deming and Swafield, 2011). For this project, literature review was collected to gain insight on the agricultural history of the Hawaiian Island and especially towards the *ahupua'a* system. Journal articles written by Native Hawaiians were collected to fully grasp the history of the islands, while providing space for their voices. This served as a way in listening to the many perspectives of the island's culture and provided insight in new inquiries for design.

A mixed-methods approach of literature and case studies will be used to examine the spatial layout and design of existing food forests and urban agriculture systems in the Pacific Rim/Tropics. Literature review is also used to define the different zones of exploration – agroforestry, urban agriculture, and aquaculture. A classification strategy type of collecting information is then used to provide a clear understanding of the principles and logic of design organization within key concepts.

Precedents are used to understand what other countries, specific to the tropics, are doing to increase resiliency and raise indigenous knowledge in food production systems. Understanding current strategies will aid in determining a design framework for Honolulu, HI. The selected precedents and literature review help aid in building a set of typologies that will assist in the final projective design.

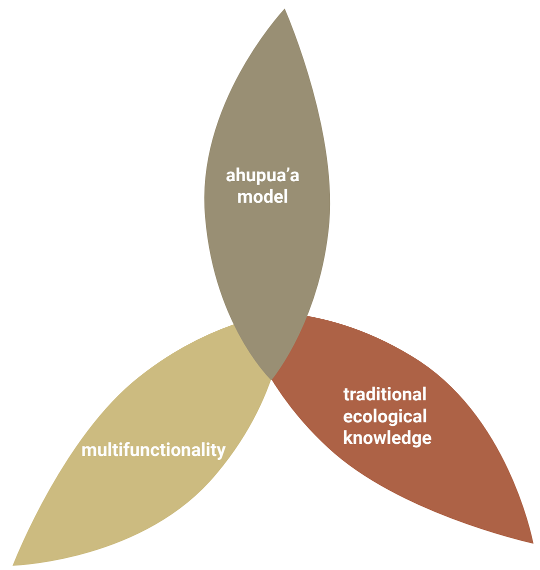
Design experiments are set within a given context, and the investigation applies different design-based strategies to investigate the possibilities (Deming and Swafield, 2011). These may relate specifically to the context – for example, how might a particular design strategy, such as process of ecological interventions, transform a type of site such as an abandoned suburban airfield (Deming and Swafield, 2011).

In design experiments the research questions will explore how new knowledge, values, or principles might emerge from the creative transformation of familiar design contexts (Deming and Swafield, 2011). My research question explores how a particular design strategy and set of principles transform various sites such as public open spaces, greenways, and rooftops.

Figure 1.10 (above)
Methodology diagram

part 2

key concepts & precedent studies



Key Concepts

Ahupua'a Model
Multifunctionality
Traditional Ecological Knowledge

For this project, multifunctional urban agriculture consists of elements found in the ***ahupua'a*** system - food forests, urban agriculture, and aquaculture (Figure 2.1). Each precedent will be analyzed on its multifunctionality as defined by Lovell (2013) as consisting of three key dimensions – cultural, ecological, and production functions (Figure 2.2), and Traditional Ecological Knowledge as defined and explored by Berkes and Watson (Figure 2.3).

__Multifunctionality__

Cultural functions, which represent the social realm of sustainability, include recreation, visual quality, cultural heritage, education, and other benefits directly experience by humans (Lovell and Taylor, 2013). Ecological functions are represented by the environmental realm of sustainability. This includes climate regulation, carbon sequestration, water infiltration, biodiversity conservation, nutrient cycling, and other benefits within environmental health (Lovell and Taylor, 2013). Production functions relate to the economic realm of sustainability, since these functions contain some market value through agricultural products including food, animal feed, fiber, and medicinal resources (Lovell and Taylor, 2013).

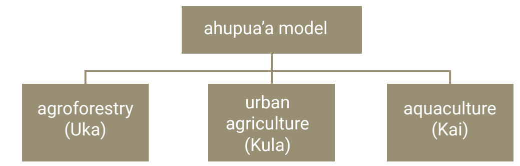


Figure 2.1.
Ahupua'a model

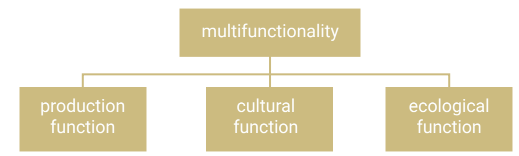


Figure 2.2.
Multifunctionality model

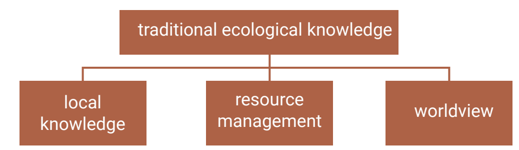


Figure 2.3
Traditional Ecological Knowledge model

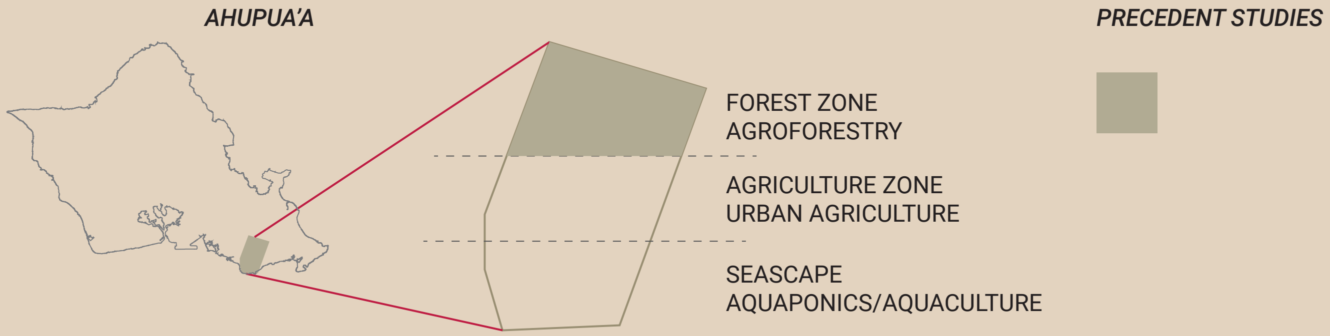
Table 1.0. Urban Planning to support various functions of urban agriculture (*Lovell, p. 253, 2010)*

Function	**Description and Justification**	**Supportive Planning Strategies**
Production	Urban agriculture produces fruits, vegetables, mushrooms, herbs, medicinal plants, and other products	Provide suitable, accessible and safe land with good solar access and an irrigation source
Economic Revitalization	Urban agriculture ventures offer new jobs for neighborhood residents and vitality from improved economics of the community	Create networks to connect laborers, farmers, and markets to help retain and grow new ventures
Energy Conservation	Producing food locally reduces the embodied energy resulting from inputs, transport, and packaging	Develop transportation systems and networks to efficiently get food to consumers
Waste Management	Organic waste products can be composted and used as a fertility resource for growing food and other products	Identify systems to collect, divert, and transport organic wastes away from landfills to urban agriculture
Biodiversity	Agricultural systems can support a wide range of species, including some native plants, as crops or associated plants	Convert open spaces areas of low diversity to community gardens and farms
Microclimate control	Urban agriculture can positively alter microclimate through humidity control, wind protection, and shade	Allow edible plantings in built areas to combat the heat island effect and other unfavorable climatic conditions
Urban Greening	Community and backyard gardens contribute to the greening of urban areas, improving aesthetics and well-being	Support efforts to convert vacant and derelict lands into productive green spaces for use by residents
Community Socialization	Community members often find gardening and farming to be a social activity through sharing food, knowledge, and labor	Along with community garden spaces, integrate other activities and features to encourage socializing
Human Health	In addition to the known benefits of access to green space, urban agriculture offers healthy food and encourages physical activity	Explore opportunities to develop community programming around gardening/farming as a healthy lifestyle
Cultural Heritage	Urban agriculture can provide access to are ethnic foods that are typically not available in existing markets	Integrate community garden spaces in areas known to have high immigrant populations, and link with culture
Education	Children and adults learn about foods, nutrition, cooking, environment, economics, and cultures through urban agriculture	Offer gardening and urban agriculture activities within existing programs, particularly during summer

<u>Traditional Ecological Knowledge (TEK)</u>

Traditional Ecological Knowledge is comprised of four interrelated levels of ecosystem management, defined by a model known as the Knowledge-Practice-Belief Complex coined by ecologist Fikret Berkes. Traditional ecological knowledge is defined by Berkes as "knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings, including humans, with one another and with their environment" (Watson, 2019; Berkes, 2012). The first and foundational level is known as the local knowledge of animals, plants, soils, and landscapes. The second level is including resource management, which encompasses local environmental knowledge, practices, tools, and techniques; along with the understanding of ecological processes and performances (Watson, 2019). The third level involves community and social organization, offering coordination, cooperation, and governance (Watson, 2019). The final level is of worldview. This level is centered around religion, ethics, and general belief systems.

Economic, social, and cultural values were used to evaluate the design's multifunctionality, while local knowledge, worldview, and resource management practices were used to evaluate the design's use of Traditional Ecological Knowledge (TEK).



Forest Zone –Food Forest

Permaculture is defined by co-originator David Holmgren as "consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fiber and energy for provision of local needs" (Holmgren, 2004).

The typical food forest design is based on a 7-layered model, according to Robert Hart:

1) A canopy layer that consists of tall fruit and nut trees.
2) A lower tree layer of dwarf fruit and nut trees.
3) A shrub layer of fruit bushes such as currants and berries.
4) An herbaceous layer of culinary and medicinal herbs, companion plants, bee- and poultry- loving plants.
5) A ground cover of edible plants that function as a living mulch.
6) A rhizosphere layer that consists of root crops.
7) A vertical layer of vines and climbers.

The inclusion of public food forests in urban neighborhoods can be a successful addition to urban agriculture typologies as it generates space for organized activity of urban foraging, recreation, and education. The introduction of food forests can also reduce household food expenses through food production, while creating jobs and increasing surrounding property values (Krishnan, 2016). As most cityscapes are devoid of edible components and instead feature traditional shade trees, lawns, and other soil-cover plantings, including public food forests can increase nutrient recycling opportunities and provide biodiversity and habitat for species (Krishnan, 2016).
The introduction of an urban food forest in current regions of Honolulu's watersheds could increase its food productivity. By integrating urban and peri-urban forests, it can produce a range of foods to supplement local diets and provide a focus for community activity. Edible green infrastructure, in the form of urban food forests and trees can help address a range of problems caused by rapid and unplanned urbanization – food scarcity, poverty, deterioration of human health and well-being, air pollution, and biodiversity loss (Castro, 2018).

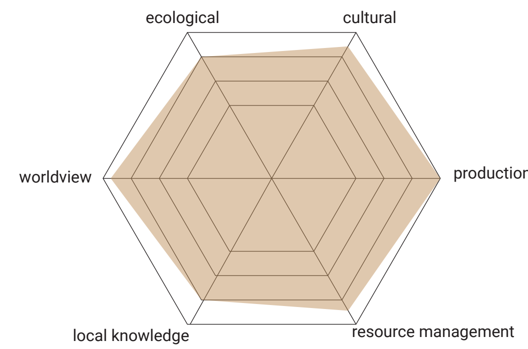
By integrating the use of edible plants that are influenced by historical, cultural, and socio-economic factors, urban spaces can provide urban dwellers with many benefits such as social cohesion while strengthening local communities, and enhancing biodiversity (Castro, 2018). The strategic use of woody perennial food-producing species in edible urban landscapes can improve the sustainability and resilience of urban communities (Clark and Nicholas, 2013).

Opposite image
Diagram showcasing selected food forest precedent study that represents agroforestry zone of the *ahupua'a*

Figure 2.4
Plan view of Mahi Whenua gardens

Figure above
Typology of Mahi Whenua gardens

Project Name: Mahi Whenua Gardens
Location: New Zealand



Located in New Zealand, this garden reflects a traditional Maori garden and incorporates a multi-layered food forest (Figure 2.4) that is accessible to surrounding residents and visitors. As Auckland grows and intensifies, the gardens and food forest become a shared space that foster principles of permaculture.

Cultural Functions

Mahi Whenua is a resource used by others as an educational tool or a place of contemplation and enjoyment. The gardens serve as an accessible green space that supports local initiative such as the Auckland Zoo. The guardians, or tiaki, of the space support the community by showcasing organic horticultural and permaculture principles, promoting the production of nutritionally-rich food in a sustainable way, and maintaining the gardens and food forest as a community research and demonstration resource that promotes self-sufficiency. The current landowner is the Ministry for Housing and Urban Development, and the mana whenua who will receive a land title to the space. The guardians work collaboratively with these groups and work to maintain positive relationships with them. The garden also serves as a food source for the local community in times of emergency.

Ecological Functions

Mahi Whenua is recognized as a biodiversity hotspot with more than 400 plant species. Educational workshops are provided, and recycling and composting are incorporated in the design with nothing going into the dump. No-till techniques increase the amount of water that infiltrates the soil and organic matter retention. Rainwater is captured and used through water catchment systems and cultural mounds (Figure 2.5) are oriented to catch the sun.

Figure 2.5 (above)
Kumara mounds

Figure 2.6 (below)
Mahi Whenua food forest

Production Functions

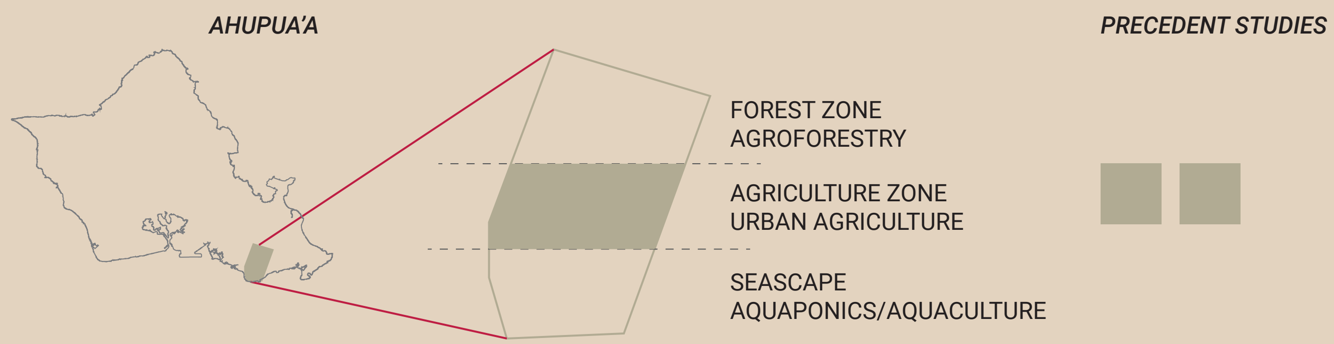
There are 120 different tree species on the property. Varieties of citrus, banana, apple, plum, guava, and feijoa are just a few species listed. Edible plants grow on lower levels. The communal gardens provide food to more than 60 members and their families and local restaurants with proceeds raised by the gardens being shared with local charities.

