Circularity Assessment Protocol
Hilo, Hawaii, USA

University of Georgia

Circularity Informatics Lab

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New Materials Institute
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The Circularity Informatics Lab at the University of Georgia is committed to information sharing, data analytics, empowering communities, and systems change related to circular materials management.

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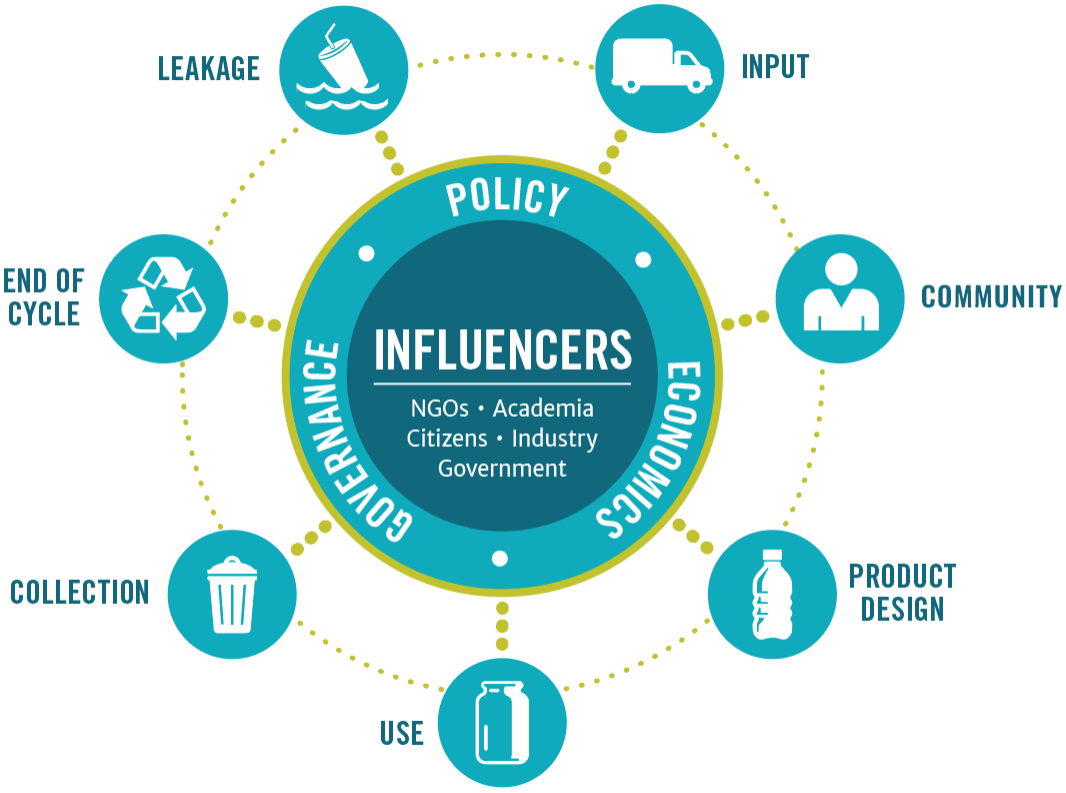
Executive Summary

Developed by the Circularity Informatics Lab at the University of Georgia, the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, is comprised of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics and governance with key influencers including non-governmental organizations, industry, and government.



In August of 2023, a team from the Circularity Informatics Lab conducted fieldwork in Hilo, Hawaii with support from United States Environmental Protection Agency (USEPA) Trash Free Waters program. Fieldwork was conducted in conjunction with Perpetual and Zero Waste Hawaii Island, and in collaboration with cultural liaison Kiana Ihilani Kuulei Kanahele ("Kuulei").

Key Findings

INPUT

Findings: Regional distribution of products in the United States was common among both manufacturers and producers, with over half of the sampled products being produced and/or manufactured in the contiguous U.S. Of the sampled products, 47 had Hawaiian parent companies and 34 had Hawaiian manufacturers. Domestic parent companies for beverages, chips, candy, and tobacco were mostly based in Hawaii, New York, California, and Pennsylvania. Internationally located parent companies included Italy, the Philippines, and Japan. Domestic manufacturing locations included Hawaii, California, Pennsylvania, and New Jersey. International manufacturing locations for sampled products were mainly located in Asia and Southeast Asia (e.g., China, Japan, and the Philippines).

Opportunities:

- Given that there are similarities between the locations of both the parent company and the manufacturer locations for products sold in Hilo, there is an opportunity to begin looking into various extended producer responsibility (EPR) models.
    - There is an opportunity for Hilo leaders and residents to engage in conversations with local manufacturers and parent companies to initiate discussions on Extended Producer Responsibility (EPR). Of the most frequent states cited for manufacturing, California is a state with an existing EPR policy.
    - With numerous parent companies and manufacturers located in the contiguous US, as well as a majority of the five top parent companies being domestic, there is an opportunity to engage with parent companies about changes in packaging materials.

Findings: Conversations among interviewees about circular economy touched on power dynamics shaped by colonialism, as well as the necessity of centering the beliefs of Native Hawaiians within these conversations. Many of these viewpoints coalesced into clear stances on returning to Indigeneity, having ethical business practices, and being cognizant of how inequality brought on by harmful systems impacts people's ability to participate in "zero waste" or "circular" activities. It should be noted that while these critiques exist among interviewees, many of them remain positive and optimistic about the ability to invoke circular change, and this optimism is also rooted in Indigeneity and Native Hawaiian beliefs. Other themes

found across interviews related to awareness, education, policies and bans, and tourism.

Opportunities:

- Interviewees are very concerned with fortifying Native Hawaiian communities, including land back (i.e., returning control and stewardship of Hawaiian land to Native Hawaiians), healing community bonds, and passing down Indigenous beliefs and knowledge systems. Circularity efforts should be viewed through this lens to ensure sustainability efforts align with community goals.
- Interviewees felt that having awareness and education being built into community activities, festivals, etc., could be beneficial, as these spaces are intergenerational and present an opportunity for education to center around family and community, rather than just individuals. This effort could link environmental justice issues in other places to what is occurring in Hilo and Hawaii more broadly.

COMMUNITY

- While tourism remains an opportunity and a challenge, visitors could be made aware of the local culture around circularity and protection of the environment through outreach campaigns, proper signage at hotels, restaurants, businesses, etc.
- Using the Kumu Honua Mauli Ola Educational Philosophy Statement as a model, the following suggestions have been aggregated from interviewees:
    - Self & Family: personal development, healing wounds that keep us from trusting each other and asking for help, building capacity in the home - taking care of ourselves so we show up optimally to the work we do, making sustainable lifestyle choices when convenient, building capacity for when not convenient, making a personal commitment to "try" and be more mindful of green habits and holistic health.
    - Community: collaborating with members of the community: other families, farmers, food producers, and folks with resources, knowledge, and skills to share. Collective brainstorming to think through waste reduction, reuse, and recycling. Developing more opportunities to learn about bioplastics, "throw away" culture shifting to shared resources, bartering, repurposing, and reuse. The restoration of political and holistic (food) sovereignty.
    - Governance and Outside Communities: Experiencing sustainable initiatives in other states/communities that may be adapted for Hilo, learning to become civically engaged and provide testimony

in support/opposition of bills, supporting interested community members to run for office, and make meaningful changes to policy.

PRODUCT DESIGN

Findings: A total of 21 grocery and convenience stores were sampled (in total, 60 items). Beverages tended to be packaged in PET (57%) or aluminum (39%), while a majority of chips (99%) and candy (93%) were packaged in multilayer film plastic. The main product packaging for shampoo and laundry detergent was HDPE, while cooking oil was primarily packaged in PET, and rice frequently came in film/multilayer film. Shampoo was the only staple item that did not have a non-plastic packaging option available, with only HDPE or PET packaging offered. Food vendors (32) were sampled to determine the materials of to-go ware (containers (including their lids), cold cups, utensils, and straws). Although compostable offerings were found across each of the four categories, plastic tended to be the most prominent material used.

Opportunities:

- For packaging that cannot be recycled (e.g., multilayer film plastic), there is an opportunity to talk with companies to discuss product design.
- Reuse and refillable alternative packaging would reduce material use and waste generation at stores and restaurants.
- There was a wide variety of to-go materials offered across the restaurants sampled. There is an opportunity to outline the types of materials restaurant owners could use as alternatives, in addition to providing financial and/or tax incentives for compliance.
    - Additionally, a directory of suppliers that offer alternative to-go ware materials may be helpful for restaurant owners.

USE

Findings: The 21 grocery and convenience stores were also sampled to determine the availability of alternatives across various product categories that usually consist of single-use plastics: picnic ware, kitchen products, household products, and personal care items. Alternatives to plastics were sampled (140 items) that included compostable materials (47%), reusable items, and refillable items, among others. The CIL encountered "degradable" designations for both freezer bags and sandwich bags. Although listed in this report as an "alternative," because most consumers would see it as such, it is important to note that "degradable" designations are not well-defined and may not mean biodegradable. The two "degradable" items within the kitchen category are cheaper than their more common plastic counterparts,

which could be further encouraging the purchasing of those products through the combination of a lower price and potential "greenwashing".

Opportunities:

- Refillable alternatives (25% of sampled products) indicate a market present in Hilo that can expand in the future. Refillable products are a form of source reduction, increasing circularity.
- Reusable foodware would reduce material use and waste generation from restaurants and increase circularity.
- Having state-level regulations around what certain terms mean (such as "degradable," "biodegradable," "compostable", etc.), as well as regulations around those products' certifications, could help alleviate any confusion that consumers may have.
- Public awareness campaigns on how to make consumer purchasing decisions when faced with various labels and designations may help consumers to make more informed choices.
- Interviewees mentioned issues with people cleaning their soiled reusable bags in grocery stores. There may be an opportunity to invest in education around reusable bag sanitation, utilizing existing resources in the community, such as the Nutrition Education for Wellness Program of the University of Hawaii Cooperative Extension Service.

COLLECTION

Findings: County of Hawaii Solid Waste Division Public Facilities are made up of the West Hawaii Sanitary Landfill, the East Hawaii Reload Facility, and 21 recycling & transfer stations. The County of Hawaii does not provide curbside waste or recycling pickup for businesses or households. If residents don't want to drop off their waste at the local transfer stations, there are private waste haulers available. The State of Hawaii has the Hawaii Deposit Beverage Container Program (HI-5). Each qualified beverage container can be brought to any of the certified HI-5 redemption centers on the island, where residents can receive 5 cents for every bottle that is returned. Metal, glass, and plastic bottles can be identified as a part of this program by the "HI-5" label affixed to the bottle. Additionally, drop-off recycling is available for residents of Hawaii County at various county recycling and transfer station locations. Accepted recyclables vary depending on the location, and can include clean corrugated cardboard, brown paper bags, and small non-HI-5 glass containers. There is a lack of composting infrastructure to handle the compostable products in Hilo.

Opportunities:

- There's an opportunity to increase composting collection to match the compostable products being sold in stores.
- Tourists could be a source of funding through a "green" fee or tourist tax to help fund waste management collection and infrastructure.

END OF CYCLE

Findings: Waste generated by the city of Hilo is either landfilled, recycled, or composted through the county's green waste recycling drop-off program. However, food waste is not accepted. Because of this, some food waste is composted through households, businesses, and schools, or by giving food waste to local farmers informally. There are no incinerators on the Island of Hawaii. In 2009, the County (and Hilo) took a zero-waste approach, with an official Zero Waste Plan, and as an island state, land conservation is very important. The county owns and operates a landfill on the west side of the island, which is where waste that is not recycled or composted is disposed of. The South Hilo Landfill was closest to Hilo, but, reached capacity and was closed in 2019.

Opportunities:

- Although there is a variety of "compostable" products offered in stores throughout Hilo, there is no industrial composting infrastructure to accommodate these products at their end of cycle. There is an opportunity to expand industrial composting infrastructure in Hilo.
- Food waste is not currently accepted in the county's green waste program, yet many residents, businesses, and schools informally donate their food scraps to local farmers, so creating a directory of local farmers in need of food scraps could help keep food waste circular within the community, while maintaining the informal nature of this practice.

LEAKAGE

Findings: In total, 995 litter items were recorded across twenty-seven 100 m^2 transects in nine different square kilometer areas sampled in August 2023. Across all surveyed transects, tobacco products and plastic fragments were the most prevalent litter item by item type, together representing 50% of all items recorded. The third largest category was plastic food packaging (21%) followed by paper (11%), metal (4%), and other plastics (3%). The remaining categories represented 3% or less of all litter items. Plastic bottles, often found in other CAP top items, were not in the top 10 items. Retail plastic bags were also not in the top 10 items (considering they are banned in Hawaii). Aluminum cans ranked 10th and plastic bottle caps ranked 6th. The lack of beverage containers in the top 10 (other than cans at number 10), indicates the HI-5 redemption program works (although some caps are lost). When

aggregated across all surveys, Hilo has an average litter density of 0.27 items per square meter.

Opportunities:

- The HI-5 program has created a market for bottles, and this program has seemed to reduce the number of plastic bottles and other containers in the environment. It may be beneficial to expand this deposit system to include other materials or keep financial incentives at the heart of any future efforts, as these aspects of the program seem to be working.
- The plastic bag policy or other regulations around single-use plastic items can help keep these items out of use and out of the environment, promoting circularity.
- Plastic bottle caps can be lost from bottles and cannot be recycled separately. Bottles could have tethered caps, similar to what is required in the European Union (EU).
- Collecting data and monitoring trends over time can provide insight into waste patterns, community needs, and the effectiveness of interventions. With continued litter monitoring in selected locations, the county may be able to identify innovative ways to prevent and abate litter in the community.
- Cigarettes are the top litter item, which could be addressed through education campaigns, litter violation enforcement, and the expansion of cigarette collection receptacles in the city. There is currently no local recycling market for cigarettes in Hilo.

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Excerpt from the Kumulipo, ca 1300 AD: Hawaiian Cosmogonic Genealogy

Hanau ka ʻUku-koʻakoʻa,
hanau kana, he ʻAkoʻakoʻa
puka
Hanau ke Koʻe-enuhe ʻeli hoʻopuʻu honua, Hanau kana, he Koʻe
puka
Hanau ka Peʻa, ka Peʻapeʻa kana keiki
puka
Hanau ka Weli, he Weliweli kana keiki
puka
Hanau ka ʻIna… Hanau kana, he Halula
puka
Hanau ka Hawaʻe, o ka Wana-ku kana keiki
puka
Hanau ka Haʻukeʻuke, o ka ʻUhalula kana keiki
puka
Hanau ka Piʻoe, o ka Pipi kana keiki
puka
Hanau ka Papaua, o ka ʻOlepe kana keiki
puka
Hanau ka Nahawele, o ka Unauna kana keiki, puka
Hanau ka Makaiauli, o ka ʻOpihi kana keiki
puka
Hanau ka Leho, o ka Puleholeho kana keiki, puka
Hanau ka Naka, o ke Kupekala kana keiki
puka
Hanau ka Makaloa, o ka Pupuʻawa kana keiki,
puka
Hanau ka ʻOle, o ka ʻOleʻole kana keiki,
puka
Hanau ka Pipipi, o ke Kupeʻe kana keiki
puka
Hanau ka Wi, o ke Kiki kana keiki,
puka
O kane ia Waiʻololi, o ka wahine ia Waiʻolola
Hanau ka Weke noho i kai, Kiaʻi ia e ka Wauke noho i uka - He po uheʻe i ka wawa, He nuku, he kai ka ʻai a ka iʻa - O ke Akua ke komo, ʻaʻoe komo kanaka

Born was the coral polyp, born was the coral, came forth
Born was the grub that digs&heaps up the earth came forth
Born was his [child] an earthworm
came forth
Born was the starfish, his child the small starfish came forth
Born was the sea cucumber, his child the small sea cucumber - came forth
Born was the short-spiked sea urchin
came forth
Born was the smooth sea urchin, his child the long-spiked - came forth
Born was the ring-shaped sea urchin, his child the thin-spiked - came forth
Born was the barnacle, his child the pearl oyster came forth
Born was the mother-of-pearl, his child the oyster - came forth
Born was the mussel, his child the hermit crab came forth
Born was the big limpet, his child the small limpet - came forth
Born was the cowry, his child the small cowry came forth
Born was the naka shellfish, the rock oyster his child - came forth
Born was the drupa shellfish, his child the bitter white shell fish - came forth
Born was the conch shell, his child the small conch shell came forth
Born was the nerita shellfish, the sand-burrowing shellfish his child - came forth
Born was the fresh water shellfish, his child the small fresh water shellfish - came forth
Man for the narrow stream, woman for the broad stream, Born is the Weke [mackerel] living in the sea, Guarded by the Wauke plant living on land
Darkness slips into light, Earth and water are the food of the plant, The god enters, man can not enter

Cultural Context

The following section on Cultural Foundations was written by Kiana Ihilani Kuulei Kanahele (Perreira-Keawekane) in honor of Hawaii and the history of Hawaiian excellence.
She is a 29-year-old Native Hawaiian activist and artist who has dedicated her life to the wellness of her people through the protection of Hawaii's natural resources. She comes from the Hawaiian Home Lands communities of Keaukaha and Panaewa, and is a descendant of John Henry Wise (Hawaiian and German), who was the first Native Hawaiian to play collegiate football in America; he did so under the leadership of John Heisman of the Heisman Trophy. Wise is known to have been a fierce leader who advocated against the annexation of Hawaii to America and was imprisoned for his allegiance to Her Majesty Queen Liliuokalani. At the turn of the government, Wise became a Territorial Senator, advocating in the US Congress for Hawaiian rights to rehabilitation through land stewardship, and later became an editorial writer, a teacher, a farmer, and a pastor of the Ekalesia o Ke Akua Ola, the Church of the Living God. Kuulei aspires to be like her kupuna (ancestor) in his dedication to his land, his people, and his God.
In the "Cultural Foundations" portion of this report, she offers the following sentiments to teach readers about Hawaii people and their love of land, despite the current climate of overconsumption and resource mismanagement evident within the islands.
She writes:

"This was not always our way;
gluttony, greed, and throw, throw away.
Ours is a way of face-to-face,
intention, connection, protection of place.
Honoring nature and all creation,
Spending our days in deep relation.
Let us open our hearts to see what is;
let us remember what was to see what can be.
That we may work again to be whole."

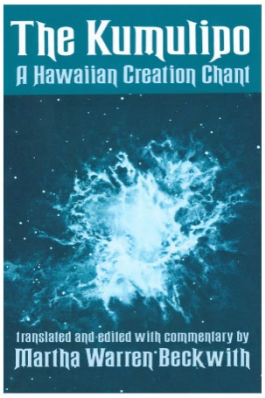
Cultural Foundations

Aboriginal indigenous Hawaiians come from a history of successful resource management and stewardship. In ancient times, survival was determined by the depth of our relationships to each other and the land, which we understood to be sacred and life-giving. Like any ancient civilization, our homes, vehicles, clothing, weaponry, and pastimes were made only of natural materials to which we had deep relation; "waste" as we understand it today did not exist, and time passed alongside ancestral knowledge, skills, and ways of abundance through the generations of trees, seeds, and human life. Upon the introduction of international trade systems, foreign values, and man-made materials, the culture of Hawaii shifted toward the commodification of Hawaii's natural resources, along with the industrial pollution of our place which has caused irreversible damage to our social and environmental climate. Prior to a detailed review on the current scope of Hawaii's waste and litter, it's most appropriate to gain a contextual understanding of Hawaii's cultural traditions and history. As this overall report is a comprehensive analysis of the waste and waste products found in Hawaii, this section is an ode to what Hawaii used to be, and to the organizations and individuals - the farmers, educators, and families dedicated to our natural world. It describes our genesis, and the beginning of our journey to consumerism and pre-packaged foods. The following is a timeline presenting people, events, quotes, and proverbs that reflect the ancient Hawaiian worldview on interconnectivity, which should be perpetuated now and in the years to come.

This timeline is presented in 5 epochs, which were previously presented by the honorable Pulama Collier and Dr. Manulani Aluli Meyer. This framework and the full articulation of each "wa" has not yet been published for public reference but was taught and physically distributed to a select group of individuals who attended a single gathering. This invaluable document is entitled "The Kawa Continuum: Space-Time Awakening - Moike Aloha Manalogue with Pulama Collier at Ka Waiwai Collective, July 11, 2020", hereon cited as (Collier 2020). The duration of each epoch and several key happenings mentioned in the following timeline are derived from that work and should not be referenced without ode and credit to her.

As a caveat, this timeline is a reflection of my current understanding of Hawaiian history, which may evolve. This timeline does not include every significant event and is a small excerpt of the larger scope of Hawaiian History.

Time Immemorial: Kumulipo *https://shop.hawaiipacificparks.org/products/kumulipo-creation-myth*



The *Kumulipo* is an ancient Hawaiian cosmogonic genealogy, which describes the creation of the universe and lists subsequent lifeforms and their relation to each other. The chant was transmitted orally to Kahuna Keaulumoku, an ancestor of His Majesty King Kalakaua, and his sister and successor to the throne who was Her Majesty Queen Liliuokalani, Hawaii's last reigning monarch before Hawaii's shift in governance toward statehood. The *Kumulipo* is a simple text that requires advanced translation and interpretation skills; it meaningfully describes the relationship between humans and nature in Hawaii, a focal point of this overall report.

There is a pattern of lines here that say *"Man for the narrow stream, woman for the broad stream, Born is the **Palaoa [sperm whale]** living in the sea, Guarded by the **Aoa [sandalwood]** living on land. Darkness slips into light, Earth and water are the food of the plant, the god enters, man cannot enter"*; the emboldened words are substituted to denote a different plant and animal relation throughout the chant. This particular line says plainly that the sandalwood plant of the uplands is protected by the sperm whale of the sea. As noted in the remaining portion of the timeline, when the whalers came from afar to harvest the palaoa, so was the aoa/iliahi mass-exported almost to extinction. In contrast to the single-use plastics and trash matter found in Hawaii, our Old People lived intentionally with the ancestral understanding that all life is deeply connected and is under the consequences of human and industrial "progress".

Refer to the Kumulipo excerpt in the previous section of this report.

