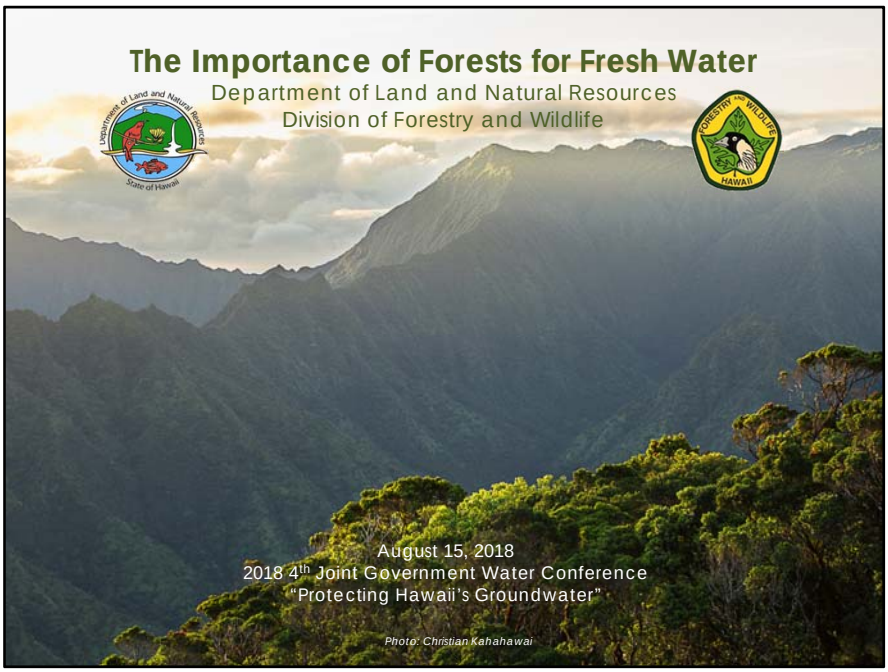
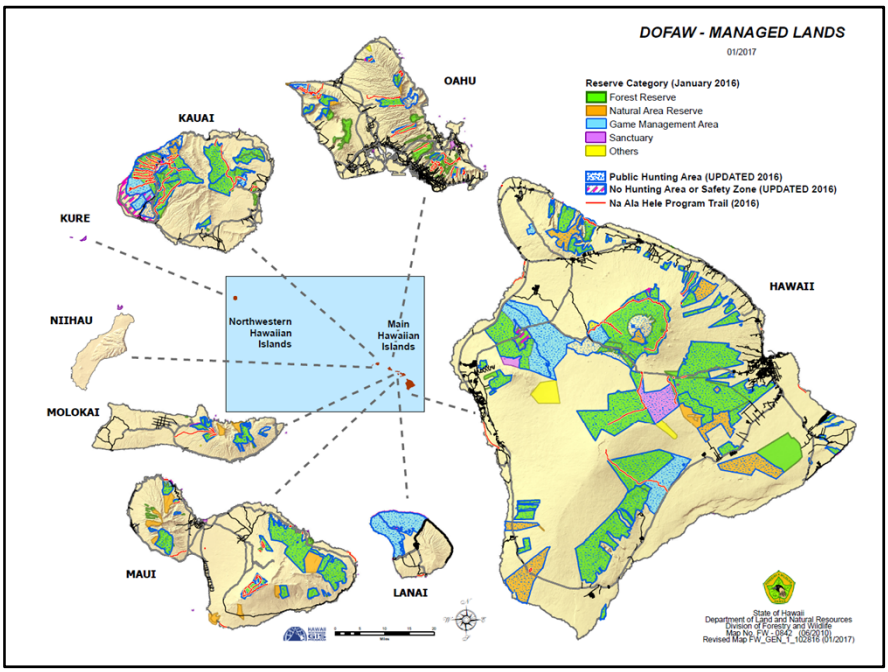


ABSTRACT

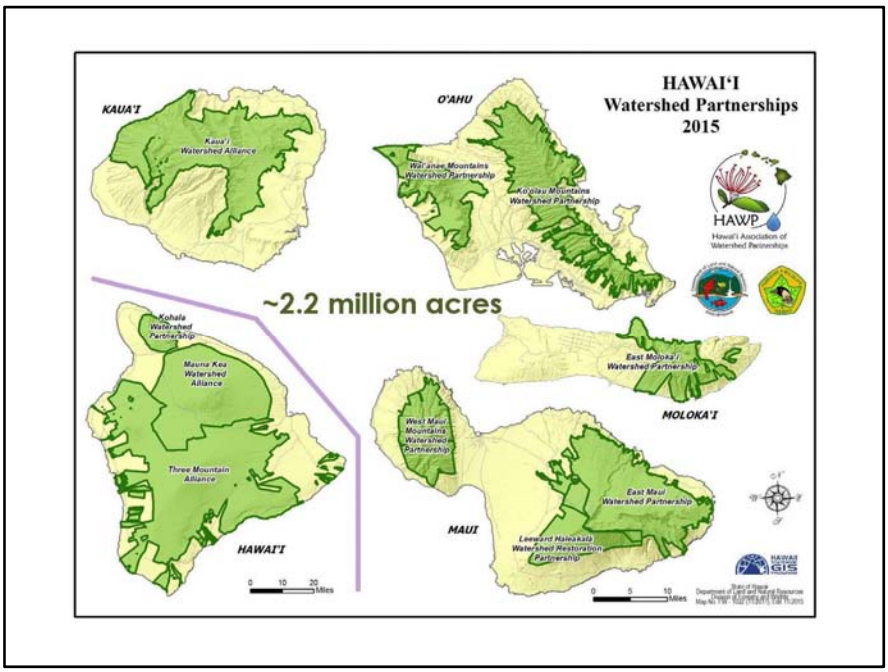
Hawaii's native forests absorb rain and cloud moisture across millions of acres - and are the source of Hawaii's fresh water. At the same time, they help reduce erosion that can impact water quality and damage coral reefs. For over a century, public-private partnerships have managed mauka forests by preventing the advance of invasive plants, animals and disease. This presentation will discuss the approaches to mauka watershed management in Hawai`i and the important role of the State's Division of Forestry and Wildlife and Watershed Partnerships in helping safeguard fresh water resources.



