Interview Synthesis

Voices from the Gulch: Practitioner perspectives and best practices on wildfire mitigation, vegetation management, and erosion control in Hawai‘i’s wet and dry drainages

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Pacific Fire Exchange

Project Contributions

This project was developed and led by the Hawai‘i Wildfire Management Organization (HWMO) through its Wildfire Resilient Landscapes and Pacific Fire Exchange programs, the latter co-led with the University of Hawai‘i at Mānoa. Project conception and leadership were provided by Elizabeth Pickett, with project administration by Andrea “Nani” Barretto. Funding was provided by the Joint Fire Science Program and the State of Hawai‘i DLNR – Division of Forestry and Wildlife. Interviews, site visits, practitioner summaries, and the first draft of the interview synthesis were conducted by Dr. Lisa Gollin. Interview synthesis editing, fact sheet and website development, and facilitation of the associated educational webinar were led by Dr. Sara Gabrielson.

Practitioner contributions were provided by Lance DeSilva (DOFAW DLNR Maui), Paul Higashino (Kaho‘olawe Island Reserve Commission), Joe Imhoff (Skyline Conservation Initiative), Yumi Kam (Wai‘anae Mountains Watershed Partnership), Cheyenne Hiapo Perry (Mauna Kea Watershed Alliance), Willie Rice (Kealakekua Mountain Reserve), Sara Tekula (Kula Community Watershed Alliance), and Amy Tsuneyoshi (Honolulu Board of Water Supply).

What this document is:

This publication is not a technical report or a set of prescriptive guidelines. Instead, it is a practitioner-informed collection of interviews, reflections, and lessons learned from land managers, watershed practitioners, and community leaders actively working in gulches and drainages across Hawai‘i. The content draws directly from managers’ own experiences, challenges, lessons learned, and decision-making processes. It highlights what has worked, what hasn’t, and what remains difficult in wildfire mitigation and restoration efforts in this challenging and common type of terrain. It compiles best practices developed through decades of adaptive management by experienced land managers across the pae ‘āina, with pertinent insights for those managing gulches and drainages throughout the islands.

How the project came about:

This project grew out of a growing number of practitioners entering wildfire mitigation work who are seeking clearer, place-based guidance on addressing wildfire risk in gulches and drainage areas—where steep terrain, water flow, access constraints, and the need to protect riparian and native ecosystems create unique challenges. Minimal documentation captures how managers actually navigate the complex terrain, safety risks, and ecological tradeoffs of working in these environments in Hawai‘i, even though drainage systems cover much of the landscape and channel both water and fire. This effort was designed to surface practitioner knowledge—especially insights often shared informally—so they can inform future planning, collaboration, and community-based action.

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Executive Summary

As wildfire risk continues to increase across Hawai‘i, communities and land managers are implementing vegetation fuels management projects to reduce the likelihood of ignition and rapid fire spread. Drainage features, such as gulches, ravines, and stream channels, present both opportunities and challenges, offering higher moisture, denser canopy, and potential natural fuel breaks, while also containing heavier, more hazardous fuels and posing significant erosion risk, along with access and safety constraints. When unmanaged, these areas can channel and intensify wildfire spread, yet guidance specific to fire risk reduction in and around drainages has been limited or focused primarily on riparian restoration rather than wildfire mitigation.

This report compiles and synthesizes best practices for managing vegetation fuels adjacent to or within drainage features with the goal to reduce wildfire risk while minimizing erosion and unintended treatment impacts. Drawing from seven case studies across the Hawaiian Islands and interviews with experienced practitioners in wildfire risk reduction, watershed protection, erosion control, and restoration, the report highlights real world strategies refined over decades of practice. A central finding is that there is no one-size-fits-all approach. Each drainage system reflects unique combinations of slope, soil, vegetation, hydrology, access, and surrounding land use. Effective management requires site specific decision making, flexibility, and adaptation based on unique site characteristics and observed outcomes.

Although a tailored approach is necessary across Hawai‘i’s diverse landscapes and project goals, several common themes did emerge that provide a useful starting point for action. Successful projects tend to start small, focusing on manageable treatment areas, learning from early results, and scaling up over time with a clear long-term maintenance plan. Phased vegetation treatments combined with erosion control measures such as mulching, wattles, check dams, and waterbars help stabilize soils and reduce downstream impacts. Reseeding strategies often balance fast growing species for immediate stabilization with longer term vegetation goals, including drought tolerant natives where appropriate.

Practitioners stressed realism and harm reduction in plant selection. While restoring native vegetation is an important objective, the complete removal of non-native species is not always feasible in steep or erosion-prone settings. In some cases, the depth and scale of gulches place them beyond conventional vegetation management, reinforcing the need to set clear and realistic objectives, such as targeting specific hazardous species and managing adjacent uplands to reduce fire intensity and ember entry into drainages. The guiding principle of “the right plant for the right place” prioritizes slope stability, flood mitigation, and safety alongside ecological goals. Similarly, many projects aim to reduce reliance on chemical treatments over time, using herbicides selectively and transitioning toward shading, canopy establishment, grazing management, or other techniques to inhibit grass regrowth.

Limited funding, workforce, and equipment are constant constraints. Practitioners often repurpose removed vegetation for erosion control, effectively turning invasive fuels into

stabilization tools. Community engagement emerged as a critical factor in project success. Volunteer participation and local stewardship not only expand capacity in a chronically underfunded sector, but also build long-term local investment and project sustainability.

Together, the case studies underscore that effective fuels management in drainages is as much a social and planning challenge as it is a technical one. Collaboration among landowners, practitioners, agencies, and community members is essential to balancing wildfire risk reduction, erosion control, and ecological integrity. The lessons documented in this report provide a foundation for adapting and scaling these approaches. Managers working across Hawai'i can use these unique case studies and the overarching lessons to guide their own land stewardship. Continued investment in applied research, cross-sector partnerships, and knowledge-sharing will be key to strengthening wildfire resilience while protecting Hawai‘i's natural and cultural landscapes.

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Participants

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Joe Imhoff	SCI
Yumi Miyata	WMWP
Cheyenne Hiapo Perry	MKWA
Willie Rice	KMR
Sara Tekula	KCWA
Amy Tsuneyoshi	BWS

Acronyms

Acronym	Expansion
BWS	Board of Water Supply
DHHL	Department of Hawaiian Home Lands
DLNR	Division of Land and Natural Resources
DoFaW	Division of Forestry and Wildlife
EWPP	Emergency Watershed Protection Program
BWS	Board of Water Supply
HWMO	Hawaii Wildfire Management Organization
KBC	Kanakaleonui Bird Corridor
KCWA	Kula Community Watershed Alliance
KIRC	Kahoʻolawe Island Reserve Commission
KMR	Kealakekua Mountain Reserve
KMWP	Koʻolau Mountains Watershed Partnership
MKWA	Mauna Kea Watershed Alliance
MOU	Memorandum Of Understanding
NRCS	Natural Resources Conservation Service
PFX	Pacific Fire Exchange
SCI	Skyline Conservation Initiative
SME	Subject Matter Expert
UXO	Unexploded Ordnance
WMWP	Waiʻanae Mountains Watershed Partnership
WUI	Wildland Urban Interface

Project Description

Background: As more communities and landowners are working to plan and implement fuels management projects to reduce the risk of wildfire ignition or rapid spread, best practices for managing the areas adjacent to waterway drainages or dry gulches have been limited and/or challenging to track down. Rarely have enough specifics related to a wildfire risk reduction intent, as opposed to riparian restoration, been explored.

Purpose: The purpose of this effort was to compile available best practice information for vegetation fire fuels management that is carried out adjacent to, or inside of, small ravines, gulches, stream channels, and other natural water drainage features to 1) prevent wildfire ignition and rapid spread, 2) minimize erosion and other impacts caused by the vegetation treatment itself.

Methods: A small representative sample of case studies was developed to share techniques and lessons learned from projects across Hawai'i. As part of the Pacific Fire Exchange program, co-led by Hawaii Wildfire Management Organization and University of Hawai'i Mānoa, the lead author conducted semi-structured virtual or in-person field interviews of eight Subject Matter Experts (SMEs). Interviews covered Hawai'i Island (2), O'ahu (2), Maui (2) and Kaho'olawe (1) and focused on wildfire risk reduction, integrated watershed protection, erosion control and restoration. The aim was to capture the challenges, opportunities, and fine-tuned strategies that practitioners have developed in their years of experience. Six of the case studies present the work of long-term projects; the final case study is a snapshot of an emerging restoration project initiated in response to the 2023 Kula gulch fires.

Interview protocol: Over the summer months of 2024, semi-structured interviews were conducted via Zoom (2) or in-person field or office interviews (6) ranging from one to four hours (with field interviews running longer than office or Zoom interviews). The researcher/interviewer took handwritten notes during and after the interviews and used the caption transcription feature on Zoom while recording field interviews with a telephone app—solely for note-taking purposes.

