Shifting limitations to restoration across dryland ecosystems in Hawai‘i

Supplemental Materials

Table S1. Annual rainfall totals for each site during the years of the study and the average of the four years prior to the study. Prior average annual rainfall was calculated from 2004 to 2008.

Rainfall Year*	LP	MP	HP
Average	297	404	481
2008-09	262	295	213
2009-10	44	68	105
2010-11	229	318	363
2011-12	110	206	162
2012-13	178	204	331

*Rainfall year is from September – August (data are from Western Regional Climate Center. 2021. *Cooperative Climatological Data Summaries*. Retrieved from **https://wrcc.dri.edu/wraws/hiF.html**)

Table S2. Number of cohort 1 outplants and seeds added to each plot at each site.

Species						
	LP		MP		HP	
	Outplants	Seeds	Outplants	Seeds	Outplants	Seeds
Dodonaea viscosa	18	810	18	810	14	810
Chenopodium oahuense	4	10,125	4	10,125	4	10,125
Bidens menziesii	3	2,025	3	2,025		
Dubautia linearis	5	120	5	120		
Sida fallax	3	405	3	405	3	405
Sophora chrysophylla	14	405	14	405	18	405
Metrosideros polymorpha	2	10,125	2	10,125	2	10,125
Diospyros sandwicensis					4	120
Osteomeles anthyllidifolia					4	2,025

Table S3. Results for fixed effects from a generalized linear mixed model analysis of survival of cohort 1 at the HP site using a binomial distribution. Model dispersion was 1.25.

	Estimate	SE	Z-value	P-value
(Intercept)	0.07396	0.36211	0.204	0.83815
HabitatQuality(Low)	0.25067	0.48148	0.521	0.60263
WeedControl(Yes)	-0.14540	0.36551	-0.398	0.69078
Species(*C. oahuense*)	2.90392	1.00756	2.882	0.00395**
Species(*S. fallax*)	0.34553	0.66073	0.523	0.60101
Species(*D. sandwicensis*)	-0.40774	0.58857	-0.693	0.48846
Species(*S. chrysophylla*)	-0.37388	0.36845	-1.015	0.31023
Species(*O. anthyllidifolia*)	-0.65513	0.60327	-1.086	0.27749
HabitatQuality(Low):WeedControl(Yes)	-0.71237	0.37161	-1.917	0.05524*
HabitatQuality(Low):Species(*C. oahuense*)	-1.13108	0.95923	-1.179	0.23834
HabitatQuality(Low):Species(*S. fallax*)	-0.62563	0.77168	-0.811	0.41752
HabitatQuality(Low):Species(*D. sandwicensis*)	-0.65123	0.69681	-0.935	0.35000
HabitatQuality(Low):Species(*S. chrysophylla*)	-0.85730	0.43789	-1.958	0.05025*
HabitatQuality(Low):Species(*O. anthyllidifolia*)	-0.52933	0.72065	-0.735	0.46263
WeedControl(Yes):Species(*C. oahuense*)	-0.75074	0.96011	-0.782	0.43425
WeedControl(Yes): Species(*S. fallax*)	0.76647	0.77131	0.994	0.32035
WeedControl(Yes): Species(*D. sandwicensis*)	0.46850	0.69460	0.674	0.50000
WeedControl(Yes): Species(*S. chrysophylla*)	0.36331	0.43596	0.833	0.40464
WeedControl(Yes): Species(*O. anthyllidifolia*)	0.25570	0.71733	0.356	0.72150

Significance codes: ** <0.01 * <0.05

Table S4. Mean abundance of common understory species in each site. Species are shown that had 0.05 or greater proportional abundance in at least one site. *indicates native species.

