

Restoration case study:
***Psidium cattleianum* dominated forest in the**
Waianae Mountains, O‘ahu

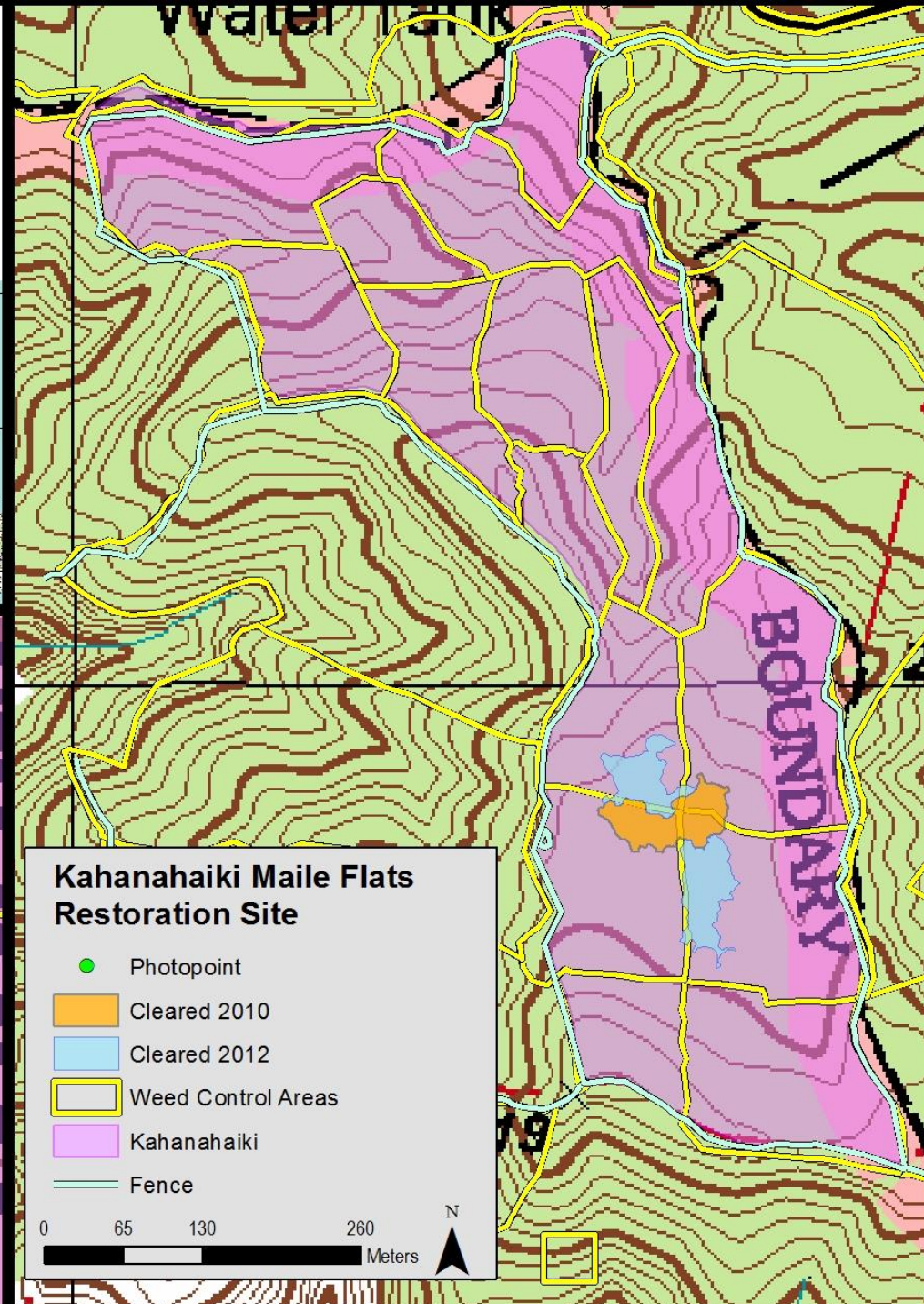
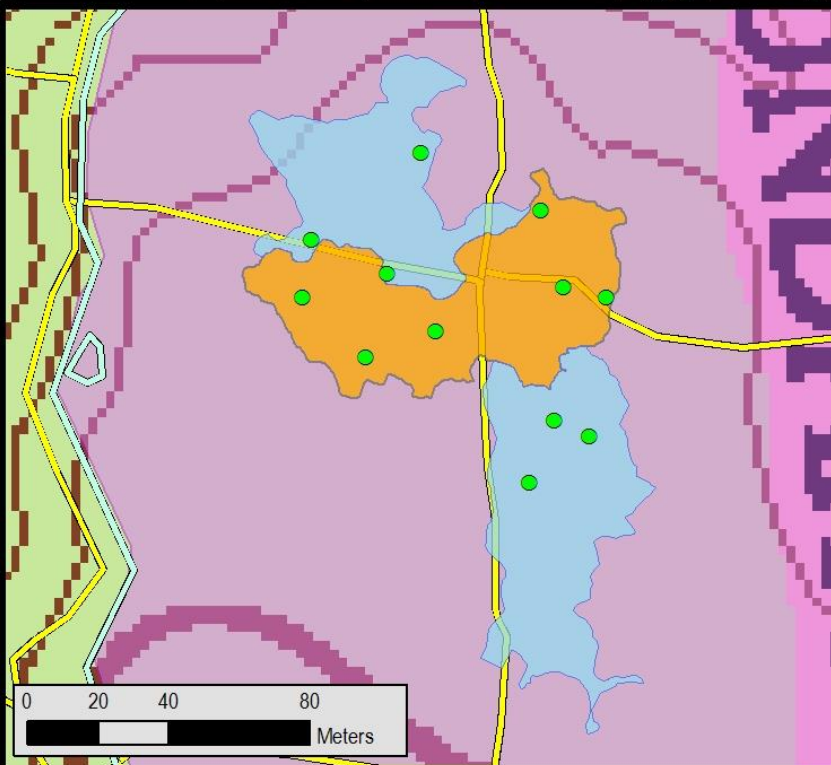
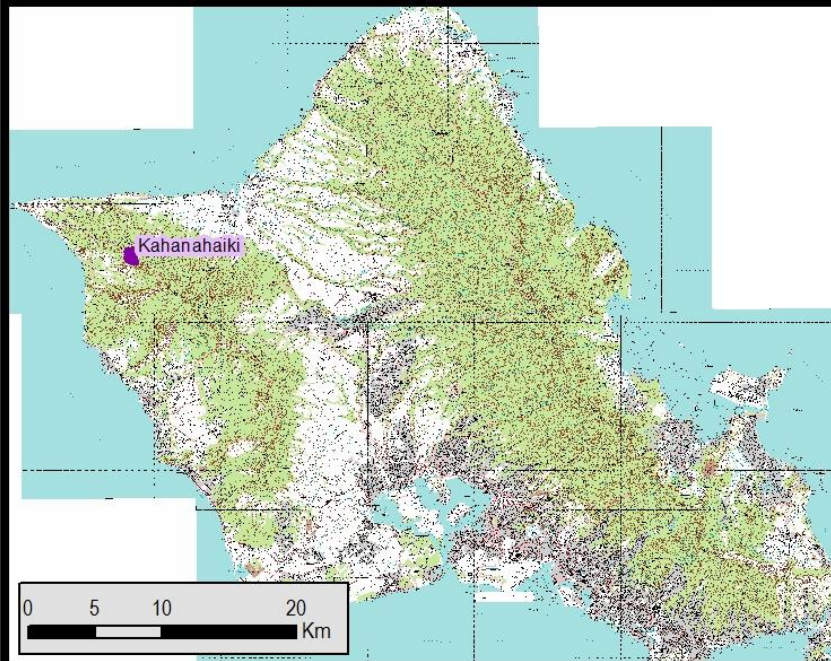


