



KAULANA & HAKIOAWA: Watershed Restoration on Kaho'olawe



Kūkulu Ke Ea A Kanaloa



Project Site Description

Kaho'olawe is approximately 45 square miles in size and seven miles southwest of Maui. The island is located in the rain shadow of Haleakalā, and receives little rainfall but once possessed a thriving native dryland forest. Archeological evidence suggests human habitation began as early as 1000 AD. Subsistence farmers and fisherman formerly populated Kaho'olawe, known at one time as a navigational and religious center as well as the site of a superior adze quarry.

In 1793, grazing animals were introduced to the island. Uncontrolled grazing by feral ungulates ravaged the

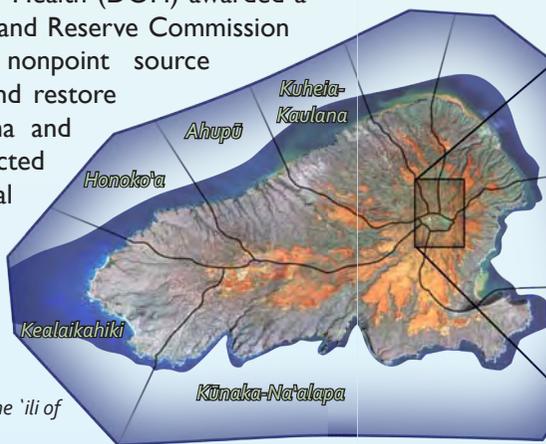
native vegetation. Without vegetation erosive processes accelerated. The topsoil washed into streams and surrounding waters, baring the island to



Rain ko'a (shrine) used to attract nāulu rains

hardpan and polluting the marine environment. As early as 1900, historical accounts describe Kaho'olawe's environmental degradation as "severe" - decades before it began its 50-year history as a military bombing range.

In 2005, the Department of Health (DOH) awarded a grant to the Kaho'olawe Island Reserve Commission (KIRC) to manage the nonpoint source (NPS) pollution problem and restore two watersheds at Kaulana and Hakioawa. The KIRC contracted the United States Geological Survey (USGS) for scientific monitoring of the project.



Two mile perimeter boundary and nine 'ili of the Kaho'olawe Island Reserve

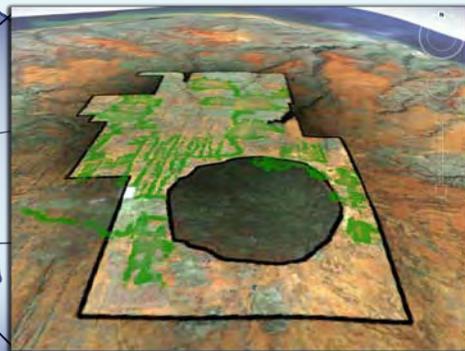
Five Year Work Plan

1. Reduce erosion and environmental degradation of Kaho'olawe
2. Re-establish a Hawaiian dryland forest ecosystem
3. Utilize local community time and labor while instilling a sense of aloha 'āina
4. Monitor, collect, and correlate data from USGS stream gages, turbidity monitors and soil erosion pin transects



Hakioawa watershed is an area of historical significance and restoration effort. Note the erosional runoff after a heavy rain

The traditional Hawaiian approach of *mauka-to-makai* (ridge to reef) maintains the philosophy that restoration on land will improve the nearshore marine environment. Restoring vegetative cover over the island will help reduce runoff and sedimentation into the ocean. Native dryland forest regeneration and erosion control will be achieved through the use of best management practices (BMPs). The physical structure and health of Kaho'olawe's reef ecosystem will be improved.



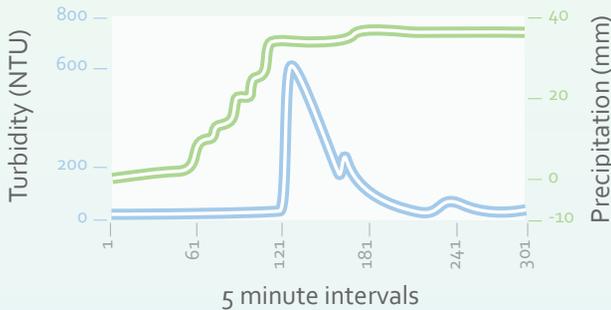
A close up of the 400 acre restoration site in Hakioawa and Kaulana watersheds at Pu'u Moa'ulanui

Monitoring and Analysis

Soil Erosion Pin Transects

Soil erosion pin transects measure rates of erosion over time. Seventy-seven pin sets were monitored over the course of one year. Extrapolation of the short term data resulted in the retention of 7.65 tons of sediment per acre per year in the restoration sites and 5.61 tons of sediment per acre per year being lost in areas with no restoration.

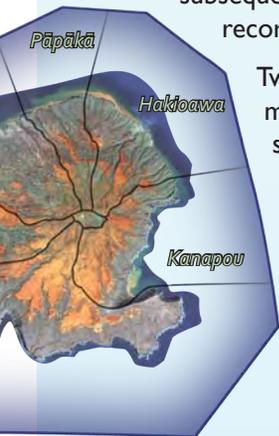
Rainfall at Hakioawa and Subsequent Turbidity Spike



Turbidity Monitors and Stream Gages

NPS pollution and turbidity occur after heavy rains wash soil/mud into the ocean. Two turbidity monitors were deployed in Kaulana and Hakioawa bays to gain base line data. Ongoing bio-fouling due to algal growth occasionally prevented the detection of turbidity events with frequent cleaning necessary. Flash flood events with subsequent high turbidity were successfully recorded for later analysis.

