

# *Herbicide Ballistic Technology:*

*A Game Changer for Protecting Hawaii's Watersheds, One Incipient Plant At A Time*



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# The Grand Challenge: *Innovation Translation*

Moving innovation from an “**artificial**”  
test site that’s *proving concept* to a  
“**real**” management landscape that’s  
*proving utility*

*We can do this!*





## Herbicide Ballistic Technology (HBT)



HBT targeting Miconia (*Miconia calvescens*)



## *Herbicide Ballistic Technology (HBT)*

**The Technology:** Encapsulated 0.68 caliber herbicide-filled projectiles pneumatically delivered to treat isolated plant populations >>> *LONG DISTANCE ACCURACY (20-30 m) WITH FULL TILT TRAJECTORY (0-90°)*

**The Problem:** Incipient populations of miconia are colonizing remote sections of class I watersheds on Maui. Average slope of terrain >50% >>> *AREAS INACCESSIBLE TO GROUND MANAGEMENT*

**The Objective(s):** Detect and eliminate incipient populations >>> Effectively contain the spread of Miconia in the East Maui Watershed.



*We can do this!*



**FIFRA Sec 24(c)  
Special Local Need**

**ACCEPTED**

January 30, 2012

**Under Hawaii Pesticides Law  
as Supplement to Product No.  
9786.263**

# **HBT-G4U200 With Garlon® 4 Ultra**

**FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF HAWAII**

FOR INDIVIDUAL PLANT TREATMENT WITHIN FORESTED WATERSHEDS AND NATURAL AREAS  
USING SPHERICAL POLYSACCHARIDE CAPSULES CONTAINING GARLON® 4 ULTRA

**ACTIVE INGREDIENTS:**

Triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester..... 10.07%

**OTHER INGREDIENTS**..... 89.93%  
100.00%

EPA SLN No. HI-120001

EPA Est. No. 86199-MI-001

**This label must be in the possession of the user at the time of pesticide application.**

**KEEP OUT OF REACH OF CHILDREN  
CAUTION/PRECAUCION**

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail).

**FIRST AID**

If swallowed:	<ul style="list-style-type: none"><li>•Call a poison control center or doctor immediately for treatment advice.</li><li>•Have person sip a glass of water if able to swallow.</li><li>•Do not induce vomiting unless told to do so by a poison control center or doctor.</li><li>•Do not give anything by mouth to an unconscious person.</li></ul>
If in eyes:	<ul style="list-style-type: none"><li>•Hold eyes open and rinse slowly and gently with water for 15-20 minutes.</li><li>•Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li><li>•Call a poison control center or doctor for treatment advice.</li></ul>
If on skin or clothing:	<ul style="list-style-type: none"><li>•Take off contaminated clothing.</li><li>•Rinse skin immediately with plenty of water for 15-20 minutes.</li><li>•Call a poison control center or doctor for treatment advice.</li></ul>
If inhaled:	<ul style="list-style-type: none"><li>•Move person to fresh air.</li><li>•If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.</li><li>•Call a poison control center or doctor for further treatment advice.</li></ul>

**HOT LINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact CHEMTREC (800-424-9300)

**PRECAUTIONARY STATEMENTS**

**HAZARDS TO HUMANS AND DOMESTIC ANIMALS**

**CAUTION:** Harmful if swallowed, causes moderate eye irritation. Avoid contact with eyes or clothing. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.



