Planning for Kiwikiu Reintroduction: Habitat Restoration in Nakula NAR

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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
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Rebuilding Habitat for Kiwikiiu

- Landscape level fencing
- Ungulate removal
- Ongoing weed management
- Experimental restoration
- Landscape level restoration
Rebuilding Habitat for Kiwikiu

- Landscape level fencing
- Hydrate removal
- Management
- Restoration
Rebuilding Habitat for Kiwikiu

- Landscape level fencing
- Ungulate removal
- Ongoing weed control
- Experimental restoration
Rebuilding Habitat for Kiwikiu

- 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

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Experimental Restoration: Nakula NAR

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• Four treatments
Experimental Restoration: Nakula N

• Experimental
  1. Natural
  2. Outplanting
  3. Seed sowing
  4. Tree care

• Four treatments
Experimental Restoration: Preliminary Results

1. Natural Regeneration
   - Restricted to few spp.
     aalii, koa, pukiawe
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

![Graph showing survivorship over time for different species](image)
Experimental Restoration: Preliminary Results

Survivorship (proportion ± SE)

- control
- herbicide
- herbicide + weed whack

$N = 549$ plants

Koa

6 mo  12 mo  18 mo
Experimental Restoration: Preliminary Results

![Survivorship Graph](image)

- **Survivorship (proportion ± SE)**
  - Control
  - Herbicide
  - Herbicide + weed whack

- **N = 342 plants**

- Timepoints: 6 mo, 12 mo, 18 mo
Experimental Restoration: Preliminary Results

Mamaki

Survivorship (proportion ± SE)

- control
- herbicide
- herbicide + weed whack

$N = 450$ plants
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?
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 use
- Native and regenerating 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)

2011

- 31.8%
- 16.5%
- 51.7%

Cover Type
- Canopy
- Grass
- Bare Ground

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

- Canopy Cover
  Natural regeneration (2013-2015)

![Map showing cover type analysis with percentages for Canopy, Grass, and Bare Ground/Rock](image-url)

- 2015:
  - Canopy: 16.46%
  - Grass: 17.40%
  - Bare Ground: 66.13%
Nakula Restoration: Cover Type Analysis

- Canopy Cover with outplanting areas (2013-2015)
  
  57% increase in Canopy Cover

Future:

- Canopy: 28.70%
- Grass: 57.53%
- Bare Ground: 13.78%
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

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- Our volunteers!
Community Involvement

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