Piko A, Piko O, Piko I: Those That Came Before, Those That are Here Now, and Those That Will Come After

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What if the fastest road to the future has to do with slowing down and looking at—and *tasting*—where we've already been? Indigenous peoples who live in symbiosis with the natural systems that surround them have developed a unique and deep-rooted awareness of the connection between people, place, and practice. This awareness influences the shape and function of their societies, which in turn can reveal other ways of knowledge-making, offering alternatives to the anthropocentric view endemic in science today. In this conversation, Ahilapalapa and Kiana explore other cultural models and approaches to ecological understandings that expand biodesign, sending it in new, sustainable directions.

Ahilapalapa Rands: I'm not directly working in the field of biodesign, so much of this conversation is really new to me. The places where my practice does intersect with *other biological futures* is through my *moʻo kūʻauhau* (genealogy) as an indigenous woman, and my work as an artist and activist. There are critical issues to address in biodesign, of biopiracy and biocolonialism of indigenous peoples. As a byproduct of the colonial project, biopiracy operates through further extraction and mining of our (indigenous peoples') knowledges of the natural world. I love the optimism and innovation of biodesign, but I remain unconvinced that we can innovate ourselves out of the current crisis without actually addressing intersectional issues of oppression. Within the wider system of capitalism, innovation to advance individualistic consumerism is always going to disenfranchise source communities and break apart the relationships that make truly sustainable innovation function in the first place.

Kiana Frank: That's a really important lens that we bring to this discussion about biodesign. Ever since first contact, Western society has stolen and capitalized on indigenous ecological knowledge—converting traditional medicinal herbs into pharmaceutical cash crops, exploiting once-sustainable marine ecosystems for commercial profit, diverting isolated water holes for agricultural expansion, not to mention appropriating values and traditions within the arts—without appropriate acknowledgement or restitution. These injustices need to be acknowledged and rectified before we can actually innovate to move forward, or we will continue to repeat the mistakes of our predecessors.

Innovation can be defined as the process of generating and translating ideas into tangible applications for enhanced societal well-being. However, the concept of innovation we are speaking to here expands beyond standard business sector definitions, where the value of innovation is only measured against profit margins and monetary gain. Our concept of innovation and biodesign inherently conforms to our indigenous worldview and sociocultural perspective because we have grown up deeply connected to our places and have developed an awareness of how relationships between people, place, and practice influence the shape and function of our society. Innovation to us doesn't necessarily mean creating or developing something brand new, rather it translates, and/or restores something ancient into the twenty-first century in a way that is aligned with the values and the cultural history of the people and the place. The same goes for my thinking about biodesign: It's not necessarily about engineering a new bio-inspired solution to solve our array of global challenges, but rather it's using the advances in technologies to better understand the intricacies of our environment, so that we can protect and promote biodiversity and ecological functions and restore resiliency back to our environments.

For example, *kilo*, the practice of observation rooted in the relationship ancient Hawaiians developed with their *ʻāina* (land) and technologies, draws on detailed phenomenological observations of space to manage resources and *ʻāina*. *Kilo* is a deep understanding of life cycles that is passed from one generation to the next. While *kilo* is an ancient practice, it is also the future of indigenous innovation. Through my work as an *ʻāina*-based microbiologist, I realized that the *kilo* metrics that I use do not match the *kilo* metrics of cultural practitioners, creating challenges in interpreting and integrating new knowledge into traditional frameworks. To remedy this situation, I connected with software developers to create *Innovative Iʻa Kilo*, machine learning software that captures and archives video of *iʻa* (fish) swimming through *makahā* (sluice gates of a fishpond) and further identifies patterns to inform management decisions. This project helped innovate the traditional practice of *kilo* by integrating contemporary technologies to enhance the productivity, sustainability, and resilience of our aquacultural resources while also enabling the sharing of *manaʻo* (wisdom) to find connections, relate these observations to past observations in *moʻolelo* (stories), and develop new place-based *moʻolelo* and *mele* (song) to preserve *ʻike* (knowledge) for future generations.