Participants were asked the following questions on: (1) the project specifics (e.g., site location, elevation, years/duration, staff, partnerships, volunteers); (2) fire risk reduction, vegetation treatments (chemical, mechanical) and harm reduction related to relevant NRCS[1] (or other) standards in dry/wet drainage areas (e.g., methods, implementation, access, training, funding); (3) challenges they faced before, during, after on the project; (4) specific methods that worked best or failed; (5) the lessons learned and what would they recommend to others planning work in a similar environment or on similar challenges; and, (6) are there any other questions we

[1] NRCS standards such as: fuel and fire breaks, earthwork best practices to avoid soil loss/erosion, trimming or removing vegetation inside a stream channel or ravine; protecting water flow by removing debris; best practices and considerations for 30-50 feet on either side of a stream channel; managing vegetation on stream banks; managing vegetation and debris accumulation at the drainage bottom where water flows; differences in treatments between grass, shrubs and trees, etc.

should be asking, anything missed? At the close of the interview, SMEs were asked if they would like to participate in an HWMO webinar to share and further discuss the project findings. Field interview photographs included in this report were taken by the Project researcher, Lisa Gollin, unless indicated otherwise.

Case Studies: Themes And Practical Takeaways

The following six case studies present lessons learned, insights, and practical tips from SMEs with experience on long-term environmental remediation and resilience projects. The case studies represent public (state, federal), private (company funded conservation programs) and third sector (nonprofit) projects — most in consortium with community volunteers — across diverse landscapes and ecosystems. The final case study (7) presents a relatively recent and rapidly emerging community-driven effort to conduct fuels reduction and restoration work in the up country Kula burn scar and environs in the immediate aftermath of the Maui fires in 2023.

Hawai'i Island

Case Study 1: Mauna Kea Watershed Alliance

Cheyenne Hiapo Perry (Manager), Mauna Kea Watershed Alliance: The Alliance is a coalition of public-private partnerships. MKWA conducts watershed management strategies (protection and restoration) using cost-effective restoration techniques: planting and seed broadcasting of native tree and shrub species, invasive weed control, and suppression of exotic pasture grasses. MKWA assists with management of a few thousand acres of Watershed Partnership lands with the current partnership consisting of around 416,000. Elevations and environments vary considerably in different project areas such as the Kanakaleonui Bird Corridor montane environment which ranges from about 6-8,000 FAMSL. The goal of the KBC is to restore forest bird corridors to facilitate movement of native birds from lower elevation native forests by providing foraging resources, shelter, and nest sites to escape avian diseases found at lower elevations. Other restoration areas are the Waipāhoehoe Management Unit on the Wailuku River watershed and the eastern slope of Mauna Kea. A key value and practice of MKWA is laulima—many hands working together—engaging the community (e.g., Hawaiian Homelands, schools, cultural practitioners) in restoration and stewardship. With the Wailuku River on the eastern slope of Mauna Kea, and many intermittent snowmelt and rainfall streams running down small gullies around the mountain, this is the primary case study and interview focused on a riverine environment with management projects running from mountain headwaters to ocean outlets, mauka to makai.

Cheyenne Hiapo Perry was interviewed on Zoom on July 16, 2024.

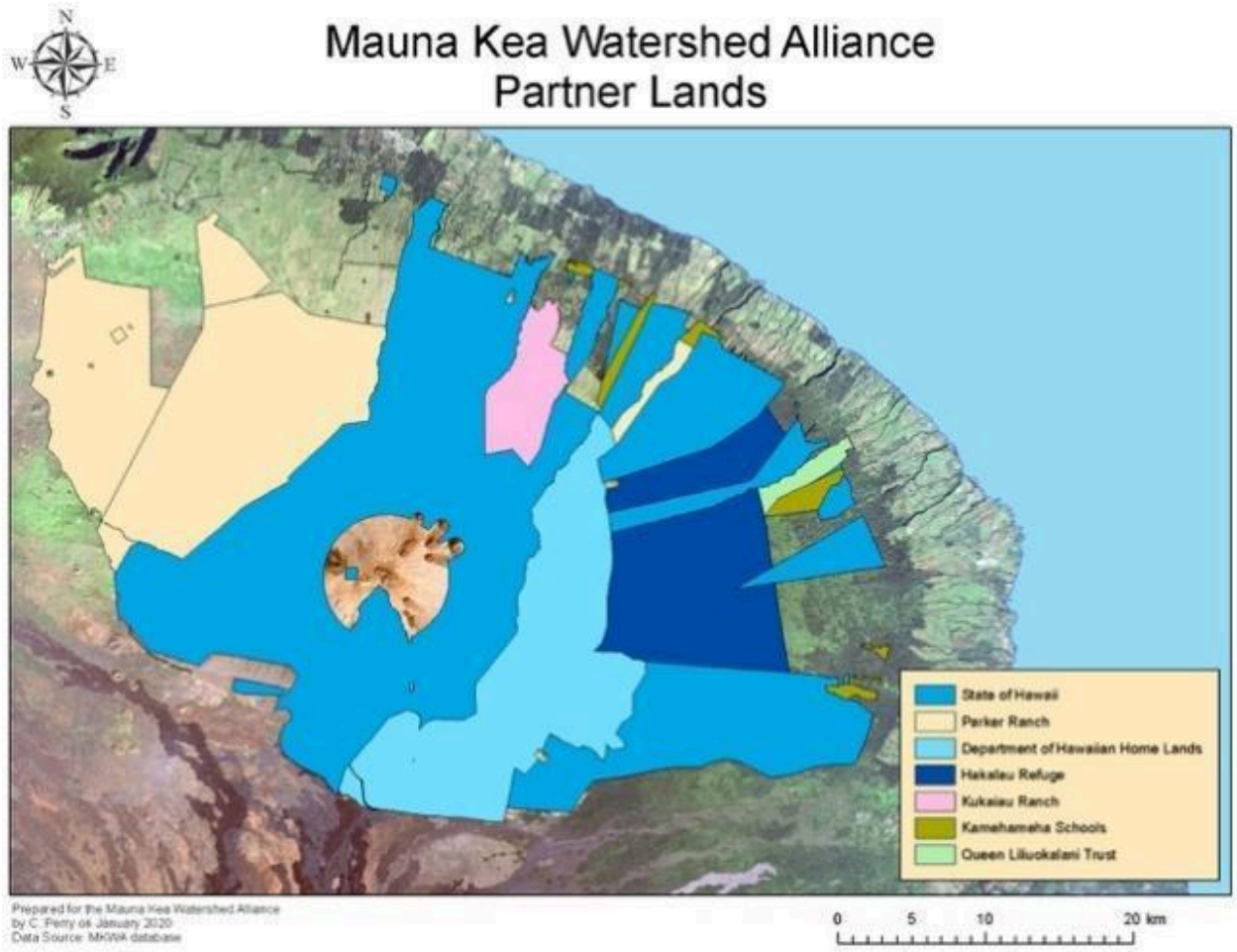

Figure 1. MKWA graphic: provided by C. H. Perry.

Insights:

Gulches as anchors points for management and restoration: Gulches serve as natural buffers and starting points for management and restoration. They are corridors for wildlife such as native birds, natural barriers for controlling (fencing off) animals, and green fuel breaks. In some units, they do not require too much management.

- Management begins inside gulches with plant surveys, fuels reduction (where feasible) in the flat terrain along the sides of the gulch. “That gives you a management footprint to be able to contain any fire that happens between them…. From there, we've been able to plant thousands of trees.”

Fuel reduction (gorse and grasses): The primary fuels are non-native pasture grasses (e.g., kikuyu, velvet grass [Holcus lanatus]) and gorse. There have been multiple fires in gorse which is

oily, flammable, and spreads fire easily. Some gulches are infested with gorse which clogs up “the veins or arteries that transport water slowing flow, stagnating water and exacerbating its spread through movement of seeds into the river and streams.” MKWA uses a variety of mechanical and hands-on techniques to reduce or altogether move away from herbicides for biocontrol.

Management of gorse: MKWA has worked with DHHL employing an effective “crush and spray” technique; using a bulldozer to push the gorse over so that it is flat and then spraying it with the herbicide Garlon (Triclopyr). Shade from canopy helps suppress seed germination and in time shading offers a long-term natural solution to weaken and reduce the gorse population, also reducing the need for herbicides

- A combination of management strategies is employed, sometimes using a helicopter for spraying in a way that does not impact native forest and species, and then following up on the ground where needed depending on the terrain. In the main infestation (~5,000 acres), DHHL cut a buffer around the gorse as a containment unit in a shaded area. Access lines were also cut to aid in fire response control gorse.

Management of grasses: “Kikuyu likes koa…. Koa is a nitrogen fixer and where there is koa there is green grass.”

