

Planning for Kiwikiu Reintroduction: Habitat Restoration in Nakula NAR



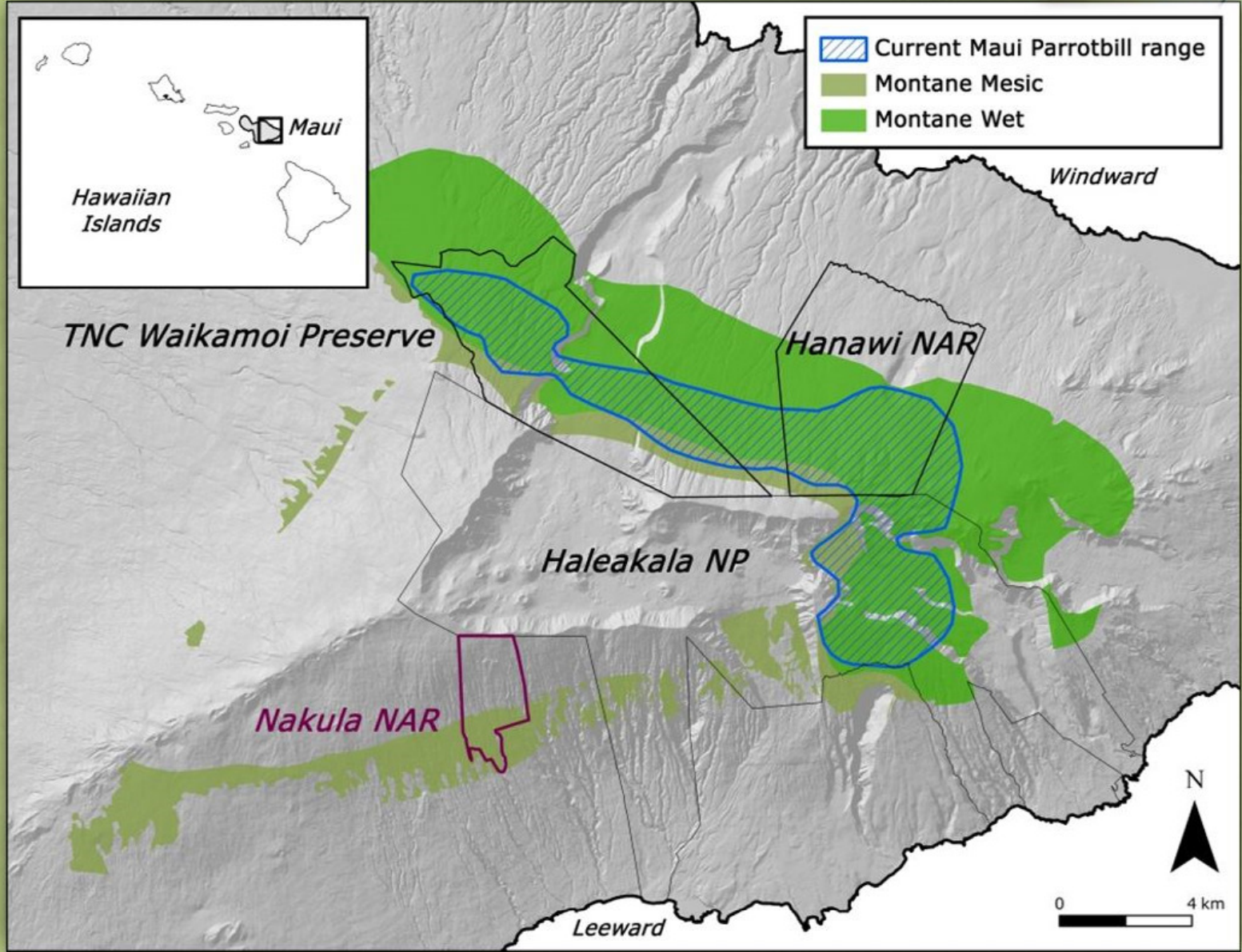
Christopher Warren, Hanna Mounce, Chris Farmer,
John Vetter, Laura Berthold, Peter Landon,
Keith Burnett, Fern Duvall, Scott Fretz

Kiwikiu Recovery

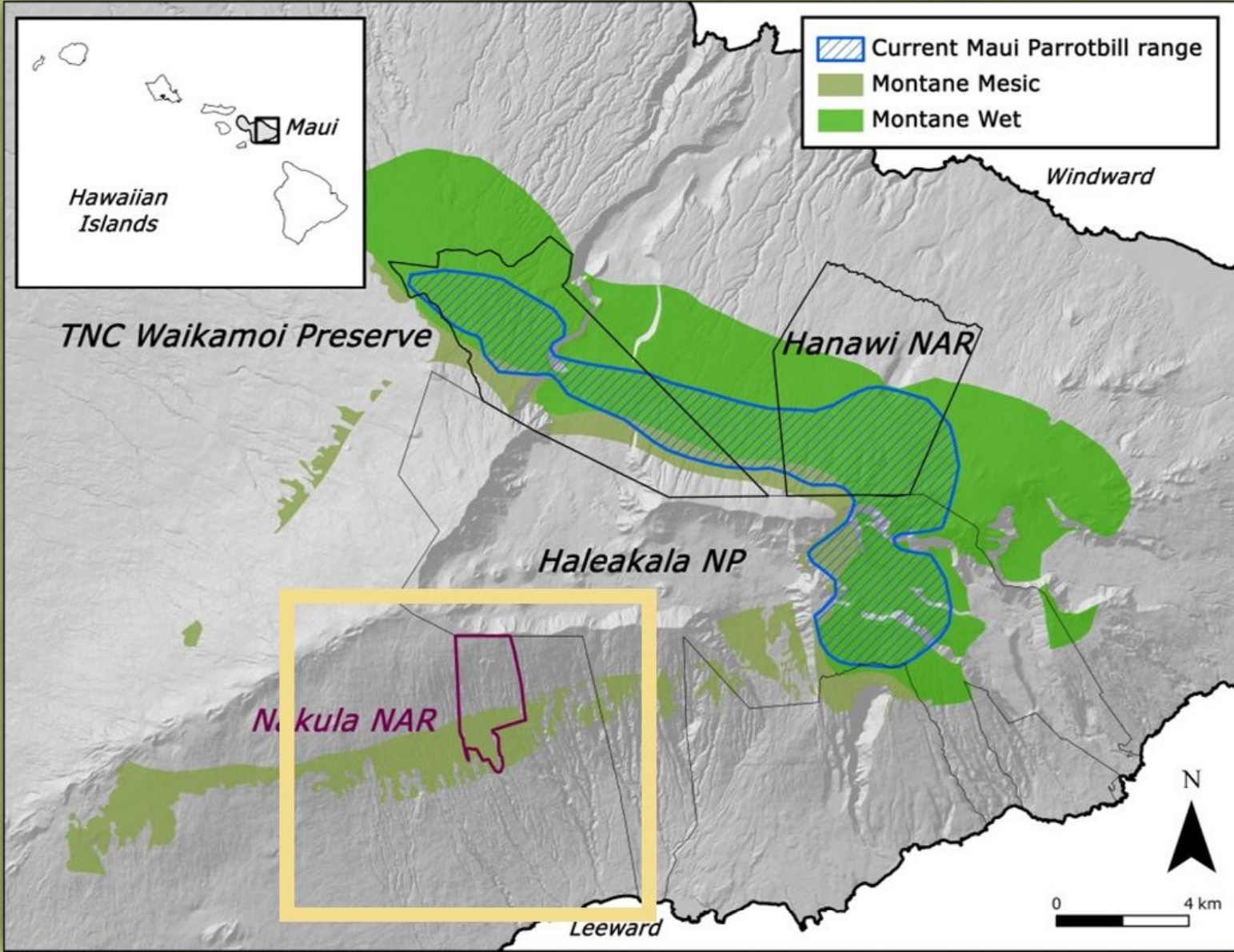


- Critically endangered
 - Found on windward east Maui
- Recovery plan calls for 2nd population
 - Plans to reintroduce on leeward Maui
 - Nakula Natural Area Reserve selected
 - Reintroduction plan in development

