



**BOK TOWER
GARDENS**
NATIONAL HISTORIC LANDMARK

Lakela's Mint and Savannas Mint: status and long-term stability



Dicerandra spp. (Lamiaceae)

- Highest ranked genus of rare southeastern endemic plants
- Restricted to scrub or sandhill habitat on upland/ridge systems; all allopatric
- 4 annual & 5 perennial mint species
- 7 species have extremely small geographic ranges (those in peninsular FL)



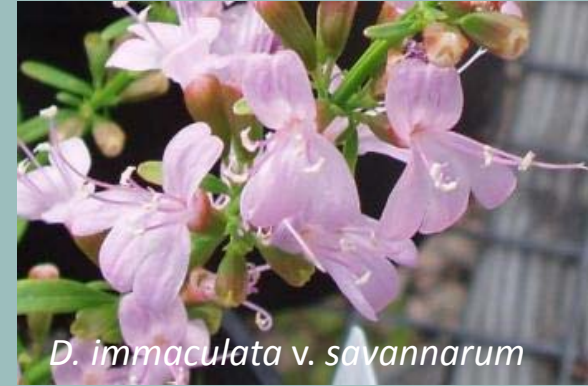
Dicerandra species



D. immaculata v. *immaculata*



D. christmanii



D. immaculata v. *savannarum*



D. frutescens



D. thinicola

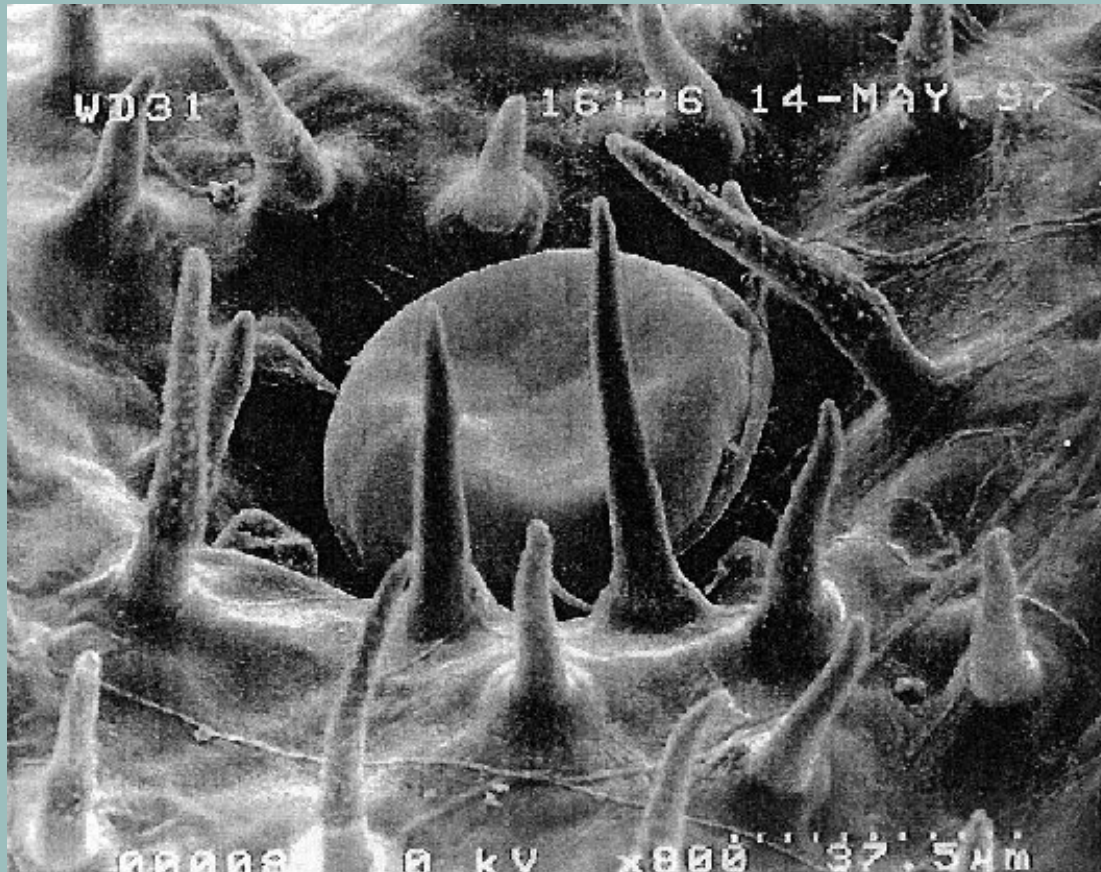


D. modesta

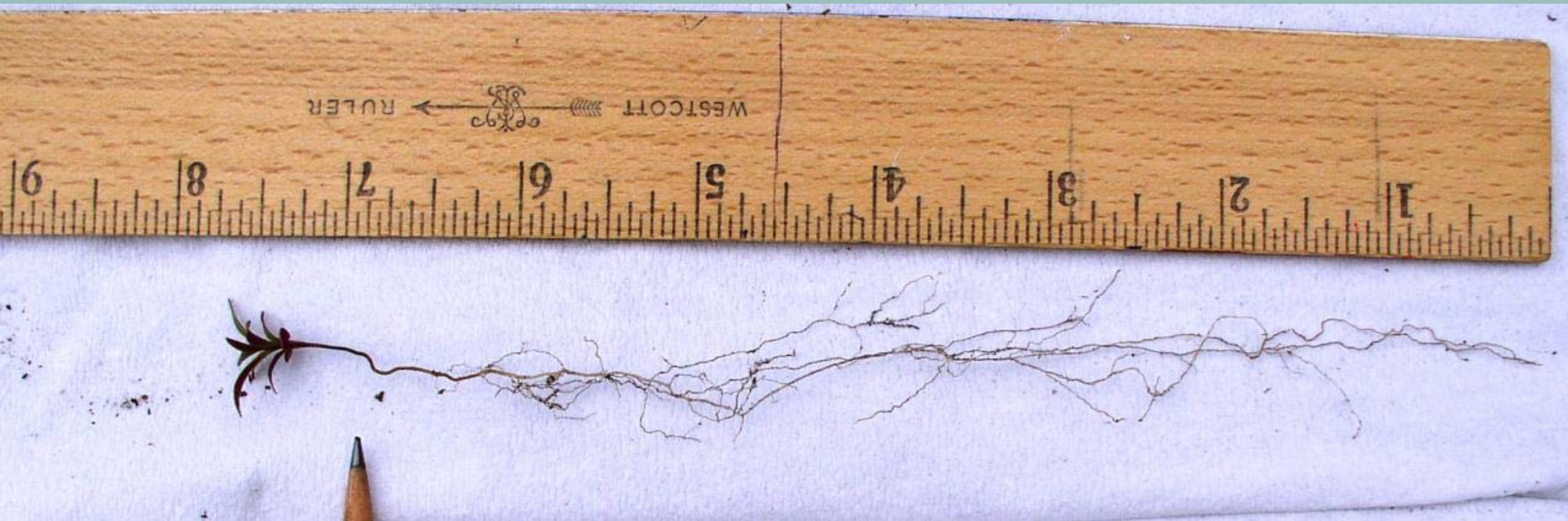


D. cornutissima

Each has a unique blend of 'essential oils' produced and stored in glandular capsules on the leaf surfaces – call tell species apart by smell



Adapted to well drained soil within higher elevations on ridge systems by rapid development of long, deep roots



Dicerandra distributions



D. cornutissima

D. thinicola

D. modesta

D. christmanii

D. immaculata var.
immaculata

D. immaculata var.
savannarum

D. frutescens

Lakela's mint (*Dicerandra immaculata* var. *immaculata*)