- After a fire there was a flush of new koa seedlings, about 30% of the landscape. The seedlings emerged but the kikuyu came back and suppressed new germination and growth. MKWA first controls the grass with herbicide. “The long-term goal is to utilize shade and leaf litter and diversify the understory by suppressing kikuyu so native seedlings can germinate.”

Koa and māmane reforestation: “Koa is our engine.” During a māmane forest fire, the māmane burned to ash. After the fire there was a pulse of koa trees which today has grown to 20 feet. “MKWA uses koa plantings up to certain elevations and replants māmane, critical for bird habitat, as we move into the future.”

Maintenance schedule: Roads and around critical infrastructure are mowed quarterly, providing defensible space and reducing the chance of accidental ignitions from hot catalytic converters. If a management unit is 90% clean of invasives, they check every year to make sure nothing is popping up. With gorse, seeds can last up to 40 years. Annual checks are critical.

Weather, safety and access roads: “Weather is one of the biggest challenges. It is particularly dangerous for field crews to get caught at a lower elevation where there's so much rain they can't get out. The field team has gotten very good at making the call, not getting trapped in a flood area.”

- Roads are maintained, making sure the roads aren't overused and overly wet. Every couple of years a bulldozer does a “scrape and fill.” There are alternative routes in case

somebody gets stuck and can't get out from an area. “If you have a couple different routes in and out, you can allow a route to rest.”

The right tools and workforce for the right operation: Consider the scale of the operation and which resources to leverage,

- Most of MKWA’s work is manual, on the ground, using ATV and UTV to access work sites. If a project requires heavy equipment such as bulldozers (outside of MKWA’s capacity), they collaborate with partners or hire contractors (e.g., spraying 200-acres of gorse).
- A contractor may be able to plant three times more than a volunteer group but working with volunteers enables connection to the community and connects the community to the places we work in. “With volunteers you may not be able to cover a large area, but you have the added benefits of connecting with community—for us, that's more important than planting a lot of trees. On average working with volunteers, we can plant 1000 trees. Planting methods are used that ensure survivorship (e.g., protection from predation and frost).”

Figure 2. Road access mowing at KBC: contributed by C. H. Perry.

Be patient, figure out what is effective at a small scale, then ramp up: “When I first started doing this work, I thought we should be able to reforest 500-acres in 10-years. That is not how it

works. Think big but start small. And then be patient with time scales for change. You will see results. For example, in the KBC there is a measurable bump in the native birds. You have to be okay with the long-term."

To restore the land, stitch a cloak of native plants: "The metaphor we use is, ʻahuʻula (feather cloak). Each native tree planted is like a feather… and some feather cloaks can take seven generations to make so patience is key. When I look at these corridors, I see a landscape that has intact forest at 6,000 feet and then another at 8,000 feet. The name of the ahupuaʻa (land division) where the bird corridor is located is Humuʻula, humu can mean to stitch. The bird corridor is one stitch that pulls those forests together. The Wailuku River is another stitch that acts to close the space so that native forest birds can go back and forth migrating mauka/makai."

Case Study 2: Kealakekua Mountain Reserve

Willie Rice (Operations Manager) Kealakekua Mountain Reserve dōTERRA: The Kealakekua Mountain Reserve (KMR) in South Kona covers about 9,600 acres and is located on a former ranch now owned by the socially and environmentally minded essential oil company dōTERRA. While the land has been overgrazed and over-logged, there are still indigenous trees on the land. The property starts at about 3,000 to 6,000 FAMSL. KMR is doing reforestation in montane dry forest (shrub and woodlands), working down into the Kona wet belt, in what is often degraded, mesic forest, dirt lands and grass. A primary source of funding is via NRCS for planting.

Willie Rice was interviewed on Zoom on July 23, 2024. In discussing management methods, lessons learned and best practices, Willie drew examples not only from his current work with KMR but also from his prior position as a forester with Forest Solutions in the Kona-Kohala regions where conservation projects included wet and dry drainage features.

Insights:

Fire risk may be lower in wet drainages, higher on the edges: "The first concept to get past is that we don't have the chimney effect in most of our drainages on Hawaiʻi Island, as they have on the mainland, as the topography is just too insignificant. Also, in places like Kohala, you can see green lines coming down the mountain, those are the gulches—they are typically wetter areas and the last to dry up and therefore pose less of a fire risk."

- The number one threat is the larger fuels that grow within the gulches because of the available water or that are dumped into a gulch (e.g., kiawe establishes within gulches, dropping leaves and branches inside the gulch).

Gulches, flashy streams and erosion management: There may be less erosion coming from within gulches. Much of the erosion in Kona-Kohala is not coming from drainages, but from outside. “You’ve got the flat lands, the pasture that the livestock are walking across, and that is where most of the sediment is moving from and going into the drainages. But you have hard rock faces from years of erosion in the bed of the gulches.” Many of the streams on Hawai‘i Island are ephemeral. If they run, they are flashy with high volumes and water speed.

- Manage erosion outside drainages. Focus on the top and restoring bare areas. Install erosion barriers before sediment gets into the stream.
- Prevent erosion by diverting water off roads with waterbars to intercept and divert water into more stable vegetated areas. “The road will last longer, and you will have less erosion.”

Fuels management (chemical treatments): “You do not need to blanket a place with Roundup once a month just to control fire. If you do, you will most likely be increasing erosion and the presence of other incipient weedy species.”

- Be selective versus broadcasting an herbicide. If you have a budget to remove trees, cut it down and spray the stump with Garlon, or another herbicide, so it doesn't regrow.
- Stump sprouts and regrowth occur quickly. “If you check regularly, you have plenty of time to pull regrowth out by hand and not use herbicides after the initial use. With a good integrated pest management program, you can minimize your use of herbicides.”
- Reach out to NRCS and other professionals for an evaluation.

Mechanical removal and harm reduction in gulches: “Take care of your bigger fuel problems first, whether it is fuel size or fuel quantity and then go into maintenance mode until you exhaust the seed bank as best as you can.”

- Consider the substrate and whether or not you will be creating an erosion problem as you use machines. “Even pushing a fire break, you will unsettle the soil which can cause years of erosion.”
- Excavators with brush cutting heads are great for large fuel clearing and getting wood chips on the ground immediately (for mulch).[2] Yes, the mulch can still burn but you are removing a lot of the oxygen that is present in the standing structure of trees and brush. Heavy mowers can mulch an area fairly quickly and are readily available these days. However, they are costly and should be factored into a long-term plan that considers maintenance.
- Where you have a significant slope, you may be stuck with hand clearing and possibly repelling into the gulch.

Management of eucalyptus trees to shade out grass fuels: On the Hamakua Coast, fires that occurred in the eucalyptus plantations were started when a nearby patch of Guinea grass or

[2] Willie noted that there are excavators on winches available in the continental US that are used for steep harvesting on (approximately) 40-degree slopes.

other fine fuel was ignited. These fires would generally remain in the understory—the lower parts of the bark would burn or just char, but the fire would not climb up the bark and into the crown. The fire could burn long enough to cause the tree to fall to the ground but I have never witnessed a crown-fire in the eucalyptus. "There are hundreds of species of eucalyptus, but the species planted within the plantations are composed of so much water that they do not easily burn."[3]

- Eucalyptus grows quickly, creating a canopy within a few (three) months that can shade out the understory. With good timely management, you can keep a lot of the understory fuels to a minimum."[4]

Restoration enclosures, fire and fuel breaks, and grazing: One project, restoration planting is done in enclosures from a quarter of an acre to 210-acres or more to protect seedlings from cattle and goats. Weeding is done within the enclosures to encourage plant growth and remove competition.

- Fire or fuel breaks are maintained around the enclosures using a backpack sprayer and glyphosate. The breaks are 20 to 30 feet around the enclosures, letting "the cattle will do the rest."
- Cattle and other grazers prefer certain grass species while rejecting others (e.g., fountain grass). How much pressure they put on fuel depends on how quickly they are moved through a paddock. "Work with the rancher and stay attuned to the rotation of cattle. Pay attention to how the cattle are grazing around enclosures. Prioritize management around enclosures surrounded by fuels that cattle, or other grazers, do not eat."

Restoration in gulches: Wet drainage areas can be a better place to plant native plants with a better chance of survival. However, it can also be harder when there is solid rock. It is difficult to get a plant in the ground and there is greater danger of flash floods that can wash the plantings away.

- "Don't restore inside, restore nearby, on the sides bordering the gulch…. and plant a few plants here and there within the gulch."[5]

Road maintenance: A rule of thumb for road maintenance is that gravel roads get sprayed, and dirt roads get mowed to prevent erosion.

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[3] The eucalyptus referenced by Willie is, *Eucalyptus grandis* "flooded gum tree" which, despite its ignition-happy volatile oils, is known to be more fire resistant. There is a growing body of research on the role bark moisture plays in regulating heat transfer in the bark and in determining the protective capability of cambium layers against fire in eucalyptus species.