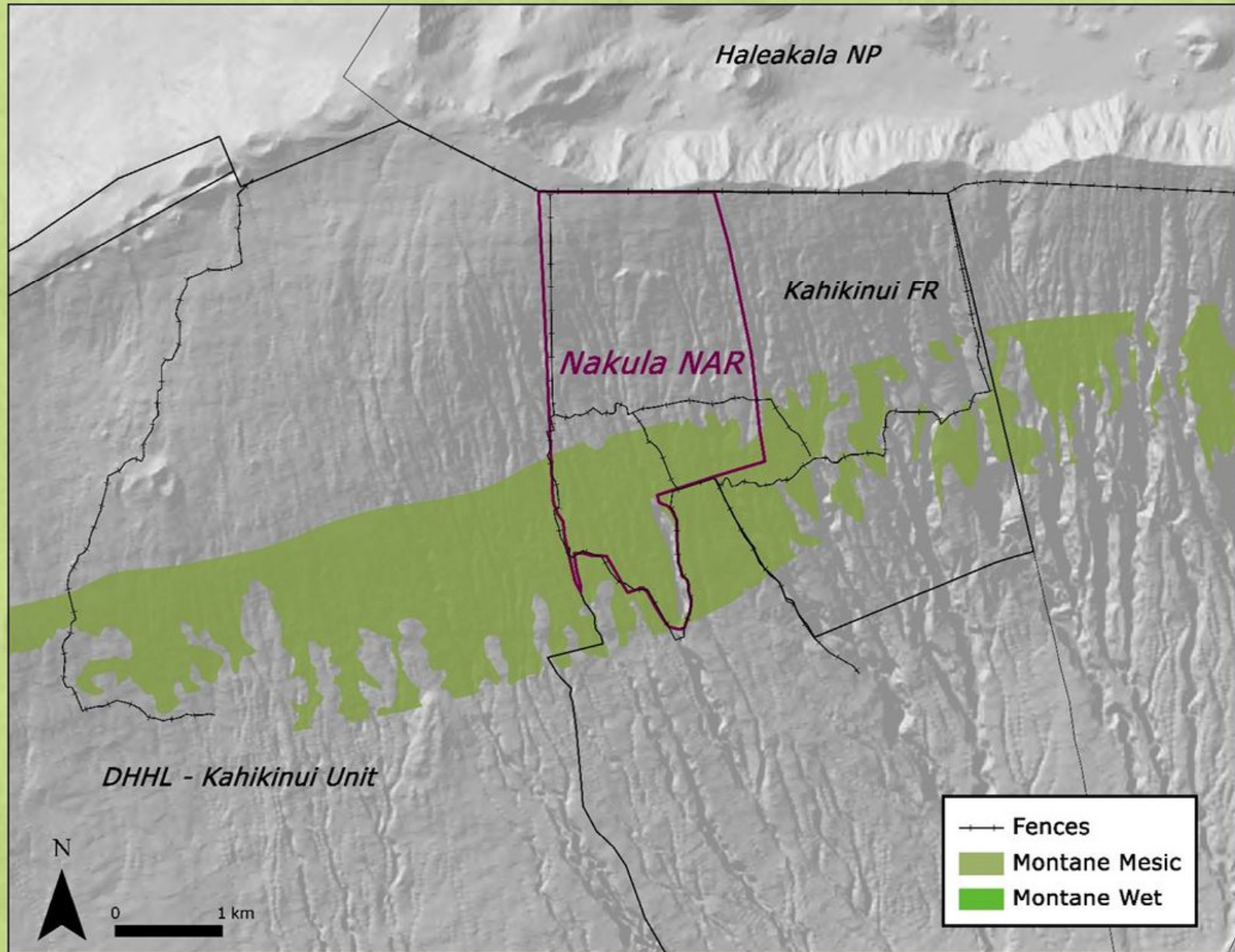
Kiwikiu Recovery



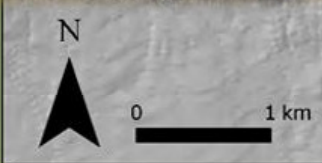
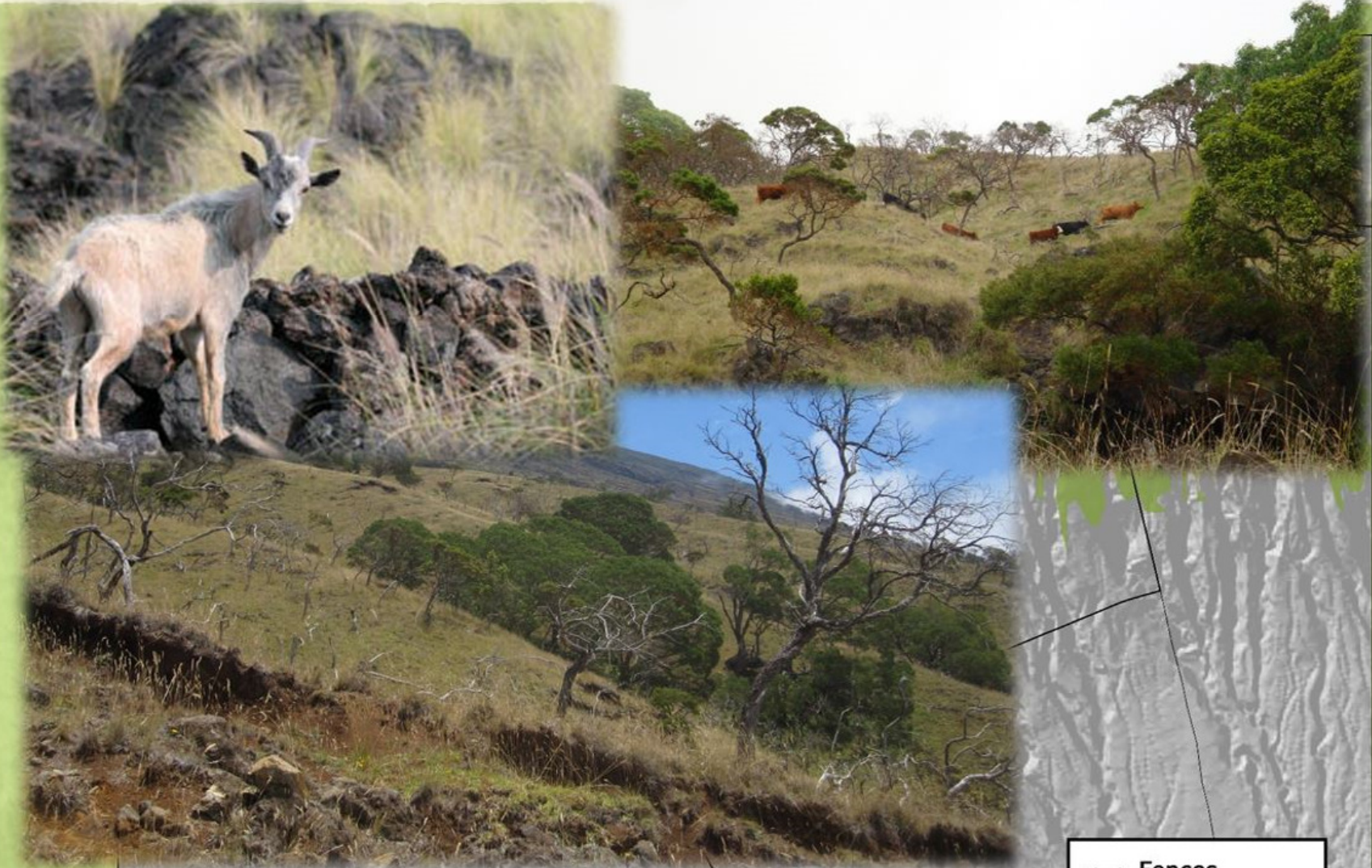
Kiwikiu Recovery



