Safeguarding our Tree Collections: Gardens coordinate to manage diversity.

M. Patrick Griffith, Rudy Aguilar, Lindy Knowles, Teodoro Clase, Falon Cartwright, Ethan Freid, Alan Meerow, Vanessa Sanchez, Sean Hoban, Murphy Westwood, Kay Havens, Andrea Kramer, Jeremy Fant, Michael Dosmann, David Lorence, Seana Walsh, John Clark, Abby Meyer, Bob Lacy, Taylor Callicrate, Tracy Magellan, Michael Calonje.

i. improving garden conservation.

ii. What do we need?

iii. Where are we now?

iv. A path forward.

i. improving garden conservation.

ii. What do we need?

iii. Where are we now?

iv. A path forward.

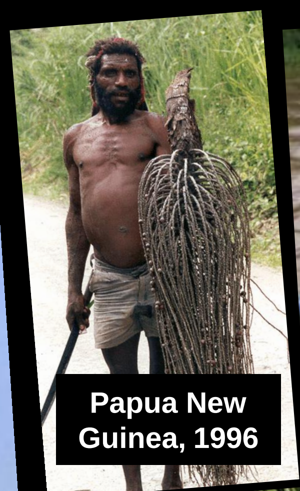

MBC
Montgomery
Botanical
Center
Miami, Florida, USA

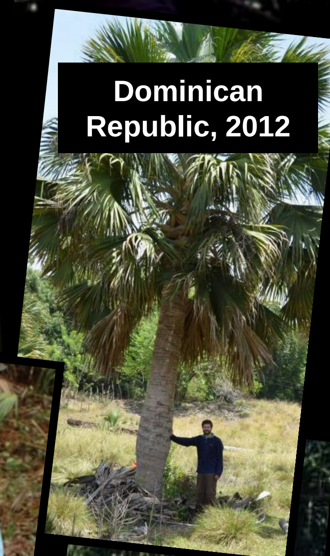

1932: Collection established

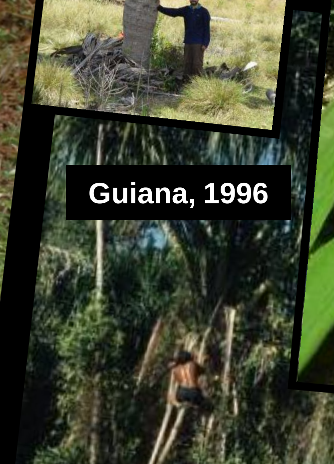
Colonel Robert Montgomery

Major Collections Development

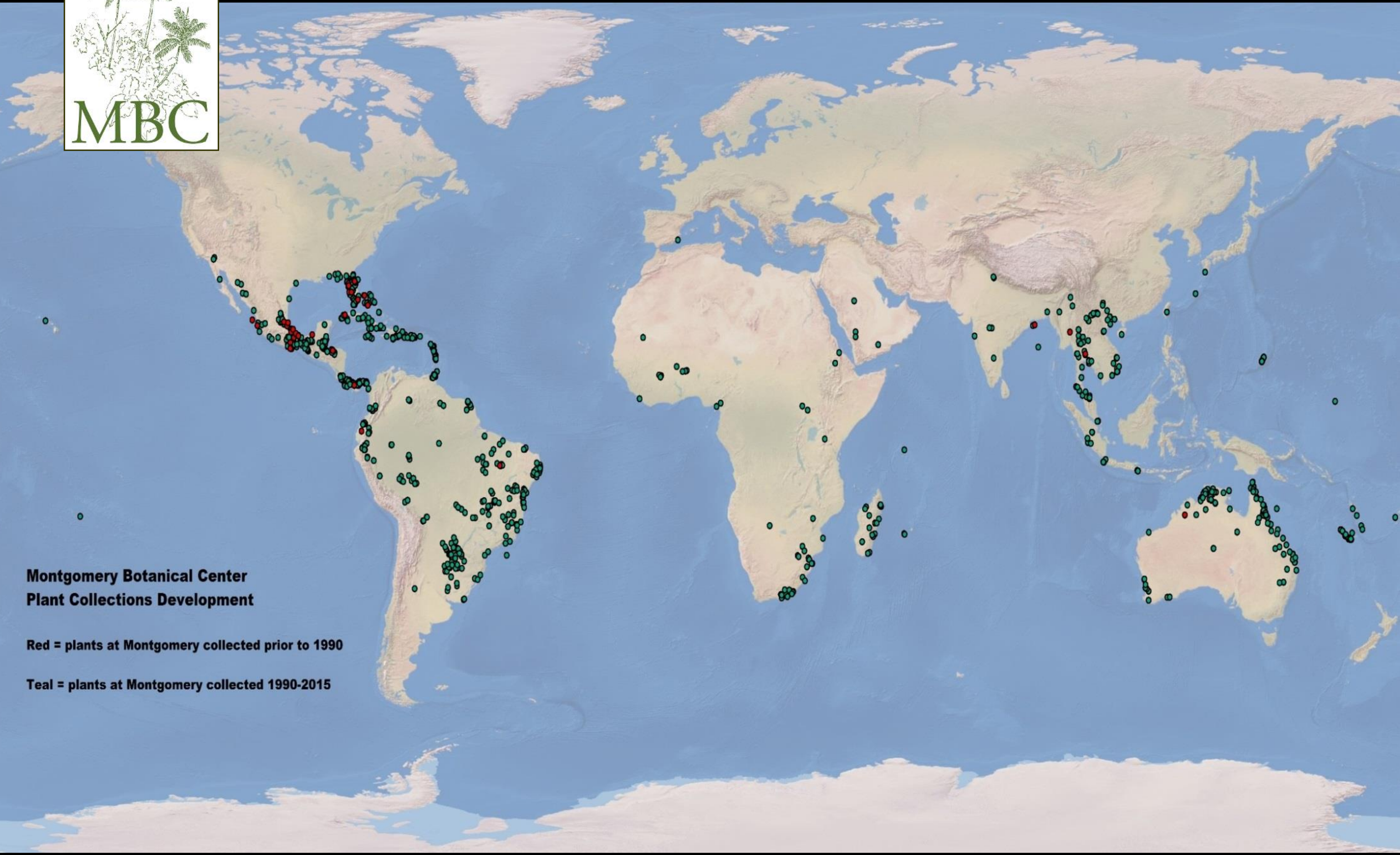
1990-present







Where we have worked



Mission:

“ . . . advance
research,
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through living plant collections.”

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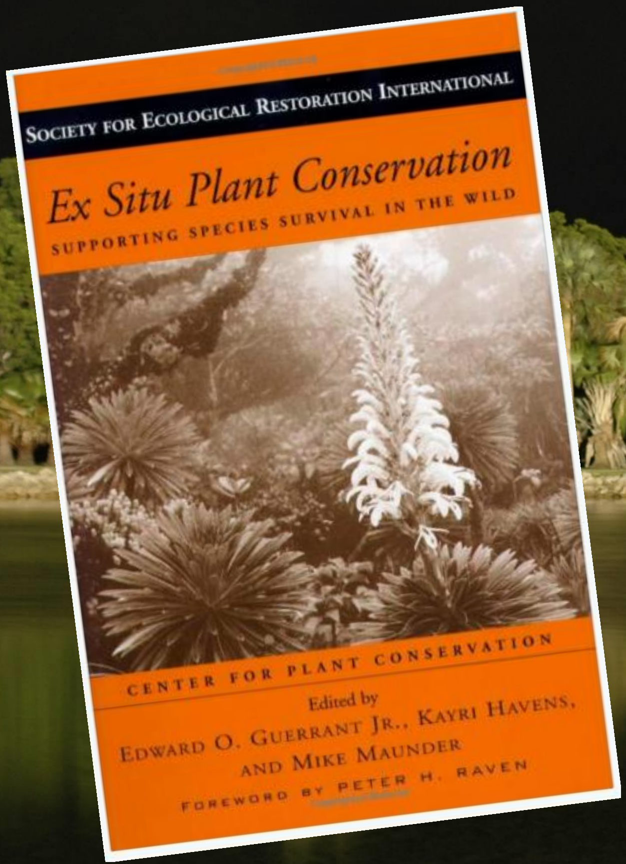

[= ex situ conservation]

Basic idea:

keep genetically diverse collections

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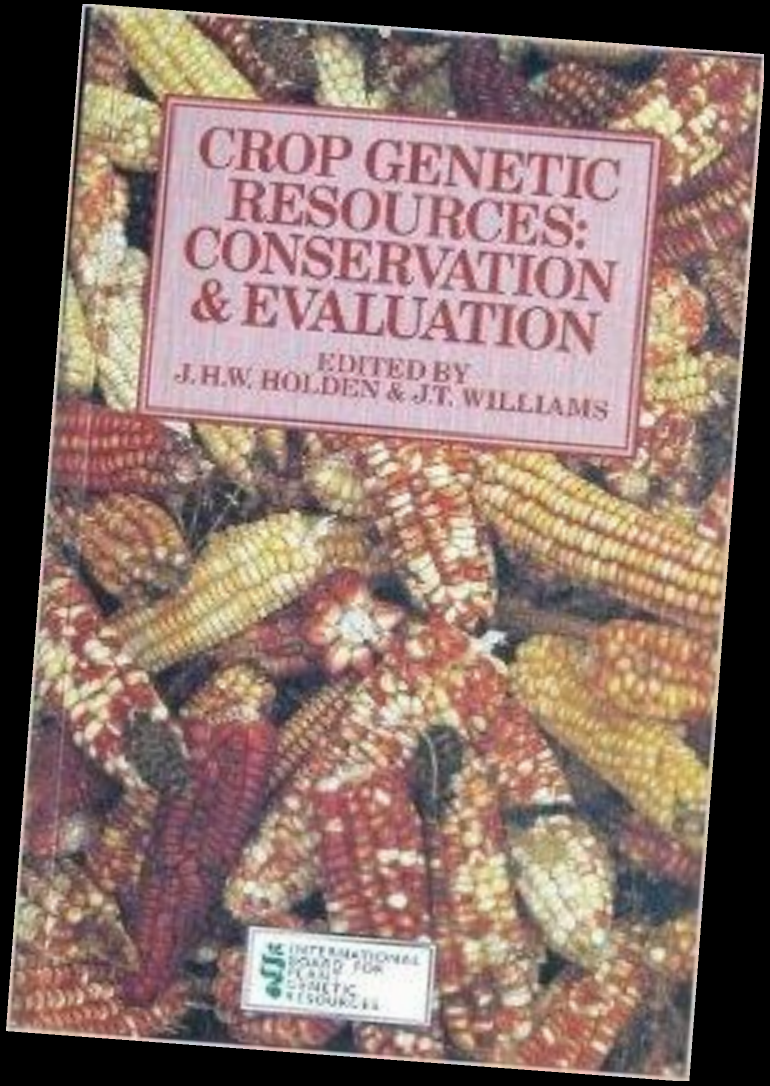
keep genetically diverse collections

Question: which plants and how many?

MBC, Early 1990s:

Strategy based on theoretical models



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Basic idea:

Broad and deep sampling of wild plant populations,

Pseudophoenix vinifera

MBC, Early 1990s:

Strategy based on theoretical models

Basic idea:

Broad and deep sampling of wild plant populations,

Adequate numbers kept in botanic garden.

Pseudophoenix vinifera

MBC Collections Policy

_Version2.1.pdf

Plants should be maintained following exemplary ho...
Plants should be incorporated into the collection in an aesthetically plea... with the overall landscape design.

Acquisition of Material

...ontgomery Botanical Center staff will strive to ensure that all plant material acquired from overseas on ...half of MBC has been collected, exported, and imported in compliance with all applicable laws and ...gulations of the country of origin and the Federal Government of the United States,. Staff are not to ...ccept plants known to have been illegally or unethically collected from the wild.

Seeds or plants arriving at MBC are delivered directly to the appropriate Biologist or, in the Biologist's absence, to the Collections Manager. The Biologist (or Collections Manager) must approve the acceptance and initiate the processing of all incoming material. For wild collected material arriving from overseas, documentation establishing proper collection and movement of plant material in accordance with all applicable laws and regulations (*e.g.*, collection/research permit, export permit, import permit, CITES permit(s), phytosanitary certificate, etc.) must accompany the material. Original documentation will be permanently maintained in the Montgomery Archive.

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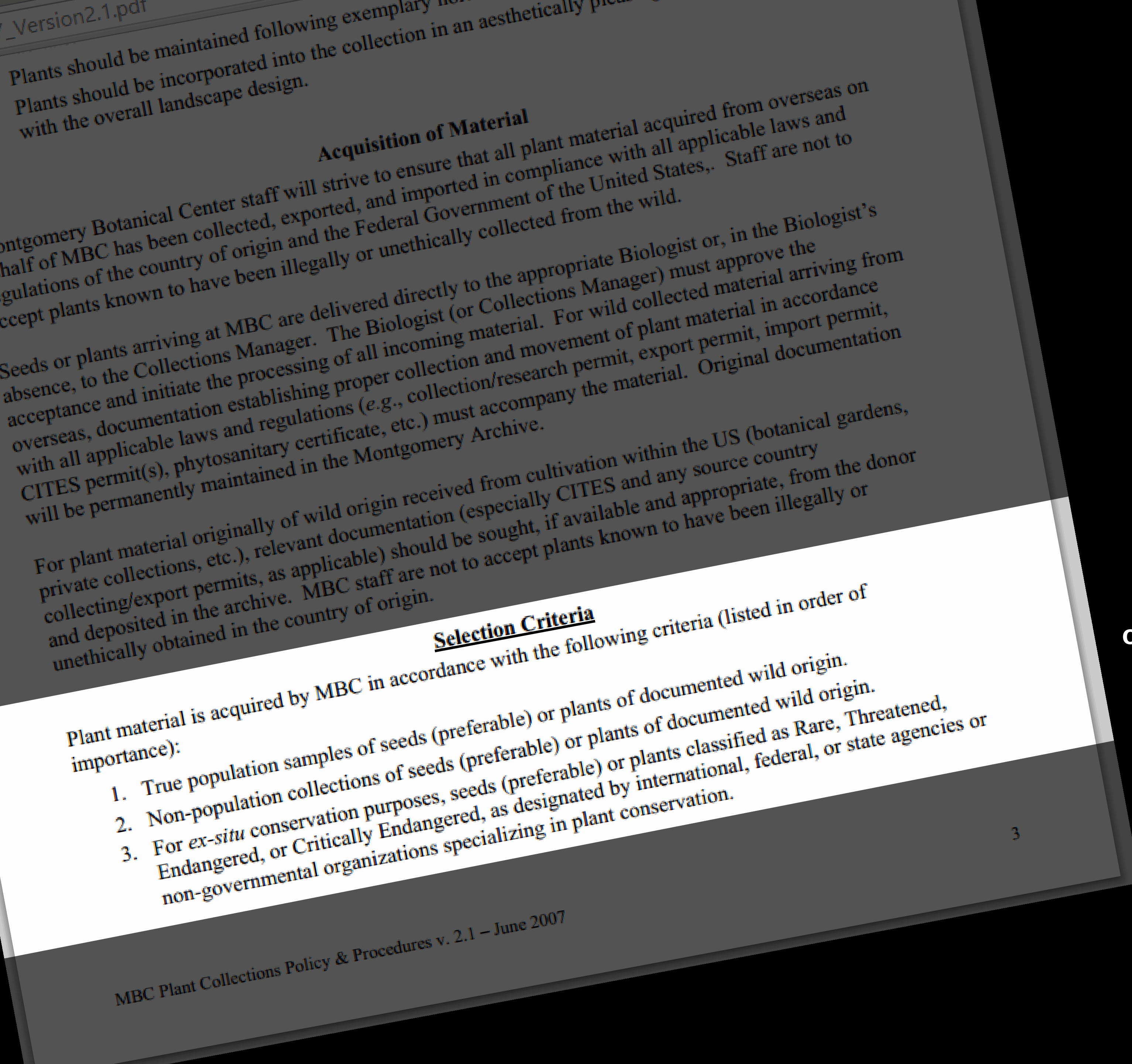
<u>Selection Criteria</u>

Plant material is acquired by MBC in accordance with the following criteria (listed in order of importance):

1. True population samples of seeds (preferable) or plants of documented wild origin.
2. Non-population collections of seeds (preferable) or plants of documented wild origin.
3. For *ex-situ* conservation purposes, seeds (preferable) or plants classified as Rare, Threatened, Endangered, or Critically Endangered, as designated by international, federal, or state agencies or non-governmental organizations specializing in plant conservation.

