Auwahi Forest Restoration Project

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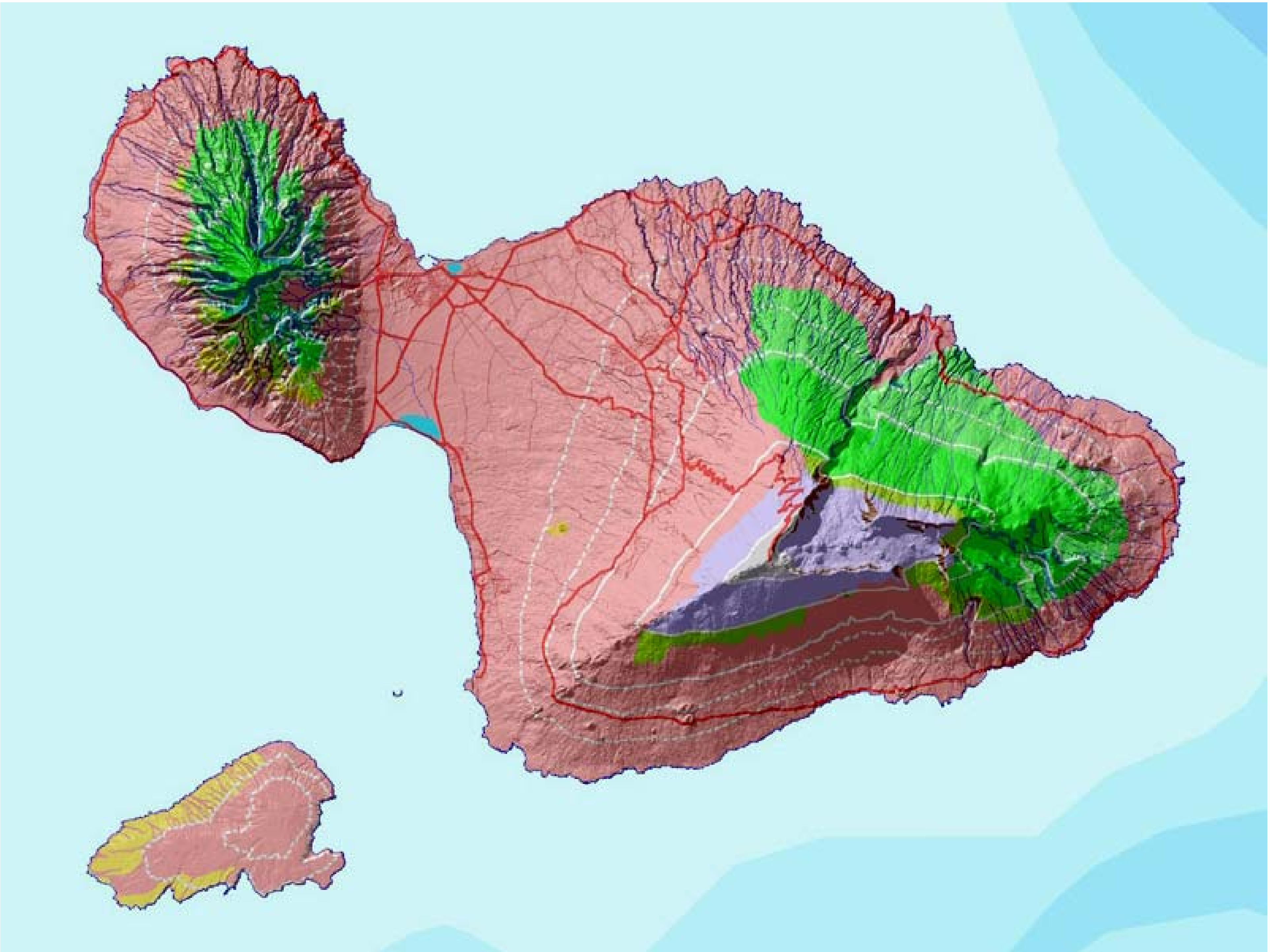
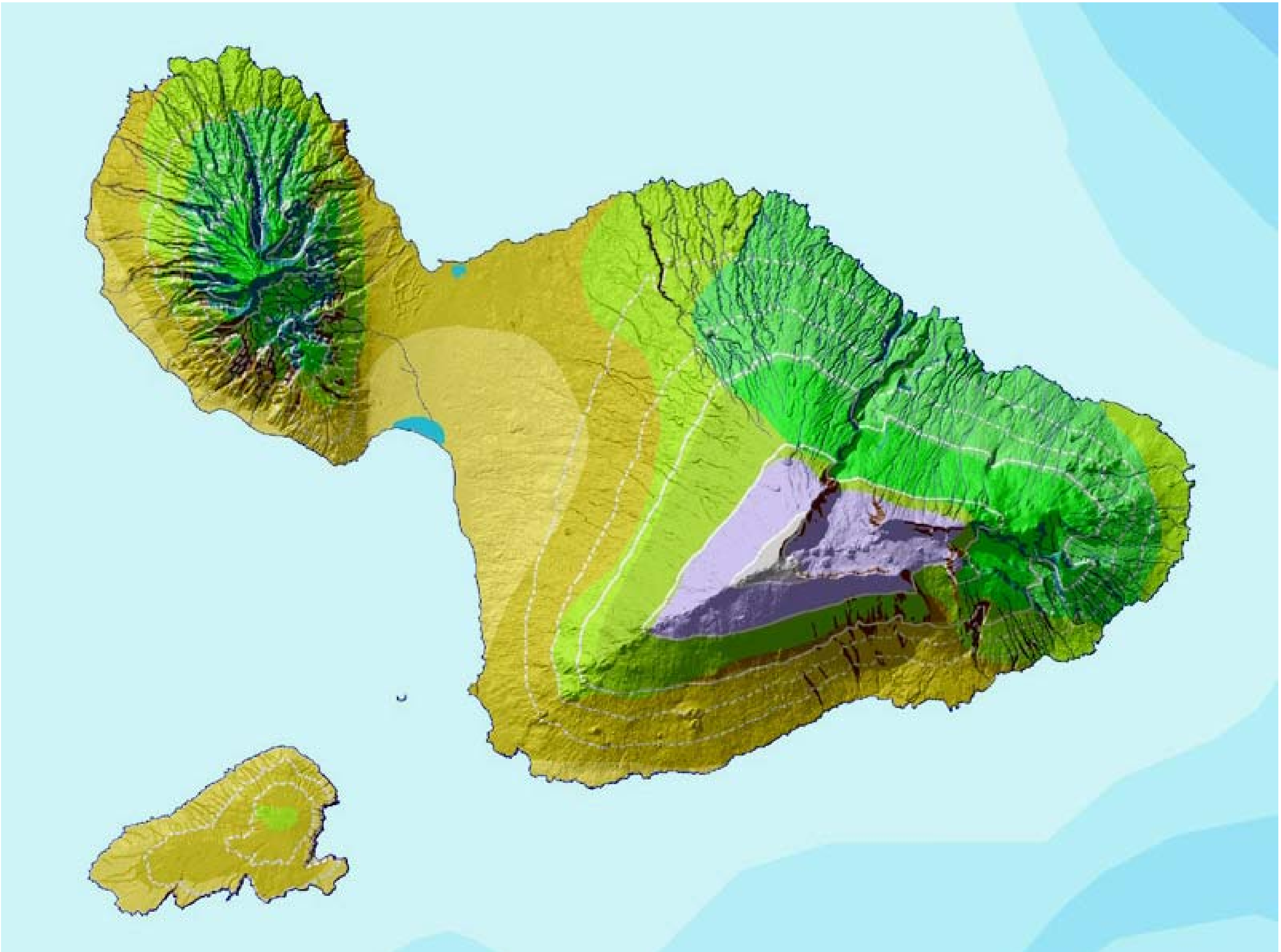
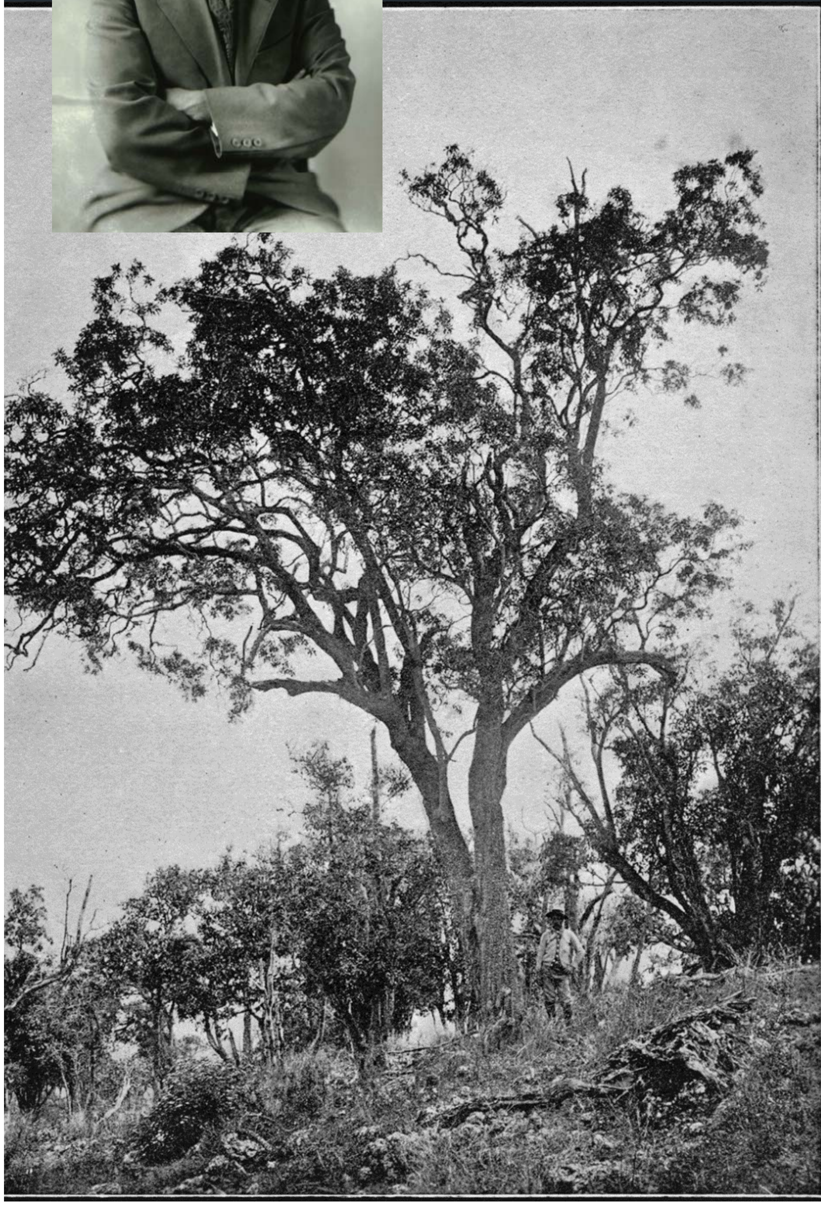
