Development of a Native Plant Understory Agroforestry System for Restoration, Invasive Species Control and Sustainable Use in Hawai‘i

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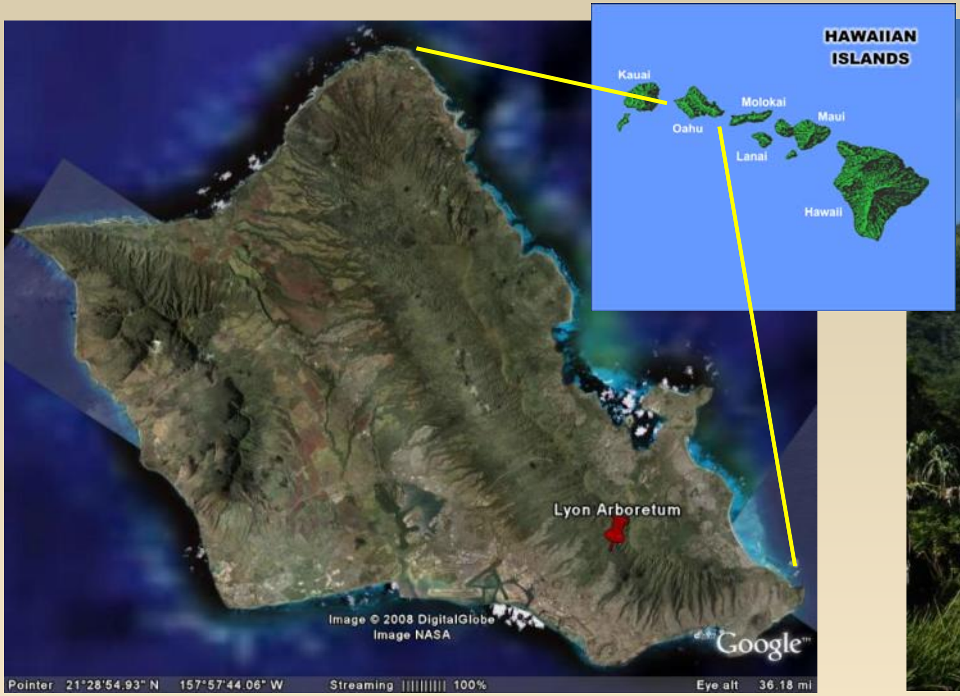
Research Area



- Harold L. Lyon Arboretum in Mānoa Valley, O‘ahu, Hawai‘i
- Two sites at 260 to 290 m elevation with steep slopes (50% to 80%)
- Annual rainfall ranges from 2000-3,000 mm.
- Soil is shallow, well-drained silt loams developed from volcanic ash and material weathered from cinders.

Purpose of Study

- Support the needs of native Hawaiian communities by providing sustainably harvestable material of culturally valued plants
  - Decrease collection pressures on wild stocks of native plants
  - Reduce dependence on imported plant materials
- Complement native plant forest restoration efforts
- Suppress or control invasive species regeneration

Selection Criteria for Native Plants

- Cultural value
  - Current use by Hawaiian culture
- Economic value
  - Monetary value of harvested plant material
- Restoration value
  - Potential ability to suppress invasive species
- Understory species
- Documented to have existed in research area

Microlepia strigosa (palapalai)


- Terrestrial fern found in the understory of Hawai‘i’s mesic forests
- Traditionally gathered for Hawaiian lei making and hula
- Decline and degradation of Hawai‘i’s forests has made it difficult to find and gather
- Harvesting of ferns can be an added pressure on already declining populations

Pipturus albidus (mamaki)

- Relatively fast-growing midstory shrub which casts moderate shade found in Hawai‘i’s mesic forests
- Traditionally used for Hawaiian kapa and medicinal uses.
- Dried leaves used for herbal tea and tonic.
- Host to endemic butterflies and moths.

Alyxia stellata (maile)

- ❖ Slow-growing woody vine found in the understory of Hawai‘i’s mesic forests
- ❖ Traditionally and commercially valued lei plant.
- ❖ Can be difficult to find desired specimens. About 90% of maile is imported from the Cook Islands.