MBC Collections Policy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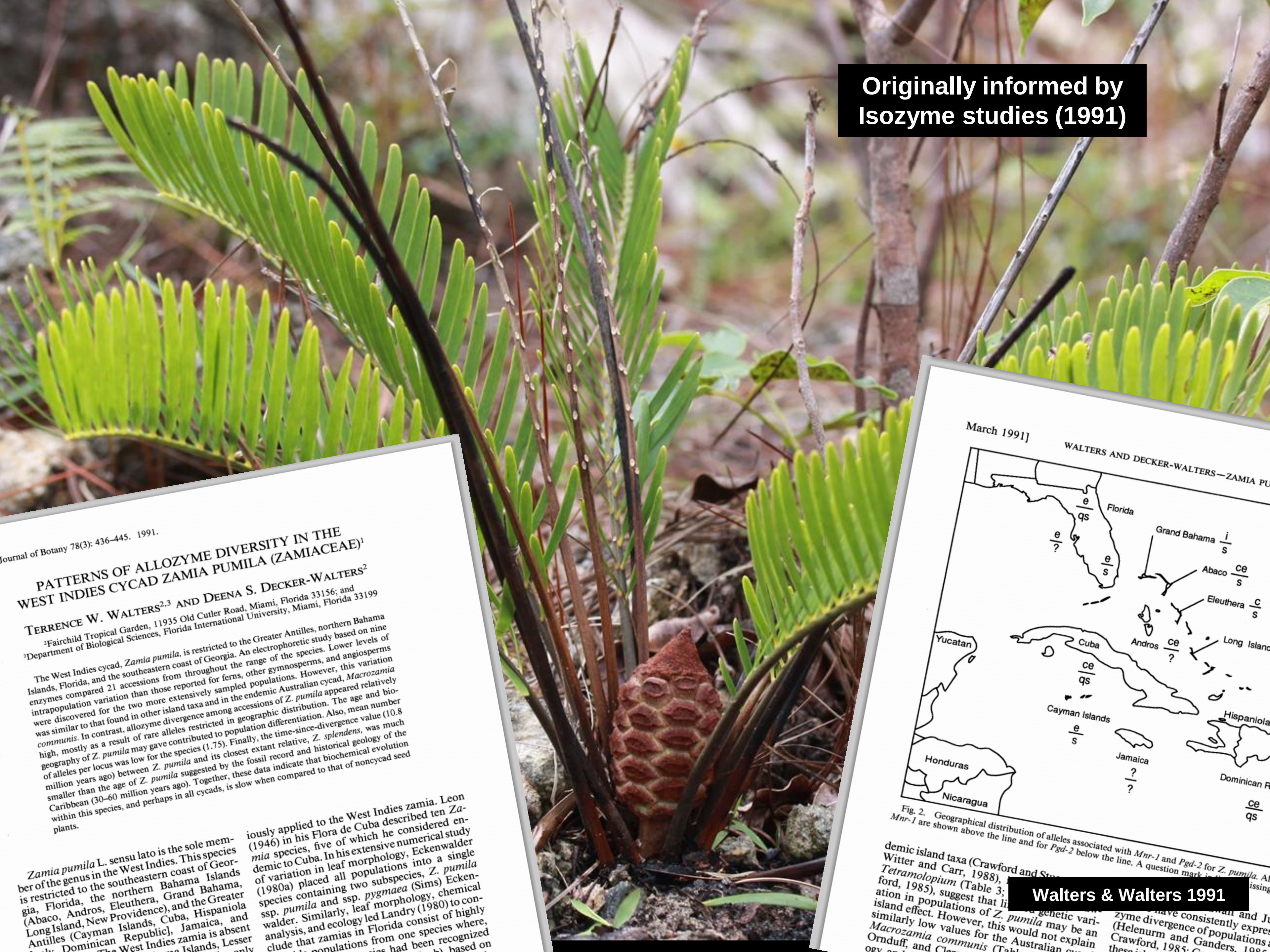
Strict emphasis on deep sampling


Originally informed by Isozyme studies (1991)
Journal of Botany 78(3): 436–445. 1991.
PATTERNS OF ALLOZYME DIVERSITY IN THE WEST INDIES CYCAD ZAMIA PUMILA (ZAMIACEAE)[1]
TERRENCE W. WALTERS[2,3] AND DEENA S. DECKER-WALTERS[2]
[2]Fairchild Tropical Garden, 11935 Old Cutler Road, Miami, Florida 33156; and [3]Department of Biological Sciences, Florida International University, Miami, Florida 33199
The West Indies cycad, Zamia pumila, is restricted to the Greater Antilles, northern Bahama Islands, Florida, and the southeastern coast of Georgia. An electrophoretic study based on nine enzymes compared 21 accessions from throughout the range of the species. Lower levels of intrapopulation variation than those reported for ferns, other gymnosperms, and angiosperms were discovered for the two more extensively sampled populations. However, this variation was similar to that found in other island taxa and in the endemic Australian cycad, Macrozamia communis. In contrast, allozyme divergence among accessions of Z. pumila appeared relatively high, mostly as a result of rare alleles restricted in geographic distribution. The age and biogeography of Z. pumila may gave contributed to population differentiation. Also, mean number of alleles per locus was low for the species (1.75). Finally, the time-since-divergence value (10.8 million years ago) between Z. pumila and its closest extant relative, Z. splendens, was much smaller than the age of Z. pumila suggested by the fossil record and historical geology of the Caribbean (30–60 million years ago). Together, these data indicate that biochemical evolution within this species, and perhaps in all cycads, is slow when compared to that of noncycad seed plants.
Zamia pumila L. sensu lato is the sole member of the genus in the West Indies. This species is restricted to the southeastern coast of Georgia, Florida, the northern Bahama Islands (Abaco, Andros, Eleuthera, Grand Bahama, Long Island, New Providence), and the Greater Antilles (Cayman Islands, Cuba, Hispaniola [Haiti, Dominican Republic], Jamaica, and
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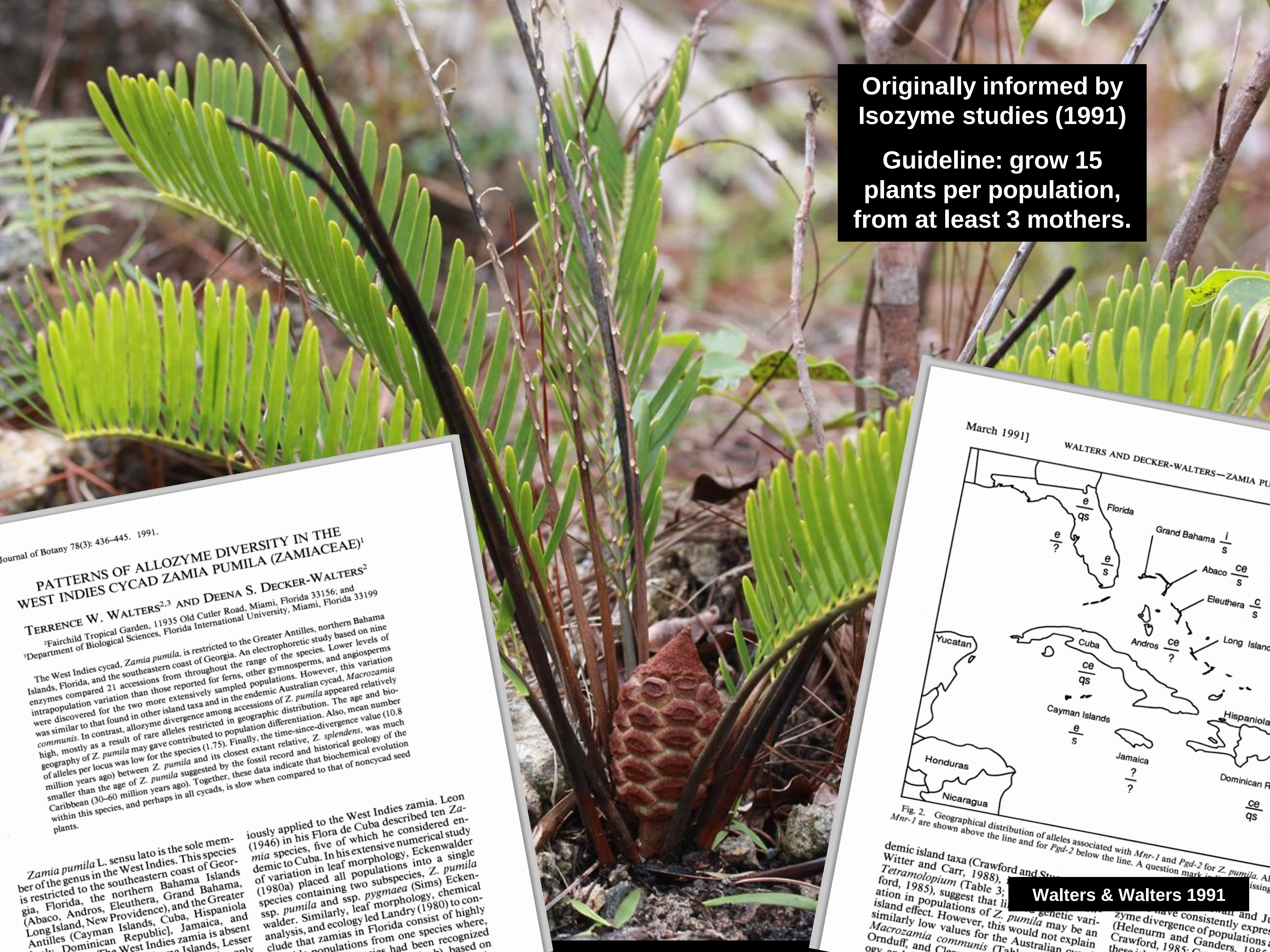
March 1991]
WALTERS AND DECKER-WALTERS—ZAMIA PU
Florida
Grand Bahama
Abaco
Eleuthera
Yucatan
Cuba
Andros
Long Island
Cayman Islands
Hispaniola
Honduras
Jamaica
Dominican R
Nicaragua
Fig. 2. Geographical distribution of alleles associated with Mnr-1 and Pgd-2 for Z. pumila.
Mnr-1 are shown above the line and for Pgd-2 below the line.
Walters & Walters 1991



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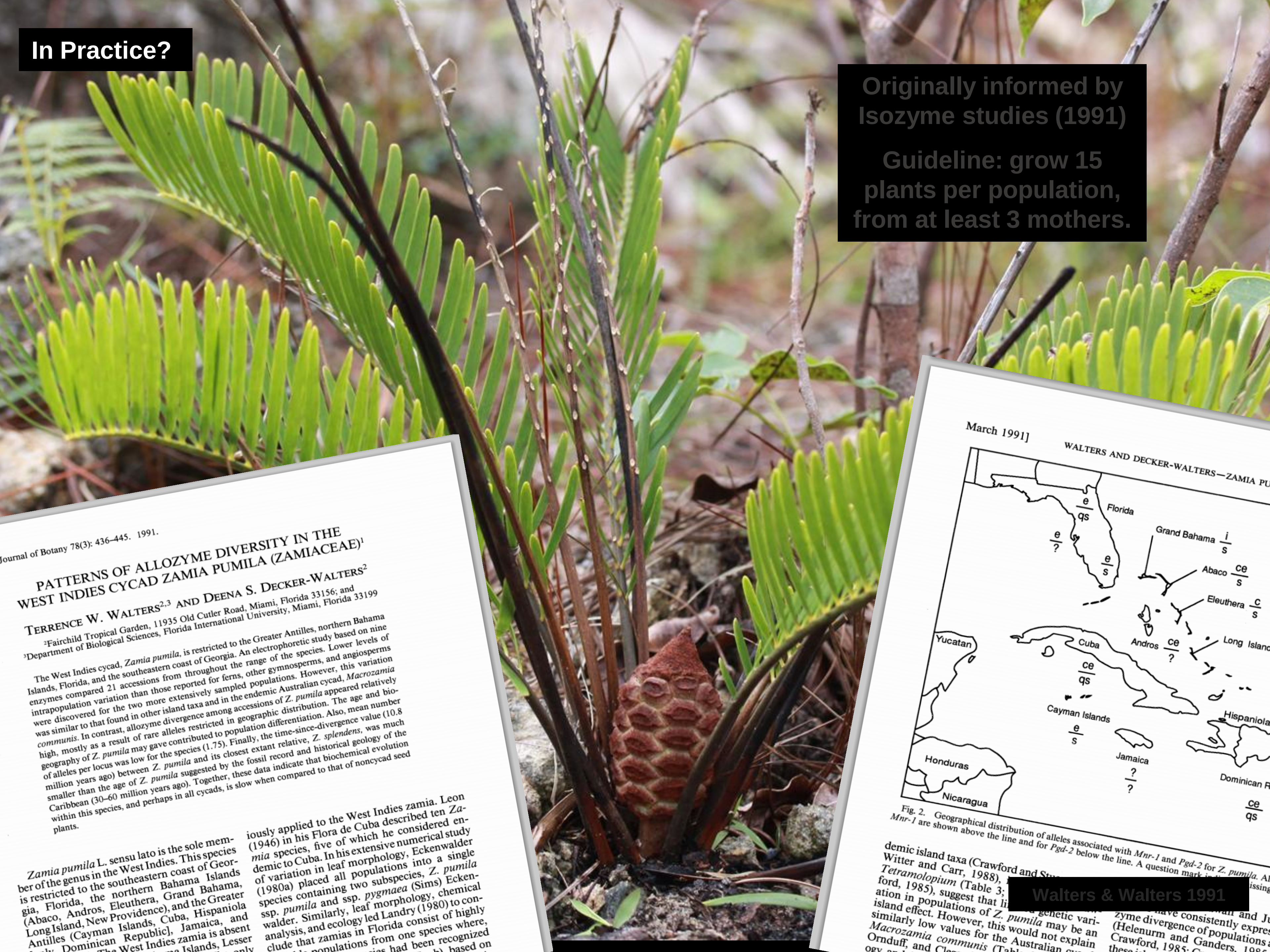

In Practice?

Originally informed by Isozyme studies (1991)

Guideline: grow 15 plants per population, from at least 3 mothers.

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... have consistently expres... zyme divergence of populations ... (Helenurm and Ganders, 198... Crawford, 1985; C... these isl...

Walters & Walters 1991

In Practice: ***Corypha taliera***

13 plants at MBC, from one mother, from 1996

IUCN EW, ca. 20 plants known.


In Practice: *Cycas micronesica,* 2007
249 plants at MBC
IUCN EN

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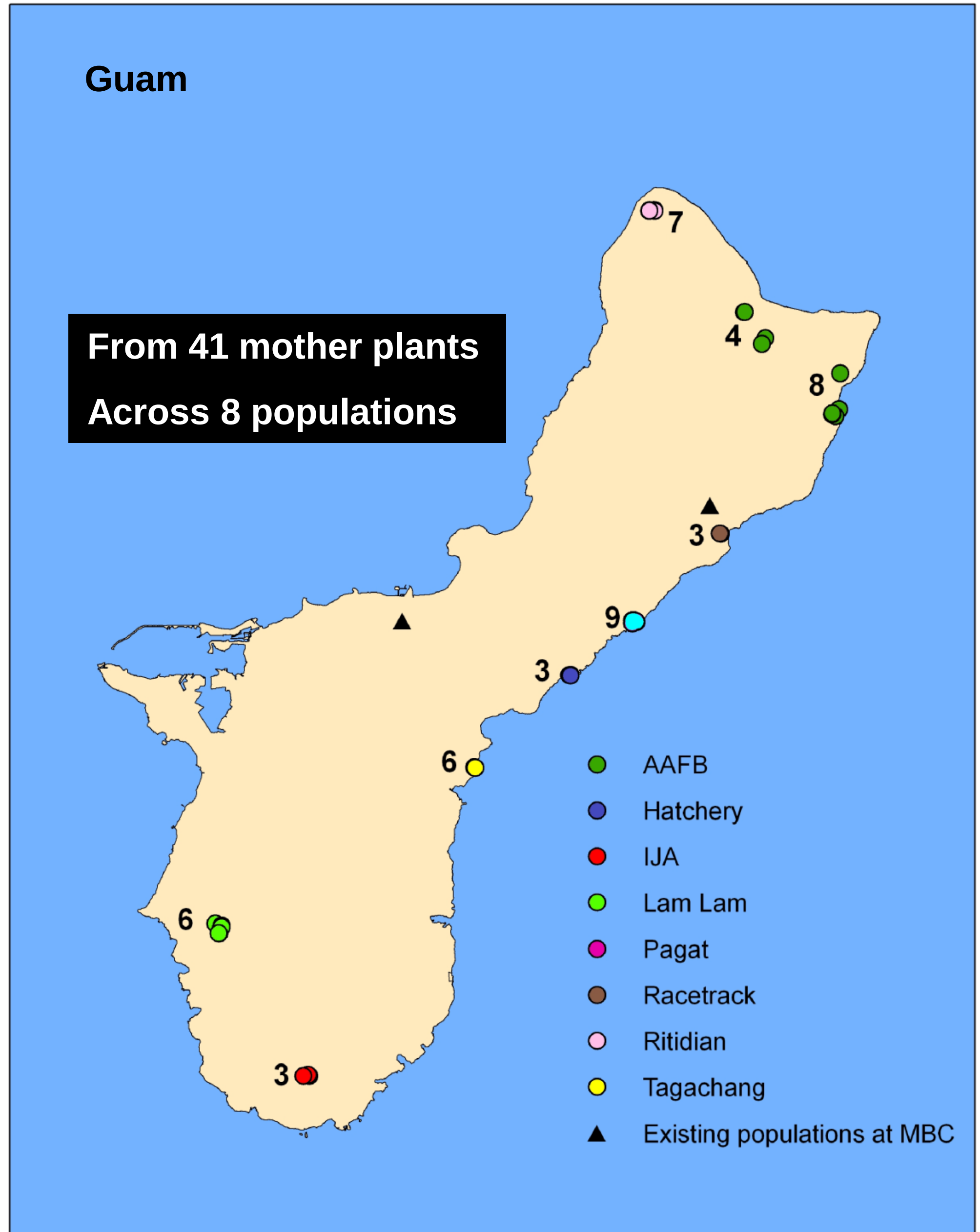
249 plants at MBC

