AUWAHI
INSIGHTS INTO FOREST RESTORATION, HYDROLOGY, AND COMMUNITY INVOLVEMENT

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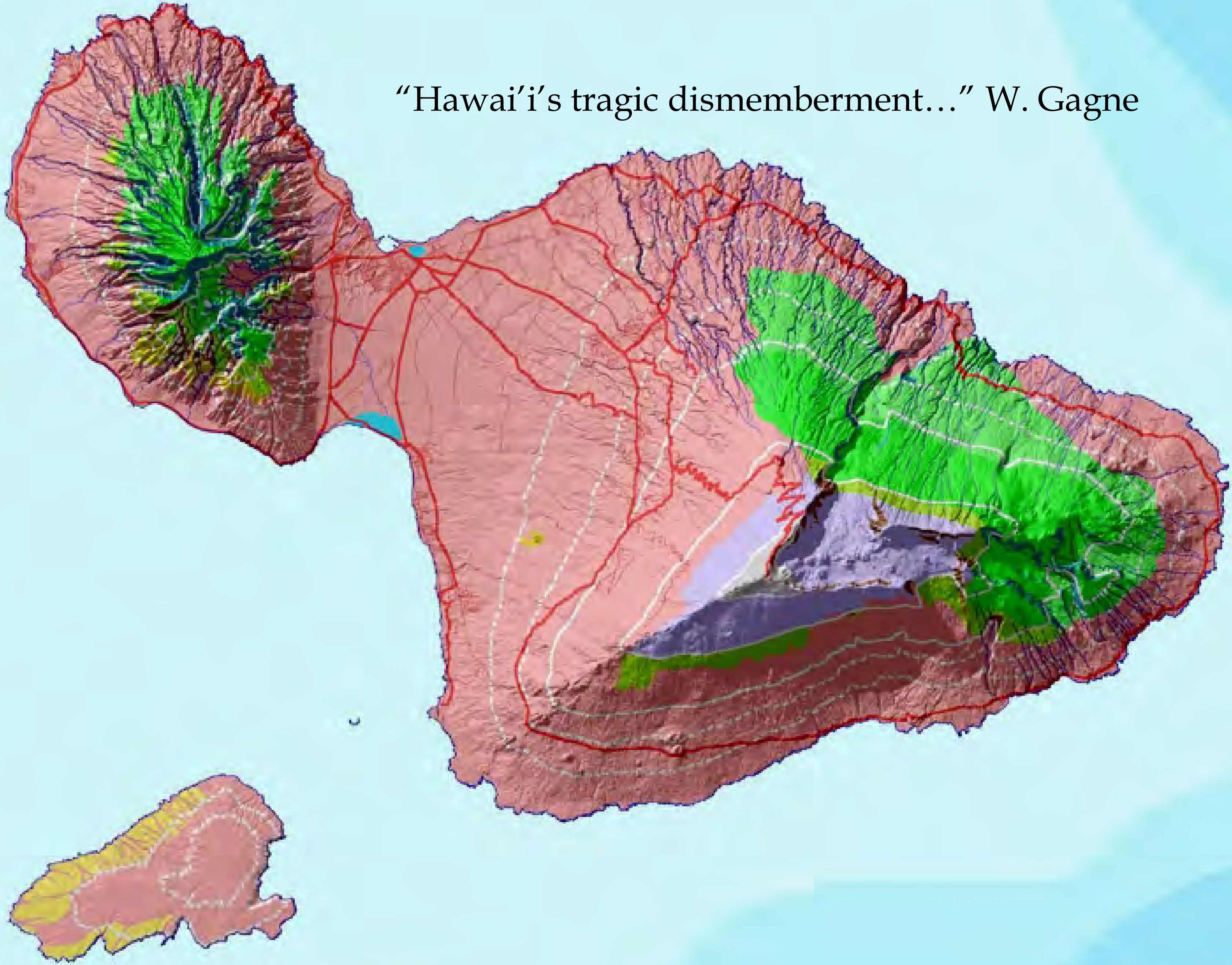