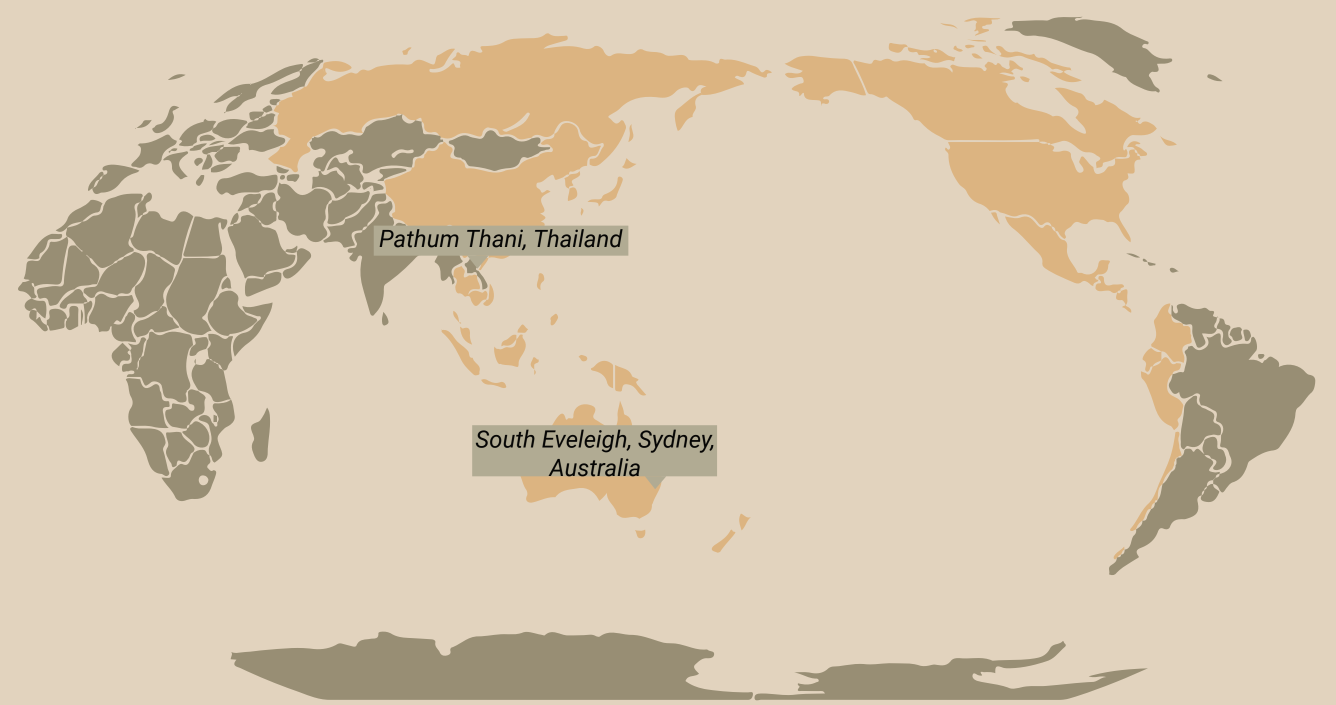
The intention of the food forest (Figure 2.6) is to promote a highly efficient, productive, and sustainable way of growing food. This food forest creates habitat for local wildlife, pest control, pollination, and healthy food for the community. It also provides fibres, wood for heating, materials, and helps to reduce water usage.

Traditional Ecological Knowledge

Mahi Whenua gardens look to the past to inform the way they move into the future. The gardens highlight the importance of cultivating plants and food in the area throughout human settlement. Kumara mounds (Figure 2.5) are placed and oriented to catch maximize sunlight and traditional methods of a mara kumara garden are shared. These mounds are viewed as a gift from Mahina, the moon. As the Māori proverb Ka mua, Ka muri tells us, 'we learn from those who have gone before us'; or 'by understanding the past we can know the future'. Tools uncovered at the site indicate that it has been cultivated continuously since pre-European times. A precious adze is embedded in front of a carving in Unitec's whare whakairo (carved meeting house)

The mounds are named Wairaka for a Maori ancestor of the Mount Albert area; she is known as one of the beautiful daughters of Toroa, chief of the Ngati Awa tribe and captain of the Matatua waka (canoe). Wairaka is known throughout New Zealand because of her bravery and is a strong leader for her people.





Agricultural Zone - Urban Agriculture

In cities of developed countries including the United States, urban agriculture offers a new frontier for land use planners and landscape designers to become involved in the development and transformation of cities to support community farms, allotment gardens, rooftop gardening, edible landscaping, and other productive features of the urban environment (Lovell, 2010). The challenge, and opportunity, is to design urban agriculture spaces to be multifunctional, matching the specific needs and preferences of local residents, while also protecting the environment (Lovell, 2010).

Urban Agriculture includes:

- Edible landscape/streetscape
- Urban farms
- Community gardens
- Rooftop gardens
- Institutional farms
- Aquaponics

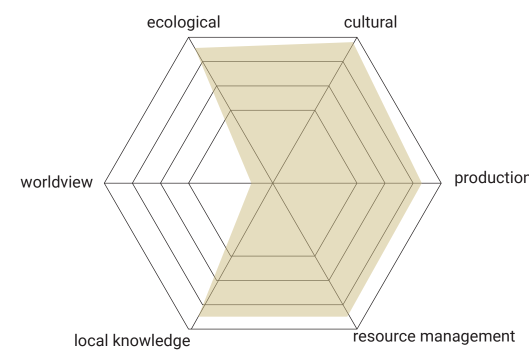
Most urban neighborhoods contain existing tracts of public or community green space that offer opportunities for establishing urban agriculture as part of the green infrastructure. Among these are parks, schoolyards, cemeteries, churchyards, and roadside right-of-ways that could possibly support food production. Public green space can be particularly appropriate for multifunctional urban agriculture, including cultural benefits, when education is considered as part of the programming of the site (Lovell, 2010). Replacing street trees with productive fruiting species, establishing a small orchard in a park, incorporating herbs and vegetables into planters, or creating a hedge of fruiting shrubs, will have a large impact when urban residents can learn about the connection between the food they eat and the landscape on which it is produced (Lovell, 2010). The benefit of urban agriculture is its ability to positively increase the well-being of surrounding community members, better health opportunities, access to food, community development and empowerment (Hou, 2017).

Opposite image
Diagram showcasing selected urban agriculture precedent studies that represents agricultural zone of the *ahupua'a*

Figure 2.7 (right)
Plan view of South Eveleigh Native Rooftop Farm

Image above
Typology of South Eveleigh Native Rooftop Farm

Project Name: South Eveleigh Native Rooftop Farm
Location: South Eveleigh, Sydney



Built on the 500-square-meter (5,382-square-feet) rooftop space of an office building, the native rooftop farm (Figure 2.7) uses principles of Indigenous knowledge, collaborative design and permaculture to create and maintain the Australia's first Indigenous rooftop farm for urban food production. Located high above Sydney on the roof of Yerrabingin House, the project has grown over 2,000 edible, medicinal and culturally significant plants.

Cultural Functions

The South Eveleigh Native rooftop farm (Figure 2.7) is open to community members with hopes to inspire locals to grow plants in the spaces they have available. The garden acts as more than just a green space as it provides sustainability workshops on topics like native permaculture design, pickling, preserving produce, making beeswax wraps and an introduction to bush foods in the garden (Spring, 2019).

Ecological Functions

The previously unused rooftop space was transformed into an environmentally friendly rooftop greenspace on the edge of a bustling city. The design interventions of this project supports a wide range of species while improving the aesthetics and well-being of the city. This cut down food miles by encouraging those working in city restaurants to stop and forage. Since trees bear too much weight on the rooftop, iron trellises (Figure 2.8) are instead incorporated to attract local birds and wildlife. Edible, medicinal, or cultural plants located in circular beds also act as pollinator beacons.

Figure 2.8 (above)
Iron trellis for native pollinators

Figure 2.9 (below)
Group tour of garden led by Yerrabingin

Draining soil was used along with plants that require little irrigation. Drainage cells are hidden under the soil to catch and hold rainwater, while excess water is drained off the side of the building.

Production Functions

Farm produce is intended to go to local chefs and restaurateurs, who are encouraged to forage in the garden. More than 2,000 plants are flourishing, some of which include bush foods such as warragal greens, ruby and seaberry saltbush, river mint, finger lime, native raspberries, lilly pilly, grevillea and thyme honey-myrtle.

Traditional Ecological Knowledge

The South Eveleigh Native rooftop farm introduces the importance and value of indigenous vegetables and herbs and how it can be distributed locally. Local environmental knowledge is provided by the Yerrabingin designers while the community center offers a space for locals to share their resources and knowledge through events and workshops (Figure 2.9).

Yerrabingin manages workshops, events and tours, workshops, native permaculture, weaving and art on the rooftop. Yerrabingin mostly hires out for functions and works with small businesses and indigenous catering companies. The space is also used as an Indigenous cultural space for music and dance performances, along with traditional workshop practices like weaving and tool making demonstrations (Spring, 2019). Designer Christian Hampson says, "the idea of people understanding the origin and cultural knowledge of those foods [is important]. People, especially younger people, are very interested in their food origin and what better food origin than food that's got knowledge that's thousands of years old" (Spring, 2019).

Educational programs are also incorporated on the rooftop farms with local schools. Projects are geared towards environmental studies and science. The rooftop also serves as a space for Indigenous employment opportunities and a range of community benefits – workshops on sustainability and well-being. The farm is self-funded through the delivery of sixteen events per month for visitors and South Eveleigh's 18,000 workers and residents.

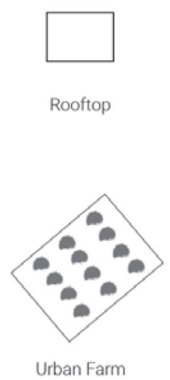
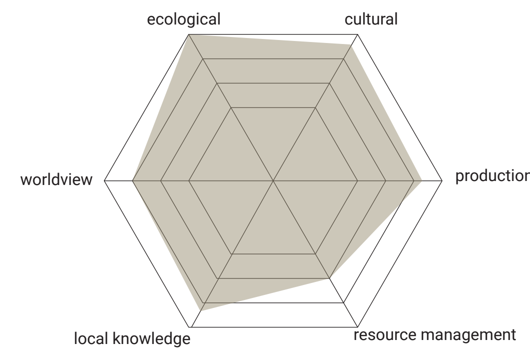


Figure 2.10
Plan view of TURF

Image above
Typology of TURF

Project Name: Thammasat University Rooftop Farm (TURF)
Location: Vietnam



Designed by landscape architects, LANDPROCESS, this rooftop farm is located at Thammasat University Rangsit Campus in Pathum Thani Province of Thailand. It has a total area of 60,000-square-meters (645,834.63-square-feet) with a 22,000-square-meter (236,806.03-square-feet) green roof (Figure 2.10).

Amidst the climate crisis, both food and water scarcity pose huge threats to human civilization. A place once rich with food sources and fertile marshlands has transformed into a space filled with concrete developments. Bangkok and cities across Southeast Asia have become victims of unregulated urbanization on rice-producing regions. In response to reviving the land, Thammasat University Rooftop Farm offers modern landscape design with traditional agriculture of rice terraces to transform a wasted space into a productive organic rooftop farm.

Cultural Functions

A large amphitheater provides accessible and flexible recreational and educational spaces while also providing 360-degree panoramic views of the university centered in the urban farm with open sky. The design reflects the tradition of rice terraces and incorporates indigenous vegetables and herbs (Figure 2.11). An outdoor classroom reconnects both students and community members with their history and educates them about sustainable, organic growing practices.

Figure 2.11 (above)
Students harvesting amongst terrace-like planters

Figure 2.12 (below)
Community members harvesting rice

Ecological Functions

Instead of another wasted rooftop which contributes to urban heat islands, the green roof utilizes its vast space as an infinite source of clean energy, while the farm creates a microclimate that attracts pollinator bird and insect species. This design repurposes previously unused space into regenerative agricultural space.

Cascading layers of planters hold soil together and slowdown runoff, food waste is composted to fertilize the farm, and water from the retaining ponds is used to water plants. This creates an entirely localized, circular system. The water system also retains and utilizes runoff efficiently to grow food for the campus. By building both the organic food source and destination in close proximity, the system is able to reduce emissions and waste-produced during production, processing, packaging, transportation, and disposal from start to finish.

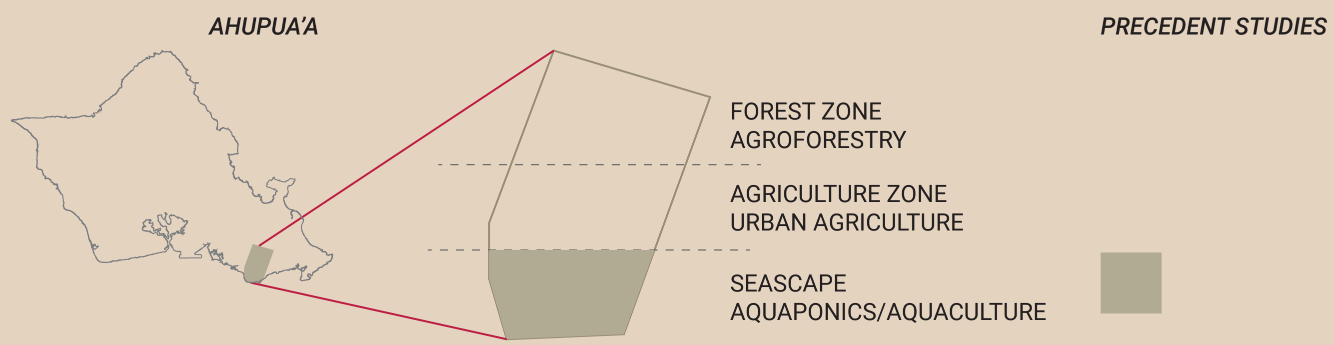
Production Functions

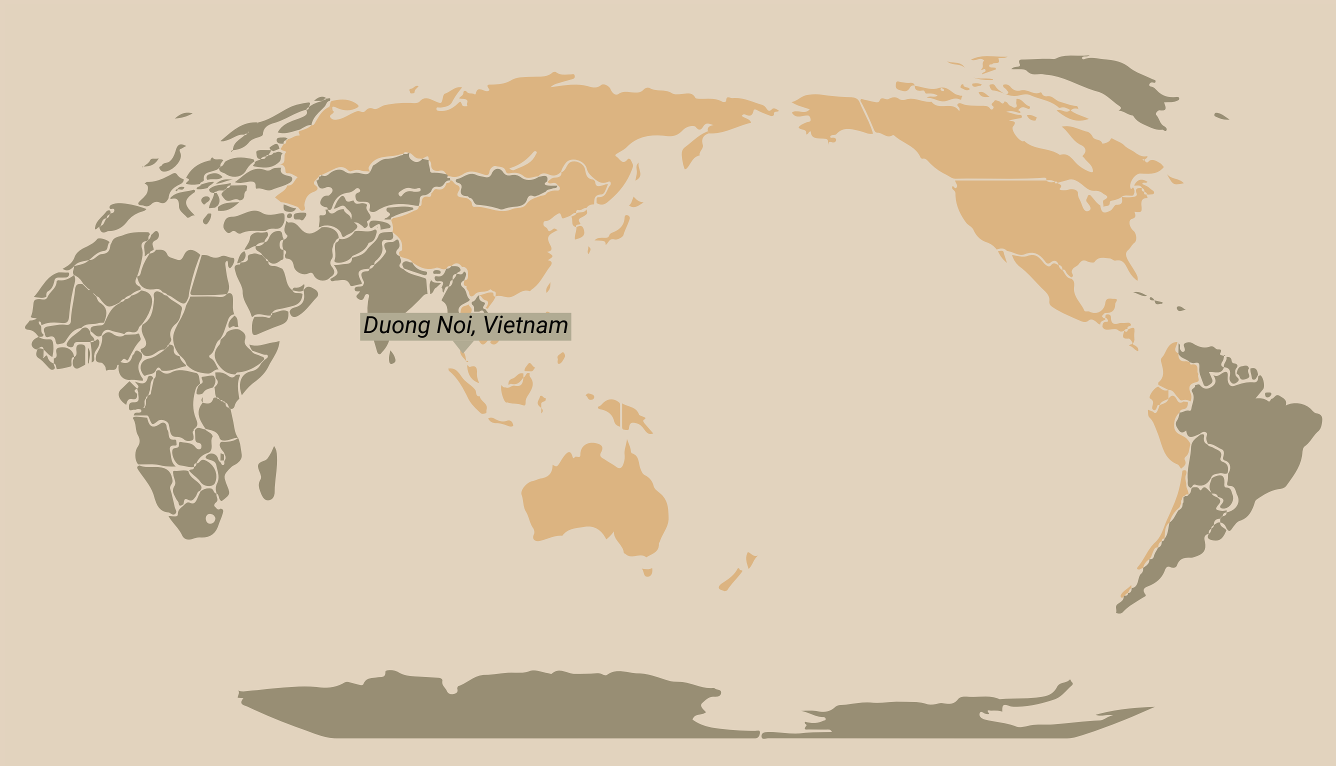
TURF produces 20 tons of rice, herbs and vegetables per year. Some of which include red and green oak-leaf lettuce, Thai eggplant, green rosells, Thai red pepper, and dill. The rooftop farm supplies canteens on campus with 20 tons of rice, herbs and vegetables per year, which in turn provides approximately 80,000 meals. This design provides access to healthy food.