IUCN EN

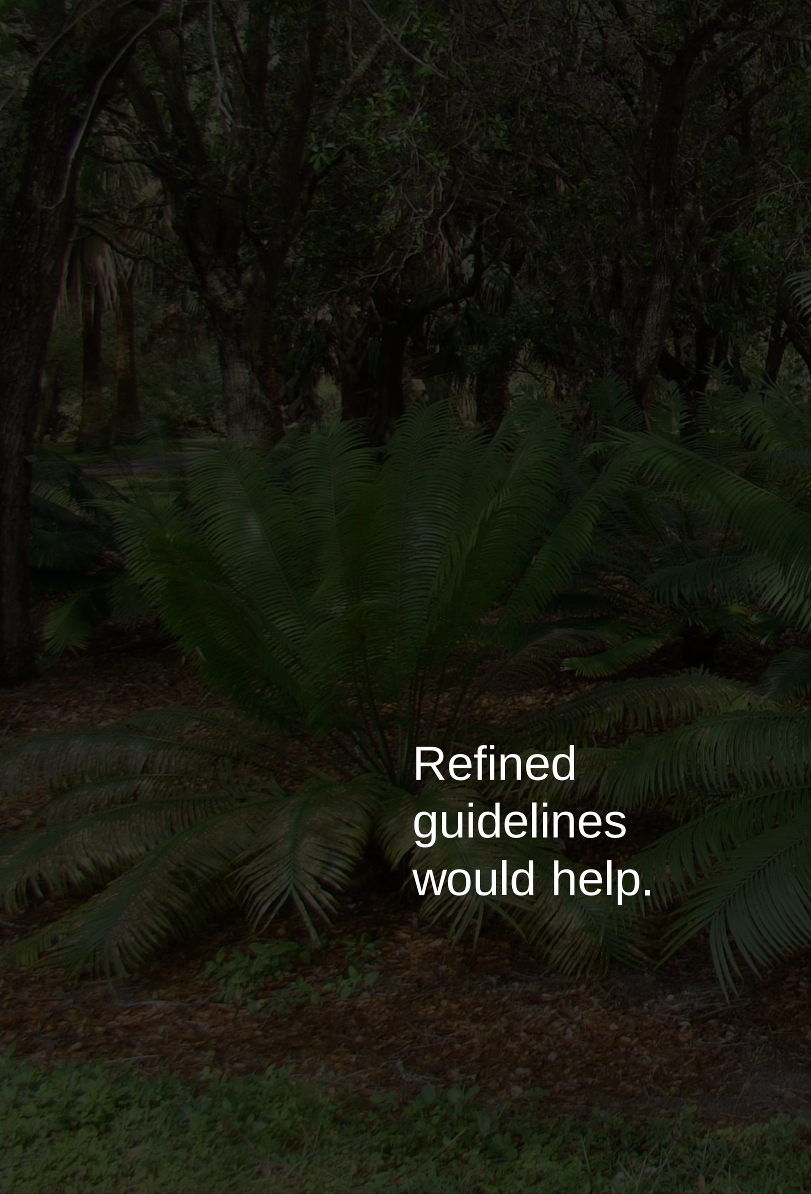


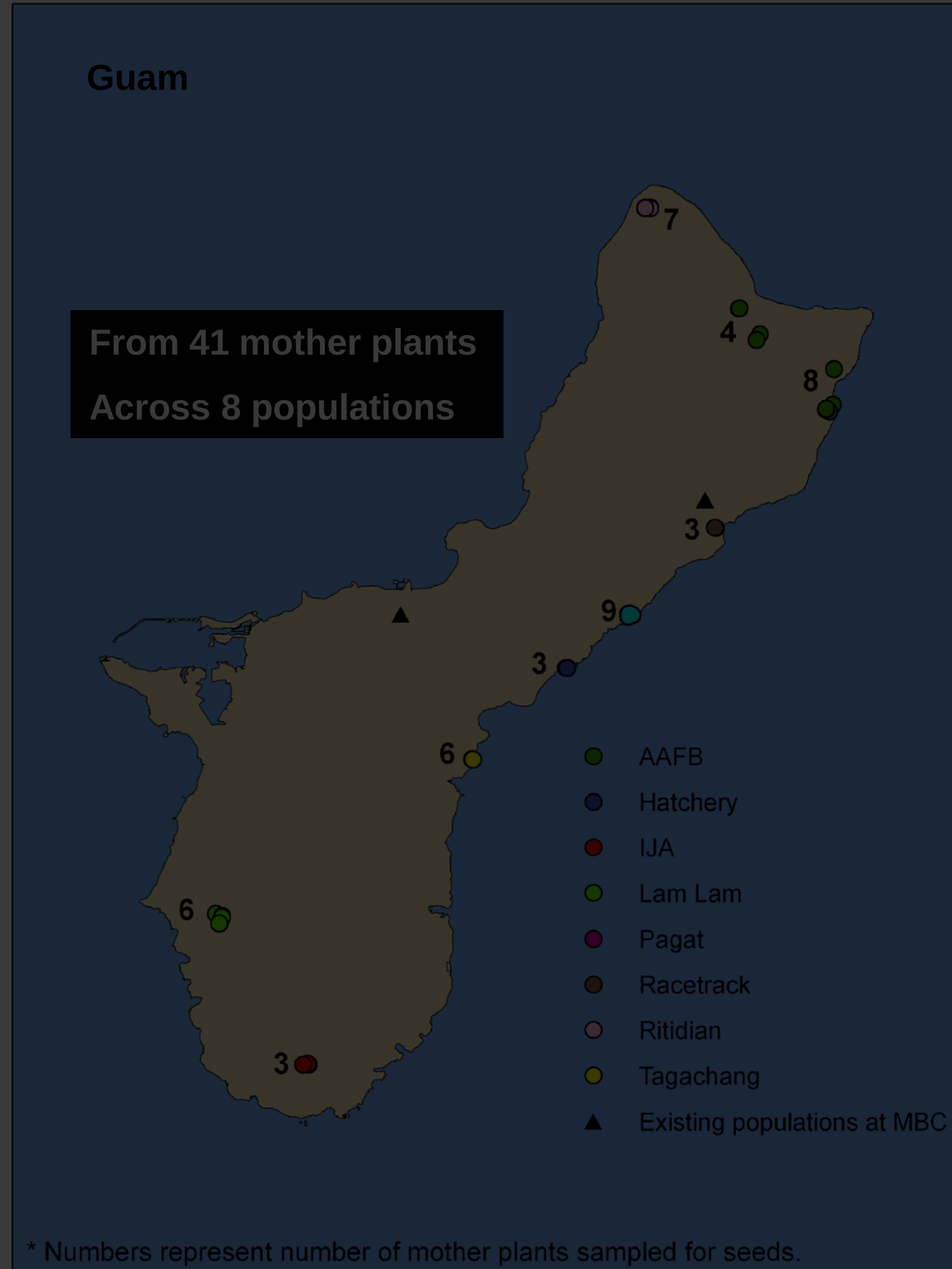
* Numbers represent number of mother plants sampled for seeds.

In Practice: *Cycas micronesica*, 2007

249 plants at MBC

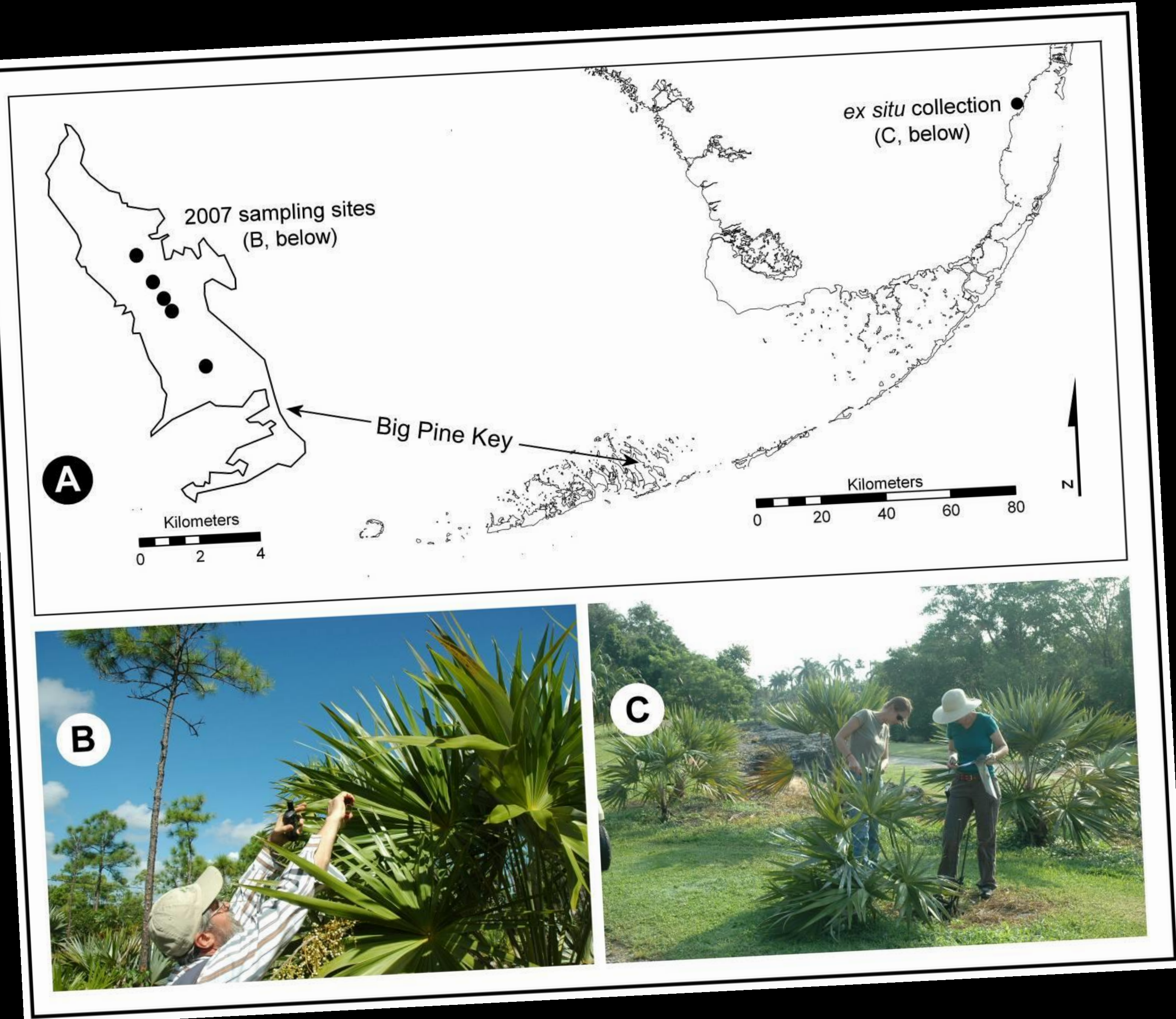
IUCN EN





First study with palms – *Leucothrinax morrisii*

Namoff et al., 2010



Compared garden collection to wild population

First study with palms – *Leucothrinax morrisii*

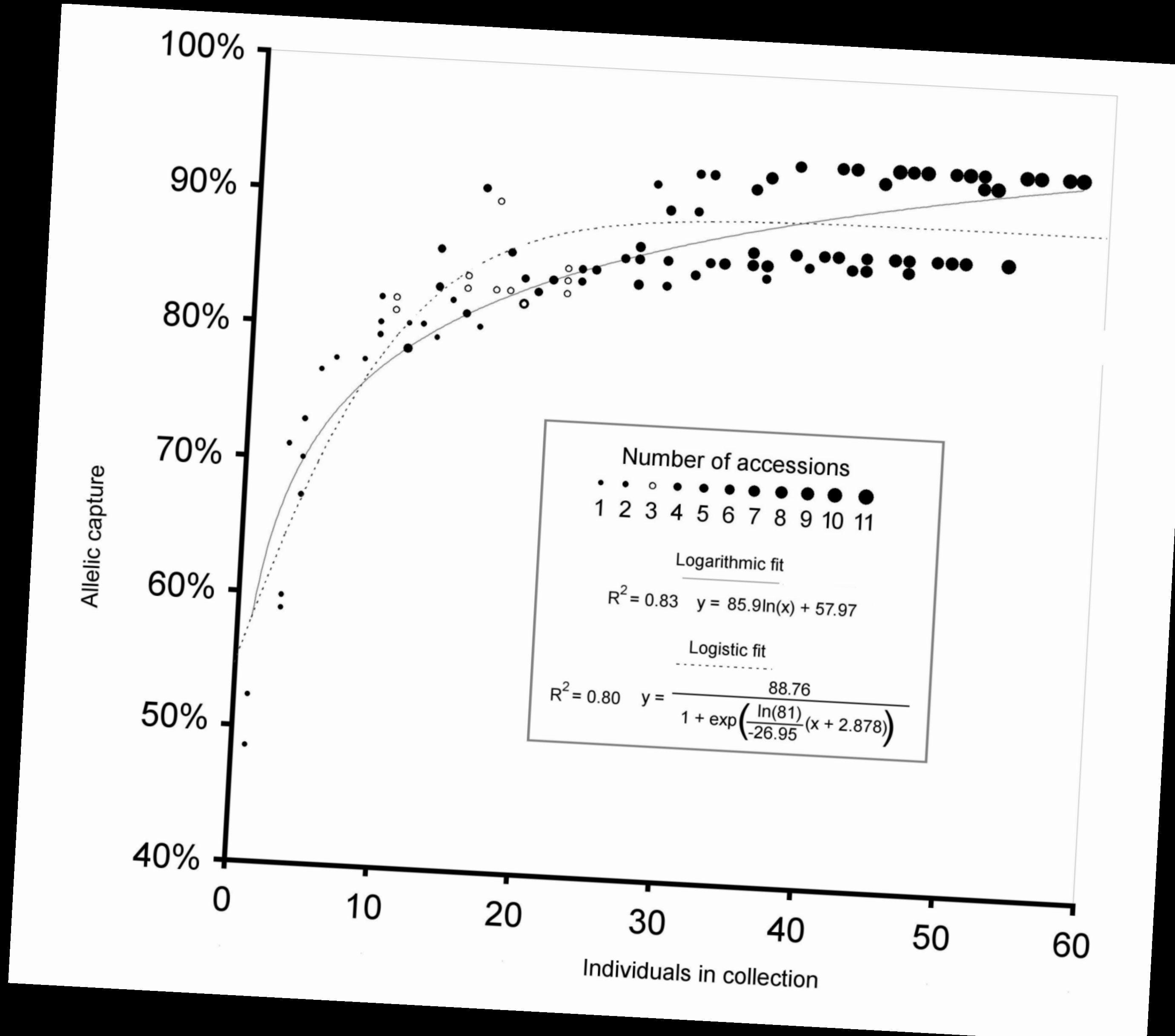
Namoff et al., 2010

Bottom line:

3 accessions, 15 plants

= good genetic diversity

diminishing returns



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Benefit:

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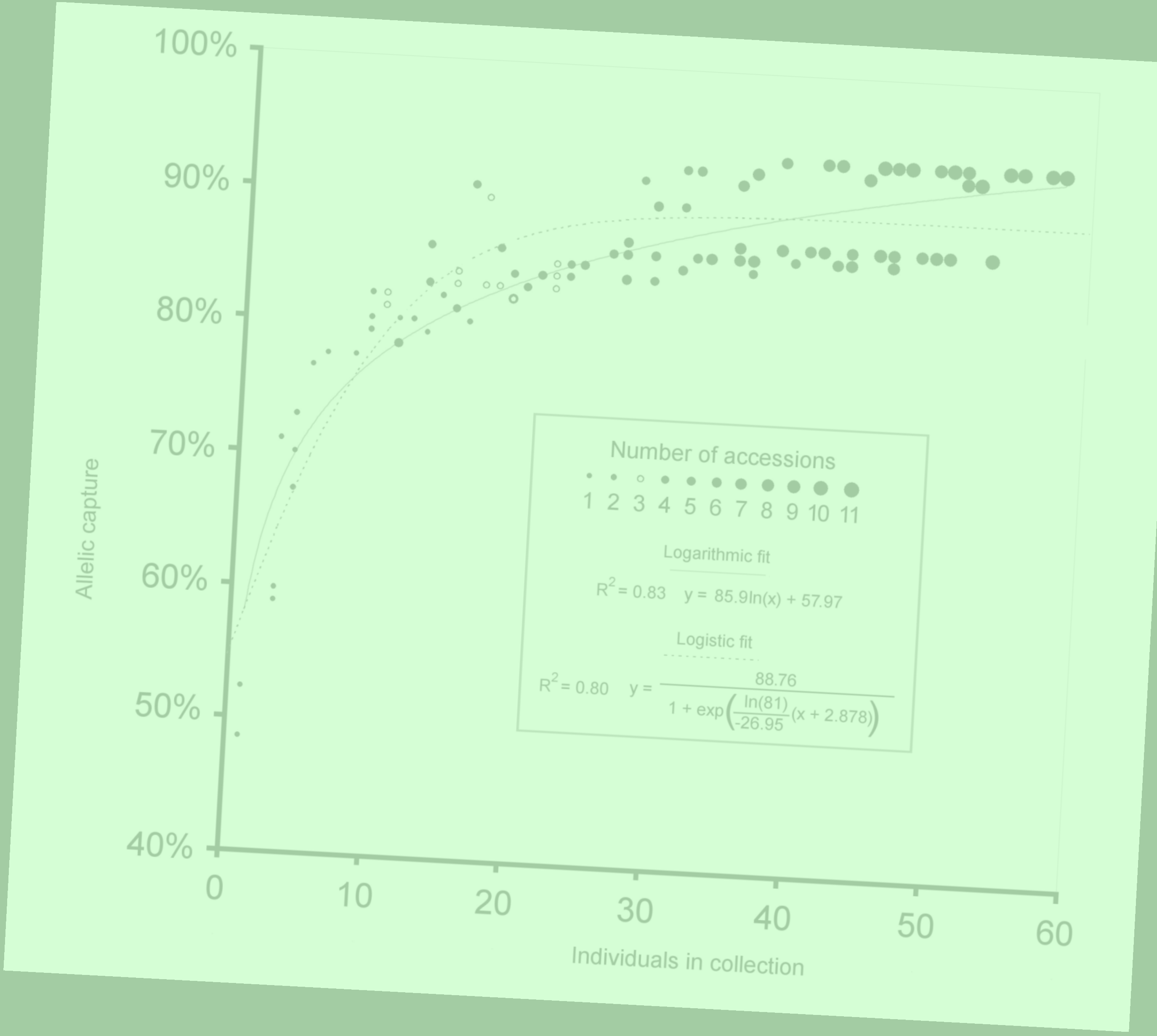

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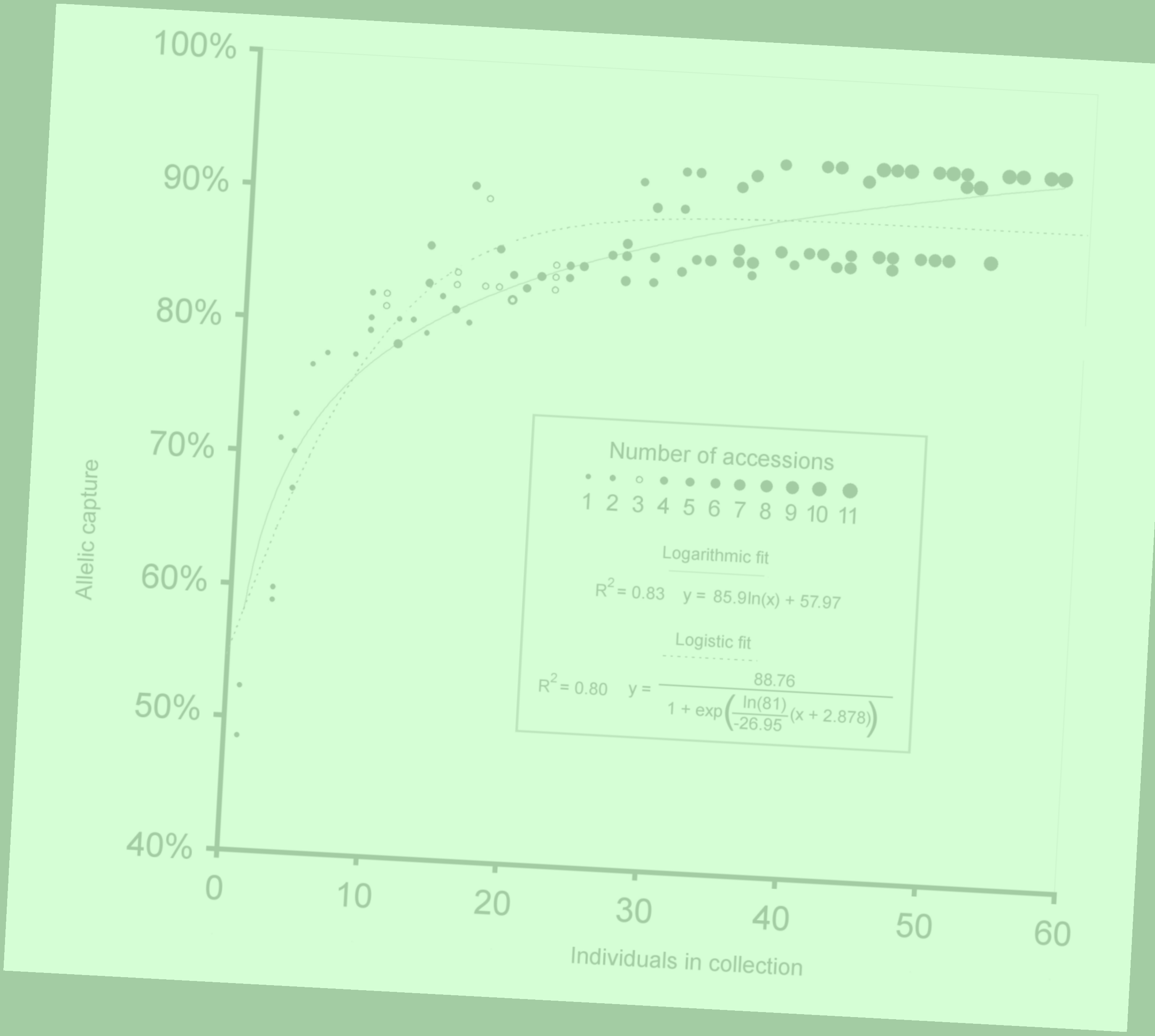
Problem:

potentially limited application



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Benefit:

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Problem:

potentially
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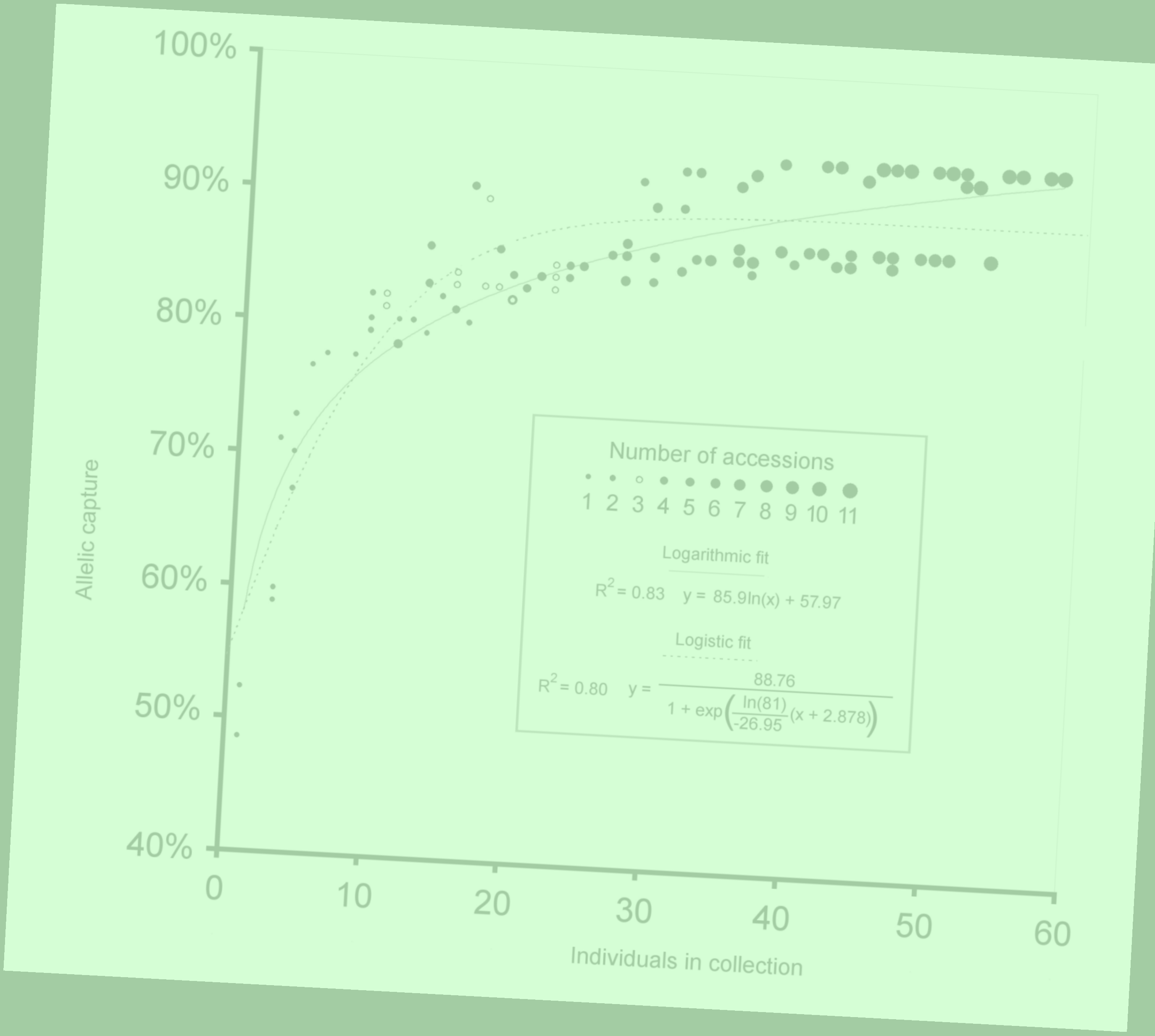
Solution:

more info



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Projects:

Mission-Based Collections Planning
Mission-Based Collections Stewardship

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Mission-Based Collections Planning
Mission-Based Collections Stewardship

Objective:

model for ex situ cycad genetics

Basic comparison

Same collections protocol + Different species

Zamia decumbens

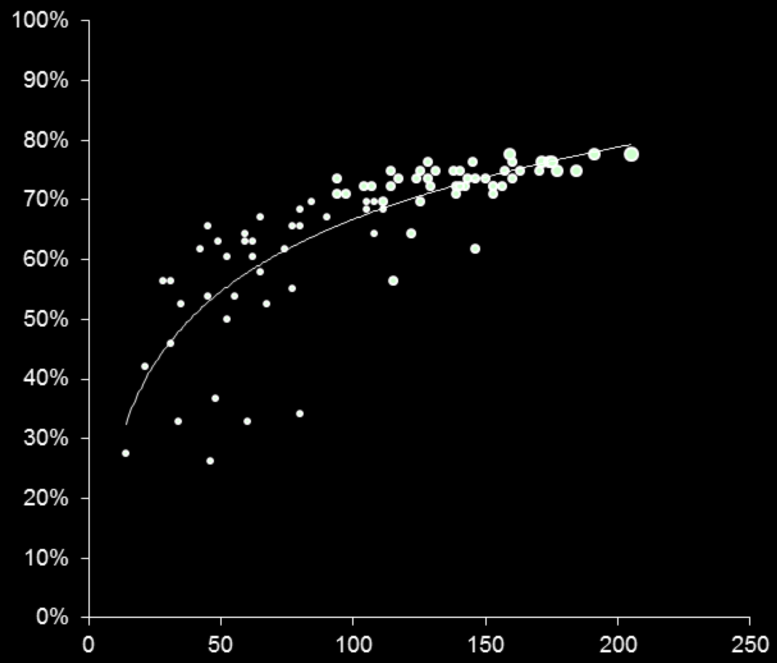
Zamia lucayana

Griffith et al., 2015, 2017

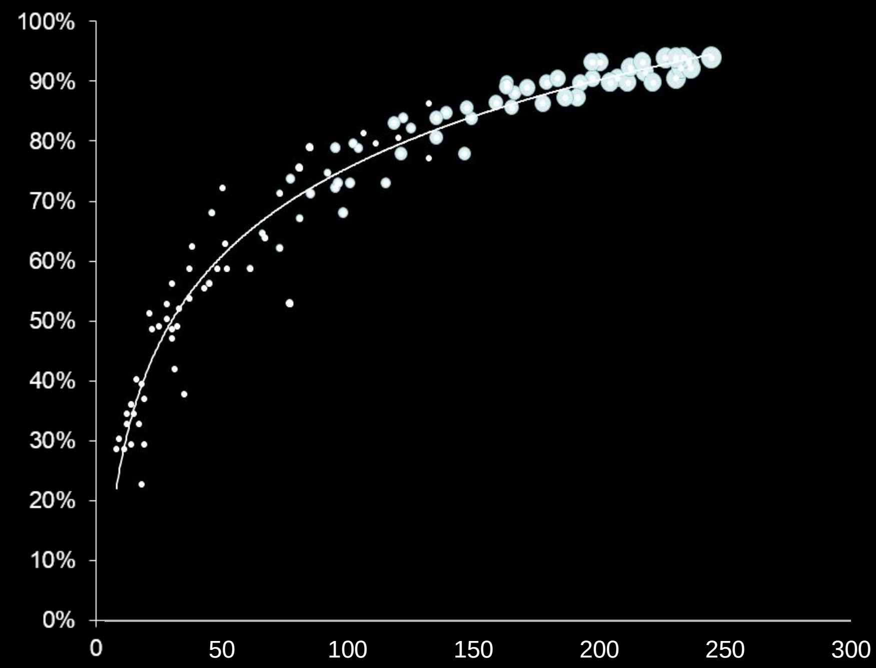
Basic comparison

Same collections protocol + Different species
= different rates of genetic capture

Zamia decumbens



Zamia lucayana



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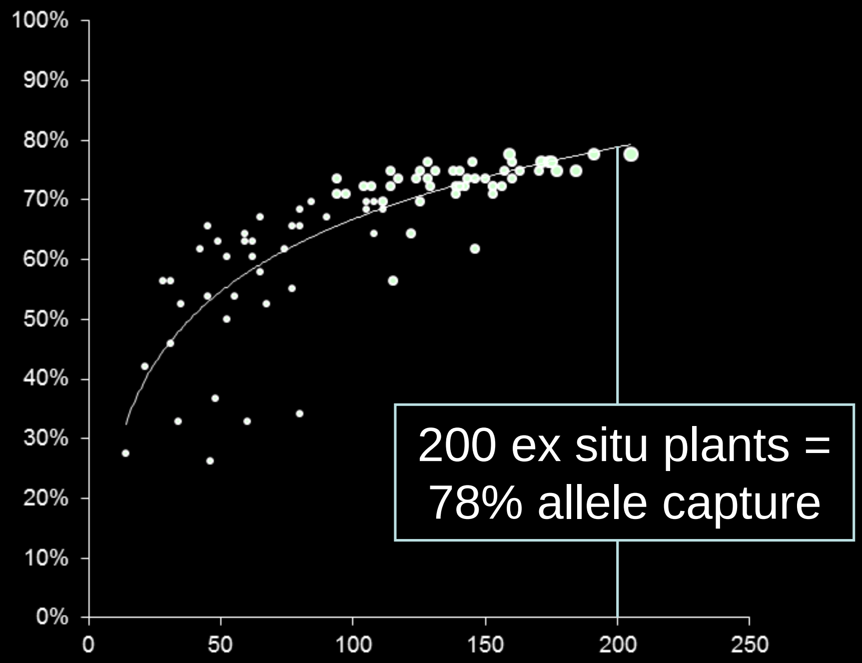

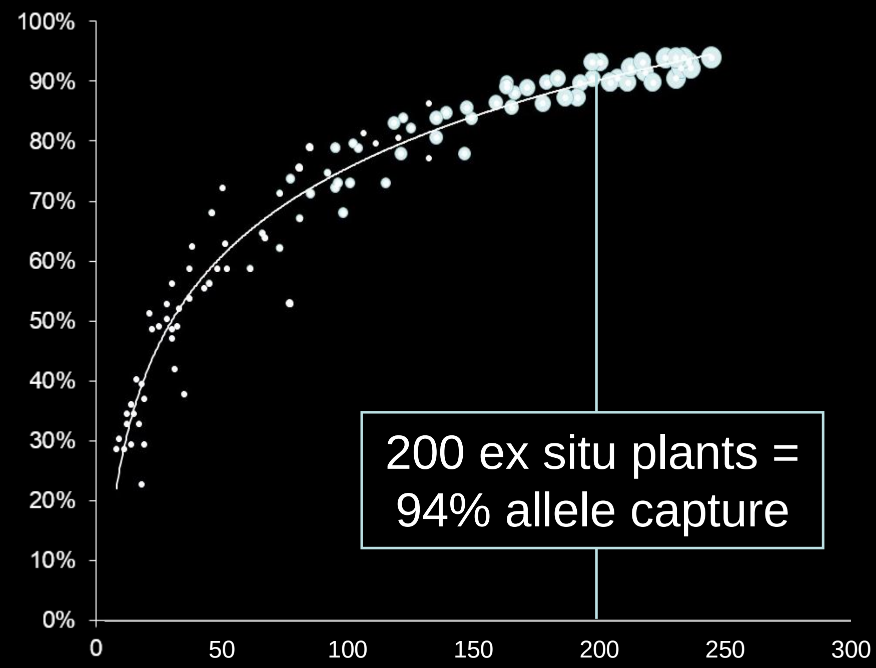

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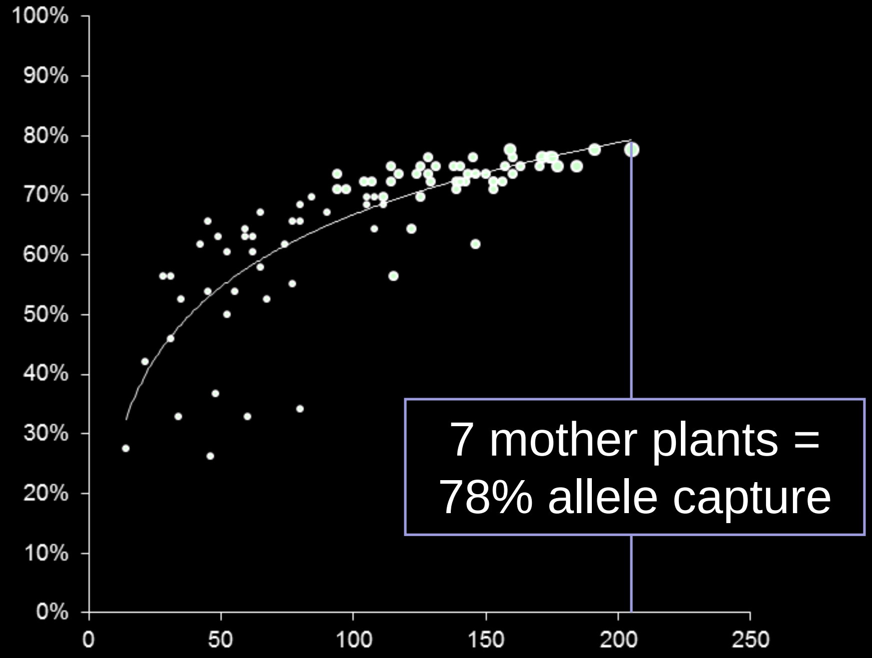
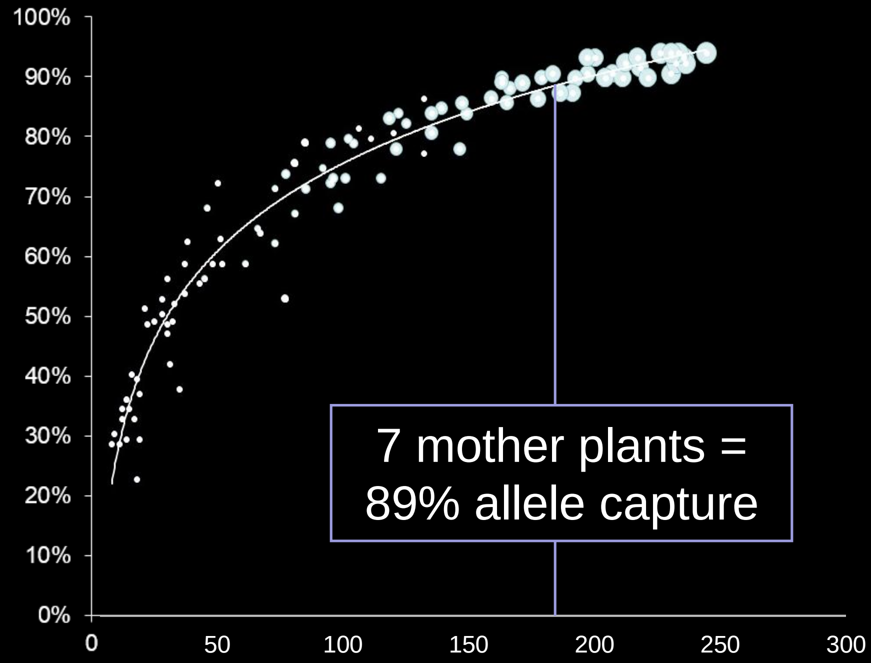


Zamia lucayana



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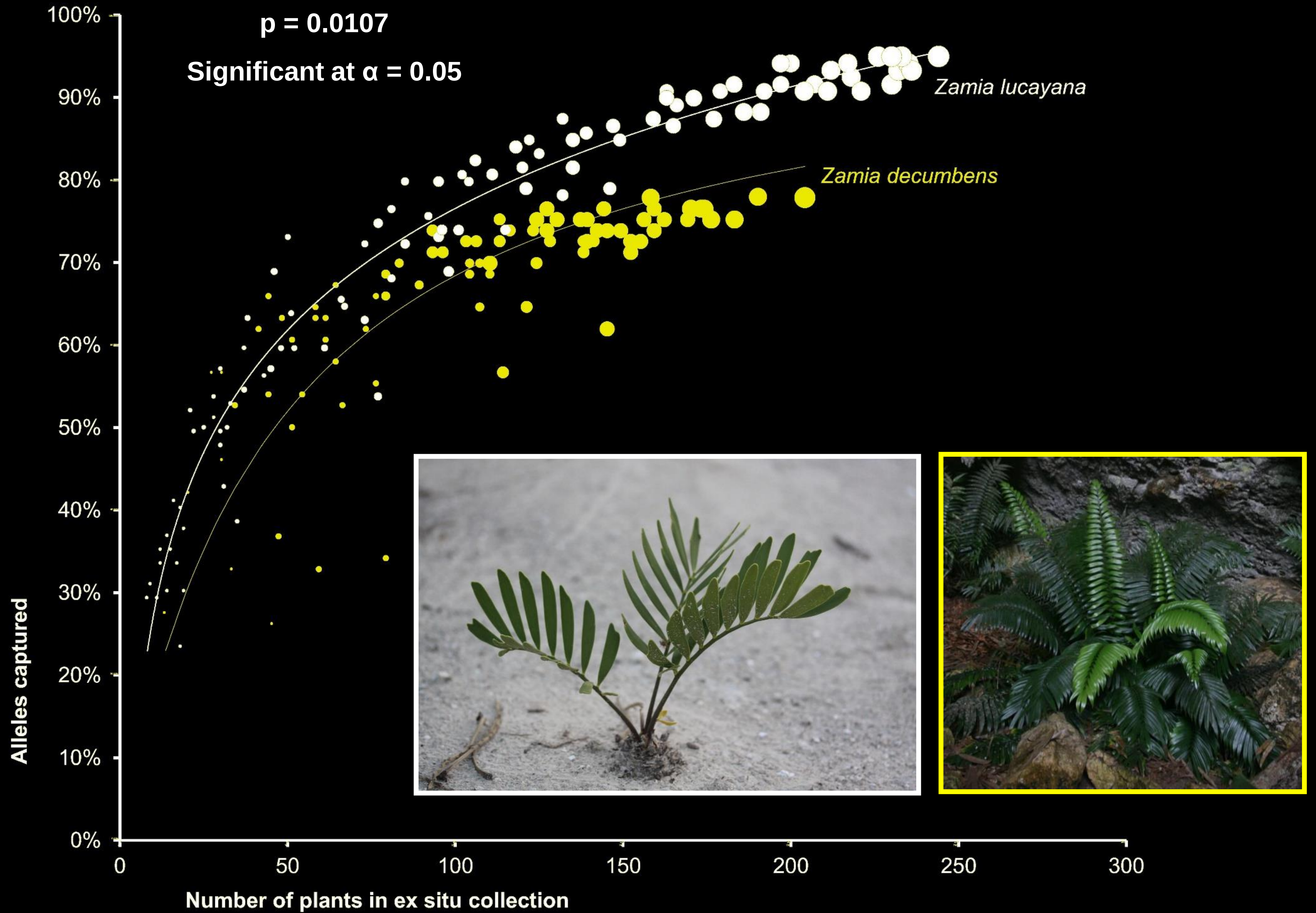


