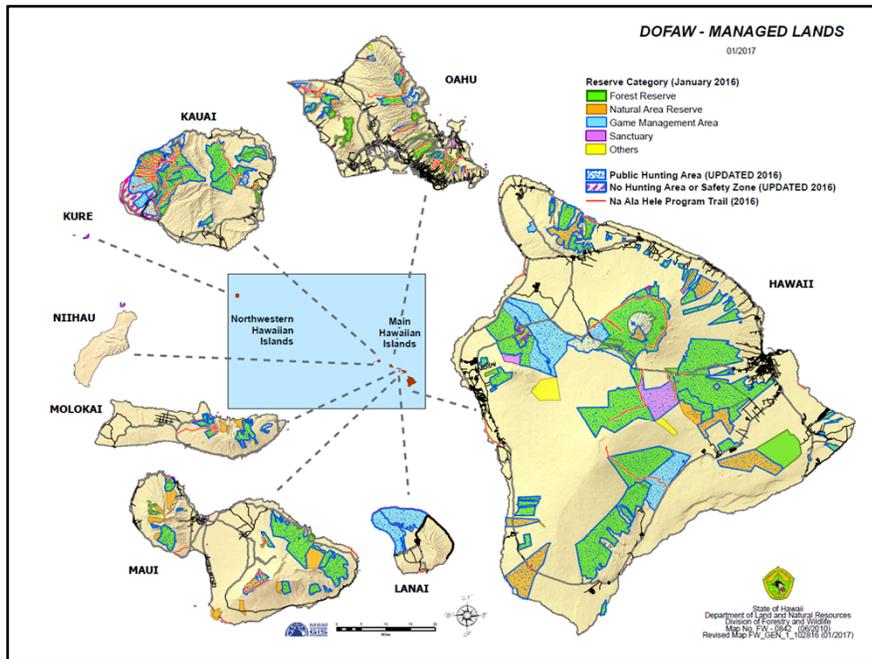


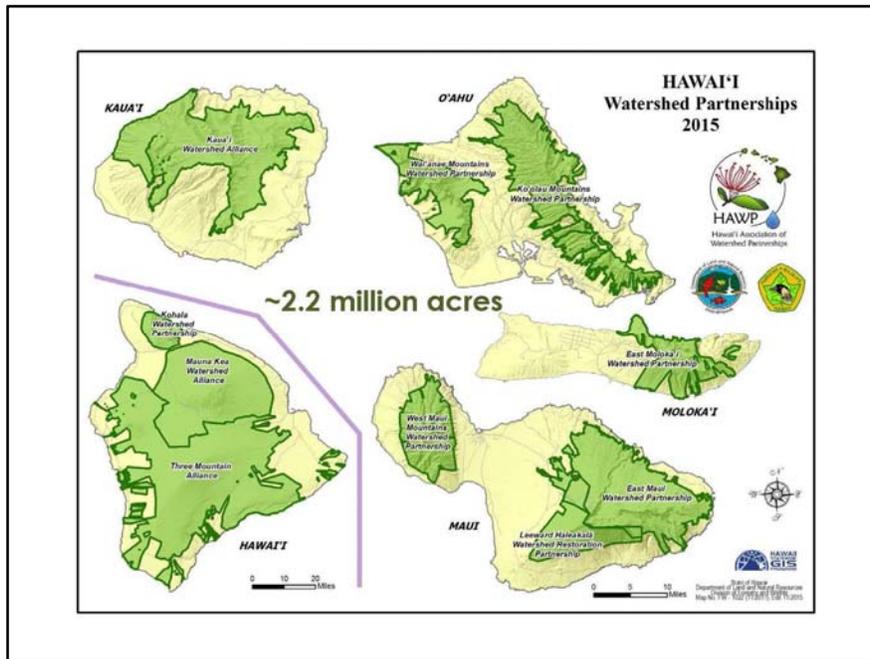
ABSTRACT

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.