TURF serves a source of local jobs. Staff are hired by the university to tend to crops, and farmers offer workshops on sustainable agriculture, permaculture and nutrition. Students and community members are invited to participate in seasonal seeding, harvesting, and maintenance (Figure 2.12). Designed to improve urban food security, the rooftop farm is also open to anyone who wishes to grow rice, vegetables, and herbs.

Traditional Ecological Knowledge

Indigenous vegetables and herbs are incorporated in the garden and serve as a part of the educational experience. The design also incorporates the resourcefulness of local farmers on mountainous terrains across Southeast Asia. TURF's landscape architect integrated the earthwork of rice terraces with modern green roof technology. Local environmental knowledge of rice terraces was highlighted. During the design and planning of TURF, public hearings with university students, staff, and neighbors were facilitated.





Aquaponics

Aquaponics, a technology that integrates aquaculture and hydroponics, combines the culture of fish and plants in a recirculating system. Aquaponic systems offer several benefits. Dissolved waste nutrients are recovered by the plants, reducing discharge to the environment and extending water use (Rizal, 2018). Aquaponic food production, which began in the 1970's, is highly efficient because it re-uses the nutrients contained in fish feed and fish feces to grow crop plants (Rizal, 2018). Aquaponic systems are characterized according to the way plants are supplied with nutrient solutions in the hydroponic systems, e.g., floating polystyrene foam sheets (floating raft), nutrient film technique (NFT), or media filled growth beds arranged horizontally or vertically, while fish are kept in standard recirculating aquaculture conditions (Rizal, 2018).

Along with its ability to serve as a food production system, small aquaponic units can also be valuable teaching tools as it can demonstrate ecological cycles and serve as decorative elements in homes or public spaces. The principles of combining fish and crop production can also be implemented from a low-tech level to a high-tech state-of-art system (Rizal, 2018).

Opposite image
Diagram showcasing selected aquaculture precedent study that represents coastal zone of the *ahupua'a*

Aquaponics has been used extensively in the education of natural sciences however little has been done to assess the social aspects (Rizal, 2018). Food security and infrastructure will become a central issue due to increase in human population, and aquaponics may prove to be a solution.

Today, many urban areas around the world face the challenge of a food supply infrastructure. Therefore, aquaponics implemented as either urban agriculture or as community farming can help alleviate food deserts (Rizal, 2018). In more dense, urban settings, aquaponics can fulfill other functions aside from food production such as an educational tool in schools, interior greening, and as a unit in social institutions. Aquaponics can help increase food security and food sovereignty.

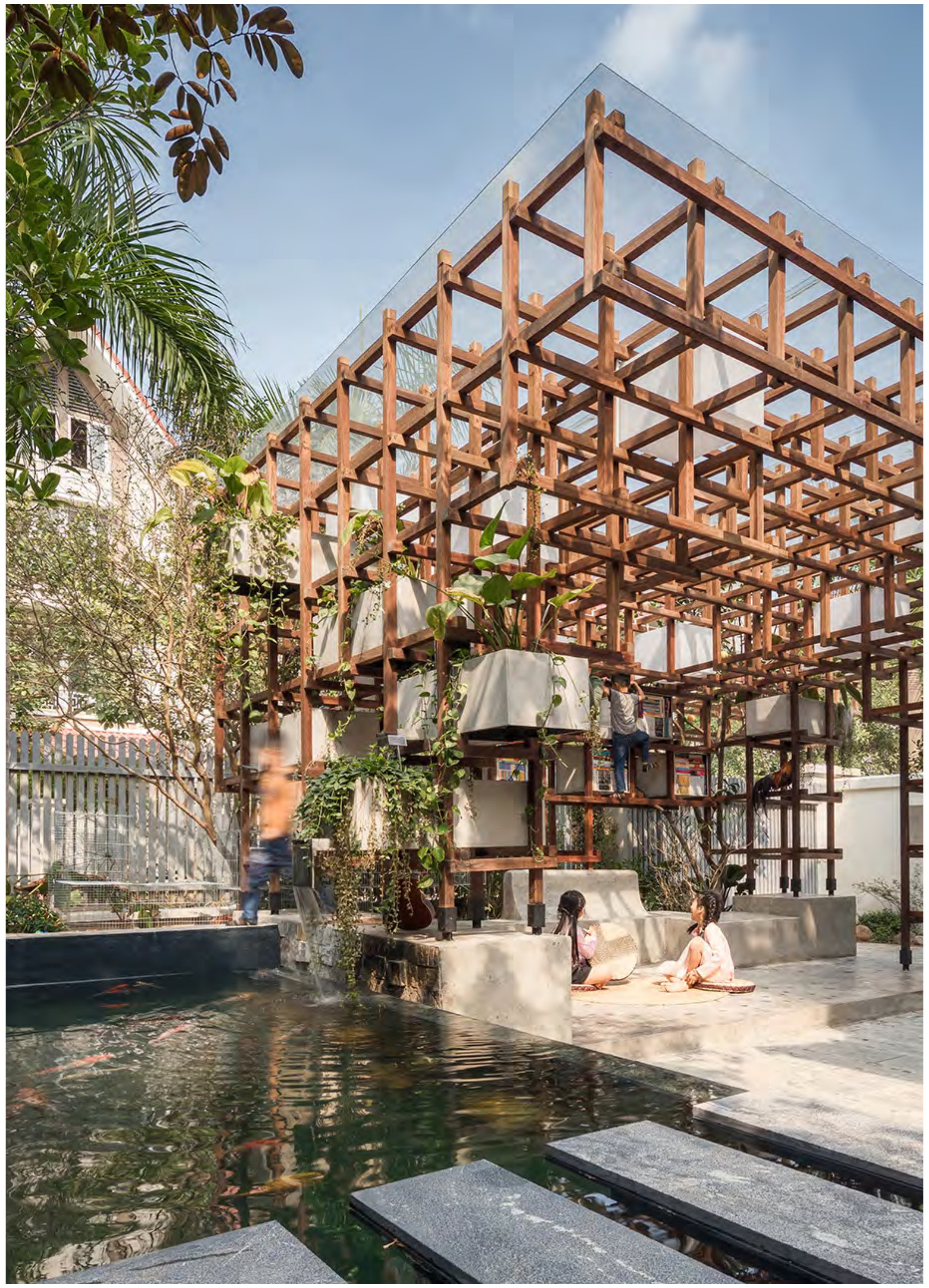
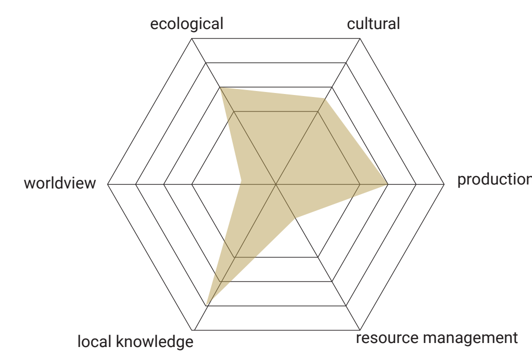


Figure 2.13
VAC Libary

Image above
Typology of VAC Library

Project: VAC Library
Location: Hanoi, Vietnam



Located in Hanoi, Vietnam the VAC Library is a 55-square-meters (592-square-feet) landscape project led by Farming Architects and completed in 2018. This design offers a distinctive aesthetic, environmentally sustainable product, and one-of-kind experience to the community (Figure 2.13).

Cultural Functions

The design of VAC Library was inspired by the deep-rooted lifestyle of the Vietnamese people who love tending to farming and agricultural activities at their homes and neighborhoods (Khan, 2019). VAC is an acronym for the Vietnamese phrase – ***Vuon (garden), Ao (Pond), Chuong (Cage).*** Located on the garden of a villa in an urban area of Hanoi, the project invited kids from nearby areas to experience the joy of reading, while simultaneously gaining knowledge about recycling, reusing, and the lost practice of 'living close to nature'.

Ecological Functions

This project integrates a living frame which not only attracts visitors and passersby but the biodiversity of place in a dense, urbanized area. The site designates areas for recycling and reuse, and the living structure is an active aquaponics system (Figure 2.14). Wastewater from the pond, filled with Koi, is fed to the potted plants which are placed on the climbing frame. The structure works as a space organizer with flexible applications that include seating, storage, lighting, and a solar panel integrated roof (Khan, 2019)(Figure 2.15). Chicken cages are also present on site and sit at the rear of the space. The chickens contribute to the library's miniature ecosystem, providing eggs for the public and manure to help fertilize the vegetables.

Figure 2.14. (above)
Children observing VAC's fish pond

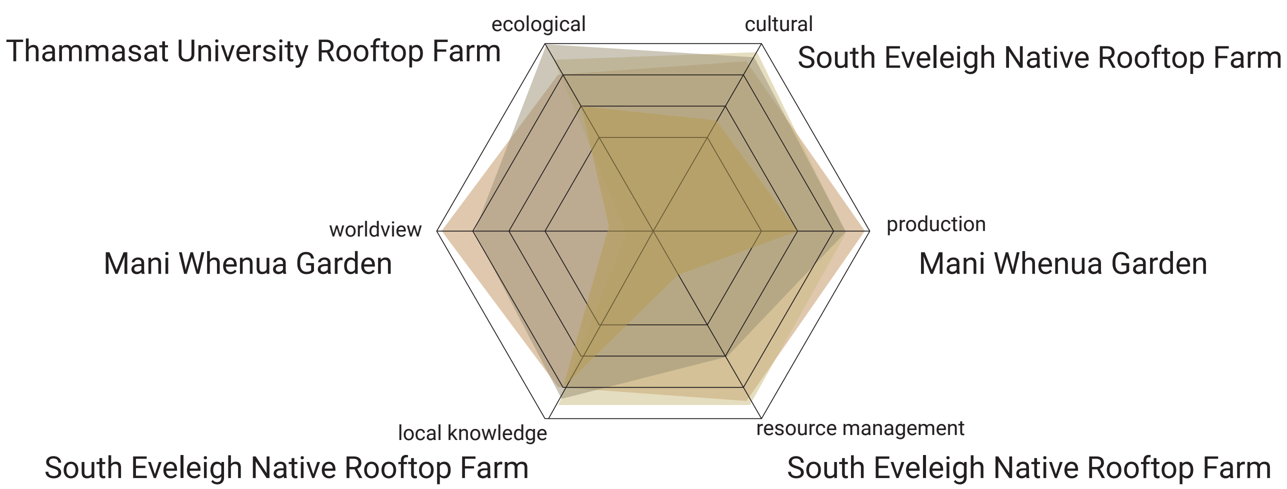
Figure 2.15 (below)
Structure of VAC allows seating and bookshelves

Production Functions

Along with eggs from the resident chickens, the VAC Library's aquaponic structure is able to produce lettuce, tomatoes, cilantro, carrots, squash, beets, and cherry tomatoes. These vegetables and eggs are used to create meals on site.

Traditional Ecological Knowledge

The design serves as a resource for visitors and educates them on how to recycle, reuse, and importantly, how small interventions can produce vegetables in their own homes. The design concept is reflective of the community, as homes across cities like Hanoi and Ho Chi Minh developed their own aquaponics systems. The technique gained prevalence over the years in response to the rising contamination in food. The community, who are true DIY enthusiasts, took matter in their own hands and started, in whichever capacity they could, to grow organic produce. In small, narrow apartments, they cleared out terraces, backyards, and small balconies to provide space to the system.



Precedent Summary Findings

Selected precedents have shown that indigenous knowledge was incorporated through a careful selection of native plant species, through designing with terraces to highlight past management styles, or through continued educational workshops given on site. Stakeholder meetings that invited local farmers and residents were a way to generate both local knowledge and resource management. Designs that highlighted traditional belief systems and history of site highlighted the importance of worldview and resource management concepts within indigenous knowledge. There is a stronger relationship between self, plant, animal, land, and others that is evident in the selected precedents, as each site highlights indigenous history, tools, and native species.

Each precedent addressed multifunctionality in multiple ways. Designs that achieved high ratings of production function were based on food forest designs as agroforestry yields the highest output of produce due to its multiple layered design. Designs that achieved the ecological function within multifunctionality addressed agricultural design that responded to biodiversity conservation, climate regulation through its site location, and water infiltration.

1 Paepae o He'eia Fishpond

key takeaway

Native Hawaiians were resourceful and managed to sustain themselves

Education is important - form of activism; allows beliefs and lessons to survive & thrive

Instill the values of our ancestors

Responsbility to take care of the land

Advocate for our ecosystems

Gratitude - land is connection to the gods/ancestors

2 Hui O Ko'olaupoko

key takeaway

Main principles of organization -
Ecological principles
Community input
Cultural Heritage

Land and medicinal plants are a teaching tool

Wayfinding signage - important to educate visitors about the watershed and history (mo'olelo) of place

Ahupua'a is a connection of all the elements

Body by 'aina - connecting with land to lead a healthy and active lifestyle

Informal Interviews

To gain a deeper understanding towards indigenous knowledge informal interviews were conducted to fully grasp the concepts of local knowledge, resource management, and worldview in Honolulu, HI. The relationship between self and land are prominent. As the land sustains and nourishes the people of that land, the care and respect must be reciprocated back. This breadth of knowledge can only be taught by those who work to restore and care for the land – the nonprofit organizations and volunteers. To provide space for them to continue those teachings is an important addition to a space. The history of site, traditional tools, cultural traditions, and native species are all woven within the watershed and should be taught to the public through signage or educational workshops. Education, whether that be for indigenous or non-indigenous peoples, is important because it is an act of activism, it teaches people how to survive and thrive, and instills tradition and knowledge that can be passed down from generation to generation. There is an abundance of knowledge from multi-generations that must be highlighted through the restoration or land back motive of this project. To work for this future strengthens the responsibility the people of Hawaii have towards caring for the land that our ancestors have built for us; it enhances sustainability efforts by providing food for the community; it protects our ecosystems and advocates the health of our land and water.

part 3

design framework

URBAN DESIGN FRAMEWORK

Strategies

My collection of literature review, precedent studies, typology analysis, and informal interviews has allowed me to synthesize a framework of design strategies (Figure 3.1)(See Appenedix) to be implemented in the Ala Wai Watershed.

Urban agricultural typologies consist of food forests with mixed layers, urban farms as rows, and aquaponics as a closed-loop system. The following spatial and design typologies were adopted from selected precedent studies and literature review. Agricultural practices, specifically in urban areas, will be implemented along urban open spaces or parks, along greenways or right-of-way, or on rooftops along selected sites.