Epoch 1 - 300 to 900 AD (+/- 600yrs)
First Migration from Marquesas to Hawaii

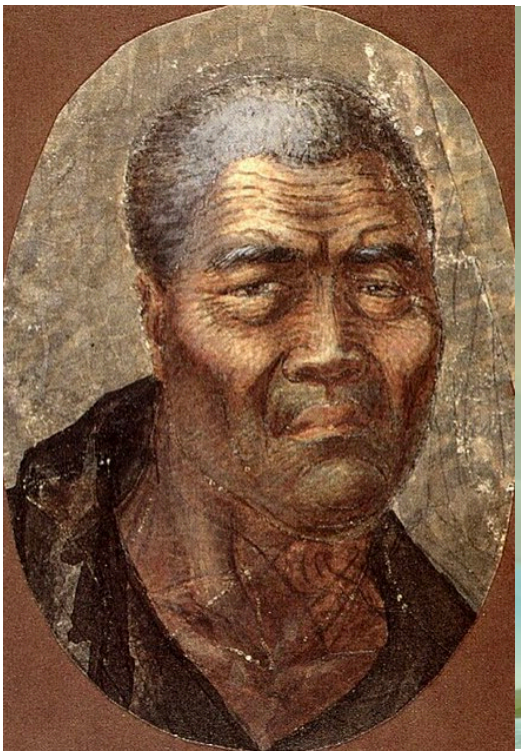
Society in Hawaii begins with systematic agriculture, family clans and island tribes. The primary religious system of this time was primal-indigenous, deeply reflecting the spiritual relationship Hawaiians originally had with nature and natural resources (Collier 2020). *Note from Kuulei: some Hawaiian cosmologies and belief systems describe that Hawaiians did not migrate to Hawaii, but emerged here, as descendants of this land. Others believe that "menehune" or "mu" were the first people, and that the original migrants lived peaceably among them.*

Epoch 2 - 900 to 1810 AD (+/- 910yrs)
Continued and Extended Migrations

Migrations continue throughout Polynesia, Paao arrives to Hawaii, the primary religious systems of this time were primal-indigenous, polytheistic, and animistic, further reflecting a deep connection to the preservation of natural resources. (Collier 2020)

c.a. 1300 AD - The Kapu System is established
A system of governance called the "kapu system" emerged, some say at the hand of Paao, a Polynesian practitioner of polytheism. (While this system brought order to Hawaiian livelihood, some refer to him as "the first colonizer".) The kapu system was a set of laws that informed the social and physical development of the land. These laws included ordinances of gender segregation, restrictions of behavior, and access to sacred places, but also included the establishment of food and gathering practices based on spawning cycles and preservation of different species of flora and fauna. Additionally, land divisions and leadership roles were established as such:

Alii were the ruling chiefs, often chosen based on cosmogonic genealogy and skill.




Portrait of Kamehameha by Louis Choris, 1816.
Kaahumanu, Herb Kane

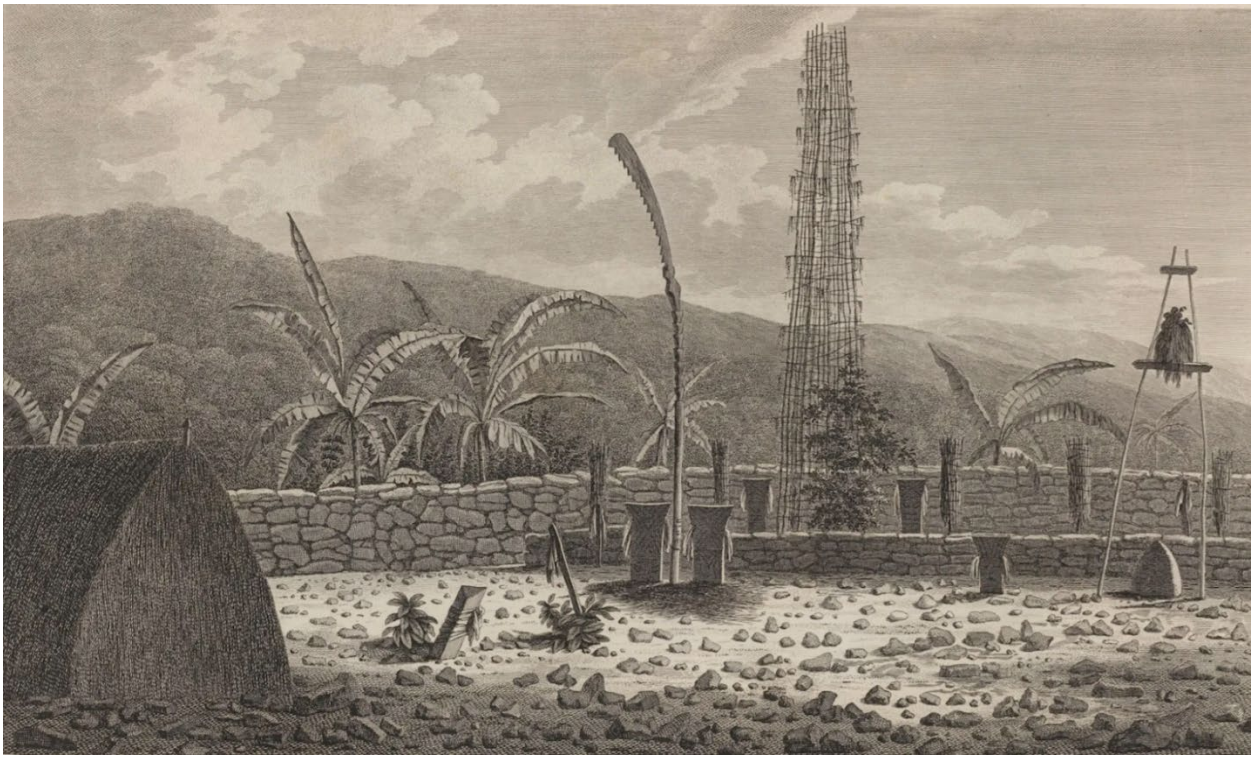
Alii Nui were the highest chiefs; they divided the island into large land divisions called **"moku"** and identified multiple **Alii Ai Moku**, who would oversee them (Hilo, Kona, Ewa, Waianae, Koolaupoko, Wailuku, Kipahulu, Lahaina, etc.). Each Alii Aimoku would identify multiple **Alii Ai Ahupuaa** or **Konohiki** who would divide the moku into smaller divisions called **"ahupuaa"** - land divisions that would often extend from the mountains to the sea and include a disbursement of water via waterfall, river, or stream (Waiakea, Laupahoehoe, Kaneohe, Waikane, Waihee, Waiehu, Iao, etc.). The konohiki would manage the smaller land divisions and ensure that the people within them would be able to establish systematic agriculture. They would collect assessments (taxes) from families in the form of fish caught, produce grown, mats weaved, mats/cordage made, etc. For context to the power dynamic, the Hawaiian proverb "he opu alii" or "the stomach of a chief" refers to a fierce leader who has the generosity and at times the temper of a chief - who will work and sacrifice well for his people and defend them with all his life.

Kahuna were the priests who often worked closely with alii to guide and inform their leadership. They conducted religious ceremonies at temples, and/or were masters of specialized fields including laau lapaau (herbal medicine), lomilomi (massage), pu'uone (located site for the construction of heiau), kilokilo (prophets who predicted the future), wa'a (navigation), etc.

Makaainana were the largest social class in Hawaii and consisted of the common people - laborers who were fishers, farmers, hunters, gatherers, and builders: fathers, mothers, cousins, friends. They were deeply connected to their dwelling places, as everything they consumed came from their portion of the land and sea. They were often well cared for and well-loved by their alii, while some makaainana were forced by their alii into tedious labor. The moku of Kau on Hawaii Island is famous for having cruel alii ai ahupuaa,

wherein the makaainana would seek kahuna consult on the cruelty of their rule, followed by the alii's timely death (by fallen logs or sinking boats for example).

Kauwa were believed to be "social outcasts" or "untouchables", comparable to "slaves", though they were not often forced into laborious positions. Some believe they were largely the descendants of the original inhabitants of Hawaii. They were a humble and virtuous people, not forced into servitude, but instead reserved for the then-newly implemented practice of human sacrifice to then-newly established temples and deities. Kauwa were not allowed to mingle with the common people; even chiefs were not to walk freely in their designated lands. It is a rare supposition that crude words and physical outcast may have been a means to preserve their sacred power, as using the word "pupuka - ugly" is tradition to describe a highly valued child, to protect them from defiled attention. Although words like "filthy beasts", "corpses", and "foul smelling things" were used to describe the kauwa, there is a deep historical reverence for their ancience and skill, and ongoing ruminations about their sacred value as sacrifices to high gods.



Heiau at Waimea Kauai originally made by John Webber

1300 AD to 1778 - Non-Polynesian travelers arrive in Hawaii

During this time, prior to the arrival of Captain James Cook, Hawaiians are believed to have had unrecorded contact with non-Polynesian travelers; iron (or the understanding of what it was) had been introduced, and had also begun washing ashore. Hawaiians quickly began reshaping and repurposing the iron pins/nails into daggers for combat.

1790 - "Eleanora" trading vessel commits Olowalu Massacre

To acquire iron nails, Hawaiians seized a rowboat from the *Eleanora* trading vessel. In retaliation, Captain Simon Metcalfe flogged Chief Kameeiamoku and massacred 100 men, women, and children of Olowalu,

Maui. The *Eleanora* departed, never to return, leaving behind a man named John Young who later became a trusted combat advisor to King Kamehameha. Chief Kameeiamoku vowed to besiege the next ship to dock.

1790 - "Fair American" trading vessel is besieged

The *Fair American*, captained by Thomas Metcalf (son of Simon Metcalfe) was the next vessel to dock; in retribution for the lives lost in the Olowalu Massacre, Chief Kameeiamoku ordered the *Fair American* to be besieged; all seamen were killed but one Isaac Davis, who also became a trusted combat advisor to King Kamehameha, teaching him how to operate the cannons (which were named "Lopaka" and "Kalola") and other foreign weaponry that were acquired from the siege. This weaponry, along with the iron that washed ashore were among the very first non-biodegradable products to be introduced to Hawaii, while also paving the way for conquest, trade, and the commodification of Hawaii land and labor.

1790 - Sandalwood export begins

Kamehameha I engaged in the mass export of iliahi/aoa (sandalwood) from Hawaii to China. Exports peaked between 1821 and 1823, when 1400 tons of sandalwood was exported to China per year. Oral stories maintain that Kamehameha forced many of his subjects to labor in the harvesting of iliahi, disrupting social order in Hawaiian communities. Men were not allowed to return home often enough to hunt and gather to feed their families, some of whom died of famine; workers died of exhaustion. Women of the time could be found uprooting sandalwood keiki (saplings) to stop the production of the plant so their children would not be subject to the same cruel conditions of labor.

> *Note: The Kumulipo expresses that the sandalwood is guardian to the whale.*

1800 - Whaling begins

Between 1800 and 1987, over 300,000 sperm whales were hunted in Hawaiian waters by whalers from Britain and New England. The blubber from the whales was in high demand as it was rendered into oil for fuel prior to the invention of electricity.

> *Note: Besides disease brought by trader ships, measles and pertussis were historically introduced by missionaries, killing 10-33% of the population of Hawaii; the cabinet that later deposed Hawaii's last reigning monarch was made up of the sons of missionaries; mission work led to the vilification of Hawaiian language, cultural practices, and cultural identity. As the next Epoch describes the contributions of Christianity to Hawaii in a positive light as it is often taught, readers healing religious trauma through liberation should proceed with objectivity, with the understanding that many of these perspectives are often challenged by indigenous scholars.*

1807 - Henry Opukahaia journeys to New England

Opukahaia joins Captain Caleb Britnall on his journey to return to Connecticut. The Historic Hawaii Foundation describes, *"When a young Hawaiian by the name of Henry Ōpukahaʻia sailed to New England, even he did not know the impact he would have on Christianity in Hawaiʻi. While in the United States, after making the decision to become a Christian, he begged his teachers to send missionaries back to the Hawaiian Islands."*

Epoch 3

1810 to 1893 (+/- 83yrs): Political and spiritual conversion (Collier 2020)

Kapu system is abolished, Hawaiian gods denounced, Hawaii becomes a constitutional monarchy, makaainana become Hawaiian subjects and nationals. Religion during this epoch is primarily monotheism via Christianity. International treaties are established between Hawaii and other countries: Belgium, Bremen, Denmark, France, Great Britain, Hamburg, Italy, Japan, Luxembourg, Netherlands, Russia, Spain, Swiss Confederation, Sweden, Norway, and the United States.

1819 - Kamehameha I dies, kapu system abolished, Battle of Kuamoo

Kamehameha I died, and was succeeded by his young son Liholiho, who ruled under the advisement of Kamehameha's favorite wife (of more than 20 wives), Kaahumanu.

Kamehameha's Final Days, Brook K Parker and Kaahumanu,

Kaahumanu and her influence abolished the kapu system, denouncing human sacrifice and other polytheistic rituals. While many ordinances intended to restrict overfishing and the harvest of spawning fish were maintained by the makaainana, the religious shift was tumultuous.

The Battle of Kuamoo was a civil war on religion between Liholiho who fought for the abolition of the kapu system, and Kekuaokalani and his wife, Manono who fought to protect it. The battle resulted in almost 300 deaths, and following it, a majority of Hawaii's historic religious artifacts and sites were desecrated and destroyed.

> *Note: The abolition of the kapu system is believed to have led to the deculturalization of Hawaiian people and the subsequent shift toward Euro-American lifestyles and worldview, which have evolved to decenter land, nature, and collective wellness, and center individual progress and success.*

1820 (March 30) - Missionaries arrive in Hawaii, the written word begins

Although merchant traders shared about Christianity and biblical teachings with Hawaiians, not until 1820 did a fleet of missionaries arrive to Hawaii. They helped to develop and convert Hawaii's oral language to a written one, further shifting our culture of memory, oral traditions, and the depth of our relations.

1827 - The Hawaiian Bible is published
Various excerpts of the Hawaiian Bible were published; a full translation from Hebrew and Greek to Hawaiian was published by 1839.

1834 - First Newspaper Series is published
The first newspaper series in Hawaii, *Ka Lama Hawaii,* was published in the Hawaiian Language, and was printed and distributed in Lahainaluna, Maui. This article was a tool to distribute reading material to students, while educating readers about the animals of the outside world (lion, elephant, "kamelopadi"/giraffe, etc.).

1839-1840 - Declaration of Rights and First Hawaiian Constitution is established
The establishment of a written alphabet for a previously oral language contributed to the development of a *Declaration of Rights* and the Hawaiian Kingdom's first *Constitution of 1840*, making Hawaii a constitutional monarchy.

1842 (April) - Three joint Ministers Plenipotentiary commissioned
A *Guest Author* of the *Ka Wai Ola* publication writes: *By the middle of the 19th century, gunboat diplomacy by foreign nations was a mounting threat in Hawaiian waters. To address this, in April 1842 Kamehameha III commissioned three joint Ministers Plenipotentiary: Timoteo Ha'alilio, William Richards, and Sir George Simpson. Their task was to gain recognition of Hawaiian independence, which at the time was a near impossible undertaking, as no non-European nation had ever achieved this feat.*

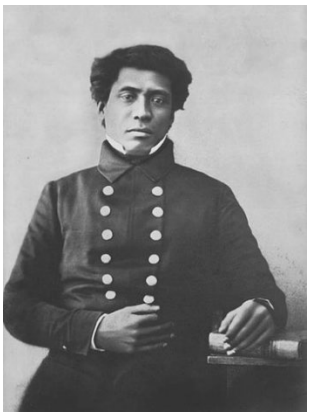
Haalilio and Richards

1843 (February 10) - Lord George Paulette arrives, Hawaii ceded
Despite Hawaii having close political ties with Britain, Lord George Paulette arrived in Hawaii from Britain and threatened to open fire if Hawaiian flags were not de-massed, and the kingdom ceded to Paulette. Although King Kauikeaouli had previously sent emirates to Britain to resolve lingering disputes, he complied with this request and gave Paulette political control over the Hawaiian Kingdom. We understand today that Paulette acted upon his own volition and did not represent the will of the British government.

1843 (July 26) - Admiral Richard Thomas arrives from Britain
Helen J Chapin of the Hawaiian Historical Society writes: *Great Britain had already recognized independence, and France had promised to do likewise. Protests mounted in the islands, but this provisional cession to Paulet was also received with consternation in foreign capitals. Admiral Thomas arrived in Honolulu on the frigate Dublin on July 26, 1843, to assure Kamehameha III of the English government's good faith.*

1843 (July 31) - Hawaii governance re-established, 1st Hawaiian holiday declared
Helen J Chapin writes: *Great Britain declared Paulet's act to be unauthorized and, on July 31, the Hawaiian flag was raised once again.* It is at this time that King Kauikeaouli uttered the famous words, *Ua mau ke ea o ka aina i ka pono - the life of the land is perpetuated in righteousness,* which ironically became the Hawaii State motto upon the shift of Hawaii's governance.

1843 (Nov. 27) - Anglo-Franco Proclamation signed, 2nd Hawaiian holiday declared
The Anglo-Franco Proclamation was a decree signed by Lord Aberdeen, representing Queen Victoria of Great Britain, and the Comte de Saint-Aulaire, representing King Louis-Philippe of France. The decree declared that both countries would consider the Sandwich Islands as an independent state and never take possession of any part of the territory. To this day, Hawaiians and non-Hawaiian allies of Hawaiian sovereignty celebrate November 27 as *La Kuokoa.* On this day, educational gatherings of food, music, and company celebrate the significant work of Timoteo Haalilio, who died for his country, never to return to his beloved wife, Hana Hoopa.


Timoteo Haalilio

1853 - Hawaii reaches a 75% Literacy Rate
The Hawaii Historic Society writes: *With the ability now to mass produce a written primer, the Hawaiian Kingdom had an unprecedented and amazing rise in literacy. In 1853 an estimated 75% of all people in the Kingdom over the age of 16 were literate, and by 1878, 80% of them were literate in Hawaiian, English, or a European language, making Hawai'i one of the most literate nations in the world at the time.*

1881 - King Kalakaua tours the world
In attempts to develop political relations with other countries, King Kalakaua visited the United States, Japan, China, Thailand, Singapore, Malaysia, Alaska, India, Russia, Egypt, London, Germany, Portugal, Spain, and New York, where he met the world-renowned Thomas Edison.

1887 (June 1) - Electricity installed at the 'Iolani Palace
Following time spent with Thomas Edison, Kalakaua had established electricity within the 'Iolani Palace, four years ahead of the American White House of Washington, D.C.

1887 - Bayonet Constitution established

In 1887, King Kalakaua was held at gunpoint by the members of his advisory cabinet and was forced to sign what is known as the Bayonet Constitution. This new law signed much of his monarchical power over to the cabinet and allowed them to take control of political decisions. This paved the way for the overthrow of the Hawaiian Kingdom.

Epoch 4
1893 – 1978 A.D. (+/- 85 years): Colonization, American Nationalization
Induration of Hawaiian Subjects, Nationals Dominate Political System, United States Illegal Occupation of the Hawaiian Kingdom begins. Primary religion of this time was Monotheism, events occurred: Pearl Harbor, WW II. (Collier 2020)

1893 (January) : Liliu proposes new constitution
In 1893, Her Majesty Queen Lili'uokalani attempted to do away with the Bayonet Constitution and proposed a new one in order to restore political power back to the position of the monarch. While her cabinet members outwardly expressed their support for this motion, they underhandedly called for support from the United States government, which sent an army of US Marines to the shores of Honolulu. The cabinet members, also known as The Committee of Safety drafted The Newlands Resolution - a Joint Resolution that was meant to replace a treaty of annexation. Queen Lili'uokalani was threatened that if she did not sign over her position of power, the United States military would open fire on the common people. Under duress, Lili'uokalani wrote that she would temporarily yield to the authority of the United States until the political wrongdoing was rectified. A Provisional Government was established to manage the powers of the Hawaiian Kingdom until a formal establishment under the United States could concur.

1893*: Kaulana Na Pua* is composed in honor of Queen Liliuokalani
The Provisional Government of 1893 (which would evolve into the Republic of Hawaii in 1894) ordered the Royal Hawaiian Band, employees of the Crown, to sign their political allegiance over to the new government. The band was told that if they refused, they would not be paid, and they would be forced to "eat rocks" for lack of their ability to afford food. They replied in unison, that they "would rather eat the marvelous rocks of their homeland" than sign away their loyalty; they marched to the house of composer Ellen Prendergast-Wright, and together they composed the infamous song, *Kaulana Na Pua*.

1895 - Hawaiian Counter-Revolution "Wilcox Rebellion" occurs
In 1895, under the command of Robert Wilcox, Hawaiian royalists (affectionately known as "loyalists" secured and took up arms against the Republic of Hawaii in the attempt to restore Queen Liliuokalani to the throne. This civil war resulted in several deaths, and the capture of an estimated 220 loyalist, including my grandmother's grandfather, John Henry Wise. Although Queen Liliuokalani had no prior knowledge of this civil upset, she was accused of conspiracy to commit treason and was imprisoned in her own home.

1896 - Hawaiian Language banned in public schools
The Hawaii State Department of Education published the following statement along with a timeline of the *History of Hawaiian Education. "In 1896, the Republic of Hawai'i* (established on July 4, 1894) *passed Act 57, an English only law which subsequently banned Hawaiian language as the medium on instruction from publicly funded schools. The Hawaiian language was not again used as the medium of instruction in our public schools until 1987, a span of 91 years."*

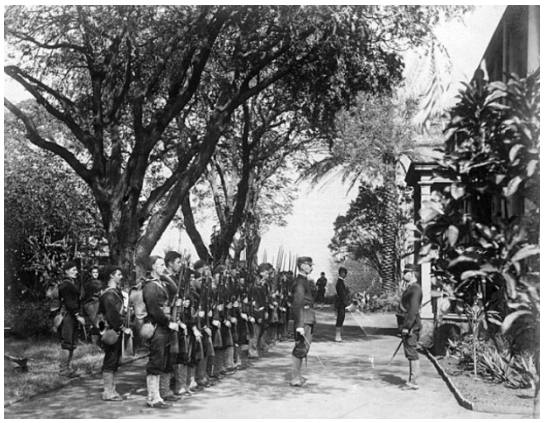
1897 - *Hui Aloha Aina* and *Kue Petitions* established

Following the overthrow of the Hawaiian Kingdom government, the *Hui Aloha Aina* was established: two groups, one of men and one of women, dedicated to promoting Hawaiian patriotism and independence. These groups founded and gathered support for the *Kūʻē Petitions of 1897*, which presented more than 21,000 signatures opposed to the annexation of Hawai'i to America. Many Native Hawaiians today have been able to find the names of their ancestors in sustained multigenerational opposition to the annexation.