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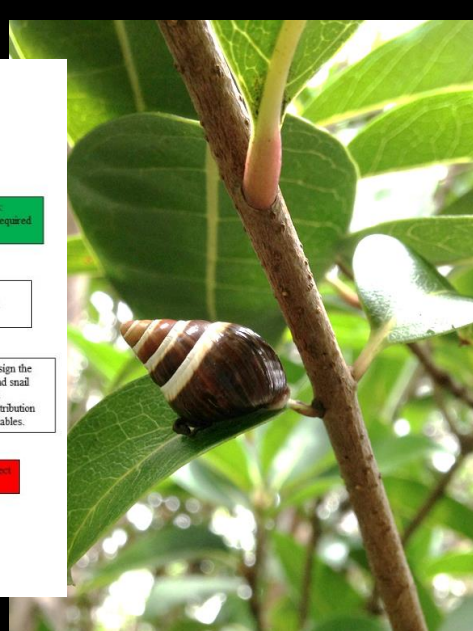
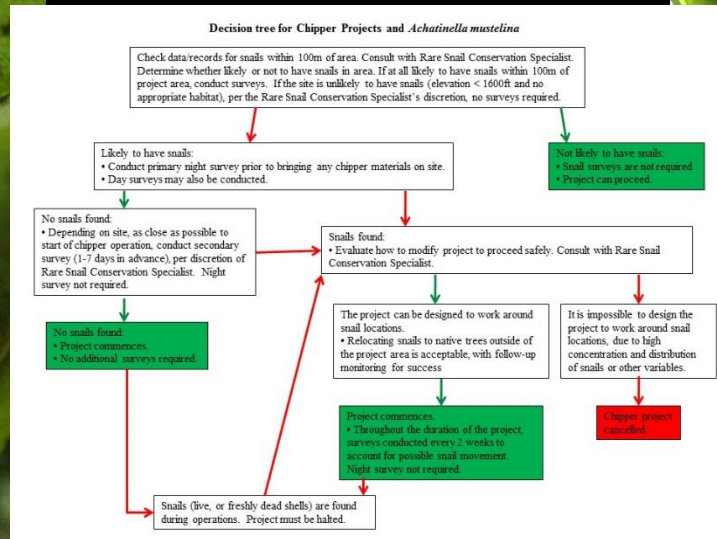
2010 June: Prior to clearing.