[4] It is worth noting here that while eucalyptus oils are indeed volatile, generally their largest contribution to fire risk is that they slow the decomposition of leaves, bark, and branches, which can build up in the understory. Plantation age is a big factor in fire risk. Twenty-30 years-old is when fuel buildup becomes a concern for many species. (Clay Trauernicht, personal communication)

[5] Willie made the point that very few restoration groups are planting directly in gulches because of the difficulty.

Planning and costs considerations: Labor is the most expensive part of restoration work. Machines may appear to be expensive but will not be as costly due to their higher production rates.

- Look for trade-offs between spraying and mowing. “If I have a road to mow and it is gravel or dirt, how wide is it? What should I do for a road that is 10 feet wide vs 50 feet? Is it better to spray or mow based on the budget and available labor?”
- Get work estimates based on area or distance rather than hourly rates. For example, a price to mow per acre will be much better than hiring someone at an hourly rate as there is an incentive to produce the desired results.

Plan for maintenance and avoid creating a larger fire hazard: Always start a project with a strong plan for maintenance and properly assess the vegetation.

- “For example, if you have $10,000 to work on fuels reduction in a gulch and a solution is to put goats or sheep in the area to graze down fine fuels, make sure you can guarantee there will be $10,000 for every year moving forward. If not, consider using the $10K to clear out larger fuels. There will still be a fire threat, but it will be fine fuels that burn quickly rather than large fuels that burn longer and hotter.”
- In a “green or living fuel break” setting, if clearance of leaf litter and fallen branches and/or irrigation is not maintained, you may be creating a larger fire hazard over time. Going into a dry landscape and installing irrigation lines and doing a lot of planting can become a recipe for future disaster if it requires too much maintenance to be feasible and sustainable.

Flops and lessons learned (beware bulldozers): Using bulldozers to push fire breaks can come with problems. Archaeological sites can be unintentionally damaged and erosion can be exacerbated. A bulldozer leaves a more permanent mark on the land whereas vegetation usually grows back following a wildfire.

- Install erosion control devices to minimize erosion along fire breaks after they have been built.

Help create a conservation economy and boost funding: “We need to move closer to a conservation economy and boost grant programs that will pay for ongoing fuels reduction and fire prevention.”

- Work with the NRCS and the state to develop programs or grants that can aid fuels reduction and fire prevention work. For example, create more support for using grazers to keep fuels down.
- Help develop an economy where services that support conservation are readily available.

O‘ahu

Case Study 3: Wai‘anae Management Watershed Partnership

Yumi Miyata (Coordinator) Wai‘anae Management Watershed Partnership: The WMWP collaborates with public-private landowners to care for watershed areas, native species and habitats, and historical, cultural and socio-economic resources in the Wai‘anae Mountains and Wai‘anae Kai Forest. The partnerships[6] share information, plan for consistent conservation management, and collaborate on landscape level projects across ownership boundaries. Many of the homes in the area are in Hawaiian Homelands (DHHL) with the highest threat for wildfire. Protecting the peri-urban interface is critical. Restoration efforts involve replacing invasive species like strawberry guava with native plants such as wiliwili (*Erythrina sandwicensis*) and to reduce erosion and improve the ecosystem. WMWP has a strong educational component with leeward coast schools and students helping to meet the goals of invasive species management, native plant propagation, and forest restoration while learning about fire mitigation, conservation and stewardship.

Yumi Miyata was interviewed on August 20, 2024 during visits to the Wai‘anae and Mililani school[7] nurseries and leeward coast field sites.

Figure 3. WMWP mauka management unit.

[6] BWS, DLNR, Ma‘o Organic Farms and Wai‘anae Community Redevelopment Corporation, Gill-Olson Joint Venture, US Army Garrison Hawaii, Navy Region Hawaii, Kaala Farms Inc.
[7] Wai‘anae and Nanakuli High Schools and Mililani Middle School

Insights:

Fuel reduction strategies: WMWP works in watersheds such as Makaha—BWS land with or near wells, reservoirs and other sources of water. As such, they primarily use mechanical methods and limit use of chemical sprays as much as possible. A lesson learned over the years is to be aggressive at the outset with fuels removal.

- Fire tree or fayabush (*Morella faya*) has been a focus of eradication efforts along with grasses. In areas where there is bare ground and grass, spray with Roundup and weed. Then lay out weed mats. Once weeds are suppressed, holes can be poked in the mat for planting.
- Weed mats have been very successful at controlling regrowth and protecting native plantings. They lay out weed mats 10-15 feet wide. Where there are service roads, the weed mats are laid next to the road, utilizing the road as an added buffer.
- Guinea grass regrows quickly. WMWP tries to figure out how best to "slow the grass-fire cycle and remove the seedbank." They sickle grass tufts and pull or dig out the root structure. It takes longer to come back and is then easier to control, particularly if removing the mature, bigger tufts. This strategy is effective, but "so labor intensive."
- In rocky and steep-sloped areas weed mats are rolled out to keep grass and other weeds down. "Weed mat is our savior."
- Weed mats last from three to five years.

Figure 4. WMWP weed mats.

Fuel breaks as habitat restoration projects: As with other restoration projects, plant densely to ensure some plants survive, even if others die, to create long-term, sustainable fire breaks.

- A lesson learned is that a 5 feet wide break is insufficient. Buffers should be 30 feet or more given the distances embers can travel.

Planting techniques and fuel breaks as habitat for restoration: Creating dense plantings, using weed mats to suppress grass, and quickly outplanting native understory and overstory species are key factors in successful fuel breaks and, generally, restoration.

- Over the years WMWP has learned to plant densely to ensure some plants survive, even if others die, in order to create long-term, sustainable fuel breaks. Initially they would space out plantings more. But some planting wouldn't survive anyway, leaving large gaps for grasses and other weeds to grow.
- Plant in layers. Don't plant trees too close to the road. WMWP may start with ground cover such as naupaka (*Scaevola sericea*), and pōhinahina (*Vitex rotundifolia*) then move 5 feet in from the road and plant ʻaʻaliʻi (*Dodonaea viscosa*) and other shrubs, then trees such as milo (*Thespesia populnea*), koa, alahe'e (*Psydrax odorata*) and ʻiliahi (*Santalum* spp., sandalwood) farther back from the road to create shade canopy over time. As trees mature, they sometimes thin them out.[8]
- Pick plants that are more drought-tolerant. For example, "milo, when they are keiki, look sad in the dry summer months. Once they get to a mature size, they stay green."
- In the coastal areas, they have been experimenting with naupaka and other more succulent plants to see if they burn slower. "We recognize fire is inevitable. We're just trying to create a good line of defense to slow that fire, to compartmentalize the fire so our firefighters have a little more time and so that it doesn't reach our upper mauka areas where there are more intact ecosystems."
- To prevent erosion in higher elevations where they are taking out large trees such as strawberry guava (*Psidium cattleyanum*), they go fast and strong on ground cover such as sedges such as ʻukiʻuki (*Dianella sandwicensis*) to hold the soil, then plant native and shrubs and trees.
- A failure and lesson learned – they have experimented with planting trees in different elevations. For example, they tried planting koa in coastal fire breaks. Eventually the koa died.

Equipment and tool tips: WMWP relies on good augers for planting, chainsaws, and weed whackers.

- They go through weed whackers quickly and keep backups on hand in order to rotate in and out as they break and require replacement or repair.
- Get good steel augers such as Echo augers or other brands. Invest in different sized bits.

[8] WMWP has invited woodworkers to assist with culling of trees which they harvest for carvings and making furniture.

Best practices for involving community volunteers: The project has a strong focus on community engagement, involving schools and volunteers in nursery operations and restoration work. Volunteers help propagate and plant native species as part of fire mitigation efforts.

- Give volunteers a sense of gratification. For example, it may be more efficient to have field crew dig holes, rather than volunteers. You don't want volunteers spending a lot of time digging the holes for the plants instead of getting as many plants in the ground as possible.
- Have field crew dig holes as part of the prep work for outplanting events and flag them.
- Solid evacuation plans and strategies are in place for working in fire-prone areas!

Figure 5. WMWP outplanting.

Case Study 4: Honolulu Board of Water Supply

Amy Tsuneyoshi (Watershed Resource Specialist) Honolulu Board of Water Supply: The BWS watershed program works with partners across O'ahu with local and federal agencies, private landowners, schools, and community groups (e.g., WMWP, KMWP) to protect and enhance priority watershed areas for groundwater recharge through resource management. Initiatives range from studies (e.g., Watershed Prioritization, Rainfall Canopy Interception, Biocontrol), to MOUs, to on the ground projects (e.g., invasive species removal and native plant restoration).