Kiana Frank doing fieldwork in Waimea, Hawaii. Credit: Kiana Frank.

Today we still look to indigenous peoples for innovation, and we should, because they represent proven models of sustainability and resilience and provide a new (but genealogically ancient) epistemology of thought to shape ecologically-driven solutions for a changing planet. But with new knowledge from traditional systems comes *kuleana*—the responsibility and privilege—to utilize specific knowledges and carry them forward through innovation in a *pono* (appropriate) way. Who are not the owners, but the caretakers of knowledge, that pioneer designed biology? Who holds the *kuleana*?

Ahilapalapa: Yes, it seems that biodesign, and Western science generally, compartmentalizes things within controlled experiments. Much of the time, results derived from these tests and developments don't cross over into how it plays out in reality. There are so many factors intersecting with one another that are outside of our ability to measure and account for. We can start to sound really poetic when we're talking about holistic systems and the interconnectedness of everything, but to view the world in this way is actually a pragmatic reality. For example, if you're bringing in a new genetically modified seed, you can't control how that's going to interact with the wider environment. Birds and mice are going to eat it, draw nutrients and material information from it at a cellular level, and excrete it over areas outside of a control zone. The effects of this and other ways of altering biology at this scale are not yet known. It's outside of our ability to control.

Kiana: So how do you think biodesign fits into systems of knowing? How do we think about engineering these new things, while we're also thinking about the symbioses between and across the whole system and in relationship with humans?

Ahilapalapa: My practice as an artist always comes back to being accountable to my ancestors, being accountable to my community, and being accountable to the people who come after me. I think this relationship and sense of responsibility to time plays into the way you work within science.

Kiana: Yes, it's your *Piko* (center, umbilical cord). *Piko A, Piko O, Piko I*: those that came before, those that are here now, and those that will come after. You're always building upon the knowledge that has come before, so you can only innovate as much as you know the framework that has come before. And you're often trying to innovate for the future, but you can only understand the implications within the present. You don't know how things are going to change in the future. You can only anticipate. And you can never truly map all of those interactions because there are lots of interactions that are happening that you can't see. I love the way that you frame it, being accountable to all of these different systems. Where do you see some of the ethical challenges that arise from biodesign?

Ahilapalapa: When we are talking about drawing upon the wealth of knowledge held within indigenous communities and the ways that it is accessed and used for global markets, the ethical dimension is key. Speaking broadly, indigenous peoples have incredible legacies within the field of sustainable biodesign, which I generally define as innovation which works alongside, and in balance with, Earth's natural systems. In 2005 for example, 80 percent of the world's remaining biodiversity was found on the customary lands of indigenous peoples. Historically this has often been misrepresented as wilderness or *terra nullius*, with the environment only flourishing because of a perceived lack of human presence. In actuality, it is the active stewardship of indigenous peoples that cultivates and protects the diversity still present today. The majority of the remaining 200 most biodiverse places on Earth are found in the territories of indigenous peoples. This is the result of a framework for innovation that looks to the human relationship with our lived environment as one of change and reciprocity. Systems such as indigenous methods of agroforestry and permaculture that have been practiced and developed over thousands and in some cases tens of thousands of years of innovation, for example, offer a stark contrast to the notions of separation that drive monocultural, industrial farming practices.

Through the devastating interruption of colonialism and its impact on our peoples, environment, and cultures, indigenous people have persisted, in spite of our being seen as a resource to be taken, used, and discarded. We are some of the most studied and extracted-upon peoples in the world. This is why it is so important to problematize biodesign within the context of ongoing colonialism and capitalism. A level of intersectional analysis is required to be able to assess the complex ways different indigenous peoples are affected by not only this but the wider colonial capitalistic project. There are issues around access, resources, and self-determination in terms of protecting our knowledges and practices from intellectual property theft. In many communities and indigenous nations, this power imbalance is only part of a much larger ongoing colonial project to alienate us from our land, languages, and culture. These are some of the very real issues and barriers we have when trying to safely navigate the terms of collaboration with outside parties looking to develop and transfer localized indigenous knowledge and land-based relationships across to a more globalized marketplace.