Species	*LP*	*MP*	*HP*
*Chenopodium oahuense**	0.09	0.01	0.07
Delairea odorata	0.00	0.06	0.00
*Diospyros sandwicensis**	0.00	0.00	0.08
*Dodonaea viscosa**	0.20	0.31	0.02
*Eragrostis deflexa**	0.00	0.07	0.00
Lepidium spp.	0.06	0.09	0.00
*Myoporum sandwicensis**	0.00	0.07	0.00
*Osteomeles anthyllidifolia**	0.00	0.07	0.00
Pennisetum setaceum	0.21	0.07	0.43
Senecio madagascariensis	0.08	0.25	0.00
*Sophora chrysophylla**	0.00	0.10	0.00

Table S5. Linear model results (F values) for analyses of native species richness.

	Num df	Den df	Native Species Richness		
			LP	MP	HP
Habitat Quality	1	4	1.33	0.43	1.72
Weed Control	1	22	0.07	2.71	1.65
Species Addition	2	22	0.25	0.13	10.86***
Year	2	62	7.32**	6.39**	28.66***
Habitat Quality: Weed Control	1	22	0.20	6.09*	0.08
Habitat Quality: Year	2	62	1.05	4.36*	1.81
Habitat Quality: Species Addition	2	22	0.77	1.64	0.02
Weed Control: Species Addition	2	22	0.07	1.79	0.18
Weed Control: Year	2	62	0.45	3.69*	1.16
Species Addition: Year	4	62	4.30**	1.91	10.30***

Significance codes: *** <0.001 ** <0.01 * <0.05

Table S6. Linear model results (F values) for analyses of native diversity. Denominator df varied depending on the number of plots that had native species at each site (DVS N = 36, MSDF N = 35, LDF N = 29)

	Num df	Native 1/D		
		LP	MP	HP
Habitat Quality	1	0.96	1.80	0.02
Weed Control	1	0.14	6.01*	3.28 .
Species Addition	2	0.02	0.13	5.04*
Year	2	5.05**	1.58	5.24*
Habitat Quality: Weed Control	1	0.31	10.46**	0.88
Habitat Quality: Year	2	1.46	2.56 .	1.65
Habitat Quality: Species Addition	2	1.56	1.00	0.20
Weed Control: Species Addition	2	0.27	1.49	0.04
Weed Control: Year	2	1.75	4.89*	0.87
Species Addition: Year	4	3.18*	1.29	0.85