Currently, BWS is working with WMWP to help establish vegetated fire breaks. Following is background information from an interview with Amy Tsuneyoshi:

From: Partner Perspective: Amy Tsuneyoshi, Watershed Resource Specialist at Honolulu Board of Water Supply
(https://pacificfireexchange.org/resource/partner-perspective-amy-tsuneyoshi-watershed-resource-specialist-at-honolulu-board-of-water-supply/)

Waianae Kai Community Forest Project. In 2003, a couple months after we did a partner signing, there was a 7-acre fire that burned fairly-intact native forest on the ridge that separates Waianae and Makaha…The BWS and DOFAW provided funds to help with restoration efforts. We were worried that we'd lose a lot of the topsoil, because nothing was holding it in place. We purchased soil erosion control materials, and along with volunteers from different agencies - Oahu Invasive Species Committee, Oahu Army Natural Resource program - we installed coconut core and straw waddle logs. We also out-planted some natives and did weed control over a couple years after the burn….A lot of the koa canopy came back on its own. It's not as diverse as it used to be, but the canopy is filling in. Work needs to be done in the understory now. We'd like to remove weeds that are underneath the canopy. There are native plants that are coming up too, like mamaki and naupaka [*Scaevola gaudichaudiana*], so there is a seed source there.

Amy Tsuneyoshi shared her efforts over the years and insights in an email to Lisa Gollin on October 16, 2024, and in an informal talk story interview at the Waiheʻe Tunnel aquifer BWS and KMWP volunteer restoration event on January 4, 2025. The email pertains to the work BWS is conducting in Makaha. The talk story 'insights' refer to a variety of projects.

Email response (Oct 16, 2024): The only riparian project we are doing is in Makaha...We are currently waiting to do an archeological survey before expanding our efforts and planting trees due to the proximity to cultural sites. During previous dry periods (no stream flow), we shored up the streambank with river rocks and created planting areas for 'ilieʻe (*Plumbago zeylanica*) to help stabilize the soil. We also planted along the top of the streambanks, which the stream can overtop during storm conditions. We have been slowly removing sections of guinea grass (*Megathyrsus maximus*) in and along the streambed, and *Cyperus* and other vegetation in the streambed. We try to keep the streambed clear of debris.

Insights:

Fuel reduction and stabilization: BWS's watershed program takes a practical, budget-conscious, use what you have on hand approach. The idea is, reduce the fuel load while providing an ecosystem service and protecting the stream.

- Rather than removing trees from embankments that are difficult to remove or destabilize the soil to remove, such as koa haole (*Leucaena leucocephala*), trees are felled, leaving the stumps for embankment stabilization and to catch debris falling from the topside.
- In some environments the fire risk is too high to leave fire prone plants. In the Makaha riparian area, it is a calculable risk worth taking. The drainage is moist enough most of

the year that the remaining stumps will decompose, nourishing the soil and providing mulch.

- Erosion and water barriers can be made by cutting trees such as koa haole high enough so the stumps are easily visible. Watch out for snags! The height of each stump is important, so nobody trips or is impaled!
- Always try to keep the bottom of a wet drainage (stream, ravine) clear. The base of koa haole trees should be cut high enough for visibility[9] and to build a barrier. Stack cut material upslope of the stumps to create a wall to catch topside debris falling into the stream. The ends of the catchments/erosion barriers should be staggered across the embankment or slope to diffuse and slow water flow.[10]
- When doing fire fuel clearance, if you cannot remove the debris from the area right away, store it at the top of the streambank well above the high-water mark. Don't throw debris into the ravine/stream.
- If you are using coconut coir or straw wattle logs for erosion control, slightly angle the ends upslope so it forms a smile to reduce runoff from the logs.
- Repurposing as much as you can not only saves costs for your organization, but it is also better for community stakeholders who don't usually have purchasing funds for restoration and stabilization projects. Use what is on hand!

[9] Amy noted that when the idea of not extracting or cutting a tree flush to the ground but leaving a stump to be used for erosion control and stabilization was proposed, kūpuna (elders) were wary of the danger of potential trip and fall hazards, and sharp edges.

[10] Refer to, USDA After the Fire — Log Erosion Barriers (https://www.nrcs.usda.gov/resources/guides-and-instructions/after-the-fire-log-erosion-barriers)

Figure 6. BWS Plantings and staggered log erosion barriers using what is on site. Contributed by: A. Tsuneyoshi.

Figure 7. BWS staggered log erosion barriers using what is on site and repurposing invasive trees. Contributed by: A. Tsuneyoshi.

Kahoʻolawe

Case Study 5: Kahoʻolawe Island Reserve Commission

Paul Higashino (Restoration Program Manager) Kahoʻolawe Island Reserve Commission, DLNR: Centuries of overgrazing, bombing and wildfires on Kahoʻolawe created a severely degraded environment where invasive fire prone flora such as buffelgrass and kiawe dominate the landscape. Hardpan and sterile hydrophobic soil comprise much of the island (upwards of 40%) and deep water-eroded fissures and gulches exacerbate erosion and toxic runoff from

military ordinances into the ocean. KIRC's near 20-year restoration work employs tens of thousands of volunteers to rejuvenate the island's ridge to reef habitats and can guide post-fire communities such as Lahaina on coping with fuels reduction, stabilization and erosion issues in a stressed environment where resources are stretched thin. The challenge is to balance restoration efforts with the realities of safety, logistics, and the availability of materials. The restoration of Kahoʻolawe requires resourcefulness, ingenuity and a toolkit of contingencies.

Paul Higashino was interviewed on August 12 and 17, 2024 at the KIRC office. Interviews were conducted before and after an access island trip to Kahoʻolawe from August 13 – 15 during which the Project researcher visited several mauka gulch sites and makai outlets to view stabilization and restoration projects.

Figure 8. Windblown ʻaʻaliʻi on Kahoʻolawe. He ʻaʻaliʻi kū makani mai au; ʻaʻohe makani nāna e kulaʻi. I am a wind-resisting ʻaʻaliʻi plant; no gust can push me over (Pukui 1983).

Insights:

Erosion control techniques in and near drainages: Due to the potential presence of UXOs and other safety risks, it is too dangerous to work inside gulches. Most stabilization and restoration efforts focus on the headwaters or upper slopes and rims of drainages. Various methods have been used to work inside gulches without people going down into steep, unstable drainages. Old and modern global practices have been tested on the island to control erosion and grow plants.

- "Learn the basics of what other people have done around the world for centuries to slow down the movement of water and soil. Such as in China where they have planted billions of trees to slow down the movement of sand from the Gobi Desert. And in the Middle East and North Africa where wadis [dry riverbeds, creeks, ravines, usually found in desert regions] are used to catch seed and grow plants wherever water flows in a dry area."

- “You have to know what's inside the box before you can think out-of-the-box; know the basics of soils, weather, plant ecology, succession, plant identification, taxonomy, natural history, putting the right plants in the right area.”
- Wattles and fascines – KIRC has experimented with branches, twigs, straw and other materials, bundled together and placed on slopes and across the landscape to slow down wind, build up soil, collect seed and hold moisture for plantings. To secure a wattle or fascine to the slope, a string or rope might be used to tie the bundle to a root. To secure a wattle or fascine to the bottom of a gulch, a bucket filled with rocks can be lowered down into the gulch to keep the bundles in place, then the bucket pulled back up out of the gulch.
- In other environments, wattles and fascines will sprout and regrow, further stabilizing the area. However on Kahoʻolawe conditions are so arid, bundles are unlikely to sprout or take root. If potentially invasive, they generally don’t present a problem because the dry environment inhibits sprouting. Certain plants are best for making wattles.
- Example – tamarisk wattles have been used successfully. The branches or limbs are cut to about three or four feet in length, tied into bundles and then interlocked, “from one bundle to another, jamming them together.” So the bundles don’t blow away, they use burlap bags with gravel or rocks on top to secure it. The wattles are easily picked up and moved to other areas.
- Beware if using invasives for barriers and breaks (such as tamarisk and ironwood) to make sure there are no fruit (seeds, seed pods) in the bundle that could spread across the landscape.
- Pili grass bales are placed on the hardpan downwind of fruiting native plants in different formations (e.g., v-shaped, crosses, and open square kipuka) to catch airborne seeds to be used for further propagation.
- Check dams made with rocks have been placed in gullies or other depressions to slow down water velocity and to accumulate soil. Check dams placed in small areas have accumulated a large amount of soil behind them which then become good areas for planting. They have used burlap bags or plastic sandbags filled with soil and soaked in water so that they solidify, become like bricks, and used them for check dams.
- Lesson learned – KIRC has had varying success using rock check dams. “It's better not to put a check dam in than to put one in the wrong way. Yes it's eroding. But if you have 20 gallons of water every 30 minutes rushing through an area and you quickly install a check dam, if that dam breaks, now you have 1000 gallons of water. The energy force will be far more damaging than having done nothing at all.”
- Lesson learned – Erosion control bundles that were made from coconut coir fiber had a fine plastic netting outside. Birds have been caught in the netting—a threat to conservation and protection of native shoreline and migratory birds.