Brief overview of your role and the role of DOFAW in managing forests/water resources.

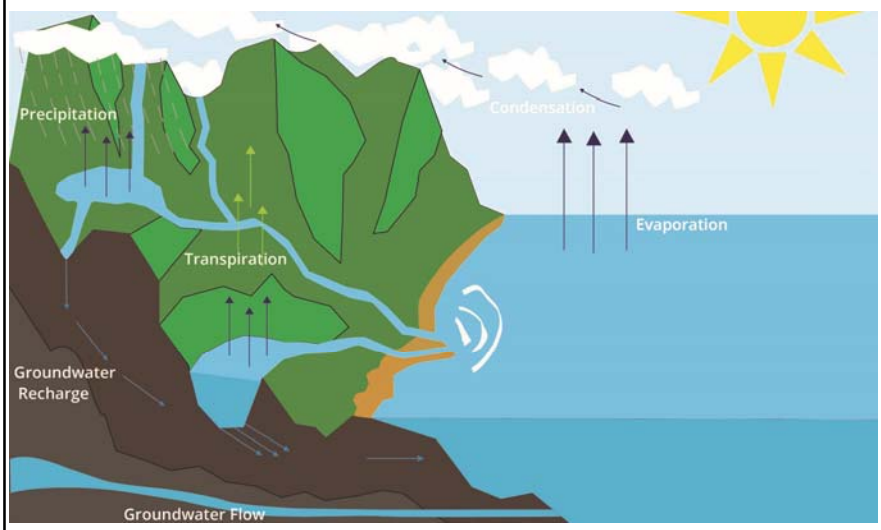
DOFAW is responsible for managing over 1 million acres (a quarter of the land in the state). Managed lands include areas for public hunting (GMAs), recreation and hiking trails, Forest Reserves, offshore islands, and Natural Area Reserves. The majority of DOFAW managed lands are forested.

As you can see this is a tremendous amount of acreage to manage. We can't do it alone.



The WPs began in East Maui in 1991 with the same goal as DOFAW – **to protect forested watersheds for water recharge**. Today, there are 10 active partnerships statewide. All the partnerships are made up of voluntary alliance of public and private landowners committed to the common value of protecting Hawaii's watersheds for water recharge, biodiversity, and other ecosystem services. Each partnership has its own **field crew and staff**, including a coordinator who helps direct the work per the goals outlined in each **management plan**.

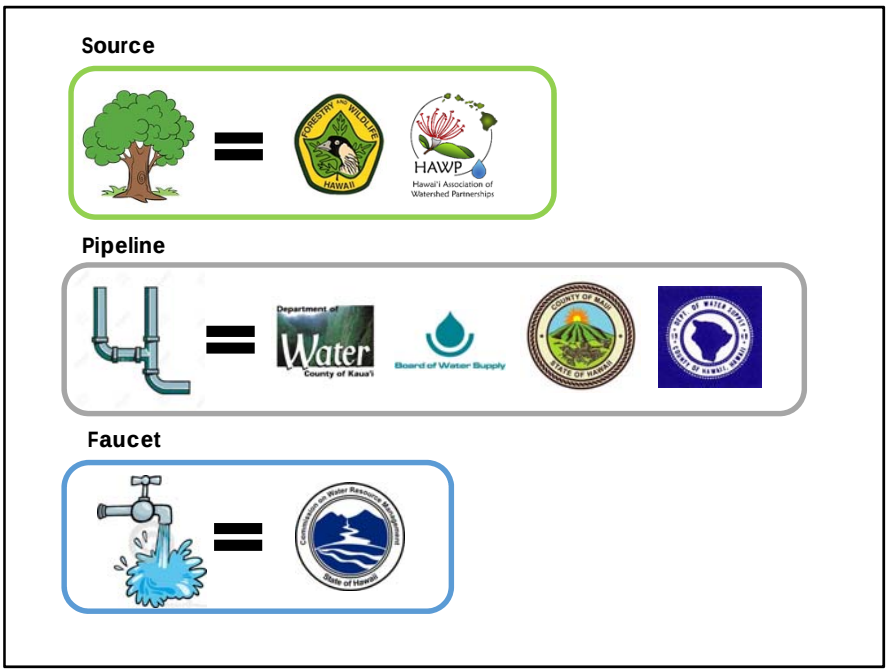
Threats to our forests don't abide by TMKs, which is why WPs are so critical to the management of watersheds because they **can work across landowner boundaries**. They help fill the management gaps.