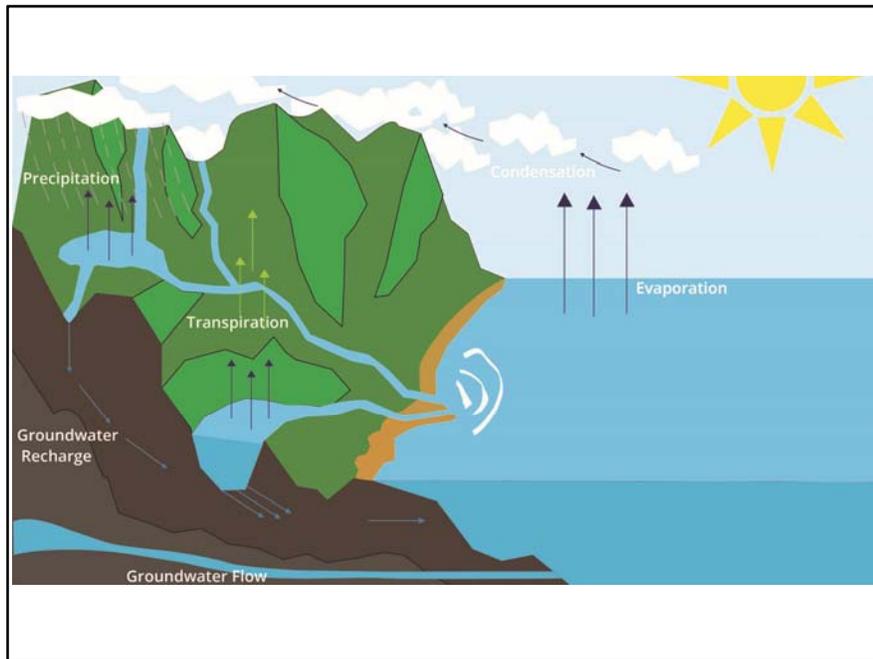
DOFAW is responsible for managing over 1 million acres (a quarter of the land in the state). This includes mauka areas and places dominated by native forests that are critical to water recharge. As you can see this is a tremendous amount of acreage to manage. We can't do it alone.



I also work with groups called Watershed Partnerships who help the State manage Hawaii’s forests and mauka areas. Note: DOFAW lands included in WP boundaries.

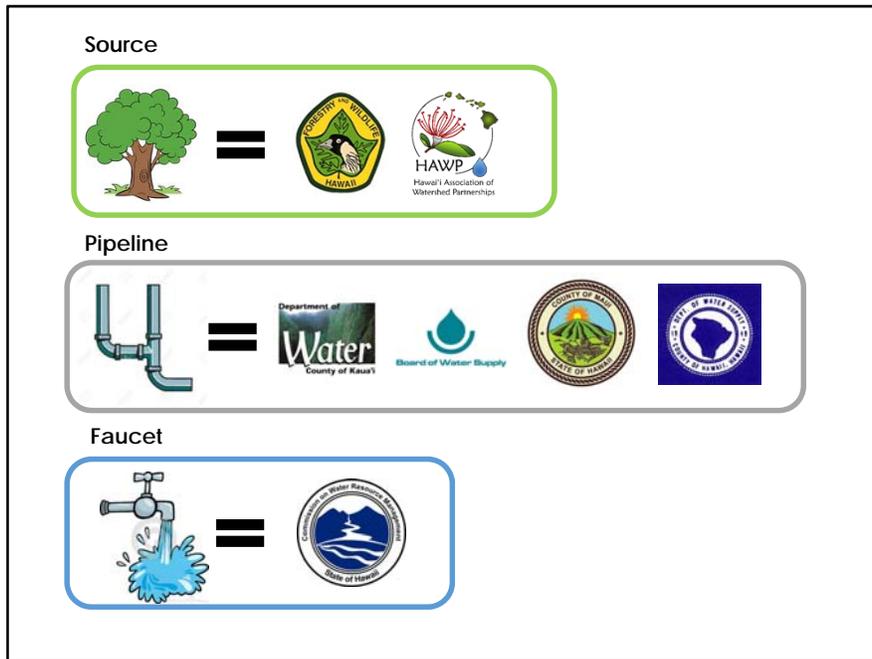
The WPs began in East Maui in 1991 with the same goal as DOFAW – **to protect forested watersheds for water recharge**. Today, there are 10 active partnerships statewide. All the partnerships are made up of voluntary alliance of public and private landowners committed to the common value of protecting 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.

Because the WPs include public and private landowners, they help fill the management gaps. Invasive species don’t abide by TMKs. **Later you will hear from [name of WP] about the specific work they do on the ground to protect our forested watersheds.**



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.

IMPORTANT! = healthy forests help sustain existing sources! It takes ~25 years for rainfall to reach the aquifer. We drink 25 year old water! 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.**

Point out that the counties invest \$ in watershed protection (BWS planning to fund \$3m per year for watershed programs and Maui DWS awards over \$2m annually). That funding, in addition to State, federal, etc. is helping support the protection of forests.