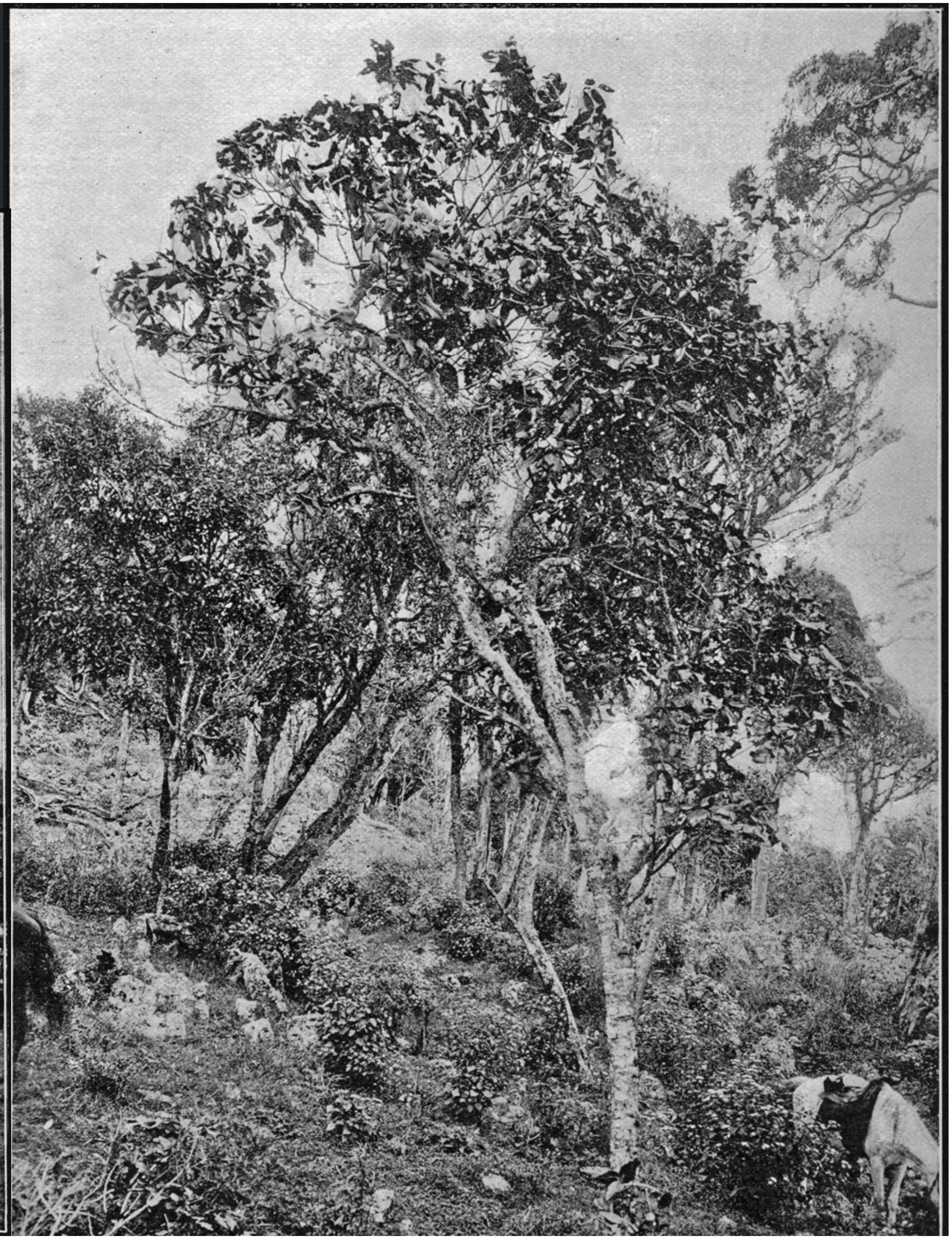
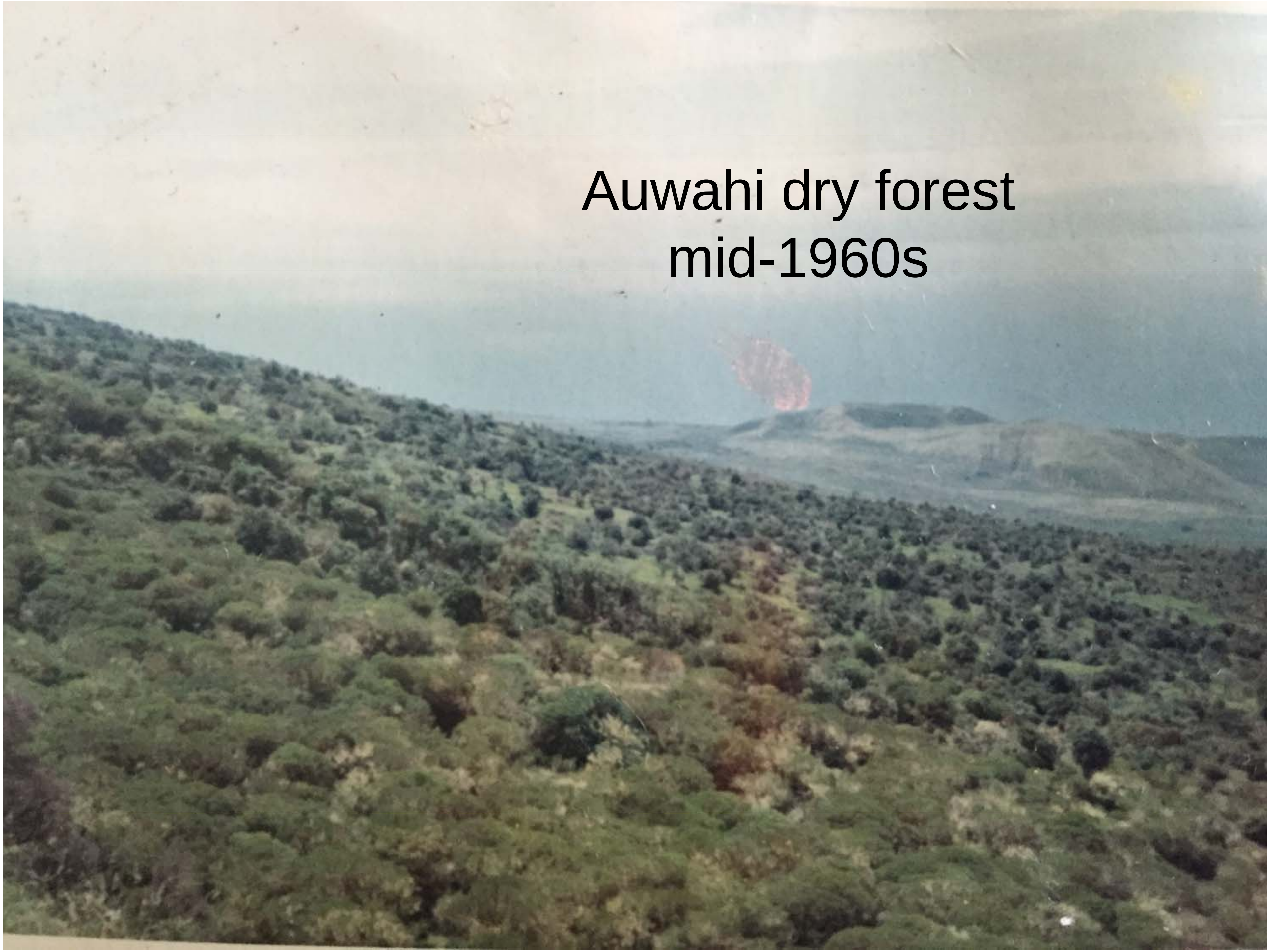