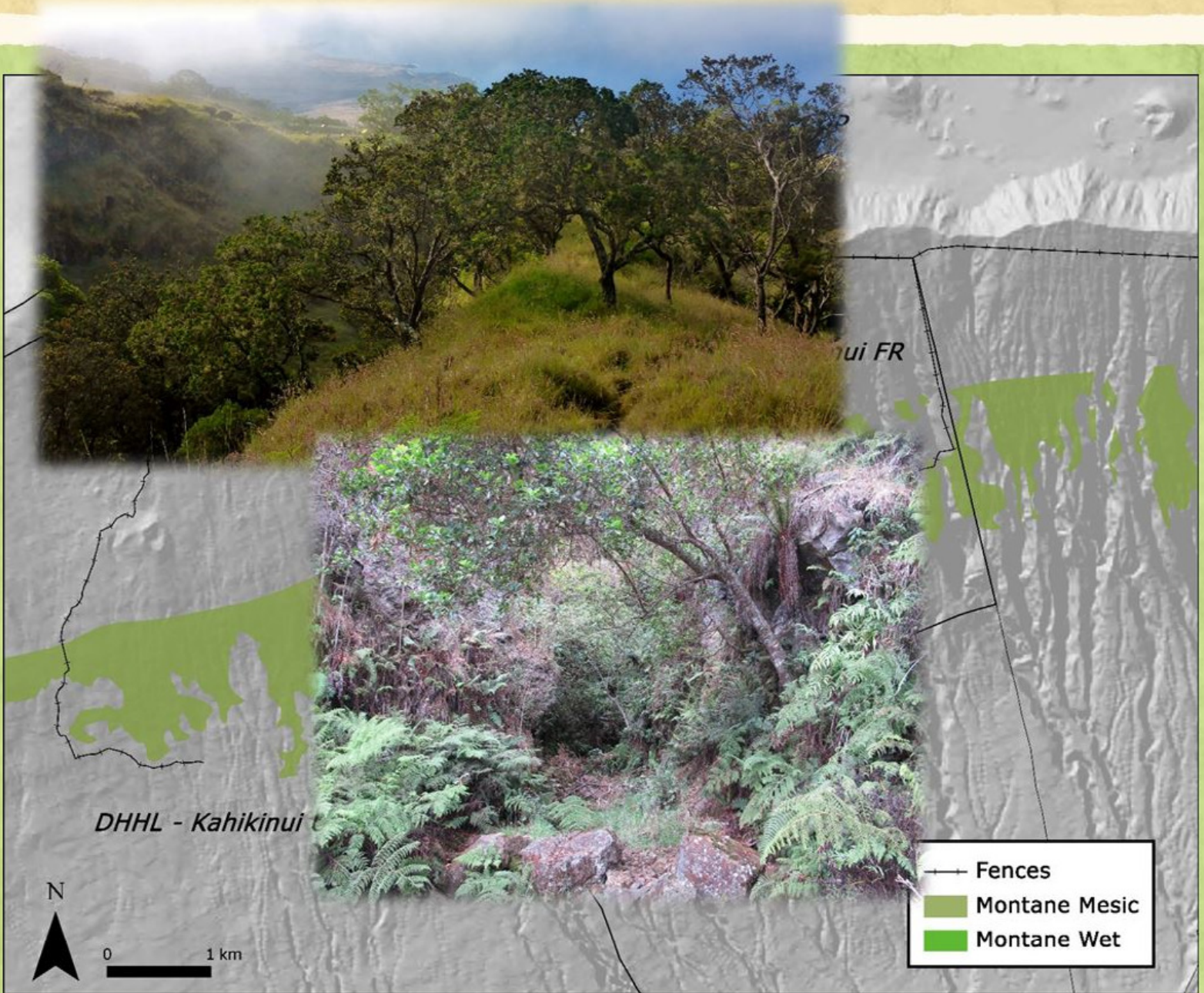
Kiwikiu Recovery



Kiwikiu Recovery



Kiwikiu Recovery



Rebuilding Habitat for Kiwikiu

- Landscape level fencing
- Ungulate removal
- Ongoing weed management
- Experimental restoration
- Landscape level restoration

Rebuilding Habitat for Kiwīkiu

- Landscape level fencing



habitat removal
management
restoration

Rebuilding Habitat for Kiwīkiū

- Landscape level fencing ✓
- Ungulate removal
- Ongoing weed
- Experimental restoration
- Landscape lev



Rebuilding Habitat for Kiwīkiu

- Landscape level fencing ✓
- Ungulate removal ✓
- Ongoing weed management

- **Experimental restoration**
- **Landscape level restoration**

Experimental Restoration: Nakula NAR

- Initial questions:
 - Native seed bank?
 - Non-native grass removal?
 - Seed sourcing?
 - Outplanting success?
- Trials designed to inform the most efficient and effective techniques



Experimental Restoration: Nakula NAR

- Experimental trials:
 1. Natural regeneration
 2. Outplanting
 3. Seed scatter
 4. Tree canopy
- Four treatments



Experimental Restoration: Nakula NAR

- Experimental trials:

1. Natural regeneration

2. Outplanting

3. Seed scatter

4. Tree canopy

- Four treatments



Experimental Restoration: Nakula NAR

- Experimental trials:
 1. Natural regeneration
 2. Outplanting
 3. Seed scatter
 4. Tree canopy
- Four treatments

Control



Herbicide



Herbicide &
biomass
removal



Biomass
Disruption



Experimental Restoration:

Nakula M

- Experimental

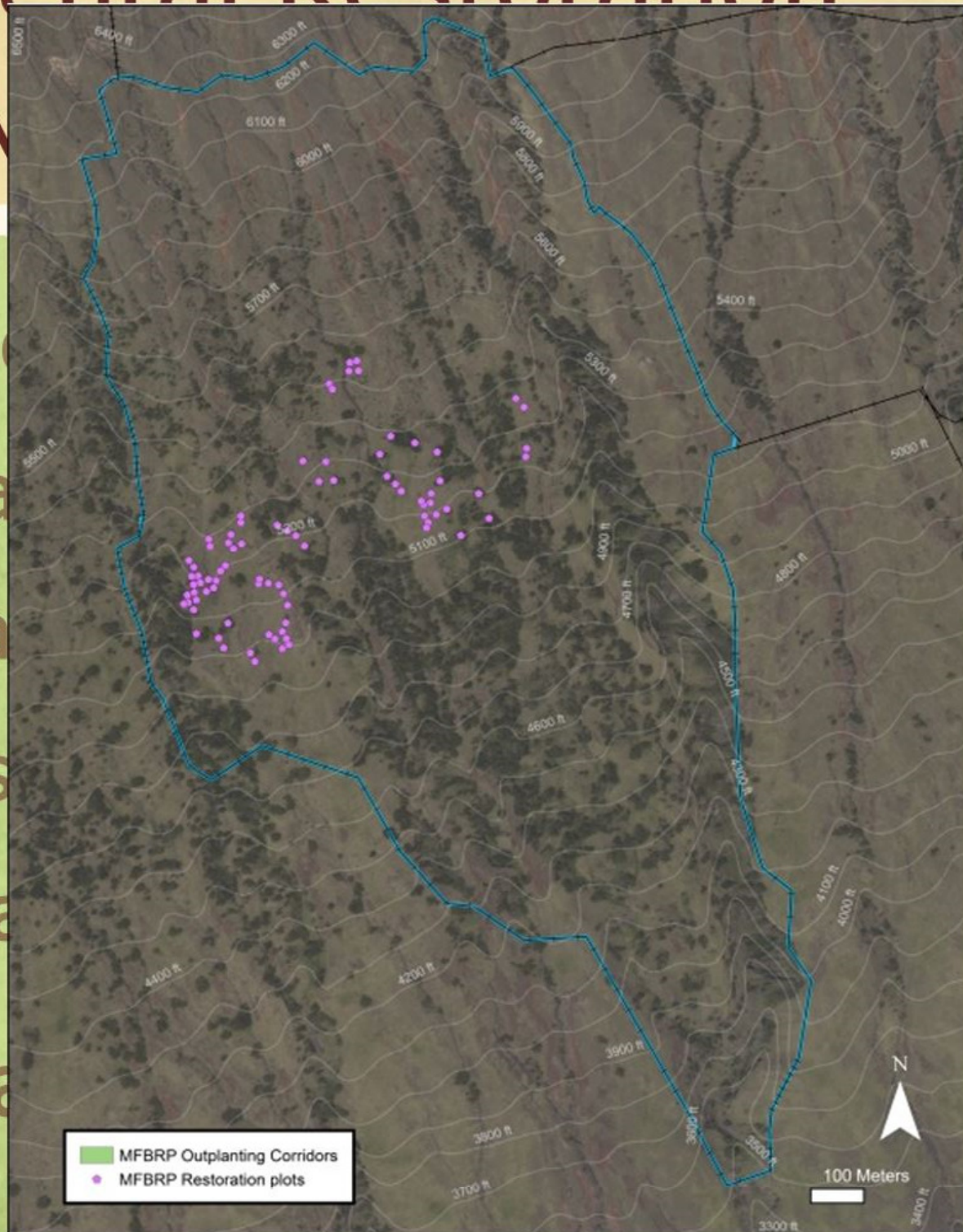
1. Natural

2. Outplanted

3. Seed s

4. Tree ca

- Four treat



Experimental Restoration: Preliminary Results

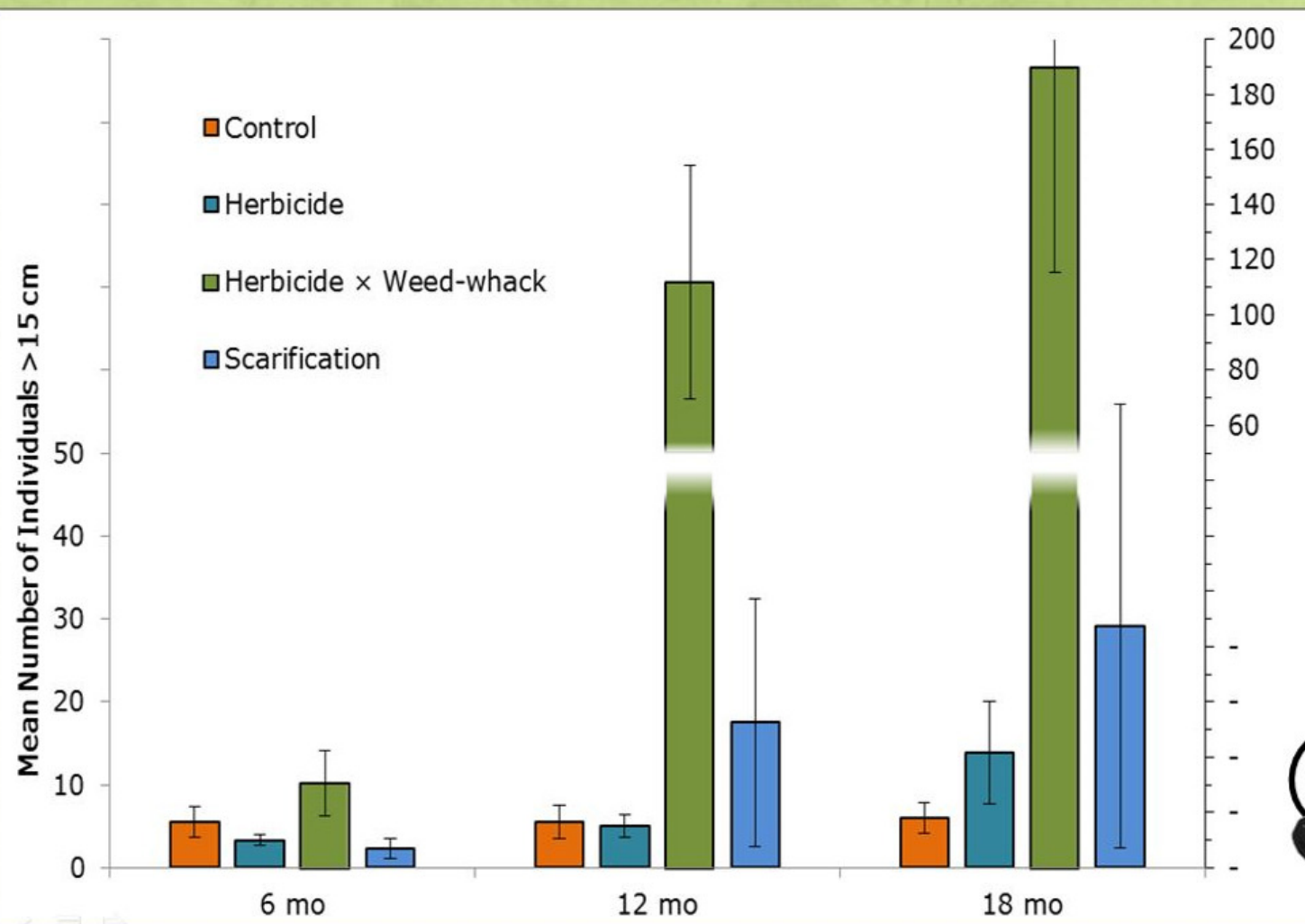
1. Natural Regeneration

- Restricted to few spp.
aalii, koa, pukiaawe

Experimental Restoration: Preliminary Results

1. Natural Regeneration

>20%
increase
with
herbicide
and biomass
removal



Experimental Restoration: Preliminary Results

1. Natural Regeneration



Experimental Restoration: Preliminary Results

2. Outplanting

- 3 groups of 3 spp.