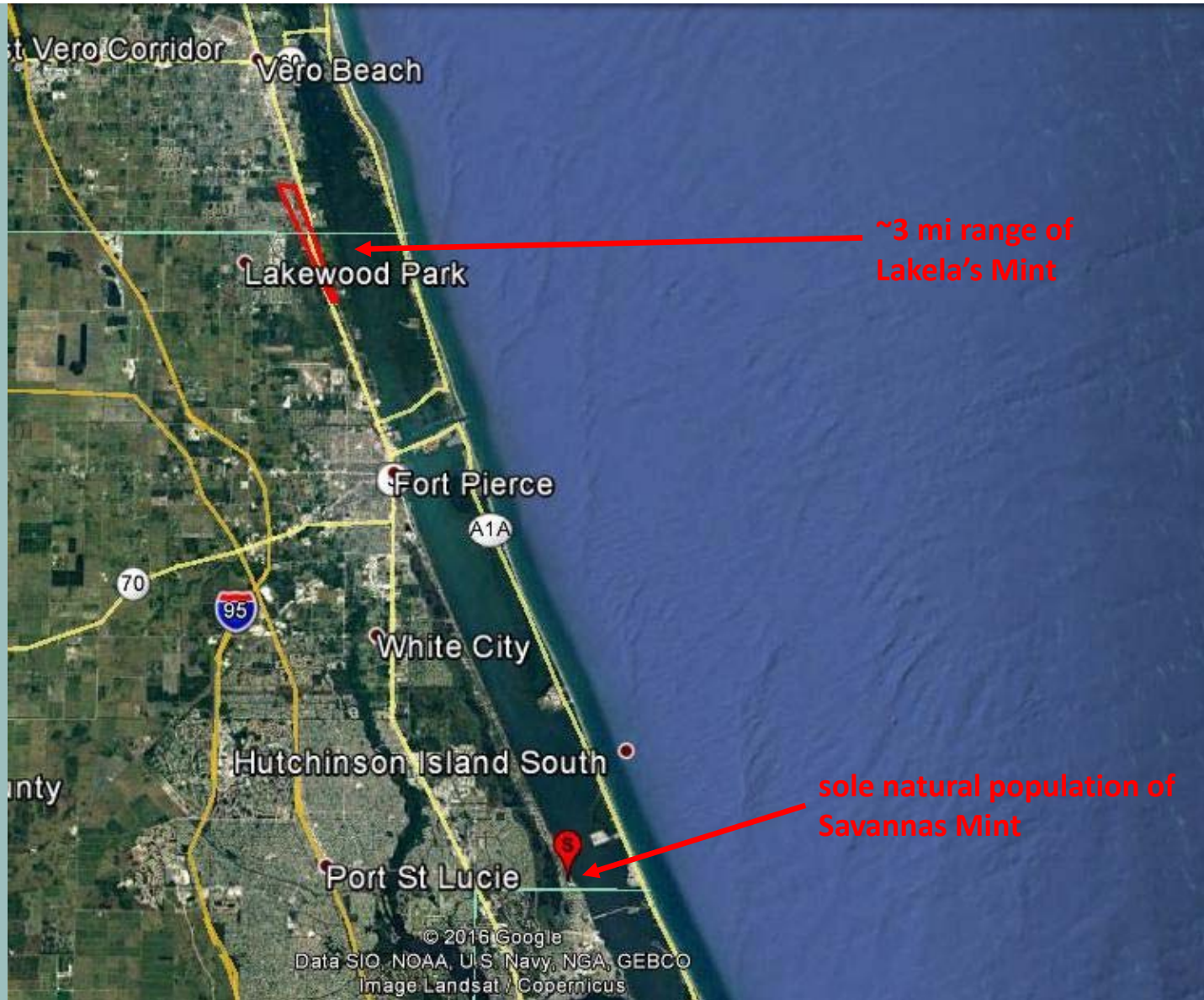


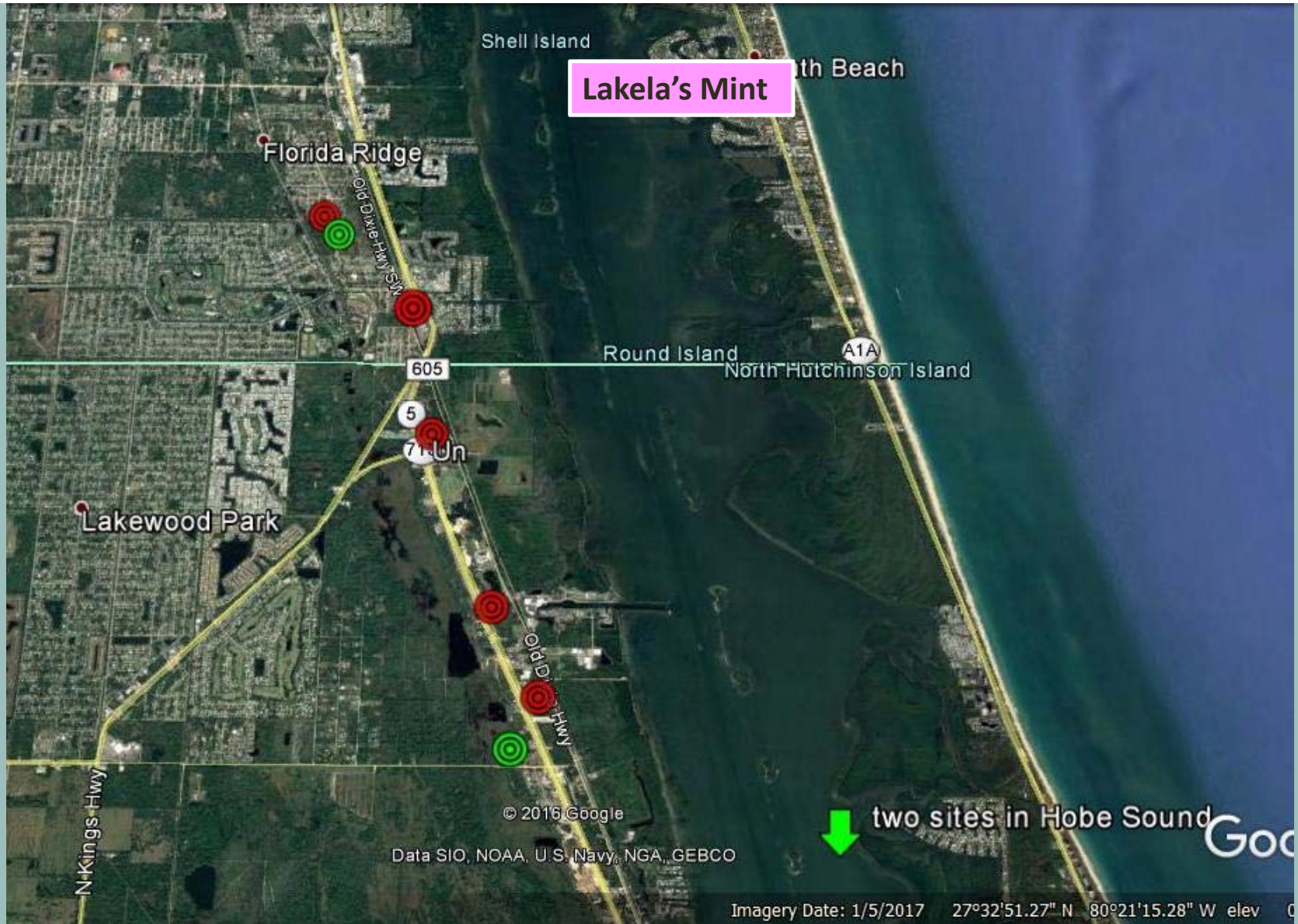
- Described by Olga Lakela in 1963
- Listed as endangered May 15, 1985
- 5 wild (historical) populations
- 3 introduced populations

Savannas mint (*Dicerandra immaculata* var. *savannarum*)



- Discovered by IRC in 1984
- 1 natural population:
 - Privately-owned, 3 adjacent small properties in a new subdivision
 - Overgrowth and disturbance: population nearly gone
- 3 introduced populations



