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
Rebuilding Habitat for Kiwikiu

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

• Landscape level fencing
• Unwanted removal
• Management
• Restoration
Rebuilding Habitat for Kiwikiu

• Landscape level fencing ✔
• Ungulate removal
• Ongoing weed control
• Experimental restoration
• Landscape level
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

- 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

- Experimental
  1. Natural regeneration
  2. Outplanted trees
  3. Seed sowing
  4. Tree canopies
- 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 plant species.](graph.png)
Experimental Restoration: Preliminary Results

![Graph showing survivorship of Koa over time with different treatments.](image)

- **Survivorship (proportion ± SE)**
- **X-axis:** 6 mo, 12 mo, 18 mo
- **Y-axis:** 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1
- **Legend:**
  - Control: green line and circle
  - Herbicide: blue line and square
  - Herbicide + weed whack: red line and diamond

- **Note:** N = 549 plants
Experimental Restoration: Preliminary Results

![Graph showing survivorship over time for Akala plants.]
Experimental Restoration: Preliminary Results

Mamaki

Survivorship (proportion ± SE)

- Control
- Herbicide
- Herbicide + weed whack

$N = 450$ plants
Experimental Restoration: Preliminary Results

3. Seed Scatter

- No spp. germinated 18 mo

- koa- Acacia
- ohia- Metrosideros
- kawau- Ilex
- olomea- Perrottetia
- kolea- Myrsine
- mamane- Sophora
- ohelo- Vaccinium
- akala- Rubus
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 environment
Landscape Level Restoration: Outplanting Corridors

• Minimal herbicide and 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 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)

<table>
<thead>
<tr>
<th>Year</th>
<th>Canopy</th>
<th>Grass</th>
<th>Bare Ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>16.46%</td>
<td>17.40%</td>
<td>66.13%</td>
</tr>
</tbody>
</table>
Nakula Restoration: Cover Type Analysis

- Canopy Cover with outplanting areas (2013-2015)

57% increase in Canopy Cover
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!