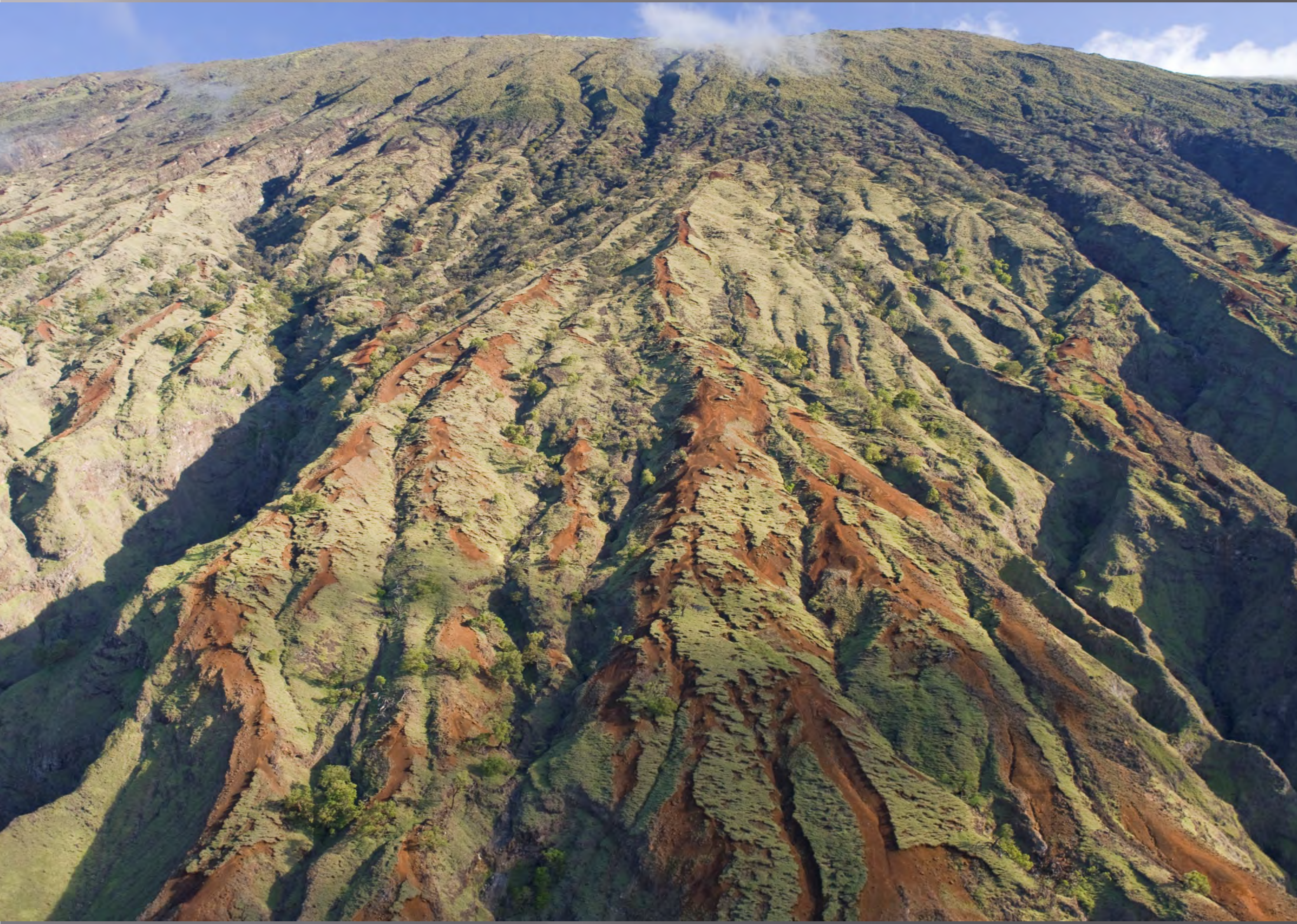
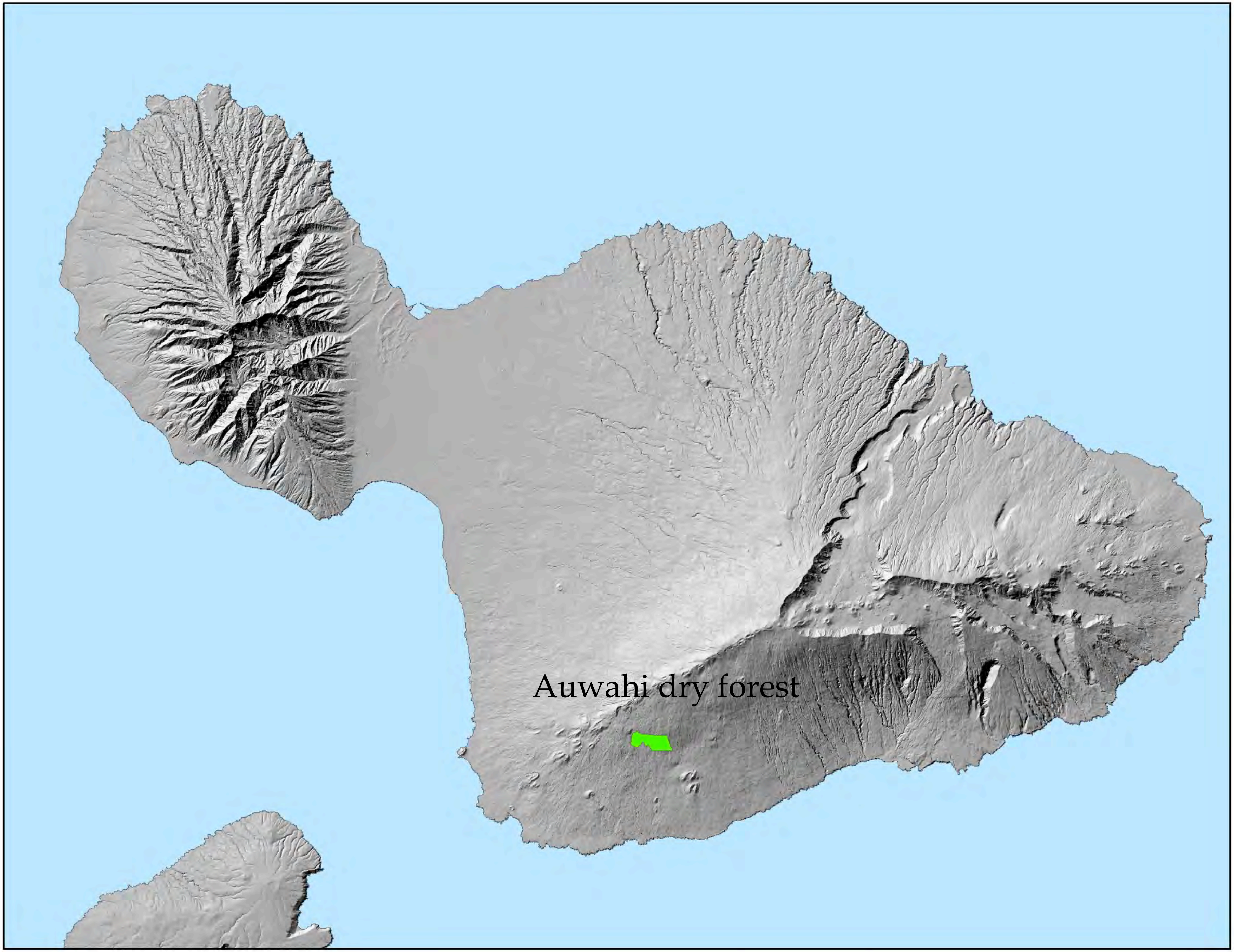
“Hawai’i’s tragic dismemberment…” W. Gagne