Kiana: I think biopiracy and the risk of biocolonization (the extraction of knowledge and biological resources from an indigenous people without compensation) are really important focal points when thinking about the future of biodesign. While Hawaii might be small, it is a bioprospectors' dream come true with around 10,000 endemic species, 11,000 native non-endemic species, and 5,000 non-native species. And as our genetic research techniques become more sophisticated, so does our ability to both exploit and leverage the relationships indigenous people have fostered in their lands to develop new drugs or modify crops to meet food security needs.

For example, in 2002, the University of Hawaii signed an agreement with the American Diversa Corporation [now part of BASF] that "gave Diversa the exclusive right to discover, harvest, and exploit genes from environmental samples collected off of Hawaii's shores in order to develop commercially marketable products." This was in direct violation of the state under the ceded land trust as well as the public trust to protect Native Hawaiian traditional rights and natural and cultural resources. The state legislative regulations related to bioprospecting were at that time nonexistent and remained in their infancy until the establishment of the Nagoya Protocol in 2010 [a supplementary agreement to the United Nations Convention on Biological Diversity that provides the legal framework for the fair and equitable sharing of benefits arising out of the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity].

The Nagoya Protocol not only addresses traditional knowledge associated with genetic resources, but also gives provisions on access, benefit-sharing, and compliance. It also addresses genetic resources where indigenous and local communities have the established right to grant access to them. The Nagoya Protocol acknowledges the relationships based on the assimilation of *kilo* (deep physical observations) over generations, which have enabled indigenous people to intimately understand and conscientiously manage complex and dynamic socio-ecological ecosystems. Safeguarding these relationships and understandings is critical because they have led to innovations that over time best support the productivity of the community.

For example, if we look within the Hawaiian *ahupuaʻa* system (traditional socio-political land parcels running from mountain to sea), we see holistic management of water resources through *ʻauwai* (irrigation channels). These ʻauwai diverted flowing, oxygenated water from streams into extensive upland *loʻi kalo* (traditional flooded agroecosystems), enriching the fluid in nutrients and discharging into *loko iʻa* (fishponds) to promote the growth of *limu* (marine algae and photosynthetic microbes), which supported a thriving aquaculture system. But the *ʻauwai* wasn't developed overnight, and that style of irrigation was only developed because of the relationships and understanding within a place. Initially, *loʻi* were started where there were springs because, "Look, there's water!" But it was eventually observed that the productivity of *kalo* (traditional starch staple crop) in spring-fed *loʻi* was low because they would rot. This is because water that bubbles up out of a rock from a spring tends to have very low oxygen concentrations: Water-rock interactions in the aquifer stripped away most of the oxygen. Even though *kalo* is a plant and it photosynthesizes during the day, it breathes oxygen at night. The spring water thus created an anaerobic environment that favored the growth of microbes that essentially ate the *kalo* (a.k.a. rot). So, based on the *kilo* that developed an understanding of the relationship between water and rock and plant, local managers realized that if the water didn't have oxygen, the plant will do poorly and likely die. They innovated their agricultural design. They developed the *ʻauwai*, which enabled water to flow and mix with the air, and get oxygenated, so now water flows into the *loʻi* to support the growth of the plant.

Degradation of these *ʻauwai* systems over time has diminished the quality of ecosystem services and biological functions that were once supported. Dramatic changes in land use over the last century—namely, shifts in agricultural management practices, the introduction of invasive species, and urban development—have seriously impacted the health and sustainability of our indigenous resources and traditional practices. In 1902, mangrove was introduced to the island of Molokai as a biological control to prevent sedimentation at the coast. Boy, did that backfire! Instead of utilizing a native plant that could serve the same function ecologically, an individual (or group of individuals) without clear understanding of the relationship to and within these places introduced a plant that not only grew incredibly fast, but also had no native predators, forever changing the landscape and connectivity of our traditional spaces.