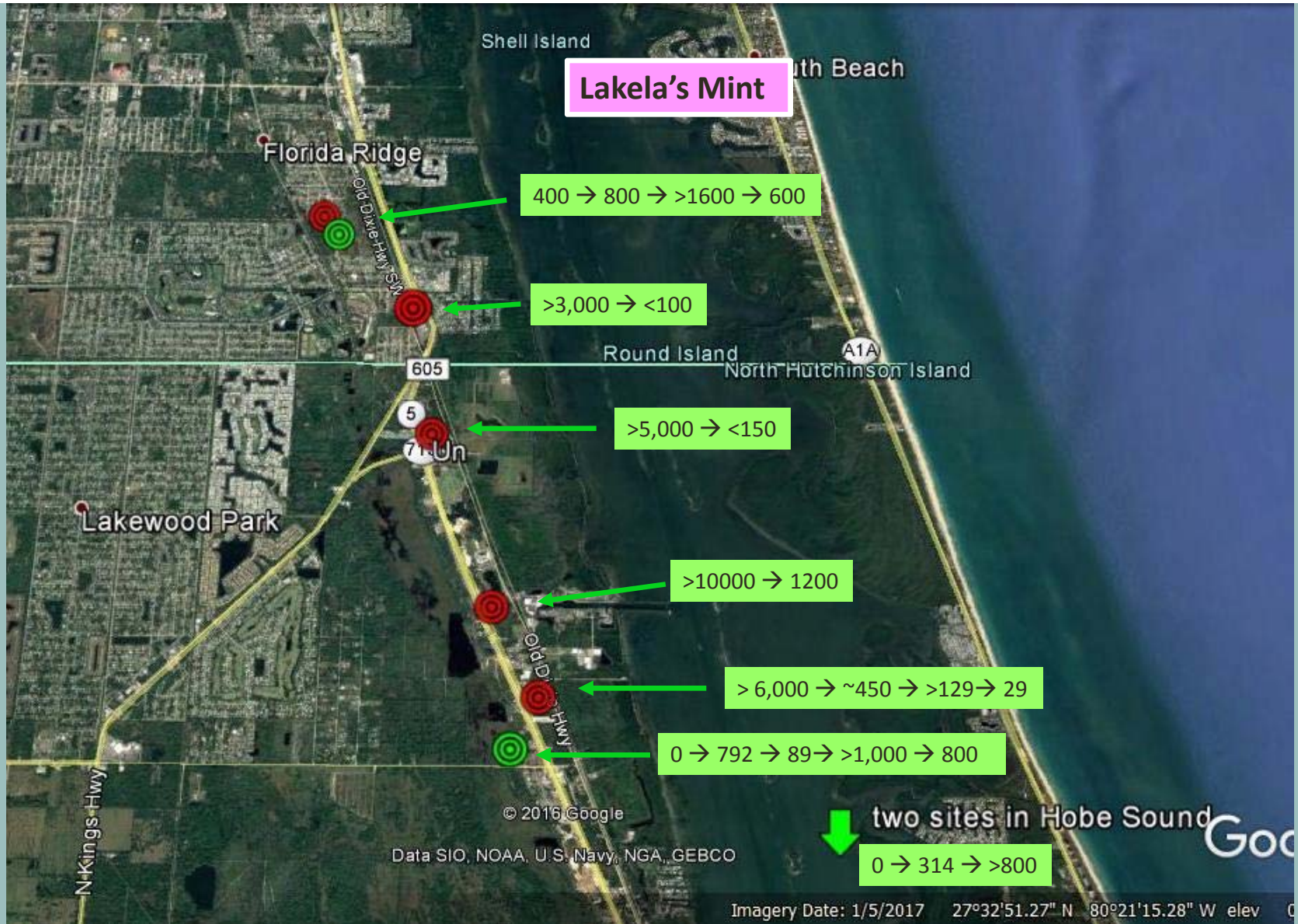


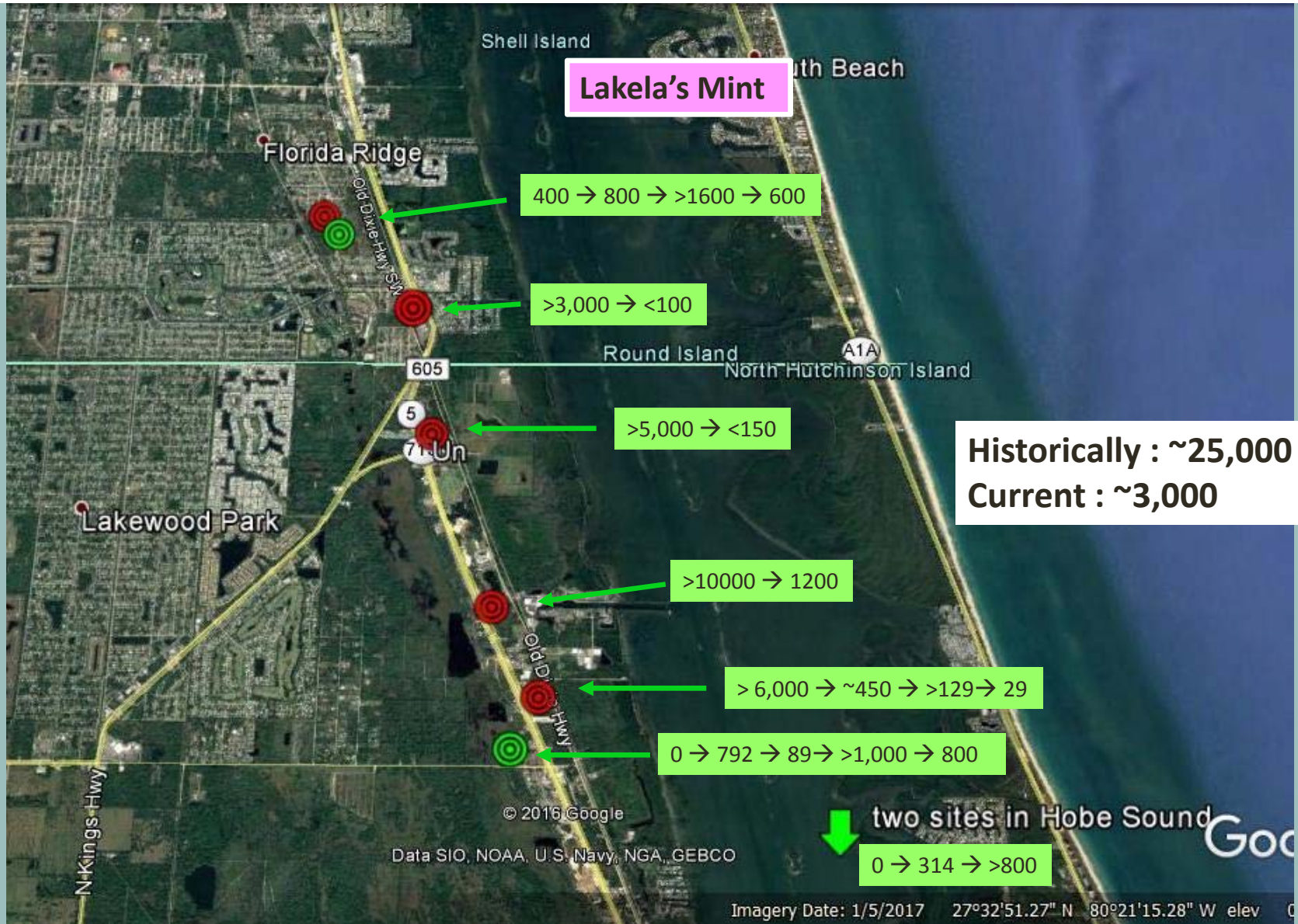
Lakela's Mint

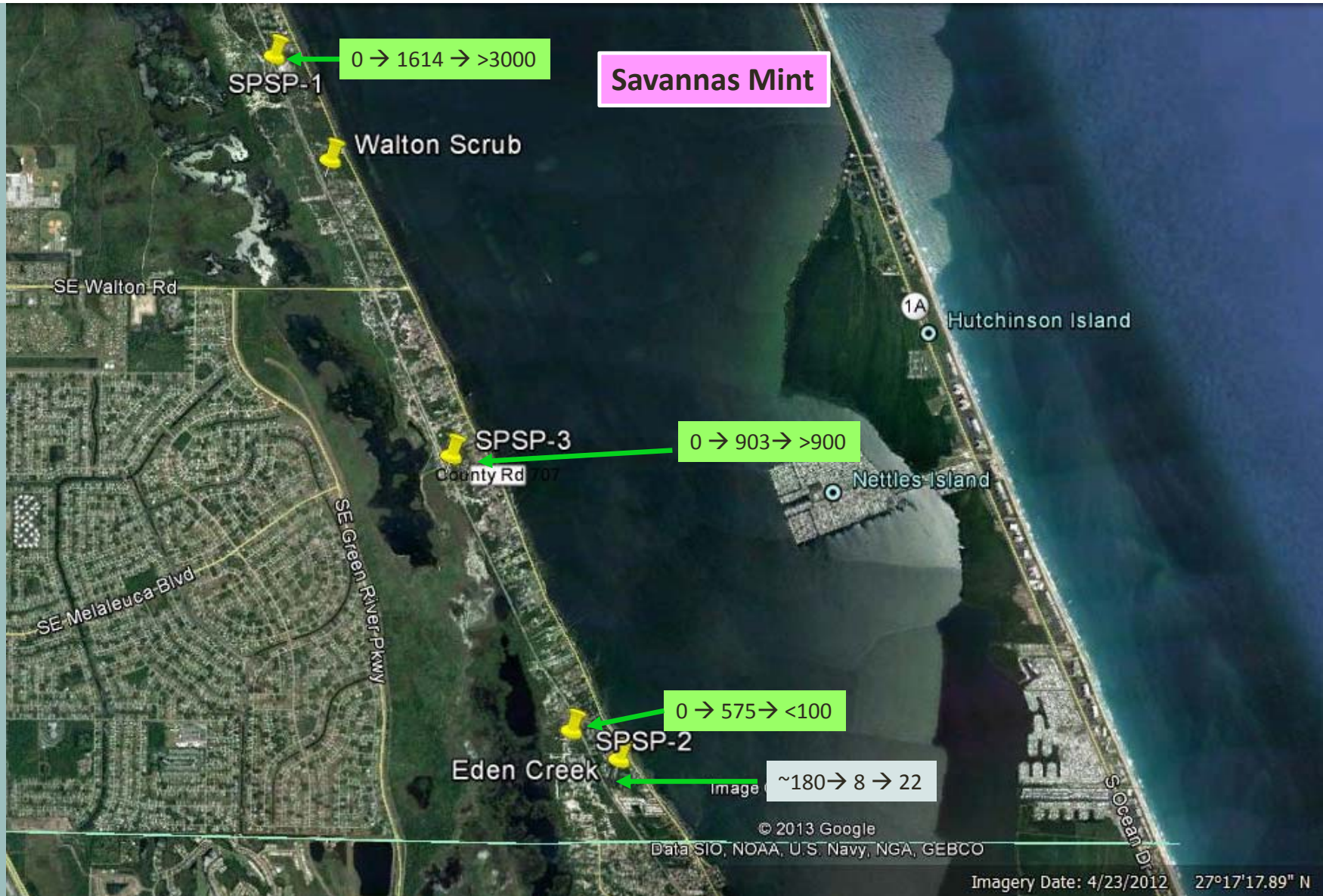
two sites in Hobe Sound

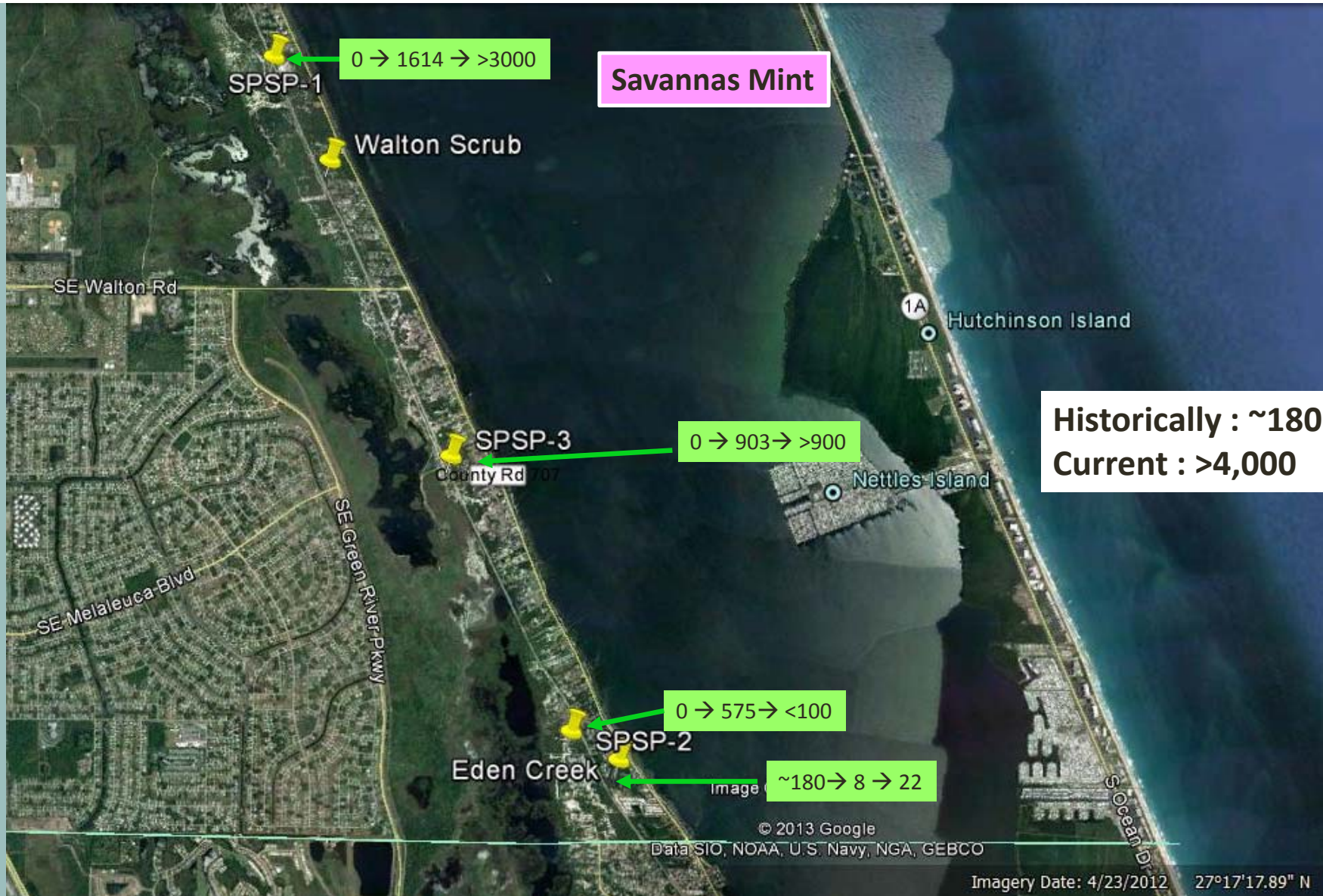
© 2016 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Imagery Date: 1/5/2017 27°32'51.27" N 80°21'15.28" W elev 0







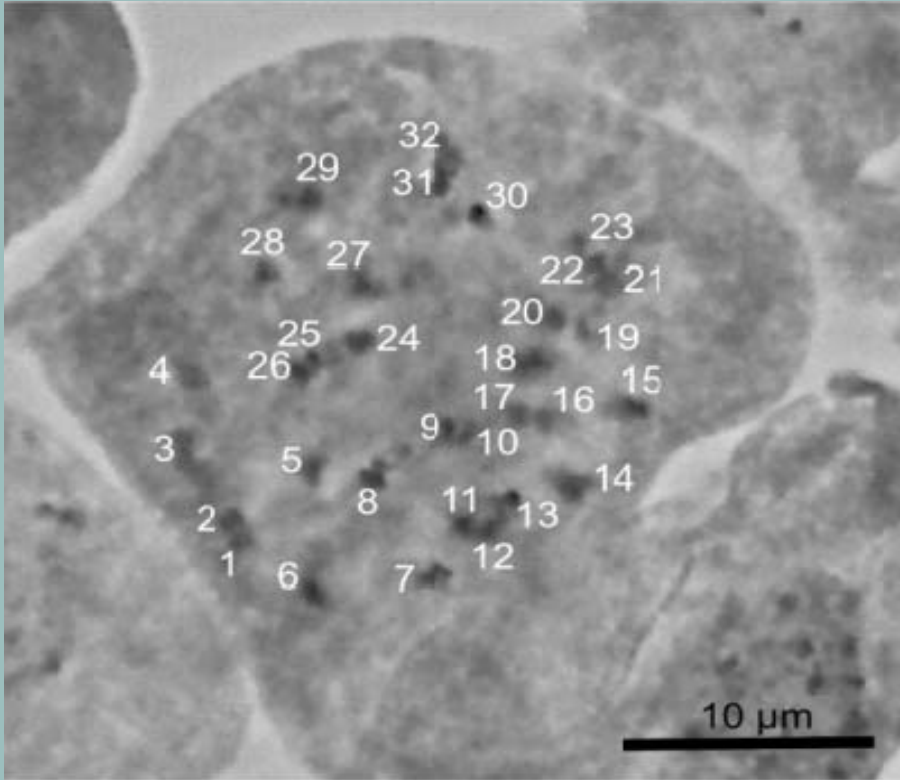


Comparative research by Bok Tower Gardens

- *ex situ* germplasm preservation:
 - Ambient, 7°C, -20°C, cryogenic storage
 - Propagation and germination trials
- *in situ* preservation
- Basic biology
- Population dynamics
 - Life cycle, demography
 - Spatial seedling recruitment, seed limited