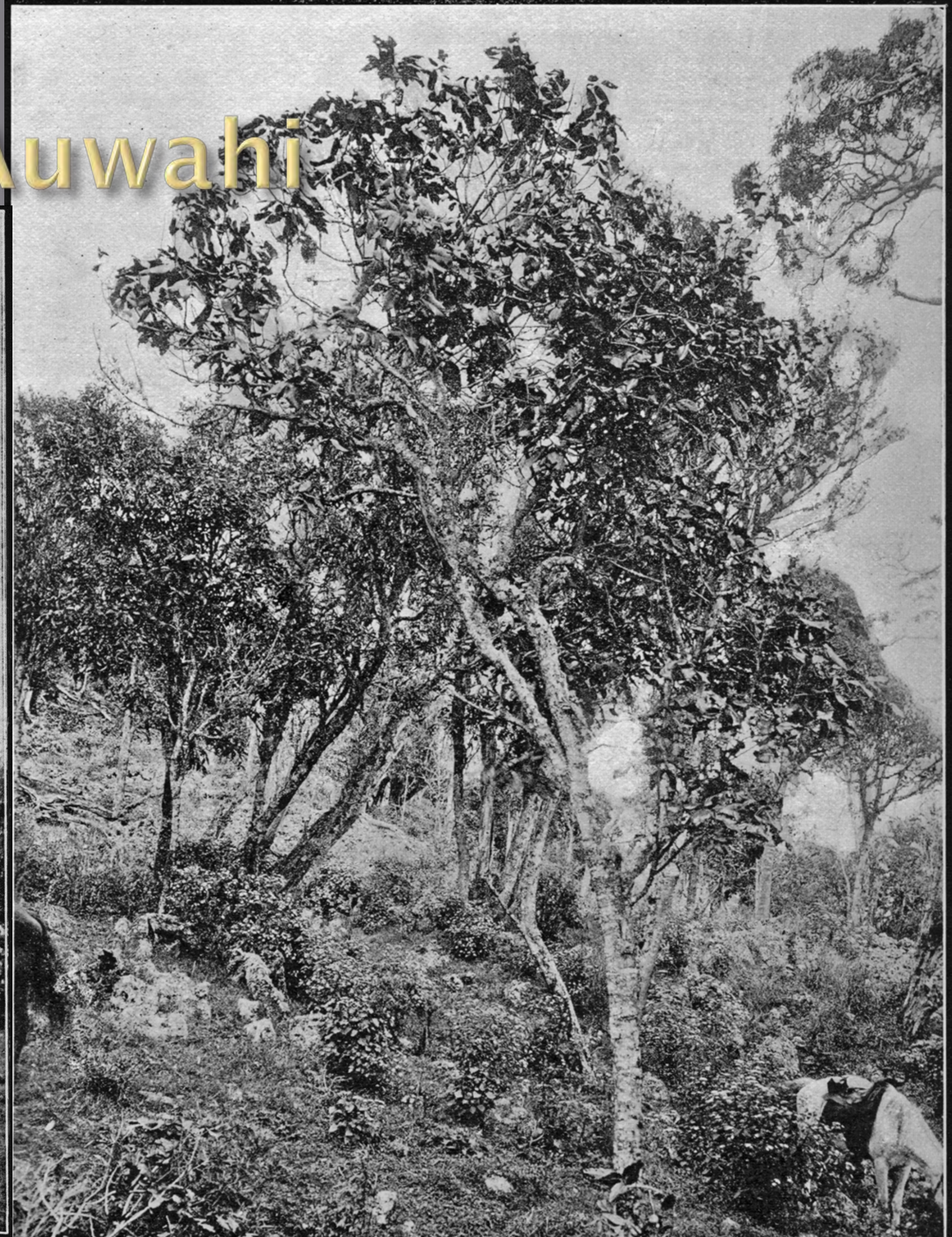


primary drivers for loss of leeward Hawaiian forests

- fire
- non-native ungulates
- non-native plant species
- non-native rodents


Auwahi dry forest

Auwahi



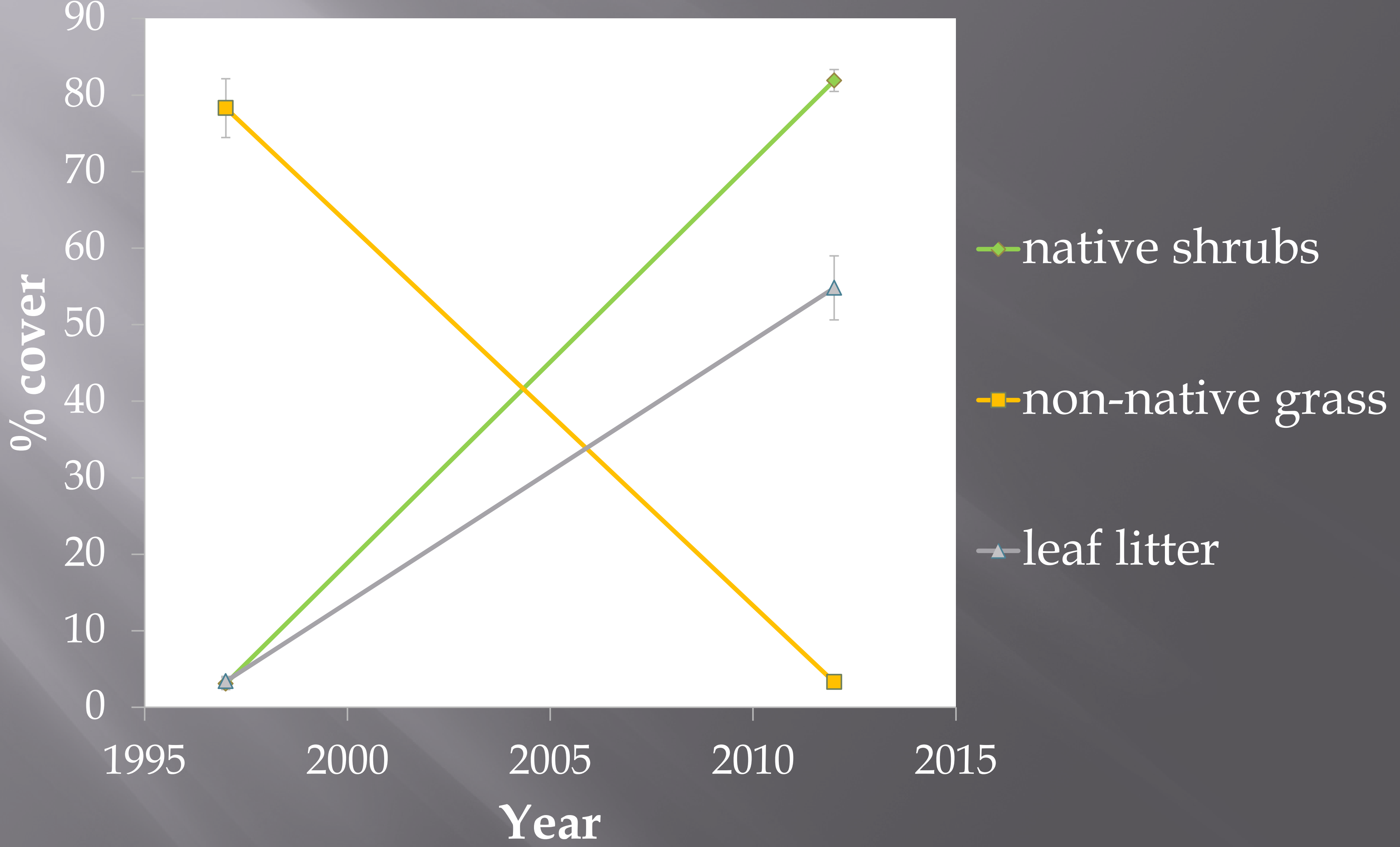


Auwahi nurse plant restoration technique

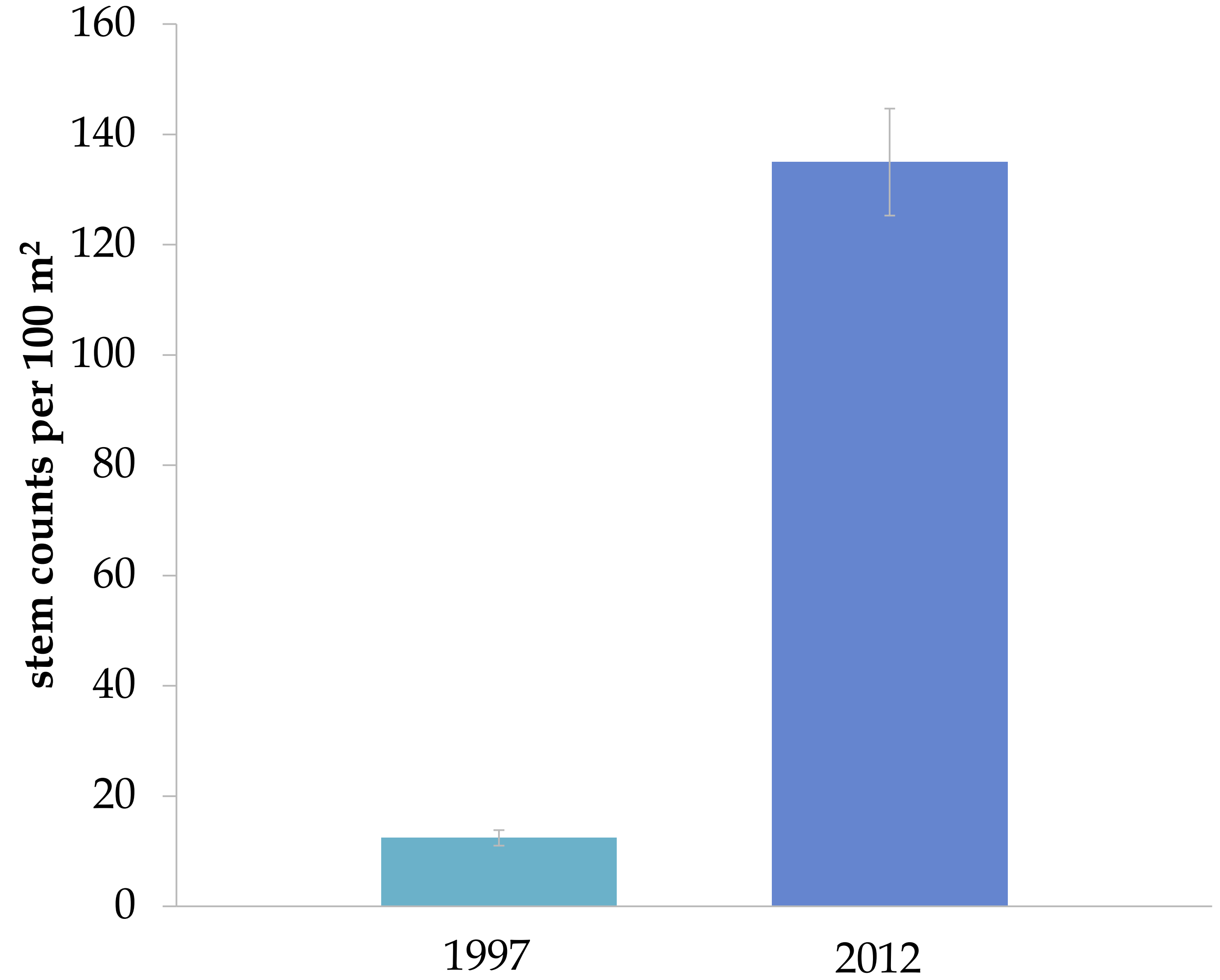
- exclude ungulates
- eliminate non-native kikuyu grass (Cenchrus clandestinus) with selective herbicide applications
- closely plant seedlings of native shrub (primarily Dodonaea) interspersed with native tree seedlings
- trim/thin nurse plant matrix to allow successional overgrowth of outplanted and naturally establishing native trees