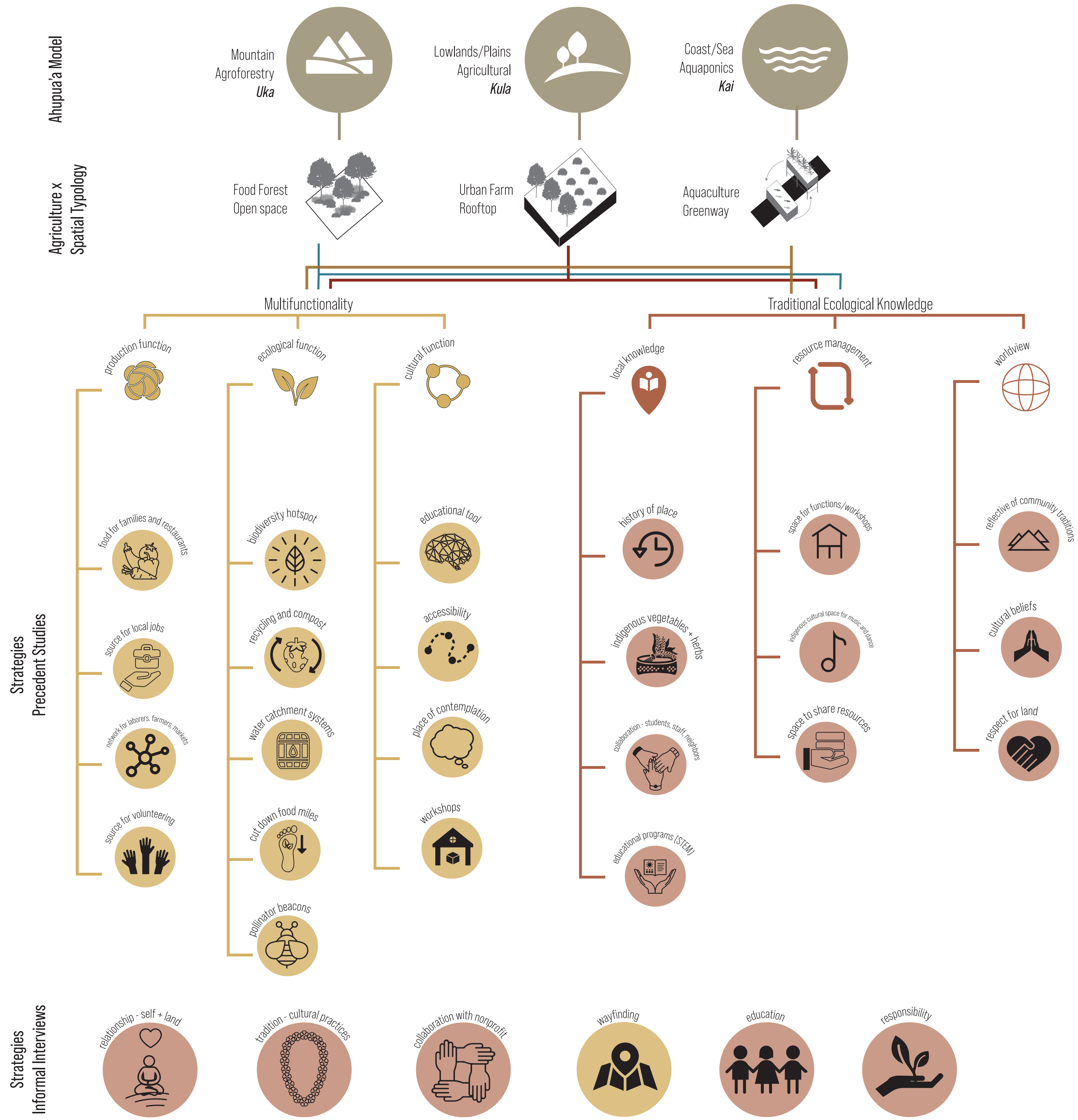
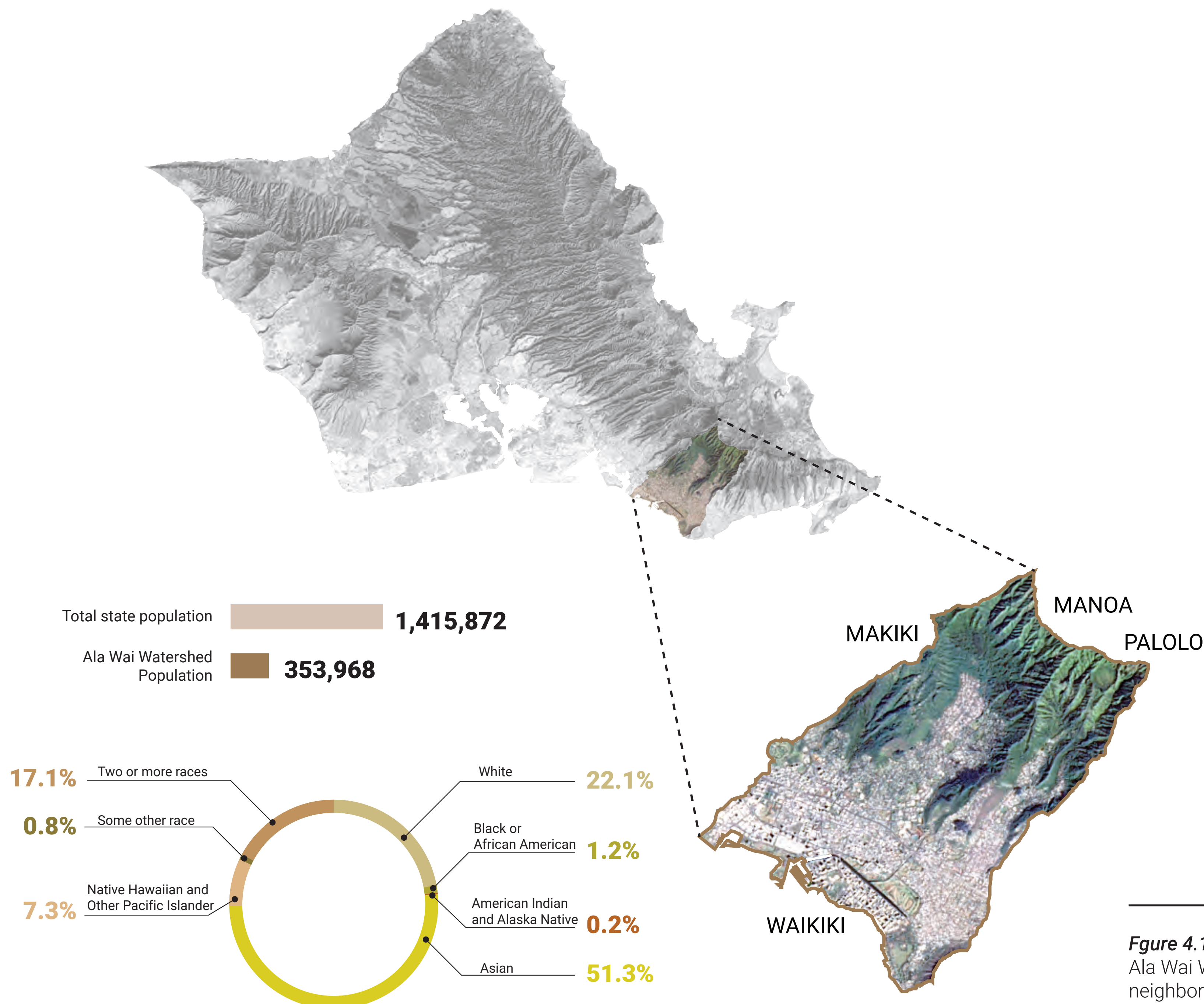


Figure 3.1
Urban Design Framework

part 4

study area



Fgure 4.1
Ala Wai Watershed neighborhoods, population, and demographics

Study Area

<u>Ala Wai Watershed</u>

The Ala Wai Watershed is an urbanized watershed on the southern shores of O'ahu that encompasses the neighborhoods of Manoa, Palolo, Waikiki and Makiki (Figure 4.1). The Ala Wai watershed's population accounts for roughly fifteen-percent of the state's population and, according to the U.S. Census Bureau, is comprised mostly of those who identify as Asian. The watershed is comprised of 3 major streams, Makiki, Manoa, and Palolo which empty into the Ala Wai Canal and is home to a 66 schools - ranging from public to private (Figure 4.2). There are also 66 acres of public open space for recreation. The upper portion of the watershed is zoned as a Conservation District, while the remainder is heavily urbanized with some of the most densely populated neighborhoods of Honolulu (Figure 4.3).

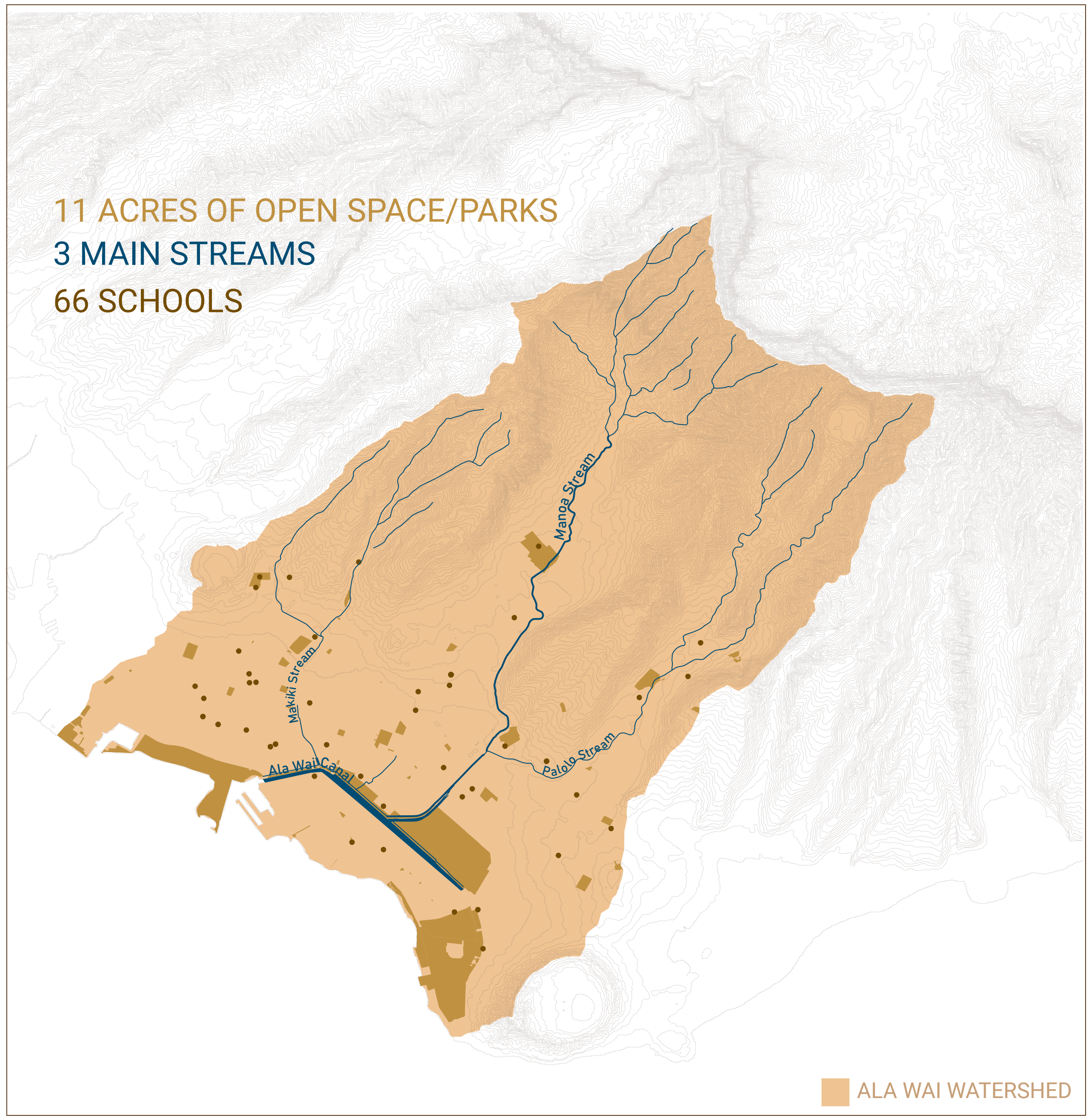


Figure 4.2.
Analysis of Ala Wai Watershed - location of parks, streams, and schools

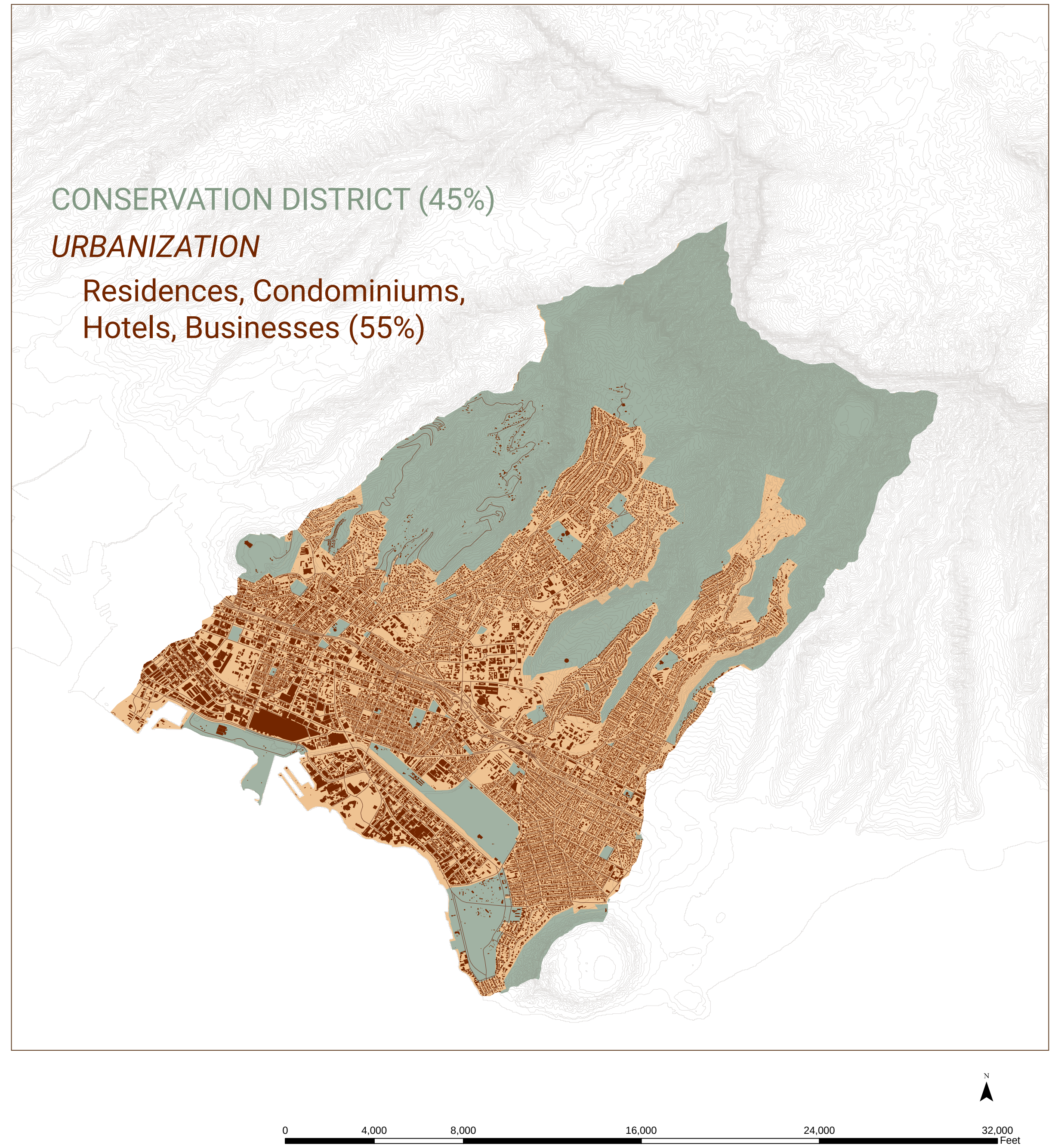


Figure 4.3.
Zoning of Ala Wai Watershed - 45% conservation district; 55% urbanized

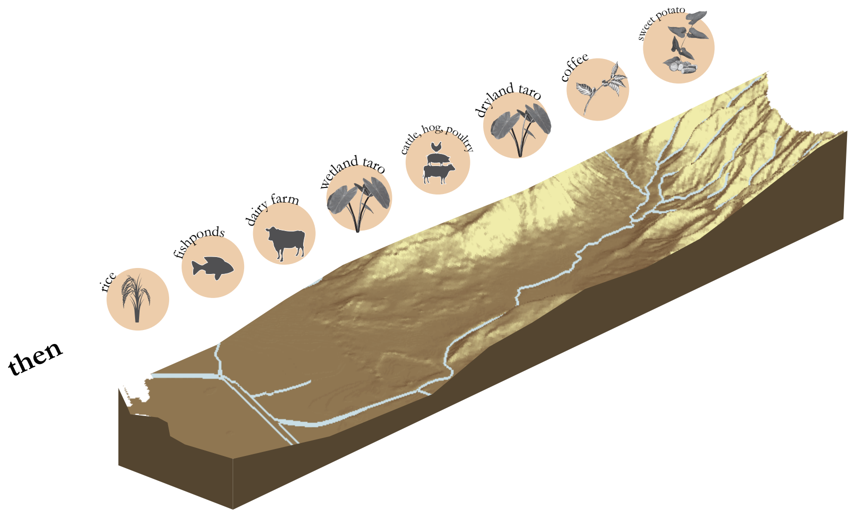


Figure 4.4.
Agricultural past of Ala Wai Watershed

__Site History__

Manoa Valley, which comprises most of urban Honolulu, once belonged to the ***ahupua'a*** of Waikiki. Once ruled under Kamehameha the Great, some of the mountainous regions were planted in sweet potato. Because the plains that Honolulu is situated on was a hot, dry environment, the Ali'i, or Hawaiian Royalty, of the early 1800's sought retreat in Manoa.