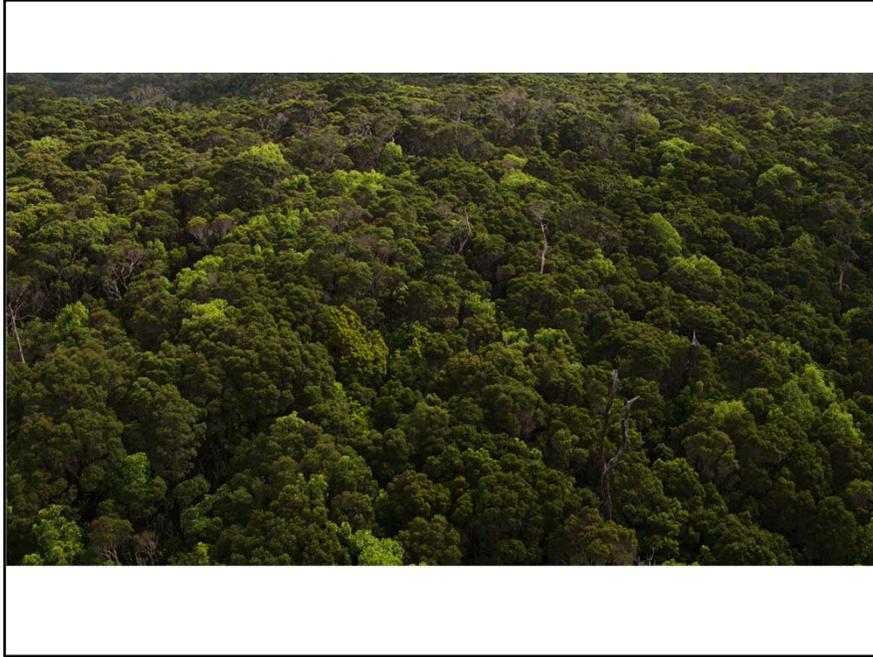


What is the source? What do our forested watersheds look like?

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.**



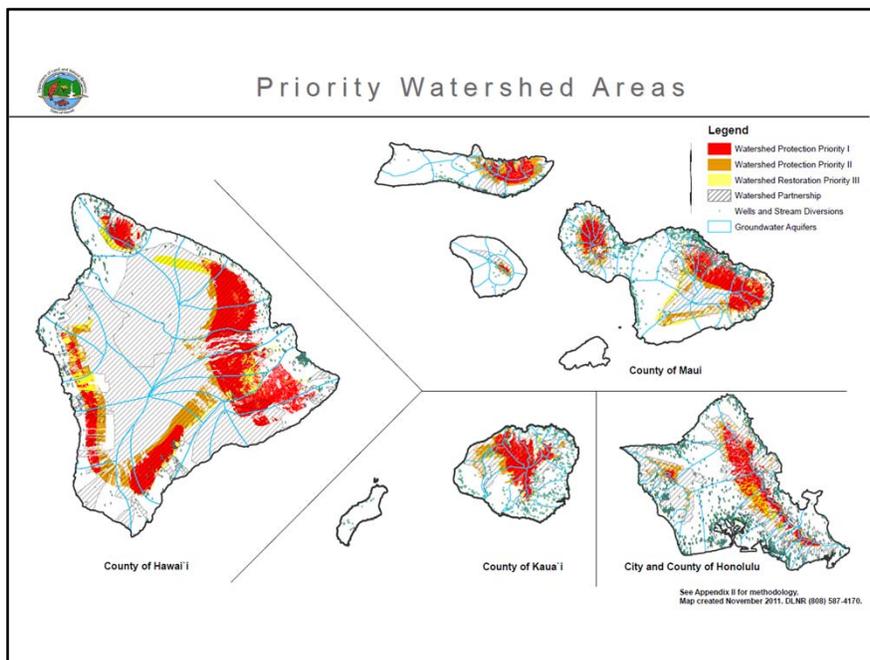
In Hawaii, the native forest has adapted to be super efficient at capturing and storing rainwater. It has a multi-layer canopy of ferns, mosses, and trees, which help slow down the flow of water, allowing it to seep into the ground.



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.

On Maui, the water we use is either captured from surface runoff or pumped from the aquifer.