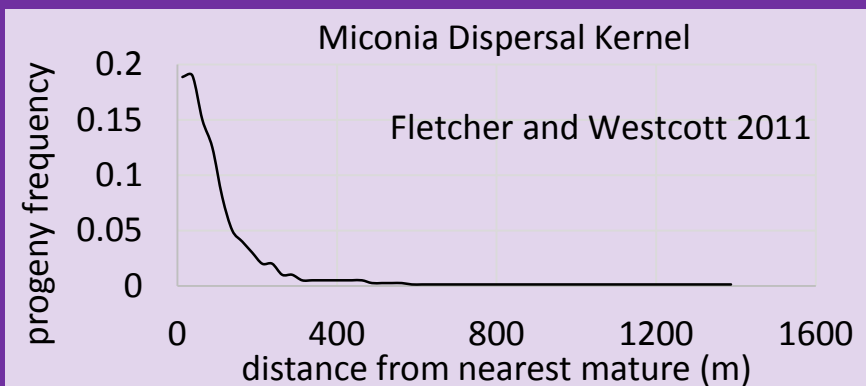
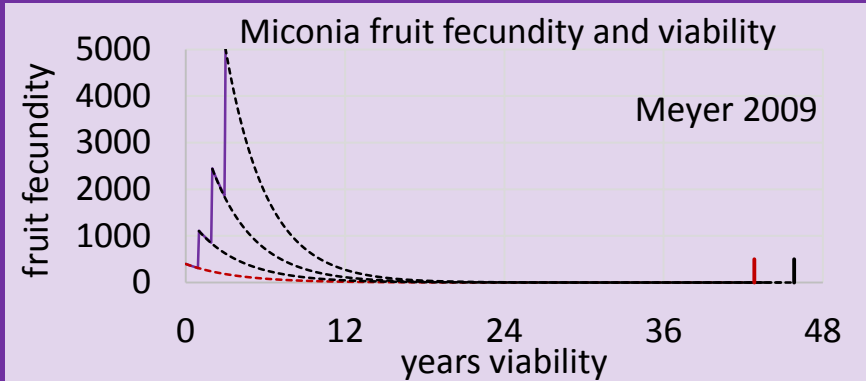
0.68 caliber soft gel projectiles  
encapsulating 200 mg triclopyr

*We can do this!*



## Invasion Biology of *Miconia calvenscens* DC)

- An autogamous (self-fertile) species
- High fecundity
- Edible fruit to a variety of frugivores
- Long dispersal range (>1 km)
- Extended Seed viability (decades)
- Germination in heavy shade





HBT operations conducted with a Hughes 500D helicopter  
Low-altitude flight patterns following terrain contour at slow search speeds  
Operational flight time 80-90 min in a fuel cycle