Manoa Valley is home to several institutions – Mid-Pacific High School, Punahou High School, and the University of Hawaii. Punahou School was once a site of dairy, started in 1844 by William Harrison Rice (Deleon, 1978). One of the early Europeans to live in the valley was John Wilkenson, who started the islands' first sugar plantation in 1825 in Manoa Valley. He also planted coffee trees which were reported to be found in the valley as late as 1956 (Deleon, 1978).

The valley of Manoa was once heavily wooded in the beginning of the 19th century with 'ohia lehua trees and other natives (Deleon, 1978). The valley floor was suited for growing wetland taro or kalo, and by all reports Manoa was extensively planted with this crop (Deleon, 1978)(Figure 4.4).

By 1890, the valley changed with full-scale agriculture of taro farming. Native Hawaiian population and traditions slowly became suppressed in this area as Chinese immigrants, who worked in the sugar plantations, moved to the valley, and produced and took care of these taro fields. During this period, dairy farming took over lush mountain sides to provide pastureland for cows.

In 1901, the mouth of the valley quickly changed due to its proximity to the city. The area transformed into a residential community. Then in 1912, the College of Hawaii known now as the University of Hawaii at Manoa was built near Mid-Pacific Institute. The school was once an agricultural college with cattle, hogs, and a poultry farm. The farm continued until the 1950's.

Over time, the population continued to grow, and with that so did the diversity in agricultural crops. Vegetable and flower gardens sprung up with taro fields still consistent in the upper valley. In 1919, the Hawaii Sugar Planter's Association established an experimental substation in the rear of the valley (Deleon, 1978). In this area, sugar cane was raised for experimental purposes, along with trees from all over the Pacific region to see how they would adapt to the Hawaiian environment (Deleon, 1978). This substation eventually became the Lyon Arboretum, which is part of the University of Hawaii at Manoa, who continues its work with nonnative trees.

Eventually, the overproduction of taro brought prices down and soon the number of these farms decreased. Flower gardening, however, became profitable due to the Hawaiian custom of giving "leis" or garlands of flowers on special occasions (Deleon, 1978). Some flowers identified were asters, gardenias, marigolds, African daisies, easter lilies, carnations, and maiden hair ferns (Deleon, 1978) and were sold to the city's florists. Vegetable gardens were also grown and consisted of dry land taro, burdock, radish, sweet potato, and carrots. These crops were sold to wholesalers or green grocers in the city. Several banana plantations were also produced in the valley and were sold in Honolulu, with a third of their crops being shipped to San Francisco (Deleon, 1978). At the center of the valley was a small business district that consisted of three general stores, a laundry, a barber shop, and two gasoline stations.

As the population grew, both the Hawaiian population and importance of agriculture declined in the valley. The taro patches that followed the stream bed down the center of the valley were now either vegetable gardens, pastureland, or abandoned (Deleon, 1978). Much of the stream's water had also been diverted for the use of the island's increasing population.

Today, Manoa Valley is a pleasant residential community with a suburban character.

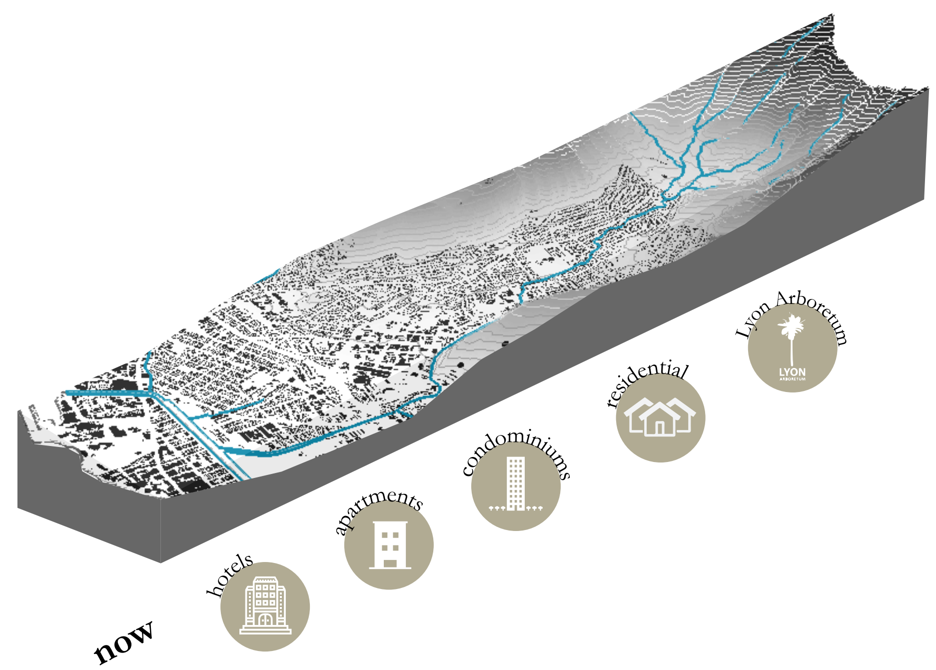
Ala Wai Canal/Waikiki

Waikiki – named for the springs and streams that extended from the shore far inland – was noted historically for its luxuriant production of food, reef breaks for surfing and canoeing, and special sites of various dedications (Connelly, 2008). Hawaiians cultivated taro and built fishponds to raise striped mullet. Later, farmers grew rice in wide, irrigated paddies (Schuler, 2019). Waikiki was once a fertile delta.

In the 1920s, years of history was dredged up and pumped into the wetlands of Waikiki in an attempt to drain them forever (Connelly, 2008). In the first part of the 20th century, Hawaii's territorial governor and the US Army Corps of Engineers filled the fishponds and dredged the two-mile-long Ala Wai Canal, draining the wetlands and setting the stage for a century of hotel and condominium development (Schuler, 2019). The Ala Wai Canal, old enough to be declared as a monument, is a murky artifact of injustice that must be remade, rededicated, and redeployed respectfully (Connelly, 2008).

Today, Waikiki is a three-block-wide stretch between the Ala Wai Canal and the ocean, located at the base of a steep, densely populated watershed (Schuler, 2019). It is situated in a dense urban core and provides a loop-trail for cyclists and pedestrians. The canal itself is utilized by many paddling teams, both private and public organizations. The environmental health of the canal, however, is contaminated with bacteria, pathogens, and automotive pollution. Most locals understand the unsafe water quality of the Ala Wai Canal and often avoid any contact within it. Increased urbanization and density in Honolulu are creating more barren, harsh rooftops that detrimentally impact people, the economy and the environment (Kaufman, 2007). Urbanization also limits the amount of space for agricultural activities and recreation. At ground level, buildings dominate the landscape (Figure 4.5).

Figure 4.5.
Current organization of Ala Wai Watershed



part 5

design possibilities

Design Concept

The kalo, or taro, (Figure 5.1) is a plant that was once grown throughout the ahupua'a and is highly respected by the indigenous people as it is viewed as their ancestor or elder. The design for each site was inspired by the structure and life cycle of the kalo (taro) (Figure 5.2)

The first phase of the taro is the establishment stage, which is represented in the coastal zone - Kai - through an aquaponics structure. The second phase is the vegetative stage, where the leaf and root begin its growth. This is represented in the plains and lowlands - Kula - through an urban rooftop farm. The final stage, where the corm begins to develop, is the maturity phase which is represented through a food forest located in the agroforestry zone - Uka.

As each site is located either near an elementary school, a university, or an elderly community housing, these alliances form the foundation of wisdom needed to nourish the urban agricultural zones. These urban agricultural practices have been situated respectively on a park, a rooftop, and along a greenway.

As a whole, these three separate sites form a multifunctional urban agricultural .
Each site is rooted through history, strengthened by indigenous and local wisdom, and rooted in the proposed design strategies (Figure 5.3).

Goals

The goal of this design is to integrate a sustainable, multifunctional food production system that includes production, distribution, and education. This would enhance the environmental, economic, and social health of those living in the urban district of Honolulu, Hawaii. The goal of this design is to strengthen the community's responsibility to care for and respect the land, along with respecting one another. It is our responsibility, as farmers, family members, and as individuals, to actively collaborate with private and public agencies to promote healthy and abundant food security and production. Caring for the land means preserving land for future generations, and respecting our self means creating better connections with food and our personal health.

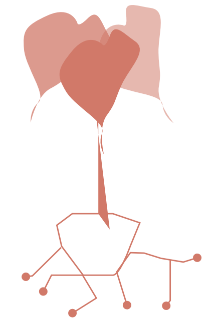


Figure 5.1
Mature taro

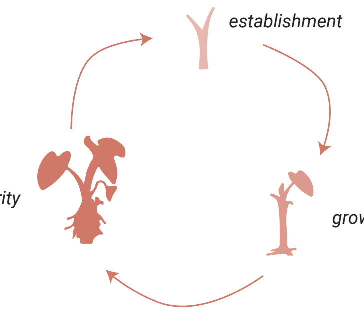


Figure 5.2
Life cycle of taro

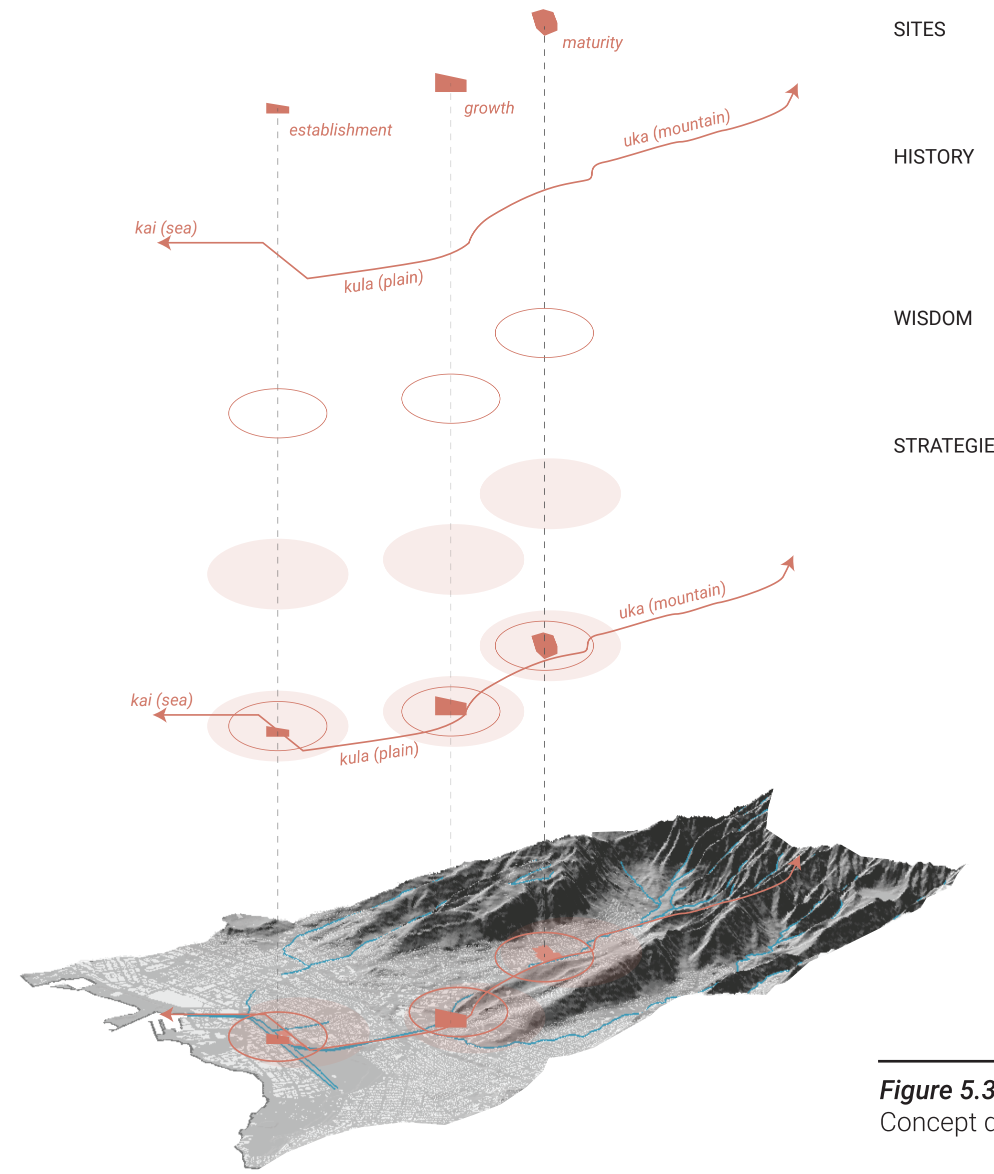
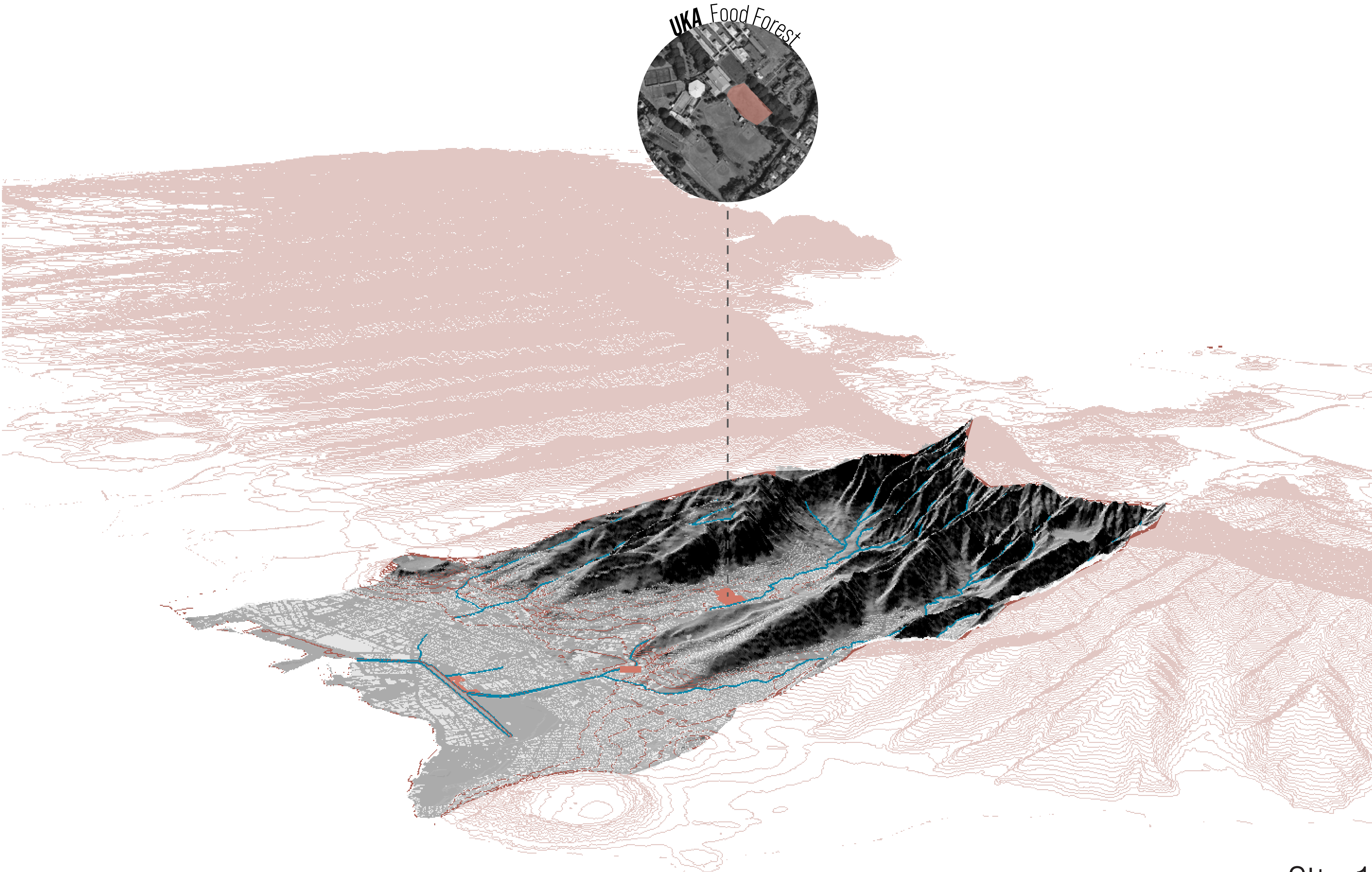