2015 July: 5 years later







Uowolo, Amanda L. and Denslow, Julie S. 2008. Characteristics of the *Psidium cattleianum* (Myrtaceae) Seed Bank in Hawaiian Lowland Wet Forests. *Pacific Science* vol. 62 no. 1:129-135

2010 June
Prior to clearing.



2010 Sept.

2 months post-clearing



2011 July

12 months post-clearing





2012 July

24 months post-clearing

2013 April

33 months post-clearing



2014 Dec.

53 months post-clearing

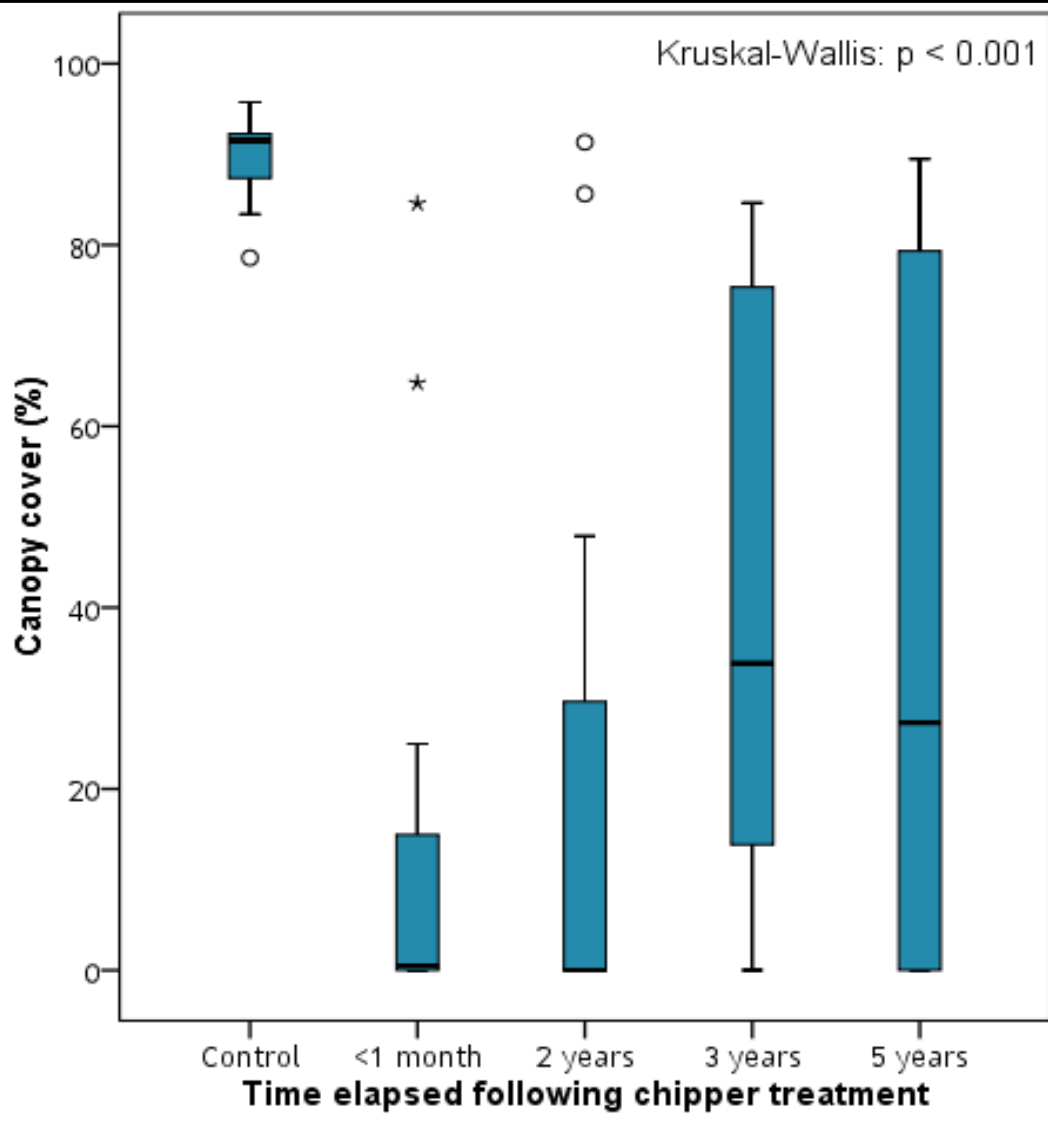


2015 July

60 months post-clearing



Total canopy cover over time.



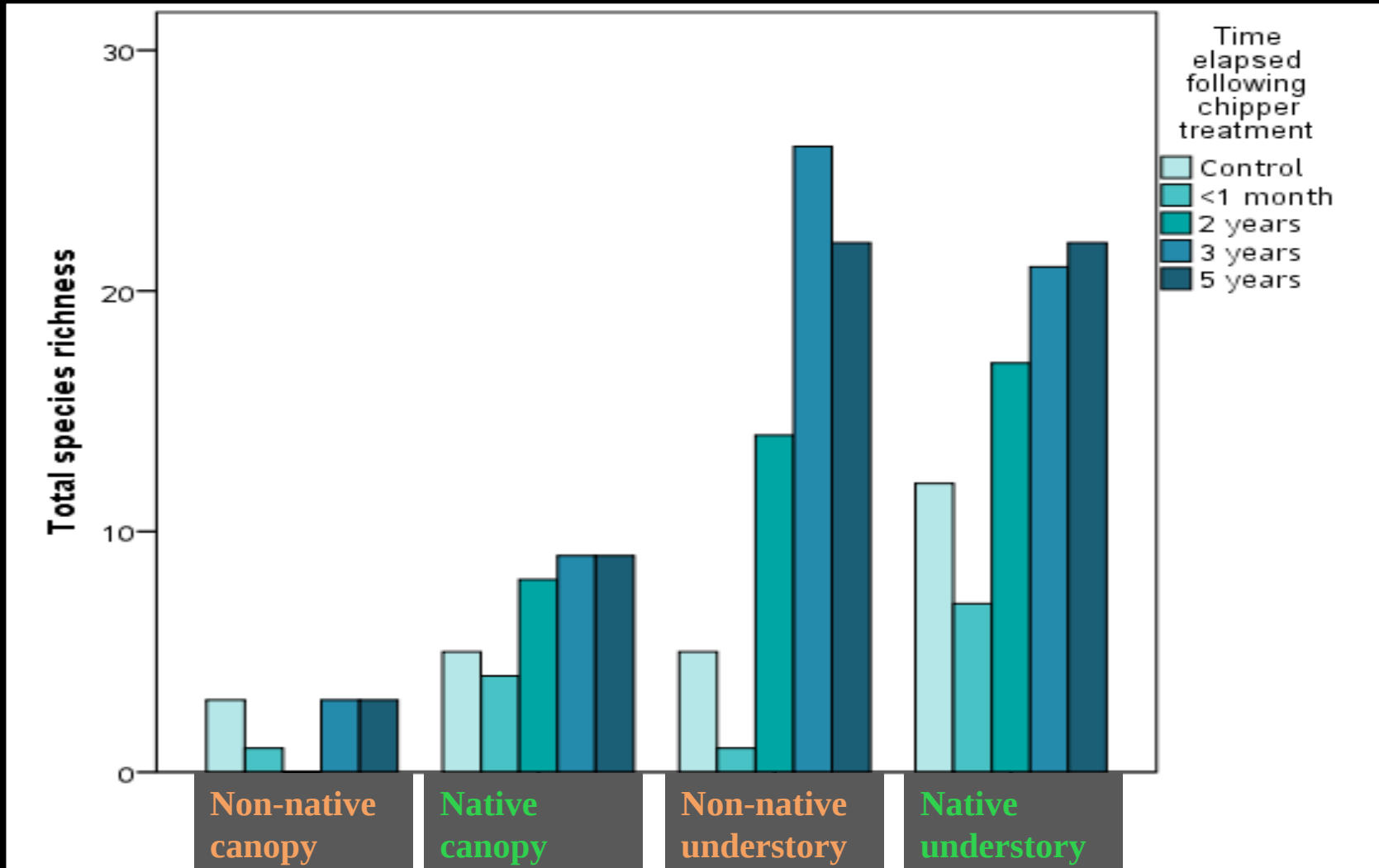
- Prior to chipping, the area was densely canopied and dominated by non-native taxa.
- Immediately following clearing, the canopy was largely open.
- After 2 years, canopy cover remained low and was predominantly native.
- After 3-5 years, the canopy continued to refill primarily with native taxa.