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 conversion 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)

Governor Ige's
SUSTAINABLE
HAWAI'I
INITIATIVE

Strengthening our waters, land and food for Hawaii's communities

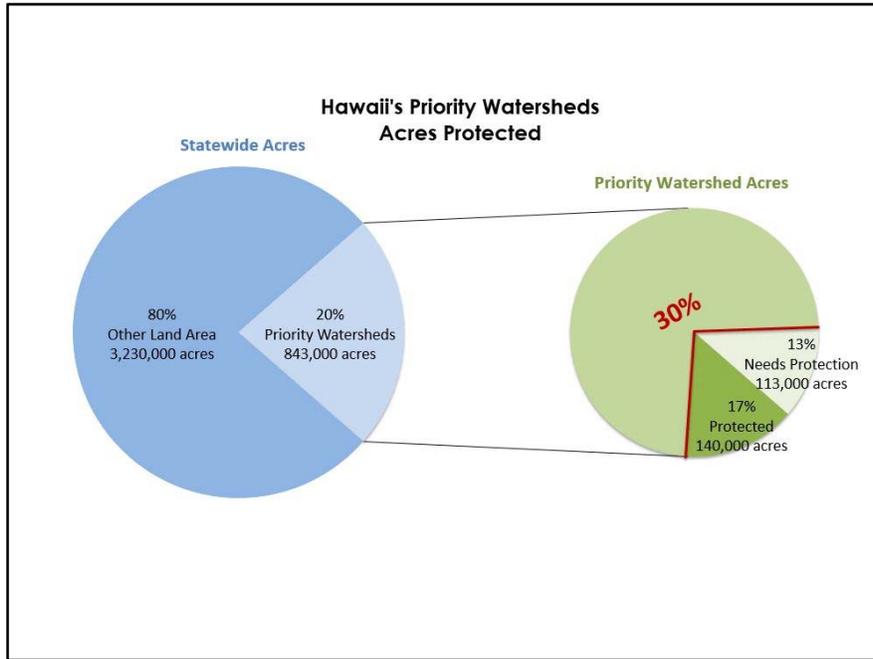
- double local food production**
100% increase in local agricultural production by 2020
- Hawai'i interagency biosecurity plan**
Stronger invasive species policy, infrastructure and capacity by 2027
- 30 x 30 watershed protection**
30% of priority watersheds protected by 2030
- 30 x 30 marine management**
30% of nearshore marine areas effectively managed by 2030
- 100% renewable energy**
Complete transfer to clean, renewable energy by 2045

Aloha+ CHALLENGE **MALAMA HONUA**

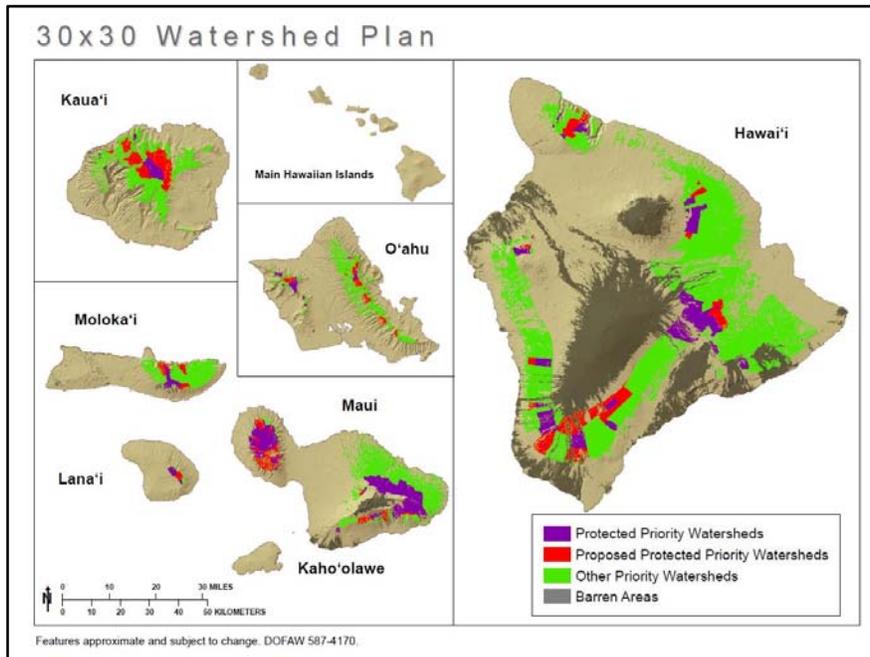
The State has a commitment to protect 30% (253,000 acres) of Hawaii's priority watersheds by 2030.