Invasive mangrove forest at Heʻeia Fishpond. Credit: Kiana Frank

Restoration of these physical systems and management practices, driven through the cultural stewardship by local communities, not only helps reestablish important traditional ecosystem services (like the enrichment of habitat supporting increased biodiversity, and the production of biological resources for human consumption), but also provides additional cultural, ecological, educational, and economic benefits to mitigate contemporary problems like food security and climate change. However, restoration takes time and the process of restoration has become a space for innovation. For one, it will take time for the ecosystem to respond to restoration. If you have an invasive mangrove forest, you can either cut things down with a machete and a chainsaw by hand, or you can bring an excavator. If you cut down things by hand, you allow the ecosystem time to respond and acclimate to those changes gradually. Whereas, if you come in one day and clear-cut the mangrove forest, you now have a beautiful open space of land, but you've also just released however many decades' worth of toxins that were captured by the mangroves into the water system.

And what are we restoring to? Ancient Hawaii? Or some sort of contemporary hybrid that still supports cultural practice but enables other economic or beneficial opportunities? Integration of traditional ecological knowledge with Western science-based approaches—when done appropriately—can help better characterize and contextualize the complexity of the contemporary ecosystem.

Ahilapalapa: It is a complex role, whether held by indigenous groups or indigenous individuals representing indigenous groups. Essentially you are weaving across epistemologies, across worldviews, and importantly, caring for the relationships that exist between the invested parties. For example, many people don't realize that there are many breakdowns and transgressions from Western environmental organizations and indigenous communities. That can be at a grassroots level all the way up to the big NGOs. On paper these two parties should find it easy to work together as the health of the natural world is such a foundational priority for both, but due to Western environmental organizations operating from within a world where the colonial project is ongoing, transgressions are unavoidable, unless they are operating from a deeply decolonial praxis.

This often stems from a lack of understanding of indigenous rights as set out in the United Nations Declaration on the Rights of Indigenous Peoples. This is the most exhaustive international text on the rights of indigenous peoples, and while it has been in the works since 1982, it was only officially adopted in 2007, so there is a big educational need here to develop a basic literacy internationally on how to be in relationship with indigenous peoples. When that work hasn't been done at the organizational level, it leads to a power imbalance with regards to land rights, cultural practices, and food sovereignty. But also, importantly, the indigenous knowledges and stories specific to any given place are ignored, wasting an opportunity for collaboration and a weaving together of expertise. This is where the work of weavers is so vital and multidimensional. Advocacy work, activism, education, arts, and science are all needed here, whether it's about working with environmental groups or anyone else. In my practice, I start with this question of accountability, but that's also partnered with a collaboration and interdisciplinary outcomes. I take a multimedia approach, using video, text, animation and more. I like to keep in mind different levels of engaging with people, the outcomes of which shift for every project. I see parallels with your practice, Kiana, and the way you approach science as an indigenous Hawaiian. How do you engage with these issues as a biologist?

Kiana: I believe that science is an important tool in our community, not only to drive data-based policy but to advance our understanding of our place and how we fit into that place. For me, the process of science—observation and experimentation—is how I connect with my place and my culture. My ancestors were pure scientists: They observed their environment and were proficient in astronomy, physical oceanography, marine biology, aquaculture, agriculture, architecture, and even evolutionary biology. Native Hawaiians constructed subsistence farming to support indigenous crops (e.g. *kalo/taro*) and extensive aquaculture systems (e.g. *loko iʻa*) to cultivate *limu* (seaweed) and herbivorous fish to support thriving local populations across intense geochemical and geomorphological gradients. These integrated biodesigned systems highlight the incredible sophistication of Native Hawaiian land management techniques. I chose a career in research because Hawaii's future requires skilled local and indigenous individuals who can bring contemporary science and technology to bear on problems such as coastal resource management, food security, freshwater management, and alternative energy that reflect the values of our local Hawaiian community.