 - population viability analysis
 - modelling climate change impacts
- Reproduction & ecology
 - Mating system
 - Pollinators
 - Seed predators



Chromosome counts & ploidy levels



Chromosome counts: $2n=32$

Determined ploidy of individuals in:
edge, center
sun, shade

Results = both species have 32 chromosomes
all plants/pops are diploid

Seed biology:

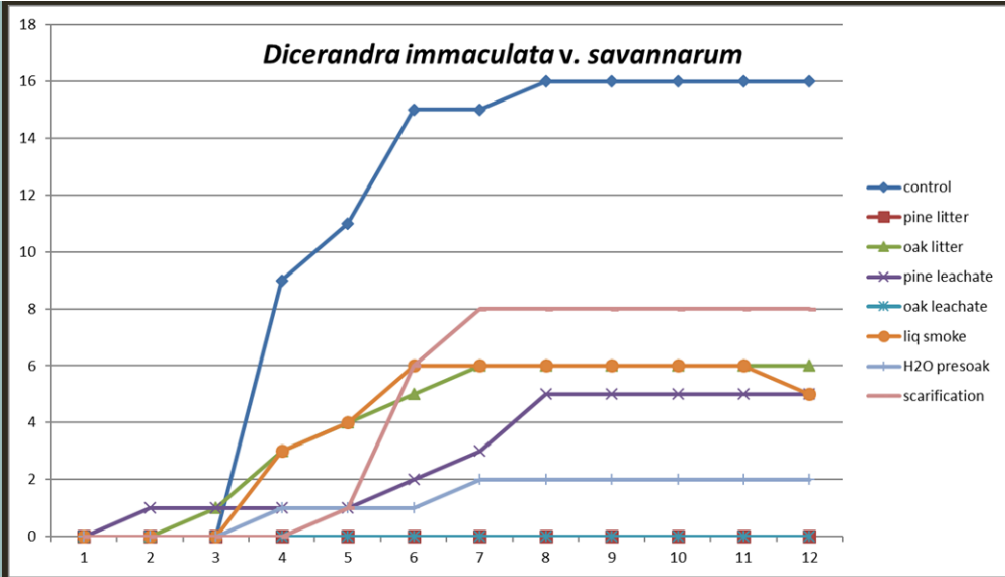


Short-lived seed bank:

- <1 yr in ambient
- 2-3 yrs at 7°C
- >3 yrs (very low) -20°C
- Cryogenic offers long-term option

Very low germination rates:

2-10% Savannas Mint
0-2% Lakela's Mint

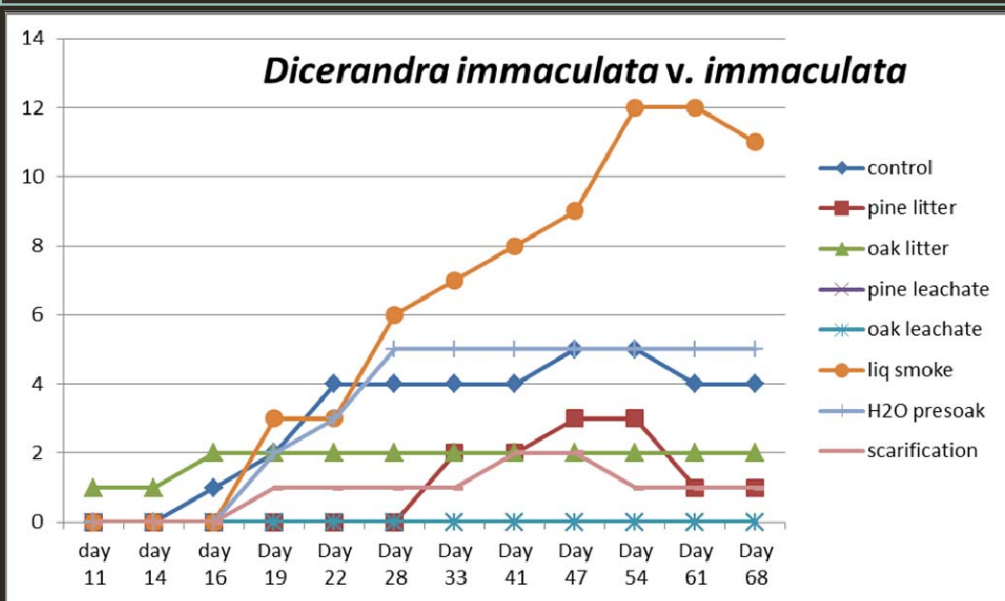


Savannas Mint (3.2%)