1898 - Illegal Annexation of Hawaii to the United States of America

Dr. Keanu Sai, Chairman of the Council of Regency, Acting Minister of the Interior and Minister of Foreign Affairs ad interim of the Hawaiian Kingdom Government, has kept detailed documentation of the illegitimacy of the annexation of Hawaii to the United States. He describes the historic act as such,

> *On January 16, 1893, United States diplomatic and military personnel conspired with a small group of individuals to overthrow the constitutional government of the Hawaiian Kingdom and prepared to provide for annexation of the Hawaiian Islands to the United States of America, under a treaty of annexation submitted to the United States Senate, on February 15, 1893. Newly elected U.S. President Grover Cleveland, having received notice that the cause of the so-called revolution derived from illegal intervention by U.S. diplomatic and military personnel, withdrew the treaty of annexation and appointed James H. Blount, as Special Commissioner, to investigate the terms of the so-called revolution and to report his findings. The report concluded that the United States legation assigned to the Hawaiian Kingdom, together with United States Marines and Naval personnel, were directly responsible for the illegal overthrow of the Hawaiian Kingdom government. The report details the culpability of the United States government in violating international laws and the sovereignty of the Hawaiian Kingdom, but the United States Government fails to follow through in its commitment to assist in reinstating the constitutional government of the Hawaiian Kingdom. Instead, the United States allows five years to lapse and a new United States President, William McKinley, enters into a second treaty of annexation with the same individuals who participated in the illegal overthrow with the U.S. legation in 1893 on June 16, 1897, but the treaty was unable to be ratified by the United States Senate due to protests that were submitted by Her Majesty Queen Lili'uokalani and signature petitions against annexation by 21,169 Hawaiian nationals.*



The USS Boston's landing force on duty at the Arlington Hotel, Honolulu

1959 - Hawaii becomes the 50th State of the United States of America

Just 66 years after the unlawful overthrow of the Hawaiian Kingdom government, many people and organizations in Hawaii wrote testimony in support of US Statehood. Unrepresented in the news coverage of the time, are the 21,000 people who signed the *Kue Petitions* in the years before.

Epoch 5

1978 - present (+/- 40+ years): De-colonization, De-Nationalization, Hawaiian Re-identification

Continued US occupation of the Hawaiian Kingdom government, Hawaiian Cultural Renaissance, 'Onipa'a Peace March 1993. Primary religious climate: Pantheism. (Collier 2020)

Amy Kanahele and Waimanalo Ohana, Onipaa Peace March, 1993

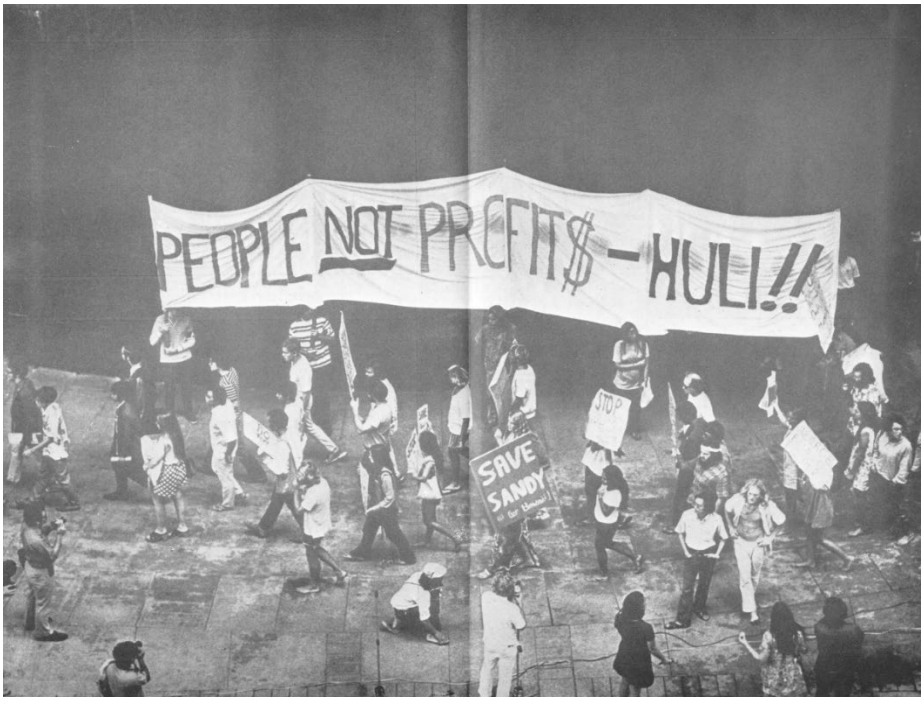
1965 - Bombing of Kahoolawe & protests

Doulton-Lee Ho writes, *To simulate an atomic blast, 500 tons of TNT are detonated on the island. A crater cracks the cap rock on the island, and that portion of the island's groundwater is lost to sea… [in] January 1976, the Protect Kaho'olawe 'Ohana (PKO) movement begins protesting on the island to stop the bombing. The first young Native Hawaiians to occupy the island, known as the "Kaho'olawe Nine," are George Helm, Kimo Aluli, Walter Ritte, Emmett Aluli, Ian Lind, Ellen Miles, Steve Morse, Gail Kawaipuna Prejean, and Karla Villalba. George Helm, the leader of the PKO, along with other members, file a civil suit against the U.S.*

Navy… [In] 1981, Kaho'olawe is listed on the National Register of Historic Places among the White House and the Lincoln Memorial. However, the bombing continues. The PKO signs a settlement with the Navy, declaring that the island can only be bombed for ten days every month and that the range of bombing should be constrained. The agreement also allows the PKO to visit the island with guests for scientific, archaeological, and religious purposes.

1971 - Kalama Valley protests

Haunani Kay Trask writes, *In contrast to the Trustees of the Bishop Estate, residents of Kalama Valley were poor and landless. Some were pig farmers, some were vegetable farmers, some were construction workers. Many were employed in working class occupations with marginal salaries. They lived in old wooden houses with their animals nearby (fig. i). Piggeries existed alongside food gardens and auto repair shops in a non-urban style variously described by residents as "Hawaiian" and "local." Opposed to the austere subdivisions that were transforming O'ahu into a Southern California look-alike (fig. 2), Kalama Valley residents lived an open, relaxed life amongst relatives and friends in a community they felt to be a "big family"… Holding a banner lettered in bold colorful strokes, KOKUA HAWAI'I ("HELP HAWAI'I"), some three dozen non-violent protesters were arrested for trespassing on private land on May 11, 1971, as they sat atop the last unbulldozed house in rural Kalama Valley on the Hawaiian island of O'ahu.1 They were well aware that, in the words of one of their young leaders, Linton Park, "Hawaiian history was being made" by the very act of their resistance.*



1979 - Sand Island evictions occur

Victoria Keith writes, *The Sand Island Story… documents 4 months of Sand Island residents attempts to forestall eviction by the State of Hawai'i. Ultimately their efforts failed and the people of this shoreline fishing community watched as bulldozers smashed their homes and destroyed their community, in order to create a public park. To this day, no public park has been created on this site.*

1983 - Makua evictions begin

Na Maka o ka Aina writes, *Makua beach has long been a place of refuge for Kanaka Maoli (native Hawaiians) pushed out of modern society. Because it is one of the last undeveloped valleys on the island, Makua has become a home for the houseless, the unemployed, the working poor, the drug addicts, the victims of spouse abuse, the sick and those that simply want to live the Hawaiian lifestyle… Despite the obstacles, Makua's residents prove that they can solve their own problems, build their own living spaces, grow their food, share their labor, clear industrial waste and trash, and even police themselves-all without big government programs and money. Makua offers a place for healing, a pu'uhonua, a place of refuge, not only for a few but for the larger Hawaiian community, which is crying out for answers to cure its social ills. But the occupying forces of the U.S. and their agent, the state of Hawai'i, have continuously evicted people from Makua, from shortly after Dec. 7, 1941 until today. A 1983 eviction was also documented by Na Maka o ka 'Aina. This documentary was produced to try to ward off another threatened eviction by the state of Hawai'i. The eviction finally took place in June of 1996.*

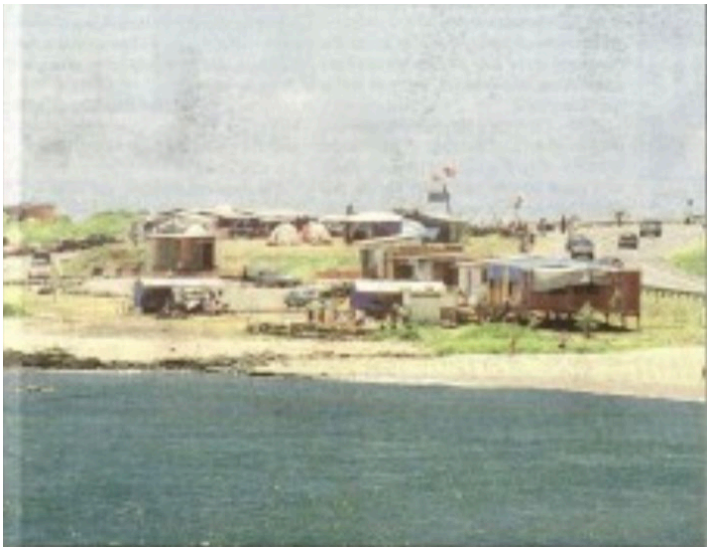
1993 (Nov. 23) - Apology Bill enacted (Public Law 103-150)

The Apology Bill was codified into Public Law. It clearly acknowledges the wrongful history of the overthrow of the Hawaiian Kingdom government, and serves as a reference for Hawaiian activists and advocates.

1994 - Makapuu evictions occur

In 1994, Patric Johnson wrote, *Just over a year ago, several members of the ʻOhana Council walked onto windswept Makapu'u and claimed the land. The settlers have now left. But not after the settlement had grown to include more than 130 people, a number of other sovereignty groups, and after the failure of an agreement to relocate the occupiers had forced a lengthy standoff between the group and the State. The last structures of the occupying group came down June 14 and, after a peaceful arrest of a small group of wahine protesters the following day and a last minute clean-up by law-enforcement officials, the park was opened to the public.*

In an informal interview today, an anonymous man who was a child at the time of the "peaceful arrests" remembers being part of a group of children who were detained by law officers in a separate area of the park, away from their parents in fear and uncertainty.



Makapuu Houses, Patrick Johnson

2019 (July 17) - Nearly 40 elders arrested in the protection of Mauna Kea

The Office of Hawaiian Affairs released a statement on the kupuna arrests, which sparked the activation of thousands who came to Mauna Kea to stand in opposition of the Thirty Meter Telescope. OHA reported, *The Native Hawaiian community weeps today. To see some of our most respected kūpuna, advocates and ʻohana get arrested for voicing the same concerns our community has expressed for decades over the state's mismanagement of Maunakea brings a kaumaha to our hearts that is unbearable. Regardless of your position on TMT, we must all agree with Gov. Ige's 2015 statement that the state has "failed" Maunakea. OHA will continue to proceed with our lawsuit against the state and UH for their mismanagement of Maunakea. We continue to call for the state and UH to be held accountable as fiduciaries for our trust resources, and we demand that a new management structure is immediately installed for Maunakea.*

Holly Johnson 2019

Cody Fay 2019

2019 - Kalaeloa/Kahuku arrests total over 200

Due to the health implications of wind farms and the protection of the opeapea Hawaiian hoary bat (an endangered species), students, staff, and community members gathered in opposition to the construction of a wind farm in Kahuku, Oahu. More than 200 people were arrested over this stance, and the wind farm was eventually built.

2021 - 19,000 gallons of jet fuel released by the US Navy, polluting drinking water
The United States Environmental Protection Agency reports, *On May 6, 2021, a pressure surge event occurred during routine fuel movement operations at the Red Hill Bulk Fuel Storage Facility. The pressure surge event caused a pipeline joint failure that released over 19,000 gallons of JP-5 jet fuel onto the tunnel floor located between the underground storage tanks. The fuel ran down the tunnel floor into containment trenches and into a fire suppression system fluid sump. The sump pushed fuel down the tunnel in a fire suppression system fluid drain pipeline, where the fuel remained until the drain pipeline ruptured on November 20, 2021. This ruptured pipeline resulted in fuel spilling into the tunnel system near the Red Hill drinking water system shaft.*

2024 - One landfill remains for all of Hawaii County
Puuanahulu is the ahupuaa which holds the only landfill on Hawaii County. The County website reports that, *The Solid Waste Division oversees the operation of 21 Transfer and Recycling Facilities, 2 Greenwaste Facilities, 1 Landfill, 1 Reload Facility, 8 Reuse Centers, and 3 key programs: Recycling, HI-5 Redemption, and the Derelict and Abandoned Vehicles program.*

The 5 epochs of time demarcated by Pulama Collier, and described above, explain the evolution of Hawaiian culture and tradition over the years. The history of interconnectedness of Epoch 1 and 2, the patriotism of Epoch 3 and 4, and the evictions and environmental protection stances noted in Epoch 5 are a representation of the deep affection that Hawaiian people and their allies have for the land and each other. Although the subsequent data in this report will dive into the material waste and products of Hawaii Island, I so deeply appreciate the opportunity to contextualize that Hawaii people, and people in general are not wasteful by original nature.

As a collective, many of our people have grown distant from the indigeneity of our practices, subscribing instead to those of consumerism, instant gratification, and an ignorance of our waste. But we here in Hawaii are working toward healing those patterns, taking good care of our bodies, and regulating our

nervous systems after 131 years of prolonged illegal occupation and the historic trauma that came from it. It is a work in progress, but as a native woman, I believe that as we begin to return to the land and her teachings, so will our health return to us. As manufacturers begin to take responsibility for the waste they generate, and as we begin to return to the identity of our kupuna and the way we are meant to care for our resources, we will be called to spend more time with each other and less money and resources on material things. I so deeply appreciate these moments of your time and attention before you read into the meat of the article on the Circularity Assessment Protocol. Wishing you an open mind and a sustained heart of stewardship for your personal relations and our natural world.

Aloha wale,
K. Kuulei Kanahele

Introduction

As of 2023, the United States (US) is home to a population of 331 million people (US Census Bureau 2020) and has an average waste generation rate of 2.24 kilograms per person per day, more than twice that of the global rate of 0.74 kilograms per person per day (Kaza et al. 2018). As a high-income nation, waste management in the US is considered advanced due to its well-designed and regulated waste management infrastructure providing high coverage of the country's growing population waste needs. These advanced waste management capabilities are met with some of the highest rates of consumption in the world, with the US generating the largest mass of plastic waste (42 million metric tons in 2016) in the world (Law 2020). The waste in the US is 12% plastic, although the largest percentage of the waste stream is paper/paperboard (23%) and organic materials, like food waste, make up 21.6%. And while nearly 100% of waste is collected in the USA, plastic waste is generally disposed of via landfill (76% by mass), combustion (12%), or recycling (8.7%) (US EPA 2020). However, the US has gained attention in recent years for exporting some of the highest quantities of plastic scrap out of the country for management elsewhere, often to developing countries (Brooks et al. 2018, Law 2020). Further, an estimated 0.28 million metric tons of plastic waste are mismanaged in the USA, with an estimated 0.51-1.45 million metric tons lost to the coastal environments in the US (Law 2020). The focus of the CAP for this project was to look at both plastics and organic materials in the waste stream that could be managed through composting, compostable products, biodegradable products, and plastic packaging.

Hilo, Hawaii is located on the Eastern side of the Island of Hawaii, also known as the Big Island. It is located in the North Pacific Ocean about 2,460 miles from the nearest major US mainland city, Los Angeles. Throughout the 53.62 square miles there are several ponds and waterfalls. As of 2020, Hilo has a population of roughly 44,186 people. This is made up of 38.2% of the population are two or more races, 31.2% are Asian, 17.1% are white, 13.2% are Hispanic, 12% are Native Hawaiian/ other Pacific Islander, and 0.7% are Black (US Census Bureau 2023). The main sectors of Hilo's local economy are education, retail, healthcare, government, and hospitality.

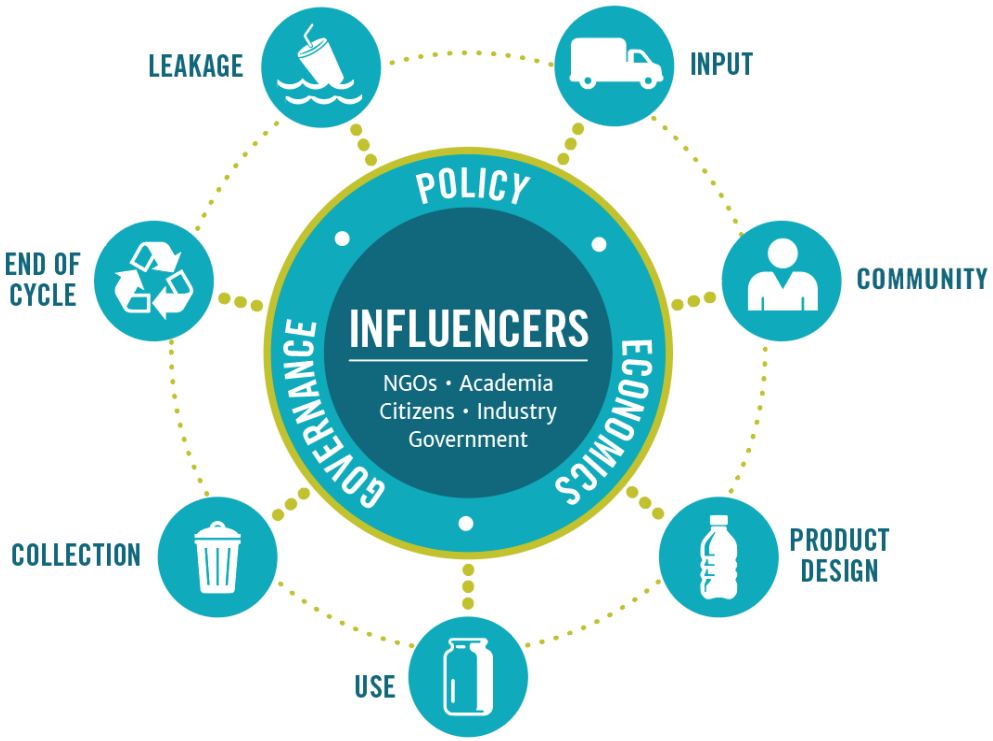
In 2022, roughly 512,000 tourists visited Hilo making up approximately 30% of all the Big Island visitors with a $2.72 billion total economic impact. This was a 74.2% increase in tourists visiting Hilo from 2021 due to an increased number of flights that service Hilo from Los Angeles (DBEDT 2023). Hawaii County's, the Big Island, per capita waste generation in 2006 was 9.4 pounds per day, approximately twice the amount of the US average (Kohala Center 2006). The waste generation situation must be similar today since there has only been about a 5% increase in tourist numbers from 2006 to 2022 in Hilo as well as the Hilo population only increasing by 2% from the 2010 to 2020 census (DBEDT 2007, DBEDT 2023, US Census Bureau 2023). Based on our interviews and various conversations with people who live in Hilo, there is increasing frustration with the amount of waste tourists create and its subsequent prevalence in the environment. These issues with pollution are generally seen as a lack of knowledge about Native Hawaiian cultural values of "mālama ka 'aina" -- taking care of the land. Although compostable materials as alternatives to plastic are increasingly common in Hilo and Hawaii more broadly, there is also concern about the lack of industrial composting infrastructure.

As one of the cities in the Perpetual cohort, Hilo set out to characterize and understand its materials flow and waste management systems and identify associated opportunities for collaborative solutions. As the first step, UGA sent members of their research team to conduct CAP in the city.

The Circularity Informatics Lab (CIL) at the University of Georgia (UGA) developed the Circularity Assessment Protocol (CAP) in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers (Figure 1). The CAP characterizes seven community components:

1. **Inputs** – What products are sold in the community and where do they originate?
2. **Community** - What conversations are happening and what are the stakeholders' attitudes and perceptions?
3. **Product design** - What materials, formats, and innovations are found in products, particularly packaging?
4. **Use** – What are the community trends around use and reuse of product types?
5. **Collection** – How much and what types of waste are generated? How much is collected and what infrastructure exists?
6. **End-of-cycle** – How is waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage** - What waste ends up in the environment? How and why is it getting there?

Figure 1: Circularity Assessment Protocol (CAP) hub-and-spoke model.