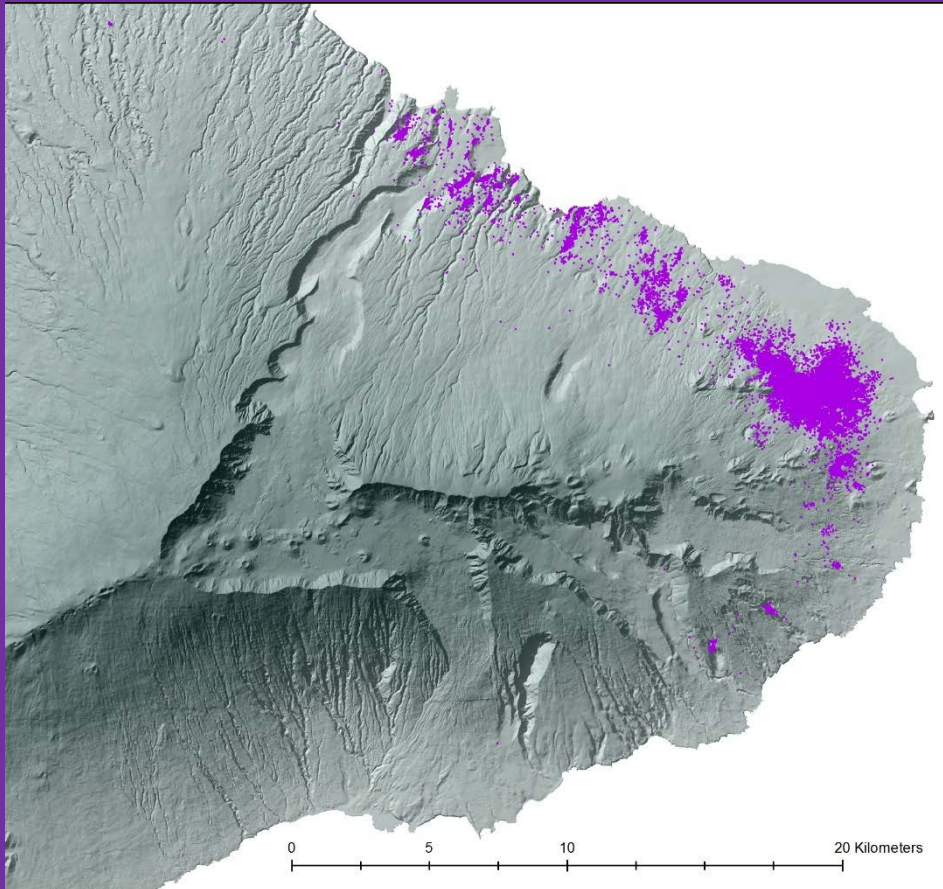


Photo: B. Berkowitz

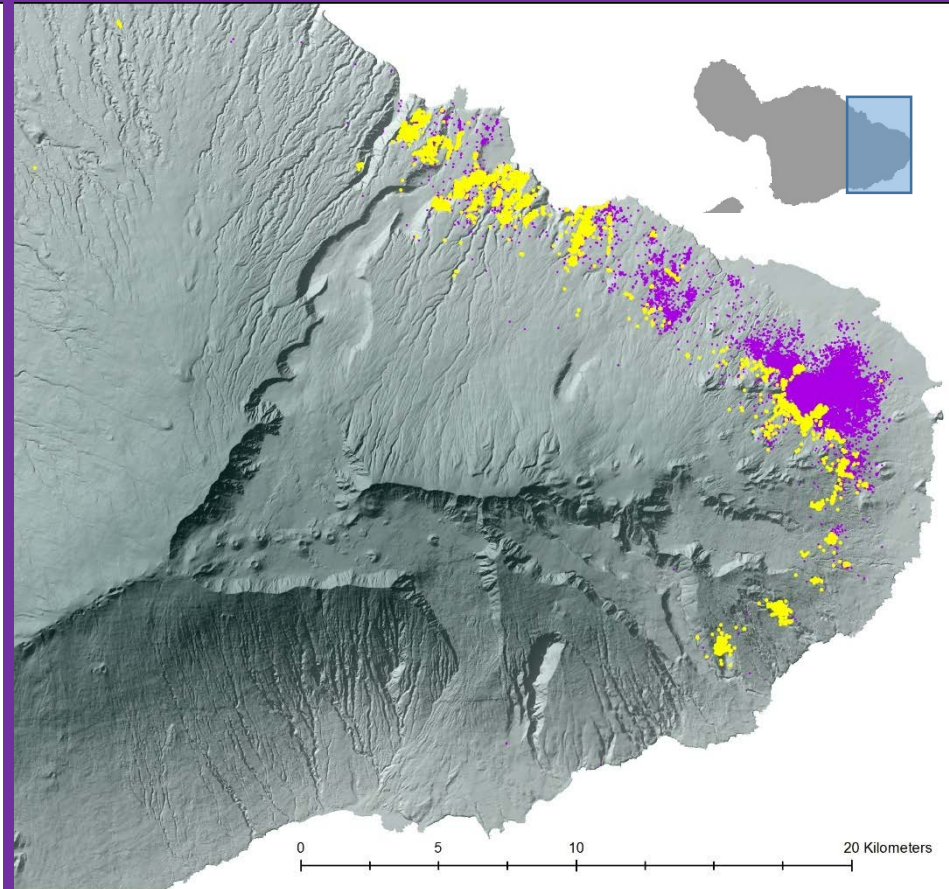
Payload Operator "Applicator" seated portside behind Pilot, with shared field of view (FOV)



1990-2011- extensive management and  
delimitation (GREAT ~~good~~ intelligence)



2012- Shift with HBT towards intensifying  
containment strategy



East Maui Watershed with historical miconia points recorded 1991-2012 (n=270,591; purple)  
and HBT target points recorded 2012-2016 (n=20,363; yellow)