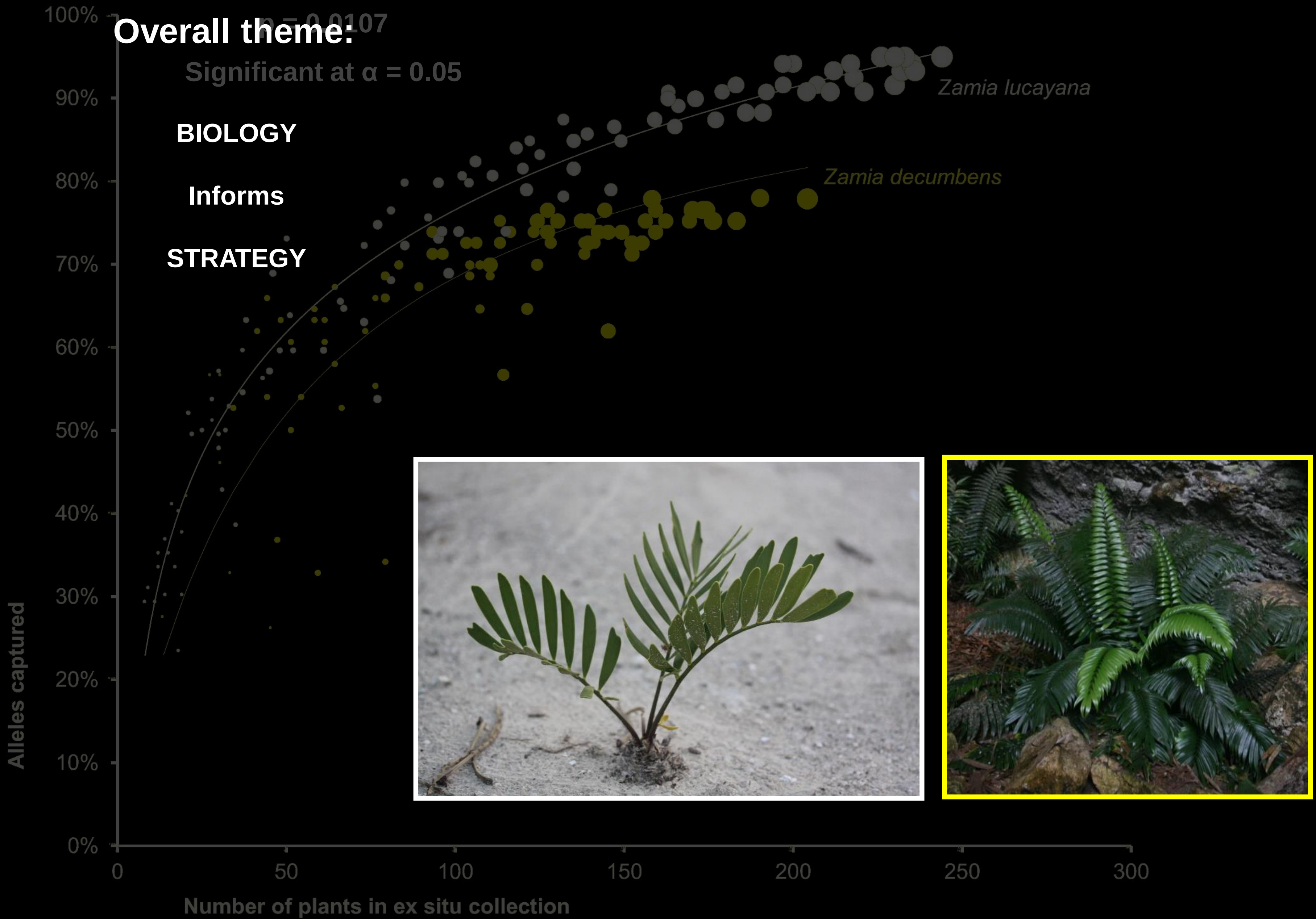
p = 0.0107
Significant at α = 0.05
Zamia lucayana
Zamia decumbens
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Alleles captured
0
50
100
150
200
250
300
Number of plants in ex situ collection

Overall theme:

BIOLOGY

Informs

STRATEGY



Overall theme:

BIOLOGY

Informs

STRATEGY

fit
your method
to
the plant


i. improving garden conservation.
ii. What do we need?
iii. Where are we now?
iv. A path forward.


i. improving garden conservation.
Refining protocols
ii. What do we need?
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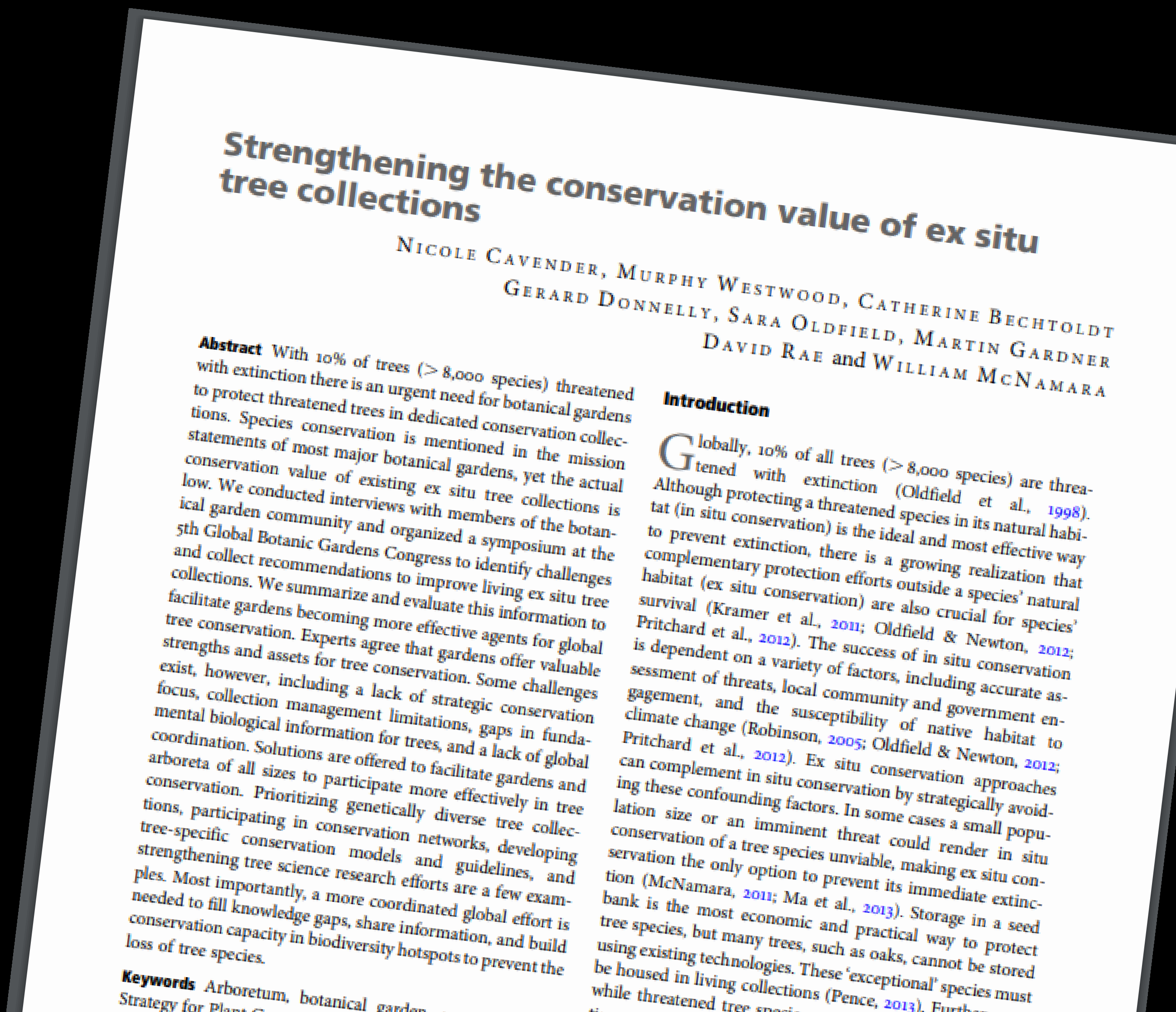
Plants are *diverse*
Block Botanical Gardens


Plants are *diverse*
Not only palms and cycads
Morton Arboretum


Some species are extinct in the wild
Arnold Arboretum



Strengthening the conservation value of ex situ tree collections

NICOLE CAVENDER, MURPHY WESTWOOD, CATHERINE BECHTOLDT
GERARD DONNELLY, SARA OLDFIELD, MARTIN GARDNER
DAVID RAE and WILLIAM MCNAMARA

Abstract With 10% of trees (> 8,000 species) threatened with extinction there is an urgent need for botanical gardens to protect threatened trees in dedicated conservation collections. Species conservation is mentioned in the mission statements of most major botanical gardens, yet the actual conservation value of existing ex situ tree collections is low. We conducted interviews with members of the botanical garden community and organized a symposium at the 5th Global Botanic Gardens Congress to identify challenges and collect recommendations to improve living ex situ tree collections. We summarize and evaluate this information to facilitate gardens becoming more effective agents for global tree conservation. Experts agree that gardens offer valuable strengths and assets for tree conservation. Some challenges exist, however, including a lack of strategic conservation focus, collection management limitations, gaps in fundamental biological information for trees, and a lack of global coordination. Solutions are offered to facilitate gardens and arboreta of all sizes to participate more effectively in tree conservation. Prioritizing genetically diverse tree collections, participating in conservation networks, developing tree-specific conservation models and guidelines, and strengthening tree science research efforts are a few examples. Most importantly, a more coordinated global effort is needed to fill knowledge gaps, share information, and build conservation capacity in biodiversity hotspots to prevent the loss of tree species.

Keywords Arboretum, botanical garden, ...
Strategy for Plant C...

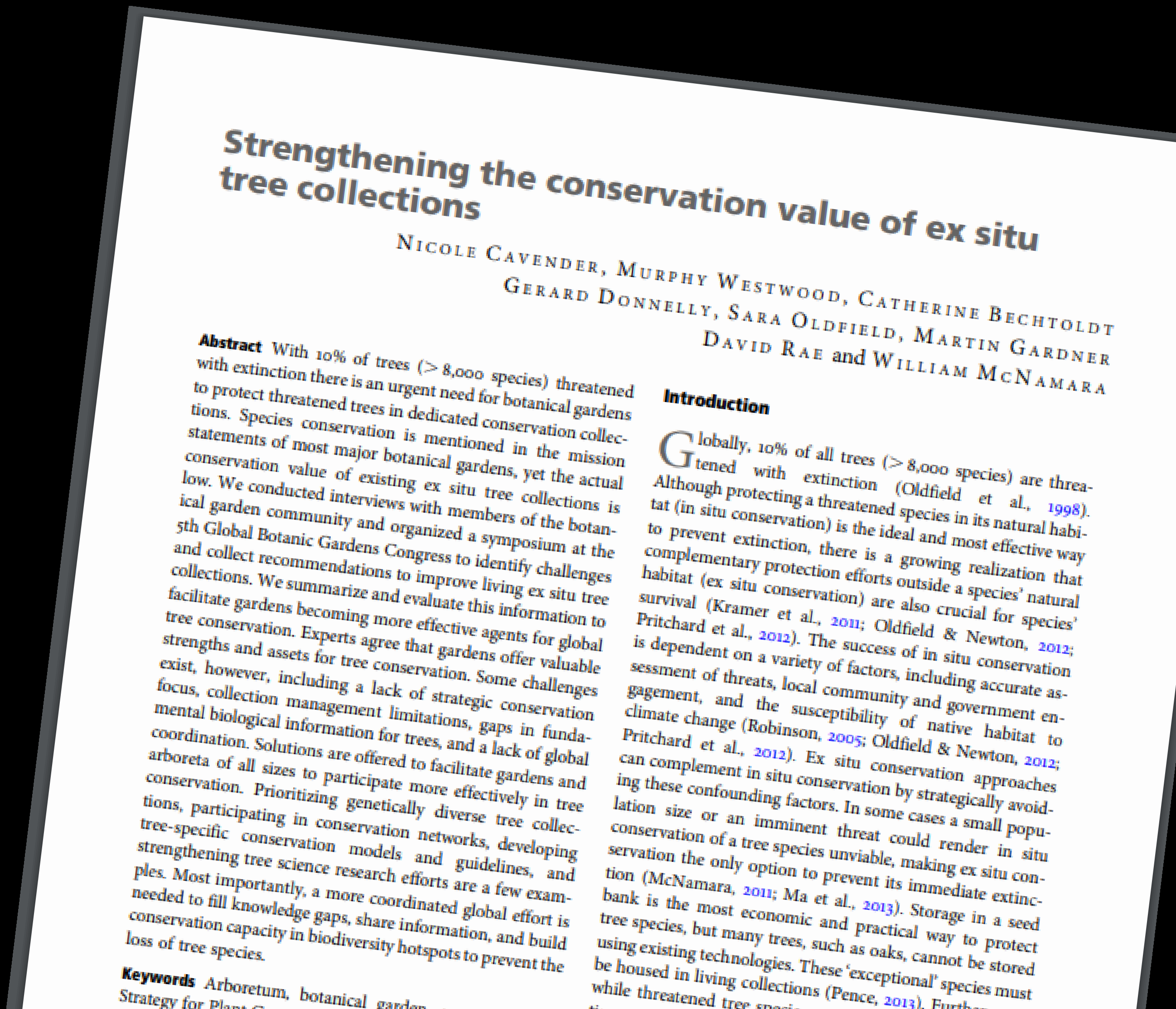
Introduction

Globally, 10% of all trees (> 8,000 species) are threatened with extinction (Oldfield et al., 1998). Although protecting a threatened species in its natural habitat (in situ conservation) is the ideal and most effective way to prevent extinction, there is a growing realization that complementary protection efforts outside a species' natural habitat (ex situ conservation) are also crucial for species' survival (Kramer et al., 2011; Oldfield & Newton, 2012; Pritchard et al., 2012). The success of in situ conservation is dependent on a variety of factors, including accurate assessment of threats, local community and government engagement, and the susceptibility of native habitat to climate change (Robinson, 2005; Oldfield & Newton, 2012; Pritchard et al., 2012). Ex situ conservation approaches can complement in situ conservation by strategically avoiding these confounding factors. In some cases a small population size or an imminent threat could render in situ conservation of a tree species unviable, making ex situ conservation the only option to prevent its immediate extinction (McNamara, 2011; Ma et al., 2013). Storage in a seed bank is the most economic and practical way to protect tree species, but many trees, such as oaks, cannot be stored using existing technologies. These 'exceptional' species must be housed in living collections (Pence, 2013). Further... while threatened tree speci...

Cavender et al. 2015

(INTER)NATIONAL NEED

"... prioritizing genetically diverse tree collections"



Strengthening the conservation value of ex situ tree collections

NICOLE CAVENDER, MURPHY WESTWOOD, CATHERINE BECHTOLDT
GERARD DONNELLY, SARA OLDFIELD, MARTIN GARDNER
DAVID RAE and WILLIAM MCNAMARA

Abstract With 10% of trees (> 8,000 species) threatened with extinction there is an urgent need for botanical gardens to protect threatened trees in dedicated conservation collections. Species conservation is mentioned in the mission statements of most major botanical gardens, yet the actual conservation value of existing ex situ tree collections is low. We conducted interviews with members of the botanical garden community and organized a symposium at the 5th Global Botanic Gardens Congress to identify challenges and collect recommendations to improve living ex situ tree collections. We summarize and evaluate this information to facilitate gardens becoming more effective agents for global tree conservation. Experts agree that gardens offer valuable strengths and assets for tree conservation. Some challenges exist, however, including a lack of strategic conservation focus, collection management limitations, gaps in fundamental biological information for trees, and a lack of global coordination. Solutions are offered to facilitate gardens and arboreta of all sizes to participate more effectively in tree conservation. Prioritizing genetically diverse tree collections, participating in conservation networks, developing tree-specific conservation models and guidelines, and strengthening tree science research efforts are a few examples. Most importantly, a more coordinated global effort is needed to fill knowledge gaps, share information, and build conservation capacity in biodiversity hotspots to prevent the loss of tree species.

Keywords Arboretum, botanical garden...
Strategy for Plant C...

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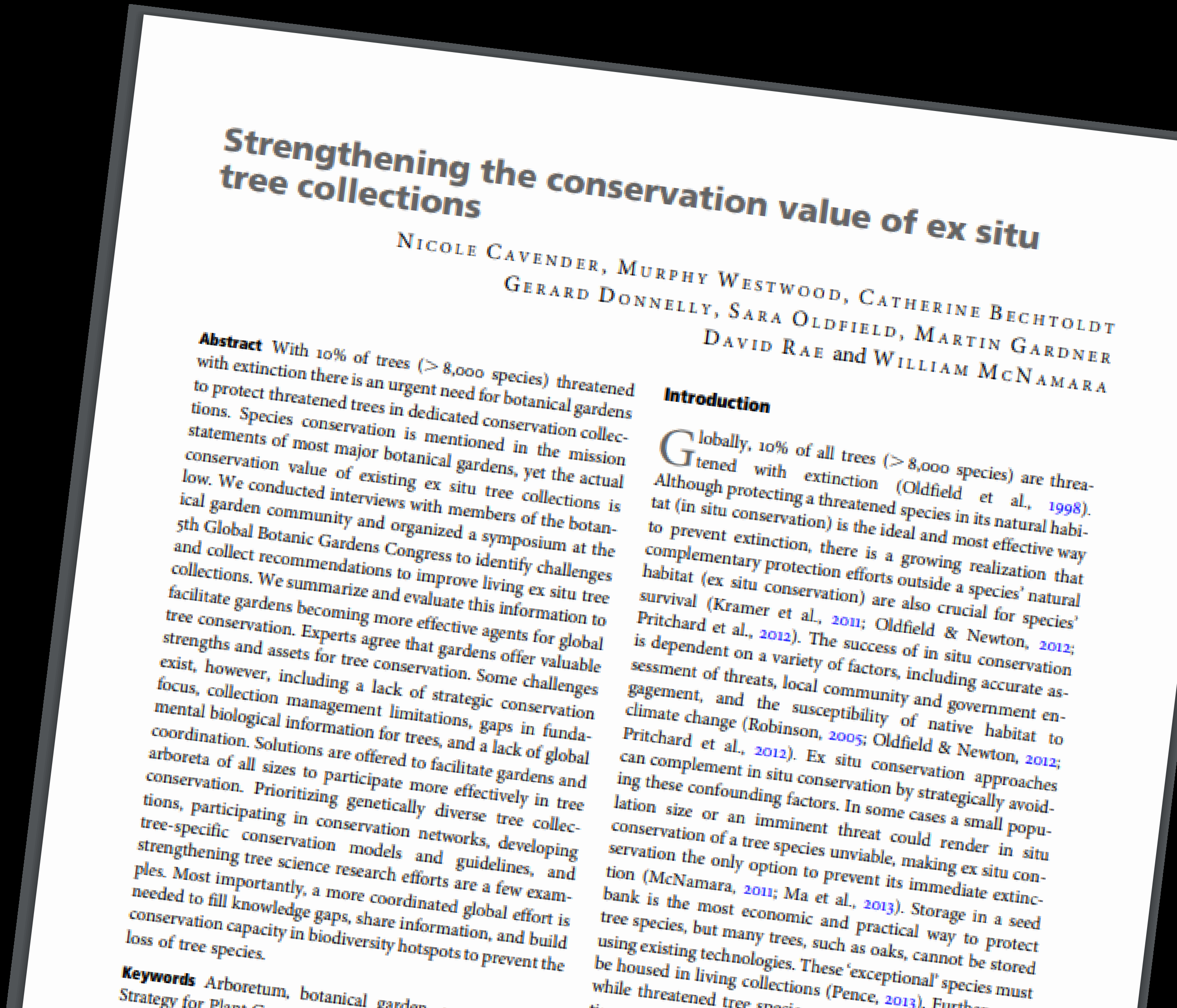
Cavender et al. 2015