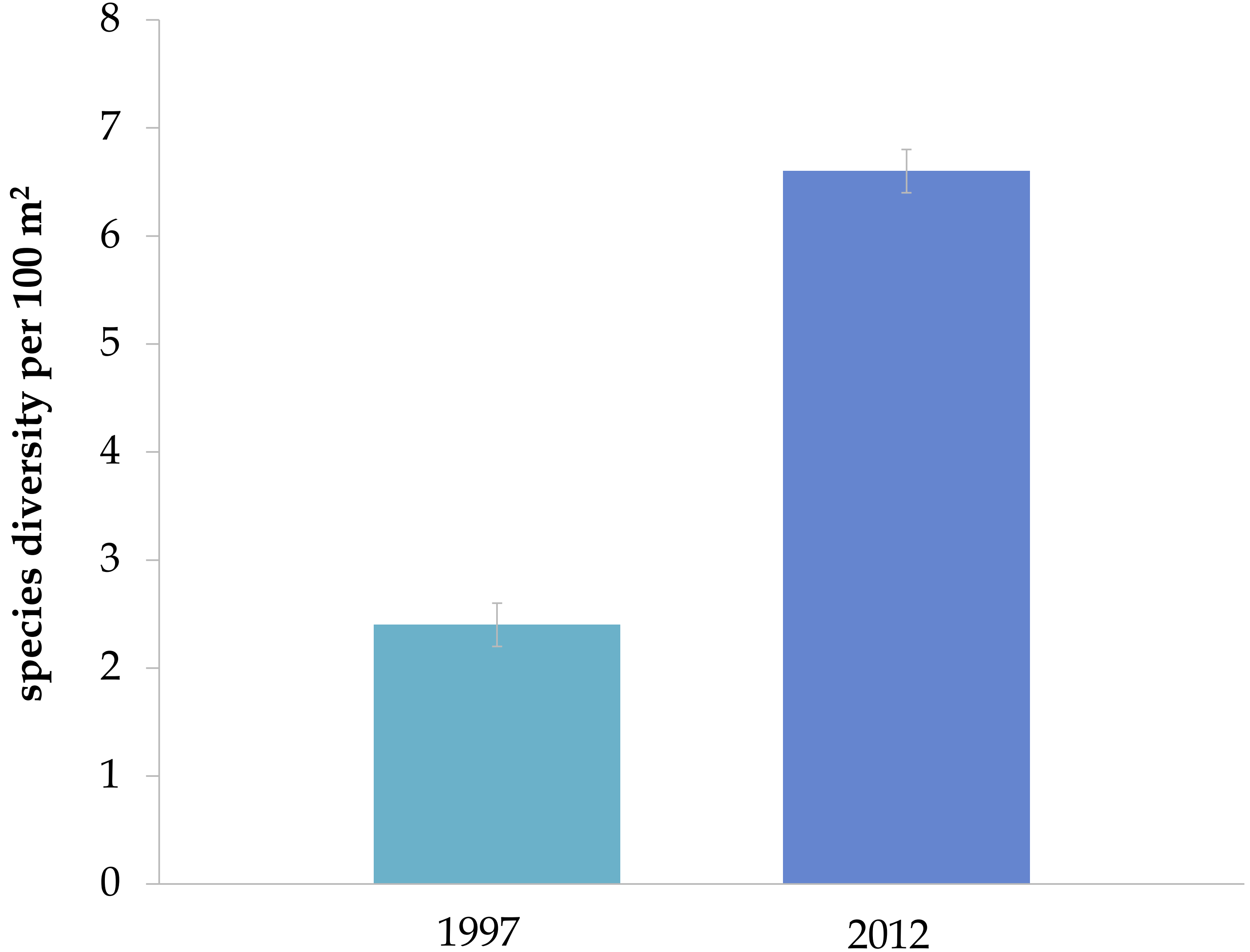

unrestored Auwahi relict dry forest, south Haleakalā, Maui island

Post-restoration vegetation changes, Auwahi I exclosure (1997-2012)