Figure 5.3
Concept diagram



Site 1

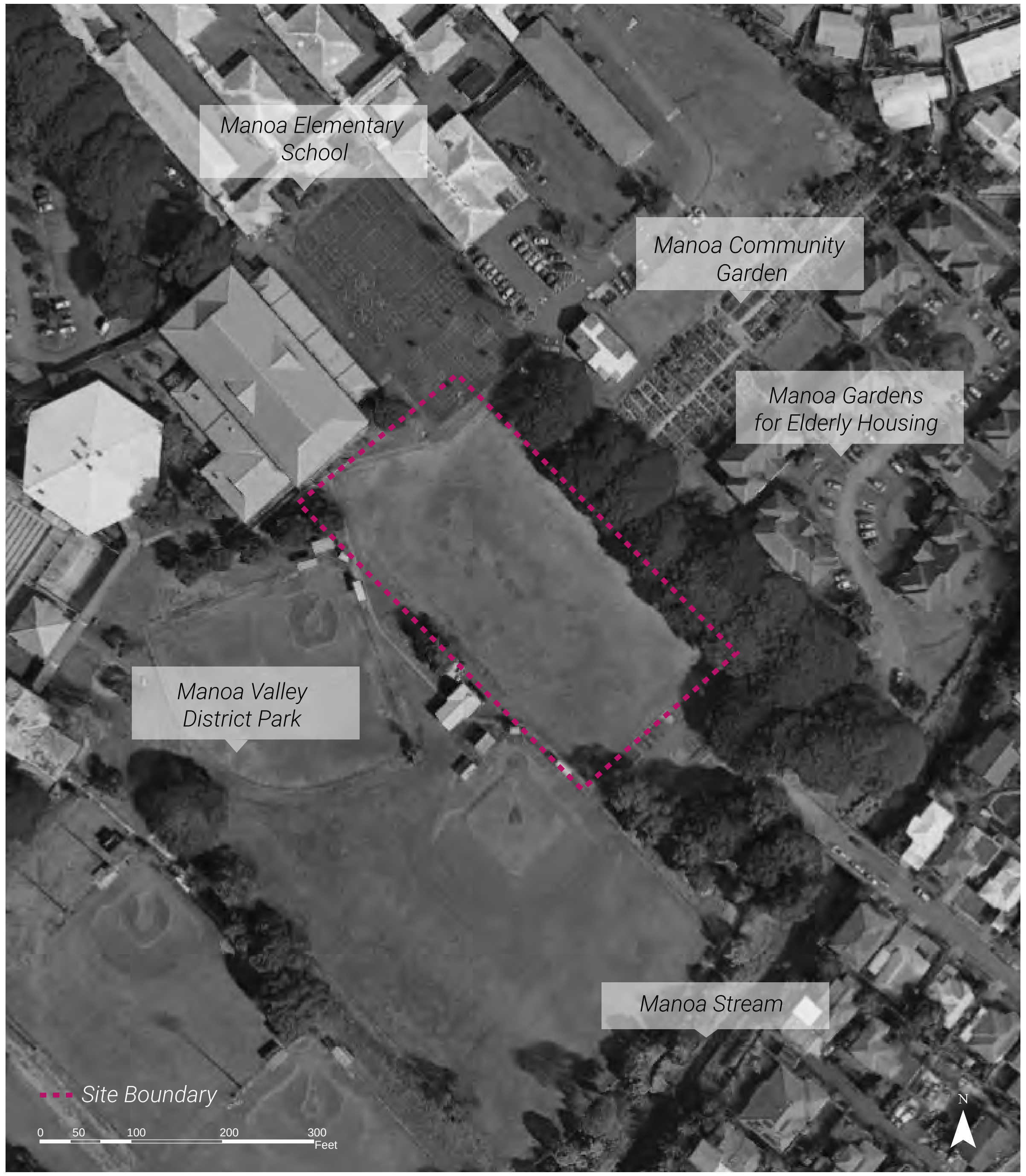
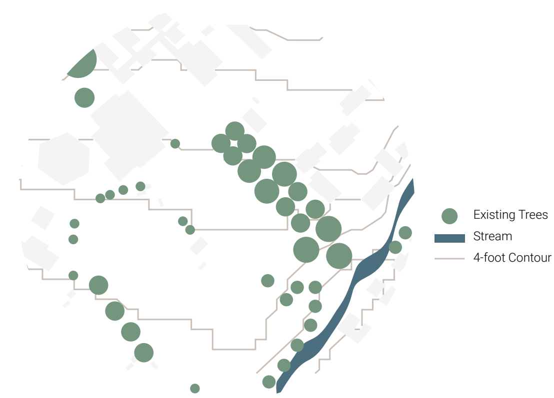
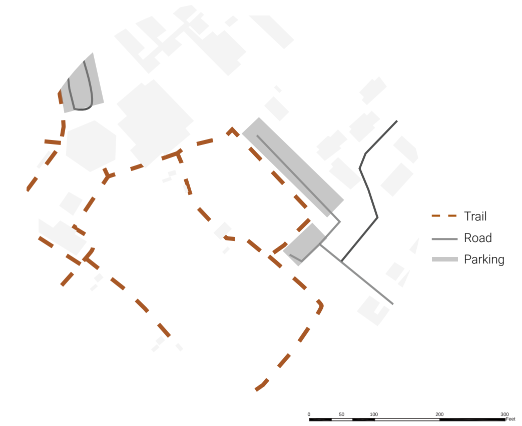


Figure 5.4
Context map

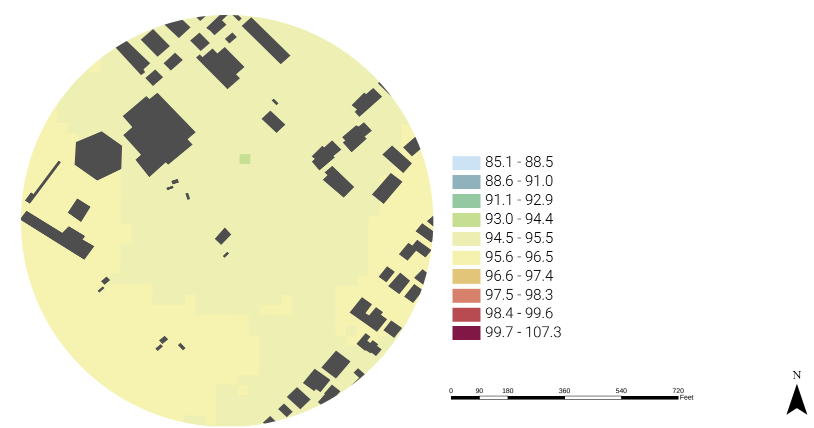
Ecology



Access



Afternoon Heat Index

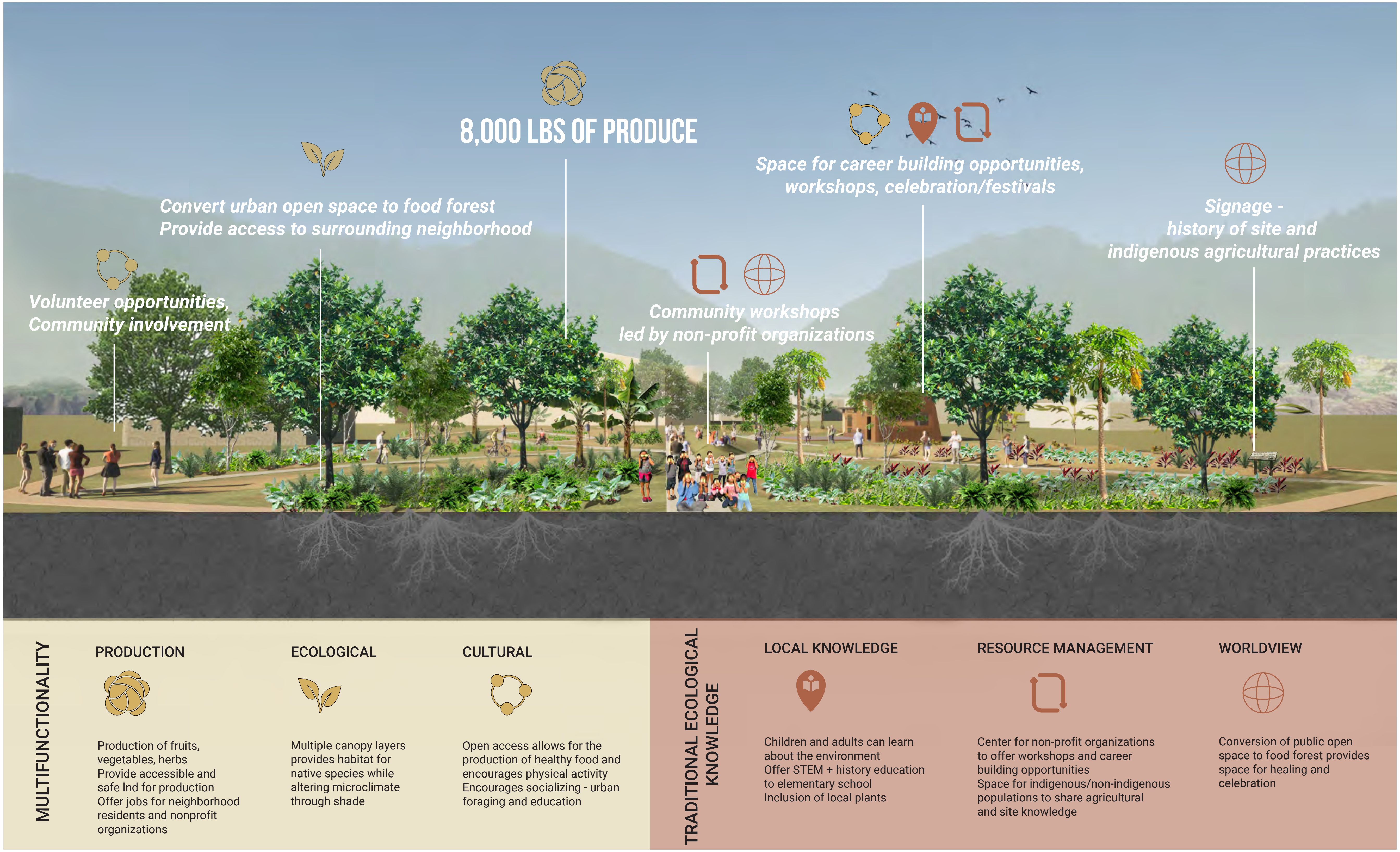


Tucked in the Manoa Valley neighborhood, the first site is engulfed by tall mountains and diversity of native flora and fauna. The Manoa Valley is rich in biodiversity and is reminiscent of the agroforestry zone in the ***ahupua'a*** model. The site is surrounded by Manoa elementary school, an elderly housing, and various recreation activities such as softball/baseball and swimming (Figure 5.4). The site is approximately 1.74 acres, which could yield 8,000 pounds of produce for the surrounding neighborhood and school (Figure 5.5). Surrounding the site are an allee of trees, recreational trails, and parking lots located NNE and SSE providing access for all. Converting the site into a multi-layered food forest could enhance its biodiversity and mitigate encroaching urban heat islands.

To strengthen the community's connection with the land and food, an alliance formed between municipalities and agencies, community groups, non-profit organizations, and schools could be formed to make use of and maintain the food forest. Opportunities for STEM could be implemented for the nearby elementary school.

Figure 5.5.
Plan overview of food forest in Manoa Valley neighborhood

Figure 5.6.
Design strategies for a Multifunctional Food Forest in Manoa Valley



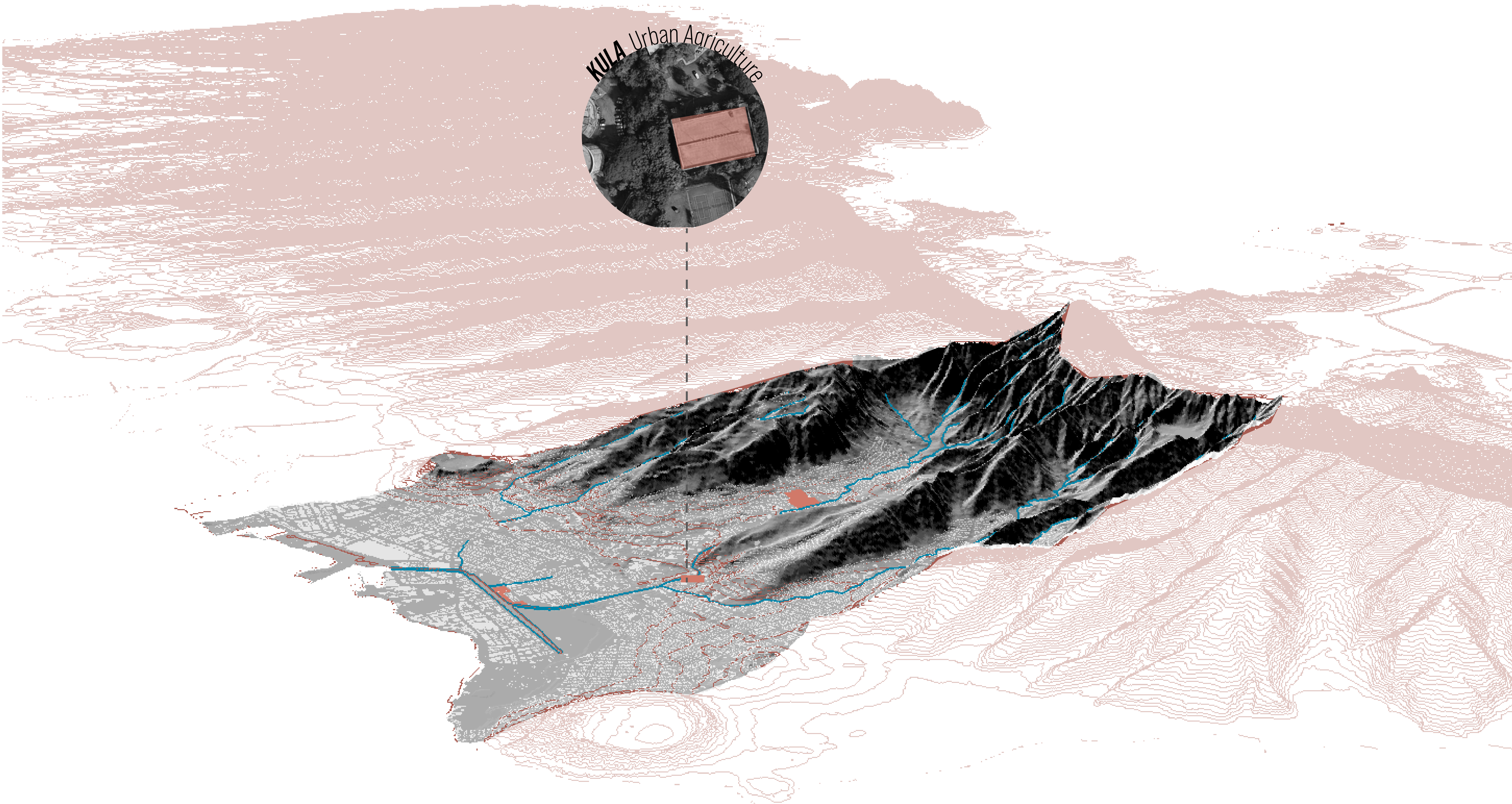
To enhance indigenous knowledge, the design for this site is reflected by the maturity phase of the ***kalo***. The ***kalo*** is reflective of the Native Hawaiian's belief (or worldview) of it being an ancestor or guardian.