Site Description

- Lower site – closed canopy forest of reforested nonnative species.
- Upper site – intermittent overstory of both nonnative and native species.
- Six 6x6 m plots at each site, half are **cleared (C)** of nonnative mid-story and half left **intact (I)**
- *Ardisia elliptica* accounts for most nonnative under- and mid-story vegetation.

Relative percent of *Ardisia elliptica*

	Understory		Midstory (DBH)			Overstory (DBH)	
Site	Seed-lings	Ground-cover	<1cm	1-5cm	5-10cm	10-15cm	15-25cm
Upper	90	75	96	71	85	17	0
Lower	97	85	88	86	57	0	0

DBH = Diameter at Breast Height

Characterization of Light Environment

Spherical densiometer used to estimate forest canopy cover per plot

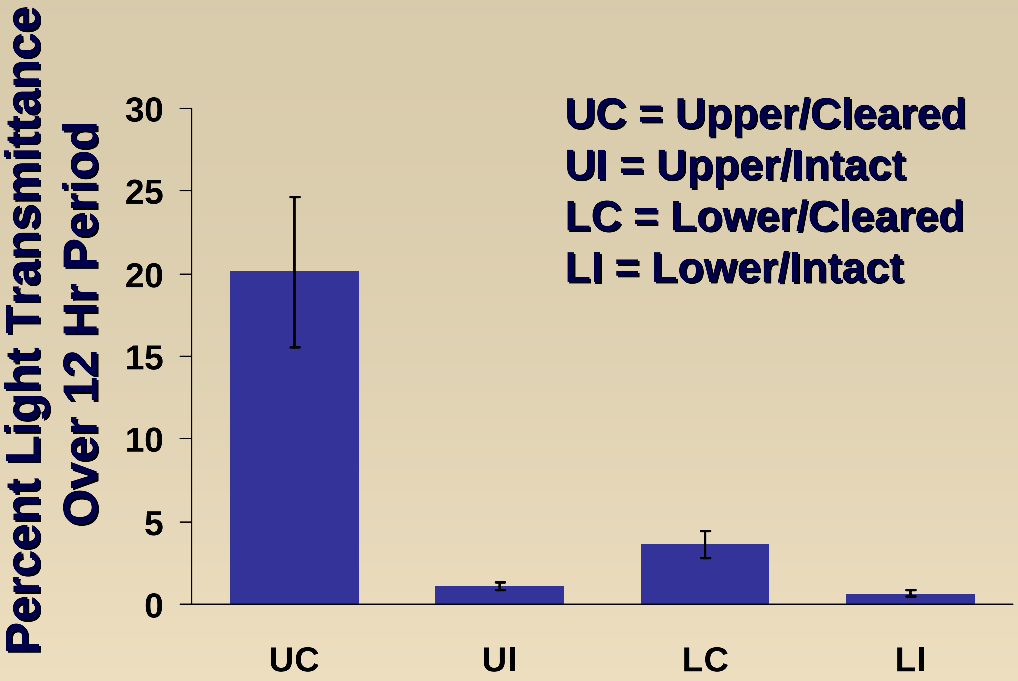
Percent light transmittance in each plot calculated using data from quantum light sensors in open and understory conditions