The specific goal of my research program in my lab, which we called *Nā kilo ao māiki* (observers of the microbial realm), is to better understand how microbes interact with their environment: who they are, what they are doing, and how fast they are doing it. Microbes—unseen but significant organisms—play critical roles in the environment and shape ecosystems along the *ahupuaʻa* from ridge to reef. My research helps to understand the connectivity from microbe to *meaʻai* (food) to promote the restoration and sustainability of Hawaii's agricultural and coastal marine resources. I use contemporary techniques like geochemical and microbial analyses to interpret scientific observations encoded in our *moʻolelo* (stories), enabling our community to build a stronger framework to evaluate overall ecosystem health and inform current monitoring, restoration, cultivation, and management efforts within the *ahupuaʻa*.

To do this properly means cultivating and nurturing my own intimate relationships with the places I study and the people that steward these sites to develop trust and a deeper way of knowing the environment there. It means being present and open to fully experience the *mana* (power) of these *wahi pana* (sacred spaces). It means honoring and respecting these communities by learning the names of their places, such that I can uncover the *kauna* (hidden meaning) embedded in the *moʻolelo* associated with the place.

Our *moʻoloelo*, *mele* (songs) and *oli* (chants) have preserved the scientific integrity of traditional phenomenological observations and remain shockingly consistent with contemporary biogeochemical and geophysical observations. One of my favorite stories, the *moʻolelo* of Meheanu, reflects a deep understanding of the biogeochemical processes within Heʻeia Fishpond. Meheanu is the *kia'i* (guardian) *mo'o* (reptile) *wahine* (woman) of He'eia Fishpond and her duty is to protect the baby fish of the pond and make sure that they are well fed and well taken care of. It is believed that she is physically present at the pond when the *hau* (*Hibiscus tiliaceus*) plants turn yellow: a result of her relieving herself in the water. Consistent with the *mo'olelo*, my work has shown that high concentrations of ammonium (a component of urine) are correlated with the presence of yellow hau leaves in the fishpond. The increase in ammonium concentration is also directly related to the increased activity of microorganisms and shifts in microbial community compositions, because ammonium is the preferred source of nitrogen—an essential nutrient for growth—for phytoplankton. This favors the growth of some of the most abundant bacterial phytoplankton species in the fishpond: *Prochlorococcus* and *Synechococcus,* thought to be one of the preferred food sources of young mullet.

The *moʻo* and *hau* of Heʻeia Fishpond. Credit: Kiana Frank.

Encoded within this simple *moʻolelo* is an intrinsic understanding of the connections between the nitrogen cycle, phytoplankton diversity, and fish productivity with implications for management. My research builds on this foundational understanding of Heʻeia Fishpond and provides a comprehensive assessment of the spatial and temporal variability of biological, physical, and chemical parameters to define what a healthy fishpond ecosystem looks like at a microbial scale and how the ecology responds to climatic forcing.

We're helping to define the most important parameters driving ecologic change to inform monitoring and management practices. These types of datasets can be very valuable to fishpond stewards because climate variability associated with climate change has been linked to the incidence of harmful algal blooms, pathogen outbreaks, and tragic fish kills. Resolving how climate anomalies impact microbial dynamics could provide insight into the contributions of microbial processes to total biological activity in the marine environment, such as food web dynamics in the fishpond. Understanding the core microbiome of a healthy system has implications for biodesign of environmental probiotics to help jumpstart the biocultural restoration of other aquaculture systems.

My practice is grounded in values of *pilina* and *kuleana* (responsibility to engage, to protect, to perpetuate knowledge) specific to the places and communities I am humbled to be a part of. By examining our indigenous stories through scientific lenses, we can begin to decode their multiple layers

of meaning, bridging cultural and historical place-knowledge with contemporary knowledge systems to better understand the insight left to us by our *kupuna* and the relevance of these stories today. This underscores the importance of place-based management strategies in restoration policy and the future of biodesign.