No 'treatment' enhances germination

Direct sow in sand best

No germination under pine litter or with oak leachate



Lakela's Mint (2.4%)

Liquid smoke enhanced germination

Both species

Oak and pine may negatively impact germination

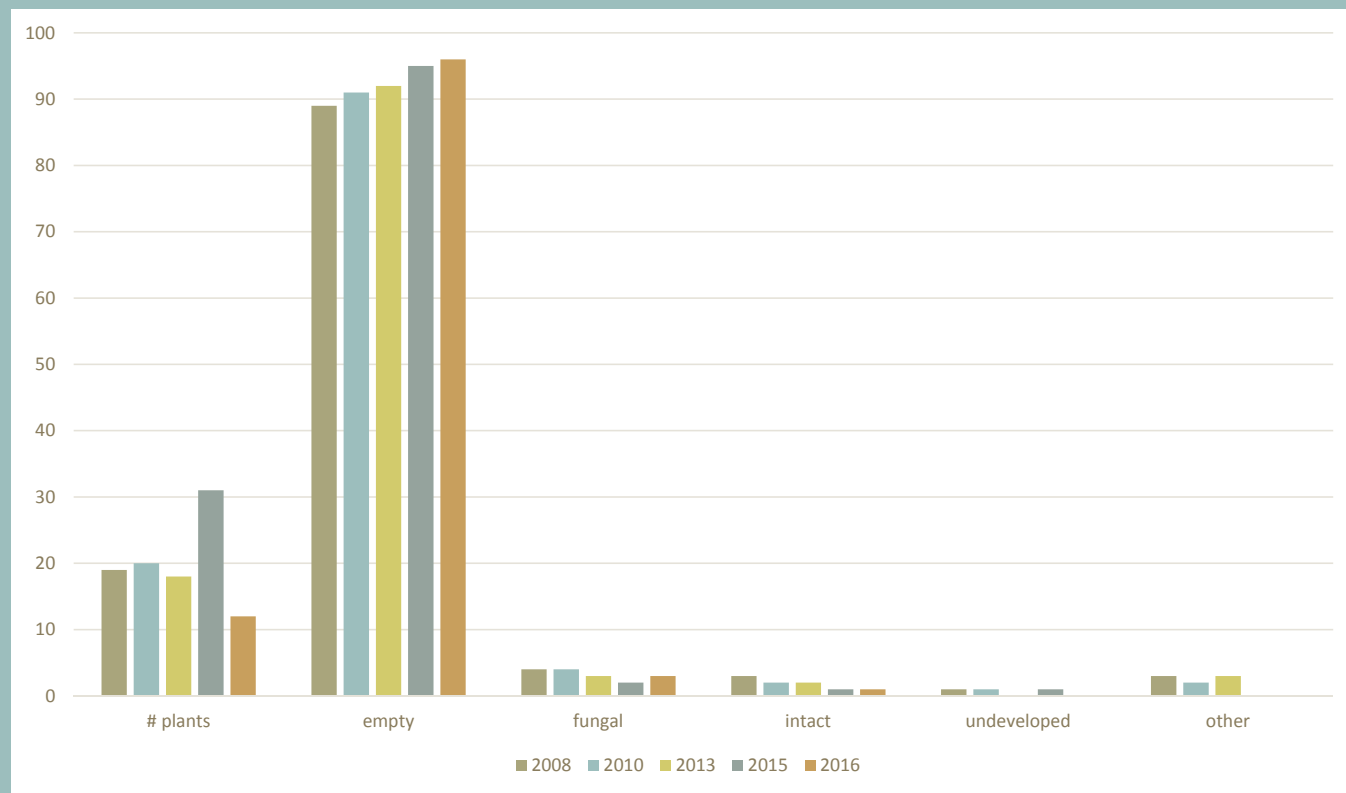
Open, bare sand needed for germination

Seed quality



Combined seed quality across harvest years

- Most seeds empty
- % intact similar to germination rate
- Fungal contamination a problem for reproduction (esp. for Lakela's Mint)
- Insect predator may contribute to empty and 'other'



Wherever there were seeds....



Harvester ant



Tawny crazy ant



Bark lice



Swollen powder bug



Aphis hairy toad-body



Gall midge



pseudoscorpion



Crab spider



Spitting spider



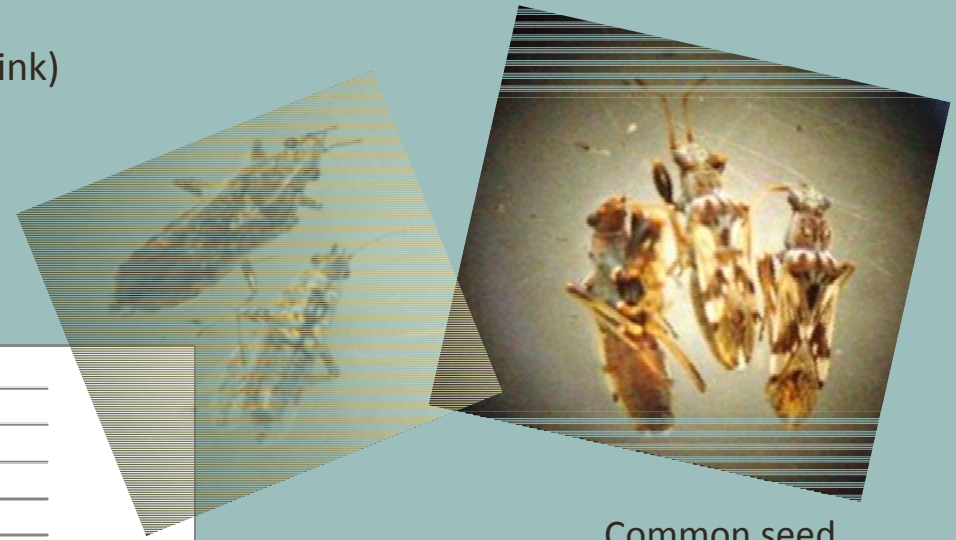
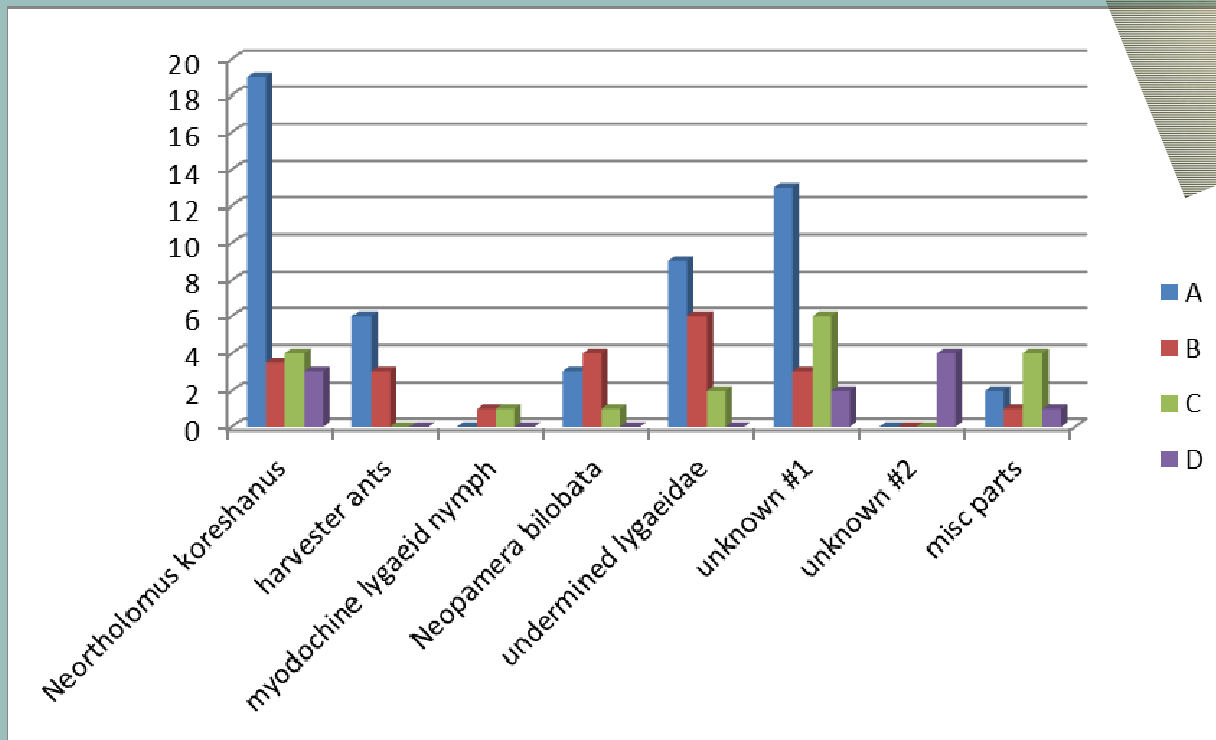
Erythraeid mite