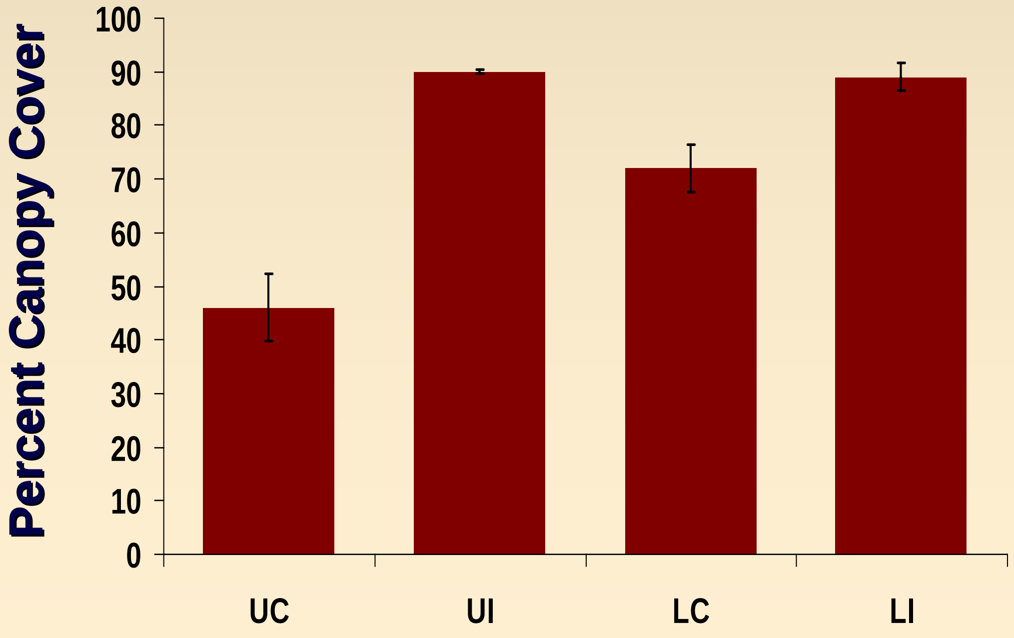
Light Environment

Site Treatment	% Light Transmittance	% Canopy Cover
Upper		
Cleared	20±4.6	46±6.0
Intact	1.1±0.25	90±0.0
Lower		
Cleared	3.6±0.82	72±4.0
Intact	0.07±0.18	89±3.0