Understory cover over time.

Time elapsed after chipping	Non-native understory	Native understory
Control	75-100%	0-25%
< 1 month	0-25%	0-25%
2 years	0-25%	25-50%
3 years	25-50%	25-50%
5 years	0-25%	25-50%

- Understory cover followed a similar pattern as canopy cover.
- Non-native vegetation dominated prior to chipping, but decreased immediately after chipping ($p < 0.001$), and stayed low for 5 years.
- Native vegetation cover increased ($p < 0.001$) by 2 years after chipping.

Total species observed among all plots in chipped areas over time.



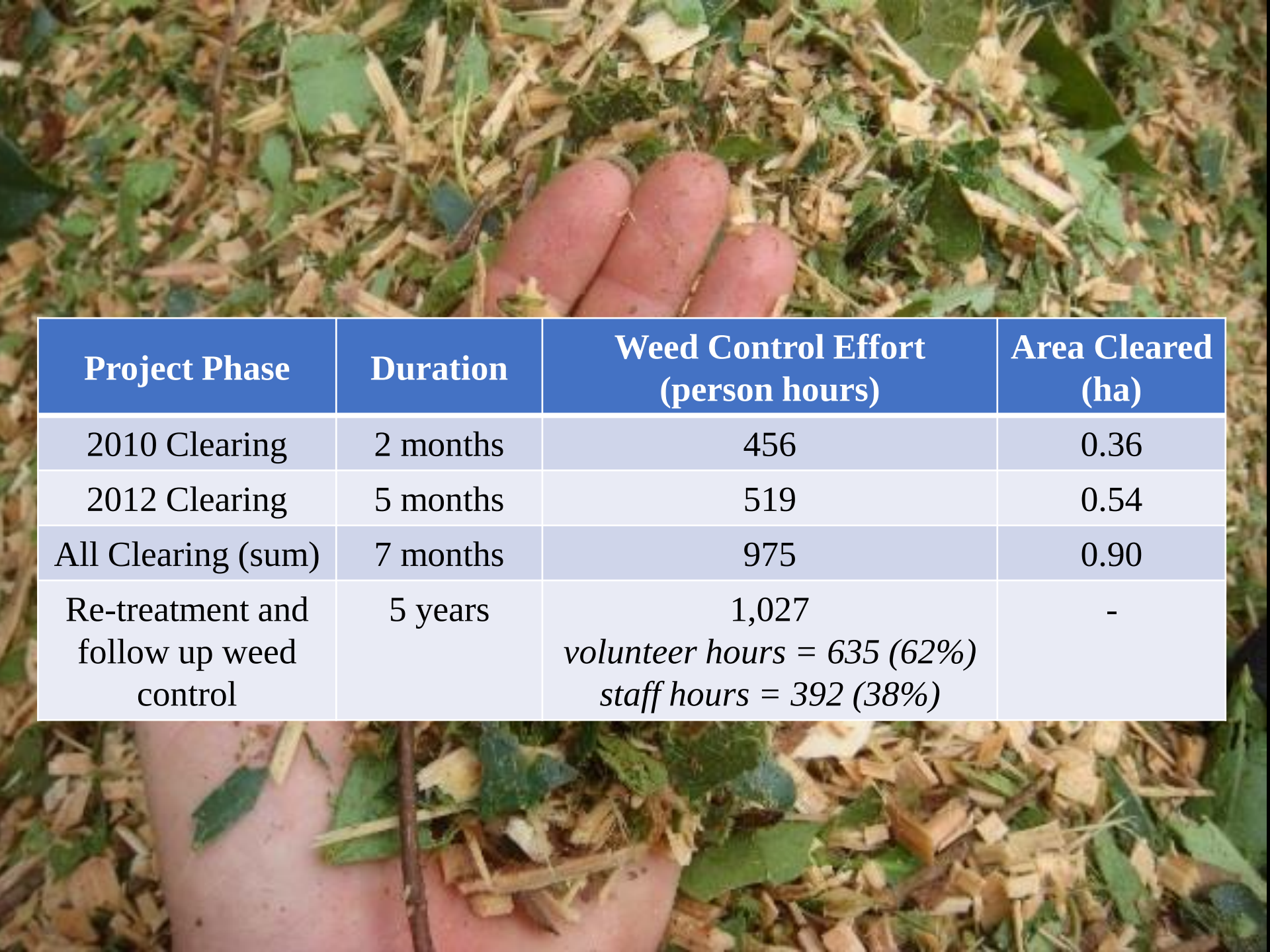
- Initially, diversity declined for all categories.
- From 2-5 years, all categories became more diverse except for the non-native canopy, which rebounded only to its original level.