Significance codes: ** <0.01 * <0.05 . <0.1

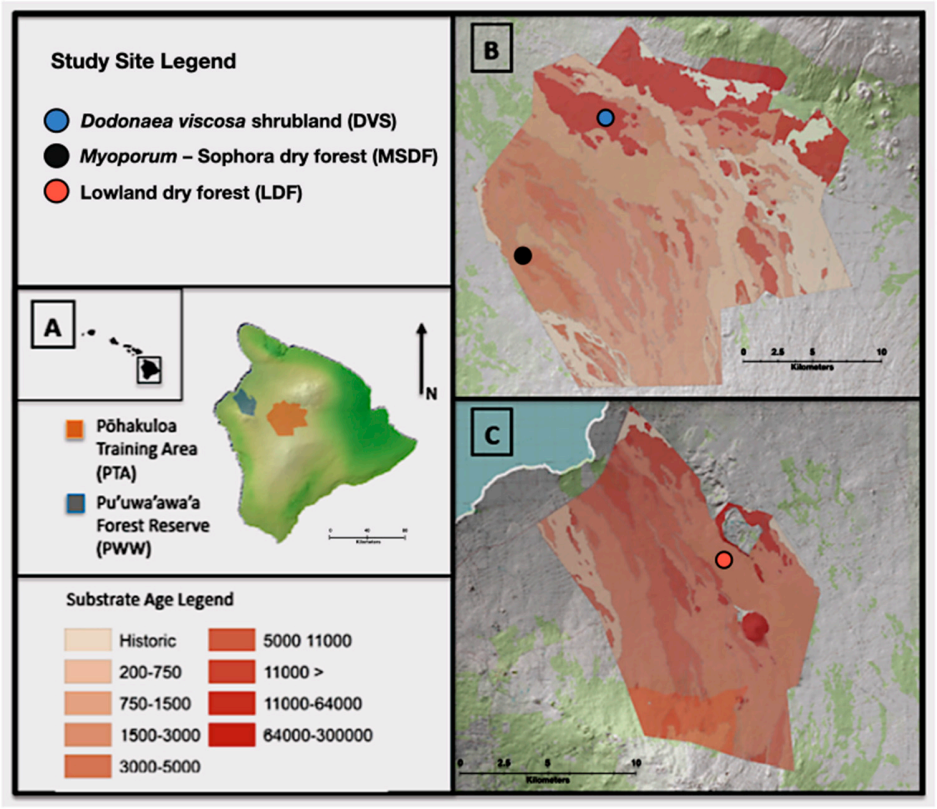


Figure S1. Map of research sites on the Island of Hawai‘i (A) in P̄ohakuloa Military Training Area (B) and Pu‘u Wa‘awa‘a (C). Substrate age units are cal BP.

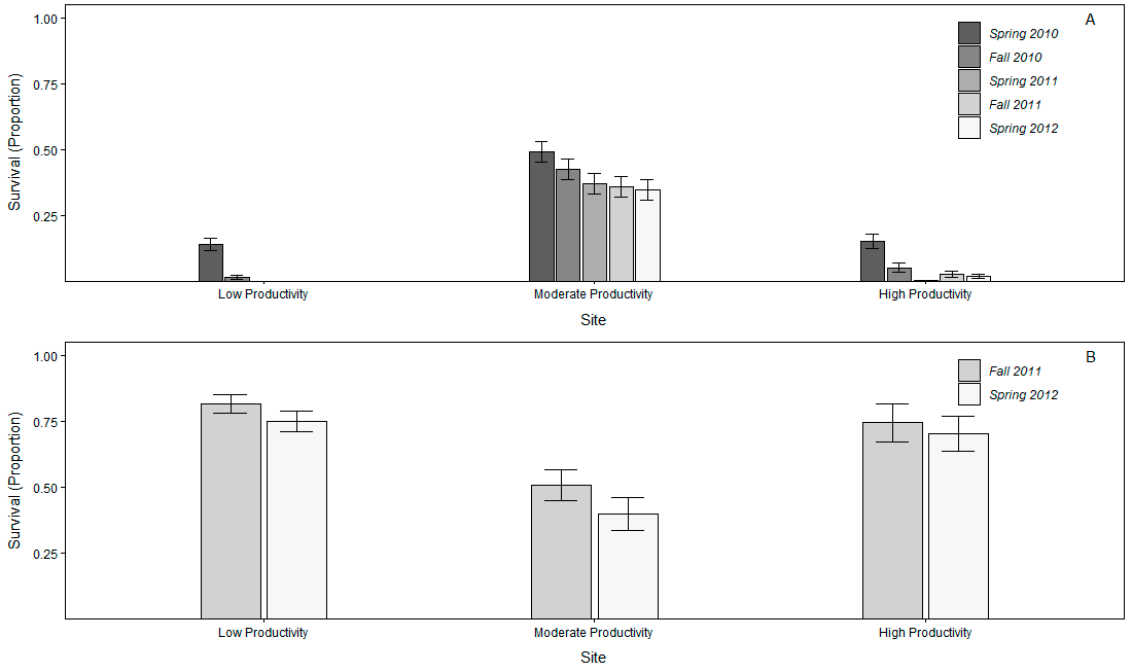


Figure S2. Outplant survival over time for a) cohort 1 and b) cohort 2. Mean and standard error for each sampling date at each site. Only sampling date had a significant effect on survival of cohort 2 at the HP ($F_{1,9} = 38.17$, $P < 0.001$), LP ($F_{1,9} = 7.50$, $P < 0.03$), and MP ($F_{1,9} = 20.57$, $P < 0.002$) sites.