*We can do this!*

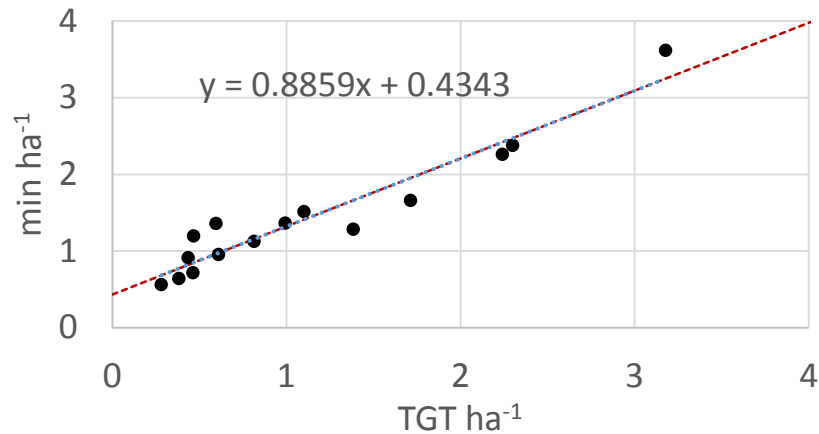


# Variable costs of operations determined by target density

\$7.96 ha<sup>-1</sup> and \$20.15 tgt<sup>-1</sup>

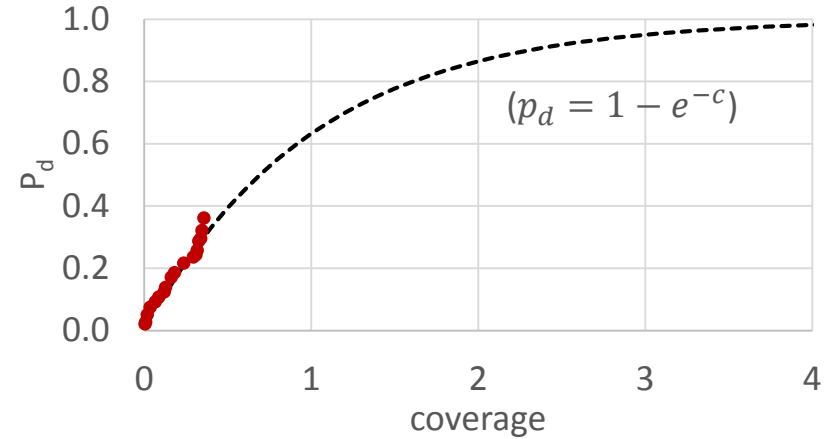
## Search Effort

26 sec ha<sup>-1</sup> = \$7.96; 53 sec tgt<sup>-1</sup> = \$13.44