Forests play a critical role in the water cycle. Not only do they absorb water (slowing it down and allowing it to seep into the ground and replenish aquifers). They also transpire and release water through their leaves back into the air, adding to the amount of water released by clouds as rainfall.

Most important – our forests are essential for water security. The majority of domestic potable water is coming from groundwater sources. But it takes 25 years for rainfall to reach the aquifer! That means we drink 25 year old water. The management actions and investments we make today are essential if we want to have water in the future.

Watershed protection is one part (arguably the first step!) in the larger picture of water security. We need our forests if we want to have water in the future.



There are a lot of different agencies that oversee the protection and management of our water resources. This diagram is a simplified way of describing the relationship that these various agencies have to water.

DOFAW/WPs protect the "source," the Board of Water Supply is the "pipeline," and the Water Commission is the "faucet." **But to get water to go into the pipeline and out the faucet you must first protect the source.**

DOH = water quality.

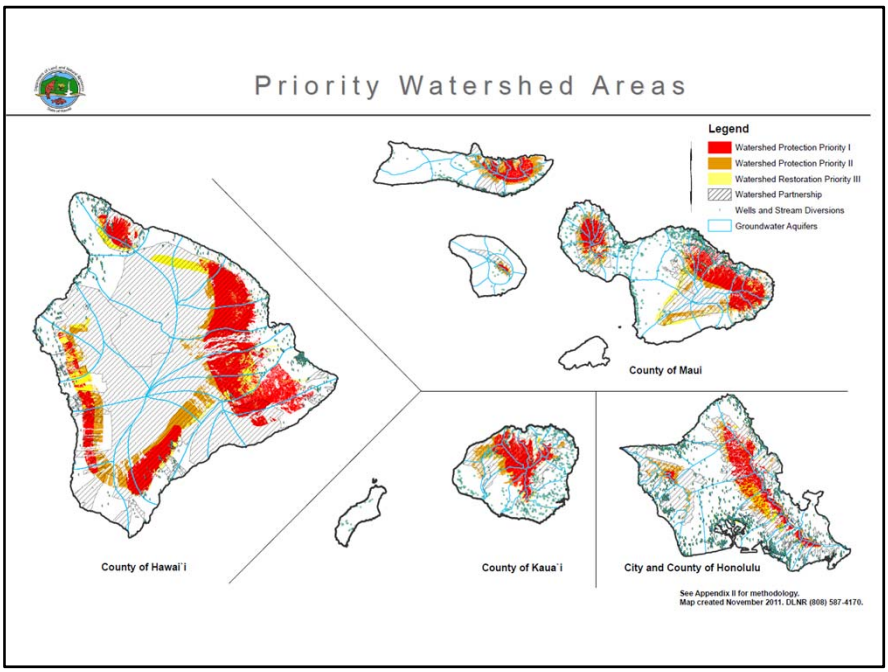
What is the source? What do our forested watersheds look like?

In Hawaii our watersheds extends mauka to makai. Water collects at the summit and drains into a common outlet (the ocean). On its way to the ocean, water is absorbed into the ground or channeled into streams. **A critical component of the watershed's ability to capture and store that water is the existence of the forest.**

While any kine forest is better than no forest, our native forests have adapted to be super efficient at capturing and storing water. It has a multi-layer canopy of ferns, mosses, and trees, which help slow down the flow of water, allowing it to seep into the ground. **A giant living sponge!**

In Hawaii, water capture and recharge is typically highest along the crest of the mountains at high elevation. Here our forests are dominated by native trees. **Ohia make up 80% of our forests and watersheds.**

The importance of our mauka forests for water capture is further demonstrated by a 2015 *USGS Report on Oahu Groundwater Recharge* which said that on Oahu, the northern section of the Koolau mountains receives as much as 180 inches of rain per year. **The average annual rainfall for Puu Kukui is over 300 inches per year.** Compared to undeveloped and non-agricultural areas at low elevation, recharge is less than 5 inches per year.



Acknowledging the value of our forests for fresh water, DLNR has identified "priority watersheds". These areas include high concentrations of native forest and are considered the best areas for recharge.

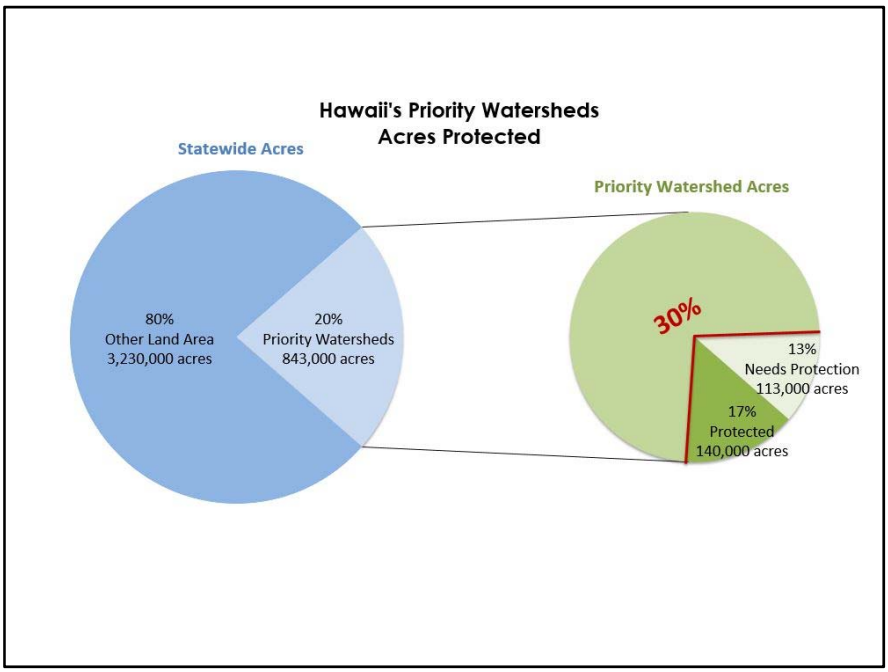
How Priority Watersheds I and II areas were determined:

- Land cover types that provide the most groundwater recharge (GAP analysis – landcover types, distribution of native vegetation types)
- Elevation, rainfall and/or fog drip
- Threat of conversation that would generally result in less recharge function, soil retention, and an increase in runoff.
- Mauka native forests that receive the most rainfall and are essential for sustaining the State's water resources, cultural and biological diversity
- Priority areas are based on climatic conditions (elevation, moisture zones including fog and rainfall levels), land cover types that provide high recharge and fog capture (native wet and mesic forest)

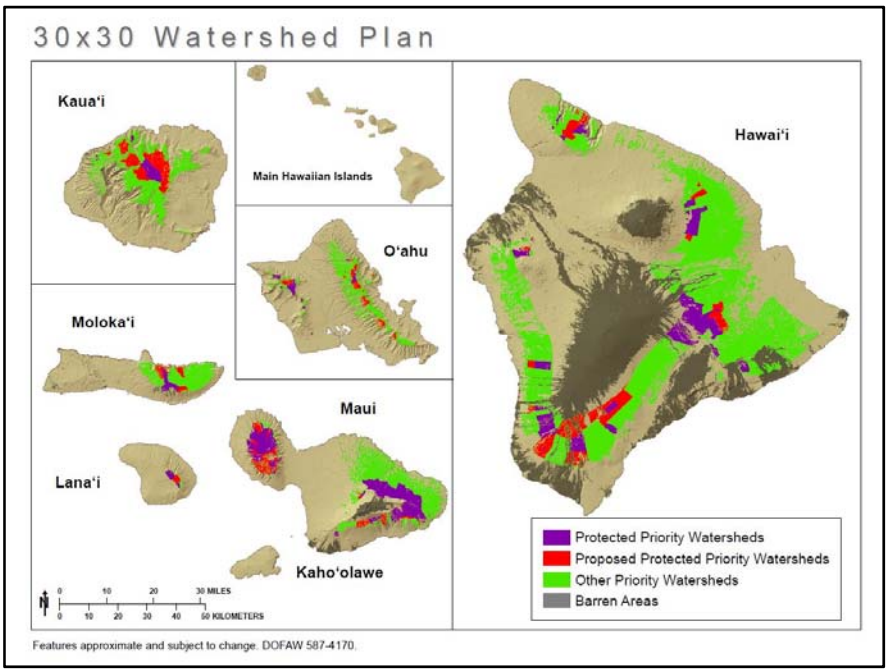
The State has a commitment to protect 30% (253,000 acres) of Hawaii's priority watersheds by 2030.

The metric we use for “protected” is acres fenced. Example of a fence separating native forest (protected on the left) vs. unprotected (grazed by goats).

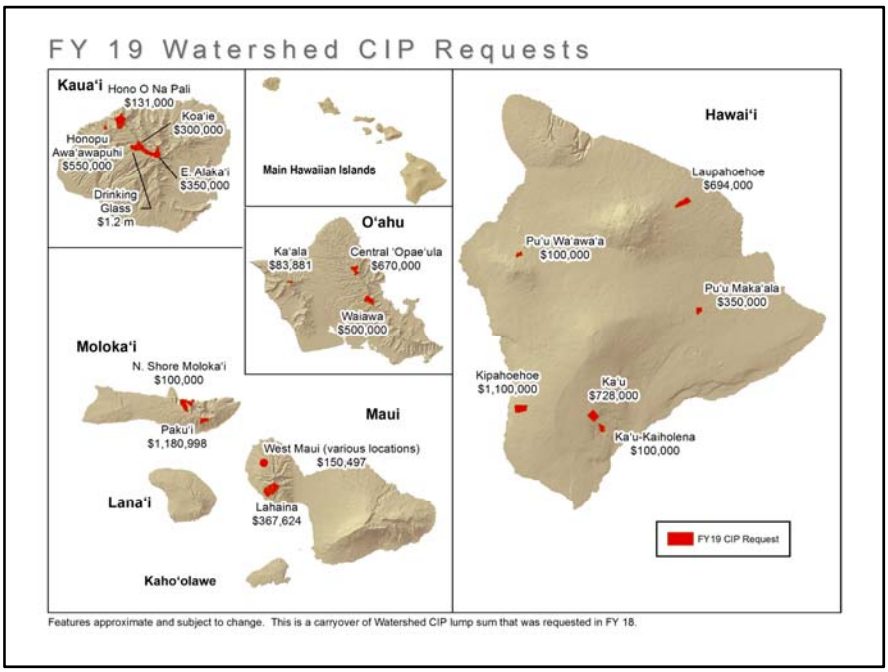
Another example from Kohala. **Fences not meant to keep people out.**



In order to reach the goal of 30% we need to protect approximately 9,000 additional acres every year.