Notable native and non-native taxon frequencies in the understory among plots over time.

Native Taxa	Frequency Change	P value
<i>Acacia koa</i>	0 to 75%	< 0.001
<i>Bidens torta</i>	0 to 60%	< 0.001
<i>Cocculus orbiculatus</i>	0 to 30%	0.009
<i>Coprosma foliosa</i>	5 to 45%	0.004
<i>Dianella sandwicensis</i>	0 to 45%	< 0.001
<i>Alyxia stellata</i>	86 to 80%	-

Non-native Taxa	Frequency Change	P value
<i>Clidemia hirta</i>	5 to 40%	0.009
<i>Conya bonariensis</i>	0 to 35%	0.004
<i>Crassocephalum crepidioides</i>	0 to 45%	< 0.001
<i>Mesosphaerum pectinatum</i>	0 to 40%	0.001
<i>Rubus rosifolius</i>	0 to 65%	< 0.001
<i>Psidium cattleianum</i>	90 to 25%	< 0.001

- Removing *P. cattleianum* created large light gaps which allowed both invasive and native plants to colonize, grow and spread in the project area.
- The dramatic increase in *A. koa* is key to recovery
- *A. stellata* frequency first decreased to 0, before recovering to original levels.
- Not all of the weeds are expected to persist, as canopy cover increases and light levels continue to change.



Project Phase	Duration	Weed Control Effort (person hours)	Area Cleared (ha)
2010 Clearing	2 months	456	0.36
2012 Clearing	5 months	519	0.54
All Clearing (sum)	7 months	975	0.90
Re-treatment and follow up weed control	5 years	1,027 <i>volunteer hours = 635 (62%)</i> <i>staff hours = 392 (38%)</i>	-

- Restoration of *P. cattleianum* stands through aggressive weed control (clearcutting and chipping) can be highly effective.
- *Native Hawaiian mesic forest can be very resilient. Within 5 years, both understory and canopy coverage reached approximately 50% vegetative cover.*
- *Seed broadcast of the short-lived perennial shrub Bidens torta was successful in creating large beds of this taxon within 2 years. Establishing a native ground cover likely reduced weed invasion.*
- *Outplanting is not necessary for restoration, although it may speed the process further.*
- *Follow-up weed control is critical to project success, and must be sustained for at least 5 years after initial clearing.*
- *The size of the project area should be based on the estimated area staff can commit to conducting follow-up weed control in, rather than the size of the area which can be clearcut in a given season.*

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