To boost production for the neighborhood, various edibles are grown in the food forest. In the agroforestry section of the ***ahupua'a*** breadfruit and taro were normally grown. This food forest provides the same plants seen in the past while also providing more room to grow an abundance of fruits, vegetables, and herbs. By converting the open space area into a food forest (Figure 5.5), it becomes habitat for native species as the food forest provides multiple layers for local pollinators. The food forest converts the space into a productive landscape that can host community gatherings and workshops (Figure 5.6). Similar to Yerrabingin Rooftop Farm, a community center can become the central hub (Figure 5.7) for the local community and non-profit organizations to host meetings, live performances, and career fairs. Various non-profit organizations, such as Ma'o or Paepae o He'eia can utilize the space for educational workshops and gardening workshops. The nearby elementary school can also utilize the space for STEM opportunities. The location of this site provides access to ethnic foods (Table 2) for the diverse residents of the Manoa Valley neighborhood.

Figure 5.7.
Community center

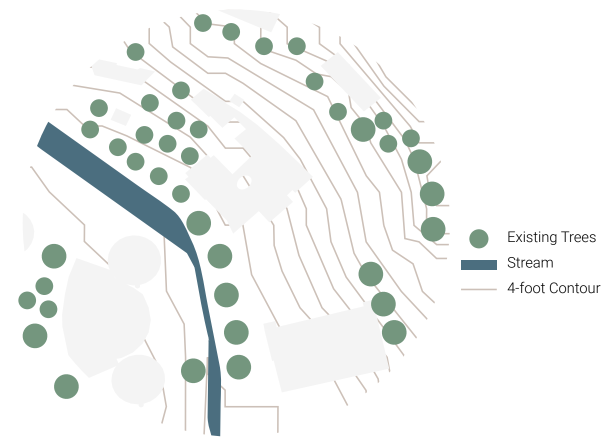
Table 2.
Food forest plant list

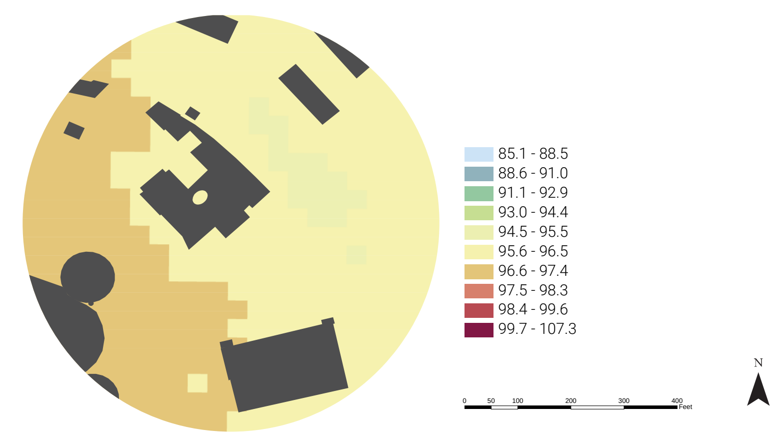
	Common name	Botanical name
Understory	Cassava	*Manihot esculenta*
	Pineapple / Hala kahiki	*Ananas comosus*
	Squash	*Cucurbita spp*
	Sweet potato	*Ipomoea batatas*
	Giant taro / Kalo	*Alocasia macrorrhiza*
	Okinawan Spinach	*Gynura bicolor*
	Walking Stick Cabbage	*Brassica oleracea longata*
	Edible Hibiscus / Hau	*Abelmoschus manihot*
	African Blue Basil	*Ocimum kilimandscharicum x basilicum 'dark opal'*
	Rosemary	*Rosmarinus officinalis*
	Thai Basil	*Ocimum basilicum var thyrsiflora*
	Hawaiian Chile Pepper / Nioi	*Capsicum frutescens*
	Turmeric	*Curcuma longa*
	Lemongrass	*Cymbopogon citratus*
Middle Story	Banana / Mai'a	*Musa spp.*
	Kava / 'Awa	*Piper methysticum*
	Ti	*Cordyline fruticosa*
	Gliricidia	*Gliricidia sepium*
	Papaya	*Carica papaya*
	Pigeon pea	*Cajanus cajan*
	Sugarcane	*Saccharum officinarum*
Overstory	Water Apple	*Syzygium spp.*
	Gliricidia	*Gliricidia sepium*
	Ice Cream Bean	*Inga spp.*
	Poumuli	*Flueggea flexuosa*
	Breadfruit / 'Ulu	Artocarpus altilis
	Yam / 'Uhi	*Dioscorea alata*
	Mountain Apple / 'Ohi'a 'ai	*Syzygium malaccense*
	Tahitian Screwpine / Pu hala	*Pandnus tectorius*
	Kukui nut	*Aleurites moluccanus*
	Avocado	*Persea americana*
	Coffee	*Coffee arabica*
	Lychee	*Litchi chinensis*
	Rambutan	*Nephelium lappaceum*
	Hog Apple / Noni	*Morinda citrifolia*
	Shampoo Ginger / Awapuhi	*Zingiber zerumbet*



Site 2

Figure 5.8
Context map





The second site, located on the University of Hawaii at Manoa's campus and near the flat lands of the watershed, is at the rooftop floor of a parking lot. This lot is conveniently located next to the university dormitories, faculty housing, Kamakakuokalani Center for Hawaiian Studies, and a working lo'i patch (Figure 5.8).

The site is approximately 1 acre and would allow for 2,500-pounds of produce to be shared within the University and community members at local food banks or for sale on campus (Figure 5.9).

As the city continues to implement BikeShare programs and carpool options, parking lot space can be a viable option for an urban farm, as it offers adequate sun exposure, can mitigate urban heat, and can withstand heavy structures.

Figure 5.9.
Plan overview of urban rooftop farm at the University of Hawaii at Manoa

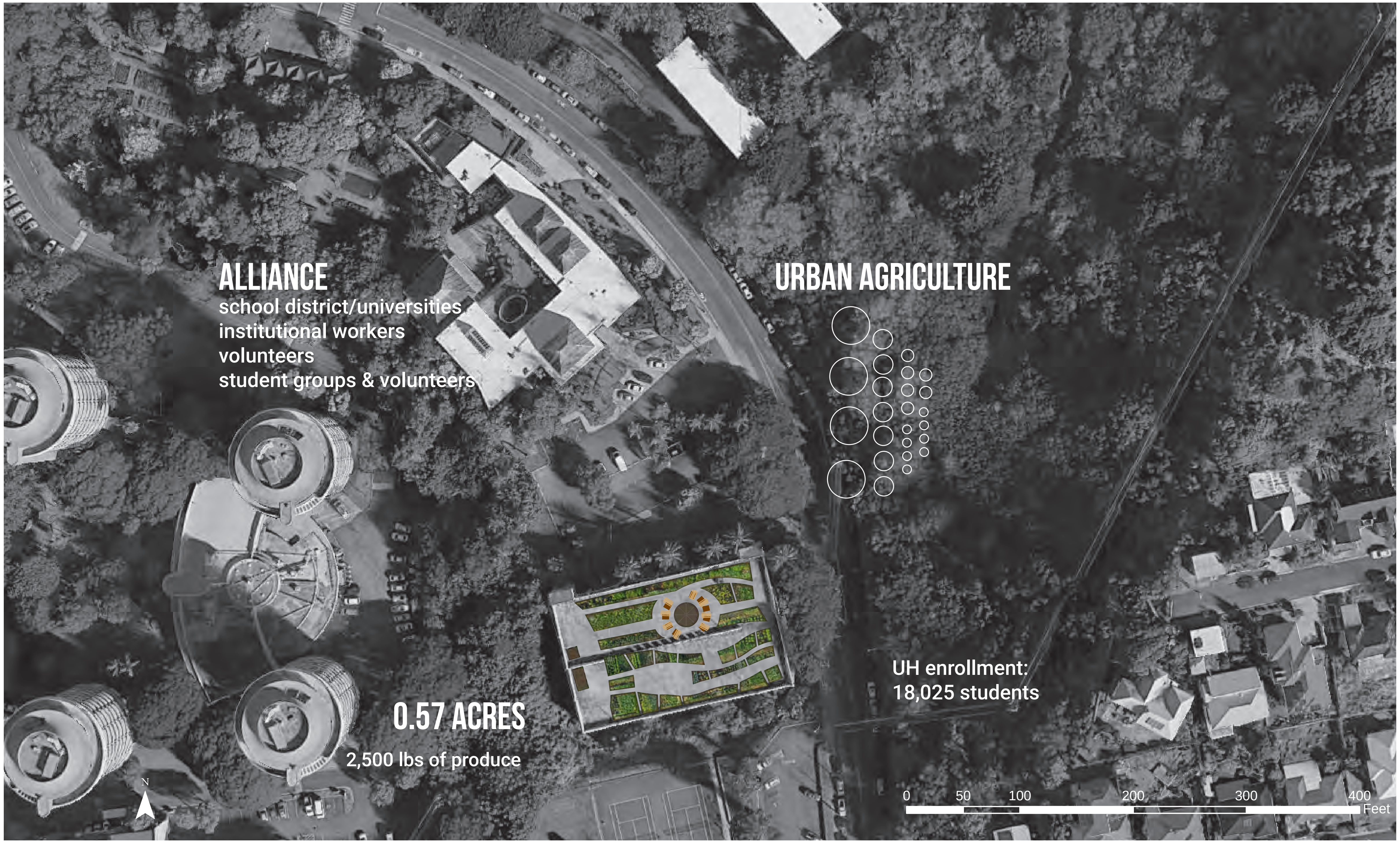


Figure 5.10.
Design strategies for a Multifunctional urban rooftop farm at the University of Hawaii at Manoa

MULTIFUNCTIONALITY

PRODUCTION

Production of fruits, vegetables, herbs
Develop network to efficiently get food to students and faculty members

ECOLOGICAL

Parking lot space transformed into ecologically friendly space
Native flower beds act as a pollinator beacon
Improves urban quality

CULTURAL VALUE

On-site consumption
Center can offer internship opportunities
Offer healthy food
Students can learn about foods, nutrition, cooking, economics, and cultures

TRADITIONAL ECOLOGICAL KNOWLEDGE

LOCAL KNOWLEDGE

Use of native edibles act as teaching tool
Offer STEM opportunities for potential + current college students
Multi-generational recipe sharing

RESOURCE MANAGEMENT

Space for non-profit organizations to lead workshops, events, educational opportunities
Provide tools for students to learn importance of recyling and composting

WORLDVIEW

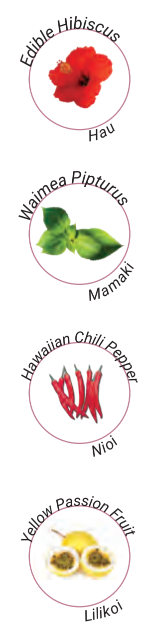
STEM education centered around history of site and protection of watershed
Instill foundation that revolves around respect between land and people

This site is designed to have a community center for outdoor learning and a gathering space to share recipes, as well as for celebration and performances (Figure 5.10). The design is reflective of the agricultural zone of the ***ahupua'a*** model and the growing stages of the ***kalo*** (worldview). An alliance formed between university students and faculty, non-profit organizations, and volunteers would be formed to maintain and care for the garden.

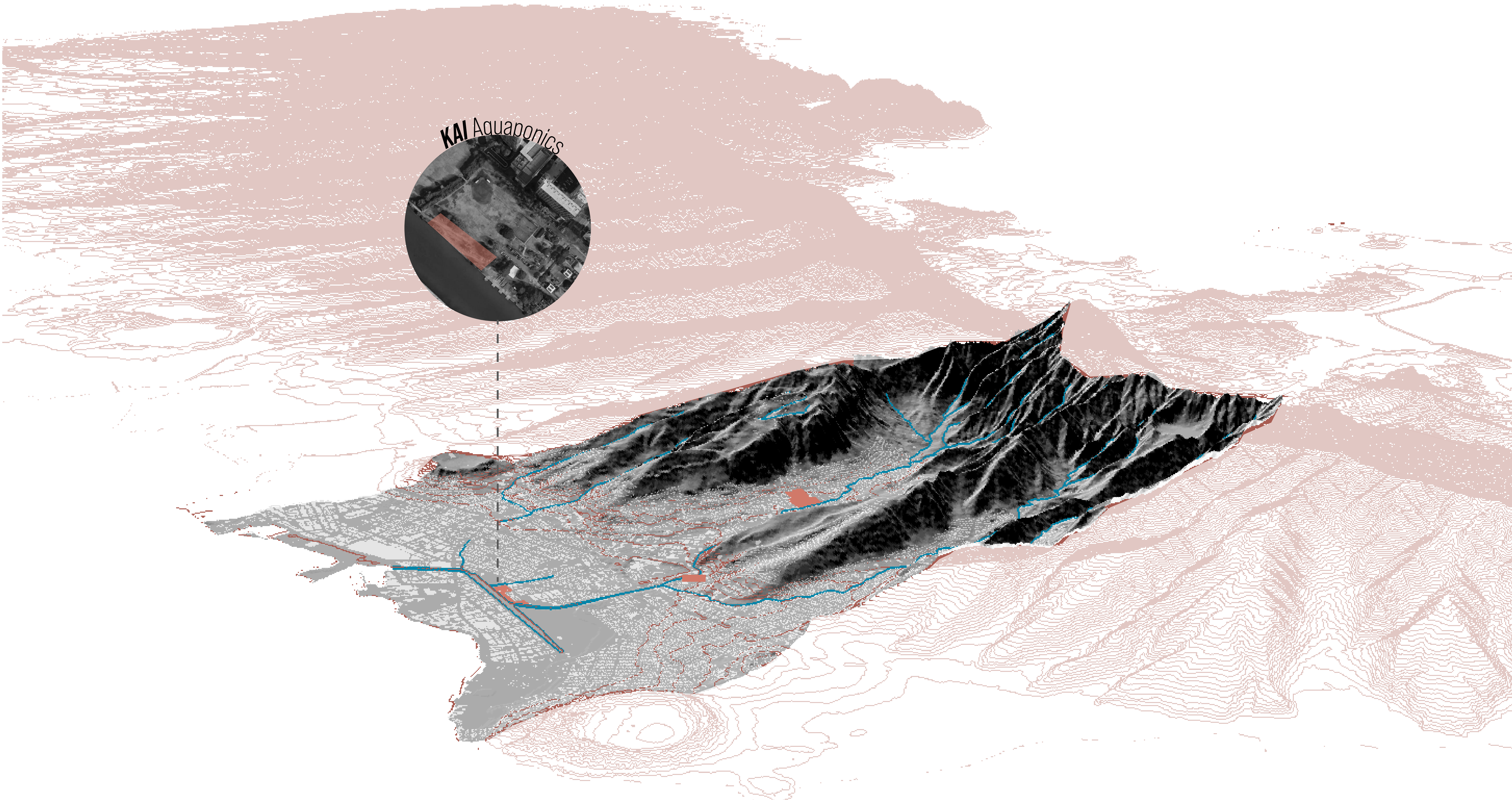
In order to respect the land and each other, we must educate others of what the ancestors have taught us. Outdoor classrooms (Figure 5.11) are designed for Hawaiian Studies classes as the Hawaiian Studies Center is nearby, non-profit organizations, and school clubs and organizations. Outdoor classrooms also offer an opportunity for hands-on learning outside which is important with COVID-19 guidelines and regulations. The community center can offer workshops hosted by various non-profit organizations. The selected plants (Table 3) can be altered by organizations and could be sold on-site or to nearby food banks.