Green areas = what DOFAW has identified as "priority watershed" (areas with the highest rainfall that are critical to recharging our water supply).
Purple = areas already under a high level of protection (aka: fenced or have natural barriers that keep it protected)
Red = future areas proposed for protection. If we are able to protect the areas in purple we will meet our 2030 goal of protecting 253,000 acres.



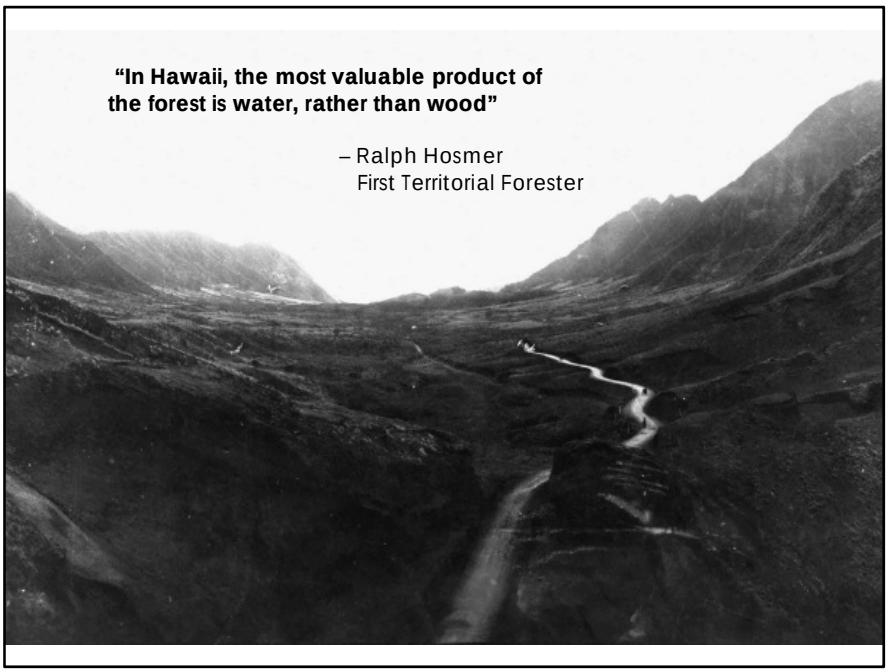
DOFAW secured over $7m in State FY19 funding. This will protect an additional 23,000 acres.

Watershed protection is not just about fences. It includes a suite of actions.

Keep in mind, the areas we work in are remote.

Field crews sometimes have to camp.

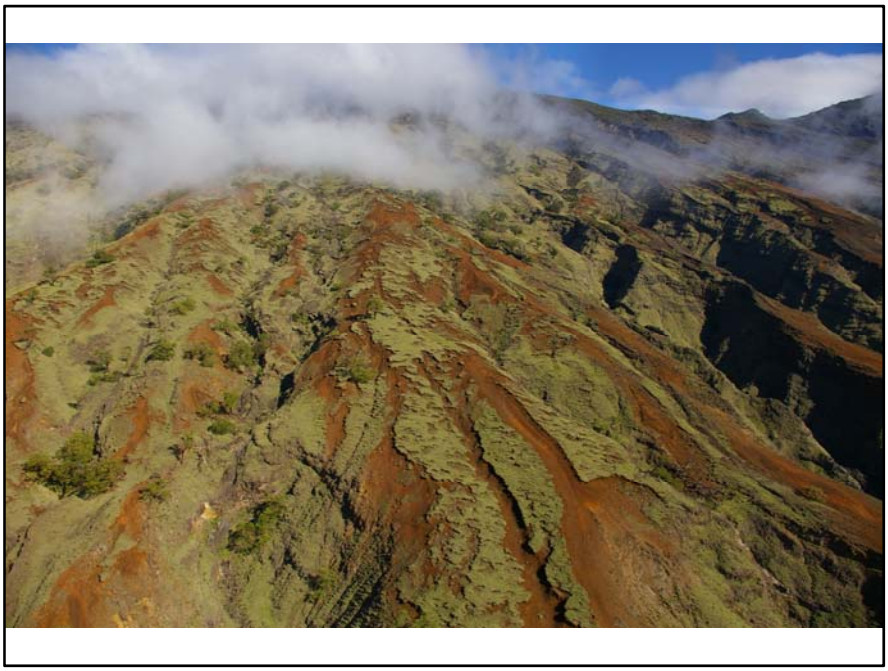
And most management sites can only be accessed by helicopter.



So while the tools we use to manage forests today have changed, the goal of forest protection is not a new concept. Hawaii's history of watershed protection began with the territory in the early 1900s. At that time, cattle and other introduced livestock were allowed to multiple and range unchecked throughout the islands resulting in the destruction of thousands of acres of native forests. The loss of the forest resulted in an alarming decrease in water supply. Territorial foresters recognized the need to protect the mauka forests to provide water for agriculture, especially sugarcane.

The push for protection led to hundreds of thousands of acres, of both public and privately owned lands, designated as Forest Reserve for the purpose of watershed protection (Act 44 on April 25, 1903). It also led to landscape-scale reforestation projects. Even though less than ideal species were introduced (albizia) the concept of forest protection and restoration to bring back the water was valid. **"The rain follows the forest" so where you have a forest, you also have water.**

The primary purpose of the Forest Reserve System has not changed since it's inception, and it currently protects 650,000 acres of Hawaii's watershed. **Water is the most important product coming out of the forest – not wood.**



Unfortunately, we are still dealing with the impacts of decades of unchecked grazing and deforestation. **Over the last 200 years, over half of Hawaii's forests have been lost.** Places like the leeward slopes of Haleakala are still in the process of recovering. The loss of forests not only impacts water recharge, it also impacts water quality.