Average max incident light is ≈ 2000 μmol m^{-2} s^{-1} so…

2000 x 20% = 400 μmol m^{-2} s^{-1}
1.1% = 22
3.6% = 72
0.07%= 14

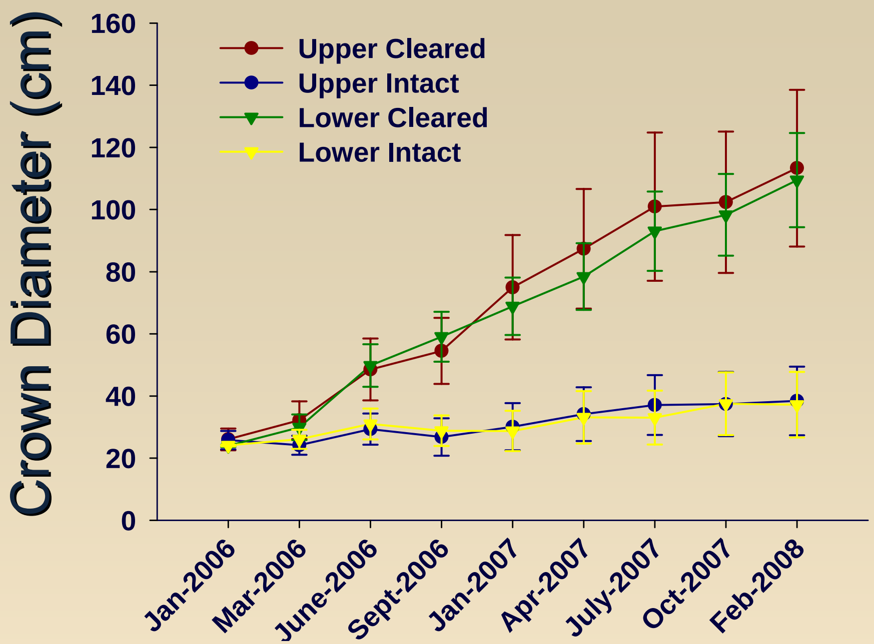


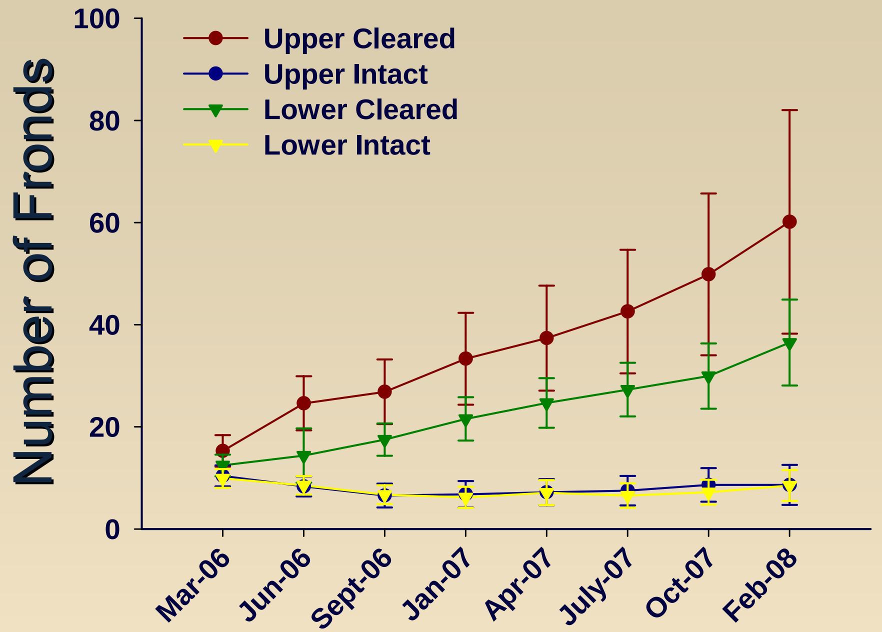


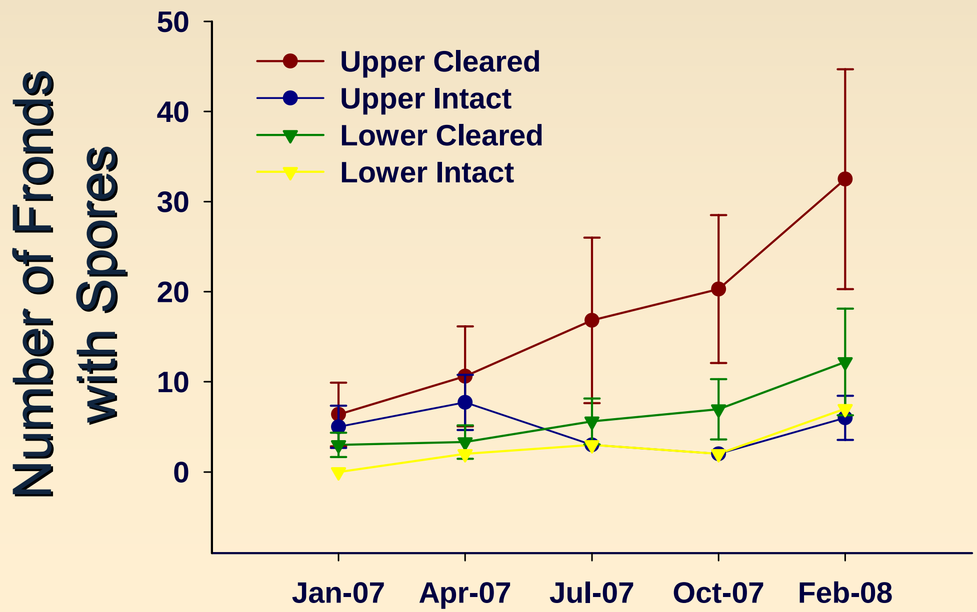
Native Plant Survival

Site	Palapalai	Mamaki	Maile
Treatment	***n*=54**	***n*=24**	***n*=18**
Upper			
Cleared	100%	63%	44%
Intact	59%	0%	0%
Lower			
Cleared	100%	25%	39%
Intact	76%	0%	17%