Figure 9. L. rock mulch planting plates to slow wind and catch soil. R. Pili bales.

Use of local materials for restoration: Kahoʻolawe's remoteness and limited resources mean that on-island materials are often repurposed for restoration and stabilization efforts. The mauka regions of the island are a testament to decades of creative experimentation with scrap material from bedsheets to dinner plates[11] used to protect seedlings from wind, attract moisture, and collect organic material.

- "There's a lot of material on island that can be kept, rather than shipped off island or burned. Wooden pallets, scrap lumber, cardboard food containers, paper products, office material and manuals, telephone books…. [can be used for protecting seedlings and mulching]. You can use a line of palettes on the landscape [for windbreaks] …. It is all going to decompose eventually. Chicken wire can be recycled to make mounds or kipuka of cardboard scraps. The chicken wire holds the cardboard together like a gabion. Or, used to make rock baskets to put along stream edges or along hillsides. Number 10 tins can be cut in half, and used to grow seedlings..."
- In gullies, fishing nets recovered from the beaches are filled with rocks to slow the flow of massive amounts of soil runoff into the ocean.

[11] Donated by the Four Seasons Resort on Maui.

Figure 10. A small rock dam catches ʻaʻaliʻi seeds in a dry rivulet.

Restoration techniques and lesson-learned:

- “One thing I wish I'd done sooner was gather kukui nut, milo and koa seeds to plant at the headwaters at the top of the island, the gulches and gullies, and let the seeds wash down. Looking at examples throughout the Hawaiian Islands you see kukui groves in little valleys and gulches running down the mountain.”
- The 2020 brush fire had an unexpected beneficial impact on the ʻakiʻaki populations in makai restoration zones. One factor promoting growth may be that many of the coastal kiawe trees burned, opening the canopy for the native grass to flourish. [12]
- Early attempts at hydromulching presented challenges (such as the low availability of native seed) or altogether failed especially in areas with barren hardpan.
- Other forms of mulching and “rock mulching” have been used to greater success. Where it is not possible to dig holes to establish plants, KIRC has made rock circles, added wood chips inside, returned three to four months later and removed the wood chips. The

[12] During the researcher’s August 2024 visit to Kahoʻolawe, the successful excavation, rescue and release of the first confirmed Hawaiian green sea turtle (*Chelonia mydas*) took place. The discovery of turtle nests and hatchlings is a testament to the success of KIRC’s ecological restoration efforts. Replacing invasive buffelgrass with native ʻakiʻaki grass most likely made the shoreline more suitable for honu nests. The dense buffelgrass mats make it difficult for turtles to dig their nesting chambers, while ʻakiʻaki grows sparsely and is easier for honu to navigate and dig through. (https://www.kahoolawe.hawaii.gov/media/10.04.24_KIRC_Honu_PR.pdf)

wood chips inside the rock circles attracted soil. “Then we laid about eight to ten plants on the ground so that they were not in the opposite direction of the wind. So that as they grew they wouldn't be fighting the wind. Then we would water, add compost, and sometimes water crystals.”

- KIRC has taken advantage of little depressions, wadis and swales,[13] for rainwater irrigation of plants, soaking the ground with water, laying the plant down, adding soil and compost with rocks or gravel on top, anticipating where water will flow. Seeds collected in pili bales are scattered in little rivulets, niches, crevasses, or gullies to germinate where they are protected from the wind and gather moisture.
- “Consider the right plant for the right place.” Of the approximately 80 or more native species KIRC has outplanted over the years, only about 15 to 20 have worked reliably. For example, ʻaʻaliʻi is perfect for xeriscaping, requiring little water once it is established. It has deep taproots and holds its ground even in extreme wind.

Figure 11. ʻAkiʻaki between burnt kiawe thrived after the 2020 fire.

Volunteer engagement: Working with volunteers on Kahoʻolawe presents unique challenges. The goal is to make the experience meaningful by educating volunteers about the history and cultural significance of the island while working on restoration projects.

- As with other aspects of life on Kahoʻolawe, “You always have to have contingencies. Consider personnel, material, equipment, and be ready if something breaks or the work

[13] Swales are somewhat different from wadis which are a natural feature of the landscape found in arid regions and only experience water flow during heavy rainfall. Kahoʻolawe’s ridge to reef gulches are carved deeper with heavy rainfall and lead to runoff. Swales are a designed feature of the landscape, usually a shallow depression or channel used to manage storm water runoff with vegetation to slow or redirect the flow of water.

is too hard or challenging for the volunteers or becomes unsafe." KIRC is always ready with an easy fallback for volunteers such as collecting seed or making seedballs.

Figure 12. ʻAkiʻaki between burnt kiawe thrived after the 2020 fireKIRC revegetation: Crown flower (*Calotropis gigantea*) and ʻaʻaliʻi from seed catchments have made their way into the gulches.

Maui

Case Study 6: Division of Forestry and Wildlife, Maui

Lance DeSilva (Forest Management Supervisor and Wildland Fire Manager for the Division of Forestry and Wildlife's Maui branch) DLNR: In upcountry Maui, DLNR state lands are in WUI areas with deep gulches and gullies oftentimes clogged with fire-friendly invasive grasses, herbaceous and woody understory plants and highly flammable trees such as black wattle (Acacia mearnsii) and eucalyptus—pervasive on the topside and along the edges drainages. Fires igniting and running down gulches, erosion and runoff are major concerns. Gulch embankments can be steep, and management of fuels is particularly technical and dangerous. DoFaW works in collaborative agreements with county and federal agencies to respond to fires across the Hawaiian Islands.

Lance De Silva was interviewed in Kula on August 19, 2024.

Figure 13. Kula gulches a year after 2023 fires: L. mauka burn scar; R. Black wattle (*Acacia mearnsii*) topside.

Insights:

Vegetation treatments in gulches: "There is no one prescription that fits all gulches." Approach mitigation and succession planning from the outside first, then inside.

- "Gulches aren't really the problem. We always look at the gulches as the problem as far as fire. But we missed the issue outside the gulches. Why don't we just try and prevent it from going in the gulch? You're not going to remove every tree from every gulch. You're not going to remove grass from every gulch because you can't and shouldn't because you need it for stabilization."
- "Some gulches are just better left untouched. Fully clearing a gulch of its fire fuels can cost 10 to 15 million dollars. You have to ask; will it really solve the problem or create more issues?" And, "If you cut all the [non-native] trees out of a gulch, more grass and other weeds will grow inside and there will be more flooding in heavy rains [where] there's no tree cover."
- "Management depends on slope percentages and the makeup of the species growing in a drainage. If there is a gulch full of black wattle trees, initially we would probably leave it as is until we get resources to treat the area. Then we [usually] go in and mechanically cut. If you can't get equipment inside, then everything gets done by hand."
- Another consideration on steep embankments is that if you create switchback trails into the gulch to do removal and restoration work at the bottom, the switchbacks can cause erosion.

- Black wattle and other invasive trees are typically managed through mechanical cutting. Treatments are done cautiously to prevent erosion. Buffer zones (40 to 50 feet from the gorge) are maintained to reduce erosion while replacing invasives with native species gradually.
- “We wouldn't necessarily go in there and cut everything. We would have to phase it in. You would go in and thin the place out of the weeds, and then plant natives that are adaptable to that environment. Eventually, as those trees grow, you go to the next tier and start cutting the [more trees before] planting.”
- In some areas where there is no ground cover, techniques like hydromulching (spraying a mixture of seed, water, and mulch onto the land to promote growth) can be used to stabilize banks and reintroduce vegetation. Whether it's a native or (sometimes) not native, grass and trees are planted to hold and shore up the banks of the gulch.
- Consult with soil erosion and rockfall specialists to develop a plan for stabilizing steep areas.
- Equipment and tools for gulch work – Bulldozers are generally too big to be used for vegetation treatment atop large drainages. Small masticators like skid steers (with masticating heads) that can chip trees are used on the top for vegetation removal on the topsides of gulches and ravines and can be used fairly close to the edge. There should be a spotter outside walking ahead of the skid steer operator. If it's not a steep area, a little ravine, they can go right to the edge. If it is steep, stay 20 to 30 feet away from the edge. Treat everything else mechanically with a chainsaw where you can go right to the edge, or even in the ravine.

Harm reduction and restoration of ravines and riparian drainages:

- Protect the corridor 50 feet on each side, fence it in and then (if possible) turn it into a long-term weeding and native restoration project. If there is rubbish inside the drainage it can carry fire. If it is owned by a ranch, right outside the fence line, have a grazing strip. If it is a riparian area put the fences right along the drainage so that the ravine is protected from grazing.
- Revegetate with native plants that are drought-tolerant such as wiliwili.

Grass for erosion control: Grasses can be a double-edged sword. Good for quickly stabilizing slopes, but problematic in a fire and generally invasive throughout Hawai‘i. Consider the balance between managing for erosion control and reducing fire risk.