1) koa-ohia-pilo

Acacia-Metrosideros-Coprosma

2) aalii-akala-ohia

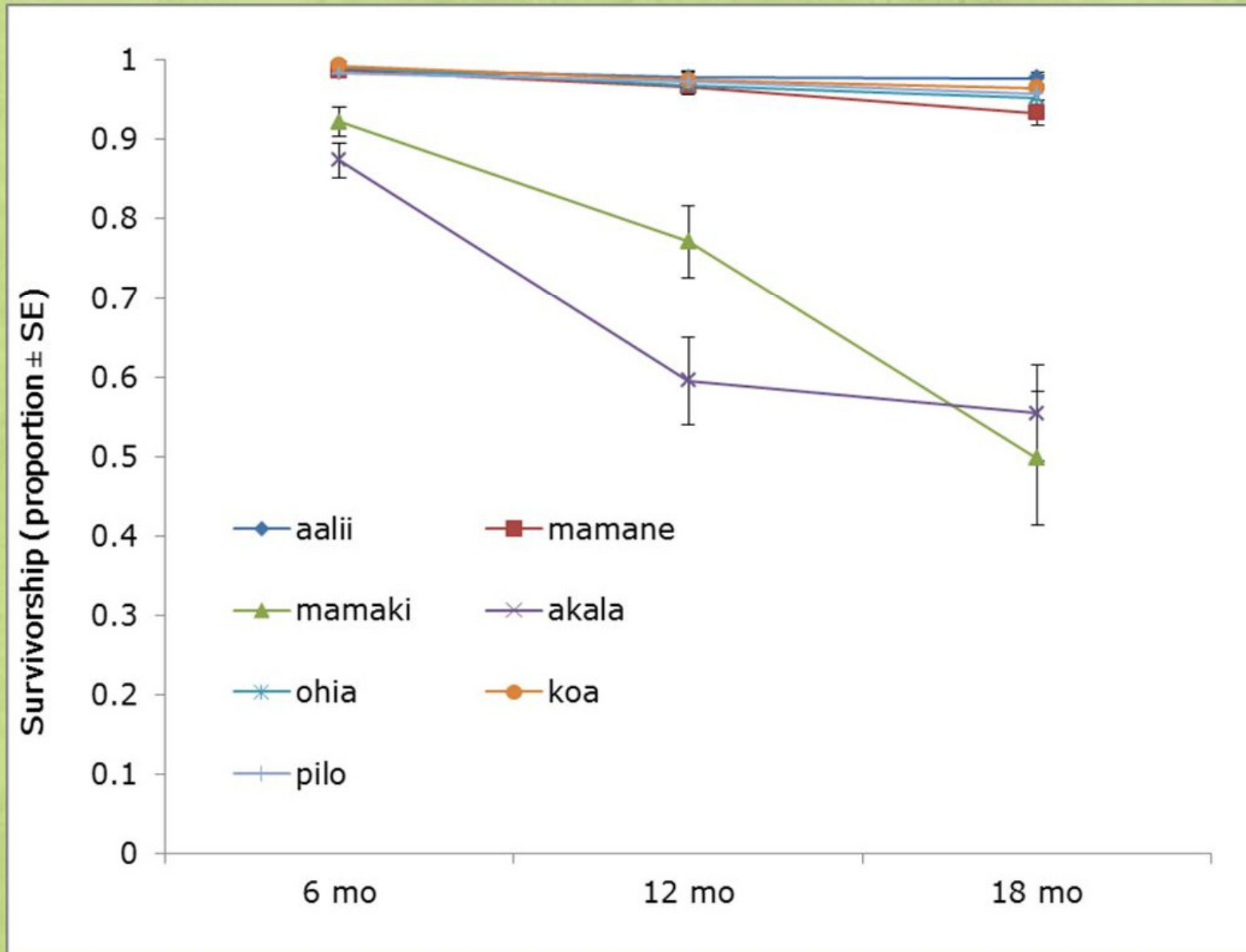
Dodonaea-Rubus-Metrosideros

3) mamane-mamaki-aalii

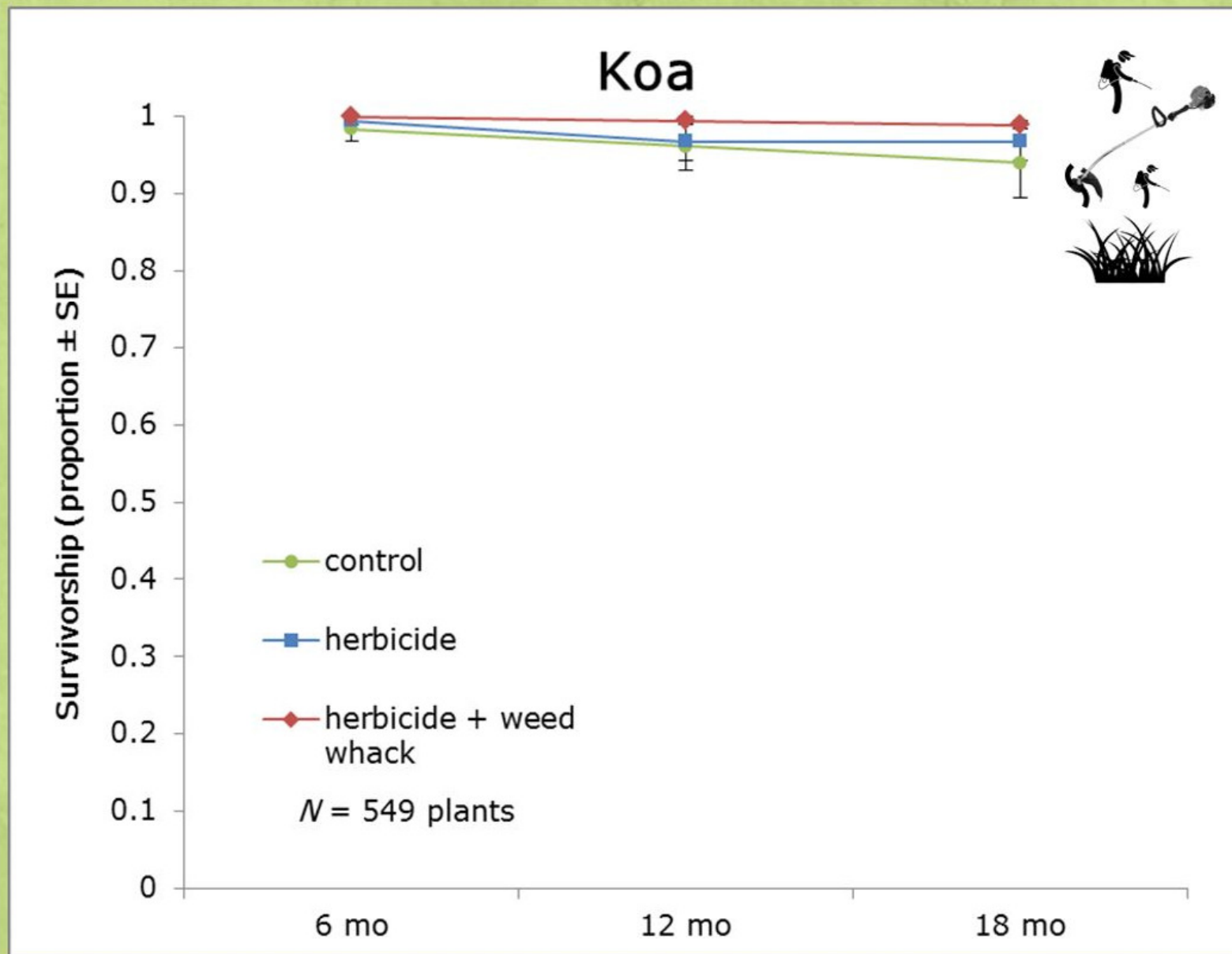
Sophora-Pipturus-Dodonaea



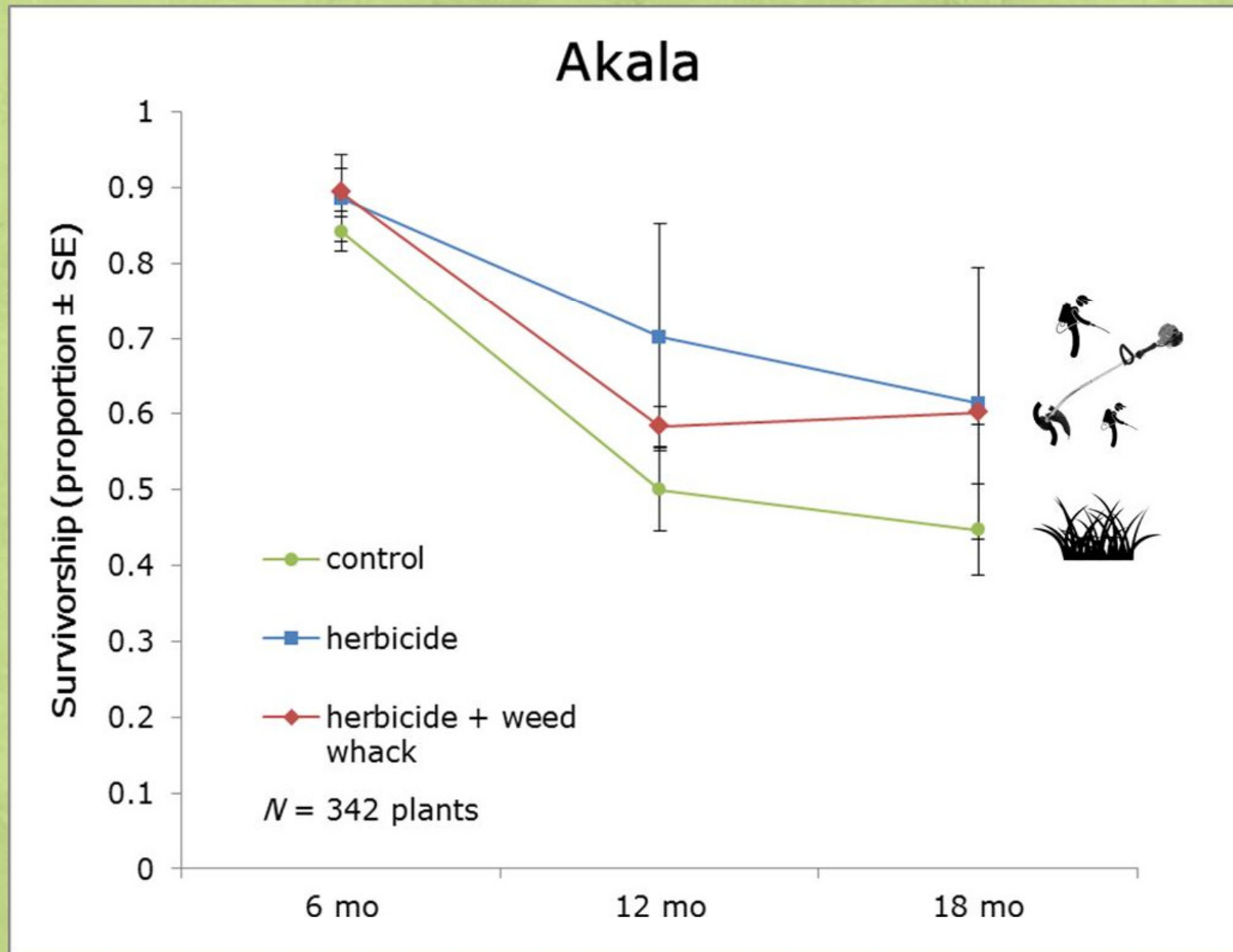
Experimental Restoration: Preliminary Results



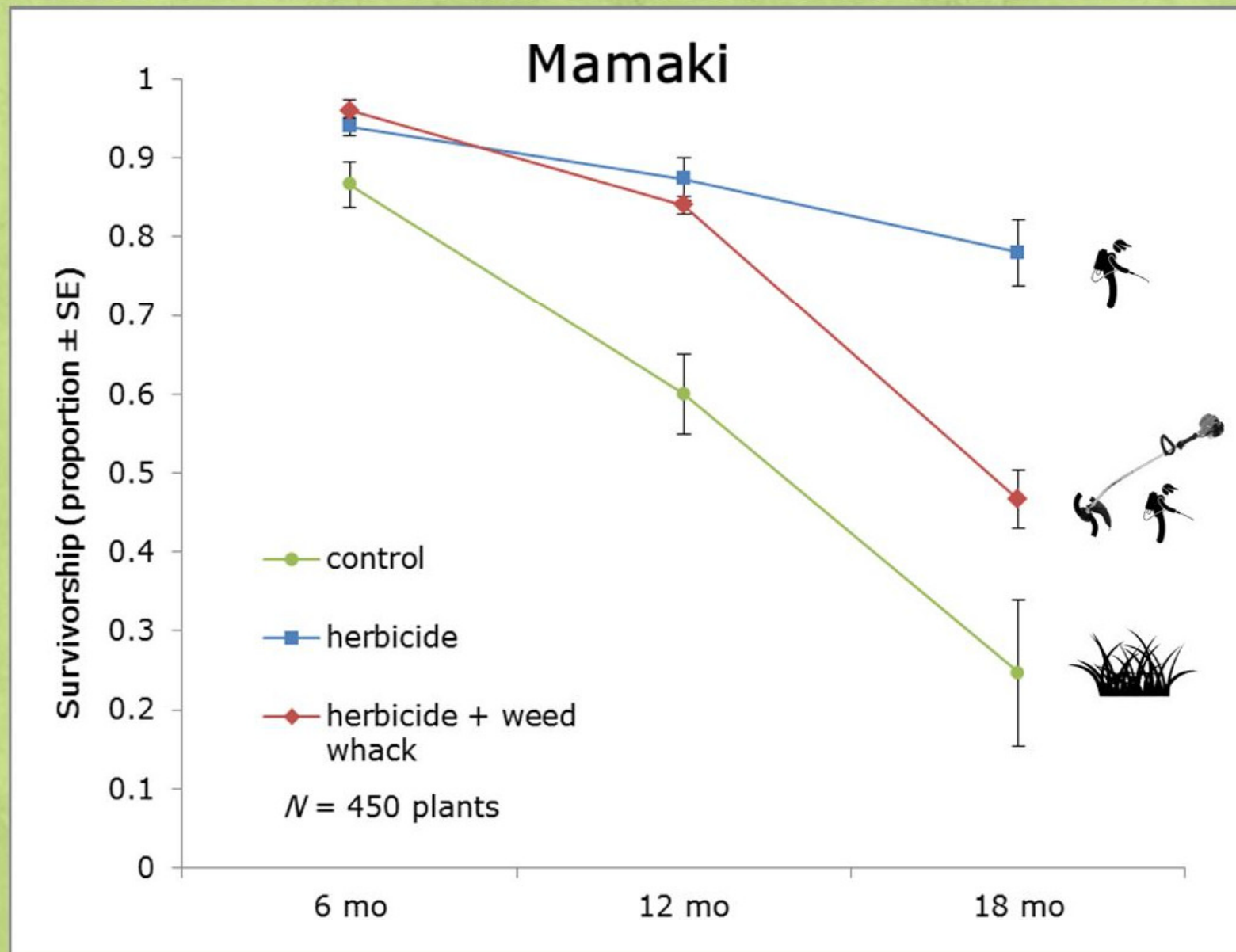
Experimental Restoration: Preliminary Results



Experimental Restoration: Preliminary Results



Experimental Restoration: Preliminary Results



Experimental Restoration: Preliminary Results

3. Seed Scatter



koa- *Acacia*

ohia- *Metrosideros*

kawau- *Ilex*

olomea- *Perrottetia*

kolea- *Myrsine*

mamane- *Sophora*

ohelo- *Vaccinium*

akala- *Rubus*

- No spp. germinated 18 mo

Experimental Restoration: Preliminary Results

4. Tree Canopy

- Could existing canopy trees enhance natural regeneration or outplanting success?
- Would results under these trees differ from in open grasslands?