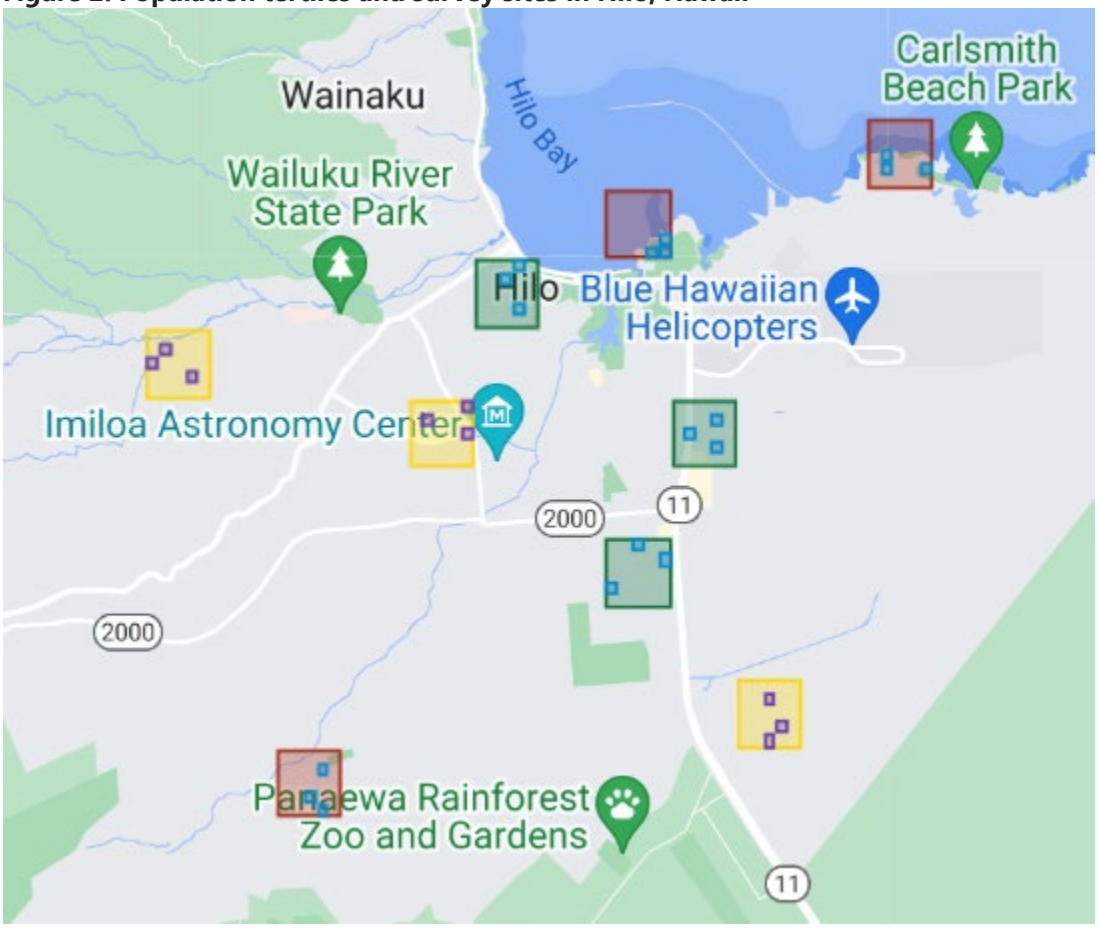


In August of 2023, a team from the Circularity Informatics Lab conducted fieldwork in the city of Hilo, Hawaii with support from United States Environmental Protection Agency (EPA) Trash Free Waters program. Fieldwork was conducted in conjunction with Perpetual and Zero Waste Hawaii Island. The CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities. The intent is for the data in this report to inform ongoing stakeholder engagement around solutions to strengthen the circular economy and waste management in Hilo, Hawaii.

Sampling Strategy

To randomly sample various locations in a city, the CAP typically identifies a 10km x 10km area over the city (with the center of the city in the center of the area). In this area, the ambient population is sectioned into three groups, or 'tertiles' (Figure 2). Ambient population count can be described as "where people go" and "societal activity" — it is not population density of where people live. These three areas typically form samples of different land uses, etc. Three 1 x 1 km areas for surveying are randomly selected within each population tertile using NOAA's Sampling Design Tool, resulting in a total of nine 1km^2 areas for surveying. In total, 9 sites were surveyed, three in each of the high, mid and low population count tertiles.

Figure 2: Population tertiles and survey sites in Hilo, Hawaii



Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Hilo, samples of fast-moving consumer goods (FMCG) in four popular categories were taken within the nine 1 km2 transects. The team selected three convenience or grocery shops to sample within each 1km2 transect area where shops were present and open at the time of surveying.

In total, 249 unique brands of convenience products were collected and sampled, including 136 candies, 41 chips, 62 beverages, and 10 tobacco products. Samples of identical brands were not collected multiple times, even when present in multiple stores. For each of the top products documented, the team noted the type of packaging (including polymer, if possible), the brand, and the parent company. From there, the team was able to discern the manufacturing location, which was determined from manufacturing locations listed on product packaging or desktop research, as well as the headquarters location for the parent company of the brand (largely determined by desktop research). Manufacturer and parent company distances (Table 1) are intended to estimate the distance in kilometers between the city and the origin of each product. The top brands in Hilo of each category, based on a visual assessment of shelf space in a store, conversations with shopkeepers, and repeated occurrence across stores, included the following:

- Beverages: Gatorade, Pepsi, Powerade, Coca Cola, Vitamin Water
- Candy: M&Ms, Reese's, Hershey's, Snickers, Haribo, Noms, Kit Kat
- Chips: Lays, Cheetos, Doritos, Maui Style, Ruffles
- Tobacco Products: USA Gold, Marlboro, American Spirit, Kool, Pall Mall (top brands for tobacco were only identified, not purchased)

Tobacco products had the highest average distance to parent companies and to store manufacturers. Chip products had the lowest average distance to parent companies, while drink products had the lowest average distance to store manufacturers (Table 1). Maps of locations of manufacturer and parent company locations are shown in Figures 3 and 4.

Table 1: Distances between Hilo and manufacturer and parent company locations for top FMCG convenience items

	Length Store to Parent Company (km)			Length Store to Manufacturer (km)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Candy	339	12,457	6,812	60	12,586	6,214
Chips	0	13,271	6,138	0	13,619	6,617
Drinks	0	11,125	6,381	0	11,005	5,996
Tobacco Products	7,348	11,749	10,470	5,102	7,906	7,227

**Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.*

Based on the origins of the convenience categories, regional distribution of products in the United States was common among both manufacturers and producers with over half of the sampled products being produced and/or manufactured in the contiguous US. Of the sampled products, 47 had Hawaiian parent companies 34 had Hawaiian manufacturers. Domestic parent companies for beverages, chips, candy, and tobacco were mostly based out of the states of Hawaii, New York, California, and Pennsylvania. Internationally located parent companies included Italy, the Philippines, and Japan (Table 2). Domestic manufacturing locations of these same products included Hawaii, California, Pennsylvania, and New Jersey. International manufacturing locations for sampled products were mainly located in Asia and Southeast Asia: China, Japan, and the Philippines (Table 3).

Figure 3: World Map displaying parent company locations for top convenience items in Hilo, Hawaii

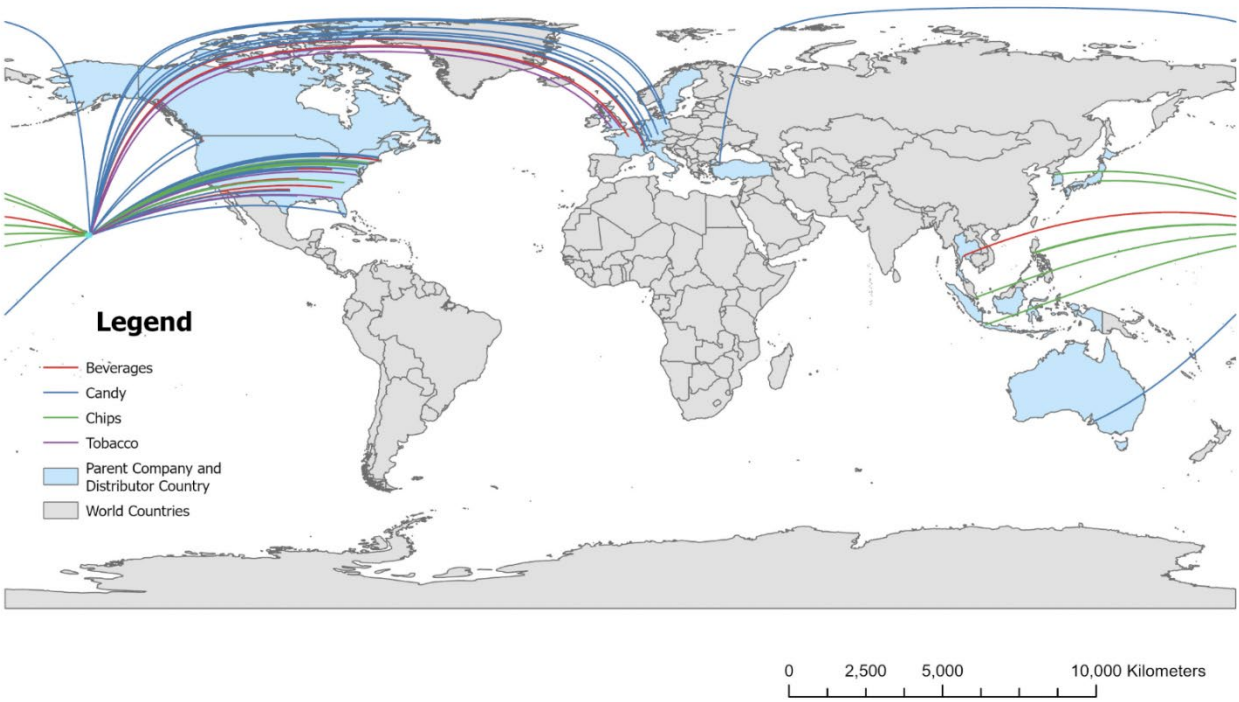


Figure 4: World Map displaying manufacturing locations for top convenience items in Hilo, Hawaii

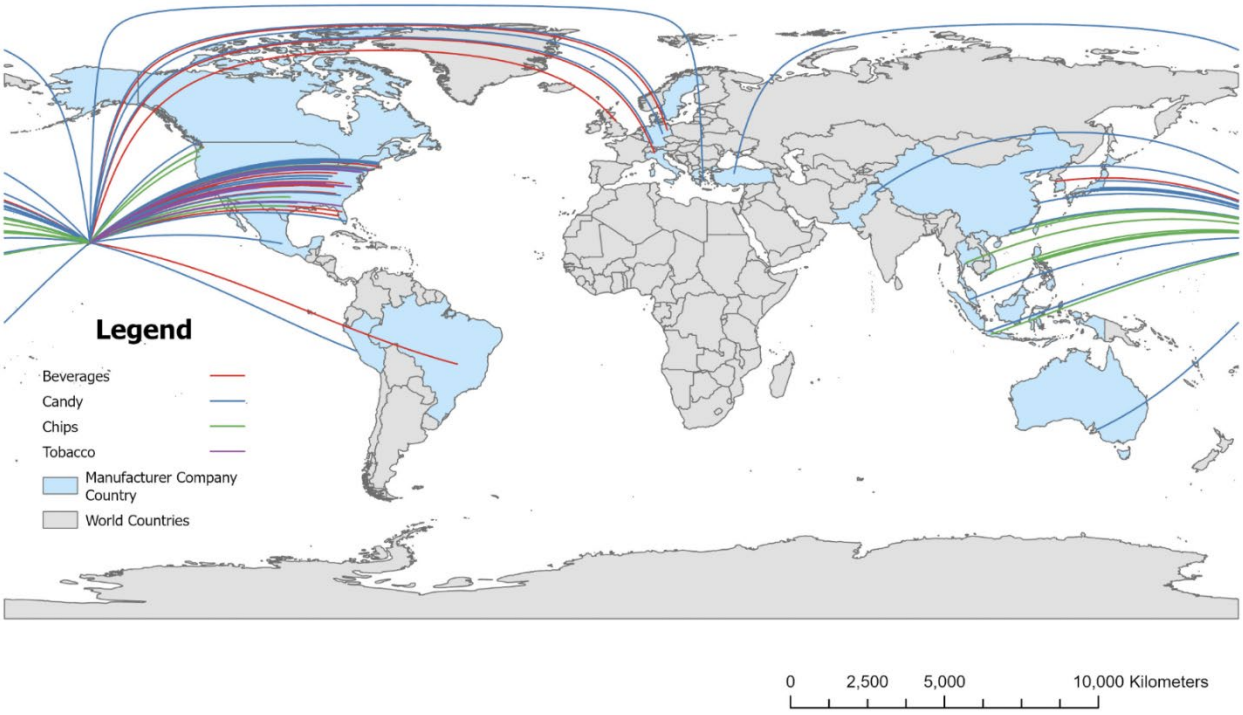


Table 2: Top 5 Parent Company Country locations for top convenience items in Hilo, Hawaii

Parent Company Country	Number of Top Convenience Items	% of Top Convenience Items
US (not including Hawaii)	138	55.4
Hawaii	47	18.9
Italy	10	4
The Philippines	9	3.6
Japan	8	3.2

Table 3: Top 5 Manufacturer Company Country locations for top convenience items in Hilo, Hawaii

Manufacturer Company Country	Number of Top Convenience Items	% of Top Convenience Items
US (not including Hawaii)	149	59.8
Hawaii	34	13.7
China	13	5.2
The Philippines	9	3.6
Japan	8	3.2

Given that there are similarities between locations of both parent company and manufacturer locations for products sold in Hilo, there may be an opportunity to begin looking into various extended producer responsibility (EPR) models. A handful of states in the US have implemented EPR policy legislation that encourages producers of products to bear some responsibility for their end-of-life management. EPR can take many forms, but common approaches throughout the world and the US include product-take-back and deposit-refund schemes as well as waste collection and take-back guarantees (UNEP 2018). They can also supply resources for current state or city-wide management systems as they currently are. The plastics industry in the US tends to oppose EPR schemes arguing that waste management relies on consumer practices and behaviors (Nash and Bosso 2013), and that the schemes can lead to increased costs, food waste, and life cycle impacts (ACC 2021).

The minimum distance for chip and drink products for parent companies and manufacturers was approximately 0 km as there were products that were produced in Hilo, such as Hawaii Island chips and Island Naturals candy. Other parent company and manufacturer locations within Hawaii included Aiea, Kapolei, and Honolulu. The close minimum location of beverages and candy indicates that there could be opportunity to have conversations with parent companies and manufacturers in Hilo and throughout Hawaii to articulate a clear vision of what multiple areas and communities in Hawaii want for EPR policy. Four of the five top parent companies are located in the U.S. (Table 4). Domestic companies are making packaging decisions for top convenience items that are being sold and consumed in Hilo. There is an opportunity for discussion with domestic parent companies to articulate changes in packaging materials. The Ferrero Group is the only international top parent company, and packaging decisions are being made internationally where Hilo potentially has less power to influence changes.

Table 4: Top 5 Parent Companies for top convenience items in Hilo, Hawaii

Parent Company	Parent Company Location
PepsiCo, Inc	Purchase, NY
The Hershey Company	Hershey, PA
The Coca-Cola Company	Atlanta, GA
Ferrero Group	Alba, Italy
Mars Inc	McLean, VA

While Hawaii does not currently have EPR policy legislation passed, it is in the initial phases. There has been frustration within the Hawaiian community with recent attempts to pass EPR legislation as described by one interviewee:

> ***"I really appreciate how Oregon went through their EPR system. They thought about it for years. Why can't there be a deliberative process [similar to this in Hawaii] so that people can understand all the impacts: all the way across from consumers understanding the impacts of what's going to happen to them, to businesses, to government. What [everyone has] to do, and stuff like that. I don't see whether it needs to be such a rush. If there was more stability, I think it would be better for everybody."***
>
> *– Compostable Foodware Rep*

Community

Key Stakeholder Interviews

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with 30 key stakeholders (Table 5). Among those interviewed, 5 were recycling experts across government and industry, 4 were local grocery store representatives, 3 were local business representatives, 2 were NGO representatives, 2 were bioplastic foodware representatives, 2 were local hotel representatives, and 2 were educators. To create a more diverse and comprehensive view of the community, the CAP team also interviewed a local artist, a local cleanup organizer, a bioplastics expert, a grassroots representative, a composting expert, a program coordinator, a civil servant, a local farmer, as well as a current and a former state representative. Interviewees included Native Hawaiians, locals of varying ethnic backgrounds, and people that lived in Hilo or in Kona (on the opposite side of the Island of Hawaii) for a number of years.

Table 5: Summary of Stakeholder Interview List

Stakeholder Group	Number of Interviews
Recycling Experts	2
Grocery Store Representatives	4
Local Business Representatives	3
Local Recycling Center Representative	3
NGO Representatives	2
Bioplastic Foodware Representatives	2
Local Hotel Representatives	2
Educators	2
Local Artist	1
Local Cleanup Organizer	1
Bioplastics Expert	1
Grassroots Representative	1
Composting Expert	1

Program Coordinator	1
Civil Servant	1
Local Farmer	1
Current State Representative	1
Former State Representative	1

Interviewees shared their thoughts, experiences, and opinions on circular economy topics as outlined in this section.

Cultural Context

In order to understand how circular activities are viewed by our interviewees, it is important to understand the cultural and political ethos that many interviewees shared. Conversations among our interviewees about many issues related to circular economy inevitably tended to touch on power dynamics shaped by colonialism, as well as the necessity of centering the beliefs of Native Hawaiians within these conversations. Many of these viewpoints coalesced into clear stances on returning to Indigeneity, having ethical business practices, and being cognizant of how inequality brought on by harmful systems impacts peoples' ability to participate in "zero waste" or "circular" activities. It should be noted that while these critiques exist among interviewees, many of them remain positive and optimistic about the ability to invoke circular change, and this optimism is also rooted in Indigeneity and Native Hawaiian beliefs.

Examples of interviewees' outlooks on the importance of understanding Hawaiian beliefs and cultural values when understanding waste and circularity are shown below:

> ***"My family has been arrested for land based initiatives for generations now. People have accepted that Hawaii is a state when there is a legal declaration from the UN saying that it is illegally occupied land; burrowing into resistance is the foundation of who I am. Yes, we are an occupied country, but we have a life and ideas that were prior to occupation. We need to get back to who we are and who we were."***
>
> – Local Farmer

> ***"Hawaiian culture is traditionally very connected to land. There is an importance placed on being connected to 'Āina [the land and natural resources]…Our campus is Indigenous and our island is Indigenous. We need to connect and take care of each other, and take care of the land and the ocean."***
>
> – Educator

> ***"I deeply believe in indigenous practices: working in harmony with the land and rebuilding the environment in a way that is regenerative, which is biomimicry essentially. Thinking we can be extractive and pollutive is a sad thing. Look at what happened to Maui."***
>
> – Bioplastics Expert

> ***"I went to a Hawaiian language immersion school. There is a Hawaiian proverb that states ' there is life in the words we say.' So I want to maintain the truth while also being positive. I don't like to say that the language is dying, but people are struggling. The number of people who speak it is growing, but not many people speak it."***

– Local Farmer

Interviewees also spoke of how abundance provided by ʻĀina (the land and natural resources) and their community have influenced their involvement in pollution spaces:

> ***"[There is a] large percentage of people [here] who embody the value system of the more you give, the richer you are. You give abundance."***
>
> – Former State Senator

> ***"I lost my place to lava back in 2018. I have no problem with an act of God taking land; I do care when people are destroying the land when it is preventable. The term, 'mālama ka 'aina' means take care of the land and it will take care of you. I was taken care of during the eruption."***
>
> – Artist

> ***"I believe what you give you get back."***
>
> – Local Cleanup Organizer

Some interviewees spoke about their motivations for being involved in waste related issues:

> ***"We are the keepers of the planet. People don't always realize that connection. Our children's inheritance is the planet."***
>
> – Educator

> ***"What is the cost of not taking care of our environment? What right do we have to pollute?"***
>
> – Grocery Store Representative

> ***"Ideally we want to work ourselves out of a job."***
>
> – NGO Representative

> ***"I love my community and I do not want my job more than I want to do the right thing."***
>
> – Civil Servant

> ***"People ask me, 'Why do you pick up everyone else's trash?' and I say, because it's the right thing to do."***
>
> – Local Cleanup Organizer

Other interviewees directly tied pollution and extractionism to histories of colonialism:

> ***"The real purpose of a business is to serve your employees. Everyone is trying to cash out, but what is your role in the system? This is the wisdom of Indigenous culture; not capitalist, colonial society. We need to move away from extraction and toward reciprocal relationships."***
>
> – Civil Servant

> ***"There is a disconnect between choices and infrastructure. It is intentional and can be linked to capitalism."***
>
> – Former State Sentaor

> ***"Circular thought is really important. Linear thought has not gotten us very far on the planet."***
>
> – Educator

> ***"People are motivated to bring stuff into the island to extract its money and value, but they are not motivated to take it off."***
>
> – Artist

Other interviewees noted how their understanding of circularity in Hilo has been shaped by recognizing how differences in people's cultural backgrounds may elicit differences in needs:

> ***"But that's the other thing is when we talk about 'local' culture, we're mainly talking about Hawaiian culture because that's the Indigenous culture that this island resides on. I don't have the statistical numbers, but then how much of people's culture or root culture is actually based around Hawaiian culture? I mean, trying to convince a Filipino lady or Thai lady about Hawaiian culture is a little bit difficult, especially if they're living on the margins of society. But then those are the local community population that's affecting our day in and day out life here locally here."***
>
> – Educator

> ***"[Native Hawaiians] just think they're part of nature. They're not the conquerors, they're the caretaker of the land. For them sustainability should be the lifestyle of taking care of nature. It's a natural relationship between humans and the land. But then how do you sell that to an ethnic group that doesn't necessarily have a connection to that?"***
>
> – Educator

> ***"A lot of the population, as far as I understand, are still kind of in a surviving mode. It's hard to ask them 'hey, take care of the world' while they are scrambling to take care of multiple kids."***
>
> – Educator

> ***"Some people look down on Micronesean people saying 'I cannot believe they just throw that plastic on the ground.' But they come from islands where you make everything from the earth and you return it to the earth. It is hard for them to understand why they can't do the same with plastic. It's a learning experience."***
>
> – Artist

> ***"We have a lot of people who are really struggling on this island, and it is a hard system to participate in if you care. I do it, but it's a lot of work."***
>
> – Grassroots Representative

> ***"Locally, environmental justice issues relate more to landfill sightings. Landfills always end up adjacent to Native HI communities. The closed landfill [in Hilo] IS 190 ft high, 40 acres wide, is now covered in astroturf, and is right next to Hawaiian Home Lands. So now this***

> ***mountain is covered with synthetic plastic, likely coated in a mold coated in PFAS, and is now turning to microplastics and raining down on the Hawaiian community."***
>
> – NGO Representative

Interviewees also shared how their various identities shaped their ability to participate in circularity:

> ***"Being disabled, my plastic usage went through the roof. I couldn't stand up, so I had to purchase frozen meals and have groceries delivered to my door, without me being able to make choices about the products' packaging. Plus being disabled is expensive so price is everything. It is a huge privilege to be able to do without plastics."***
>
> – Artist

> ***"There are not a lot of options. I am a mother and my daughter likes little packaged goods and candy. I do not always know what to do or say to her. Post COVID, everything became individually packaged. Schools don't like homemade treats."***
>
> – Program Coordinator

Awareness

Interviewees shared their thoughts on the level of awareness that local community members had about plastic waste and circular economy activities more broadly. Some interviewees shared optimism about the current state of awareness related to these issues:

> ***"There is always some resistance, but people are more open minded than they give them credit for… People do genuinely care about the ocean here. There is lots of love for the ocean and shores and reefs."***
>
> – Grocery Store Representative

> ***"I would like to think people are into environmental issues. It's kind of a watered down concept so people support it on a surface level."***
>
> – Local Hotel Representative

Other interviewees felt that awareness was mixed:

> ***"People are aware of plastic in the ocean and how bad it is for wildlife. It's taught a lot in schools. People think a lot of it comes from elsewhere."***
>
> – Grocery Store Representative

> ***"My direct personal community is very aware. My parents are old school and they keep everything to reuse. They are not at the place to make different packaging choices when purchasing products. Overall, awareness and interest are there, but how much effort are you willing to put into it?"***
>
> – Program Coordinator

> ***"People have heard about plastic pollution, but few have changed their lifestyles. People need to understand its connectedness to their own lives. You are part of this planet so anything you do is part of it."***
>
> – Educator

> ***"I started to understand sustainability is a religion. People who believe it understand that God exists. For those who don't believe in it, sustainability is not real. But then a lot of people in the middle, they don't care. They only link to where it's convenient for them, if that makes sense. I am pretty sure they would want to switch to reusable and drop off only if it's convenient for them."***
>
> – Educator

Some interviewees affiliated with local businesses spoke about how their customers feel about plastic alternatives and participating in broader sustainability efforts:

> ***"I don't think there's pressure [from the consumer to bring in plastic alternatives]…We like to offer different products for different clientele… sometimes when [alternatives] come out, people get excited and then they lose interest and then we get stuck with a lot of products that we purchase anticipating sales. We can't please everyone, so we try to please some… We offer alternatives to plastic as they become available, but consumers mostly ignore them."***
>
> – Grocery Store Representative

> ***"We are working on attracting a conscious minded traveler, a kind traveler. We have worked hard on making a positive impact on our community and how we are trying to give back. We are gaining more awareness now as we share what we are doing. We are retaining people."***
>
> – Local Hotel Representative

Some interviewees felt that awareness is best partnered with ease and various incentives:

> ***"There is a misconception that people don't care about the environment. You just need to make it kind of easy and add incentives."***
>
> – Grocery Store Representative

> ***"A lot of times people will make the right decision if it makes more sense money-wise."***
>
> – Recycling Expert

Other interviewees mentioned how awareness varies depending on the community:

> ***"Some people are aware of zero waste issues, but it is culturally specific."***
>
> – Composting Expert

> ***"For a lot of local people, their biggest barrier is their language. They're coming from immigrant backgrounds, or even if they're here for several generations, but then they're still surrounded within their own people. So the language barrier is huge. It's mind blowing."***
>
> – Educator

> ***"I'm quoting a person saying she's like all the locals: she resents the visitors and all that. They don't want the visitors coming here, but then look at those who are trashing our beaches. Now, the visitors and the locals are trashing our beaches. I'm not saying every visitor is good, but then it is a reality that you see in the parks or along the roadways on the beaches. The locals just leave the trash there when they leave. On the other hand, the visitors have a lot more respect, or not necessarily respect, but then a lot more awareness, education and education, like environmental, mental, environmental issues and stuff."***
>
> – Educator

> ***"I think [awareness] depends on the community you live in. So for example, in Los Angeles, the standard of living is a bit higher in certain areas. So when you walk through markets like Whole Foods, everything is sustainable even. I think it depends on what the average household income is. Once you reach a certain threshold, I think the study was $80,000 and above. People start to care much more for the environment than where their next meal is going to come from. And here it's a little difficult financially on average. So I think right now people are more worried about income."***
>
> – Grocery Store Representative

Another interviewee added on to this sentiment, stating:

> ***"I think Hawaii County has over 50% ALICE (Asset Limited, Income Constrained, Employed) population. So I think it's an equity question that we're heading towards really. I think Hawaii County with a 50% or plus 50% ALICE population, they're looking at the economy of things and not necessarily the regenerative or sustainable approach, honestly."***
>
> – Grocery Store Representative

Youth awareness and engagement was also mentioned as being important in growing awareness of circularity:

> ***"As a senator, cracking the shell of how to get the younger generation involved was very difficult, especially in government things."***
>
> – Former State senator

> ***"There's a lot of awareness [among youths] but they do not know where to plug in."***
>
> – Program Coordinator

> ***"I mean most young people, they kind of grew up with that idea of trying to be more regenerative or more sustainable. It always helps to have opportunities for education, more areas to participate in a circular [system], if you buy it, you take it home."***

– Grocery Store Representative

Education

Current educational efforts as well as ways to expend education were mentioned by interviewees. These included focusing on more positive messaging, the importance and complications of educating children with varying levels of access to outdoor spaces, and the need to ensure that education efforts are not happening in a vacuum:

> ***"We want to shift from 'recycling and waste' to more positive terms…We are trying to make our newsletter more positive. We have been focusing on not using mainland images and getting stories from local customers."***
>
> – Local Recycling Center Representative

> ***"If we teach them while they are little, they will grow up with that mindset of sustainability. It can feel like a pebble in a pond, but it's the ripple effect that's important."***
>
> – Educator

> ***"We have to educate people that not all of life is convenient."***
>
> – Educator

> ***"Education [on environmental issues and circularity] is really important, but education with action is more important."***
>
> – Educator

Bans and Policies

The effectiveness of various bans and policies were also brought up by interviewees. Many interviewees cited inconsistent and constantly changing regulations, a lack of proper labeling, a lack of data, rampant greenwashing, and other factors that all complicate existing and potential bans and policies:

> ***"Because environmental legislation keeps changing all the time, it doesn't make sense to manufacture any of that stuff here…I'm not considering manufacturing anything here. Businesses want stability. They want regulations that they know are going to be around. They want to know what the rules are. And when you don't know if the rules are going to change in another two years, there's no incentive to manufacture anything locally."***
>
> – Compostable Foodware Representative

> ***"We need better labeling. Get rid of those numbers and stop putting those stupid arrows on it if it is not recyclable."***
>
> – Local Recycling Center Representative

> ***"There's no consistency about labeling, about testing, about information that the consumer has. And so it's very confusing for the consumer. The brands don't have consistency because it is not like we coordinate... And so you can't just rely on industry to kind of resolve this because we all have different and sometimes conflicting interests in that regard."***
>
> – Compostable Foodware Representative

> ***"There is definitely a greenwashing issue with marketing for shelf packaging. Not only there but state, government, and nonprofit environmental organizations are mislabeling programs. Hi5 is not recycling, greenwaste program is not composting, glass is not recycling. So that is going on at every level."***
>
> – Local Business Representative

When speaking about bans and policies in Hawaii, one interviewee invoked previous unsuccessful legislation:

> ***"That's what really frustrates me is they run through these bills and they don't think about the consequences...You literally wrote the bill. How could you not know this was going to happen? And it happens all the time...Then at the end of it, the environmentalists are always angry about how it turns out."***
>
> – Compostable Foodware Representative

Single use plastic bags were banned in Hilo in 2014, and expanded polystyrene food service containers were banned effective 2019. Both of these bans were also mentioned by interviewees. Once again, interviewees spoke of how these bans created confusion in terms of jurisdiction and enforcement.

> ***"With regards to the polystyrene ban at the county, I would have hoped that the state would've taken a preemptive approach and devised rules for all counties. Just like our liquor laws, there's a county of Hawaii liquor law, there's city and county of Honolulu liquor law, there's Maui. So sometimes it gets a little difficult and confusing to navigate [all the different laws across counties], especially for the bigger retailers that have multiple locations within the state in different jurisdictions. So the preemption of the state would probably have been a little bit better for laws such as these because there'll be a pretty clear understanding of what's expected."***
>
> – Grocery Store Representative

> ***"Each county has their own bag bans, some of them have multiple. It's very confusing."***
>
> – Compostable Foodware Representative

> ***"So single-use plastic bags were banned a number of years ago. From an operational standpoint, we certainly understand the reason why the ban was put in place and personally I can appreciate why the legislature or the mayor signed the ordinance into law, right? From an operational standpoint, we had seen a significant rise in theft in our operations because people would just be walking out without bags. I think if you ask any grocery retailer in the state, they'll probably give you the same analysis that theft did rise without the single use plastic bags in place."***

– Grocery Store Representative

> ***"We no longer have white bags, but at the farmers markets we see prolific use of single-use plastic produce bags. They use thousands of those bags. To me it is a violation of the plastic bag ban."***

– NGO Representative

Some interviewees viewed the state-level bans positively:

> ***"We were taking steps in the right direction [with the plastic bag and styrofoam bans] as we did that; going back to more recyclable products like paper. I think that is the right direction to take."***

– State Representative

Other interviewees felt like the state-level bans had unforeseen consequences:

> ***Paper bags did go on a rise, but we know that doesn't mean that [paper bags] are better for the environment, right? [Paper bags are] in today's landfills where you're absent light, water, and air, and it necessarily doesn't degrade. You'll dig it up a hundred years from now and you'll find that paper bag still in the condition that it was on the day that was issued. It takes 19% more energy to produce a bag. It takes 20% more shipping space to ship the bag from. We have no production in Hawaii for paper bags. They're all primarily generated out of the Pacific Northwest, and depending on what kind of inks you're using and starching some other environmental concerns that I think if you look at it from the outside in, it's arguably not better for the environment at all."***

– Grocery Store Representative

> ***"The ban on styrofoam containers has us using a lot of plastic, maybe even more than we did before, and none of it is being recycled."***

– NGO Representative

Interviewees also mentioned current regulations that are being drafted:

> ***"There is a carrot and the stick [policy] currently in the works. Just now the county council is considering an ordinance that would ban certain commodities from commercial sources to go to the landfill. Over 52% of materials that go to the landfill are organics or fibers. There could be an ordinance that restricts putting that in a landfill. If you include glass, metals, etc, you can quickly get a 60-70% diversion rate from the landfill. Change is hard -- you get this malaise where people want to do things but it is hard to make change quickly -- ordinance would make that happen quickly." (***

– Recycling Expert

> ***"With the SUPs bill, we are trying to get away from oil and hold them accountable. If we can make a toilet that works on Mars, we can get materials that aren't plastic. There is lots of fighting at the government level that is 30 years behind, while activists are wanting to be 50 years ahead."***

– Civil Servant

Other barriers to enacting bans and policies mentioned by interviewees included the prominence of the waste industry in Hawaii:

> ***"We are in the process of developing a SUPs bill, but the [plastics companies] have billions of dollars and they will always fight scientists."***
>
> – NGO Representative

> ***"As long as the landfill is open, Waste Management has a contract. 200,000 tons of trash have to be supplied per year, and the county has to pay if they don't meet it. The more trash the DEM gets, the lower the prices. This was set in the 70s."***
>
> – Local Recycling Representative

> ***"Realistically the biggest push back is our largest mafia in Hawaii, which is waste collection. Their networks are in everything but especially tourism, which is one of the largest waste producers.***
>
> – Former State Senator

Tourism

Tourism was frequently brought up as a factor that complicates many types of sustainability efforts, especially those related to waste and plastic materials. One interviewee noted how there has recently been an emphasis on encouraging tourists to focus on mālama. A "way of life that involves respecting and protecting the environment, culture, and community" (Mālama Learning Center 2020).

> ***"Instead of focusing more energy on getting people here, they're focusing energy on mālama. It's a message that a local could speak to a visitor, if that makes sense. It's like, 'don't turn your back towards the waves', for example, or 'don't take the rocks away, put the rocks back where they belong.' [Its focus is] kind of ritual, kind of environmental, but then is also more focused around safety and Native Hawaiian culture related things."***
>
> – Educator

Regardless of this more recent initiative, interviewees noted how tourism can be tied to colonialism, consumerism, and extractionism. One interviewee spoke about how recreational activities as brought on by the tourist economy has disconnected people from the abundance of natural resources that have historically been available on the island, citing the decrease of fish populations in fish ponds as an issue directly related to extractionism and other tourist activities. Other interviewees had this to say:

> ***"In Hawaii, a lot of local communities don't really necessarily welcome visitors. They think they're coming here to take the resources. And then if you go to the west side, Kona, you see all the nice beaches and resorts are all located in nice places, and then they're so expensive.***

Even though I live here, it's understandable. There's a lot of local resentment towards it and a lot of negative perception towards the industry."

– Educator

"Every time the cruise ships let people off, they bring Walmart bags, new snorkeling gear, and new lawn chairs. They crush the coral, sleep on the beach, and eat their chips, and then they leave all of that stuff behind. Or worse, try to return it to Walmart."

– Artist

"Tourism and commercial activity has displaced Keaukaha people who have been living here for thousands of years. The county parks, although established by a colonial government, were meant to provide parks for the Native people. The county parks are also supposedly supposed to be not commercial, but tour buses go through here all the time. Thousands of dollars go through this park every day."

– Artist

"Tourism is a [big issue]. There are 250 - 500,000 extra people on the island each month. It is our main economic engine, and there is no standard setting at airports, hotels, etc."

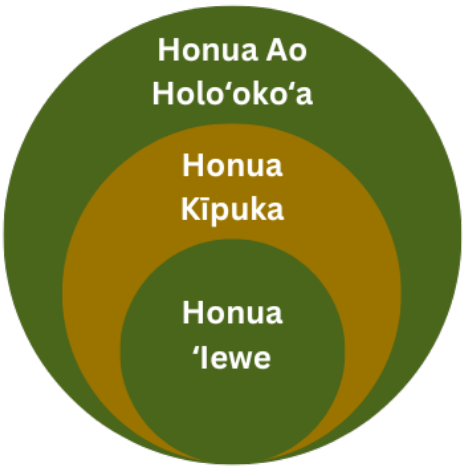
– Composting Expert

Recommendations from Interviewees

Regardless of the issues related to recycling, awareness, education, policies, and composting, interviewees mentioned many current initiatives that are going on as well as ideas they had for the future.

One interviewee mentioned the Kumu Honua Mauli Ola Educational Philosophy Statement published by the Hale Kuamoo, a branch of the University of Hawaii in Hilo's Ka Haka Ula o Keelikolani College of Hawaiian Language and the Aha Punana Leo organization. The interviewee used this model to critique Western notions of circularity that focus on the individual's actions rather than the relationships between individuals, their community, and outside communities. This interviewee's critique is shown below:

Kumu Honua Mauli Ola Educational Philosophy Statement published by the Hale Kuamo [Kuulei]



> ***"There is a circular model derived from an educational philosophy statement from the College of Hawaiian Language. It consists of three circles. The inner circle is the womb, the middle circle includes and sustains the family (community and school), and the outer circle represents systems of relations between outside communities. The circular economy [as it has been articulated in Western spaces] only focuses on the inner circle of personal decision-making when the other two circles need to be addressed. The family system of returning to land. Returning to Native practices will begin to support those decisions."***
>
> – Local Farmer

Based on the Kumu Honua Mauli Ola Educational Philosophy Statement, the CAP team situated interviewees desires, wishes, and suggestions within an inner circle representing actions taken in a family setting, a middle circle representing the familiar community in close proximity to the home, and an outer circle symbolizing the outside world - in this context, the third circle will represent collaborations between government and other places of community. Quotes from interviewees related to the change they would like to see are situated within these three circles. Most of the suggestions for change can be found in the middle circle: interviewees are most concerned with fortifying Native Hawaiian communities, including land back, healing community bonds, and passing down Indigenous beliefs and knowledge systems. A majority of interviewee suggestions that fall into the outer circle consist of various structural changes that would help aid changes in the middle circle, including land back, regulations at the federal and/or state level, EPR, and linking environmental justice issues in other places to what is going on in Hilo and Hawaii more broadly. **As a note, each circle is not mutually exclusive; community health reinforces the health of the individual and vice versa -- it is all connected.**

Inner Circle on Family and Personal Decisions

> ***"It would be great to create a list of five easy actions people can take around reducing plastic pollution."***
>
> – Educator

Middle Circle on Proximal Community (Community and School)

> ***"We need more land for Native people and having a program to rehabilitate Hawaiians and Hawaiian family systems through the land. If we restore our connections to each other and to our cultural pride, there will be a lot less need for the products that create waste. This [connection to land] needs to be at the forefront of ecotourism; farming and fishing for Hawaiians. I want it to be profitable for Hawaiians to come home from living in the continental US because other people are doing it now and profiting off our wisdom."***
>
> – Local Farmer
>
> ***"We need to change the prioritization of money being the focus of local industry, and begin recognizing social and environmental equity as just as important."***
>
> – Bioplastics Expert

Middle Circle on Proximal Community: Recycling

> **"Finding a way to find a way to make it much easier to recycle would be ideal. Right now there is no one locally so you have to ship everything out. Hawaii's economy is not big enough for anyone to want to move in to do it anyway so that's the catch."**
>
> – Bioplastics Expert

> ***"I would love to see curbside pickup for garbage, recyclables, and reusables. I think that would make a reuse system more viable."***
>
> – Grassroots Representative

Middle Circle on Proximal Community: Food Sovereignty

> ***"We are seeing a huge shift to going back to nature-based solutions and Indigeneity, which is really about food sovereignty… a core part of culture here is to grow food and to share [it]…Everything is a system. We are talking about farm to school, but we are really talking about zero waste: bolstering garden programs and state procurement from local agriculture. Our local food systems can be done in a way that are sourced locally and we can even have a reuse system. Our food systems are a lot closer to us."***
>
> – Former State Senator

> ***"Bolstering the farming economy will bolster composting. Farming is decreasing due to dependence on imports."***
>
> – Bioplastics Expert

> ***"Equipment for local food production. Machines that could process coconuts quickly for local agricultural products (ulu, taro, and coconuts require lots of work!) We import 90% of our food, but Pepsi and Coca Cola package here on the island because it is cheaper to just ship syrup here. So having facilities for co-packing for foods coming in, as well as equipment and more dishwashing facilities would be beneficial."***
>
> – Grassroots Representative

> ***"We want our food land back. This [land] was not meant to be for recreation…My aim would be for this entire region to be a bountiful fishery where people can come and feast and play and learn and be together in a peaceful existence."***
>
> – Artist

Middle Circle on Proximal Community: Infrastructure, Equipment, and Space

> ***"I would want a one stop shop with warehouse space, including safe, secure, waterproof storage, that is easy to drive to. This way, it would protect [collected recyclables] from the elements and theft, which is common."***
>
> – Local Recycling Center Representative

"I see an opportunity to work with HOA/ second, third, fourth home ownership, resorts, hotels, etc. [to minimize waste.]"

– Recycling Expert

"Money for infrastructure. We lack money for infrastructure in general in Hawaii. 2-3 resource recovery parks for construction and demolition, textiles, electronics, refurbishing, hazardous waste collection, recycling of whatever packaging materials can be processed here locally (like cardboard), and storage space. When the resorts and hotels need new mattresses and furniture, there's all this stuff that's available that can be reused and sold, but there is no space to put it in the interim."

– Grassroots Representative

"I like the thrift store at transfer stations. I would like to see more 1 stop shops [for materials disposal]. I would also like to see an increase in hazardous materials drop offs."

– Program Coordinator

"We need technicians and parts to repair machinery. It is difficult to find people qualified to fix it on the island."

– Local Recycling Center Representative

Middle Circle on Proximal Community: Policies/Bans/Ordinances

"There have been rumors of people going to a landfill and seeing recyclables there. We have ordinances but we don't have enforcements for the plastic bags, Styrofoam, and sunscreen bans. I have asked for penalties to go to recycling, just like penalties for sunscreen go to parks and recreation)."

– Local Recycling Center Representative

Middle Circle on Proximal Community: Community Engagement and Events

"[Solutions/changes] have to be grassroots and have roots here. The deeper the roots the better. It has to be [people] who really clearly understand colonial history and can build relationships and trust. If that help is coming from outside, especially if there is money involved, there is a wall that goes up. Also identifying key, trusted figures in the depths of our community that are usually the least heard. [There is a] disconnect between those who show up because they are white and settlers and others are there but are not front facing, so shifting so that more of them are in power [is really important]."

– Former State Senator

"It would be great to have more community oriented workshops to determine how system changes will work in real time. Really include people in the process with a focus on the 3x bottom line: people, planet, profit. This will be more beneficial for all, and will get us out of short term, high gain."