- Kikuyu works particularly well in the upper elevations of Kula. It is used for erosion control despite being non-native. Kikuyu grass is effective at holding soil in place, but it presents fire hazards due to its deep-rooted runners making fire mop-up efforts more difficult.[14]

[14] It is worth noting that kikuyu is typically not available or propagated from seed and usually spreads vegetatively which can prevent it from being used as a post-fire treatment as opposed to annual grasses such as ryegrass.

- Annual and perennial ryegrasses (*Lolium multiflorum* and *L. perenne*) germinate quickly and provide immediate ground cover. Ryegrass is not considered invasive in Hawai‘i and is often used in hydromulching projects for stabilizing soil, especially in areas where invasive species have been removed.
- Choosing whether to use annual or perennial rye grass depends on your purpose. For example, when you see hydromulching projects along the banks of highways and roads, it is generally perennial rye which doesn't die off. For quick stabilization and vegetation conversion, perennial grass may be used with other species thrown in.
- Example – The West Maui exclosures for protecting endangered species were cleared down to bare soil to install an apron around the fence to prevent pigs from digging into the exclosure. With a four or five foot wide corridor of bare dirt, a steep hill, in high rainfall, there was danger of erosion. Annual and perennial rye grass planted around the fence line for soil stabilization sprouted quickly.

Balancing native plant revegetation and fire risk: When an area is revegetated with native shrubs and trees, it can burn at higher fuel loads than grass. Heavier fuels create higher BTUs (British Thermal Units). Consider where to draw the line, solutions that balance fire prevention and erosion control without sacrificing ecosystem integrity.

- “We can't be in fear of fire to the extent that we are just going to have manicured landscapes [everywhere], so we don't have to worry about fires everywhere.”

Grazing as a mitigation tool: Grazing can be used to manage fire risk. But pay attention to overgrazing which can lead to further environmental degradation.

- In grazing gulches, always consider what is downslope from the mountain and possible runoff.
- Grazing can be effective in maintaining grass heights and reducing fire hazards. It must be done responsibly to avoid soil erosion. Private landowners may lack the resources to manage vegetation effectively on their properties. Axis deer on property will graze, but also overgraze down to the dirt. This complicates efforts to create a cohesive wildfire prevention strategy across the landscape.

Case Study 7: Kula Community Watershed Alliance and Skyline Conservation Initiative

Sara Tekula (Executive Director, Kula Community Watershed Alliance) and Joe Imhoff (Program Manager) Skyline Conservation Initiative, Skyline Hawai‘i: Case study 7 focuses on the emerging efforts of the Kula Community Watershed Alliance started in 2023 following the Kula gulch fires. KCWA’s work is in part guided by recommendations from the Skyline Conservation Initiative located above (mauka) of the 2023 Kula burn scar — similar topographies, at different elevations and distinct micro-climate and ecological conditions.

Spouses and business partners, Sara Tekula (KCWA) and Joe Imhoff (SCI) generously shared their insights, and how lessons learned from SCI's restoration work is being applied to KWCA's project planning and implementation. Joe is an advisor to KCWA based on 10 years of experience doing restoration work at the zipline business, Skyline Hawai'i.

Kula Community Watershed Alliance: In the aftermath of the 2023 Kula fires, the KCWA was formed by fire survivors (primarily private homeowners) as a community-driven effort to conduct ecologically responsible fuels reduction and begin restoration work to stabilize and regenerate disturbed soil, and to protect and plant native flora in the residential area of the Kula burn scar and adjacent Pōhakuokalā- Pūlehu Gulch in the Waiakoa watersheds.

Skyline Conservation Initiative, Skyline Hawai'i: SCI is restoring native forest at nearby Pōhakuokalā Gulch, the site of Skyline Hawaii's Haleakalā 5-Line Zipline Tour. SCI has cleared eucalyptus trees which are then used as "nurse trees" on slopes to both prevent erosion and provide wind protection and attract moisture for native seedlings or, are chipped to create mulch for plantings —inhibiting weeds while also holding moisture in the ground. SCI coordinates with school and community volunteer groups and provides conservation training for Skyline staff. Many of SCI's stabilization and restoration techniques served as models for KCWA's response to the Kula fires.

Figure 14. KCWA native seedlings in burn scar with black wattle mulch.

Sara Tekula and Joe Imhoff were interviewed in Kula on August 16, 2024. The interview with Sara took place at the ignition site of the 2023 Kula gulch fire and KCWA stabilization and restoration sites, and was followed by the interview with Joe at Skyline Hawai'i`s SCI nursery and reforestation sites. This summary encompasses both interviews highlighting themes and

practical tips particularly on how KCWA and SCI have repurposed wattle and eucalyptus trees for erosion control, soil rehydration, and restoration work.

Figure 15. Upper Kula erosion control using eucalyptus logs and wattle chips above the gulch.

Insights:

Management of fire fuels in gulches: Eucalyptus and wattle trees, are ubiquitous alongside and even inside deep drainages. Often on steep slopes, they are particularly hard to manage for individual homeowners. Removing trees is difficult due to the terrain, and regular maintenance is financially and physically overwhelming for most landowners. Through state and federal funding, consultation, and professional assistance (e.g., NRCS, EWPP),[15] community involvement and—in the case of SCI, a well-trained, dedicated conservation staff—KCWA and SCI have been able to remove large wattle and eucalyptus[16] trees in different sites to be reused for mulch, log erosion barriers for stabilization and "nurse logs" to support saplings.

Use of fire fuels for stabilization and restoration: "You can use fire fuels in restoration. Usually you think, fire fuels are over here. Restoration is over here. You could actually use the fire fuels as a soil stabilizer and as mulch to help improve the soil content underneath and also to prevent invasives from coming back."

- After the fire, teams collected the wattle trees that had been felled by the high winds or partially burned in the fire and used them for log erosion barriers and wood chips which were then spread over the burned areas to stabilize the soil and suppress weed growth.

[15] As part of an EWPP, NRCS-funded project, burnt debris that could wash downstream and clog a culvert will be removed from the gulch using teams repelled into the gulch to cut up debris into manageable pieces which are then hoisted out of the gulch with a winch or other specialized equipment.

[16] At Skyline Hawai'i, removing eucalyptus led to unexpected benefits such as the resurgence of springs and improved soil moisture retention. Joe explained that eucalyptus trees consume a large amount of water, "up to 100 gallons per tree per day," which depletes water resources and creates fire hazards.

- Log erosion barriers and “nurse logs” – Eucalyptus logs were cut to certain sizes and installed into the soil about 6-inches deep to slow down storm water and control erosion as the first order of business. The areas in between the logs were filled in with wattle chips. Using sprinklers, they simulated rain events to test whether the mulch and soil would hold.
- Mulching with wattle – “They do a better service for us in chip form. Wattle trees extract a lot of groundwater, transpiring it fast. They don't hold it in their bodies very long. But when you chip them, that same habit of grabbing onto water really helps with retaining moisture in the soil.” Wattle mulch is particularly useful in the burn scars, where hydrophobic soil with the consistency of powder is impossible to plant. “You can't just stick plants in dust. In a heavy rain, they're just going to wash away.”
- Eucalyptus log erosion barriers and “nurse logs” – Eucalyptus, like black wattle, are water guzzlers (and hoarders) with some species holding on to massive amounts of water in the cambium layers of the tree. Eucalyptus logs are used for slope stabilization and restoration. Coupled with good mulch between the barriers, native seedlings safely nestled behind nurse logs seals in soil moisture and do not require much or any watering.
- Hotspot management – KCWA tested wood chips on two hotspots to see if the area would reignite. They ran sprinklers over the area for 24-hours before they laid down the wood chips. “The soil was so hydrophobic. You can try and dump water onto the soil and it will literally sit on the surface and not penetrate. So just by wetting the surface and then putting three inches of wood chips, it trapped the moisture and snuffed out the hot spots.”
- Wood chips reduce the need for herbicides and are being used on steep slopes. “The wood chips have not gone down stream during the last storm. The more wood chips we get onto the soil, the less herbicide we need to use along the gulch…. Once every few years, we reduce the ladder fuels and knock down the grass. But even the grass is less in the shaded areas. We parked the woodchipper on the hill and just broadcast chips down along the slopes of the gulch.”
- The NRCS played a key role in identifying areas at risk for erosion and providing stabilization plans to protect the watershed – The NRCS conducted a survey of all the burn zone areas and determined where there was high risk of landslides, mudslides, or soil discharge into drainages. They mapped out the best areas for chipping as a form of stabilization using material nearby. Factoring wind patterns, they did not advocate using silt fences. This is likely because the soil could blow away.

Figure 16. Skyline Hawai‘i: Eucalyptus erosion/nurse logs protecting native plantings, e.g., koa and ‘a‘ali‘i.