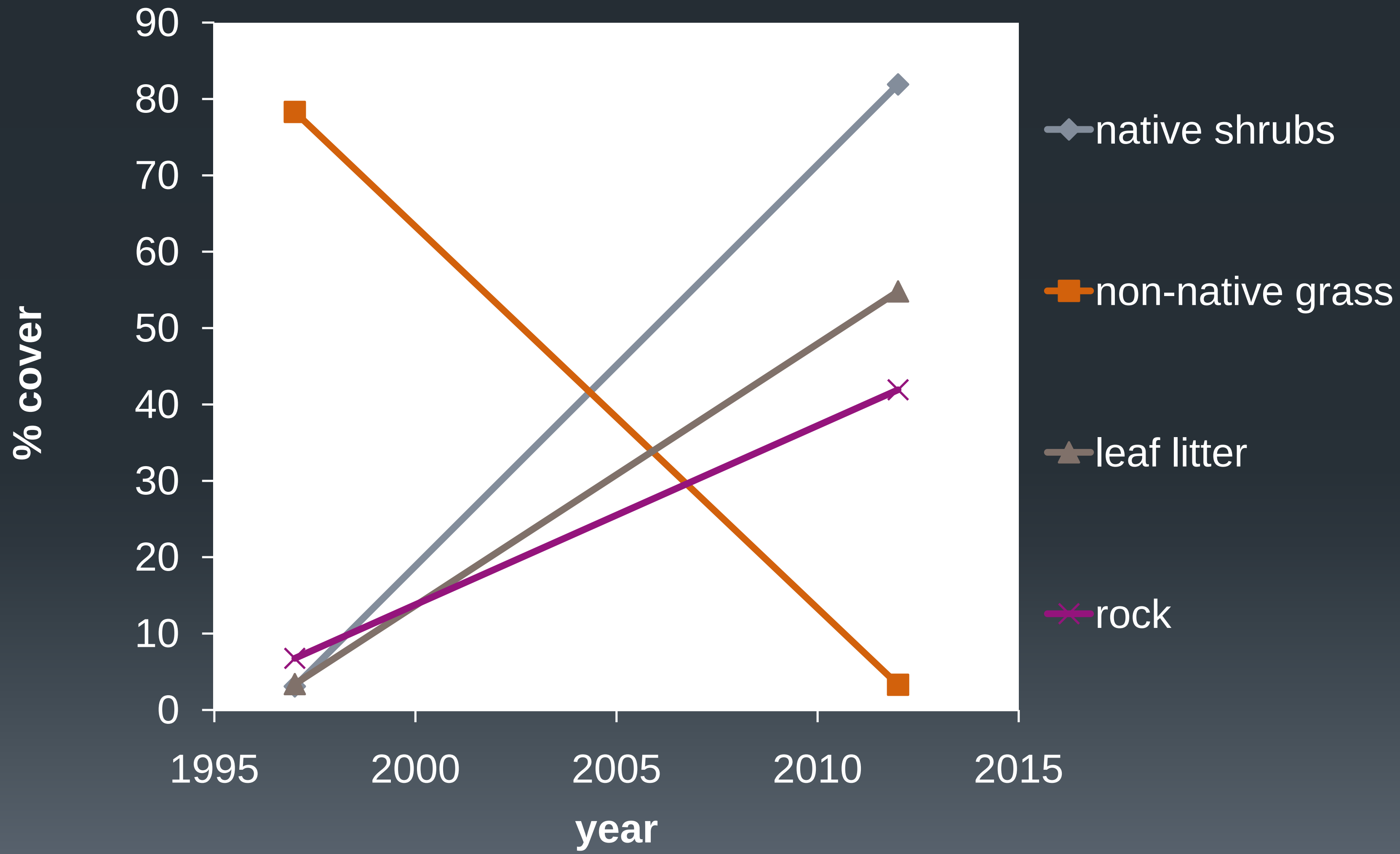




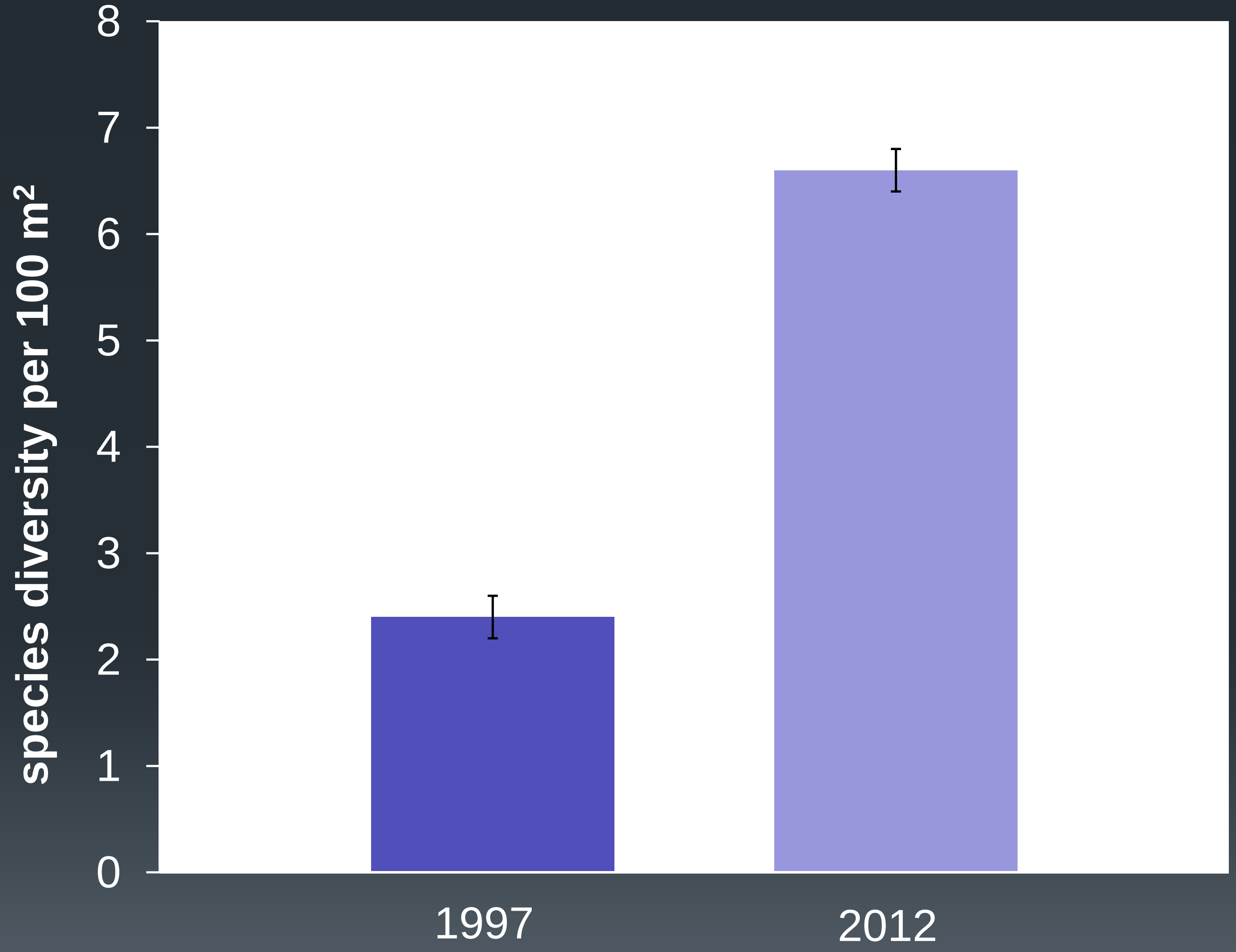

Auwahi dry forest
mid-1960s


Auwahi dry forest
2005

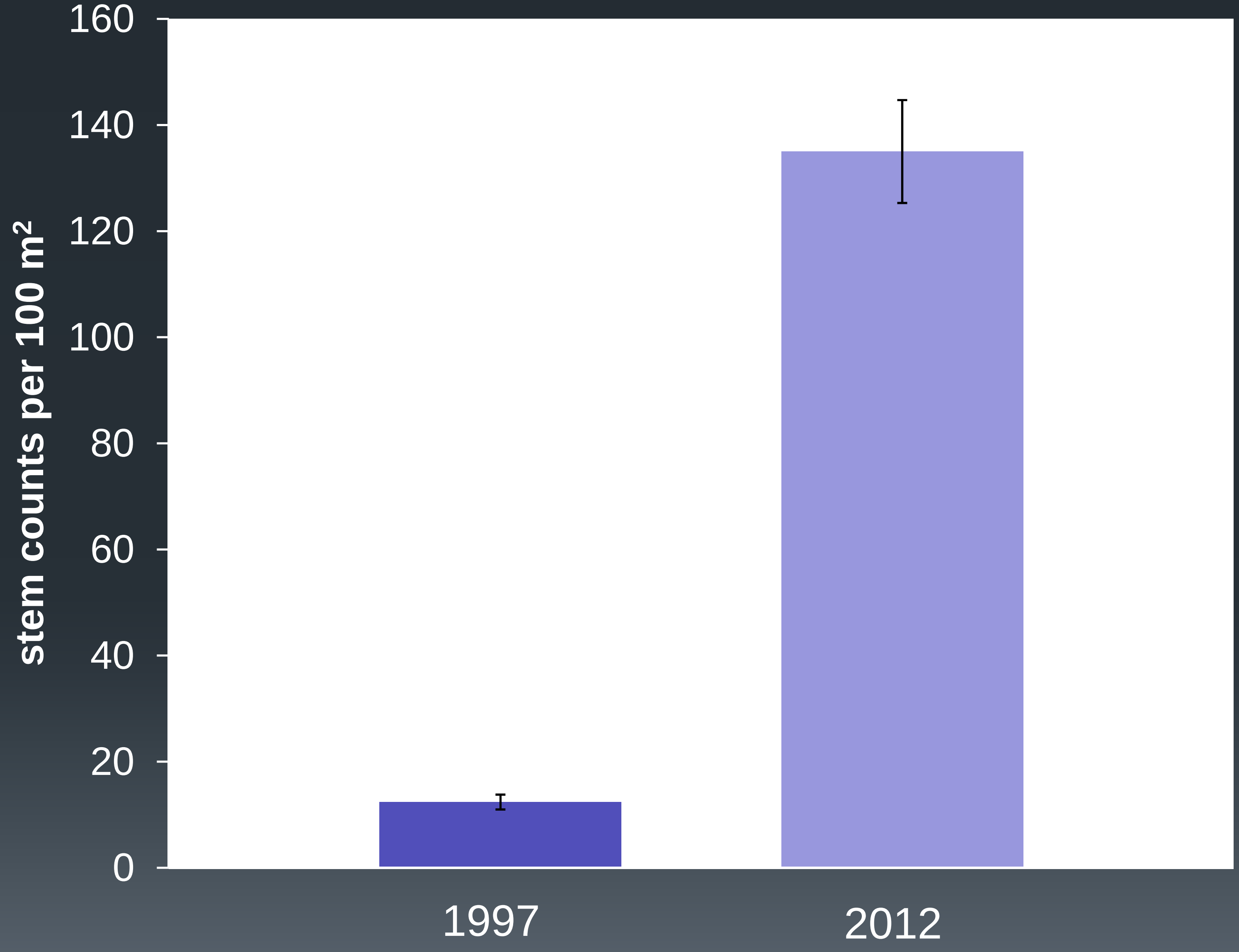