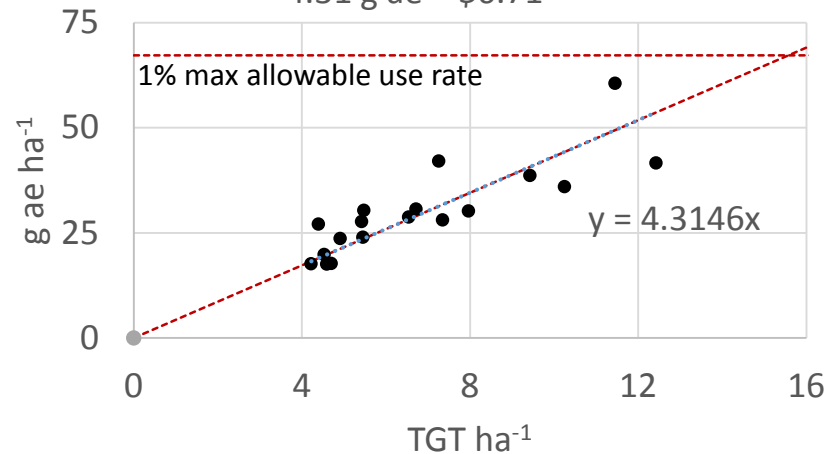
## Random Search Effort

coverage = 1.0 in ~13 years



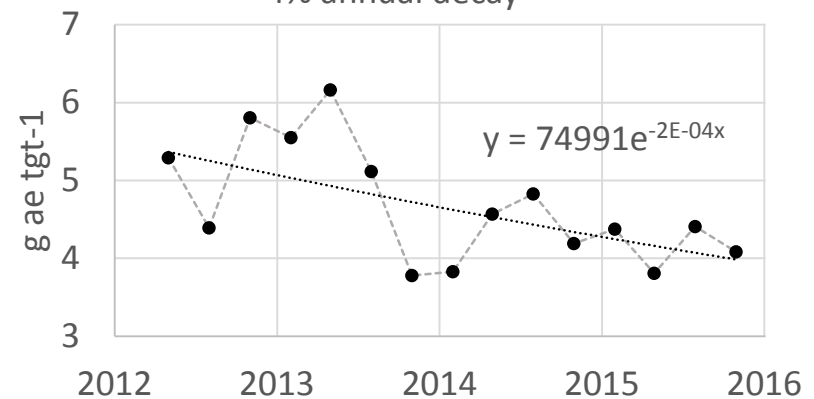
## Herbicide Use Rate

4.31 g ae = \$6.71



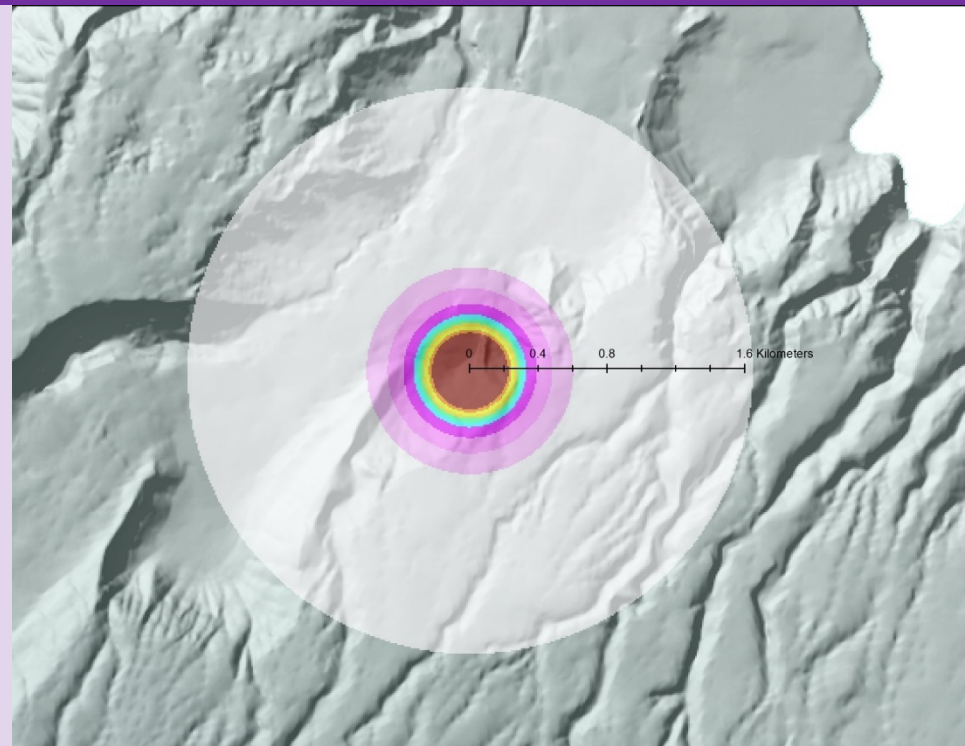
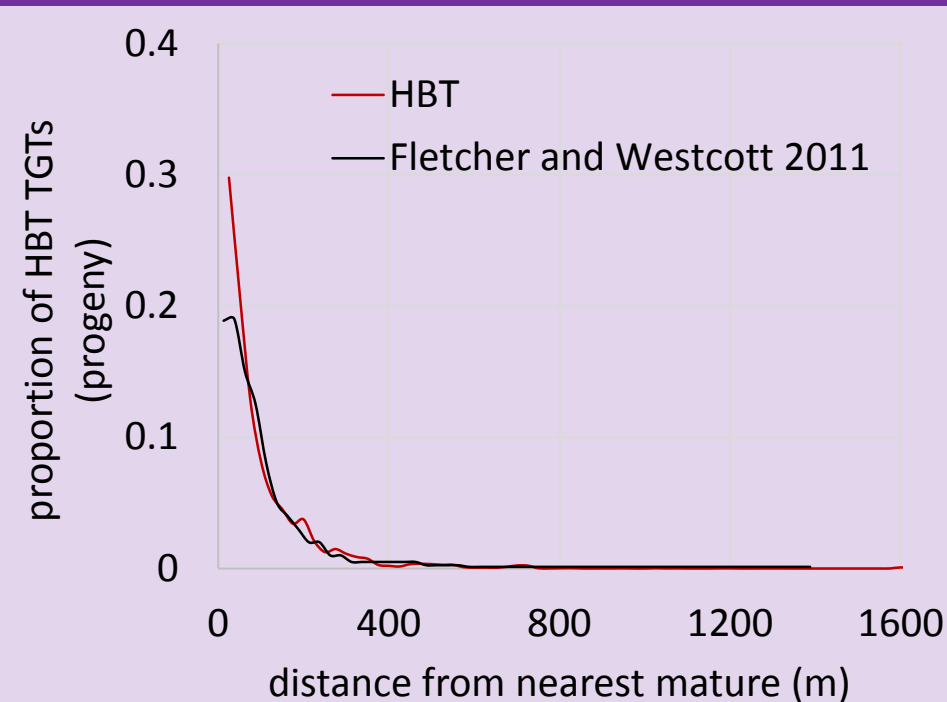
## Dose