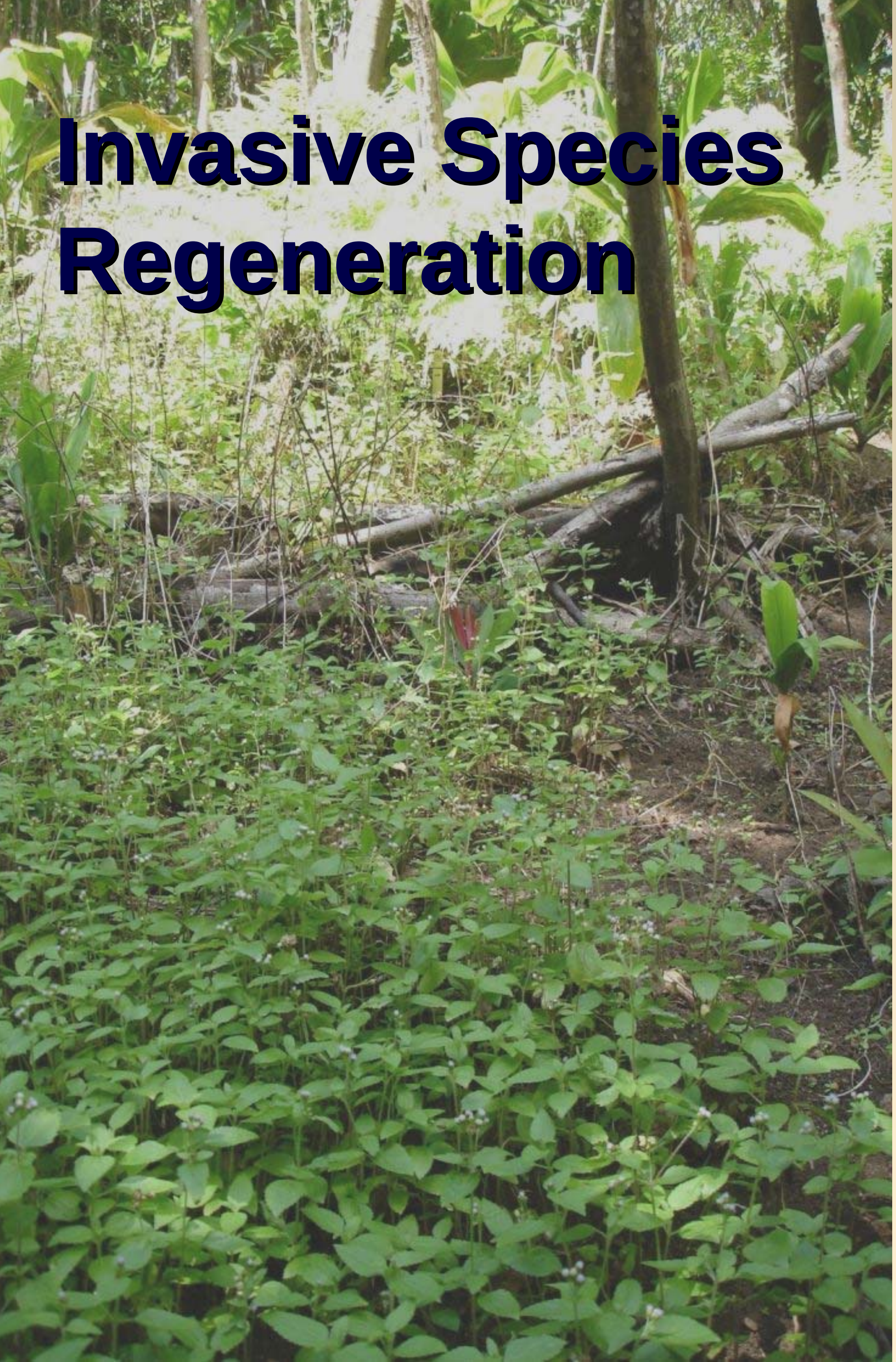
Palapalai Growth

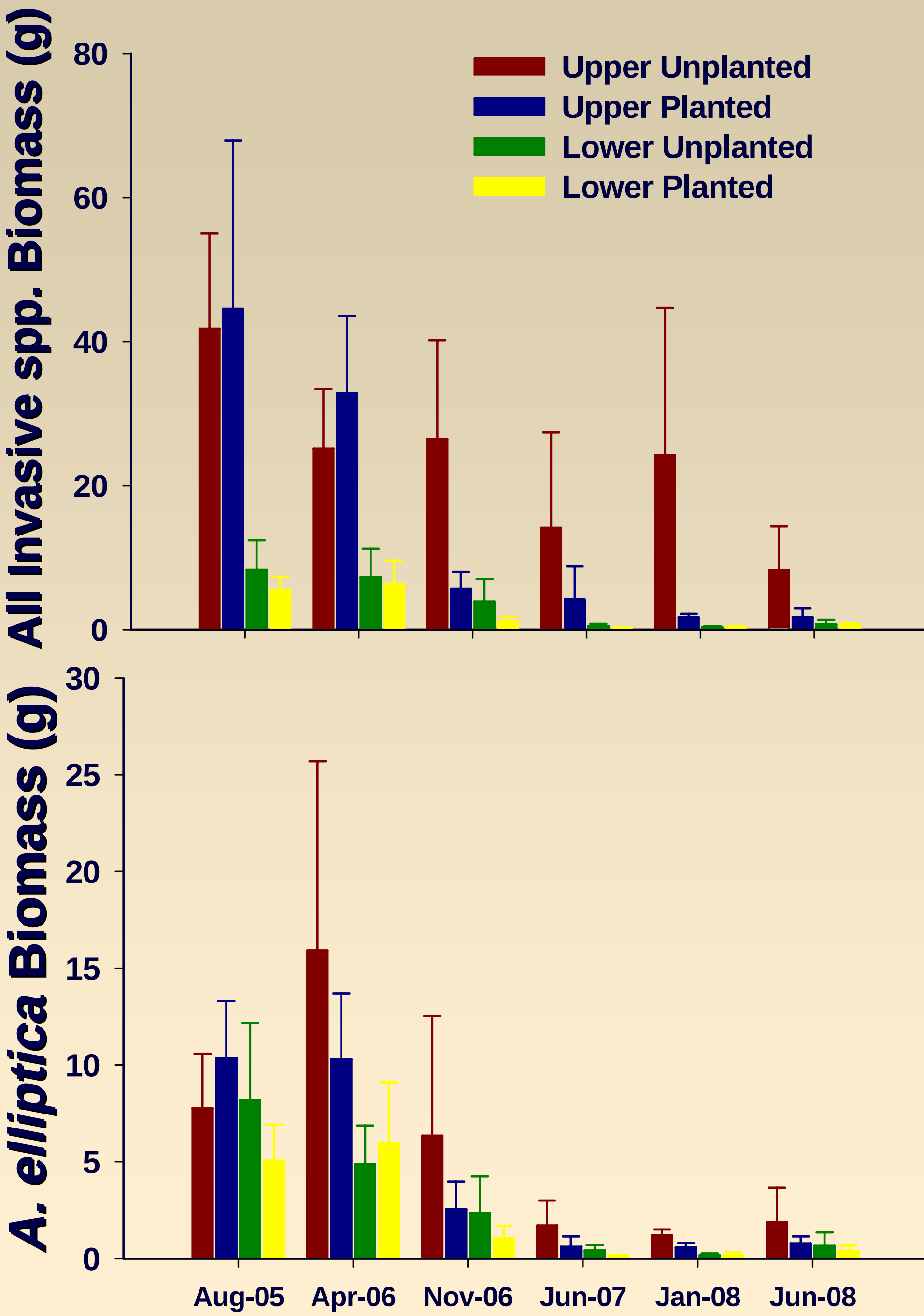






Invasive Species Regeneration





Potential Harvestable Yield

- 108 harvestable mature palapalai plants
- Average total number of fronds per plant = 50.
- One lei approximately needs 3-8 fronds, depending on size of lei needed
- Hence, harvesting 6 –16% of each plant will provide one lei per plant.

Conclusion

- Survival and growth of native outplantings is improved when invasive midstory is cleared.
- Invasive species regeneration can be controlled using native outplantings and biannual weeding.
- Palapalai has potential to be sustainably harvested 1-2 years after outplanting.

Future Goals

- Determine sustainable harvestable yield of palapalai.
  - How much? How often?
- Implementation and management by local community groups (e.g. hula halau).
  - Land access? Gathering rights?
- Further research to improve survival and growth of outplanted native species.
  - Appropriate levels of resource acclimation?

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