(INTER)NATIONAL NEED

"... prioritizing genetically diverse tree collections"

"... developing tree-specific models and guidelines"



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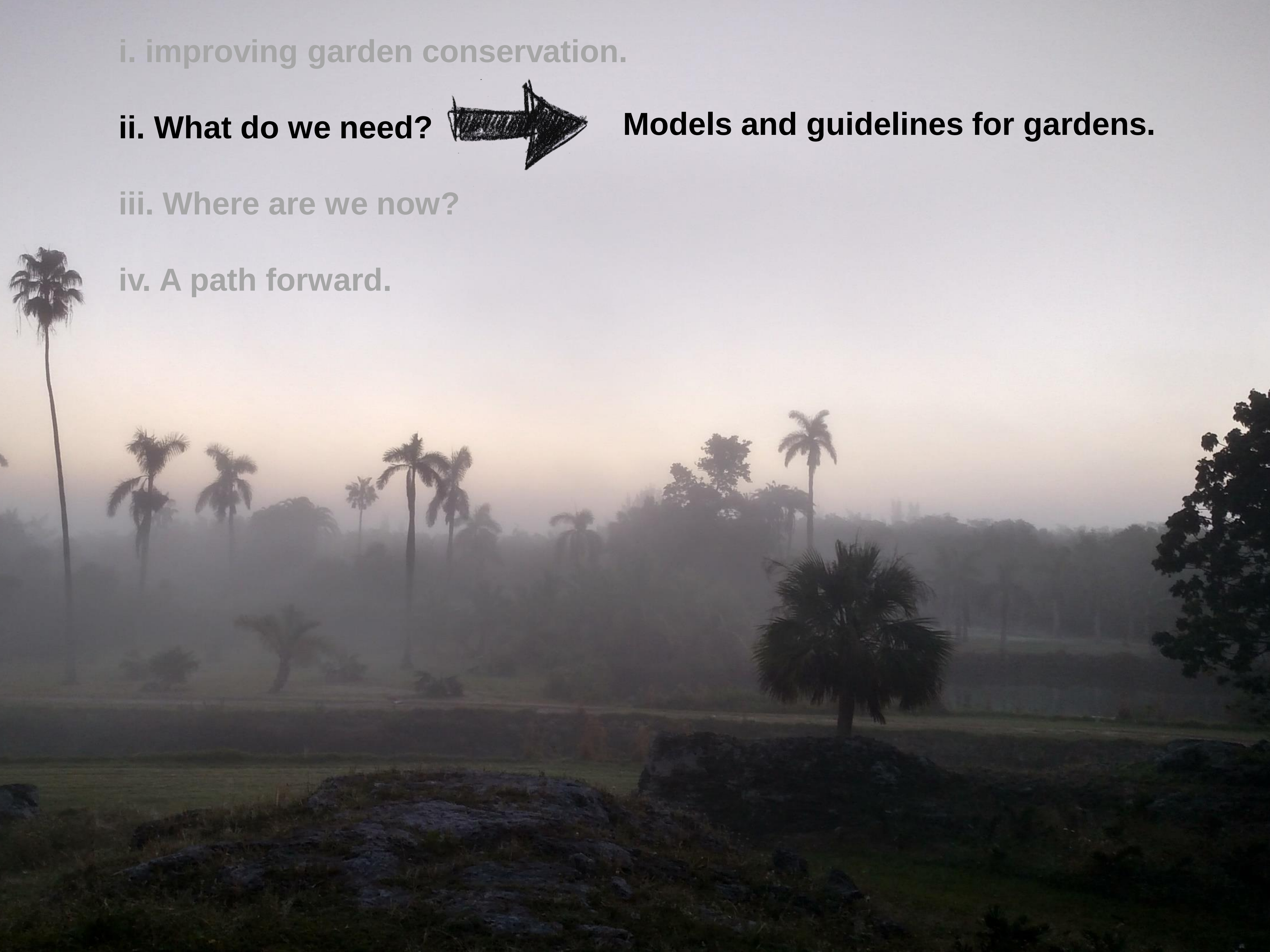
Cavender et al. 2015


i. improving garden conservation.
ii. What do we need?
iii. Where are we now?
iv. A path forward.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Current project, 2016-2019:
Safeguarding our Plant Collections

Institute of Museum and Library Services

National Leadership Grant

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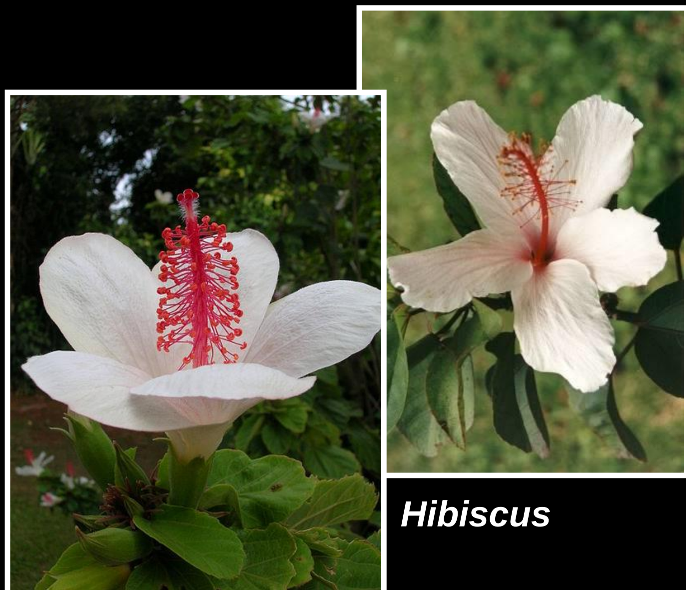
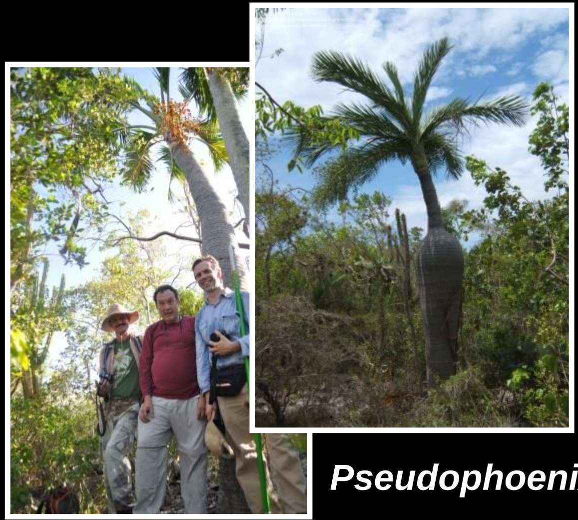


Hibiscus

Magnolia

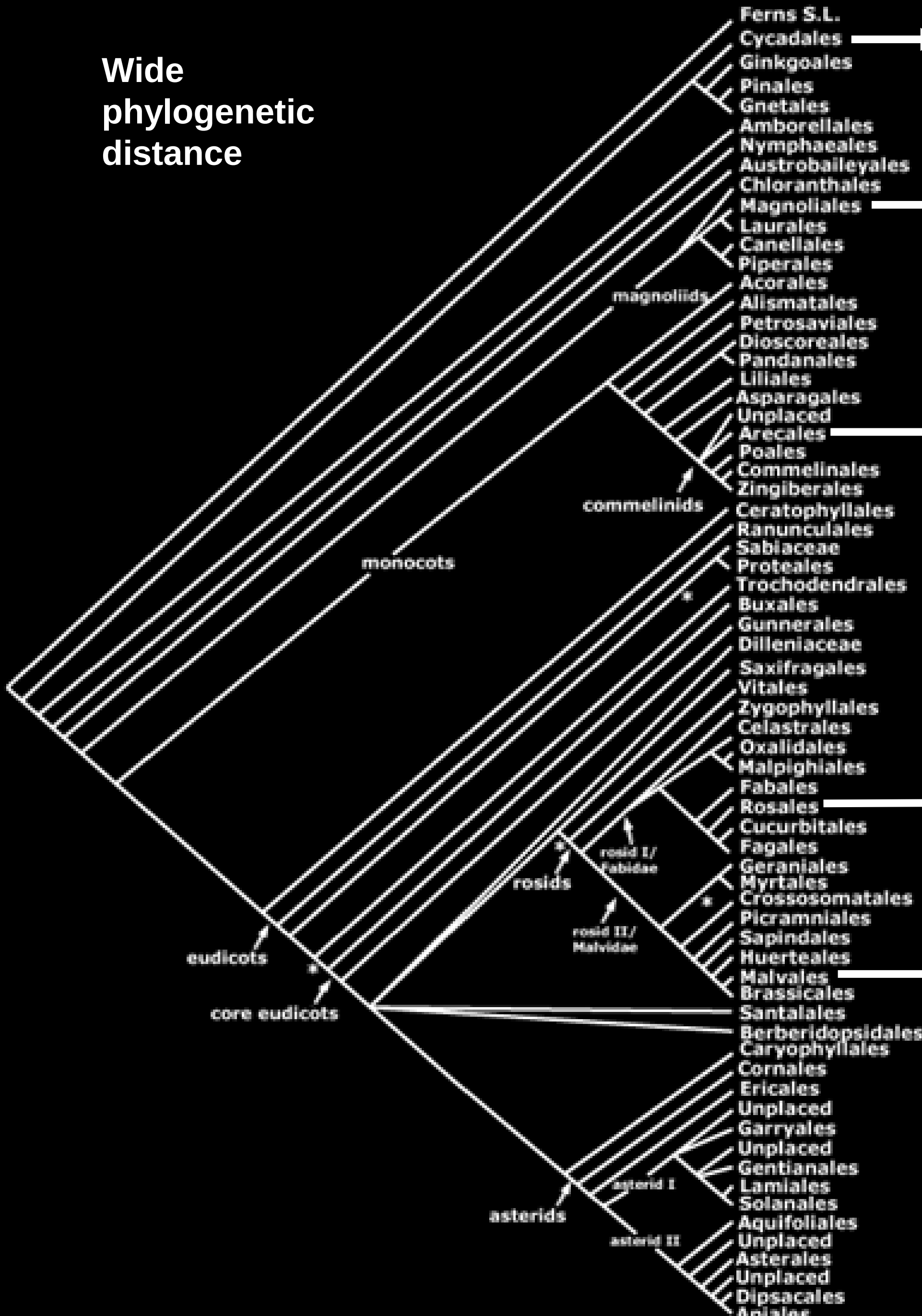


Pseudophoenix

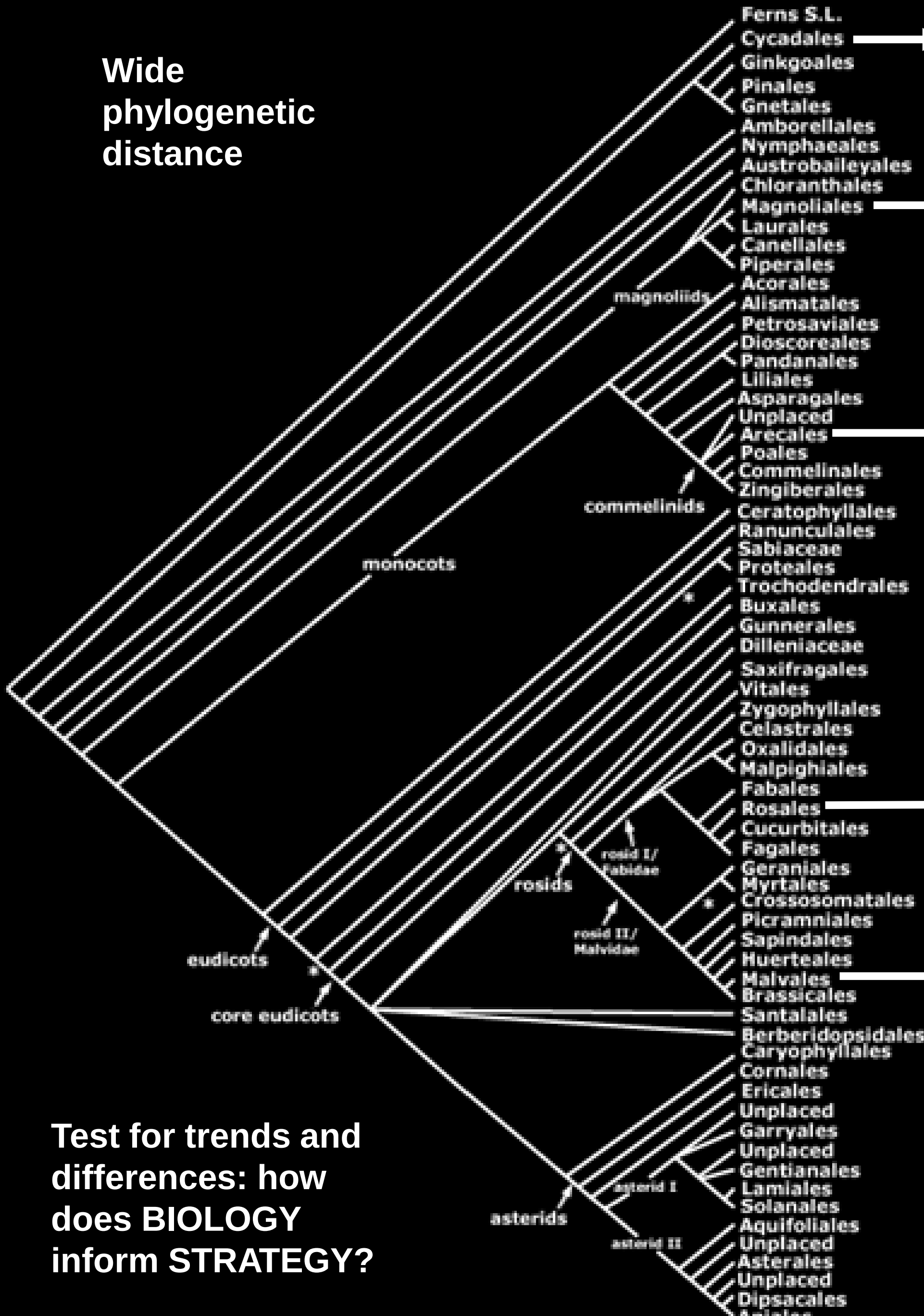
Quercus

Zamia

Wide phylogenetic distance



Wide phylogenetic distance

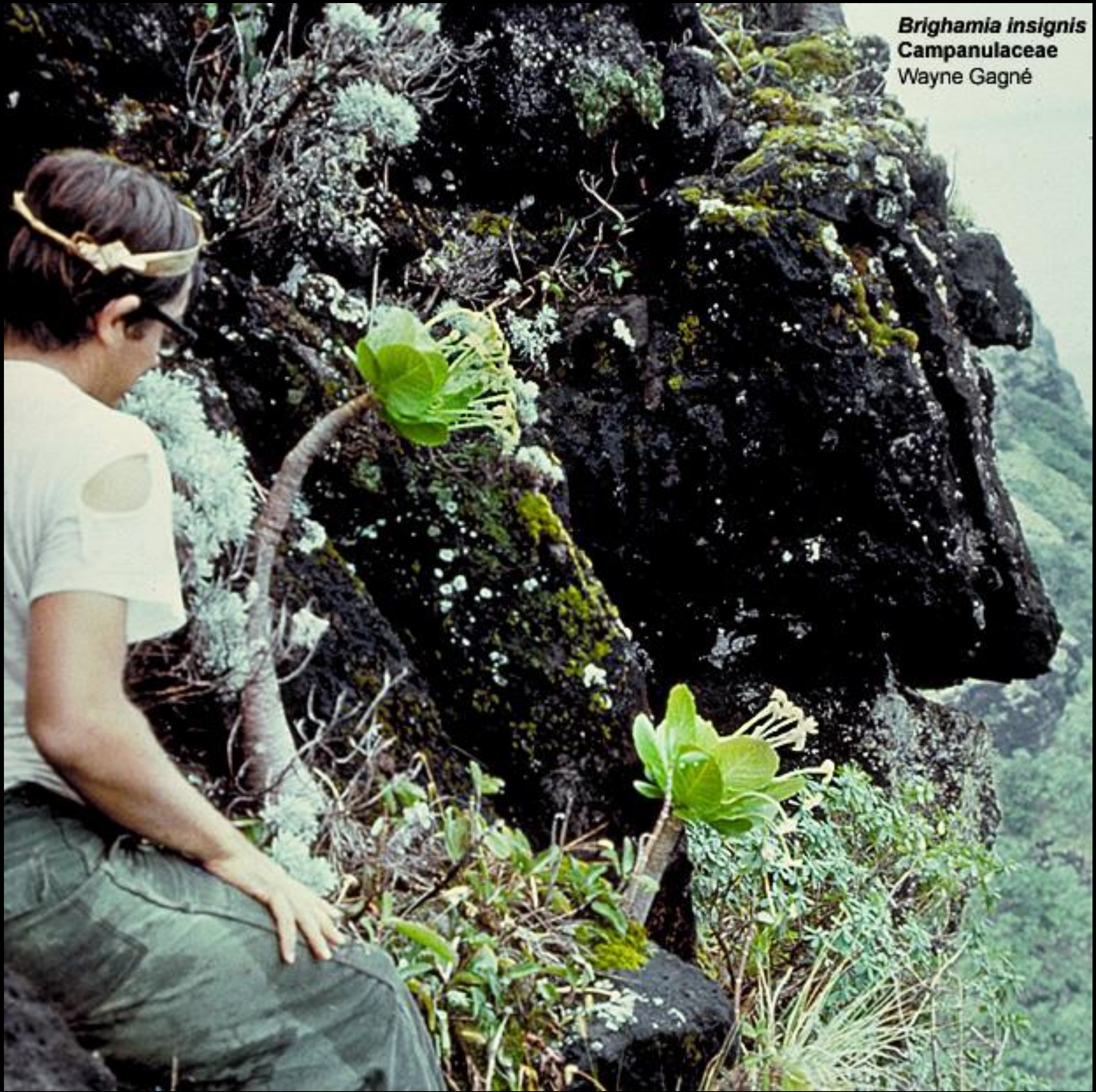


Test for trends and differences: how does BIOLOGY inform STRATEGY?