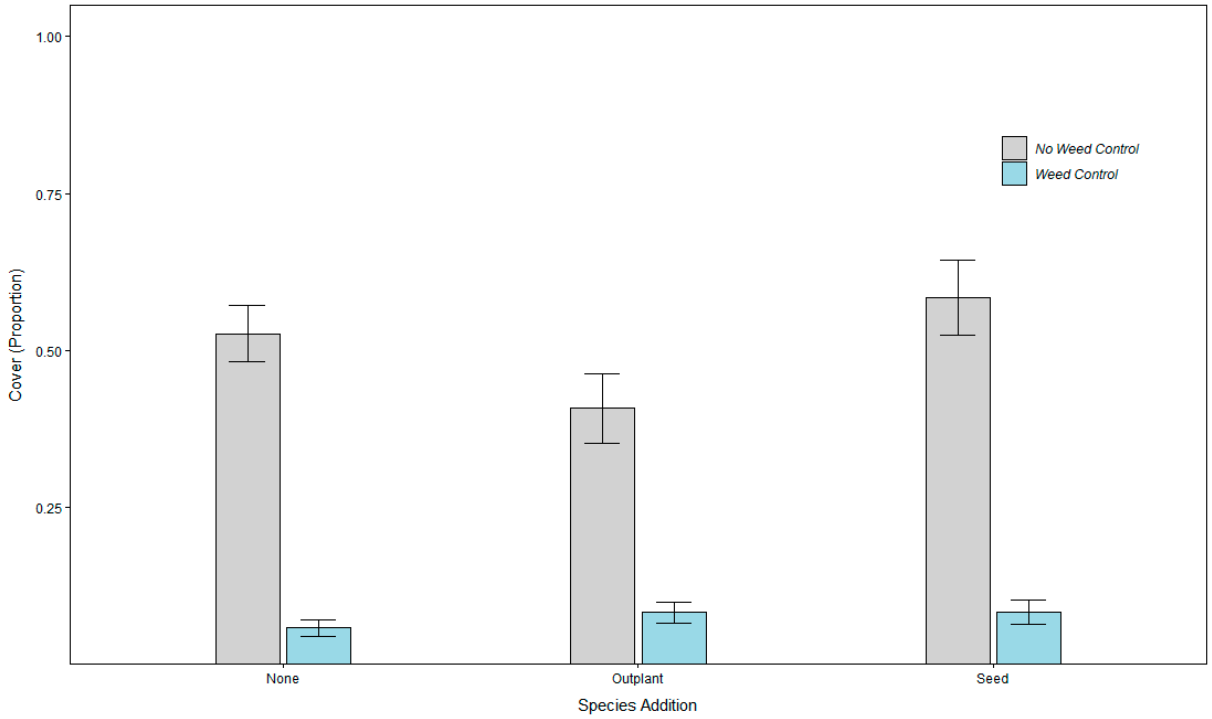


Figure S3. LP site non-native cover by weed control and species addition treatments. The difference in nonnative cover between weed control treatments was slightly lower in the outplant treatment possibly because nonnative cover overall was lower in the outplanting treatment.