Post-restoration vegetation changes Auwahi forest restoration area (1997-2012)



Medeiros, vonAllmen and Chimera, 2014



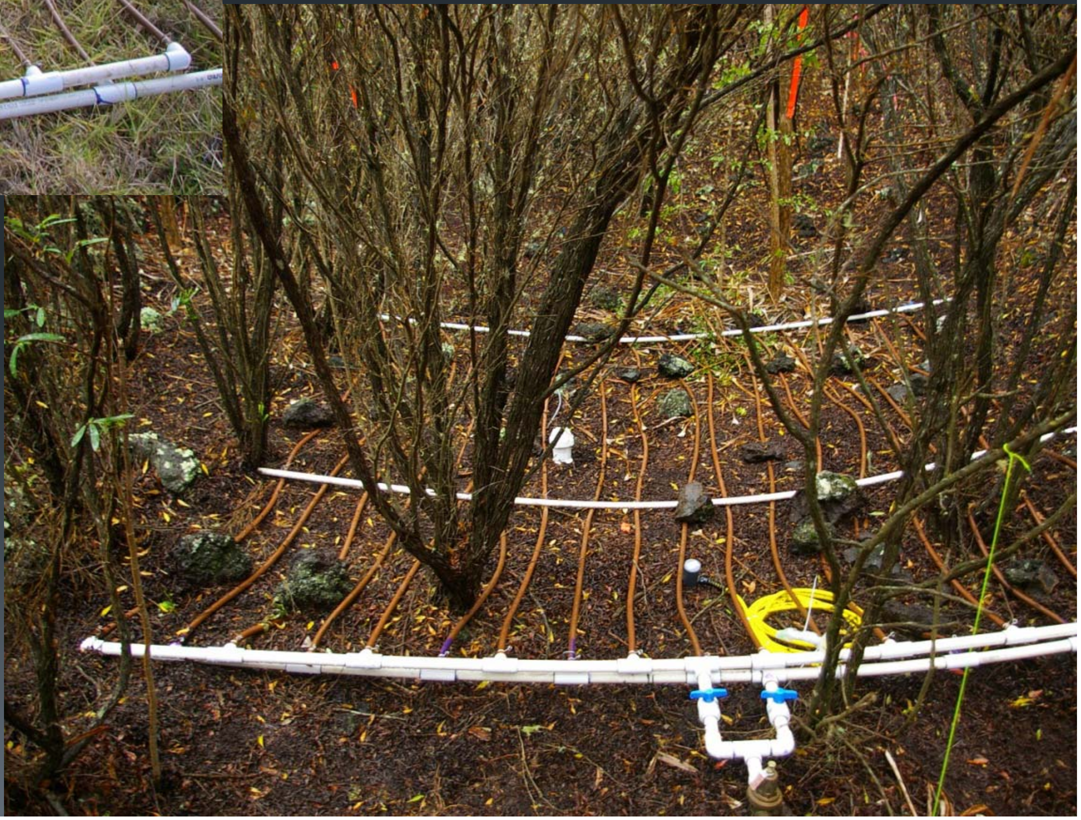
species diversity per 100 m²
0
1
2
3
4
5
6
7
8
1997
2012



stem counts per 100 m²
160
140
120
100
80
60
40
20
0
1997
2012


RVCA

pasture
woodland
site



restored
native
forest
site

results:

	Average velocity (cm/min)		Increase in % volumetric water	
Depth of sensors	Forest	Grassland	Forest	Grassland
0-50 cm	6.7	4.7	0.096	0.054
50-75 cm	10.6	8.2*	0.44	0.10*
75-100 cm	15.8	0.9**	0.11	0.025**

P-values are calculated from 2-sample t-tests, assuming unequal variance.
* significant at 95% confidence level, ** significant at 99.9% confidence level

results:

- in restored native forest at the 1m depth, water transport was significantly faster (99% confidence level) and more efficient (greater water content) than in the kikuyu grasslands (99% confidence level)

- the Auwahi experiment demonstrated that native forest restoration altered soil-water properties on decadal time scale, increasing deep percolation, a fundamental component of aquifer recharge.

- non-native kikuyu grasslands at Auwahi and likely elsewhere appear to strongly deter downwards water movement and blocking deep percolation.

Perkins, K. S., J. R. Nimmo, A. C. Medeiros , D.J. Szutu, and E.I. von Allmen. 2014. Assessing effects of native reforestation on soil moisture dynamics and potential aquifer recharge, Auwahi, Maui. Ecohydrology DOI:10.1002/eco.1469.

Perkins, K. S., J. R. Nimmo, and A. C. Medeiros. 2012. Effects of native forest restoration on soil hydraulic properties, Auwahi, Maui, Hawaiian Islands. Geophysical Research Letters 39 (5): L05405.

GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L05405, doi:10.1029/2012GL051120, 2012

Effects of native forest restoration on soil hydraulic properties, Auwahi, Maui, Hawaiian Islands

K. S. Perkins,[1] J. R. Nimmo,[1] and A. C. Medeiros[2]

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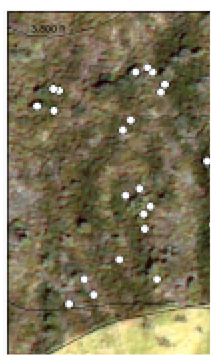
[1] Over historic time Hawai'i's dryland forests have been largely replaced by grasslands for grazing livestock. On-going efforts have been undertaken to restore dryland forests to bring back native species and reduce erosion. The reestablishment of native ecosystems on land severely degraded by long-term alternative use requires reversal of the impacts of erosion, organic-matter loss, and soil structural damage on soil hydraulic properties. This issue is perhaps especially critical in dryland forests where the soil must facilitate native plants' optimal use of limited water. These reforestation efforts depend on restoring soil ecological function, including soil hydraulic properties. We hypothesized that reforestation can measurably change soil hydraulic properties over restoration timescales. At a site on the island of Maui (Hawai'i, USA), we measured infiltration capacity, hydrophobicity, and abundance of preferential flow channels in a deforested grassland and in an adjacent area where active reforestation has been going on for fourteen years. Compared to the nearby deforested rangeland, mean field-saturated hydraulic conductivity in the newly restored forest measured by 55 infiltrometer tests was greater by a factor of 2.0. Hydrophobicity on an 8-point scale increased from average category 6.0 to 6.9. A 4-point empirical categorization of preferentiality in subsurface wetting patterns increased from an average 1.3 in grasslands to 2.6 in the restored forest. All of these changes act to distribute infiltrated water faster and deeper, as appropriate for native plant needs. This study indicates that vegetation restoration can lead to ecohydrologically important changes in soil hydraulic properties over decadal time scales. Citation: Perkins, K. S., J. R. Nimmo, and A. C. Medeiros (2012), Effects of native forest restoration on soil hydraulic properties, Auwahi, Maui, Hawaiian Islands, *Geophys. Res. Lett.*, *39*, L05405, doi:10.1029/2012GL051120.

1. Introduction

[2] Dryland forests in Hawai'i have been heavily impacted

hypothesize that reestablis
reverse these soil hydraulic
short time scales (e.g., deca
of how this process occurs i
term impacts of restoratio
changing environment.

[3] In 1997, land owners
and volunteers began an eff
of Auwahi, on the leewa
(Figure 1). They aimed to
ecosystem [*Bruegmann*, 19
once an important reso
[*Medeiros*, 2003; *Medeiros*
was chosen at about 122
exclude grazing animals, g
Mats of the invasive kikuy
num) were eliminated with



ECOHYDROLOGY
Ecohydrol. (2014)
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Assessing effects of native forest restoration on soil moisture dynamics and potential aquifer recharge, Auwahi, Maui