Without forests, rain can quickly erode topsoil and cause flooding and landslides that impact our beaches, reefs, and fisheries downstream with muddy water. **Studies have shown that forests can reduce erosion by 90%.**


Kawela, Moloka'i – April 2009

Preliminary results of a Molokai erosion study by USGS indicate that after just 4 years of hoofed a sediment eroding from the 3,300-acre watershed decreased from 6 metric tons/year to 2 metric t to an increase in vegetative cover from 0% to over 70%.

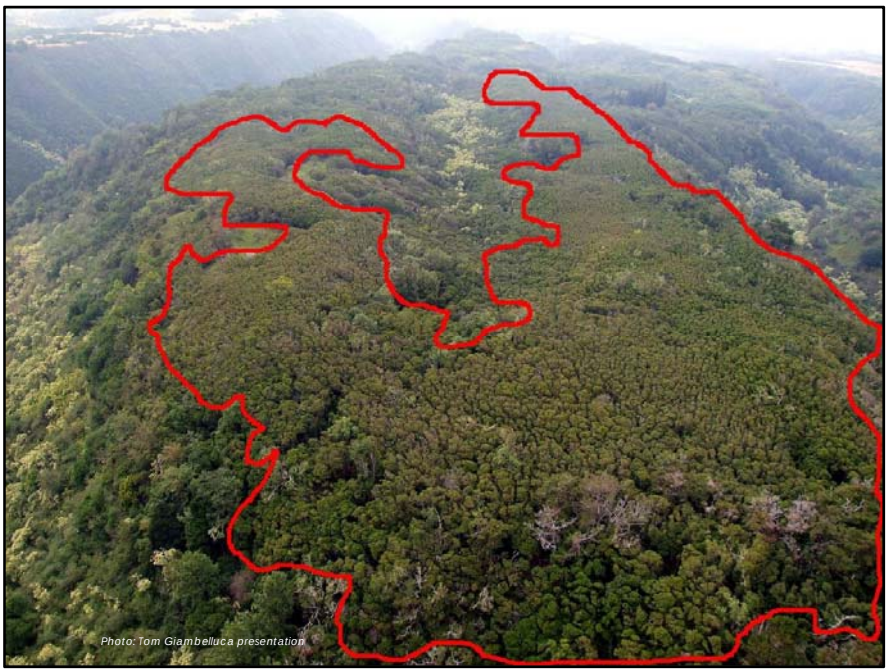
Note: less DOT overtime pay as indicator of success.

Forests are also important for their ability to capture water. **Conversion of native forests into non-native forests can have possible negative effects on water processes and the amount of water recharged into the ground.**

Unlike this ohia, **non-native plants have been shown to be 50% less efficient at collecting water**. Why? There are **morphological characteristics** that make invasive plants less effective at gathering water. Invasive plants are fast growing, must keep their stomata open for longer periods of time, more water escapes, less water recharged into ground. Certain non-native species like strawberry guava also have smooth bark which allows water to runoff more easily and inhibits growth of epiphytes which can assist with water collection.

A native Hawaiian forest can collect up to 30% more water just by fog drip alone!

On Hawaii Island, one study showed that 27% of the total precipitation was collected as fog drip in an ʻōhiʻa-dominated forest, but that number decreased to 16% where a forest had been invaded by strawberry guava.

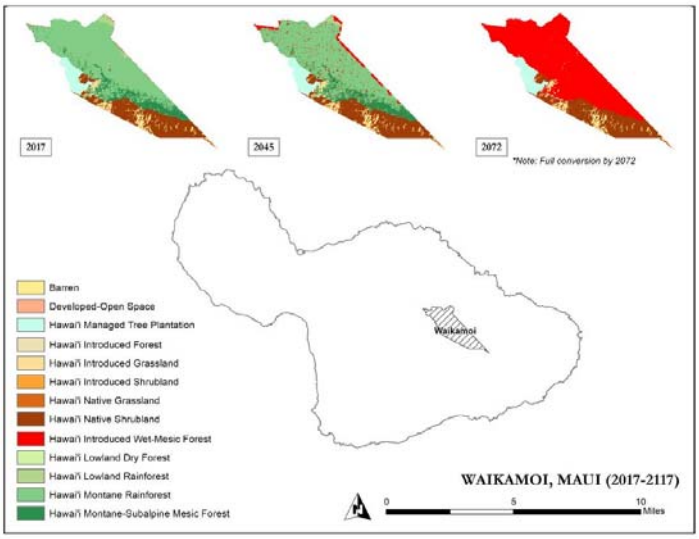


Certain invasive species, like strawberry guava, create monotypic stands and can outcompete native species. Nothing grows underneath.

Although we don't know precisely how much recharge will be reduced by the conversion of native forests to non-native vegetation, research shows that **strawberry guava trees evapotranspire 27-53% more water than native forests**, causing extensive water loss (*Giambelluca et al, 2008*). **In East Hawaii, non-native vegetation has already reduced estimated groundwater recharge by 85 million gallons a day** (*Engott, 2011*).