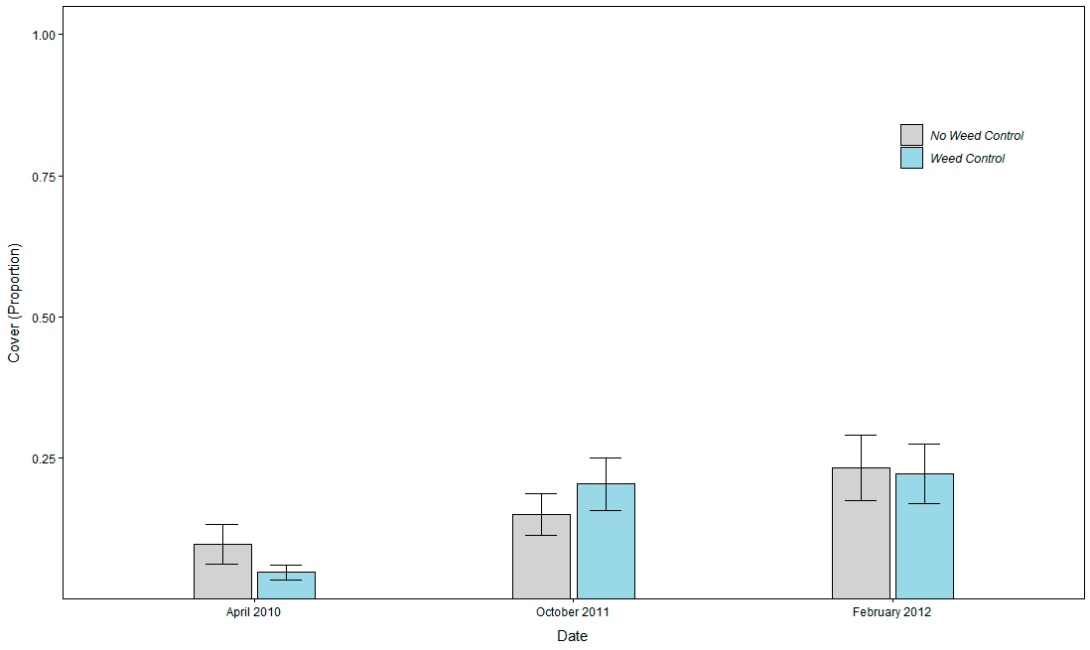


Figure S4. HP site native cover by weed control and date. There were small effects of weed control treatments that did not persist to the final sampling date.

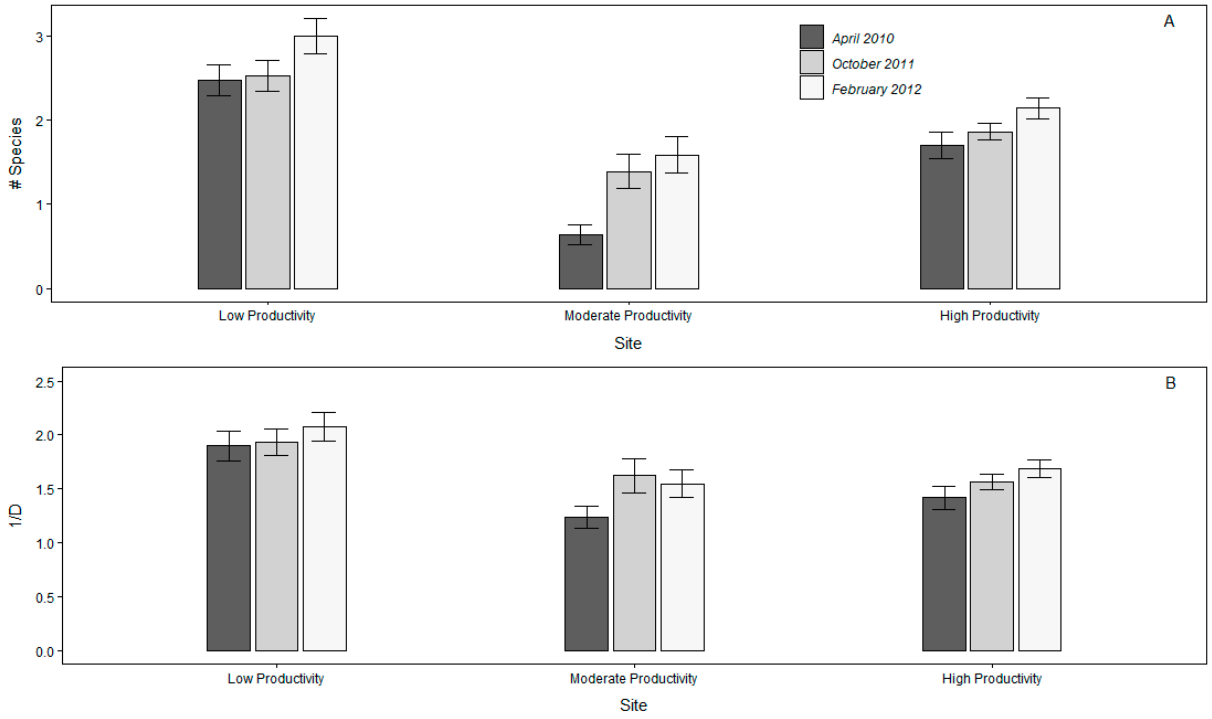


Figure S5. Richness (A) and diversity (B) by date among sites.