WHAT DOES "PROTECTED" MEAN? Example of a fence separating native forest (protected on the left) vs. unprotected (grazed by goats)

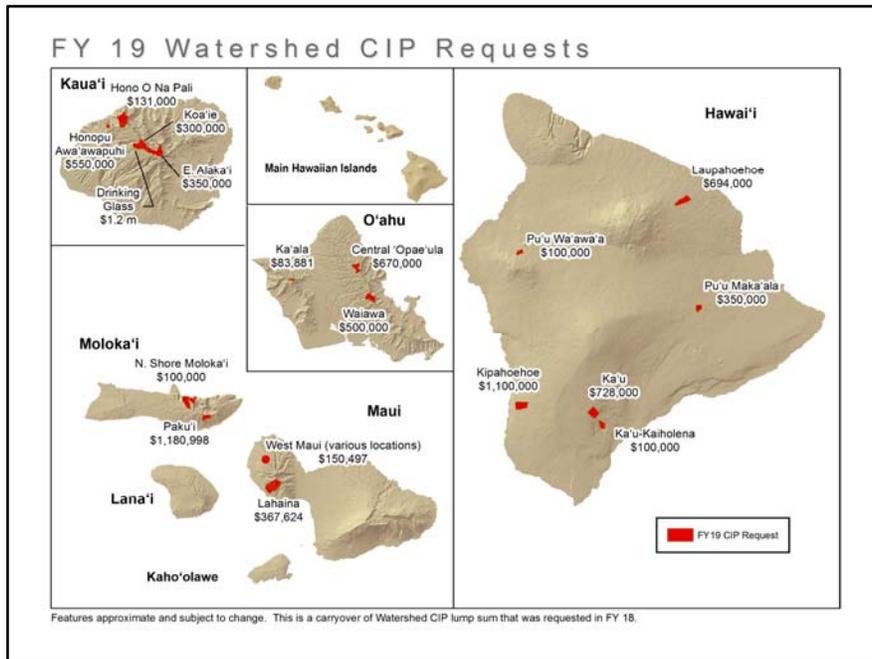


In order to reach the goal of 30% we need to protect approximately 9,000 additional acres every year.



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.

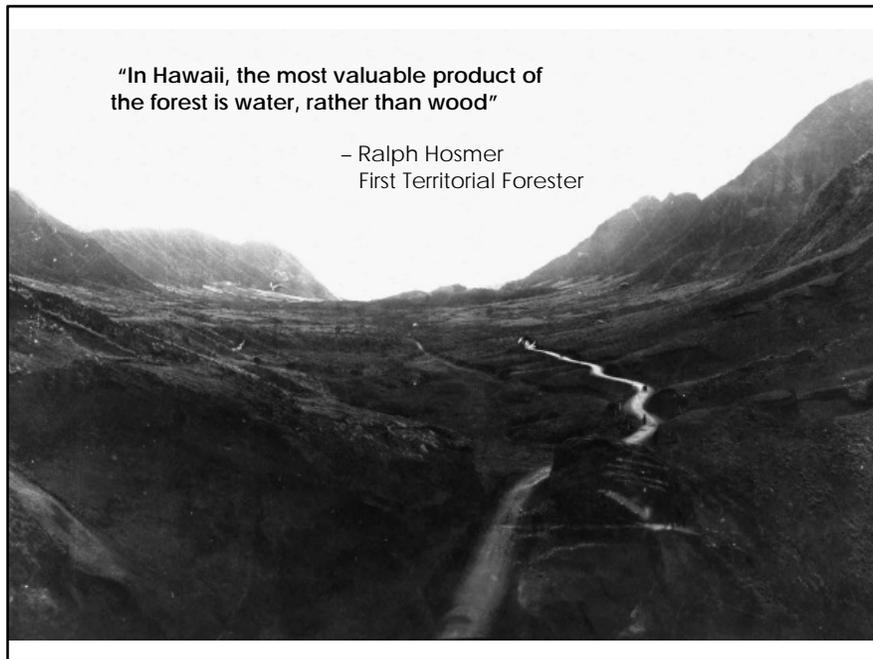
FY19 CIP award of \$7m+ which will fund some of these projects and protect an additional 23,000 acres.



DOFAW secured over \$7m in State FY19 funding.