A Flowering is just finishing up (some petals or a final flower, some residual brown flower remnants)

B All flowers gone (no flower remnants, calyxes still fresh/pink)

C Most calyxes starting to brown:

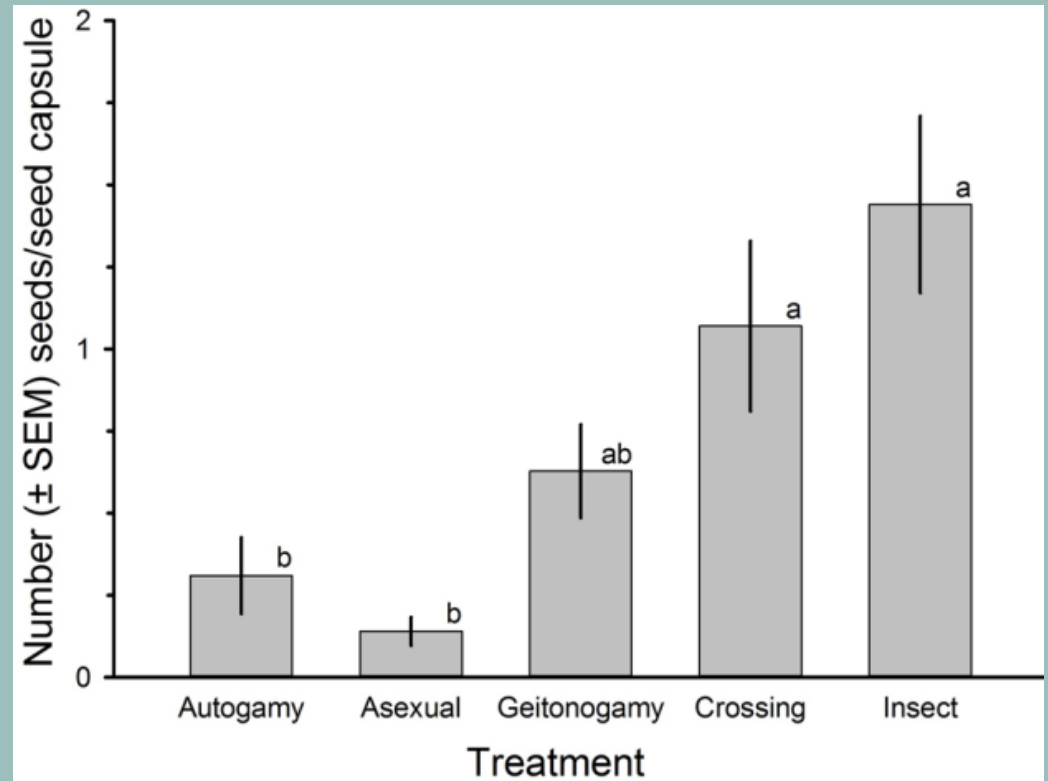
D calyxes fully brown & dried, seeds fully ripe, dehiscing.



Common seed predators favored early stages of seed development

Savannas Mint study currently underway

- Facultative outcrossers
- cross-pollination 2x more successful than selfing



Autonomous = spontaneous self-pollination; Asexual = agamospermy; Geitonogamy = self-pollination; Crossing = cross-pollination; and Insect = insect-pollinated control. Means with different letters are significantly different (Tukey's means separation test, $P < 0.05$)

Bombyliid fly (*Bombylius mexicanus*)

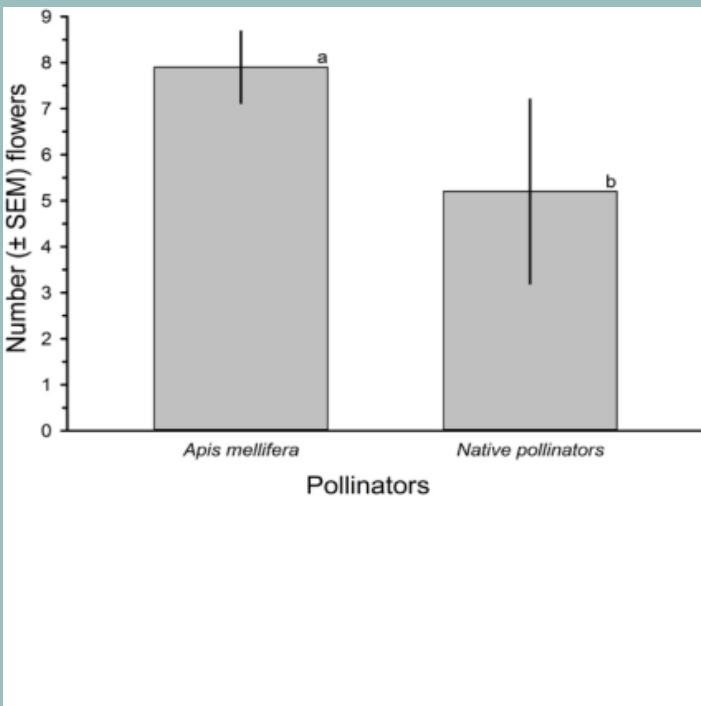


Lakela's Mint: Pollinator observations

Honey bee (*Aphis mellifera*)



- 2012 & 2014 study: >93% pollinators are non-native honeybees, 7% are native pollinators (bumblebees, butterflies, moths, flies, and a wasp)
- Presumed similar for Savannas Mint (research planned....)



- Honeybees visit plants...
 - in sunny habitat
 - with large floral displays
 - Predominantly visited flowers within a plant
- Native pollinators visit plants...
 - sun or shade
 - mostly with large floral displays, but not as much
 - Visited 1-2 flowers within a plant, then moved to next plant



Honeybees visit 1.5x times more flowers within a plant than natives.
May promote selfing

Implications of non-native honeybee pollinators:

Primarily only large plants in full sun get pollinated: not all plants contribute to next generation = loss of genetic diversity with each successive generation

Encourages selfing → inbreeding depression over time

Half as many seeds may be produced through selfing

Serious reproductive problems:

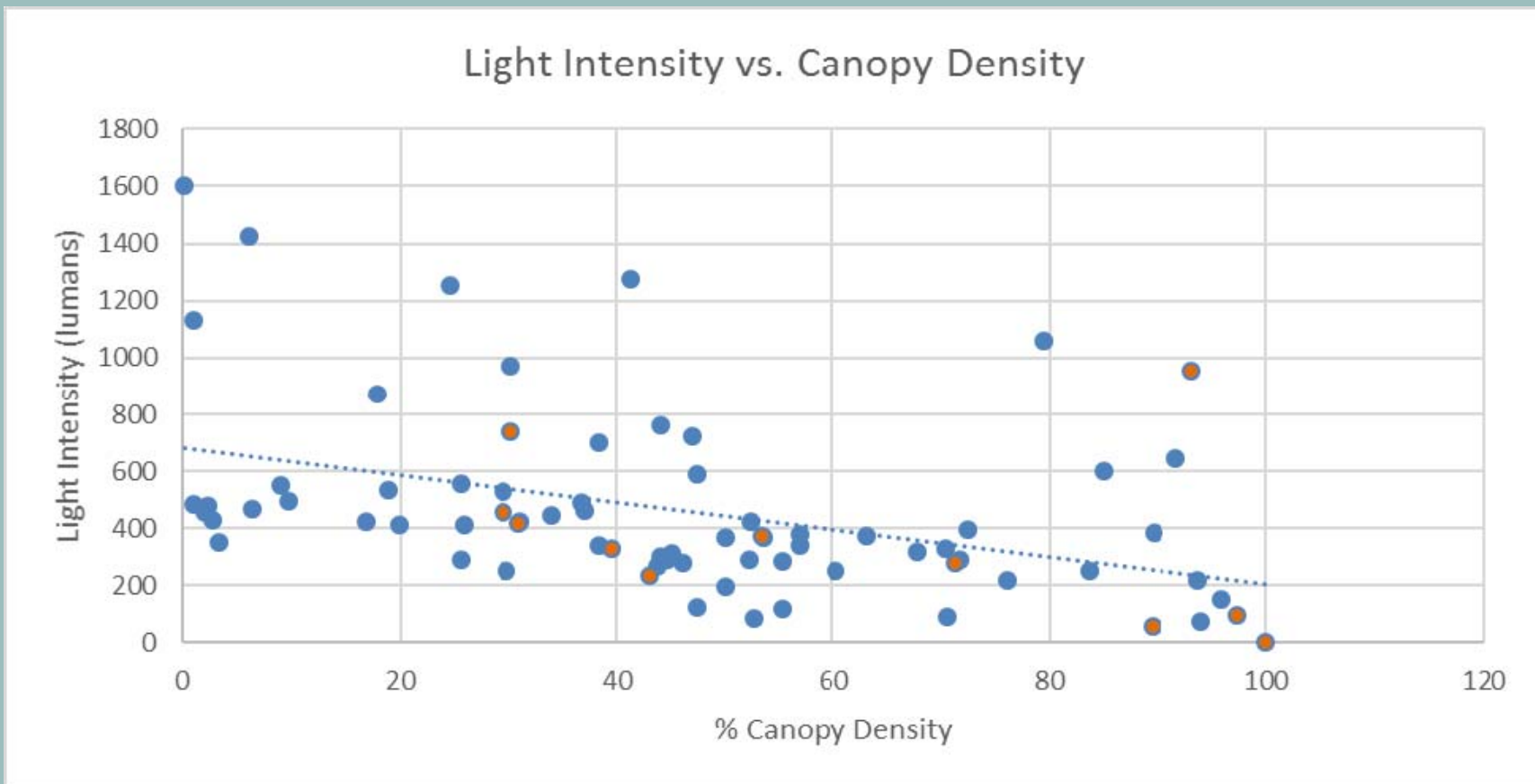
- Most seeds empty or destroyed by fungus/seed predators
- Only ~4% (avg of both species) seed viability
- Seeds probably only last < 1 year in seedbank
- Pollinator behavior may be reducing seed number to half and reducing genetic diversity each generation
- Increasing overgrowth in populations contributing greatly to reproductive weakness

Sad Plant →



Populations need lots of plants and in open sunny areas!