– Bioplastics Expert

> ***"The thing to focus on is events. It is the easiest first step -- people are eating the thing and getting rid of the container right there on the spot, there is time to talk to them, they are there with their kids." (I20 NGO Representative)***
>
> – NGO Representative

> ***"I would like to reoccupy and re-envision spaces that are no longer relevant, like the mall. The mall sits on Hawaiian Home Lands community land, and those beneficiaries are not really benefiting from that lease. How can we envision this? We are already coming here for commerce -- the Walmart and Target -- but the mall itself has so many vacant spaces that could be used for tying in circular economy things. Even if we just implemented cardboard box collection, shredding, and selling or a system of collecting from businesses and getting it from farmers market. The same thing is possible with bottle reuse, we can return jars there. The space could also be open to education with a family component, even if it is just once a month. Not only do we share and have reciprocity, we are a huge community of volunteerism and we teach our kids that from when they are small."***
>
> – Former State Senator

Outer Circle on Governance and Distal Communities:

> ***"Land back is huge. Let's start with that as a solution. Not a landlord/tenant contract because that's traumatizing and triggering in all of the ways. Tourists would participate in this too, which would help with antagonism between locals and non-locals. When you are learning alongside and when you are coming to give back instead of to take, it establishes good intentions in actions rather than just words."***
>
> – Former State Senator

> ***"People who are most impacted by plastic production are people who live in Texas and Lousianna. We have those impacts here because of aloha culture -- we care about other human beings. This is how we generate the road show to support a plastics ban."***
>
> – NGO Representative

> ***"If [Native Hawaiians] were in charge of our own governance we would be able to close Hawaii to restore our coral, forests, and trails. Tourism has a role of dissonance, so the lack of it would have a role of reclamation."***
>
> – Local Farmer

> ***"To me it really comes down to a system. The PLA that takes 25 years to break down isn't viable…Bioplastic could be more water soluble for this region. It needs to be specific to the region it is in. But it is all about formulation. We have 10 out of 12 microclimates on this island; we need 1 plastic type/per mico climate."***
>
> – Bioplastics Expert

> ***"There needs to be [compostable] labeling at the federal level, as well as standardization and access to information. Any product that claims compostability should have a QR code that lets people know where products come from."***
>
> – Bioplastics Expert

> ***"I really want to see more controls on what we are bringing in. So many plastics are coming in and staying here. I also want to see EPR, with Walmart and Target as examples."***
>
> – Program Coordinator

The recommendations above allude to the following themes:

- Self & Family: personal development, healing wounds that keep us from trusting each other and asking for help, building capacity in the home - taking care of ourselves so we show up optimally to the work we do, making sustainable lifestyle choices when convenient, building capacity for when not convenient, making a personal commitment to "try" and be more mindful of green habits and holistic health.
- Community: Collaborating with members of the community: other families, farmers, food producers, and folks with resources, knowledge, and skills to share. Collective brainstorming to think through waste reduction, reuse, recycling. Developing more opportunities to learn about bioplastics, "throw away" culture shifting to shared resources, bartering, repurposing, and reuse. The restoration of political and holistic (food) sovereignty.
- Governance and Outside Communities: Experiencing green initiatives in other states/communities that may be adapted for our home communities, learning to become civically engaged and provide testimony in support/opposition of bills, supporting interested community members to run for office and make meaningful changes to the law.

The fulfillment of each circle of the Honua Mauli Ola framework through the accomplishment of the recommendations above has the potential to generate change within the Hawaii community. The perspectives shown above can be utilized and referenced in testimonies, the solicitation of grant funds, and for personal encouragement to inform each other of shared perspectives.

Product Design

To characterize material types used in common consumer products, samples of common convenience were obtained as described in the Input section. The CIL team sampled stores in each of the nine 1km^2 transects areas. Thirty unique forms and brands were purchased to obtain packaging weights. The average weight of both the packaging and the product itself were collected for all samples (Table 6).

Table 6: Average weight of products and their plastic packaging for common convenience items.

Product Type	Number of Samples	Average Weight of Plastic Packaging (g)	Average Quantity of Product (g or mL)
Beverages	10	28.7	560
Candy	29	5.1	73.5
Chips	21	8.2	80.4

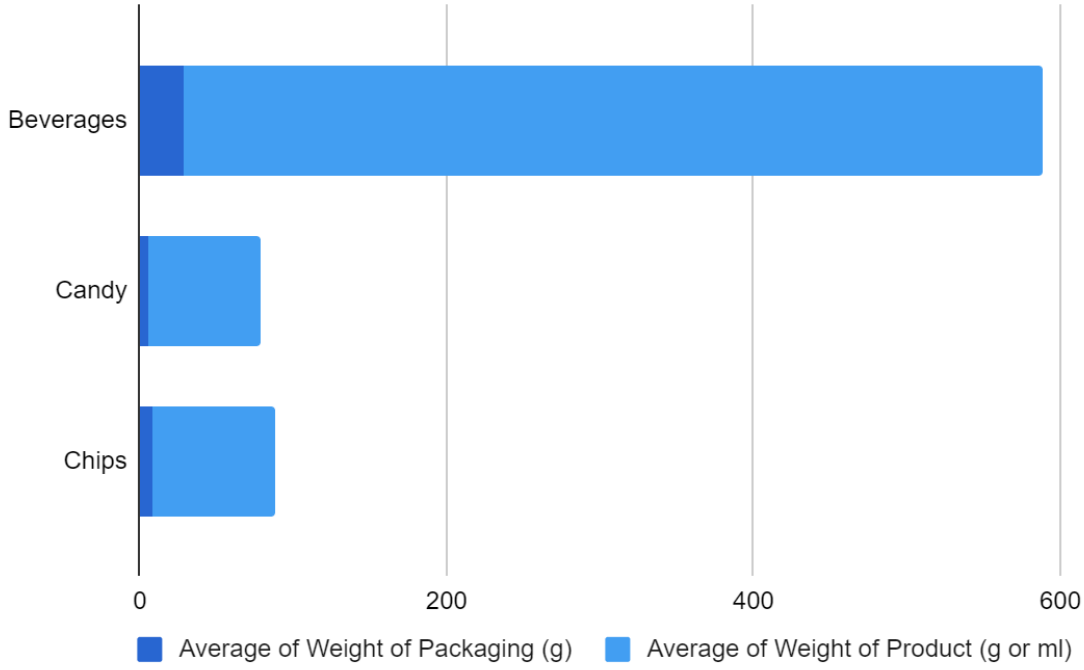
In comparison with other samples from around the world, several cities in India showed that the average product weight for candy items was around 3.8g and the average packaging weight was around 0.15g — those found in Santiago were around 10 times larger for both product and packaging weight. Smaller product sizes may lead to more frequent, less individually expensive purchases compared to larger product sizes, although there is often a "poverty tax" associated with these small packets compared to the price per quantity in larger sizes, in addition to the generation of more packaging weight in summation.

For domestic comparison, samples taken in Miami, Florida showed an average product weight for candy items was around 1.4g (more than 3 times larger in Hilo), for chip items was around 4.7g (around 2 times larger in Hilo), and for beverage items was around 27.5g (similar to Hilo). The average packaging weight for candy items was around 42.6g (around 2 times larger in Hilo), for chip items was around 81.7g (similar to Hilo), and for beverage items was around 458 mL (slightly larger than Hilo). Larger product sizes lead to less frequent, less individually expensive purchases compared to smaller product sizes as well as less generation of packaging. Hilo's remote location from the contiguous US and Asia may contribute to larger product sizes.

Cigarettes were excluded from our purchasing of samples in this case, but they are typically a standard size, and we have previously found an average of about 10g of plastic packaging to about 15g of product. This relatively high plastic packaging to product ratio means cigarettes generate larger amounts of plastic waste per unit of product. Cigarettes typically include cellulose acetate filters weighing about a gram each which remain in cigarettes after they are smoked.

A total of 21 grocery and convenience stores were sampled across the nine transects. 10 stores consisted of convenience stores like 76 and 7-Eleven. Eight of the stores included large grocery chains such as Target and Safeway; local grocery stores were also sampled. The team also sampled a local boutique, drug store, and a discount chain store. Sixty items were sampled in total. Candy and chips both had relatively low product and packaging mass, probably due to multilayer film's light weight (Table 6 and Figure 5). Most of the packaging for both candy and chips are multilayer film, except for multi-material chip canisters (such as Pringles cans) and candy packaged in paper and hard plastic. Although multilayer film can be useful for its ability to preserve and protect food products, its combination of materials in a film makes it difficult to isolate in traditional recycling processes, resulting in a material that has little value in recycling markets.

Figure 5: Convenience items packaging to product weight ratio, shown in grams (not including unknown products or tobacco as there is no weight data for tobacco)



Beverages had the highest product mass and packaging mass when compared to chips and candy (Table 6). This difference could be attributed to both the high density of polyethylene terephthalate (PET) commonly used in plastic beverage bottles, as well as the high density of liquid found in beverage products. Candy and chips had a packaging to product ratio of 0.07 and 0.10 respectively. However, beverages had the smallest packaging to product ratio of 0.05. This means that chips produce twice as much packaging waste per unit of product than beverages. Reducing the ratio of plastic packaging to product through minimal packaging design and/or increasing quantities of products can make product delivery more efficient (Youngblood et al. 2022). For each FMCG surveyed, the CIL team also documented the polymer/packaging type (Table 7 and Figure 6.)

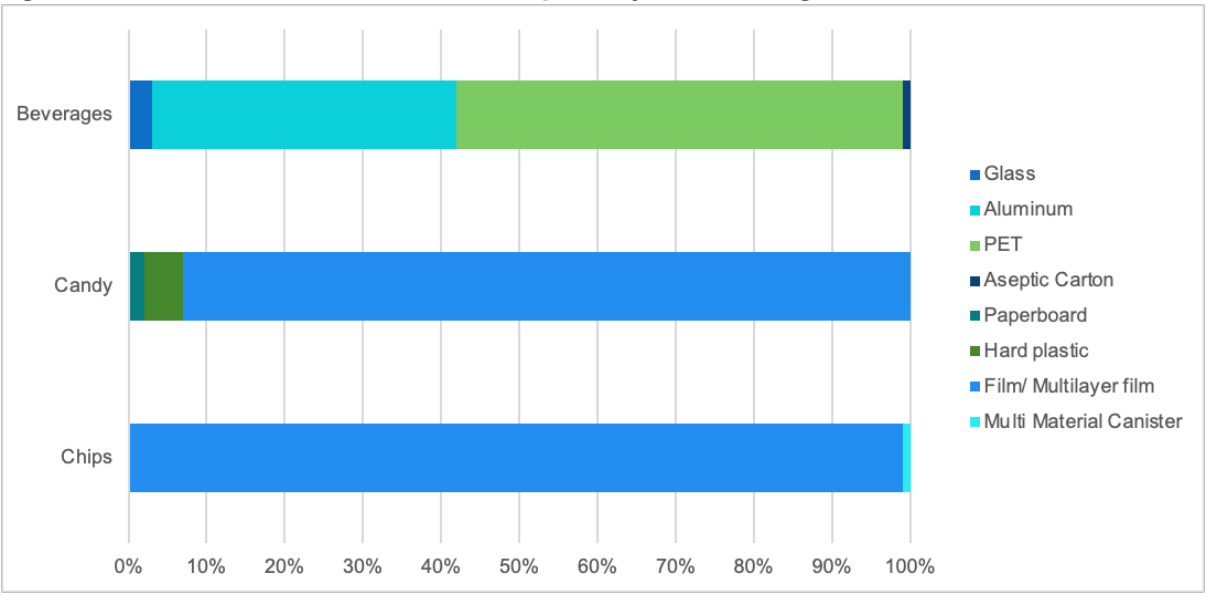
A majority of the candy sampled was packaged in multilayer film plastic (93%), while the remaining materials consisted of hard plastic (5%), paper (2%). Chips were overwhelmingly packaged in multilayer film (99%) with a small percentage (1%) being multi-material canisters. Over half of all beverages sampled were packaged in PET (57%) followed by aluminum (39%). Glass and aseptic cartons were less popular packaging materials for beverages in Hilo making up 3% and 1% respectively (Table 7).

Table 7: Overall material breakdown of chip, candy, and beverage convenience items.

	Candy	Chips	Beverages
Glass	-	-	3%
Aluminum	-	-	39%
PET	-	-	57%

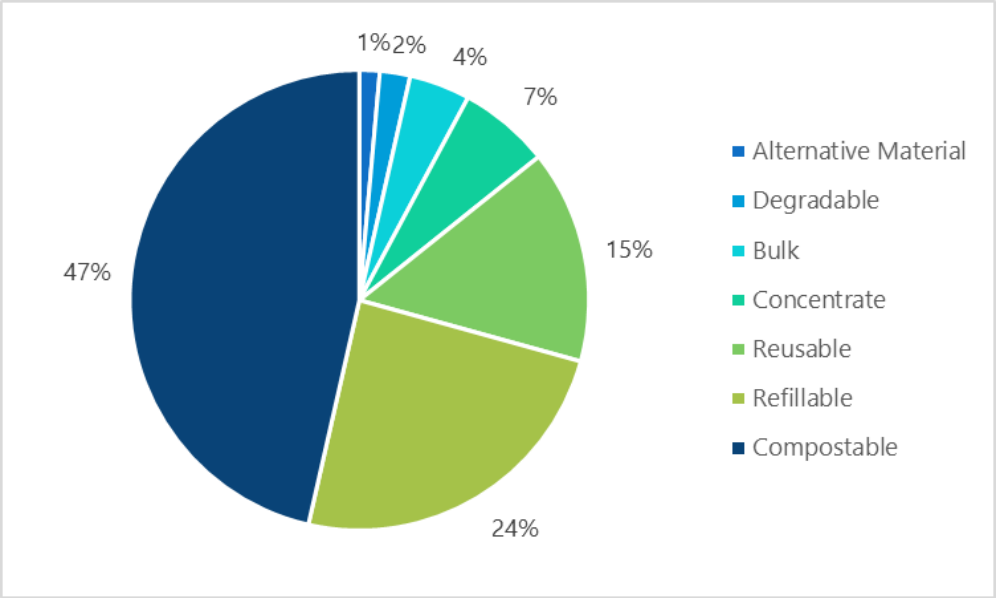
Aseptic Carton	-	-	1%
Film/ Multilayer film	93%	99%	-
Paper	2%	-	-
Hard plastic	5%	-	-
Multi Material Canister	-	1%	-

Figure 6: Overall material breakdown of chip, candy, and beverage convenience items.



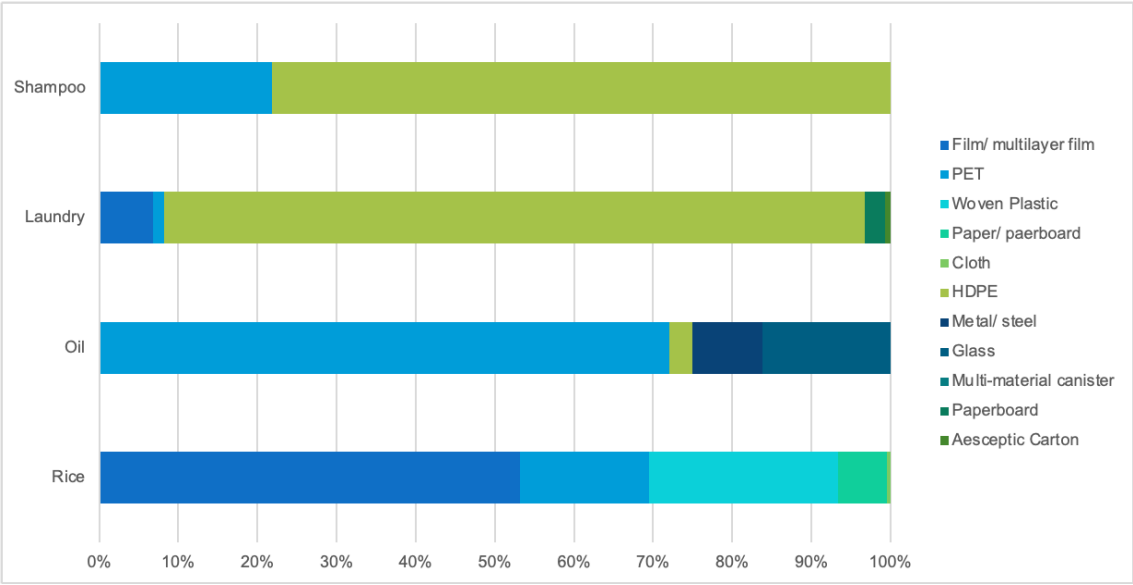
The CAP team also sampled a variety of products to determine the availability of potential plastic alternatives in product packaging within the sampled stores, including items found in the picnic, personal care, and cleaning sections. The team collected 140 samples that included compostables, reusables, and refillable items, among others. Interestingly, compostable alternatives made up 47% of all plastic alternatives sampled despite the lack of composting infrastructure to handle the products in Hilo. Refillable alternatives were roughly 1/4 of all plastic alternatives (Figure 7). This indicates a market present for refillable in Hilo that can expand in the future. Refillable products are a form of source reduction which is the most preferred option in the EPA waste hierarchy. There are numerous advantages including saving natural resources, conserving energy, and reducing pollution (EPA 2024).

Figure 7: Material breakdown of plastic alternatives (n=140)



Product packaging for the staple items of shampoo, laundry detergent, oil, and rice were sampled (Figure 8). The main product packaging for shampoo and laundry detergent was HDPE, while cooking oil was primarily packaged in PET, and rice frequently came in film/multilayer film. Shampoo was the only staple item that did not have a non-plastic packaging option available, with only HDPE or PET packaging offered. Despite the non-plastic alternative of shampoo bars rising in popularity throughout the US, there were no shampoo bar offerings readily available during data collection at the sampled stores.

Figure 8: Overall material breakdown of shampoo, laundry, oil, and rice staple items



In addition to surveying convenience and grocery stores, the CIL team surveyed restaurants in each of the nine 1 km^2 transects areas. Through visual assessments and discussions with restaurant owners, we assessed the material type for to-go food items like containers (including their lids), cold cups, utensils,

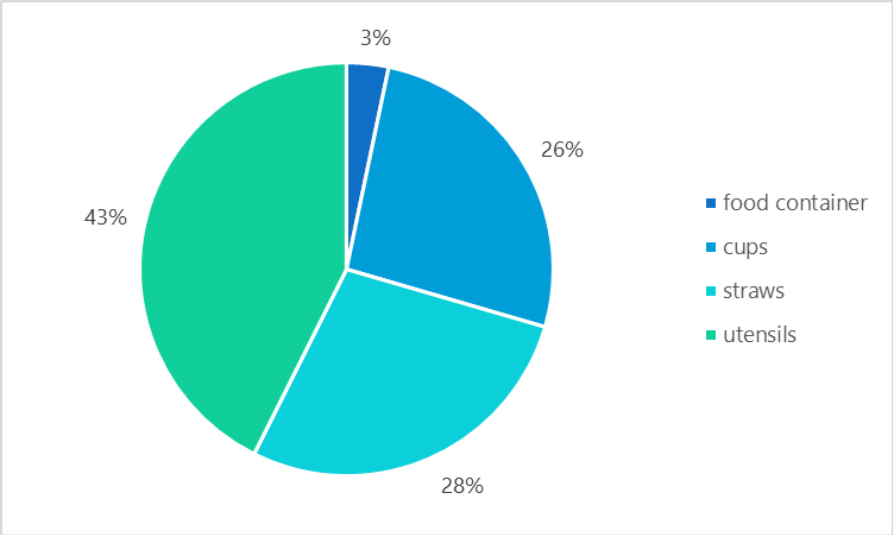
and straws. 32 food vendors were sampled in total, including local and chain restaurants. Although compostable offerings were found across each of the four categories, plastic tended to be the most prominent material used (Table 8).

Table 8: Restaurant material types of cup, food containers, straws, and utensils

Material Type	Cups	Food Container	Straws	Utensils
Compostable	16%	2%	17%	26%
Plastic	23%	35%	67%	63%
Paper	`10%	14%	17%	-
Foam	6%	4%	-	-
Plastic-Lined Paper	29%	6%	-	-
PLA	16%	2%	-	-
Aluminum	-	4%	-	-
Fiberboard	-	8%	-	-
Film Wrap	-	21%	-	-
Cardboard	-	4%	-	-
Wood	-	-	-	11%

Utensils were the most popular compostable to-go food item (43%), cups and straws were similar, at 26% and 28% respectively, while food containers were the least common compostable to-go food item (3%) (Figure 9). There have been several issues with compostables in industrial settings with many interviewees in multiple CAP projects speaking on how compostable plastics often look like plastics, and as such, end up contaminating composting streams. Cities like Ann Arbor no longer accept BPI certified material due to these challenges. While Hilo does not currently have the necessary composting infrastructure to accept compostable products, these issues must be considered in the future to be as efficient as possible when composting.

Figure 9: Compostable restaurant to-go food item breakdown



Use

During fieldwork, 21 grocery and convenience stores were sampled to determine availability of alternatives across various product categories that usually consist of single-use plastics: picnic ware, kitchen products, household products, and personal care items (Table 9).

Table 9: Picnic ware

Product	***Alternative Type***	***Avg. Cost of Alternative ($/unit)***	***Avg. Cost of Plastic or Similar ($/unit)***	***Avg. Cost Difference for Alternative (%)***
Bowls	*Compostable*	*$0.41*	*$0.32*	*26%*
Chopsticks	*Compostable*	*$0.03*	*$0.06*	*-39%*
Cups	*Compostable*	*$0.41*	*$0.10*	*295%*
	Refillable	*$0.61*	*$0.09*	*511%*
Dessert Plates	*Compostable*	*$0.23*	*$0.07*	*243%*
Dinner Plates	*Compostable*	*$0.27*	*$0.27*	*70%*
Straws	*Compostable*	*$0.10*	*$0.05*	*169%*
	Reusable	*$1.498*	*$0.10*	*1,463%*
Utensils	*Compostable*	*$0.12*	*$0.06*	*102%*

With the exception of chopsticks, plastic bowls, cups, dessert plates, dinner plates, straws, and utensils all tended to be significantly cheaper than their various compostable and reusable counterparts. The two

most expensive alternatives per unit average when compared to their plastic counterparts were the refillable cups (511% more expensive than plastic cups) and the reusable straws (1,463% more expensive than plastic straws). Although compostable chopsticks were on average 39% cheaper than plastic chopsticks, interviewees noted how a lack of composting infrastructure on the island makes it difficult to encourage compostable alternatives (see End-of-Cycle, "Composting").

When looking at kitchen products (Table 10), the CIL encountered "degradable" designations for both freezer bags and sandwich bags. Although listed here as an "alternative," because most consumers would see it as such, it is important to note that "degradable" designations tend to be a form of greenwashing that denotes a certain plastic product's ability to break down at a quicker rate than other plastics. This means that the product still breaks down into microplastics and possesses harmful chemicals and additives that are still released into the environment. Interestingly, the two "degradable" items within the kitchen category are the only ones that are cheaper than their more common plastic counterparts, which could be further attempts at encouraging the purchasing of those products through the combination of a low price and greenwashing tactics.

The highest average cost per unit for alternatives within this category included all of the reusable items: food wrap, gallon bags, quart bags, sandwich bags, and snack bags (Table 10). These reusable items tend to have a higher cost per unit because it is designed to be used repeatedly. Reusable plastic wrap tends to be made of 100% cotton beeswax wraps, while gallon, quart, sandwich, and snack bags tend to be made from silicone. Regardless, there is an obvious price difference between single-use plastics and their single-use compostable alternatives; there is also a notable cost difference between single-use compostables and reusable alternatives.