Two gaging stations installed near the mouths of Kaulana and Hakioawa streams automatically record stream information and collect water samples during rain events. Real-time water level and discharge data are sent via a satellite communication system to the USGS, and the water samples are processed for suspended sediment.



Ocean Program Coral Reef Studies

KIRC surveys have documented that the highest percentage of coral coverage occurs at the east end of the island, including survey sites adjacent to Hakioawa and Kuheia. Observations over time suggest watershed restoration is positively impacting coral coverage at these sites. Additional data will be needed to attribute increases of coral cover and diversity to the watershed restoration work.



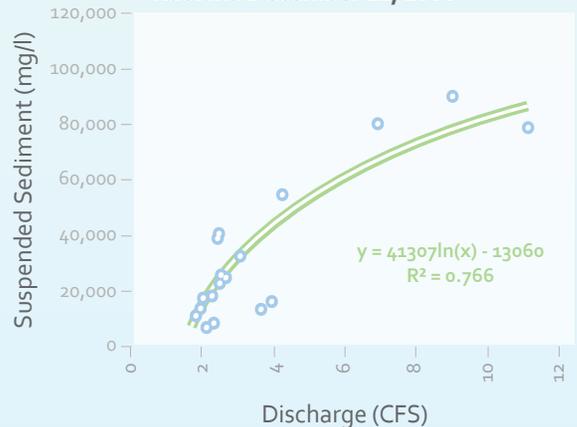
A member of the KIRC Ocean Program monitoring coral in Kaulana bay

Final Analysis

The 2000+ volunteers make up the backbone of the watershed restoration effort with their time and effort. In return a sense of *aloha`āina* (love of the land) and *kuleana* (responsibility) of the people of Hawai'i to Kaho'olawe is shared.

BMPs formulated for the island will be important in future restoration work. Initial USGS data indicates that erosion has been reduced in the watersheds. Measurements of planted 'a'ali'i monitored show increased cover by 50% after one year. This information shows great promise for the restoration of Kaho'olawe. Additional data and final results will be available at <http://kahoolawe.hawaii.gov> in September 2010.

Discharge (CFS) Versus Suspended Sediment (mg/l) Kaulana December 11, 2008



Mitigative Measures to Control Problems

Five watershed restoration challenges on Kaho'olawe

1. A harsh climate consisting of low seasonal rainfall (10-25" per year), high solar radiation, high rate of evaporation, and strong persistent trade winds
2. Severe soil erosion that has reduced available nutrients, organic matter, and microbial activity
3. Invasive species that currently out-compete native species
4. Logistically difficult access to a remote island
5. Continued presence of unexploded ordnance (UXO)

To overcome these challenges, multiple strategies and BMPs are used. The KIRC built a 450,000 gallon water catchment for drip irrigation of native plants. Seedlings are inoculated with a beneficial fungus that allow them to absorb micro-nutrients and water from the earth. Hardpan is broken up to allow roots to grow outward. Soil is amended with organic fertilizer and compost. Pili grass hay or kiawe mulch is spread around seedlings to reduce water evaporation. This planting strategy has greatly increased the plant survival rate on Kaho'olawe.

Planting areas threatened by alien species are managed to help re-establish the native forest. Invasive tree species are controlled by applying herbicide to the sapwood. Handtools and stump pullers are utilized to remove other alien plant species.



Pili grass "kīpuka" planter boxes and plantings along irrigation lines help stabilize soil



Shade cloth windbreaks are provided for selected species to protect them from the harsh elements

Pili grass bales and coconut geo-textile matting are used for erosion control and catch sediment that would otherwise be lost into the ocean. Check dams made of pili also build up the soil and allow for back planting.

The "Kīpuka Strategy" uses pili grass bales as planter boxes for hard pan or areas only cleared on the surface of UXO. Fertile soil and seeds are added to the *kīpuka* creating a protective micro-habitat for new growth. The *kīpuka* also catches wind blown dust moisture and seed. A variation of this method utilizes kiawe mulch as a substrate for seeds.

UXO remains widespread on Kaho'olawe and identification and avoidance procedures are critical. The UXO removal effort cleared only about 10 percent of the land area to a depth of four feet for planting and restoration. Strict rules limit access and activity on the island and all volunteer workers are accompanied by KIRC trained "Access Guides."

The physical restoration of Kaho'olawe is also considered a spiritual healing of the island. A holistic approach using traditional Hawaiian protocol is incorporated into the restoration effort. Cultural training includes appropriate protocols, history, and site-related chants



Restoration volunteers with their 'a'ali'i kīpuka grown from seed

to instill proper respect for, and understanding of historic and archeological sites. Annually, the planting season begins with a traditional ceremony, *Ka Holo Ka Lani*, to call the life giving rains to the island.



Signs across the island warn against the dangers of UXO

KIRC: The Vision

The kino of Kanaloa is restored. Forests and shrublands of native plants and other biota clothe its slopes and valleys. Pristine ocean waters and healthy reef ecosystems are the foundation that supports and surrounds the island.

Nā Po'e Hawai'i care for the land in a manner which recognizes the island and ocean of Kanaloa as a living spiritual entity. Kanaloa is a pu'uhonua and wahi pana where Native Hawaiian cultural practices flourish.

The piko of Kanaloa is the crossroads of past and future generations from which the Native Hawaiian lifestyle spreads throughout the islands.

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