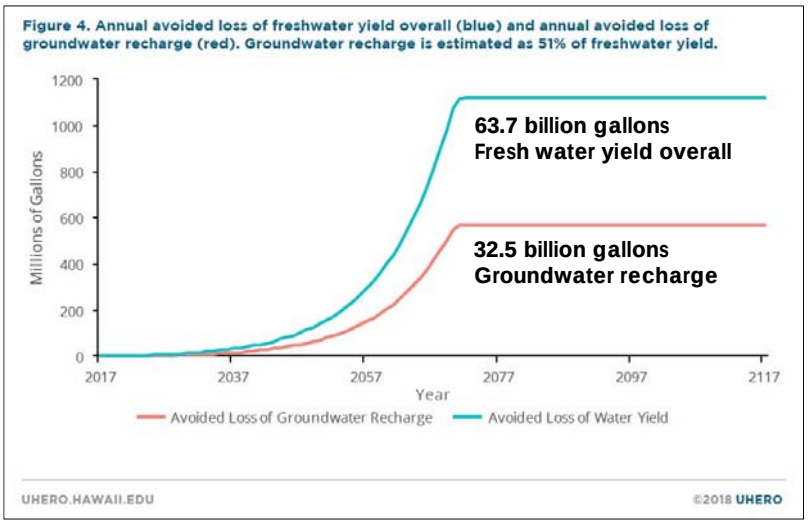
Imagine if each of these trees had a straw that was sucking up 53% of the water. That means less water for drinking, agriculture, etc.

Figure 1. Study site and simulated conversion of native to non-native forest over time in the absence of management. Without management actions, complete invasion of existing native forest is projected to occur in 65 years in year 2072.



We are also trying to understand the economic value of our protection efforts.

Using land cover scenarios, UHERO was able to quantify groundwater recharge services in the absence of conservation activities. While Waikamoi (9,000 acres) is currently under a high level of protection and management, this study looked at the avoided loss by keeping forest native vs. allowing invasion to occur.



The research indicates that there is significant value in investing in the management of these forests for fresh water. If not protected, conversion to non-native forest would generally result in loss of recharge function and decline in water supplies.

Precipitation in Waikamoi replenishes the Koolau aquifer (175 mgd SY).

Value of Protecting Waikamoi Forest:

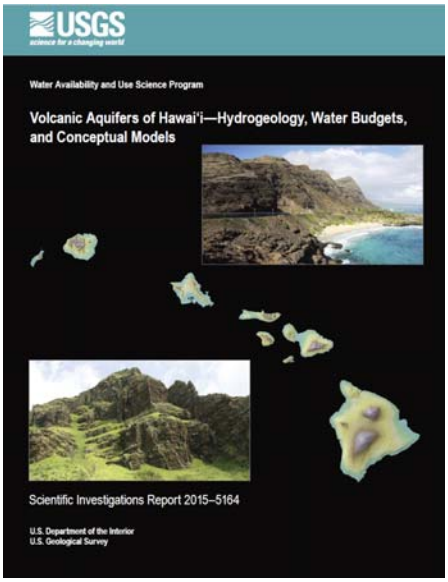
- Recharge 32.5 billion gallons of groundwater over next 100 years
- Produce $36.2 million worth of fresh water
- Prevent 4,300 tons of sediment per year from washing into ocean by 2072
- Management at Waikamoi contributes half of freshwater yield that recharges Koolau aquifer

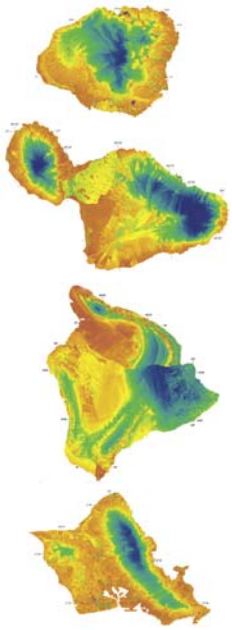
Mention other studies being done by Leah Bremer and Ike Wai to evaluate how groundwater recharge may change under a range of possible land use/land cover and climate futures for Pearl Harbor.

USGS and researchers at UH (Tom Giambelluca) are also trying to gather species specific data to better understand how native and non-native species impact hydrology and water supply.

This study started on Maui. Maui County DWS invests millions of dollars every year in watershed protection, but they are interested in better understanding the return on investment. With funding from Maui DWS and CWRM, USGS has identified sites where they can sample native and non-native plant species.

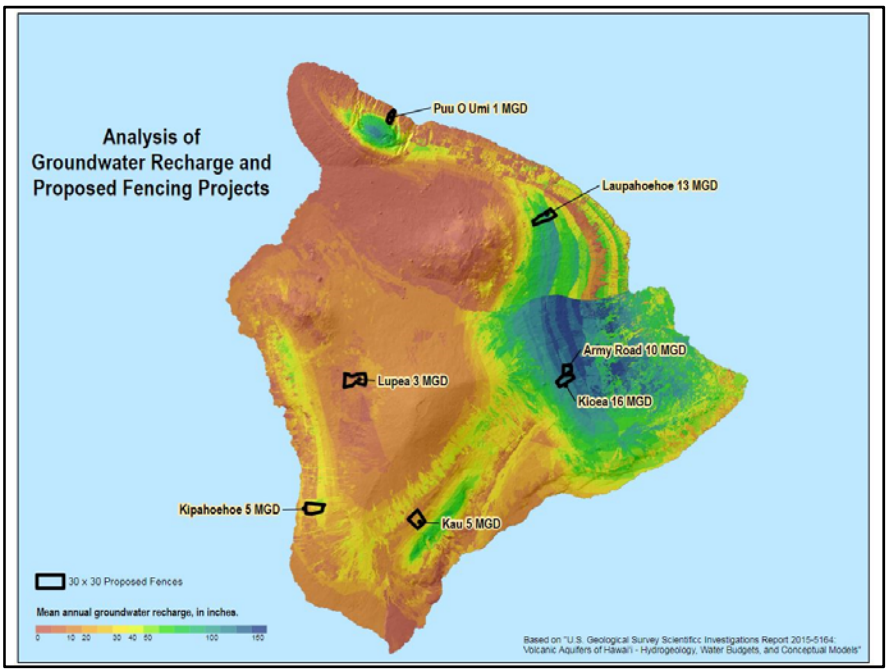
This study has been expanded to include Kauai, Oahu, and Hawaii Island. The data will be used to help refine the water budget model, which we are using to estimate recharge. **All our knowledge about effects of invasive plants on water processes is based on limited studies, on a few species, at a few sites.**