Table 10: Kitchen Products

Product	***Alternative Type***	***Avg. Cost of Alternative ($/unit)***	***Avg. Cost of Plastic or Similar ($/unit)***	***Avg. Cost Difference for Alternative (%)***
Dish Soap	*Concentrated*	*$0.009*	*$0.006*	*55%*
	Refillable	*$0.01*	*$0.006*	*111%*
Food Wrap	*Reusable*	*$4.34*	*$0.32*	*1,276%*
Freezer Bags	*Compostable*	*$0.36*	*$0.18*	*98%*
	Degradable	*$0.22*	*$0.52*	*-58%*
Gallon Bags	*Compostable*	*$0.29*	*$0.18*	*62%*
	Reusable	*$5.997*	*$0.18*	*3,207%*
Quart Bags	*Compostable*	*$0.19*	*$0.14*	*32%*
	Degradable	*$0.13*	*$0.30*	*-57%*
	Reusable	*$21.49*	*$0.14*	*14,871%*
Sandwich Bags	*Compostable*	*$0.17*	*$0.05*	*2615*
	Degradable	*$0.03*	*$0.09*	*-64%*

	Reusable	*$10.54*	*$0.14*	*13,079.5%*
Snack Bags	*Compostable*	*$0.14*	*$0.05*	*204%*
	Reusable	*$7.995*	*$0.05*	*17,306%*
Small Trash Bags	*Compostable*	*$0.32*	*$0.26*	*27%*

In household goods (Table 11), reusable dryer sheets tended to be the most expensive product per unit when compared to plastics, and these alternatives usually take the form of wool dryer balls. Bulk alternatives, although sometimes packaged in plastic, are listed as an alternative because they have a higher product to packaging ratio than their single-use plastic counterparts.

Table 11: Household products

Product	***Alternative Type***	***Avg. Cost of Alternative ($/unit)***	***Avg. Cost of Plastic or Similar ($/unit)***	***Avg. Cost Difference for Alternative (%)***
Dryer Sheets	*Reusable*	*$2.91*	*$0.07*	*4,296%*
Floor Cleaner	*Bulk*	*$0.007*	*$0.009*	*-15%*
Glass Cleaner	*Bulk*	*$0.003*	*$0.004*	*-23%*
Household Cleaner	*Bulk*	*$0.004*	*$0.005*	*-20*
	Concentrated	*$0.09*	*$0.005*	*1,651%*
	Refillable	*$0.01*	*$0.005*	*194%*
Laundry Detergent	*Alternative Material*	*$0.25*	*$0.24*	*4.2%*
	Concentrated	*$0.02*	*$0.24*	*-91%*

These bulk products (floor cleaner, glass cleaner, and household cleaner) tended to be cheaper per unit than their single-use plastic competitors. Concentrated items were less consistent in terms of price per unit across product categories. Household cleaner concentrate was 1,651% more expensive per unit than regular plastic household cleaner options, and laundry detergent concentrate was cheaper (-91%) than usual plastic laundry detergent products.

In personal care items (Table 12), all hand soap alternatives - bulk, concentrated, and refillable - tended to be cheaper per unit than single-use plastic hand soap products. Compostable toothbrushes were over 300% more expensive than plastic toothbrushes and were only offered at a natural foods store. Similarly, the reusable swab was documented as being over 300,000% more expensive per unit than regular single-use swabs, and this alternative was also only sold at a natural foods store. While this suggests that personal item alternatives tend to be more expensive per unit, there may also be a discrepancy in where these products are sold.

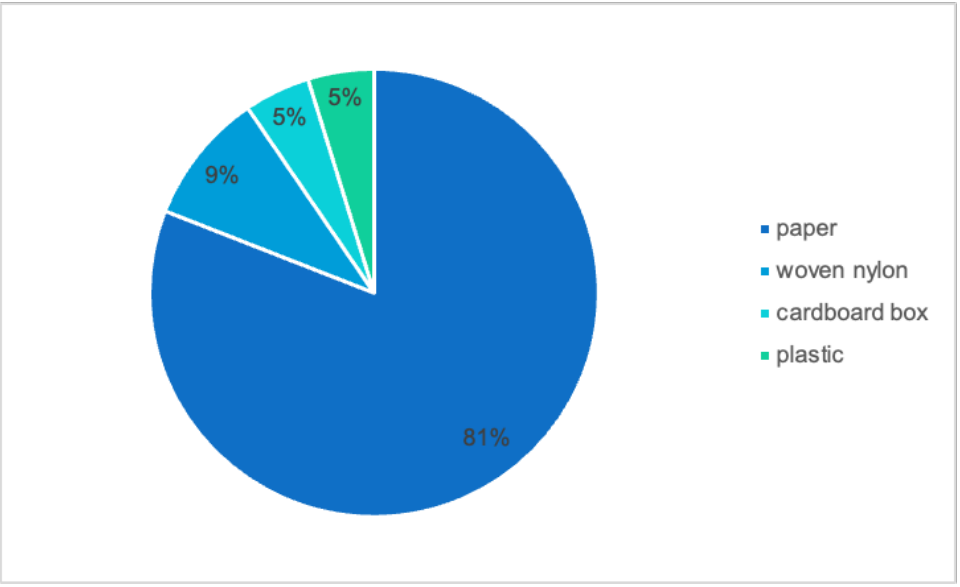
Table 12: Personal care items

Product	***Alternative Type***	***Avg. Cost of Alternative ($/unit)***	***Avg. Cost of Plastic or Similar ($/unit)***	***Avg. Cost Difference for Alternative (%)***
Toothbrush	*Compostable*	*$4.99*	*$1.19*	*319%*
Floss	*Alternative Material*	*$0.22*	*$0.14*	*54%*
Hand Soaps	*Bulk*	*$0.0096*	*$0.01*	*-30%*
	Concentrated	*$0.007*	*$0.01*	*-33%*
	Refillable	*$0.01*	*$0.01*	*-28%*
Reusable Swab	*Reusable*	*$14.39*	*$0.005*	*300,946%*

Within the last 10 years, the County of Hawaii instituted a plastic bag reduction ordinance, following growing concerns over the item's effect on marine life and environmental pollution (County of Hawaii DEM 2024). The aim of this ordinance is to reduce the use of plastic bags in various check out scenarios and to subsequently encourage increased use of reusable bags (County of Hawaii DEM 2023). Phase I of this ordinance began in early 2013, which stated that businesses may provide plastic bags to customers for a fee that is to be determined by each business. The plastic bags permissible under Phase I include plastic bags without handles, such as the ones used for meat, seafood, deli foods, and fruits and vegetables, as well as plastic bags used for smaller items such as ribbon, beads, jewelry, and small hardware items (County of Hawaii DEM 2023).

In early 2014, Phase II of this ordinance went into effect, and businesses were no longer allowed to offer single-use plastic bags at all (County of Hawaii DEM 2023). This ordinance is reflected in the data collected in stores and restaurants. In store surveys, 13 stores offered reusable bags, while 8 stores didn't offer reusable bags. Alternatives to single-use plastic bags found in stores are shown in Figure 10. Of the reusable bags offered, 23 cloth bags were sampled, with an average cost of $5.23. The pricing of 4 woven thick plastic reusable bags were on average less than half the price of the cloth bags, with an average cost of $2.01.

Figure 10: Single-use plastic bag alternatives available in stores



Although reusable bags were more common in stores in Hilo than in other locations in the U.S due to the plastic bag reduction ordinance, there have been some unforeseen consequences to those who have to deal with the reusable bags in retail contexts, as described by one interviewee:

> ***"We've been pushing a lot more of the reusable bags. One of the challenges that we do run into is that not everybody keeps their bags as hygienic as possible. So you have a significant amount of the public who shows up to the store with bags that are pretty filthy and milk or blood from things to get on these bags. And if it's a canvas bag, it gets pretty nasty pretty quick. So I think sometimes for our cash wrap stations and our cashiers, you do feel for them that primarily handle that stuff because none of us like unhygienic situations. So yes, the use [of reusable bags] has gone up and we do promote the use of reusable bags. It comes with challenges as well."***
>
> – Grocery Store Representative

Collection

County of Hawaii Solid Waste Division Public Facilities are made up of the West Hawaii Sanitary Landfill, the East Hawaii Reload Facility, and 21 recycling & transfer stations. The County of Hawaii does not provide curbside waste or recycling pickup for businesses or households. If residents don't want to drop off their waste at the local transfer stations, there are private waste haulers available. Municipal waste is accepted at the county transfer stations. Some of these locations accept scrap metal and white goods/appliances, green waste recycling, and drop-off recycling. A map of these facilities is shown in Figure 11 (DEM, "Transfer Station Map" 2023). The nearest facilities to Hilo for waste, recycling, green waste, scrap metal, as well as the South Hilo Landfill (no longer landfilling waste, landfill capped in 2019), are all co-located near each other and shown in Figure 12 (Ref: County ArcGIS). Many of the transfer stations are open daily from 6am to 6pm, however, some are only open 3 days a week. Drop off of other waste streams, like green

waste or scrap metal, are available during fewer hours (e.g., not accepted past 4pm) (Hawaii Zero Waste, 2024). With the closure of the Hilo Landfill in 2019, the county has tried to reduce waste generation and divert as much waste as possible from the landfill through composting and recycling.

Figure 11: Public Facilities: Landfill/Transfer Stations on the Island of Hawaii

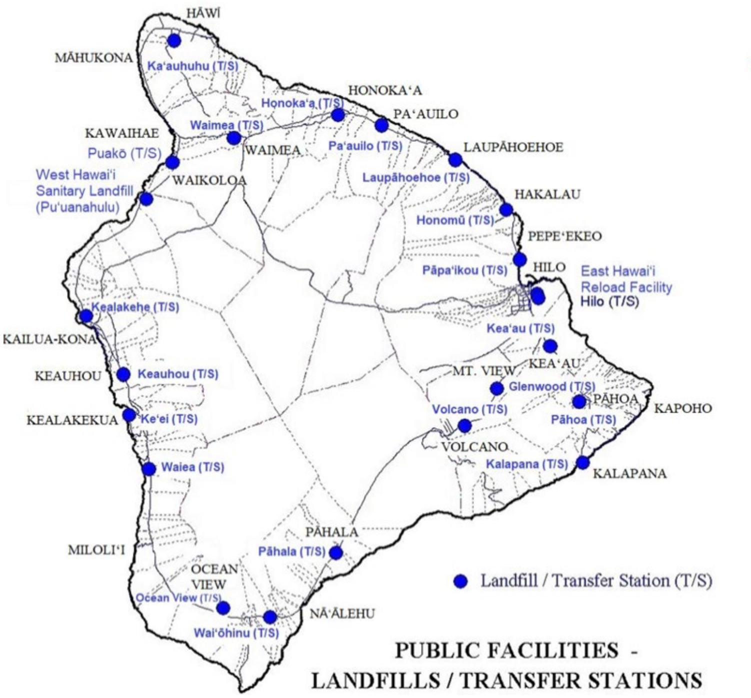


Figure 12: Nearest Waste and Recycling Drop-Off Facilities to Hilo (orange markers)

Recyclable Materials and HI-5 Redemption

Drop off recycling is available for residents of Hawaii County at various county recycling and transfer station locations. Accepted recyclables vary depending on the location, and can include clean corrugated cardboard, brown paper bags, and small non-HI-5 glass containers (DEM "Drop-Off Recycling Program"). Recycling in Hilo and across the Island of Hawaii was a topic frequently mentioned by interviewees. Generally, perceptions of the effectiveness of recycling in Hilo were mixed. Some interviewees mentioned skepticism and rumors about whether recyclables were actually being recycled by the county:

> ***"Correct me if I'm wrong, but I don't think the county's even recycling anymore. They're just trashing it. So you train the generation right to separate out the sevens from the fives, but the county's not recycling it because there's no market for it in China anymore."***
>
> – Grocery Store Representative

> ***"I heard from reliable sources that recycling [at the drop off stations] does not even happen. I stopped recycling at home because of it. If there was a good recycling program, we would jump on board."***
>
> – Local Business Representative

Other interviewees mentioned price and contamination as factors that complicate recycling efforts:

> ***"Glass recycling at the transfer station is often contaminated with ceramic dishes."***
>
> – Local Business Representative

> ***"We have to buy glass and then ship it back to the mainland to recycle it; it costs $20 to ship it back and $2 to recycle it."***
>
> – Grocery Store Representative

As referenced in the accepted recyclable materials list, the State of Hawaii has the Hawaii Deposit Beverage Container Program (HI-5). Each qualified beverage container can be brought to any of the 15 certified HI-5 redemption centers on the island, where residents can receive 5 cents for every bottle that is returned (DEM "Drop-Off Recycling Program"). Metal, glass, and plastic bottles can be identified as a part of this program by the "HI-5" label affixed to the bottle.

Some interviewees vocalized their frustration with the general public's misunderstanding of the HI-5 program; although many believe it is a recycling program, it actually functions as a redemption program. Some interviewees shared critiques or concerns about the effectiveness this program, shown below:

> ***"Hi-5 is promoted as a recycling program, but it is not recycling: it is a collection and redemption program. A lot of people think when they drop their HI-5 stuff off it is being recycled and a lot of times it's not. No one really gets into where those containers go after***

> ***they get to the recyclers. I am willing to bet those plastics go wherever. At best, plastic gets recycled a few times and then gets downcycled into PPE and then ends up as microplastics."***
>
> – NGO Representative

> ***"The state had a plastic bottle bill passed years ago, but I think it is not doing what it was intended to do. The idea was that everybody would get a rebate if they brought back their plastic bottles, but I am pretty sure lots of bottles are just going into the waste stream."***
>
> – State Representative

Education and outreach were also mentioned as an issue within the HI-5 program:

> ***"HI-5 was successful but then the state cut their education and outreach budget. Redemption went down significantly. This is now the biggest challenge."***
>
> – Local Recycling Representative

> ***"There's an education gap in terms of people not cleaning the HI-5 containers before redemption."***
>
> – Local Recycling Center Representative

Interviewees voiced concerns over the economic aspects of the Hi-5 program, including fraud and a lack of mechanisms for adjusting for inflation costs, which puts a burden on small recycling businesses:

> ***"There's lots of fraud in Hi 5. Lots of over and under reporting. There needs to be accountability to fight fraud."***
>
> – Local Recycling Center Representative

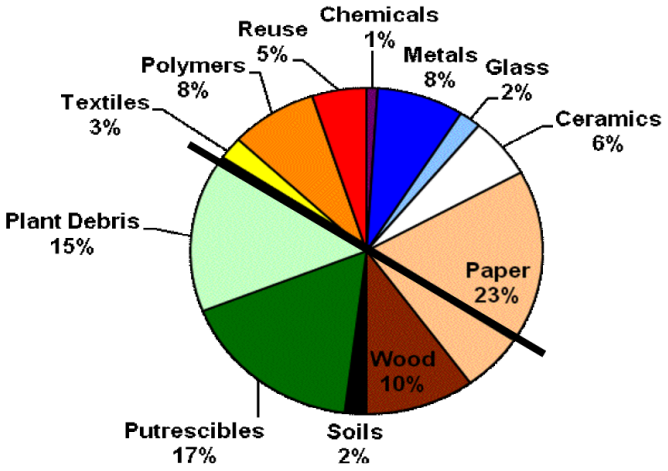
> ***"We are losing money from the Hi-5 program, even though the state provides inflation costs. There is currently no mechanism in place for adjusting fees for cost of living and the cost it takes to run a business. They are raising the minimum wage at the state level, but how are we going to pay for it?"***
>
> – Local Recycling Center Representative

End of Cycle

Waste generated by the city of Hilo is either landfilled, recycled, or composted through the county's green waste recycling drop off program. However, food waste is not accepted. Because of this, some food waste is composted through households, businesses, and schools giving their food waste to local farmers informally. There are no incinerators on the Island of Hawaii. Attempts were made at bringing in an incinerator in 2008-2009 and also 2014, but in both cases, the community members and city commission decided against incineration. In 2009, the County (and Hilo) took a zero-waste approach, with an official Zero Waste Plan published in 2009 (Hawaii Zero Waste Plan, 2009). The county owned and operated

landfill on the west side of the island is where any waste that is not recycled or composted is disposed (Big Island Now, 2014), as the landfill closest to Hilo, the South Hilo Landfill, reached capacity and was closed in 2019 (Watershed Geo, ND). Data from 2008 (Figure 13) showed that about 30% of the materials generated by the County could be composted (Richard Anthony Associates, 2008). The County outlines reduction, reuse, recycling and composting as important actions to divert waste from the landfill.

Figure 13. Waste Characterization in Hawaii County (Richard Anthony Associates, 2008)



The following action items were outlined in the Zero Waste Plan based upon stakeholder input.

1. Producer and Retailer Responsibility
2. Source Separation Ordinance
3. Get Organics Out of the Landfill
4. Construction & Demolition (C&D) Recycling
5. Planning, Zoning, Health and Incentives

These five components each had an associated cost estimate. Some of these actions appear (based upon the findings of this CAP) to have been implemented, at least partially in some cases. For example, green waste composting is available, and there is a Health Ordinance against illegal dumping. Zero Waste is a long-term goal often complicated by both quantity and characterization of waste changing over time. But having zero waste as the overall goal catalyzes creativity and circularity, two things that seem to also resonate with Hilo based upon their culture (see previous Cultural Sections). This sentiment is also expressed by "Recycle Hawaii" on their website with a tagline of "Think Global, Act Island" (Recycle Hawaii, 2024).

Recycling

Hawaii Zero Waste has information available on everything that can be recycled in Hilo (Figure 14). Each section below has more detail for each category of items (when clicked). They also provide "Hoʻopōʻaiapuni" and the Top 10 Reasons to Recycle which include that it is good for the economy, creates jobs and reduces landfilling (Hawaii Zero Waste, 2024). As described in the Collection Section, recycling must be dropped off at transfer stations or picked up by private haulers.

Figure 14. Categories of items accepted for Recycling at Transfer Stations in Hawaii County

HI-5 container redemption centers return the deposits that are paid for each container sold in HI, which is $0.05 per container. When returned for redemption, containers must be clean and empty of free liquids because rates are often paid on weight instead of counts (although customers can request a count if they think it is needed for non-standard sized containers). Any container marked with the HI 5¢ can be returned for redemption. According to Atlas Recycling, the following prices are paid as posted on their website: Aluminum cans: $1.60 per pound, Small plastic containers (17 oz or less): $1.315 per pound, Mixed plastic containers (over 17 oz): $0.94 per pound, Glass: $0.12 per pound, Bimetal cans: $0.295 per pound (Atlas Recycling 2025).

Composting

Composting is available at some green waste drop-off sites around the County (co-located with some transfer stations). While the green waste recycling program expanded in 2013, it only accepts the following materials currently: palm fronds (may exceed 3-foot length), leaves, tree, shrubs, bush and hedge cuttings, grass clippings, untreated and unpainted wood pallets, and small logs and branches. Food scraps, food waste, and compostable products are not accepted (Zero Waste Hawaii, 2024). Composting infrastructure as well as compostable materials were also mentioned by interviewees. Prominent concerns among interviewees include a lack of composting infrastructure, fluctuations in demand for compostables, having the appropriate knowledge and training, and navigating legal and regulatory gray areas:

> ***"As a state, we are being told to shift to composting, but there is no composting infrastructure."***
>
> – Local Recycling Center Representative

> ***"There needs to be some education around how compostables are an illusion."***
>
> – Grocery Store Representative

> ***"We've switched to some compostable items and corn based items, but then you go back to the subject of, 'hey, show me in the county of Hawaii where there's a compostable site.' So we're adding costs for consumers to businesses to use compostable wear and compostable trays, but there's no composting site. So it doesn't necessarily make total sense there. And***

> ***so we get it as an organization. We understand the importance of climate change and sea level rise. We get it. We also understand some of the complexities."***
>
> – Grocery Store Representative

> ***"I think the pandemic created huge variations in demand and usage. Sometimes I can't keep [compostable plastics] in stock, and sometimes I'm holding it for six months. So the demand and supply is broken… I think there's overstocking and understocking going on because our customers, the stores, and the distributors don't know how much they need to carry."***
>
> – Compostable Foodware Representative

> ***"Hilo is perfect for composting -- the moisture, the temperature -- the problem is having enough people who know what they are doing. We get a lot of people who are partially into permaculture with not a lot of resources, training, oversight, training, etc…necessary to go bigger than a backyard compost scale."***
>
> – Composting Expert

> ***"For processing and distributing compost, there is a legal gray area. There is no market standard for locally processed compost."***
>
> – Composting Expert

> ***"There is one state health department for all the counties and islands with different standards, and it is based in Oahu. It is difficult to get inspected to operate."***
>
> – Composting Expert

One interviewee who picks up slop from local schools to feed their pigs went a step further, commenting on how inequality can be seen via compost materials:

> ***"We pick up slop from schools. Slop is fresh food, cafeteria food, and produce that doesn't get eaten. You can see privilege in their slop. [The more well funded schools] have whole foods and some cooked foods, with the occasional stainless steel forks and knives. The Keaukaha school has plastic, fruit cups, plastic cutlery. We do our best to remove plastics from the slop so that the pigs do not choke at night."***
>
> – Local Farmer

Some interviewees vocalized their frustrations with compostable materials, which have become more prevalent in response to the state-wide plastic bag and styrofoam bans:

> ***"Plastic and styrofoam ban created a market for different types of plastics, specifically compostable plastics. We do not have the infrastructure for it. I used to think being zero waste was too radical -- there was no way to stop plastics completely. But now I think the only way forward is to cut it off at the source. What we learned from that is if you shut off***

> ***one market, you have to be intentional about it and make sure the same people are not getting involved again."***
>
> – Artist

A couple interviewees spoke about how the price differences between compostable plastics and traditional plastics presents an issue:

> ***"Alternatives cost more money - but isn't it better to have a clean environment? It's an artificially cheaper cost of living. We're passing it off to our grandkids to clean up our mess."***
>
> – Grocery Store Representative