One of the most impactful examples of cultural stewardship and outpouring of community strength on behalf of fishpond restoration (the likes of which had not been seen in over 200 years) was *Pani ka puka* on December 12th, 2015. Over two thousand individuals stood in a human chain stretching a quarter of a mile from the ocean to the fishpond, passing rocks from hand over hand without the material ever touching the ground. Credit: Kiana Frank.

You mentioned the unknown implications of engineered seeds. We have been genetically modifying organisms for centuries, selecting the most advantageous traits to best fit our engineered ecosystems, which happened over time. Modifying the genes of nightshade to a tomato took hundreds of years. Now we can do it overnight. What does that mean for biodesign? More importantly, how will biodesign influence the biodiversity and ecosystem stability of our planet? As we derive new forms of biological entities, specifically tailored to fit society's present needs and fill our current voids, how do we ensure that they integrate positively into our landscape? This brings to mind community ecology competition models of Lotka and Volterra and the Resource-Ratio hypothesis. New biodesigns will likely result in ecological interactions where the use of a resource by one will influence the availability of resources for another in the ecosystem. Given that ecosystems are connected, how will this biodesign change our landscapes?

Ahilapalapa: I can relate to the speed thing, in the sense of how rushed everyone is within a capitalist society, primed to rapidly produce and consume without time to reflect on the implications of that perpetual cycle. As a global society, since we have not aligned our technologies with a defined social code of ethics, we don't actually know how to relate well with these and other technologies. Our bodies are in pain, our necks are getting out of line, and our relationships are suffering because we're not present anymore.

Take virtual reality as an example. It's a useful medium for many indigenous artists due to its expansive nature. It can bring our stories to life. But without a collective understanding or vigorous dialogue, what remains sacred? What are the parameters of engagement with this technology? An example of this is a work from Heiltsuk artist Shawn Hunt, an artist from the Heiltsuk group of tribes in Canada, titled *Transformation Mask*. He's made this big, ceremonial raven mask, held at head height in a gallery. The viewer puts their head into it and it's actually an adapted virtual reality headset. Upon activation, you are brought into a fire ceremony. At first I was thinking, that's amazing that then I thought, "Does that mean anyone can just come and be in ceremony?" And if you are, are there protocols in place for behavioral conduct and intention? And if you aren't, and it's just an empty experiential moment, then does this work actually further dehumanize cultural practices, opening them up for empty consumption and fetishization?

There are all of these different questions emerging as technology develops, and I don't know yet if we are taking enough time to really contend with what it all means. Many of us use art as a vehicle to process the intergenerational trauma of colonization and as ways of reclaiming our spaces and cultural practices. You can move really fast within art-making, but how do we keep the necessary cultural conversations evolving at the same pace as these new technologies and innovations are developing?

This question I raised earlier of "Who am I accountable to?" becomes a useful way of navigating this tension. I'm often working with relationships and perspectives drawn from the necessary dualism that comes with being an indigenous person raised in the West. It can be incredibly productive as you are developing and creating while thinking about different spheres of accountability. Depending on the project, the answer to that question can shift significantly.

Kiana: So, you practice your art through multiple interfaces of different types of worldviews? In a way you could almost think of yourself as the *mailwai* (river mouth), creating at an interface that spans fresh and saltwater, or you could also see yourself at the surface of the ocean, the interface between water and air, full of power and tension to create waves or flow in glassy calm. These are the environmental metaphors of where interfaces actually happen. If you overlay an indigenous lens… I always think about *Haumea* (the Hawaiian goddess of fertility and childbirth), because she's the element of intersection, a force that helps to catalyze interactions and bridges between two things that are not supposed to go together. I work in that realm a lot because I study organisms that bridge aerobic and anaerobic environments. There are so many parallels between my work and your art, and the methodology we use to actually shed light on these intersections.