Figure 5.11.
Outdoor classroom

Table 3.
Urban agriculture plant list



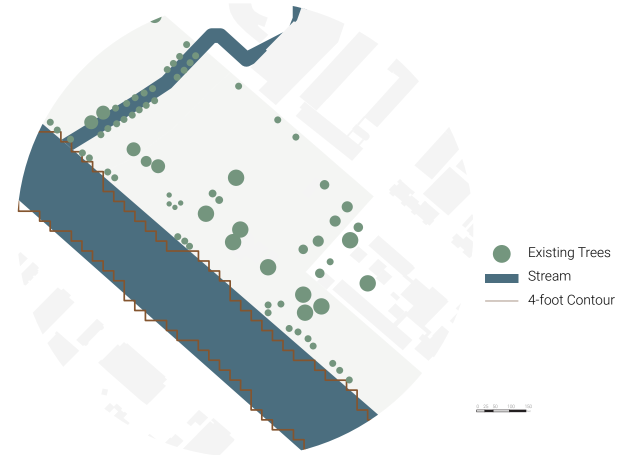
Common name	**Botanical name**
Okinawa Spinach	*Gynura crepioides*
Edible Hibiscus / Hau	*Hibiscus sabdariffa*
Chaya	*Cnidoscolus aconitifolius*
Cassava	*Manihot esculenta*
Ginger / Awapuhi	*Zingiber officinale*
Pigeon Pea	*Cajanus cajun*
Hawaiian Chili Pepper / Nioi	*Capsicum frutescens*
Moringa	*Moringa oleifera*
Taro / Kalo	*Colocasia esculenta*
Waimea Pipturus / Mamaki	*Pipturus Albidus*
Tumeric / 'olena	*Curcuma longa*
Kale	*Brassica oleracea*
Brown Mustard	*Brassica juncea*
Arugula	*Eruca vesicaria ssp. sativa*
Yellow Passion Fruit / Liliko'i	*Passiflora ligularis*
Spinach Tree	*Cnidoscolus aconitifolius*
Arugula	*Eruca vesicaria ssp. sativa*
Parsley	*Petroselinum crispum*
Swiss Chard	*Beta vulgaris subsp. vulgaris*
Basil	*Ocimum basilicum*
Sage	*Salvia offinalis*



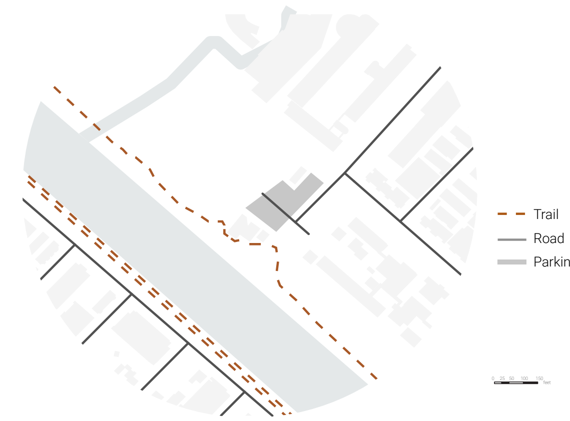
Site 3

Figure 5.12
Context map

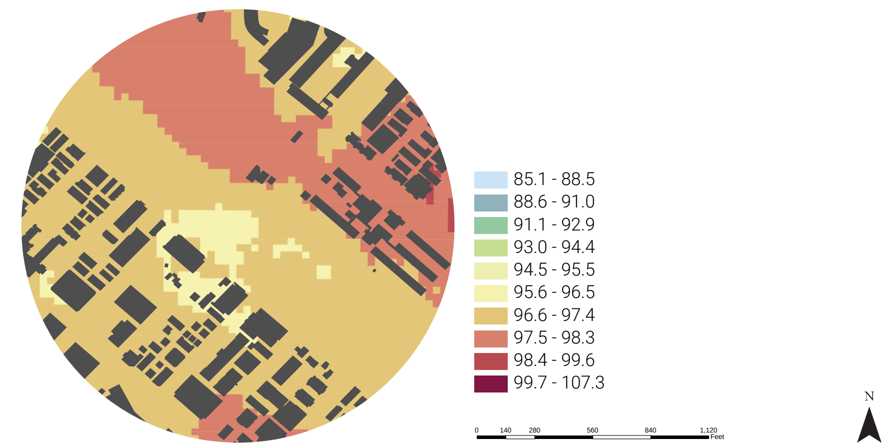
Ecology



Access



Afternoon Heat Index



The final site, located near the Ala Wai canal, is known for its abundance in toxic chemicals. The canal is used as an entryway into the ocean for paddling teams across the island. The canal is also surrounded by recreational trails, lined with lawn and palm trees, used by surrounding community members. It is near the neighborhood park making it accessible to the public, a community garden, and the Ala Wai Elementary School (Figure 5.12).

The polluted waterway and inactivated lawn space prove that a more multifunctional space can increase ecological functions on site. The design for this canal is centered along the greenway and offers a wooden structure that can serve as an aquaponic system, seating for visitors, and shade for vendors. The structure is approximately 700-square-feet offering about 700 pounds of produce to the community (Figure 5.13).

The heavily urbanized area could also benefit from the design as the site faces increasing temperatures throughout the day.The section closest to the canal contains a bioswale which could help mitigate any runoff from the trail and nearby road.

Figure 5.13.
Plan overview of aquaponics structure along Ala Wai Canal

Figure 5.14.
Design strategies for a Multifunctional aquaponics structure along Ala Wai Canal

MULTIFUNCTIONALITY

PRODUCTION

Production of fruits, vegetables, herbs, and tilapia
Offer new jobs for neighborhood residents

ECOLOGICAL

Structure can offer shade for locals
Structure can support a range of species
Location near city center reduces energy resulting from transport and packaging

CULTURAL VALUE

Offer healthy food and encourage physical activity
Provide access to food
Community programming around gardening as a lifestyle

TRADITIONAL ECOLOGICAL KNOWLEDGE

LOCAL KNOWLEDGE

Structure can act as a teaching tool for all
Offer STEM opportunities for all levels of education

RESOURCE MANAGEMENT

Greenway design can connect indigenous farmers and organizations to venture and grow new ventures

WORLDVIEW

Connection between canal strengthens relationship with watershed

The structure is representative of the establishment stage of the taro life cycle. Herbs, vegetables, and taro are grown within the floating trays of the structure. Families and children can peek inside the fish tanks and sit within the structure while walking along the Ala Wai canal (Figure 5.14). Being near the Ala Wai canal can help visitors understand the importance of our watershed and waterways (Figure 5.14). Having this understanding allows members to take better care of our island's water and see the possibilities it has by producing food and providing habitat. The surrounding plants can become destinations for local pollinators.

Honolulu's art and food scene are thriving allowing this to be used by artists, farmers, and local vendors to sell their work or use as a stage for events. The vendor space can serve as an educational area where children and adults can learn about foods, nutrition, cooking, cultures, and the environment through aquaculture. The nearby elementary school can use this space to teach children of the importance of the watershed, of food, and the island's history. Agricultural classes offered by the University can be held here and it can also serve as potential research opportunities.

To preserve indigenous knowledge and wisdom, the structure can serve as a seed sharing and saving library (Figure 5.15). Similar to neighborhood free library stations, wooden boxes can be set along the structure's shelves to keep any seeds.

The location of this structure serves as a beacon for the surrounding residents, especially since this neighborhood is rich in diversity. This structure can serve as a link for the community and provide access to various vegetables (Table 3).

Figure 5.15. Aquaponic structure as a learning tool, seating and shade structure

Table 3. Aquaponic plant list

Common Name	**Botanical Name**
Butter Head Lettuce	*Lactuca sativa var. capitata*
Red Romaine Lettuce	*Lactuca sativa L. var. longifolia*
Okinawan Spinach	*Gynura bicolor*
Bok Choy	*Brassica rapa subsp. chinensis*
Green Onions	*Allium fistulosum*
Watercress	*Nasturtium officinale*
Taro / Kalo	*Colocasia esculenta*
Tilapia	*Oreochromis niloticus*

part 6

discussion

Based on the scope of this project, my projective designs showcase how urban agriculture practices can be sited and designed within the Ala Wai watershed that is both multifunctional and enhances traditional ecological knowledge. Each site was reflective of the ***ahupua'a*** model, an important aspect to this research with the resulting designs not being limited to the designated spatial typologies assigned. These designs can also be woven together to create a hyperfunctional design. These designs can also be situated across any watershed within the Hawaiian Islands, and the corresponding plant lists can be incorporated into residential backyards.

After listening to some folks speak of the important relationship between us and the island, reading of other countries and how they place indigenous knowledge at the forefront of their agricultural practices, and examining the history and structure of the ***ahupua'a*** system and how it self-sustained communities present, I learned how indigenous knowledge still is not at the forefront of landscape architecture. Place is an important aspect to this profession, and it is dependent on local knowledge, resources, and traditions. Memory and storytelling are ingrained in local knowledge. The native species, waterways and trails are part of our resources, and as designers we must learn how to work towards culminating spaces that both heal and celebrate the rich history of a place. This starts with the acknowledgement of the spaces we design for and highlighting the technological ingenuity that indigenous peoples have created.

These designs may not have responded to each category in its fullest sense, however this research responds to a needed conversation of how landscape designers should raise indigenous knowledge and wisdom into their practice. There is a lot that indigenous folks have done that is a pure reflection of what multifunctionality means today. If Honolulu, along with other cities across the nation, has its concerns towards climate change, then traditional practices should be investigated as it could be beneficial towards the makeup of our industrialized cities.

As seen from the precedent studies, centering design around indigenous knowledge can strengthen communities and provide opportunities for growth. It is important to acknowledge that our cities have been quickly built over indigenous lands which calls for us as designers and planners to rethink our zoning laws to become more inclusive.

Given the event of the pandemic, more work could have been done towards meeting with community members on the design stage, nonprofit organizations, and professors at the University of Hawaii at Manoa. The precedents I chose to analyze were specific to landscape design in urbanized areas, although there are many other working farms across the Pacific Rim in both rural and suburban settings whose work could also be analyzed for the project.

To further this research, strategies towards seed saving and sharing can be incorporated. Seed sharing is beneficial to indigenous knowledge as it preserves cultural identity and serves as a teaching tool for the younger generation. Many of the crops on the islands are also vulnerable to natural disasters and human-caused disasters especially by the introduction of genetically-modified organisms (GMO) farms. To take control of what we eat, we must also take control of our island's seeds. The waterways of the Ala Wai Watershed could be further examined due to the manipulation of its directionality throughout the years. Healthy soils and water work symbiotically making it a valuable addition to this project.

As landscape designers and planners, we must be more critical of how we design our cultural landscapes. This project shows how not many projects, especially productive landscapes, do not highlight traditional ecological knowledge as part of its design metrics. This research, therefore, provides a framework for future landscape designers when designing agricultural designs into their sites. It also serves as a guide for the community if and when deciding to create their own planting interventions.

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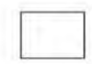
URBAN DESIGN FRAMEWORK		
AHUPUA'A MODEL		
Mountains *UKA*	Plains *KULA*	Coast *KAI*

URBAN AGRICULTURE X SPATIAL TYPOLOGIES		
 Open space	 Rooftop	 Public Space
 Food Forest	 Urban Farm	 Aquaculture

STRATEGIES					
MULTIFUNCTIONALITY			TRADITIONAL ECOLOGICAL KNOWLEDGE		
Production	**Ecological**	**Cultural**	**Local Knowledge**	**Resource Management**	**Worldview**
Production of fruits, vegetables, mushrooms, herbs, medicinal plants, and other products	Producing food locally reduces the embodied energy resulting from inputs, transport, and packaging	Community members often find gardening and farming to be a social activity through sharing food, knowledge, and labor	Gain insight from literature, articles, informal interviews	Provide space for workshops – allows members of the community and nonprofit organizations to share agricultural and site knowledge	Belief systems - Learn indigenous knowledge and teachings, and how it can enhance agricultural development
Offer new jobs for neighborhood residents and vitality from improved economics of the community	Organic waste products can be composted and used as a fertility resource for growing food and other products	Offer healthy food and encourages physical activity	Knowledge on plants, animals, natural phenomena, landscapes of specific site	Embrace indigenous tools and techniques; appreciate local environmental knowledge	Holistic approach forms a greater understanding between the environment and self
Provide suitable, accessible, and safe land with good solar access and an irrigation source	Agricultural systems can support a wide range of species, including some native plants, as crops or associated plants	Provide access to ethnic foods that are typically not available in existing markets	Offer space for community members to share local knowledge of plants and animals	Community members, indigenous community, nonprofit organizations are vital resources	Environment is part of both social and spiritual relationships

Create networks to connect laborers, farmers, and markets to help retain and grow new ventures	Urban agriculture can positively alter microclimate through humidity control, wind protection, and shade	Children and adults learn about foods, nutrition, cooking, environment, economics, and cultures	Develop space to generate exchange of multigenerational recipes	Offer space to instill knowledge to the younger generation	Instill a respect for ancestors, respect for self, respect for each other
Develop transportation systems and networks to efficiently get food to consumers	Collect, divert, and transport organic wastes away from landfills to urban agriculture	Along with community garden spaces, integrate other activities and features to encourage socializing – urban foraging, recreation, education	Edible plants can act as a teaching tool, especially medicinal plants	Create network to connect indigenous farmers and organizations to retain and grow new ventures	Instill a strong foundation that revolves around the respect between land and people
	Convert open spaces areas of low diversity to community gardens and farms	Explore opportunities to develop community programming around gardening/farming as a healthy lifestyle	The zones of the *ahupua'a* offered space for foraging, recreation, and prayer	Agricultural land can offer space for community members to grow food	The *ahupua'a* connected people with the land and their ancestors. The kalo is sacred
	Allow edible plantings in built areas to combat the heat island effect and other unfavorable climatic conditions	Integrate community garden spaces in areas known to have high immigrant populations, and link with culture	Agricultural land can offer STEM opportunities for all levels of education	Community gardens provide space to grow ethnic foods	
	Support efforts to convert vacant and derelict lands into productive green spaces for use by residents	Offer gardening and urban agriculture activities within existing programs, particularly during summer	Community garden spaces can allow indigenous/non-indigenous populations to connect and learn