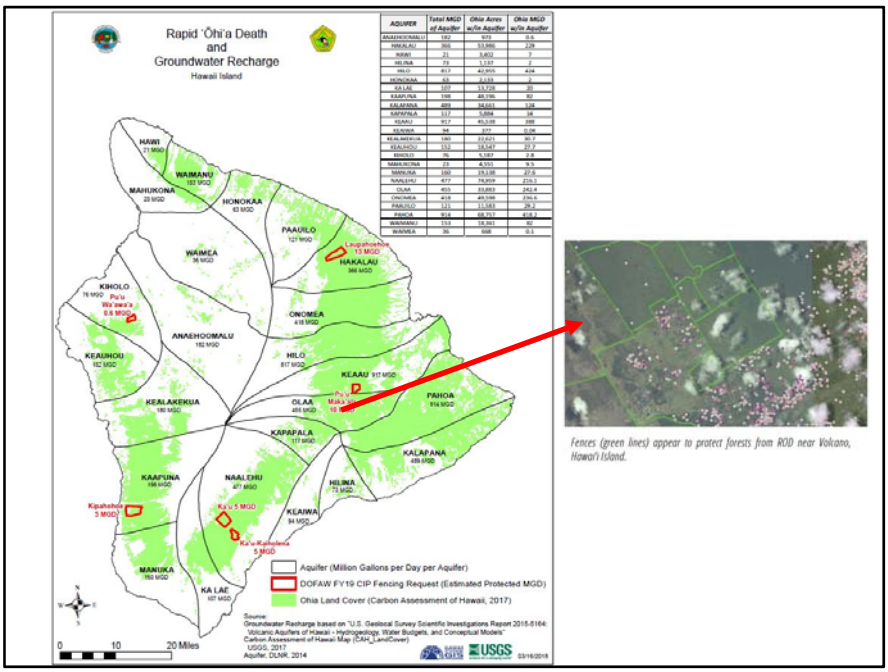
A lot of the data we use to better understand the impact of our management on ground water comes from USGS water budget model. Taking the data generated by this model, we have been able to estimate the amount of ground water recharged within our management areas.

Amount of mgd <u>protected</u> by investing in fences - maps generated using USGS water budget data from *Volcanic aquifers of Hawaii – Hydrology, water budgets, and conceptual models. Scientific Investigation Report 2015-5164*
https://pubs.er.usgs.gov/publication/sir20155164



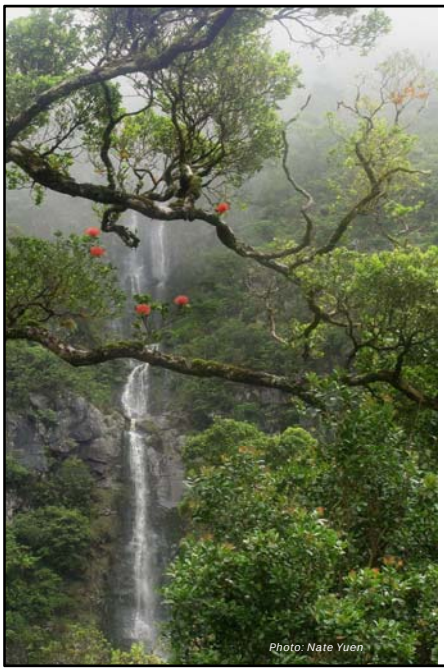
Estimates generating using existing data for water budget model. More studies are needed that look at species specific information. We don't know the hydrologic impacts of Hawaii's dominant plant species. The more data we can plug into the water budget model, the more refined these estimates can be.

Quantifying the <u>exact effect on recharge</u> remains a challenge. A lot more research is needed before we can definitely say how much recharge we get by protecting "x" amount of acres.



Fences (green lines) appear to protect forests from ROD near Volcano, Hawai'i Island.

Fencing to protect water resources is also part of the strategy to contain the spread of ROD. Watershed fencing projects help stop damage from ungulates that wound trees and make them more susceptible to ROD. In some places we have noticed that fencing may help prevent the spread of ROD by creating a barrier that prevents impacts from animals. Projects such as fencing is **helping keep forests more resilient** and therefore better able to cope with disease. **If we lose our ohia forests we not only lose our forests, we could also lose the engine that is helping create fresh water.**



Mahalo

Katie Ersbak
DOFAW, Watershed Planner
Katie.C.Ersbak@Hawaii.gov