Documentation of the 'Oceanic Reading Room' with Ahilapalapa Rands in conversation with a local elder in Whitby. Kiana Frank's interview plays in the foreground. Credit: Ahilapalapa Rands.

Ahilapalapa: I think that is definitely where I am heading and have been for a long time, working at the intersection and weaving things together, overlapping things to see what bubbles up. Usually, this is at least in part to do with Pacific and Western understandings of the world. The balance between these two worlds and my primary audience shifts with each project. For example, the *Oceanic Reading Room* I just worked on with you brought Pacific perspectives and histories into a celebration of the eighteenth century British explorer Captain James Cook in the town of Whitby, on the northeast coast of England. The context was hostile as the lack of criticality around Cook meant that we, the people of Oceania, were a footnote in this British man's story of imperial expansion. In this instance it was more of a raw educational project that provided a platform for Pacific voices but was necessarily geared toward educating and sharing with the people of this town in England, where Cook once lived.

Stills taken from "Pacific Perspectives," moving image work as part of the Oceanic Reading Room, 2018, Whitby Library in partnership with Invisible Dust. Credit: Ahilapalapa Rands.

The project *Lift Off* that follows it is completely different. It's exploring speculative futurism through animation and is part of a wider exhibition called *The Commute* at Brisbane's Museum of Contemporary Art in Australia. It's curated by and features indigenous peoples from around the world. In this instance, my primary audience is us: I made it for *Mauna Kea* and *Kanaka Maoli* (indigenous Hawaiians). It feels so special and healing to be in a more generative space where I can actually imagine and build, rather than attempt to redress and educate. And here I am able to tap into indigenous science fiction. What I love about the function of science fiction is that it gives you license to build new futures. Speculative futurism is just what it sounds like: We're given new license to dream and build and create new worlds. This is an inherent toolkit that we, as indigenous peoples, need and already use to resist and flourish within an oppressive and imbalanced reality.

Still taken from the moving image work "Lift Off," 2018, The Commute, MA, Brisbane. Credit: Ahilapalapa Rands.

Kiana: I think that's beautiful, and it aligns with the evolution practice through time we were talking about: to stick with the metaphor, the *mailwai*, where you're butting up against these two different water systems, and there's a little bit of mixing, but it's not controlled. One can easily overpower the other. Normally, the ocean will overpower up the stream, no matter what, and there's an interface. As you're evolving, you're understanding the nuances within this interaction, but taking ownership of it for your people. I see this next phase—perhaps I'm totally metaphorical/taking what I'm hearing—as if you're building a fishpond, so that you can promote the resources, and you can utilize that mixing and control it to build resources and productivity to feed your people.

You're doing such amazing things, and that evolution, we see it in the environment, we see how people are experiencing it. We see it in art. These are the layers that we need to think about, when we think about biodesign, right? There's this need to rustle this interface between biology and all of these design elements, and they're warring with the *mailwai*. But how do we actually make it a pono space, where we can control that and understand, but also flow with both, where you are in a space where you are neither harming the ocean nor the river? Instead, you're creating this beautiful mixing space to be productive for both. Now you can feed your people, now you're seeding the reefs with more fish so that the ocean side is healthy. You're maintaining water quality.

Ahilapalapa: There's a moment when you form the right relationship with a movement, a project, people, and things just start to flow and the idea of collaboration is exciting. But how do you make parameters of engagement that are safe within our current climate? I have no idea. That's the only thing getting in the way of these innovations or making them really extractive and horrible. How do we protect (or in some cases reinstate) self-determination and sovereignty with regards to indigenous epistemologies?

Kiana: I don't know. That's a really large question, above my pay grade! But I feel like it always comes back to *pilina* (relationships). Creating those safe spaces, methodologies, and parameters to actually be productive. Creating balance requires an understanding of the whole system. To do that you have to have those relationships in place.