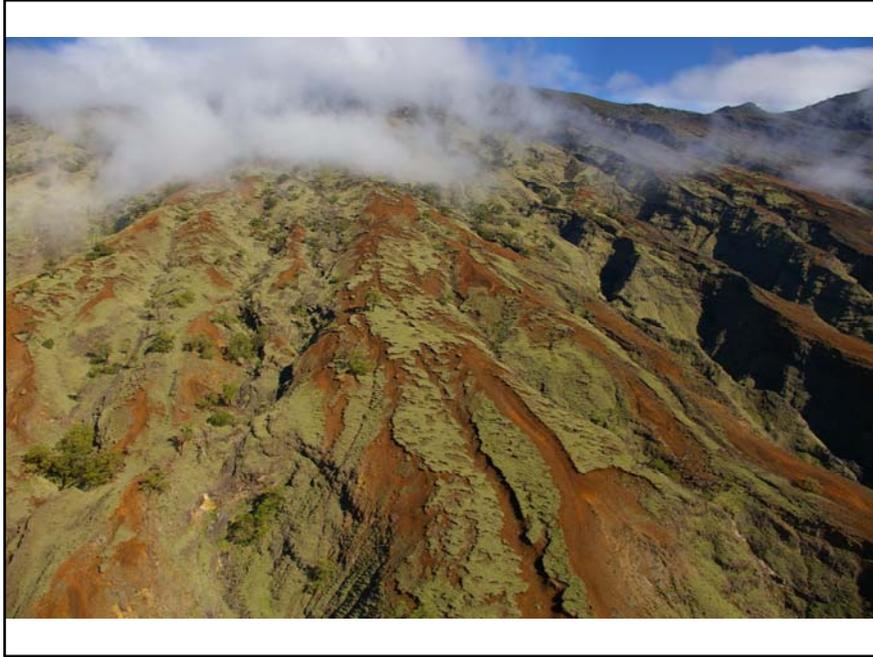
Watershed management includes a suite of actions. Protection = acres fenced.



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.



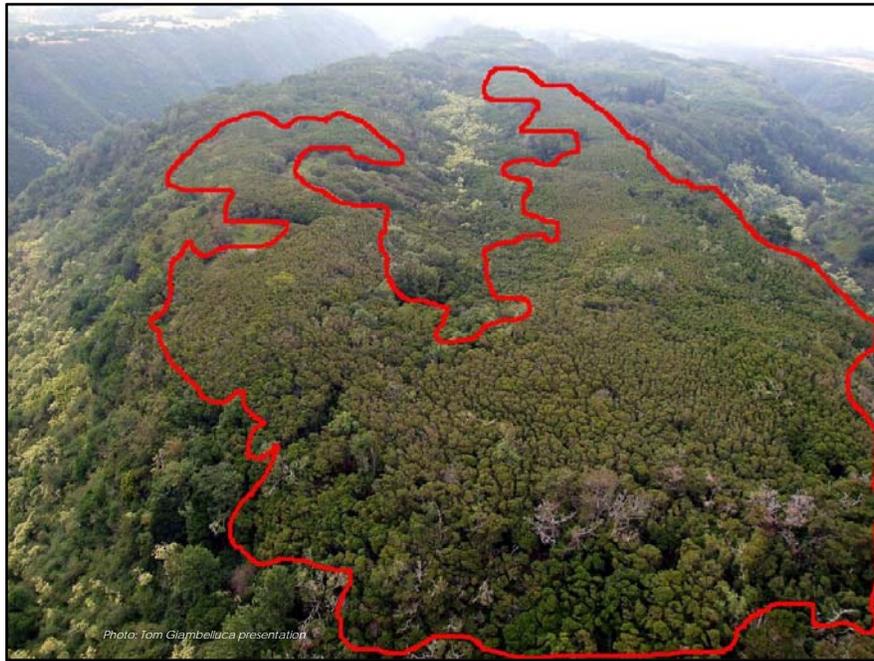
Forests are also important for their ability to capture water. **In fact, conversion of native forests into non-native forests can have possible negative effects on water processes.**

- Reduced soil infiltration rates
- Reduced fog interception
- Increased evapotranspiration

The morphological characteristics of native plants are thought to enhance water collection. Forests can absorb as much water as rainfall – doubling the amount of fresh water collected! On Lāna‘ihale (the forested top of Lāna‘i), fog drip accounts for 60-80% of water input. On Hawaii Island, one study showed that 27% of the total precipitation was collected as fog drip in an ‘ōhi‘a-dominated forest, but that number decreased to 16% where a forest had been invaded by strawberry guava.