What about extirpated species?
National Tropical Botanical Garden

Brighamia insignis

Functionally extinct in the wild



Brighamia insignis

Functionally extinct in the wild

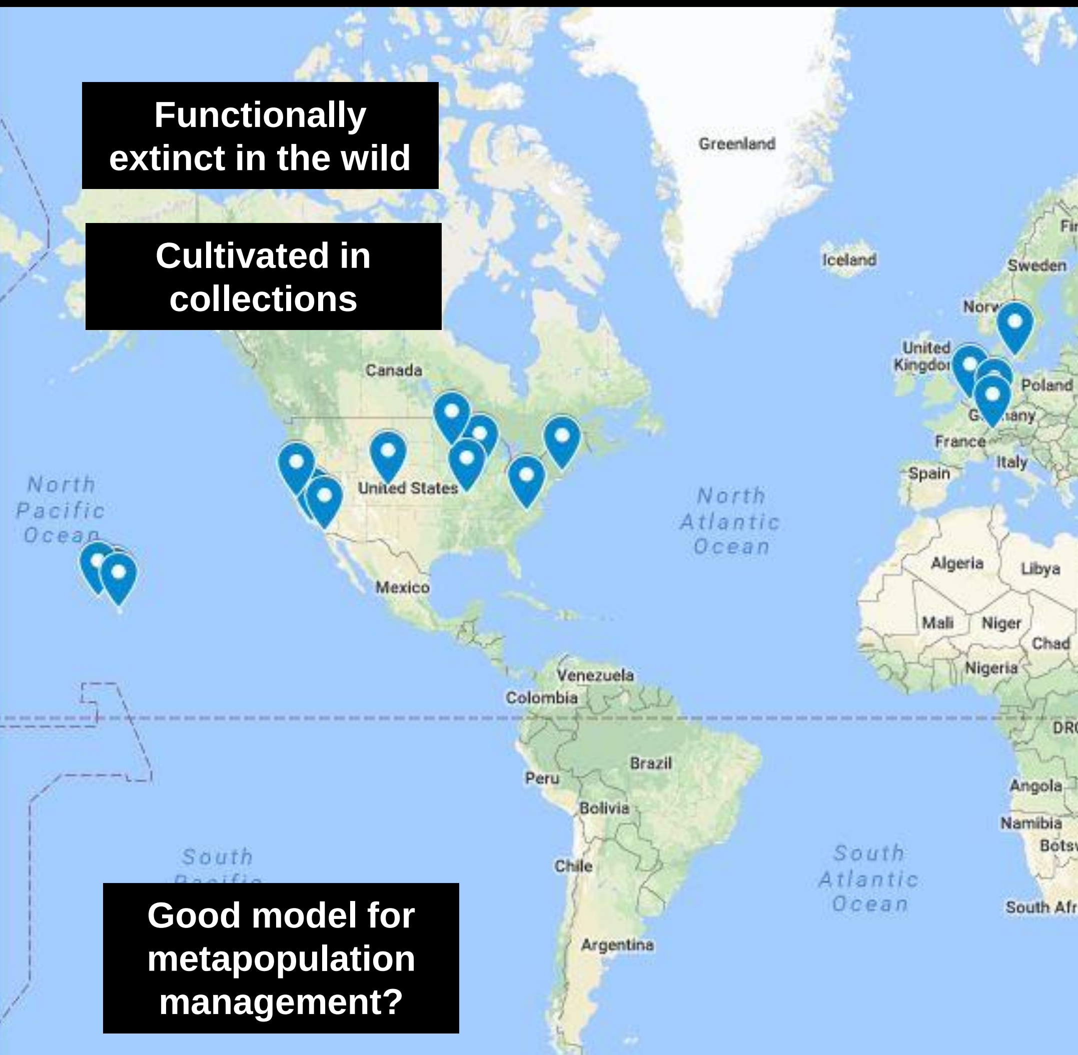
Cultivated in collections

Brighamia insignis

Functionally extinct in the wild

Cultivated in collections

Good model for metapopulation management?



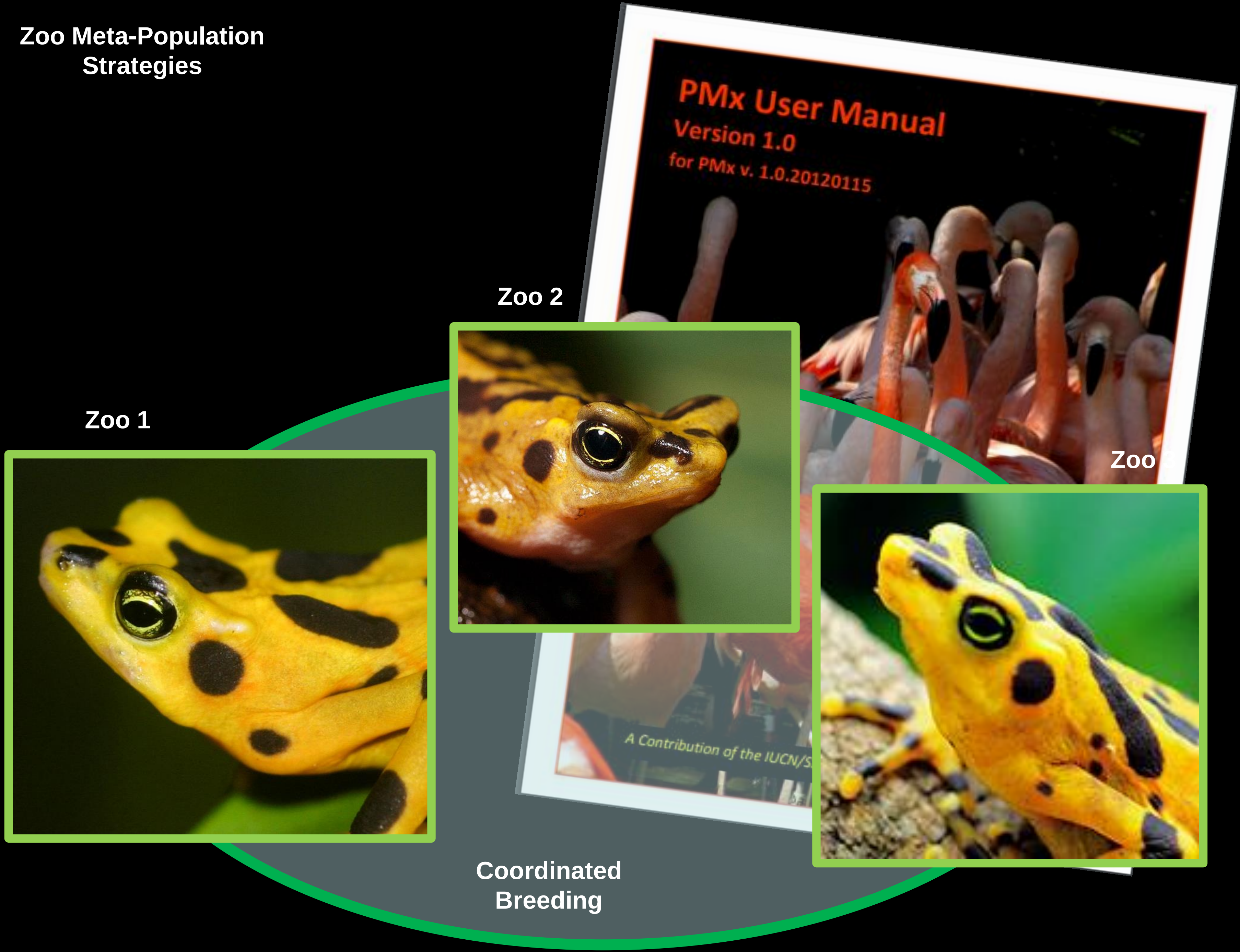
Zoo Meta-Population Strategies

Zoo 2

Zoo 1

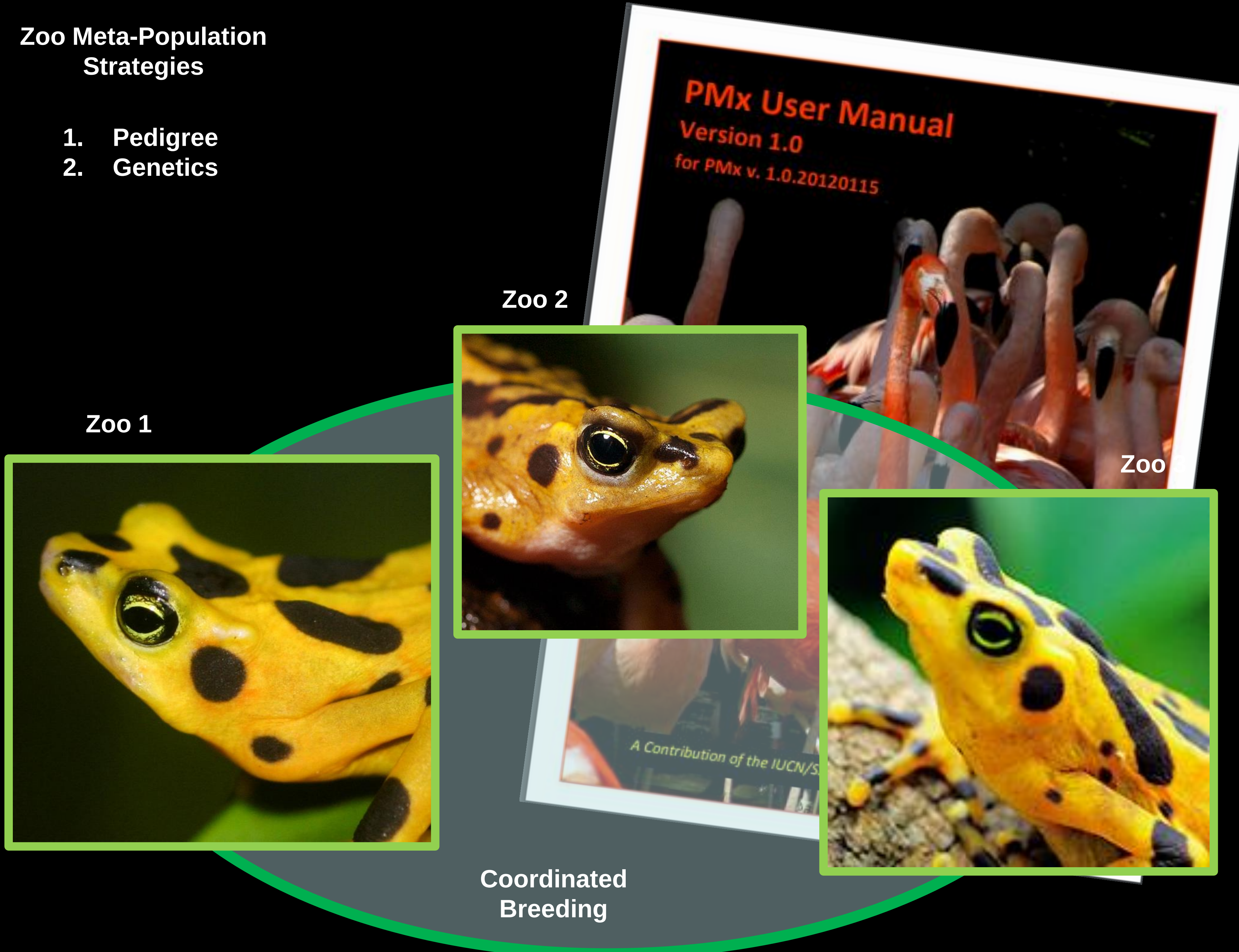
Zoo 3

Zoo Meta-Population Strategies



Zoo Meta-Population Strategies

1. Pedigree
2. Genetics



Zoo Meta-Population Strategies

1. Pedigree
2. Genetics

Adaptable for plants?

Garden
~~Zoo 2~~

Garden
~~Zoo 1~~

Garden
~~Zoo~~

Coordinated Breeding

First project meeting, October 2016, Morton Arboretum

Defined scope and objective of study

Jordan Wood

Fieldwork for
Quercus oglethorpensis,
2016.

Sean Hoban

Fieldwork for *Quercus boyntonii*, 2017.

Seana Walsh

Fieldwork for *Hibiscus waimeae*, 2017.

Patrick Griffith
Fieldwork for
***Pseudophoenix sargentii*, 2017**

Patrick Griffith
Xavier Gratacos
Teodoro Clase
Pedro Toribio

JARDÍN BOTÁNICO NACIONAL
"Dr. Rafael Ma. Moscoso"

MBC

Fieldwork for *Pseudophoenix ekmanii*, 2017

Vanessa Sanchez

Extensive labwork (2016-2018)

Zoo workshop: April 2018

BROOKFIELD ZOO

Chicago Zoological Society

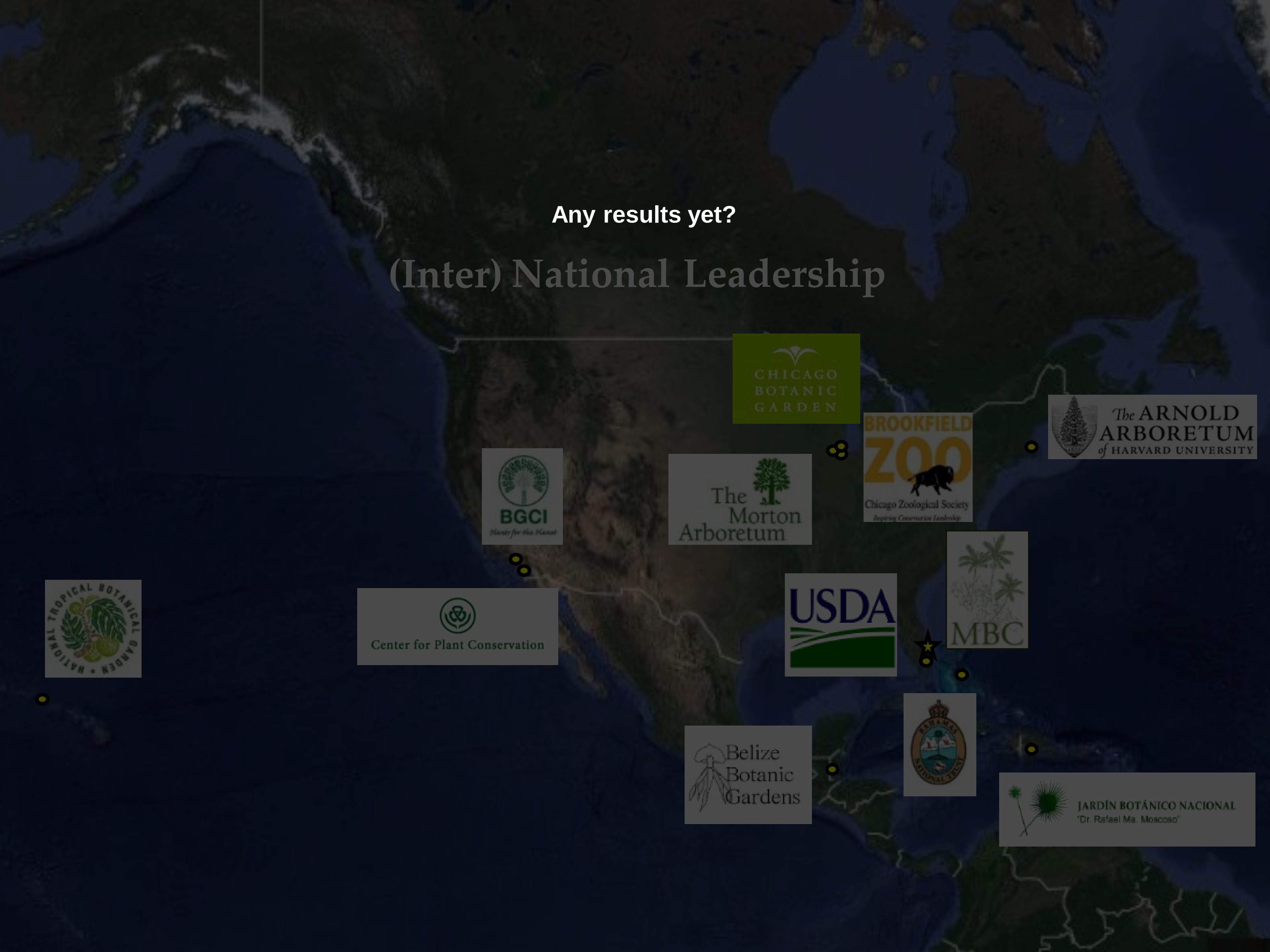
Inspiring Conservation Leadership

National Leadership

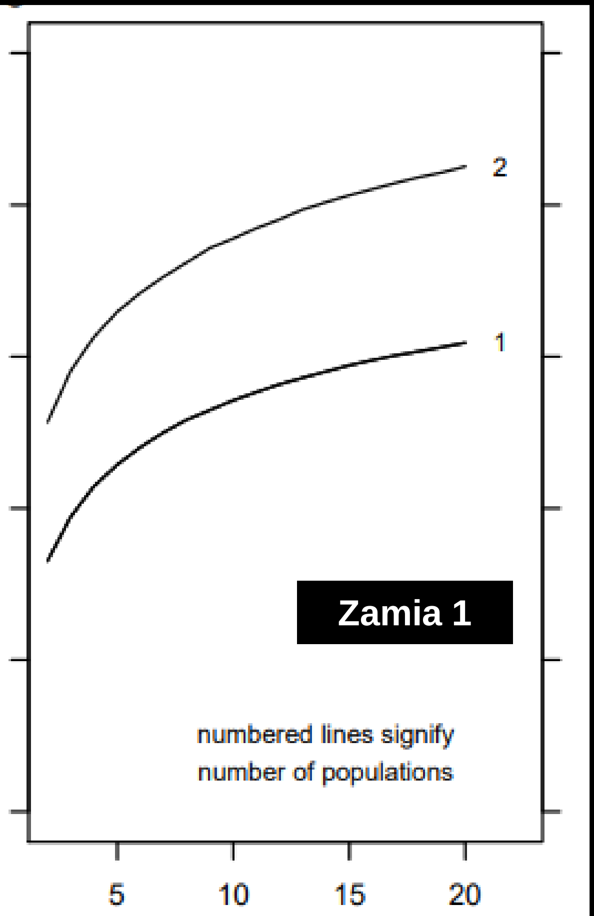
(Inter) National Leadership

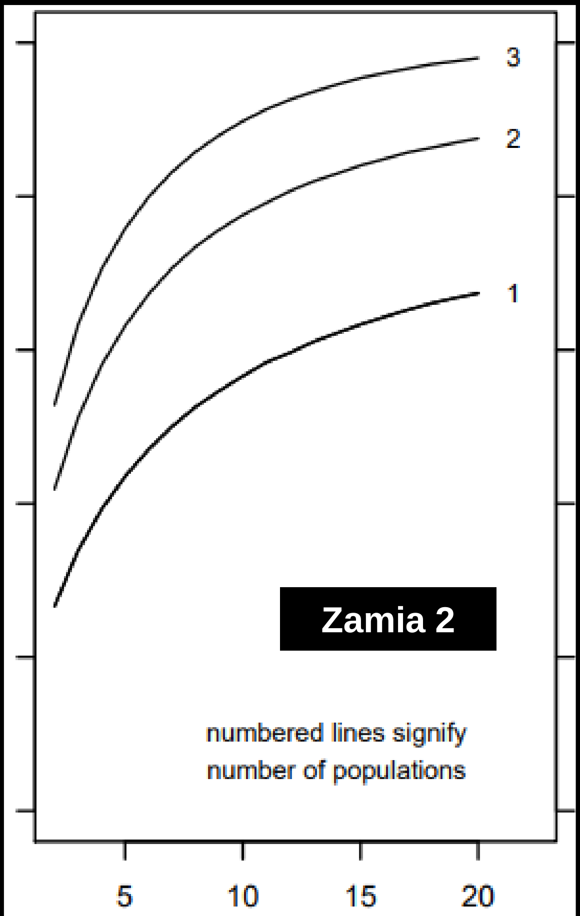
Any results yet?