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ABSTRACT

Understanding the role of soils in regulating water flow through the unsaturated zone is critical in assessing the influence of vegetation on soil moisture dynamics and aquifer recharge. Because of fire, introduced ungulates and landscape-level invasion of non-native grasses, less than 10% of original dry forest (~730 mm precipitation annually) still exists on leeward Haleakalā, Maui, Hawaiian Islands. Native dry forest restoration at Auwahi has demonstrated the potential for dramatic revegetation, allowing a unique experimental comparison of hydrologic function between tracts of restored forest and adjacent grasslands. We hypothesized that even relatively recent forest restoration can assist in the recovery of impaired hydrologic function, potentially increasing aquifer recharge. To compare restored forest and grassland sites, we experimentally irrigated and measured soil moisture and temperature with subsurface instrumentation at four locations within the reforested area and four within the grassland, each with a 2·5 × 2·5-m plot. Compared with grassland areas, water in reforested sites moved to depth faster with larger magnitude changes in water content. The median first arrival velocity of water was greater by a factor of about 13 in the reforested sites compared with the grassland sites. This rapid transport of water to depths of 1 m or greater suggests increased potential aquifer recharge. Improved characterization of how vegetation and soils influence recharge is crucial for understanding the long-term impacts of forest restoration on aquifer recharge and water resources, especially in moisture-limited regions. Published 2014. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS infiltration; preferential flow; reforestation; unsaturated zone; aquifer recharge; soil moisture

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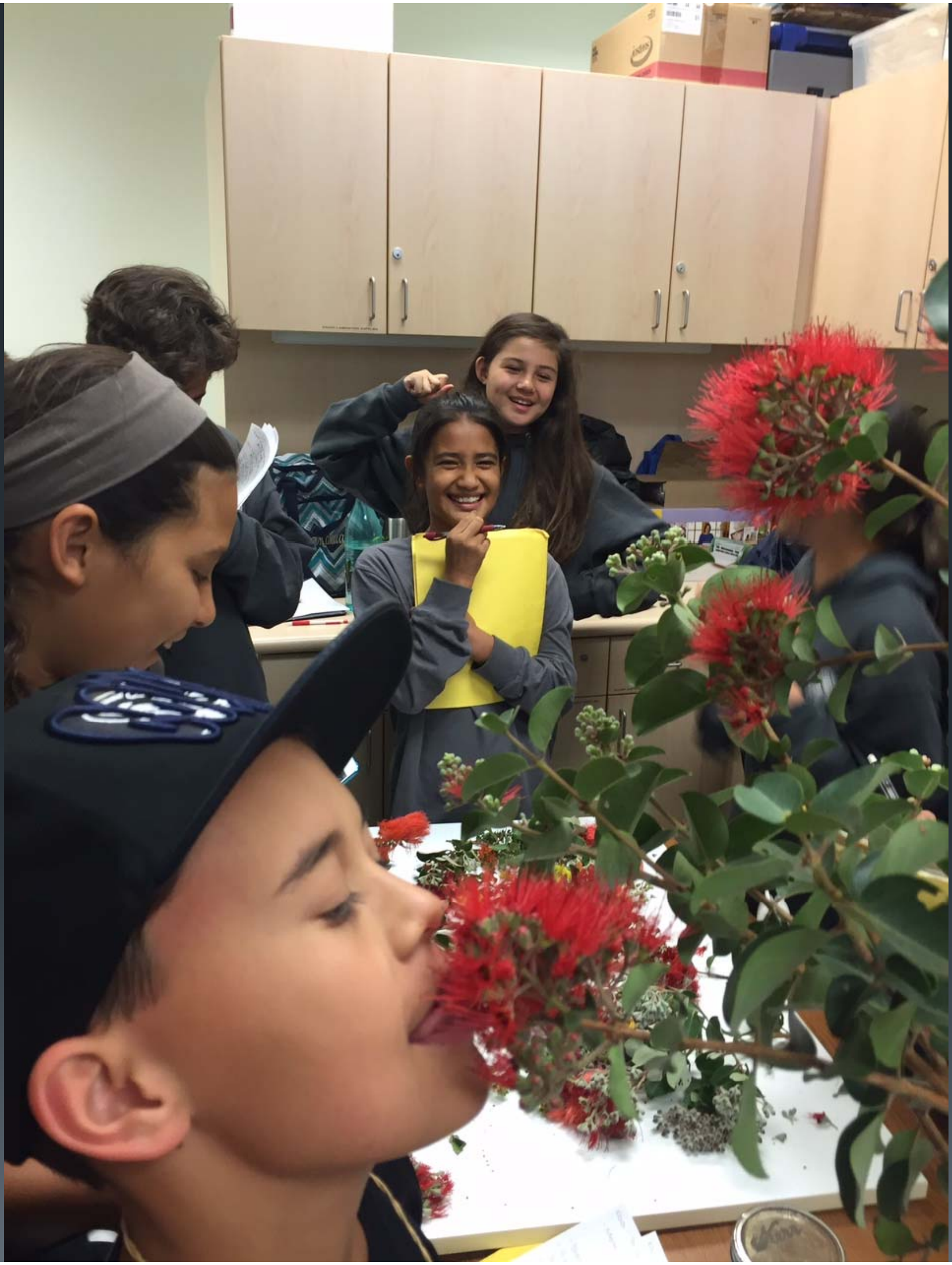
kikuyu dominated areas
Data MBARI
Data USGS
Data SOEST/UHM
Imagery Date: 1/12/2013 20°47'34.99" N 156°20'30.20" W elev 1825 ft eye alt 48
Google ea

Importance of Auwahi as site for education, outreach, and meaningful environmental volunteerism


HAWAI'I PACIFIC COLLECTION



Dear Dr. Art,
Thank you for
spreading your aloha
with us today. I want
to help you plant more.
I will do it in Oahu

Love,
Kalani

pau

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