Medeiros, vonAllmen and Chimera, 2014


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

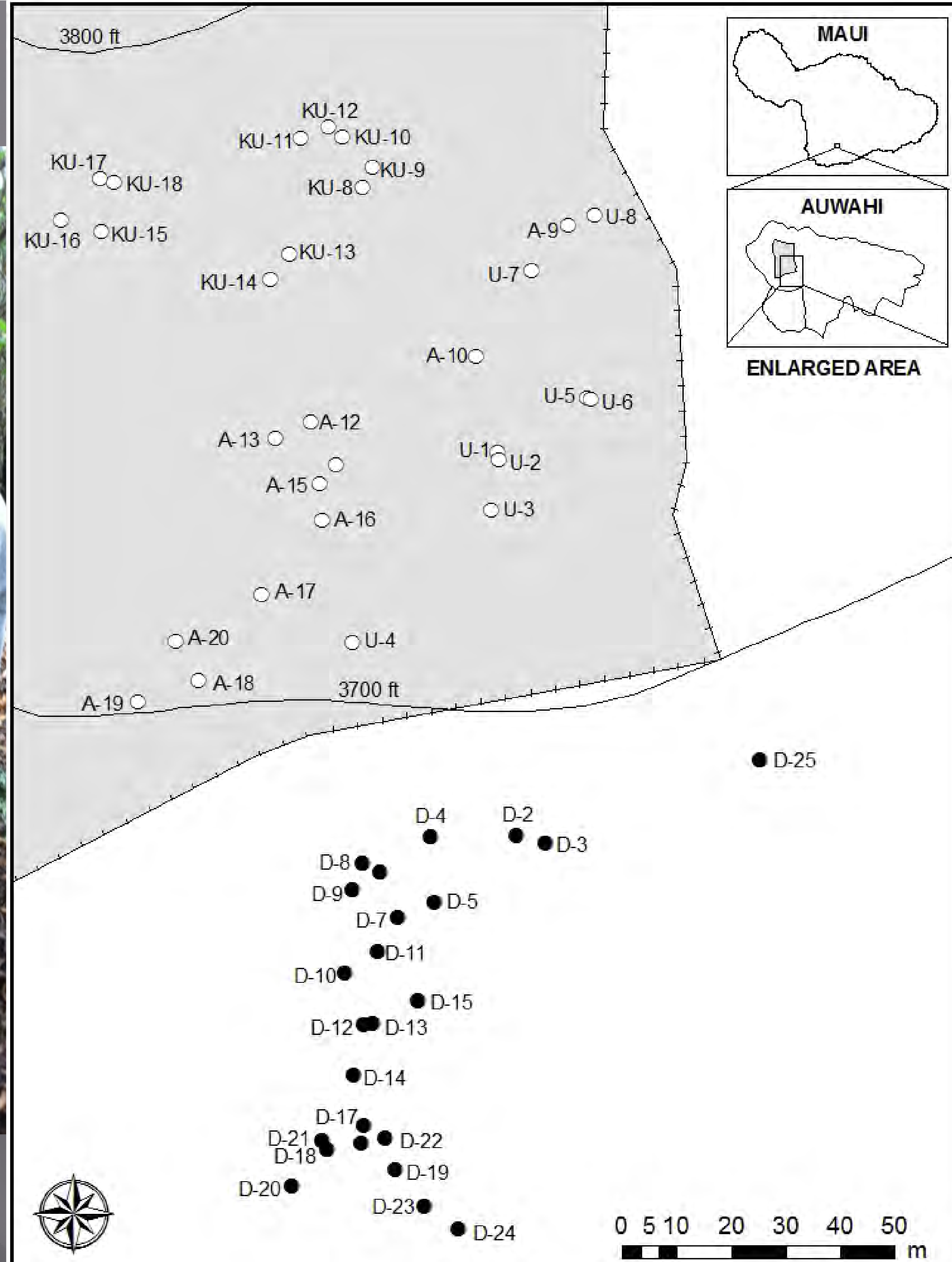


species diversity per 100 m²
0
1
2
3
4
5
6
7
8
1997
2012

By 2012, seven rare dry forest tree species, *Charpentiera obovata, Nothocestrum latifolium, Ochrosia haleakalae, Pleomele auwahiensis, Santalum ellipticum, S. haleakalae,* and *Streblus pendulinus,* had established seedlings and/or saplings within the restoration site, notable because natural reproduction is largely lacking elsewhere.

halapepe

<u>Chrysodracon auwahiensis</u>



3800 ft
3700 ft
MAUI
AUWAHI
ENLARGED AREA
KU-12
KU-11
KU-10
KU-9
KU-8
KU-17
KU-18
KU-16
KU-15
KU-13
KU-14
A-9
U-8
U-7
A-10
U-5
U-6
A-12
A-13
U-1
U-2
A-15
A-16
U-3
A-17
A-20
U-4
A-18
A-19
D-25
D-4
D-2
D-3
D-8
D-9
D-5
D-7
D-11
D-10
D-15
D-12
D-13
D-14
D-17
D-21
D-22
D-18
D-19
D-20
D-23
D-24
0 5 10 20 30 40 50
m