Experimental Restoration: Preliminary Results

4. Tree Canopy



**No increases in
natural regeneration
or outplanting
survival**

Landscape Level Restoration

- Outplanting Corridors
- Erosion Scars



Landscape Level Restoration

- Outplanting Corridors
- Erosion Scars



Landscape Level Restoration: Outplanting Corridors

- Minimal herbicide in areas with native and regenerating vegetation

- Survivorship as with the e



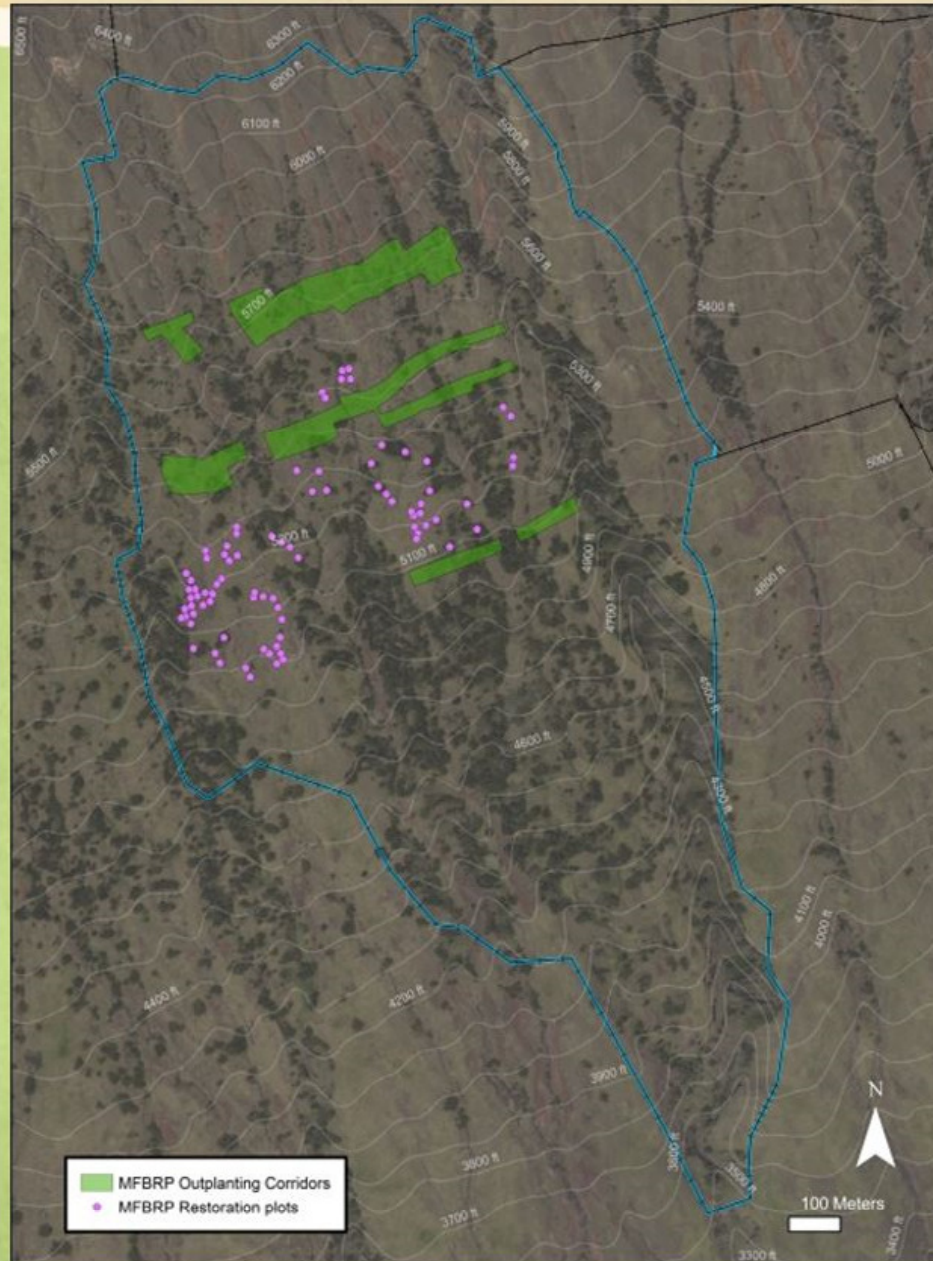
Landscape Level Restoration: Outplanting Corridors

- Minimal herbicide
native and rege
vegetation



- **Survivorship is similarly high
as with the experimental plots**

Landscape Level Restoration: Outplanting Corridors

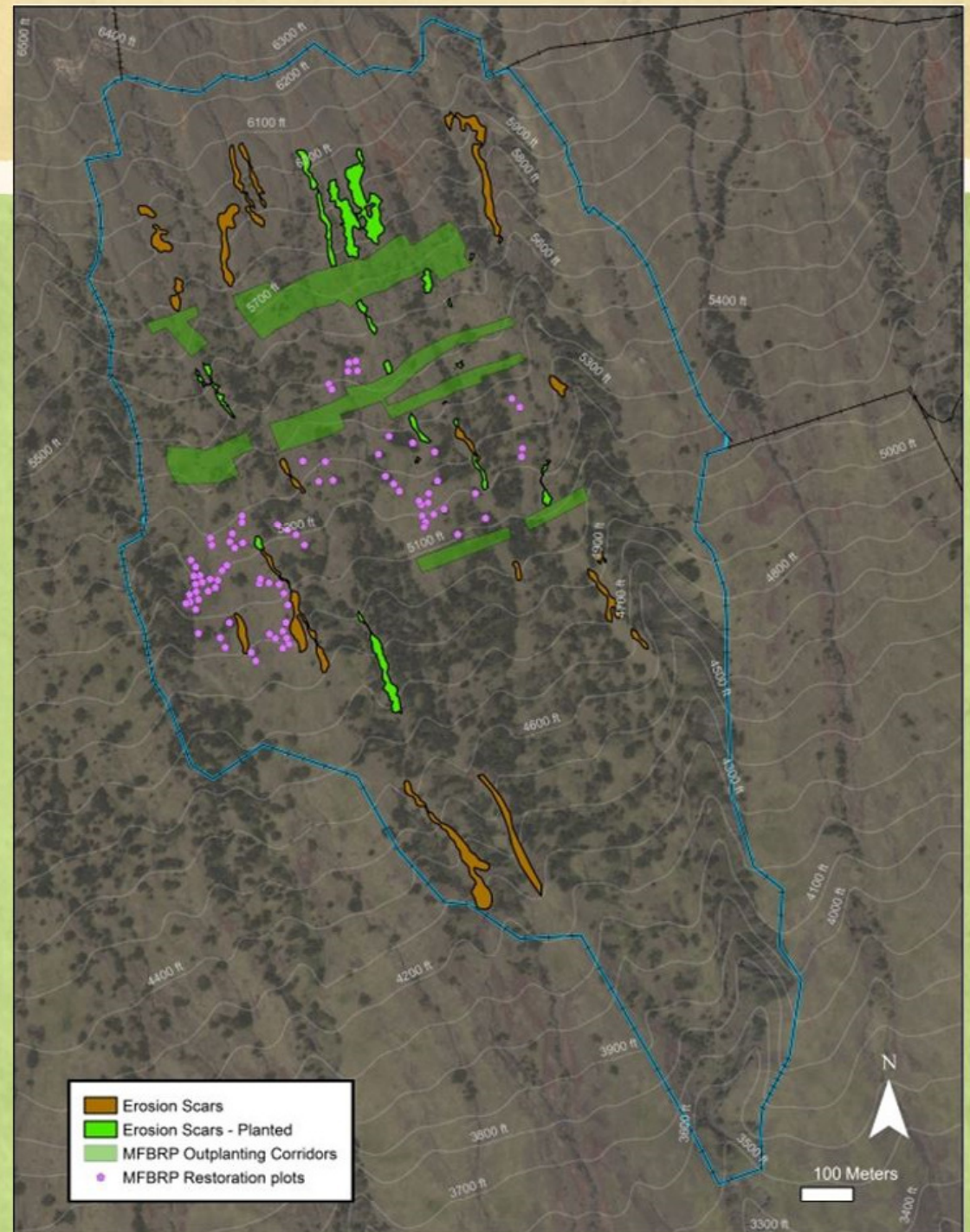


Landscape Level Restoration: Erosion Scars

- Using outplantings to reduce erosion
- Predominately two early colonizing spp.
 - akala and aalii