Fewer viable seeds produced by most genotypes in areas of lower light and greater canopy cover



Habitat critical to species survival

- Grows in open, sunny habitat (i.e., “gap specialist”)
- Both sand and canopy gaps essential
- Filtered sunlight
- Herbaceous scrub associates & lichen positive
- pines and hickories, preferred over oaks
- Invasive competitors extremely detrimental

Likes pine or hickory treeline



Overgrowth of oaks bad

Does best with few woody species in vicinity, but likes small herbaceous Scrub

Needs 40-60% bare sand



Influence of community structure on the spatial distribution of critically endangered *Dicerandra immaculata* var. *immaculata* (Lamiaceae) at wild, introduced, and extirpated locations in Florida scrub. Matthew L. Richardson, Montserrat L. J. Watson, Cheryl L. Peterson. *Plant Ecol* (2013) 214:443–453.

Parent Genotype and Environmental Factors Influence Introduction Success of the Critically Endangered Savannas Mint (*Dicerandra immaculata* var. *savannarum*). Cheryl L. Peterson, Gregory S. Kaufmann, Christopher Vandello, and Matthew L. Richardson. *PloS One*. April 2013.

What a mint wants....



How to kill a mint....



overgrowth



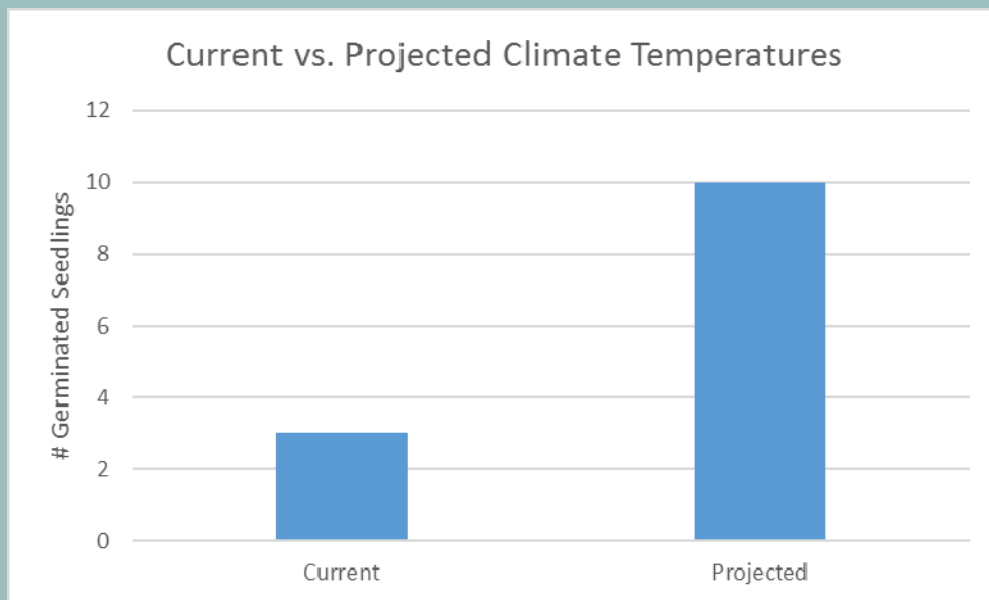
Cogon grass and other outcompeting species



Love vine quickly kills all mints in an area

**Long-term predictions:
looking at the potential influence of climate two
ways:**

Controlled condition Germination trials (Savannas Mint)



Faster germination with higher temps, but weeds much more abundant and watering needs much higher



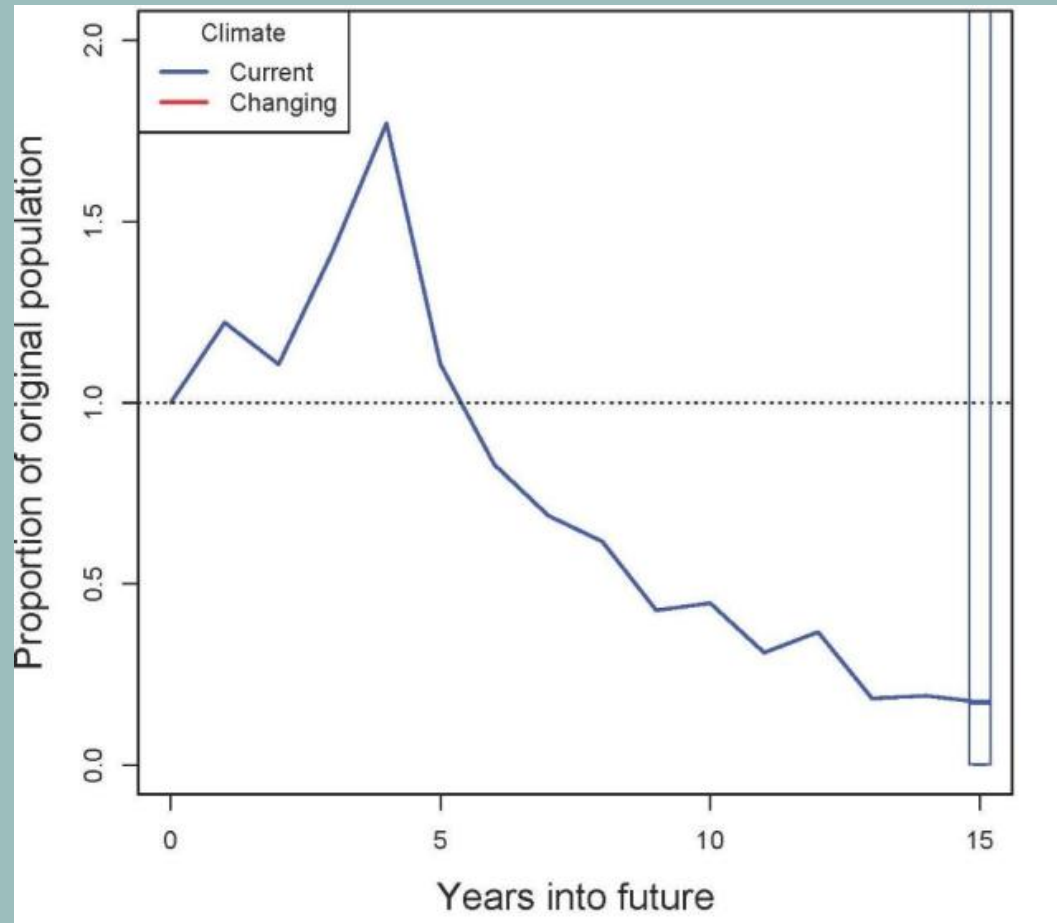
Population viability modeling (Lakela's Mint)