Preprint: Perkins, K. S., J. R. Nimmo, and A. C. Medieros (2012), Effects of native forest restoration on soil hydraulic properties, Auwahi, Maui, Hawaiian Islands, Geophys. Res. Lett., doi:10.1029/2012GL051120, in press. (accepted 17 February 2012)

Effects of Native Forest Restoration on Soil Hydraulic Properties, Auwahi, Maui, Hawaiian Islands

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Abstract

Over historic time Hawai'i's dryland forests have been largely replaced by grasslands suitable 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 such as grazing 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 some measure of 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 are 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. Optimal soil properties promote infiltration and distribution of water throughout the depth and volume of the root system while minimizing losses to evaporation or drainage below root-accessible depths. This study indicates that vegetation restoration can lead to ecohydrologically important changes in soil hydraulic

Hydrology study (2011-2013)
to compare hydrology of restored native forest and adjacent non-native grasslands to investigate the effects of restoration on aquifer recharge


Na wai ho'i kaole o ke akamai, he alanui i ma'a i ka hele 'ia e o'u mau makua?

16 year old restored native forest

non-native grasslands

Depth of sensors	Forest average velocity (cm/min)	Grassland average velocity (cm/min)	P-value comparing average velocity	Forest average percent water content increase	Grassland average percent water content increase	P-value comparing percent water content increase
0-50 cm	6.7 (n=32)	4.7 (n=48)	0.239	0.096 (n=22)	0.054 (n=47)	0.23
50-75 cm	10.6 (n=22)	8.2 (n=22)	0.533	0.44 (n=12)	0.10 (n=11)	0.161
75-100 cm	15.8 (n=26)	0.9 (n=14)	0.00012***	0.11 (n=13)	0.025 (n=4)	0.002**

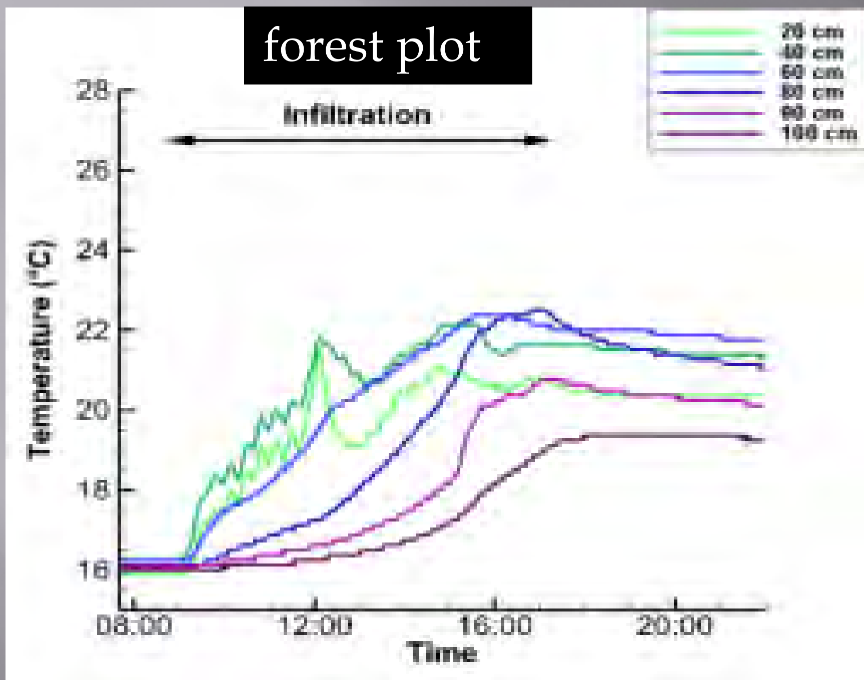
Table2. Average velocity and percent water content increase in forest and grassland plots comparing sensors less than 50 cm, 50 to75cm, and greater than 75 cm depths P-values are calculated from 2-sample t-tests, assuming unequal variance.

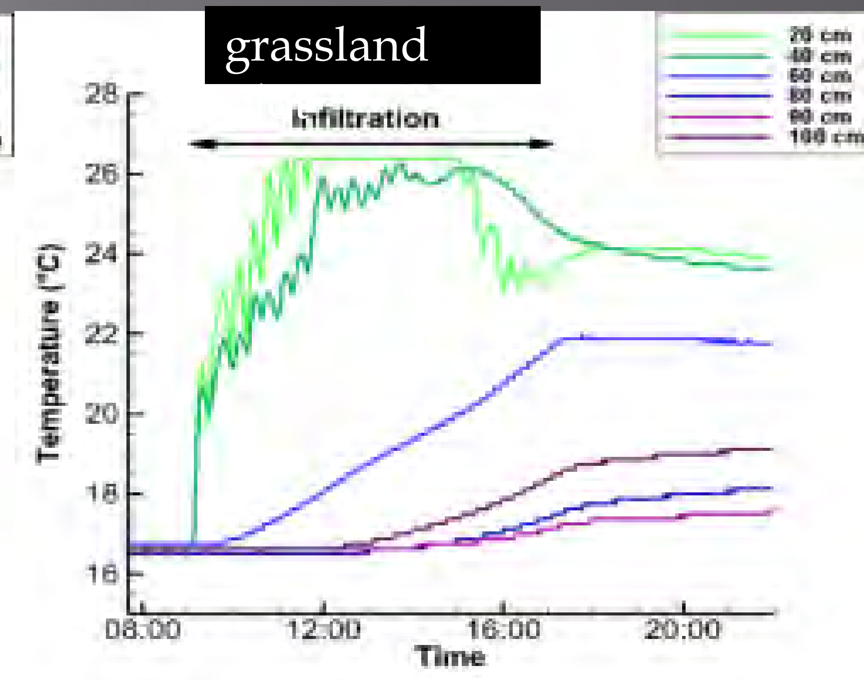
** indicates p-value significant at 99% confidence level

*** indicates p-value significant at 99.9% confidence level

Reforestation projects such as Auwahi can have highly significant ecohydrologic effects, such as promoting more rapid deep movement of water and potentially increasing the amount of soil water available for recharge.