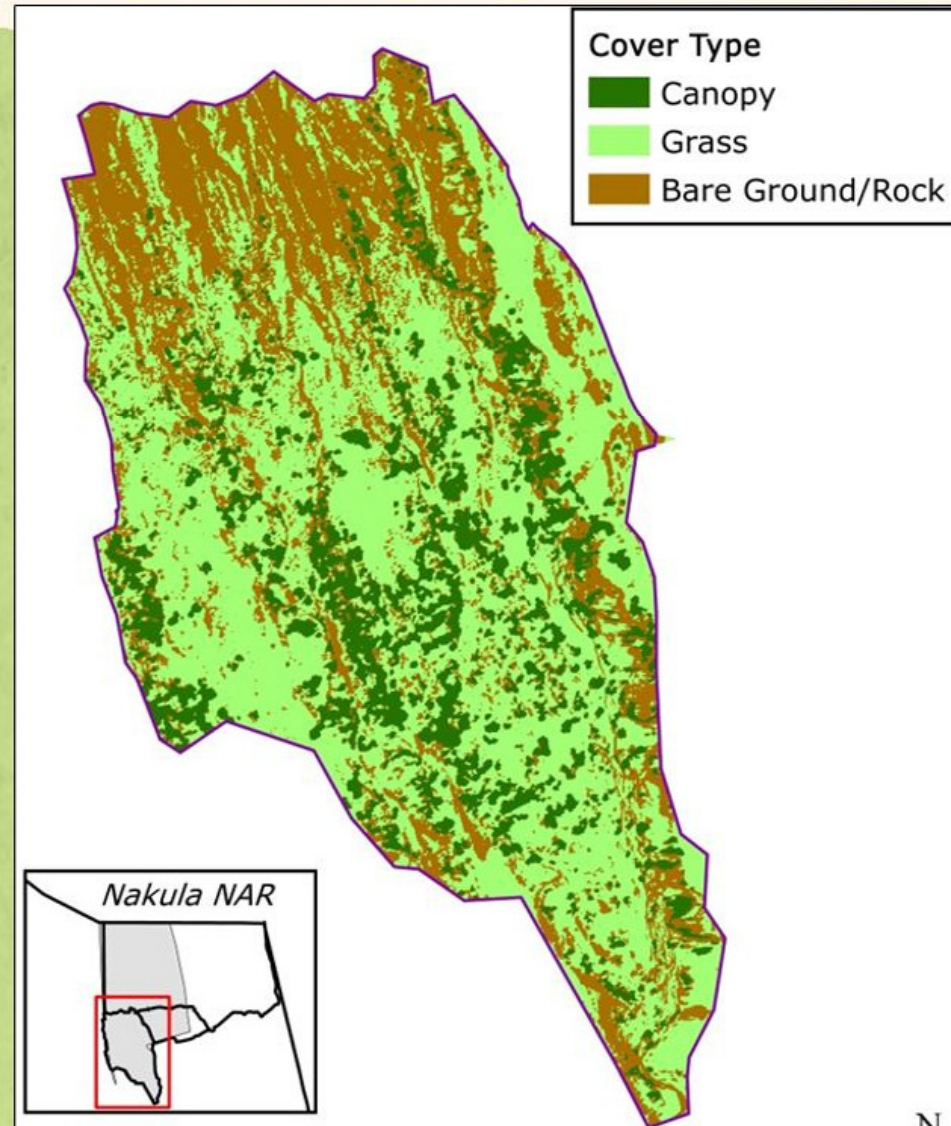
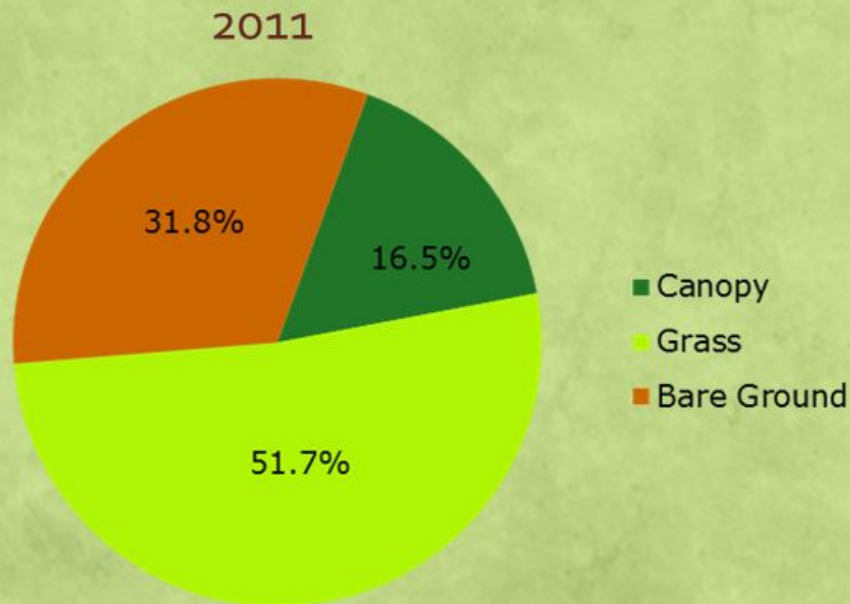


Landscape Level Restoration: Erosion Scars



Nakula Restoration: Cover Type Analysis

- Canopy Cover
Pre-restoration (2011)



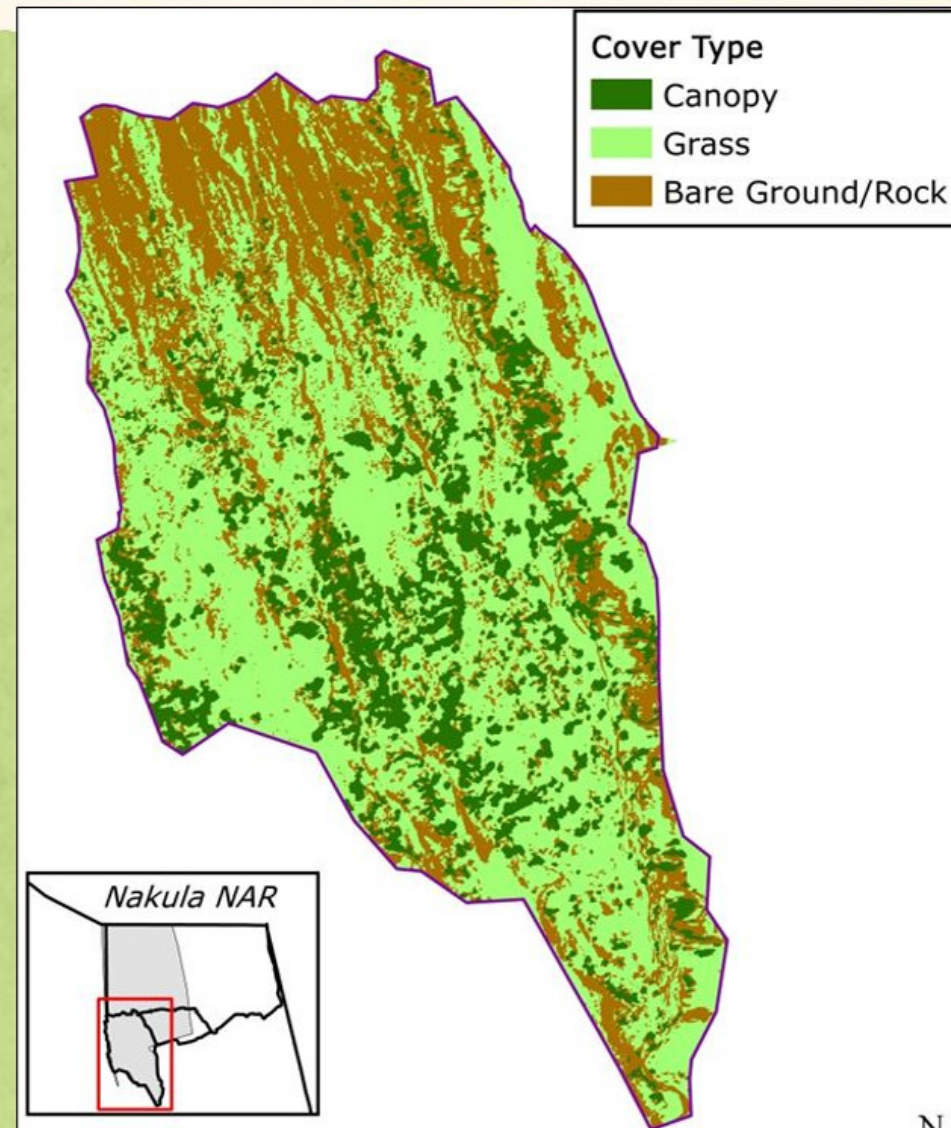
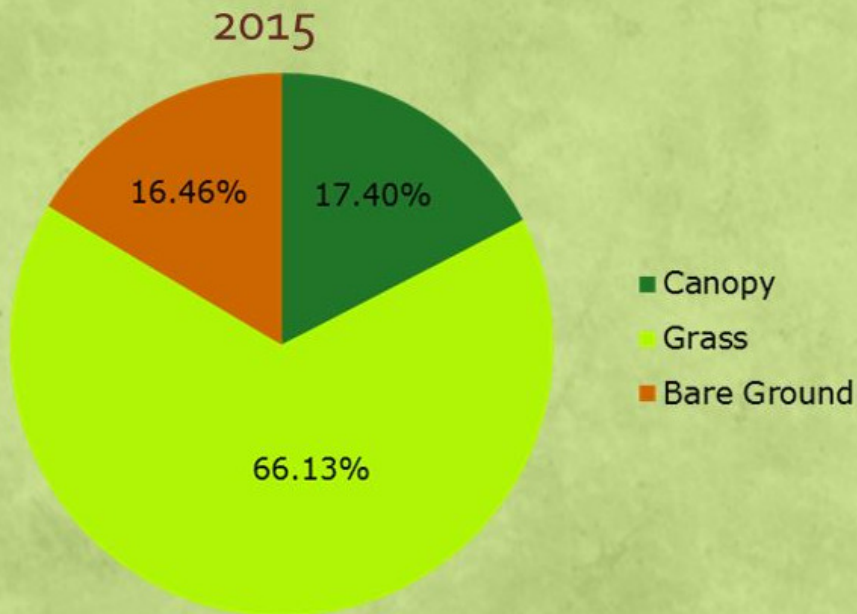
Cover type analysis by Keith Burnett.
Data extrapolated from World View 2
Satellite imagery courtesy of County of
Maui & Digital Globe - 2011.