Based on 10 yrs data, 2 sites, 40,000 observations

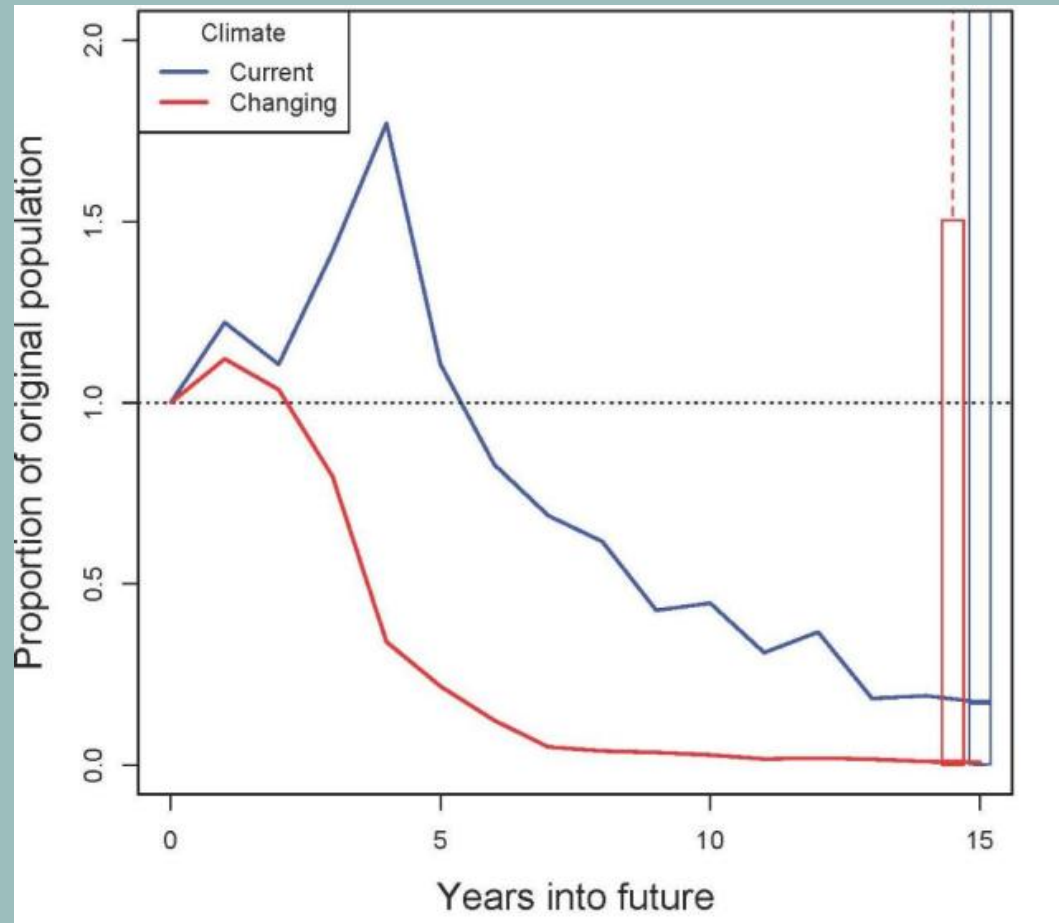
Dr. Matthew Richardson, University of D.C.
Dr. David Zaya, Illinois Natural History Survey
Cheryl L. Peterson, Bok Tower Gardens
Dr. Eric Menges, Archbold Biological Station

Predicted response to current versus changing climate

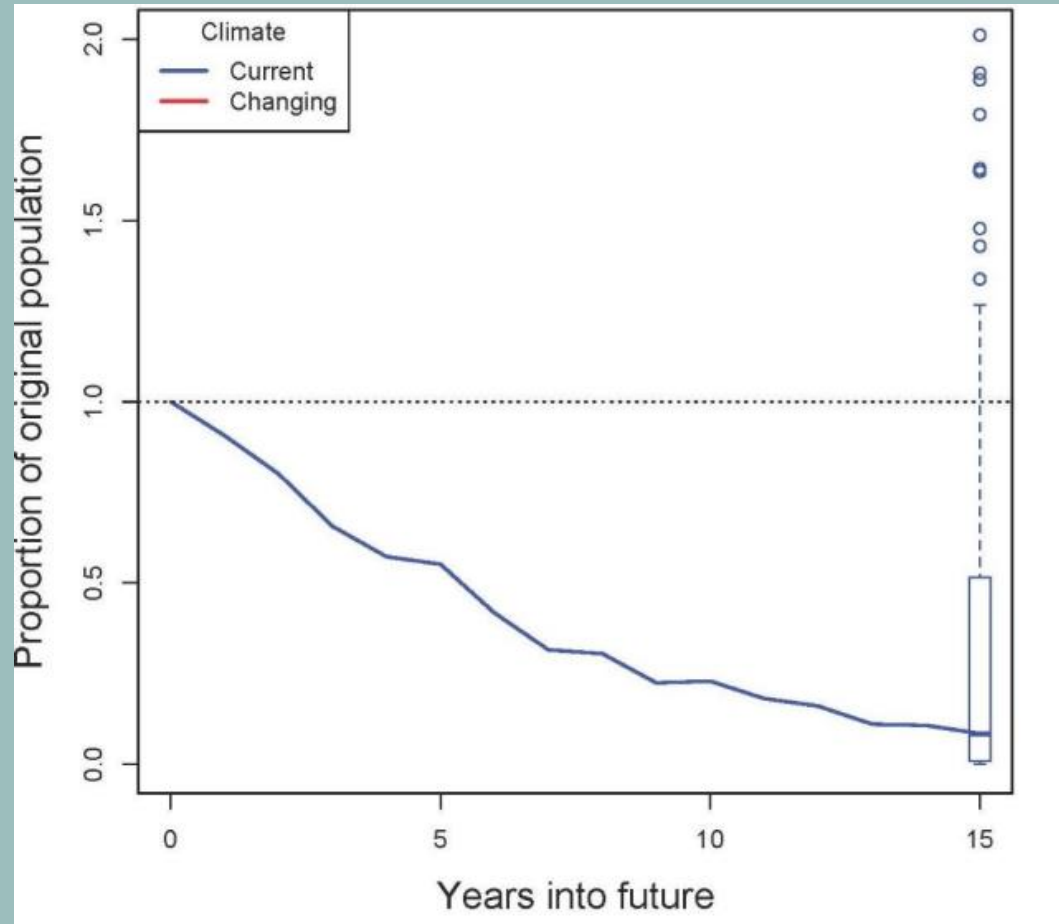
Site 1: Augmented



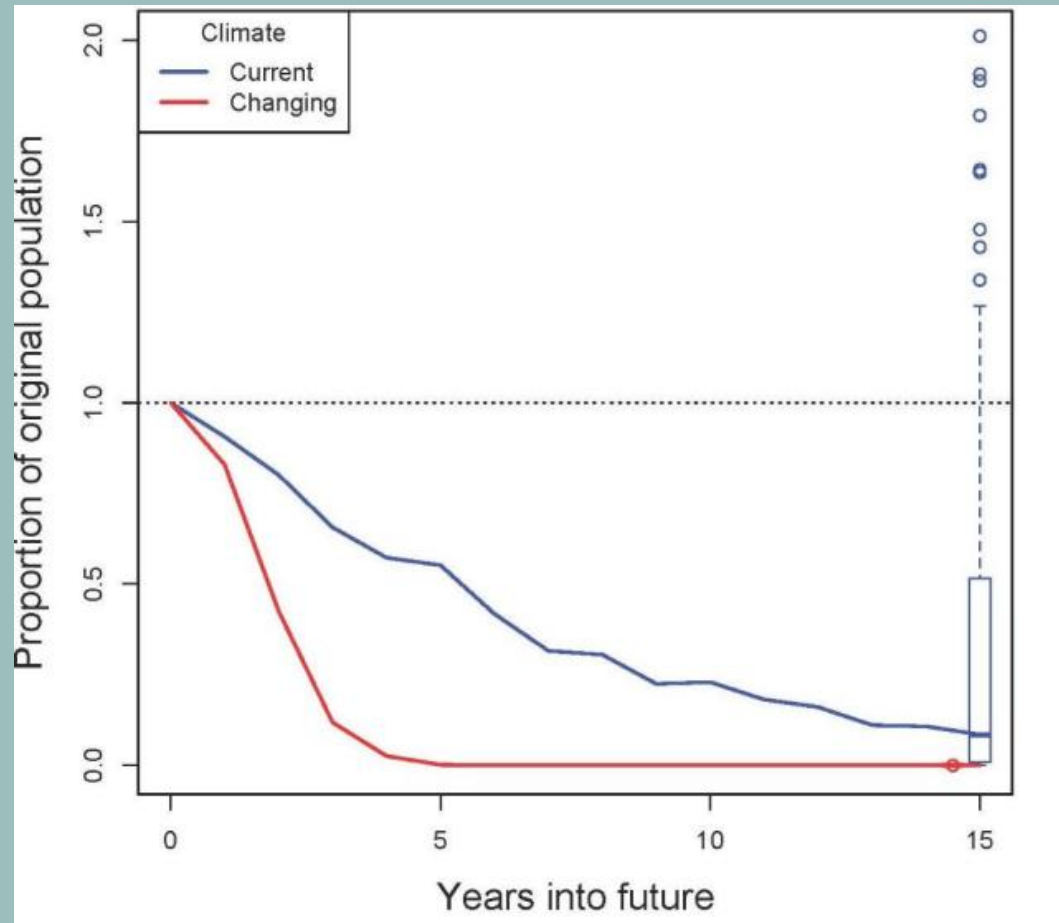
Site 1: Augmented



Site 2: Wild



Site 2: Wild



Summary:

~3,000 Lakela's Mint remaining: 5 natural, 3 introduced sites – all declining

~ 4,000 Savannas Mint remaining: 1 natural, 3 introduced sites –
just 1-2 introduced populations may be stable

ADDITIONAL PROTECTED, MANAGED POPULATIONS CRITICALLY NEEDED

Sufficiently large populations with suitable habitat essential to prevent extinction

Populations less stable with climate change; can probably thrive with improved habitat

Vital to prevent extinction = remove overgrowth, love line, runner oaks, cogon grass
maintain canopy and sand gaps

Patchy, prescribed fire likely optimum

in lieu of fire - gentle, regular hand maintenance may be key to preservation
(prescribed fire may enhance seed germination in Lakela's Mint)



Acknowledgement & thanks

University of the District of Columbia - Dr. Matthew Richardson

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Harbor Branch Oceanographic Institute/FAU – Katha Kissman, Stewart Moreaux

Indian River County - Beth Powell, additional IRC staff and volunteers

Volunteers: Jerry Burns, Dick Diener, Dave Martin, Ric Stange, Jackie

McIntyre, Al Smith, M. Watson, M. Bell, R. Bell, G. Bupp, and J.

Thompson, Paige van Antwerp, many others...



**“Make ye the world a better place or more beautiful
because you have lived in it”
Edward Bok**