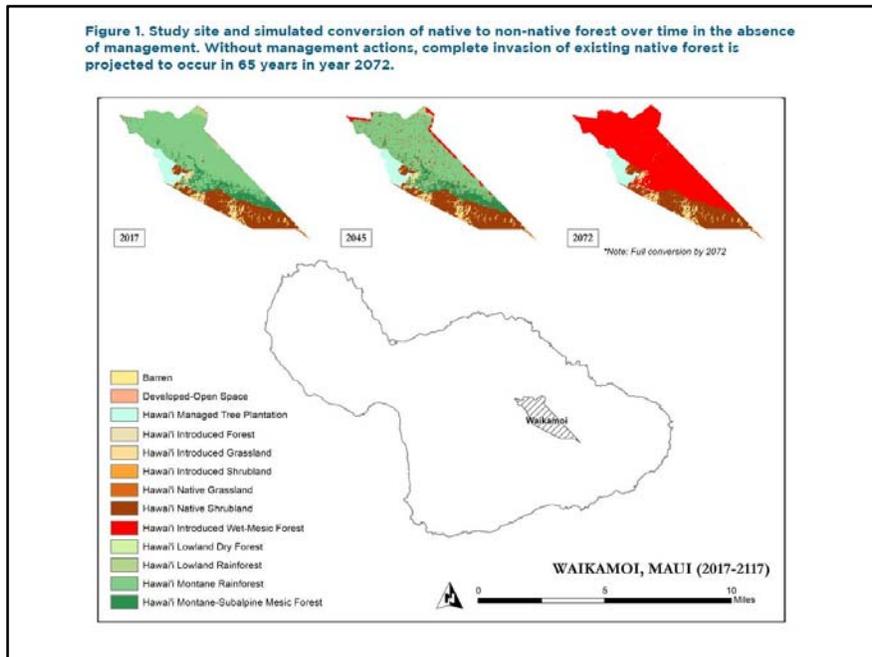
Conversely, **non-native plants have been shown to be 50% less efficient at collecting water** than our native species. Why? Invasive plants are fast growing, must keep their stomata open for longer periods of time, more water escapes, less water recharged into ground. Certain non-native species like strawberry guava also have smooth bark which allows water to runoff more easily and inhibits growth of epiphytes which can assist

with water collection.



Certain invasive species, like strawberry guava, create monotypic stands and can outcompete native species.

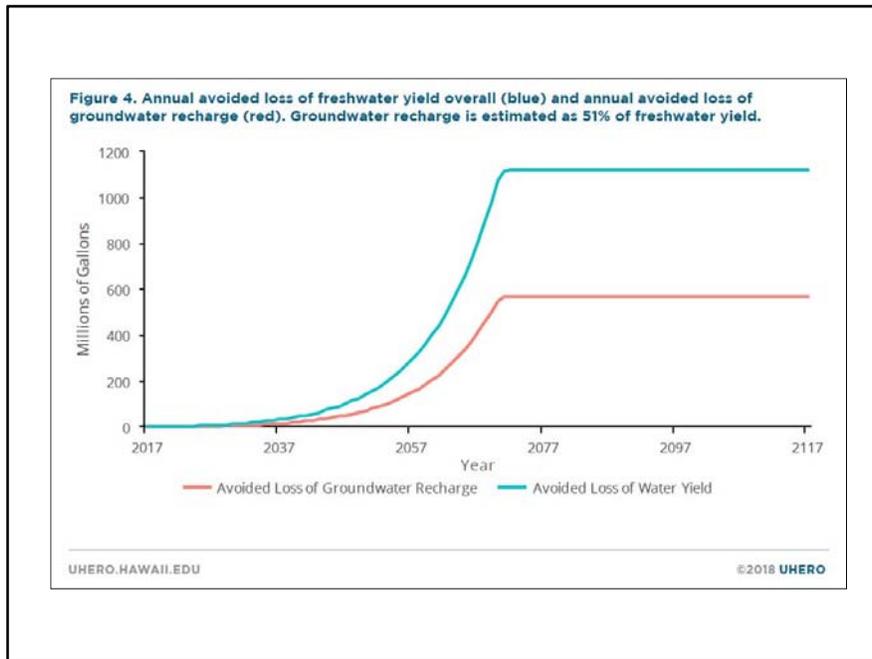
Although we don't know precisely how much recharge will be reduced by the conversion of native forests to non-native vegetation, research shows that **strawberry guava trees evapotranspire 27-53% more water than native forests**, causing extensive water loss (*Giambelluca et al, 2008*). **In East Hawaii,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



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

UHERO recently published findings on the economic value of watershed protection activities at TNC's Waikamoi Preserve on Maui. While Waikamoi is currently under a high level of protection and management, this study looked at the value of total avoided loss by keeping forest native vs. allowing invasion to occur.

Waikamoi Preserve on Maui = 9,000 acres under active management by TNC.



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.

| | | |
|--|---|---|
| | | <h3>Value of Protecting Waikamoi Forest:</h3> |
| | <p>PROJECT ENVIRONMENT</p> <p>ECONOMIC VALUATION OF THE NATURE CONSERVANCY'S WATERSHED CONSERVATION ACTIVITIES IN WAIKAMOI PRESERVE, MAUI</p> <p>APRIL 2018</p> | |
| | | |

That is enough water to fill 130 Olympic sized swimming pools with fresh water every day.