> ***"When you're telling somebody [compostable plastics] are three times more expensive and it doesn't work quite as well, it's a hard sell."***
>
> – Compostable Foodware Representative

> ***"At first, there was some resistance [to switching to compostables] because compostables were perceived as dirty, but now they are less spillable. There is less of a price differential between compostables and plastics because now they are more widely distributed. Now it's less of a price premium."***
>
> – Grocery Store Representative

Other interviewees, mostly grocery store representatives, mentioned how compostable materials tend to interact with Hawaii's climate:

> ***"What makes compostable also really difficult is it tends to melt and warp at about 110 degrees. Being in Hawaii early on when compostables started to pick up maybe 10 years ago, a lot of our suppliers didn't have the proper warehouse to store them and we didn't have that either. So it would come in and then it would warp over time [because of the climate and temperature]…It's really difficult to get compostables to work here in Hawaii. It seems like they credit us what they can, but that only increases the price that they sell it to us by. That's a lot of loss. It's quite difficult."***
>
> – Grocery Store Representative

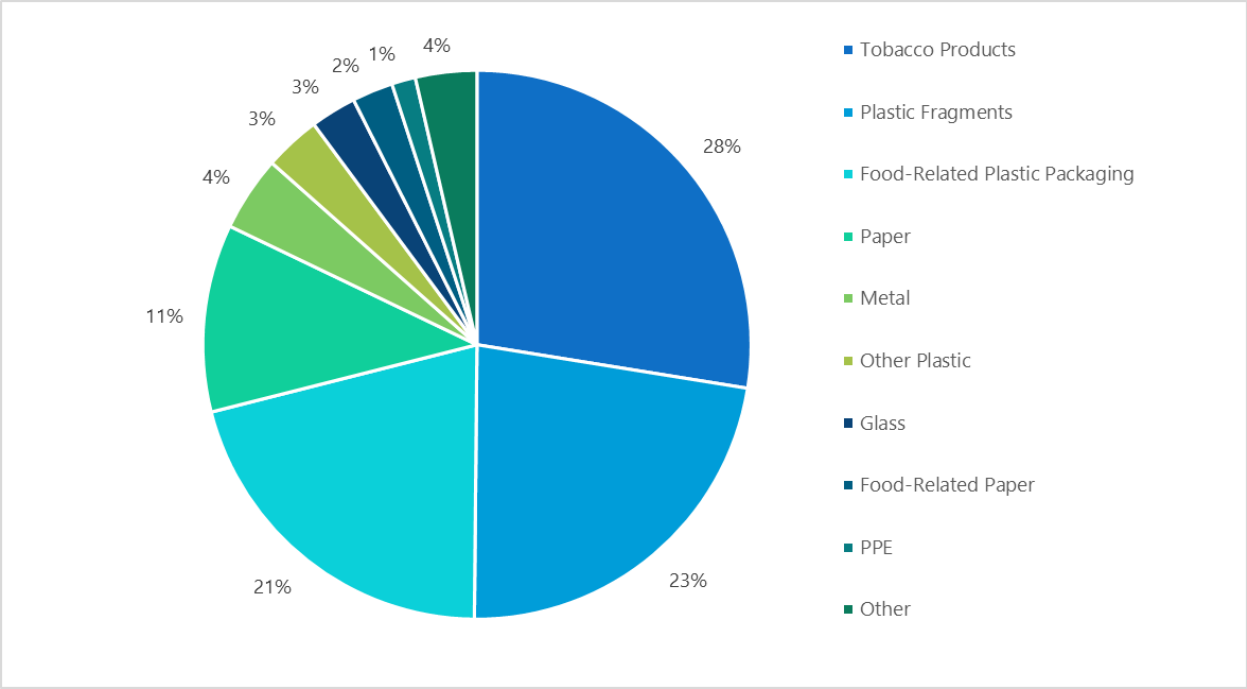
> ***It's a little difficult because even with different bamboo or paper wear, it depends on what goes into it. They don't hold grease or oils very well. Hawaii is really big on rice and the rice gets stuck to the container, so it just makes the customers upset. We're trying many different things. It just doesn't seem like the material technology is there yet. Yeah, it's hard. And if they do make it stick free, like a certain cup, they're probably lined with some kind of plastic liner, so that defeats the purpose."***
>
> – Grocery Store Representative

Leakage

A spatially stratified random sampling method generated survey areas for conducting transects, which were selected within nine 1-square kilometer areas and were distributed across three groups of population count (upper, middle, lower) across Hilo. This ambient population was based on the Oak Ridge National Laboratory's LandScan global ambient population data for 2021 (Sims et al. 2022). Litter items were recorded using the open-source Debris Tracker mobile application ('app') (Jambeck and Johnsen 2015). A full list of items available in the app and their associated material categories can be found in the Appendix. Litter was examined based on abundance, proportion of material and product types, and product densities across all transects and aggregated across the three population groupings.

In total, 995 litter items were recorded across twenty-seven 100 m^2 transects in nine different square kilometer areas sampled in August 2023. Across all surveyed transects, tobacco products and plastic fragments were the most prevalent litter item by item type, together representing 50% of all items recorded. The third largest category was plastic food packaging (21%) followed by paper (11%), and metal (4%). and other plastics (3%). The remaining categories represented 3% or less of all litter items (Figure 15).

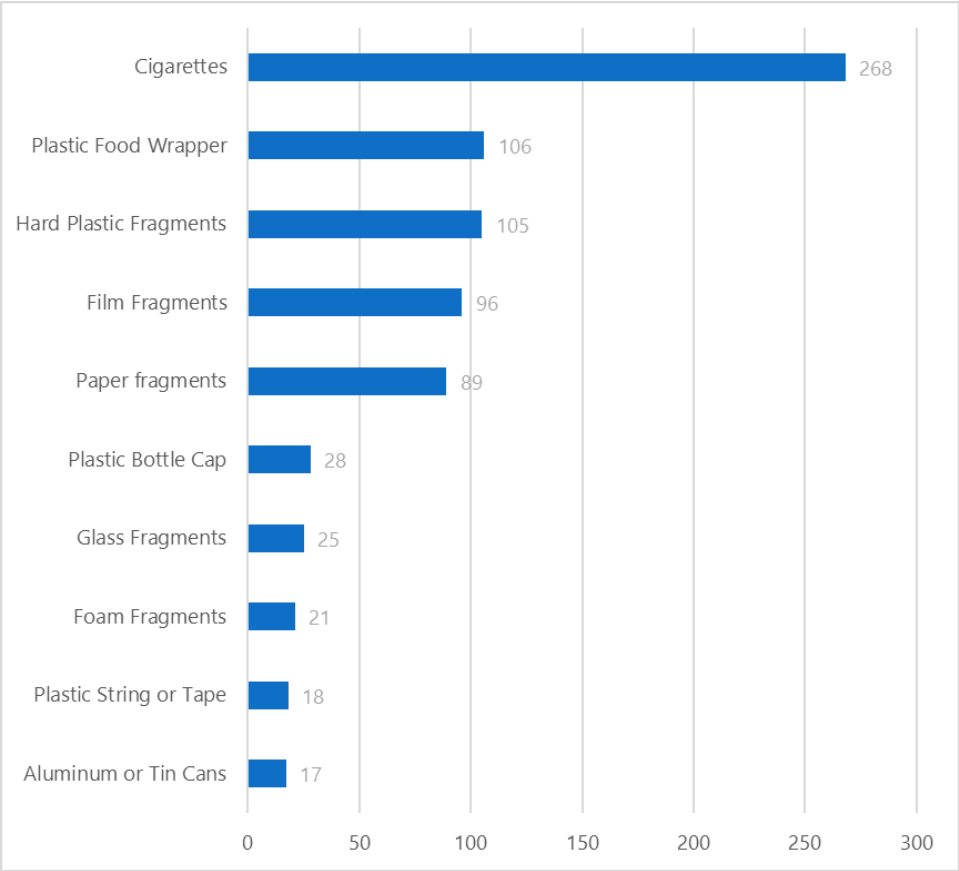
Figure 15: Litter Material Breakdown



The top 10 litter items (Figure 16) had cigarettes at the top. Cigarettes are often misconstrued as 100% paper, but the filters are plastic (cellulose acetate). Plastic food wrappers were the second most documented litter item, which is common to see since they have no value at end-of-life and as a lightweight film are often lost to the environment. Hard plastic fragments were also prevalent, but by the time a litter item has fragmented in the environment, it is difficult to discern what that item initially was. This indicates that these items have been in the environment long enough to break into smaller pieces

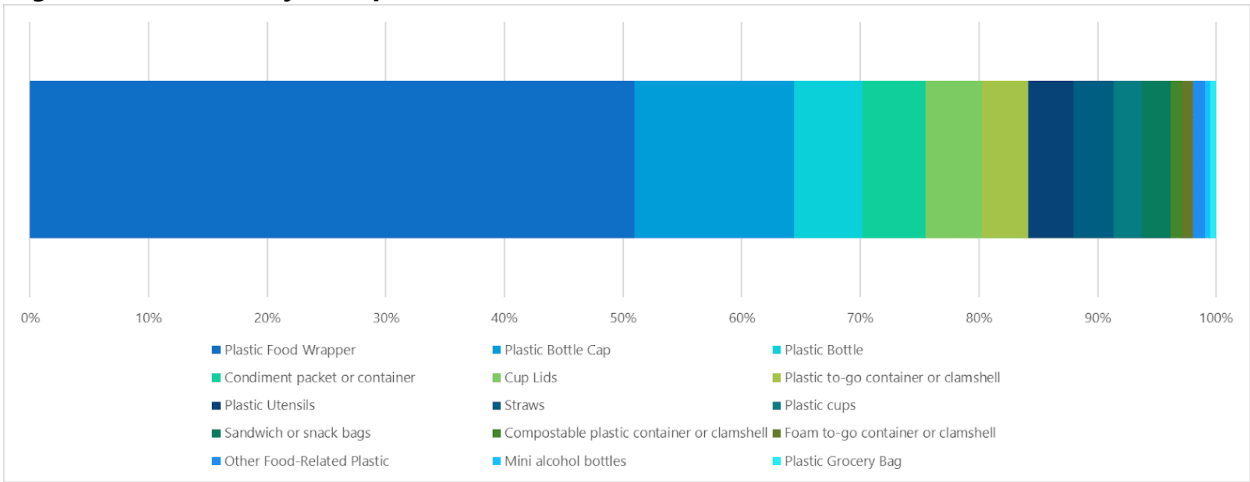
from weathering (this might not take very long in the Hawaii hot sun and weather). Film, paper, glass, and foam fragments were also documented, suggesting that some of these materials are not being captured in current waste management and recycling systems. Plastic string in the top 10 litter is relatively uncommon and may be from local recreation and/or fishing activities. Plastic bottles, often found in other CAP top 10 items, were absent, while aluminum cans were number 10 and plastic bottle caps number 6. The lack of containers in the top 10 (other than cans at number 10), indicates the HI-5 redemption program works (although some caps are lost). Besides people taking the containers to redemption centers, there is a market for those in poverty and unhoused residents to collect bottles to redeem for a small amount of income. These activities would reduce plastic bottles found in the litter.

Figure 16: Litter survey top 10 litter items



When looking at food plastic only (Figure 17, 21% of the litter) the most common food plastics found in the transects include plastic food wrappers (50% by count), plastic bottle caps (15% by count), and plastic bottles (5% by count). Common food packaging like candy and chip wrappers are not recyclable, are lightweight, and are most common for goods that originate outside of the community. Plastic bottle caps frequency in the litter is higher than plastic bottles likely because they must be removed from plastic bottles before the bottle is redeemed for money through the HI-5 redemption program. In addition, caps are not collected for separate recycling in Hawaii County (County of Hawaii DEM 2024).

Figure 17: Litter survey food plastics breakdown



When aggregated across all surveys, Hilo has an average litter density of 0.27 items per square meter with cigarettes being the top litter item. The lowest litter density was found in the middle population tertile, 0.17 items/m^2. The highest litter density was found in the upper population tertile, 0.37 items/m^2 (Table 13).

Table 13: Top litter items and litter densities for population tertiles in Hilo

Population Tertile	Top 5 Litter Items	Litter Density (count/m^2)
Upper	1. Cigarettes 2. Plastic Food Wrappers 3. Hard Plastic Fragments 4. Paper Fragments 5. Film Fragments	0.37
Middle	1. Cigarettes 2. Hard Plastic Fragments 3. Plastic Food Wrapper 4. Paper Fragments 5. Film Fragments	0.17
Lower	1. Cigarettes 2. Film Fragments 3. Paper Fragments 4. Hard Plastic Fragments 5. Plastic Food Wrappers	0.25

Cigarettes dominated the top items in each tertile, but the amount of food wrappers varied across tertiles. Infrastructure impacts overall litter leakage across the tertiles. The lowest litter density average in the middle tertile could mean that infrastructure is optimized based upon the overall population count. Often, the low population tertile lacks adequate infrastructure because localities are less likely to offer waste management services in areas that house fewer people. In contrast, high population tertiles can sometimes have a high litter density regardless of their infrastructure, as societal activity in these areas can lead to more leakage, especially when these areas are frequented by tourists. At the time of litter data collection, seasonality and tourist numbers could have impacted the amount of litter found. If data was collected at a different time in the future, the variation in litter densities between the three population tertiles may be different.

When compared to other US Cities, Hilo has a lower average litter density when looking at Miami (also a tourist destination), where the average litter density was 2.58 items/m^2. Hilo also has lower average litter density than Minneapolis, Minnesota (0.68 items/m^2); Cape Girardeau, Missouri (0.55 items/m^2); Blytheville, Arkansas (0.77 items/m^2); Vicksburg, Mississippi (1.1 items/m^2); Athens, Georgia (1.2 items/m^2); and Atlanta, Georgia (1.14 items/m^2). The lower density could be from many reasons including the HI-5 redemption, expanded polystyrene ban, as well as the Native Hawaiian cultural values of "mālama ka ‘aina".

Hawaii is in a unique geographical situation with its placement in the Pacific, so marine debris and plastics often wash up on shore. While the CAP does not measure litter or debris on coastlines, we want to call attention to this issue and removal available for marine debris from the State Department of Natural Resources. Hawaii also has a Trash Free Hawaii Campaign addressing stormwater protection and trash leakage prevention, as well as a State of Hawaii Department of Health Notice on Illegal Dumping requiring residents and businesses to manage their waste in permitted and regulated facilities (https://www.hawaiizerowaste.org/info/illegal-dumping/).

Opportunities

CIL found the following opportunities to expand and enhance circularity in Hilo, Hawaii, based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model. Stakeholder engagement with the partners of this project can further expand, refine and prioritize these opportunities based on local context, impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions do not happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

Input

- Given that there are similarities between the locations of both the parent company and the manufacturer locations for products sold in Hilo, there is an opportunity to begin looking into various extended producer responsibility (EPR) models.

    - There is an opportunity for Hilo leaders and residents to engage in conversations with local manufacturers and parent companies to initiate discussions on Extended Producer Responsibility (EPR). Of the most frequent states cited for manufacturing, California is a state with an existing EPR policy.

- With numerous parent companies and manufacturers located in the contiguous US, as well as a majority of the five top parent companies being domestic, there is an opportunity to engage with parent companies about changes in packaging materials.

Community

- Interviewees are very concerned with fortifying Native Hawaiian communities, including land back (i.e., returning control and stewardship of Hawaiian land to Native Hawaiians), healing community bonds, and passing down Indigenous beliefs and knowledge systems. Circularity efforts should be viewed through this lens to ensure sustainability efforts align with community goals.
- Interviewees felt that having awareness and education being built into community activities, festivals, etc., could be beneficial, as these spaces are intergenerational and present an opportunity for education to center around family and community, rather than just individuals. This effort could link environmental justice issues in other places to what is occurring in Hilo and Hawaii more broadly.
- While tourism remains an opportunity and a challenge, visitors could be made aware of the local culture around circularity and protection of the environment through outreach campaigns, proper signage at hotels, restaurants, businesses, etc.
- Using the Kumu Honua Mauli Ola Educational Philosophy Statement as a model, the following suggestions have been aggregated from interviewees:
    - Self & Family: personal development, healing wounds that keep us from trusting each other and asking for help, building capacity in the home - taking care of ourselves so we show up optimally to the work we do, making sustainable lifestyle choices when convenient, building capacity for when not convenient, making a personal commitment to "try" and be more mindful of green habits and holistic health.
    - Community: collaborating with members of the community: other families, farmers, food producers, and folks with resources, knowledge, and skills to share. Collective brainstorming to think through waste reduction, reuse, and recycling. Developing more opportunities to learn about bioplastics, "throw away" culture shifting to shared resources, bartering, repurposing, and reuse. The restoration of political and holistic (food) sovereignty.
    - Governance and Outside Communities: Experiencing sustainable initiatives in other states/communities that may be adapted for Hilo, learning to become civically engaged and provide testimony in support/opposition of bills, supporting interested community members to run for office, and make meaningful changes to policy.

Product Design

- For packaging that cannot be recycled (e.g., multilayer film plastic), there is an opportunity to talk with companies to discuss product design.
- Reuse and refillable alternative packaging would reduce material use and waste generation at stores and restaurants.
- There was a wide variety of to-go materials offered across the restaurants sampled. There is an opportunity to outline the types of materials restaurant owners could use as alternatives, in addition to providing financial and/or tax incentives for compliance.
- Additionally, a directory of suppliers that offer alternative to-go ware materials may be helpful for restaurant owners.

Use

- Refillable alternatives (25% of sampled products) indicate a market present in Hilo that can expand in the future. Refillable products are a form of source reduction, increasing circularity.
- Reusable foodware would reduce material use and waste generation from restaurants and increase circularity.
- Having state-level regulations around what certain terms mean (such as “degradable,” “biodegradable,” “compostable”, etc.), as well as regulations around those products’ certifications, could help alleviate any confusion that consumers may have.
- Public awareness campaigns on how to make consumer purchasing decisions when faced with various labels and designations may help consumers to make more informed choices.
- Interviewees mentioned issues with people cleaning their soiled reusable bags in grocery stores. There may be an opportunity to invest in education around reusable bag sanitation, utilizing existing resources in the community, such as the Nutrition Education for Wellness Program of the University of Hawaii Cooperative Extension Service.

Collection

- There’s an opportunity to increase composting collection to match the compostable products being sold in stores.

- Tourists could be a source of funding through a "green" fee or tourist tax to help fund waste management collection and infrastructure.

End of Cycle

- Although there is a variety of "compostable" products offered in stores throughout Hilo, there is no industrial composting infrastructure to accommodate these products at their end of cycle. There is an opportunity to expand industrial composting infrastructure in Hilo.
- Food waste is not currently accepted in the county's green waste program, yet many residents, businesses, and schools informally donate their food scraps to local farmers, so creating a directory of local farmers in need of food scraps could help keep food waste circular within the community, while maintaining the informal nature of this practice.

Leakage

- The HI-5 program has created a market for bottles, and this program has seemed to reduce the number of plastic bottles and other containers in the environment. It may be beneficial to expand this deposit system to include other materials or keep financial incentives at the heart of any future efforts, as these aspects of the program seem to be working.
- The plastic bag policy or other regulations around single-use plastic items can help keep these items out of use and out of the environment, promoting circularity.
- Plastic bottle caps can be lost from bottles and cannot be recycled separately. Bottles could have tethered caps, similar to what is required in the European Union (EU).
- Collecting data and monitoring trends over time can provide insight into waste patterns, community needs, and the effectiveness of interventions. With continued litter monitoring in selected locations, the county may be able to identify innovative ways to prevent and abate litter in the community.
- Cigarettes are the top litter item, which could be addressed through education campaigns, litter violation enforcement, and the expansion of cigarette collection receptacles in the city. There is currently no local recycling market for cigarettes in Hilo.

Glossary

CAP: Circularity Assessment Protocol

CIL: Circularity Informatics Lab

EPR: Extended Producer Responsibility

EPS: Expanded polystyrene

FMCG: Fast moving consumer goods

HDPE: high density polyethylene

MSW: municipal solid waste

PET: polyethylene terephthalate

PP: polypropylene

SUP: single-use plastic

UGA: University of Georgia

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Appendix

Table A1: Full List of Debris Tracker Litter Items and Associated Material Categories

Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Towels or rags Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Wire Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope
Glass	Glass Bottle Glass or Ceramic Fragments Other Glass
Metal	Aluminum Foil Aluminum or Tin Cans Foil to-go container

	Metal Bottle Caps or Tabs Metal Fragments Other Metal
Organic Waste	Food Waste Other Organic Waste
Other	Other Popsicle or lollipop Stick
Other Plastic Products	Bulk Bags Flip Flops or shoes Plastic String, Tape, or Packing Straps Rubber Bands Trash bag Tires Balloons Plastic toys or balls Car Parts Hard plastic jugs or containers Other Plastic
Food-Related Paper	Paper cups Paper food box or container Paper plates or bowls Compostable paper cups Paper food wrapper Compostable food box or container Napkins Other Food-Related paper

Paper	Office paper and newspaper Tags, tickets, and receipts Corrugated Cardboard Paper fragments Other Paper
Personal Care Products	Blister Pack or other pill packaging Cotton Buds Ear plugs Personal Care Product Sachet or packet Toothbrushes Toothpaste or Other Product Tube Flossers Feminine products Needles and syringes Other Personal Care Product
Food-related plastic	Foam cups Plastic cups Compostable plastic cups Cup Lids Plastic Bottle Aseptic cartons Mini alcohol bottles Plastic Bottle Cap Plastic Food Wrapper Condiment packet or container Plastic Grocery Bag Sandwich or snack bags Plastic Utensils

	Straws Foam to-go container or clamshell Plastic to-go container or clamshell Compostable plastic container or clamshell Other Food-Related Plastic
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Rubber/ tire fragments Other Fragments
PPE	Disinfectant Wipes Disposable Gloves Face Masks Other PPE
Tobacco Products	Cigarette Packaging Cigarettes Tobacco Sachets or packets E-cigarettes and vaping Plastic cigar/cigarillo tips Lighters Cannabis-related waste Other Tobacco Product