Restoration techniques and tips:

- Volunteer gratification – “When you're bringing in volunteers, I guess the plant matters. So there's some sense of accomplishment.” Initially volunteers would help weed the areas carpeted with wattle. If baby wattle is pulled earlier and earlier in their life cycle, and still small, it is not too difficult to remove. Beyond that, it is very difficult to dig out of the ground. However, it was carpeting the landscape. “Volunteers would spend all day in one little area pulling wattle and then turn around and say, ‘That's all I did today?’” It was more efficient to spray the wattle and use volunteers to pull out fireweed which comes out easily in big clumps.
- Koa and ‘a‘ali‘i are restoration champions – Generally robust and faster growing than other natives, “When you put those two together, you get the girth of the ‘a‘ali‘i and the height of the koa with its nice, sprawling canopy.”

Overview And Conclusion

This report highlights the nuanced and diverse approaches required for managing vegetative fuels and mitigating erosion in drainages across Hawaii's unique landscapes. By visiting field sites, conducting interviews, and synthesizing the insights from Subject Matter Experts and local practices, the findings emphasize the need for tailored strategies that account for varied topographies, vegetation types, and community contexts across Hawai‘i. Adaptive management practices, incorporating feedback loops and environmental cues, are critical to achieving long-term sustainability and resilience in these efforts.

Central to these approaches are methods such as the strategic use of mulching, erosion control structures, phased vegetation treatments, and community engagement in restoration efforts. These practices not only mitigate wildfire risks but also foster ecological restoration and community stewardship. Effective management hinges on collaboration among agencies, practitioners, and landowners to share resources, refine techniques, and balance priorities like erosion control, fire risk reduction, and native habitat restoration.

While approaches may vary (e.g., anchoring work in or outside of a drainage), some key points are stressed throughout the case studies:

- Don’t bite off more than you can chew. Figure out what is effective at a small scale, then ramp up. Reflect. And always have a long-term plan for maintenance.

    When I first started doing this work, I thought we should be able to reforest 500-acres in 10-years. That is not how it works. Think big but start small. And then be patient with time scales for change. You will see results. For example, in the KBC there is a measurable bump in the native birds.

    If you have $10,000 to work on fuels reduction in a gulch and a solution is to put goats or sheep in the area to graze down fine fuels, make sure you can guarantee there will be $10,000 for every year moving forward. If not, consider using the $10K to clear out larger fuels.

- Be selective with chemical treatments with the goal of gradually phasing out herbicides and in favor of other techniques such as establishing canopy to shade out grass fuels.

    (We) use mechanical and hands-on techniques to reduce and, ultimately, move away from herbicides for biocontrol as much/soon as feasible.

    You do not need to blanket a place with Roundup once a month just to control fire. If you do, you will most likely be increasing erosion and the presence of other incipient weedy species.

- "The right plant for the right place"[17] means that the (idealized) goal of removing all non-native, invasive fire-prone plants and restoring exclusively with natives may not be feasible when considering harm reduction variables such as erosion and flooding.[18] [19]

    Some gulches are just better left untouched…. You have to ask, will it really solve the problem or create more issues? If you cut all the [non-native] trees out of a gulch, more grass and other weeds will grow inside and there will be more flooding in heavy rains [where] there's no tree cover.

    There are hundreds of species of eucalyptus, but the species planted within the plantations are composed of so much water that they do not easily burn. Eucalyptus grows quickly, creating a canopy within a few (three) months that can shade out the understory.

    Annual and perennial ryegrasses germinate quickly and provide immediate ground cover. Ryegrass is not considered invasive in Hawai'i and is often used in hydromulching projects for stabilizing soil, especially in areas where invasive species have been removed.

- Repurpose what you have on hand and be creative in the face of limited, and often fluctuating resources — funding, workforce, and equipment. Flip the invasives! Put removed fire fuels to the work on recovery.

    Repurposing as much as you can not only saves costs for your organization, but it is also better for community stakeholders who don't usually have purchasing funds for restoration and stabilization projects.

    Rather than removing trees from embankments that are difficult to remove or destabilize the soil to remove, such as koa haole, trees are felled, leaving the stumps for embankment stabilization and to catch debris falling from the topside.

    There's a lot of material on island that can be kept, rather than shipped off island or burned. Wooden pallets, scrap lumber, cardboard food containers, paper products, office material and manuals, telephone books…. [can be used for protecting seedlings and mulching]. You can use a line of palettes on the landscape [for windbreaks] …. It

[17] The gardeners' principle to match the plant with the garden conditions is increasingly accepted among people working on wildfire risk reduction, integrated watershed protection, erosion control and restoration.

[18] To paraphrase the restoration ecologists, Suding and Hobbs (2009), the pathway to restoring an ecosystem can be very different from the one that led to the degraded state.

[19] While most Hawaiian native plants have not evolved with fire, a few stand out as more fire-adapted and resistant such as koa, `a`ali`i, `ohi`a (*Metrosideros polymorpha*), and `ulei (*Osteomeles anthyllidifolia*). Some native species are less flammable and may fare better in fire because of their high-water content such as ʻāweoweo (*Chenopodium oahuensis*) (https://mauiinvasive.org/2021/03/18/native-plant-firebreaks-may-be-a-tool-to-control-wildfires/). For more resources for green breaks visit: https://pacificfireexchange.org/resource/coastal-plants-for-creating-greenbreaks/

is all going to decompose eventually…. In gullies, fishing nets recovered from the beaches are filled with rocks to slow the flow of massive amounts of soil runoff into the ocean.

Eucalyptus, like black wattle, are water guzzlers (and hoarders) with some species holding on to massive amounts of water in the cambium layers of the tree. Eucalyptus logs are used for slope stabilization and restoration. Coupled with good [black wattle] mulch between the barriers, native seedlings safely nestled behind nurse logs seals in soil moisture and do not require much or any watering.

- Community engagement and volunteerism is the life's blood of most projects. Give volunteers a sense of gratification, a stake in their work, and plan pragmatically.

  You don't want volunteers spending a lot of time digging the holes for the plants instead of getting as many plants in the ground as possible. Have field crew dig holes as part of the prep work for outplanting events and flag them.

  A contractor may be able to plant three times more than a volunteer group but working with volunteers enables connection to community and connects the community to the places we work in… On average working with volunteers, we can plant 1000 trees. Planting methods are used that ensure survivorship (e.g., protection from predation and frost).

  On Kaho'olawe, you always have to have contingencies. Consider personnel, material, equipment, and be ready if something breaks or the work is too hard or challenging for the volunteers or becomes unsafe. KIRC is always ready with an easy fallback for volunteers such as collecting seed or making seedballs…. The goal is to make the experience meaningful by educating volunteers about the history and cultural significance of the island while working on restoration projects.

  Volunteers would spend all day in one little area pulling wattle and then turn around and say, "That's all I did today?" It was more efficient to spray the wattle and use volunteers to pull out fireweed which comes out easily in big clumps.

Looking forward, the lessons documented here provide a foundational guide for scaling and adapting these methods to other fire-prone regions with similar challenges. Continued research, funding, and public-private partnerships will be pivotal in refining these practices and addressing emergent threats. By integrating local knowledge with best practices, Hawai'i can advance both wildfire resilience and ecological restoration while preserving the integrity of its natural and cultural landscapes.

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Appendix A: Outreach Letter (Email)

Vegetative Fuels Management Near Riparian Areas and Water Drainage Features:
Lessons Learned and Best Practices

Invitation: Hawai'i Wildfire Management Organization is seeking your experience, mana'o and recommendations on fuels reduction and management in Gulch areas. *What are the best practices and lessons learned to reduce wildfire risk with minimal erosion and other harm reduction considerations?*

Background As more communities and landowners are planning and implementing fuels management projects to reduce the risk of wildfire ignition or rapid spread, the best practices for managing areas adjacent to waterway drainages or dry gulches have been limited.

Purpose To develop Information and FAQ sheets and a webinar, HWMO is compiling technical advice on vegetative fire fuels management being carried out adjacent to, or inside of, small
ravines, gulches, stream channels, and other natural water drainages to: prevent wildfire ignition and rapid spread *while* minimizing erosion and other potentially harmful impacts caused by vegetation treatment.

Your contribution? Over **June - mid August 2024**, HWMO will be conducting online and in- person consultations (semi-structured interviews} of specialists working on integrated watershed protection, riparian restoration, erosion control, and wildfire risk reduction to capture the challenges, opportunities, and the fine-tuned strategies you have developed over years of practice. ***What is involved?***

- **Zoom interview**: 1-2 hrs. *if an in-person, field site consultation is not feasible*, ***or***;
- **Field interview and site visit**: 1-2 hrs. interview and field visit/s (half to full day or more} *HWMO researcher is happy to include volunteer work during her visit;*
- **Post-consultation review and approval correspondence/phone call**: review and make corrections and additions to your consultation summary for HWMO use.

Should your time not allow for an interview, HWMO can provide a simple list of questions you can answer via email. **Mahalo nui!**