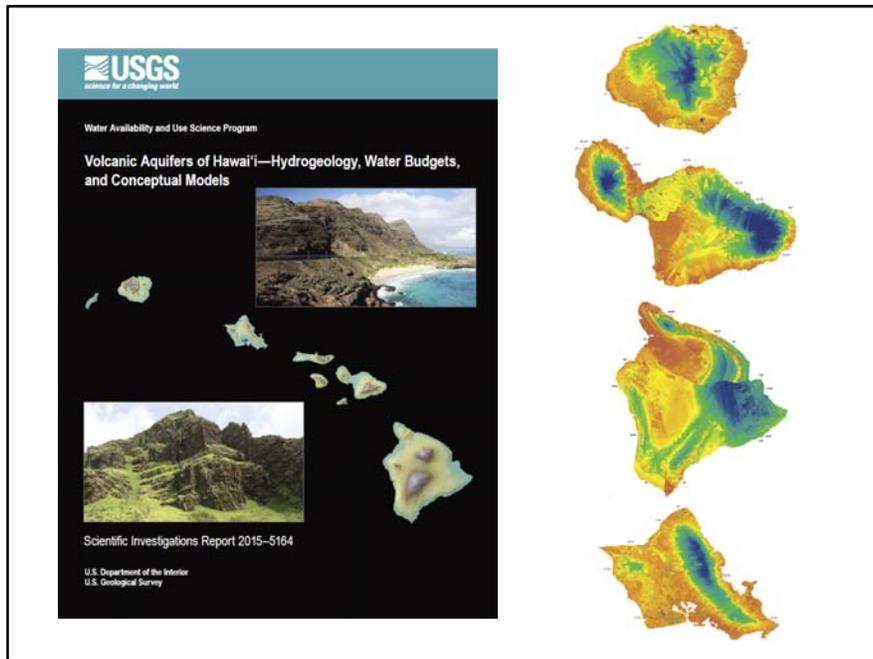
Mention other studies being done by Leah Bremer and Ike Wai to evaluate how groundwater recharge may change under a range of possible land use/land cover and climate futures for Pearl Harbor.



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.

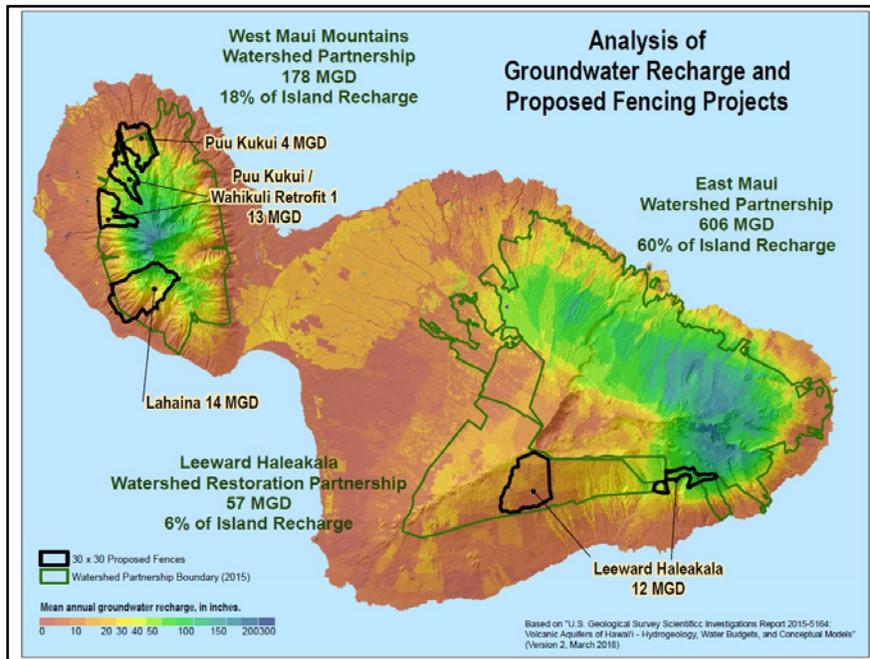
This study started on Maui. Maui County DWS invests millions of dollars every year in watershed protection, but they are interested in better understanding the return on investment. With funding from Maui DWS and CWRM, USGS has identified sites where they can sample native and non-native plant species.

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 protected 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 exact effect on recharge 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.



Mahalo

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