To follow on from the metaphor of building a fishpond. You have to have the relationships with the people, because they're going to be the labor that will bring the rocks and set them. You have to understand the relationship with place, because not all fishponds are going to be created equally. You need to look at the fringing reef and you need to look at the geography of the area in order to know where you're going to place things. You need to know the relationships of the fish and the moon, and seasons, because that's how you put gates and how you build your gates is going to be dependent on what type of fish you're trying to harvest and their behavioral patterns. Both you and I are trying to show that there are other sides to the story. We have to decolonize those siloed, purely utilitarian aspects of science. There's so much of the intangible here that plays a really big role in understanding the world around you. That's where I think other cultural models are important, because Western models have siloed into technical, specific fields and they're missing all of the interconnection, and the relationship to *ke akua* (the gods) and to all of our ancestors.

Sometimes, you read the stories that our *kupuna* (ancestors) left for us, and you look at their innovating designs and it often makes one wonder, "How did you even know that?" There is a spirit and the sense of our intuition, being guided by your ancestors. It took centuries of modern science innovation to build a fancy machine to land on the same conclusion. I'm not saying that every single one of our lineage had that intuition. That's why we had *Kahuna*, skilled practitioners. We need to see that the poetry and art of indigenous people are really important aspects of biodesign and innovation. It's about seeing the whole story and seeing it through a very enlightened imagination. Art is so important in order to communicate meaning and emotion. A scientific paper can't do that.

Ahilapalapa: I feel like art, or more broadly, creative practice, is key. Both in terms of disrupting the silos of industry between art and science, but also acknowledging the transferable skills that come from nurturing the ability to think creatively, to problem solve, and to communicate ideas in relatable ways.

Kiana: Western science engages your brain, but indigenous science, because it has all of these layers and music and dance, engages your brain, your heart, and your spirit. There're ties to the future through a relationship with the past. If you believe that you are physically related to the Earth, you are more likely to take care of it.

Kiana exploring Kawainui marsh in 1993 on the hunt for *lepo* (ʻai Kea). Credit: Kiana Frank.

When I was a little girl, I grew up in the *ahupuaʻa* of Kailua with my toes in the mud, romping around the wetlands of Kawainui marsh. I loved to get dirty and explore. I was fascinated by the *moʻolelo* of the *lepo* (ʻai ʻa—the edible mud of Kawainui—that fed Kamehameha's brave band of warriors during the battle of ʻNu ʻuanu. My great grandmother would tell me that the *lepo* (*mud*) was just as delicious as the freshest and sweetest *poi* [traditional Hawaiian starch staple made from pounded taro] I had ever tasted, but the only way to harvest it was to be incredibly quiet. If I uttered even a single word, the edible *lepo* would hide from me and never be found. So, with a notebook in one hand and a shovel in the other, I spent many silent summer days tasting a ton of mud! The black mud, the red mud, the green mud, the grey mud; all of which were not delicious.

I wondered why different colored *lepo* smelled and tasted so different? What made the *lepo* edible? I started to hypothesize: Perhaps the *lepo* ʻai ʻia was living, more like a plant or an algae, rather than a mineral? If that was true, what conditions were unique to Kawainui to promote the "growth" of this *lepo* ʻai ʻia here, and only here? It was that line *of inquiry* combined with my deep *kuleana* (responsibility) to *mālama ʻāina* (care for the land) that shaped my career trajectory. When I learned about the amazing world of microbes, my relationship and understanding of that *moʻolelo* and my place grew even deeper. Decades later, I still haven't found the *lepo* ʻai ʻia, but that *moʻolelo* grounds me to my place, my family, and my approach to research, with feet firmly planted in the *ʻāina* (land), eyes looking to the past, a spirit guided by my *kupuna*, a heart full of *aloha*, hands willing to *hana* (work) and a mind ʻ*imi* (*ke kuna* (seeking the source).

Therefore, imagine indigenous biodesign that promotes *other biological futures through the acknowledgement and honor of* those that came before, those that are here now, and those that will come after. *Piko A, Piko O, Piko I.*

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