0 500 Meters

N

Nakula Restoration: Cover Type Analysis

- Canopy Cover
Natural regeneration
(2013-2015)



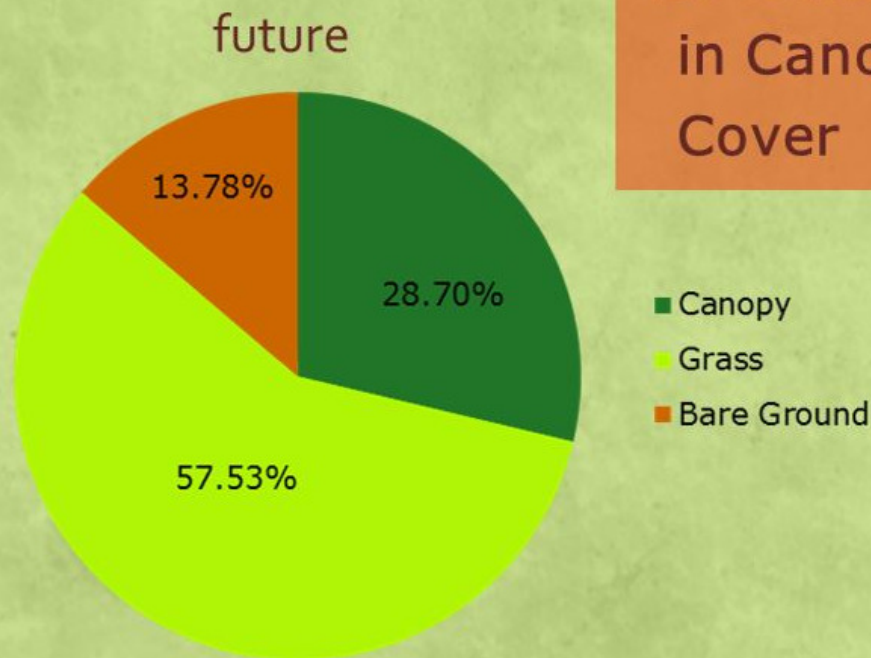
Cover type analysis by Keith Burnett.
Data extrapolated from World View 2
Satellite imagery courtesy of County of
Maui & Digital Globe - 2011.

0 500 Meters

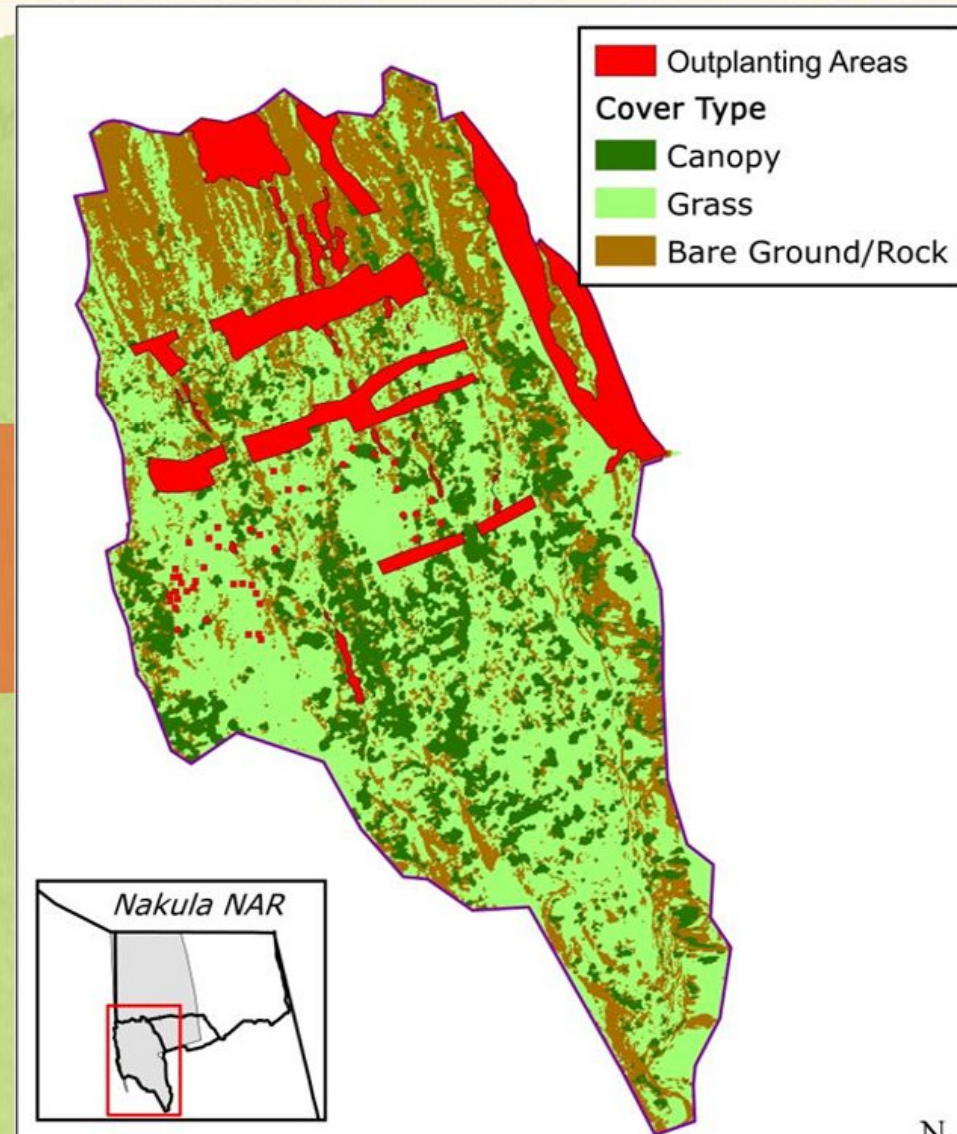


Nakula Restoration: Cover Type Analysis

- Canopy Cover with outplanting areas (2013-2015)



57% increase
in Canopy
Cover



Cover type analysis by Keith Burnett.
Data extrapolated from World View 2
Satellite imagery courtesy of County of
Maui & Digital Globe - 2011.

0 500 Meters

N

Nakula Restoration: Moving Forward

- Continued outplanting
 - Add. spp.–Kiwikiu forage
- Experimental suggestions?
 - Facilitate natural regeneration thru grass biomass disruption
 - Enhance outplanting survival?
 - Spray or not spray?
 - Spp. dependent?
 - Seed scatter not viable option



Acknowledgements



- Collaborating and supporting partners



- Wildlife Restoration and State Wildlife Grants, American Bird Conservancy, and private donors
- Our volunteers!



Community Involvement

- Impossible without volunteer help
- 80 volunteers and >10,000 hours so far!