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.





Forest soils remain cooler especially in the rooting zone of most plants from 20-40 cm


- What were the primary detected hydrological differences between non-native grasslands and 16-year old restored native forest at Auwahi, Maui?
- 1. water travels more efficiently in restored areas (infiltrates more quickly, to greater depth, and at greater volumes given equal inputs)
- 2. soils of restored forest remain generally cooler but especially during periods of intense solar radiation

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"Data and observations from this study along with inferences from other studies suggest that reforestation projects similar to those ongoing at Auwahi can have highly significant ecohydrologic effects, such as promoting more rapid deep movement of water and potentially increasing the amount of soil water available for recharge."

Perkins *et al* 2014

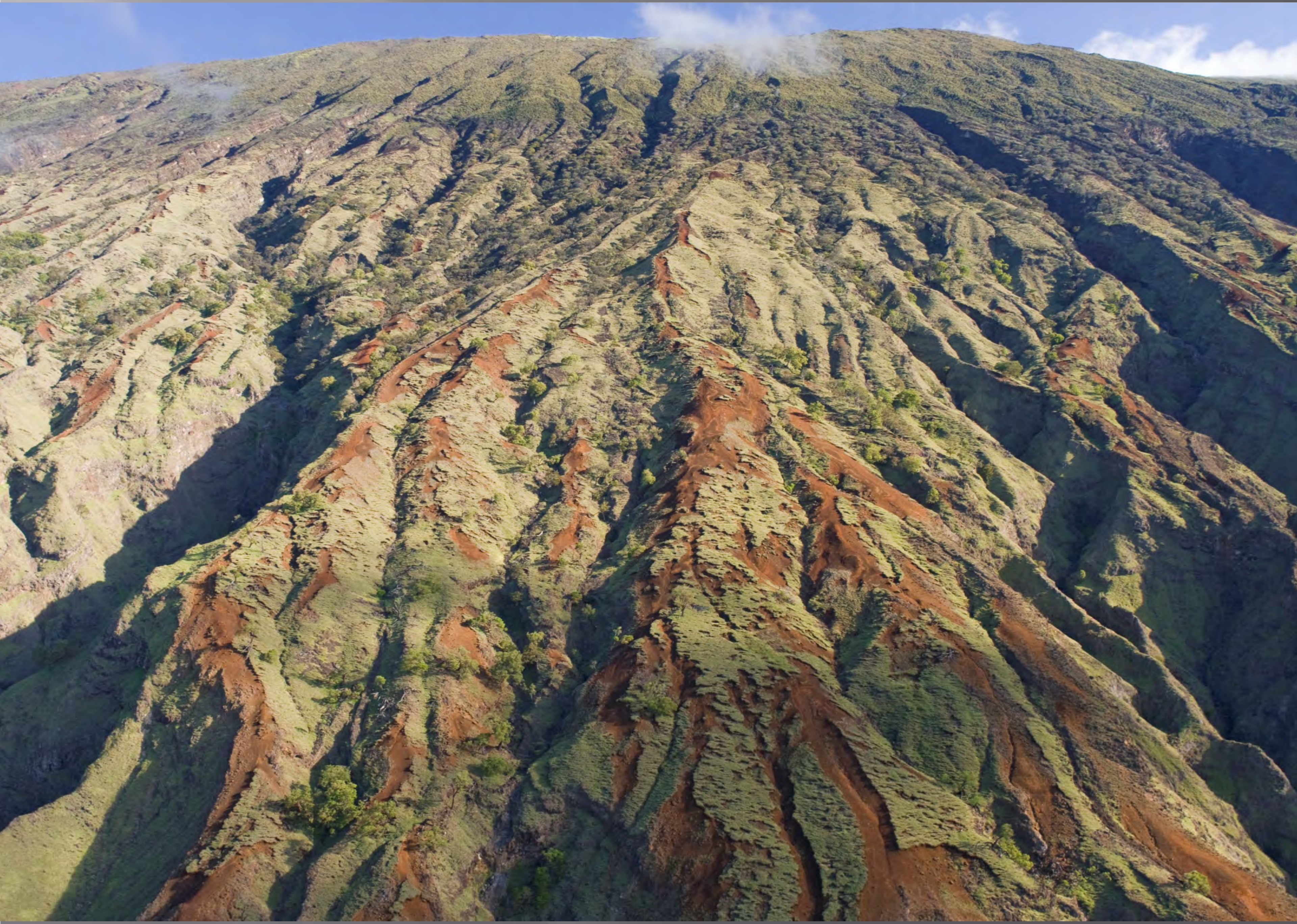

GMO
ZONE
BUY ORGANIC


MAUI


DA HUI
North Shore
HAWAII


DA HUI
North Shore
HAWAII

volunteerism - one of the most powerful forms of science education and outreach…



mahalo no