4% annual decay





The miconia dispersal kernel empirically derived from HBT targets is highly congruent to the model developed in Australia.



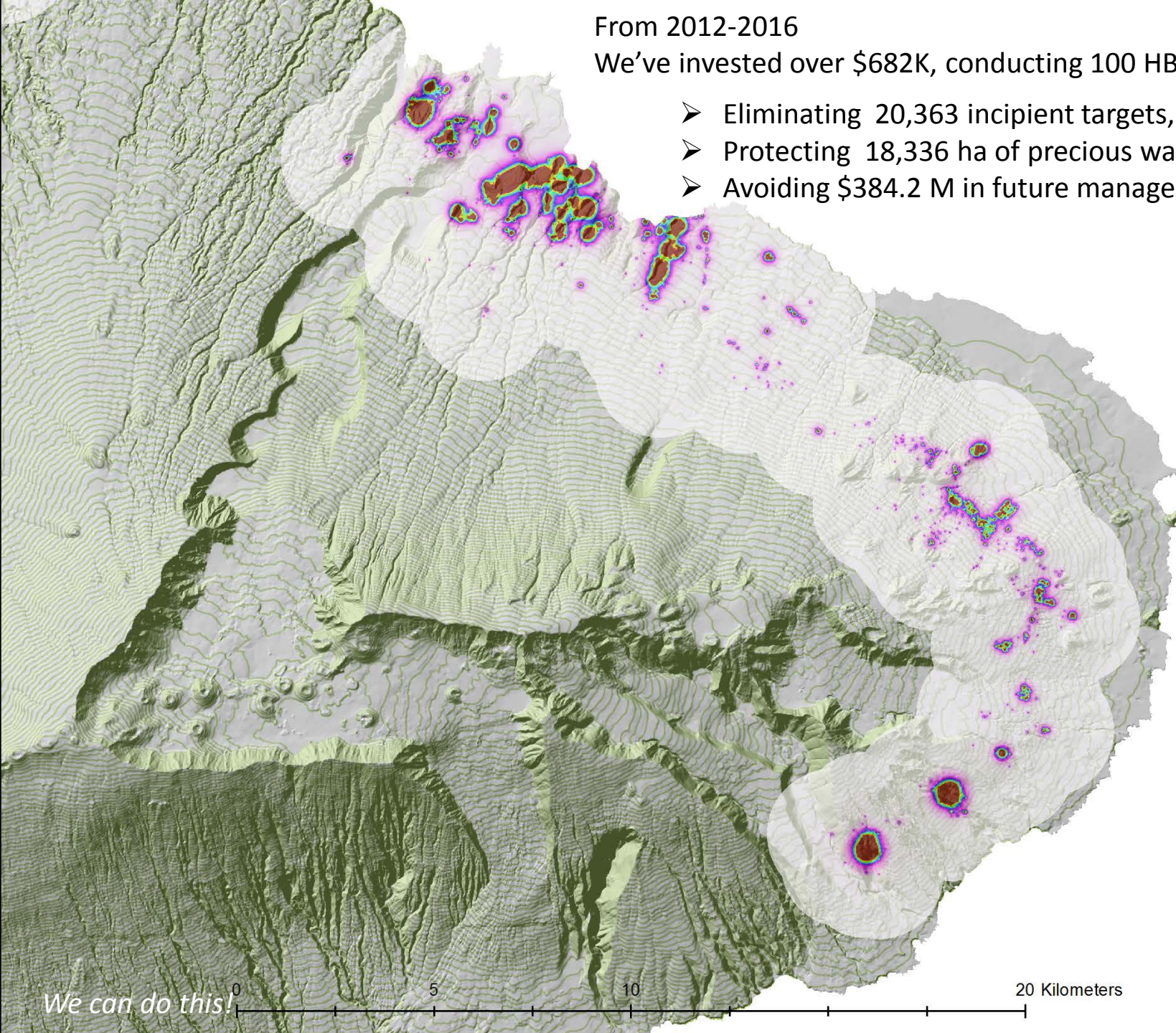
Dispersal kernel with a 1644m radius equivalent to 849 ha isotropic footprint.  
One new mature plant obligates an est. \$155K in management costs over a 43-year period



From 2012-2016

We've invested over \$682K, conducting 100 HBT operations

- Eliminating 20,363 incipient targets,
- Protecting 18,336 ha of precious watershed
- Avoiding \$384.2 M in future management costs



*We can do this!*

0 5 10 20 Kilometers





## Accomplishments in *Proving Utility*:

- HBT is becoming institutionalized in one of the largest, most comprehensive invasive plant management projects in the world.
- HBT is a highly surgical and efficient method of treatment presenting the lightest footprint on the landscape.
- The HBT platform encourages greater investment in ISR (*Intelligence, Surveillance and Reconnaissance*) for improved decision making and containment of spread.
- Elimination of one incipient plant is equally determined by detection and treatment lethality (Mortality Factor; Cacho et al. 2006).
- An effective strategy is achieved when target mortality outpaces biological recruitment.

*We can do this!*

*HBT treatment symptoms to PSICAT 100-200 days after treatment*



## Technological Challenges:



- Adopting Big Data Analytics for monitoring tactical performance and strategic projections.
- HBT with Telemetry system (HBT-TS) recording over 10k datum in a single operation.
- Higher resolution of the management terrain and better cell network access for high quality data and real-time processing.
- Heavy-payload UAS with adequate sustained flight to complement and eventually displace manned operations
- Climate observatory network for developing real-time correspondence with miconia phenology (i.e., seed bank recruitment and mature fruit reproduction).

*We can do this!*

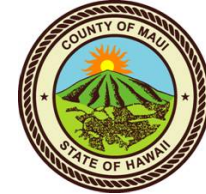


# *With Partnerships, We Can Do This !!!*

*Collaborators:*



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- Hawaii Invasive Species Council Research and Technology Grant Program
- Maui County Department of Water Supply and the Office of Economic Development via collaboration with the Maui Invasive Species Committee

*MAHALO*