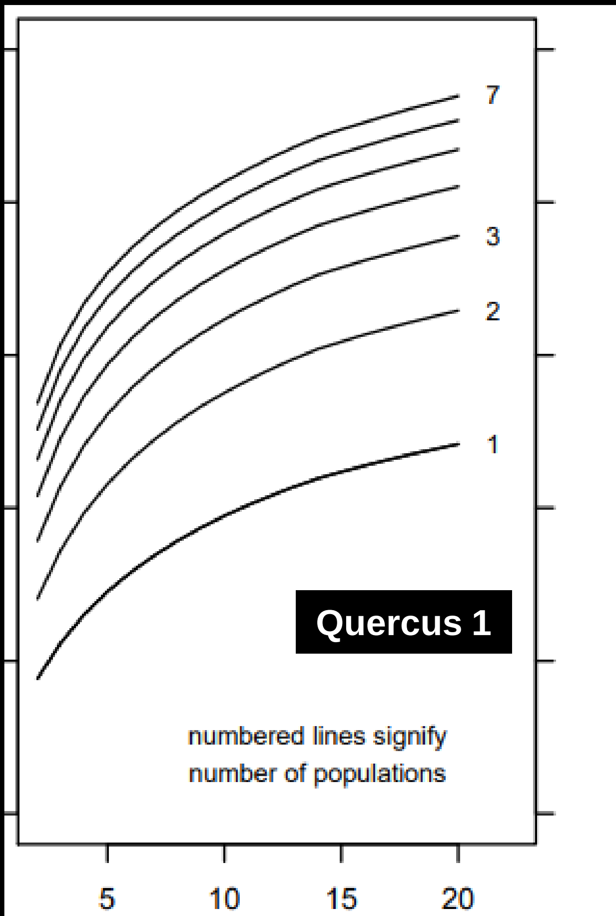
(Inter) National Leadership



Data show similarities and differences!







sample accession	sample accession qualifier	sample accession year	sample date entry for PMx	sample genus	sample species	sample received as	maternal accession	paternal accession	source type	source site	source state	source country	wild state	wild details	wild collector	wild collection date	putitive population	putitive population code	putitive subpopulation
060024	030	2006	20060101	Brighamia	insignis	seed	020036	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
090445	002	2009	20090101	Brighamia	insignis	seed	060024	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
090445	003	2009	20090101	Brighamia	insignis	seed	060024	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
090445	004	2009	20090101	Brighamia	insignis	seed	060024	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100231	002	2010	20100101	Brighamia	insignis	seed	050389	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100231	014	2010	20100101	Brighamia	insignis	seed	050389	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100274	002	2010	20100101	Brighamia	insignis	seed	990836	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100274	006	2010	20100101	Brighamia	insignis	seed	990836	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100274	007	2010	20100101	Brighamia	insignis	seed	990836	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100274	010	2010	20100101	Brighamia	insignis	seed	990836	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100274	011	2010	20100101	Brighamia	insignis	seed	990836	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	001	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	002	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	003	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	007	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	008	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	009	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	012	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	016	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
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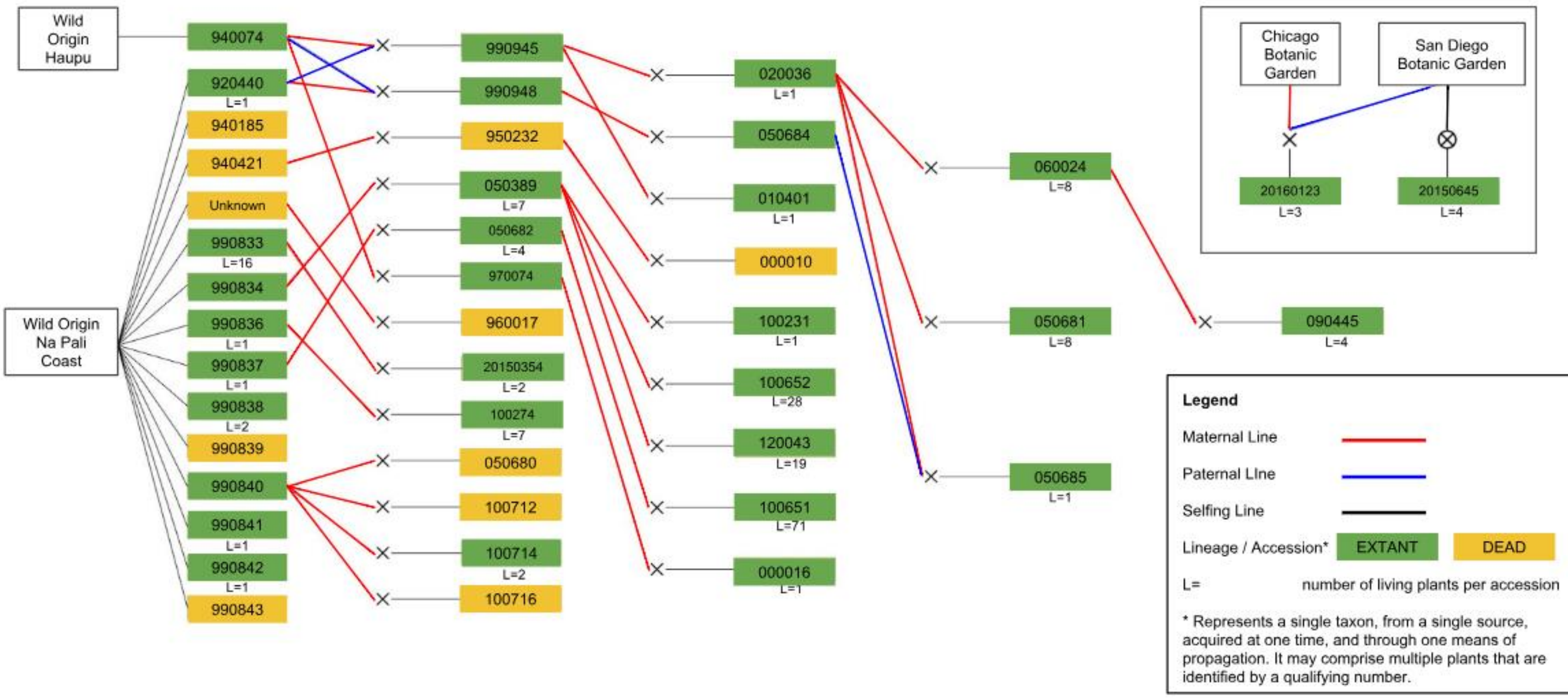
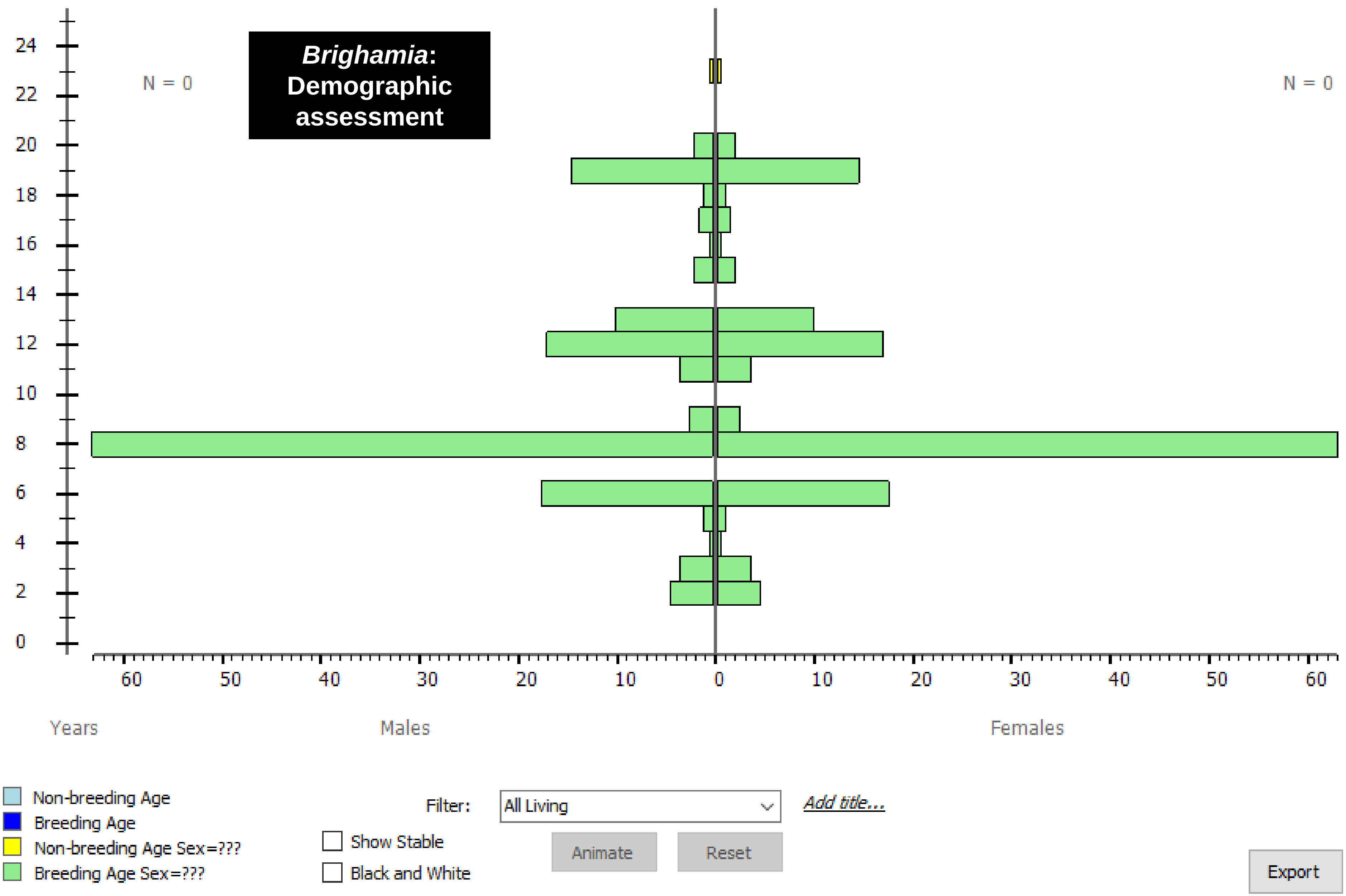
100651	024	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	036	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	044	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	054	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali
100651	059	2010	20100101	Brighamia	insignis	seed	050682	unknown	cultivated, known wild origi	National Tropical Botanical Garden	Hawai'i	United States	n/a	n/a	n/a	n/a	Kauai	KAU	NaPali

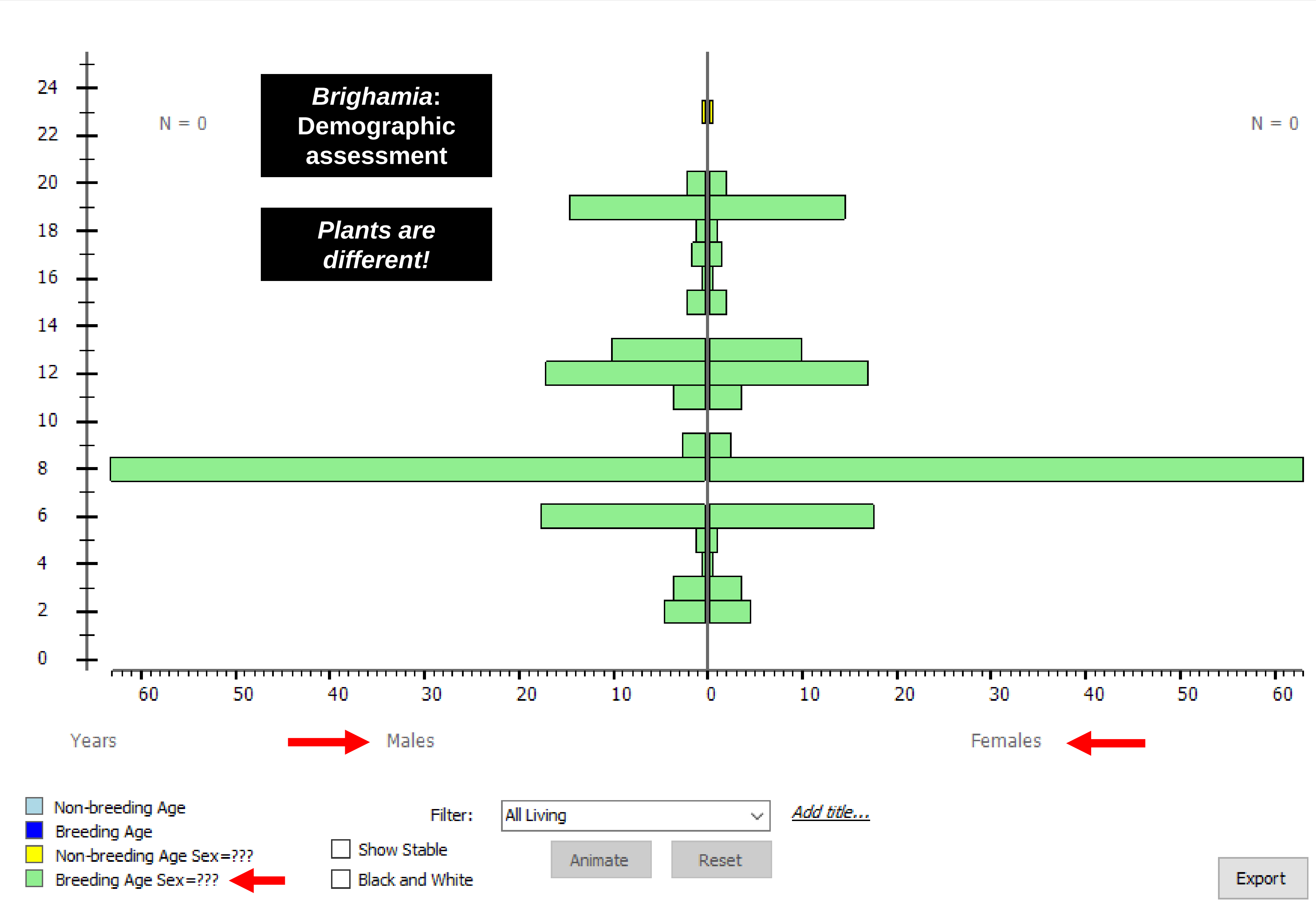
Brighamia – 1400 records imported into PMx

Brighamia – pedigree of NTBG plants





Brighamia: Demographic assessment
N = 0
N = 0
24
22
20
18
16
14
12
10
8
6
4
2
0
60
50
40
30
20
10
0
10
20
30
40
50
60
Years
Males
Females
Non-breeding Age
Breeding Age
Non-breeding Age Sex=???
Breeding Age Sex=???
Filter:
All Living
Add title...
Show Stable
Black and White
Animate
Reset
Export



Brighamia: Demographic assessment
Plants are different!
N = 0
N = 0
24
22
20
18
16
14
12
10
8
6
4
2
0
60 50 40 30 20 10 0 10 20 30 40 50 60
Years
Males
Females
Non-breeding Age
Breeding Age
Non-breeding Age Sex=???
Breeding Age Sex=???
Filter:
All Living
Add title...
Show Stable
Black and White
Animate
Reset
Export

Which plants and how many?

Which plants and how many?

Parent 1

Parent 2

PMx :: BrighamiaKinships :: Genetics

Overview | Founders | Individuals | Kinship Matrix | Pairwise Info | Pairing | Culling | Management Sets | Graphs | Settings | Selection

Males

Specify Pairs | Read Pair File | Repro Goals

UniqueID	MKdynamic	MKdynRank	KVdynamic	PedigreeKnown	AgeYears	Lc
110	0.2461	54	0.4100	1.0000	19	US
500	???	263	???	1.0000	19	US
51 U	0.7836	262	0.5656	0.0000	---	US
81	0.2915	61	0.5002	1.0000	19	US
82	0.2915	61	0.5002	1.0000	19	US
83	0.2915	61	0.5002	1.0000	19	US
86	0.2915	61	0.5002	1.0000	19	US
87	0.2915	61	0.5002	1.0000	19	US
88	0.2915	61	0.5002	1.0000	19	US
89	0.2915	61	0.5002	1.0000	19	US
90	0.2915	61	0.5002	1.0000	19	US
91	0.2915	61	0.5002	1.0000	19	US
92	0.2915	61	0.5002	1.0000	19	US
93	0.2915	61	0.5002	1.0000	19	US
94	0.3140	75	0.4932	1.0000	19	US
95	0.3365	84	0.4862	1.0000	19	US
96	0.2915	61	0.5002	1.0000	19	US
97	0.3140	75	0.4932	1.0000	19	US
269	0.0056	7	0.0042	1.0000	19	US
270	0.0456	23	0.0273	1.0000	19	US
935	0.0033	1	0.0034	1.0000	19	US

Export | Filtered (showing 376) | Filter

Females

UniqueID	MKdynamic	MKdynRank	KVdynamic	PedigreeKnown	AgeYears	Lc
110	0.2461	54	0.4100	1.0000	19	US
500	???	263	???	1.0000	19	US
51 U	0.7836	262	0.5656	0.0000	---	US
81	0.2915	61	0.5002	1.0000	19	US
82	0.2915	61	0.5002	1.0000	19	US
83	0.2915	61	0.5002	1.0000	19	US
86	0.2915	61	0.5002	1.0000	19	US
87	0.2915	61	0.5002	1.0000	19	US
88	0.2915	61	0.5002	1.0000	19	US
89	0.2915	61	0.5002	1.0000	19	US
90	0.2915	61	0.5002	1.0000	19	US
91	0.2915	61	0.5002	1.0000	19	US
92	0.2915	61	0.5002	1.0000	19	US
93	0.2915	61	0.5002	1.0000	19	US
94	0.3140	75	0.4932	1.0000	19	US
95	0.3365	84	0.4862	1.0000	19	US
96	0.2915	61	0.5002	1.0000	19	US
97	0.3140	75	0.4932	1.0000	19	US
269	0.0056	7	0.0042	1.0000	19	US
270	0.0456	23	0.0273	1.0000	19	US
935	0.0033	1	0.0034	1.0000	19	US

Export | Filtered (showing 376) | Filter

Results | Do not show Paired | Show F adjusted

Resulting Offspring F	0.9000	
	New Value	Change
Gene Diversity	0.6949	-0.0059
Gene Value	0.5437	-0.0005
FGE	1.6388	-0.0323
Analytic Known	0.5698	0.0011

Success: 1 | # Offspring: 1 | Accept | Auto

Selected Pairs

Sire	Dam	Success	Offspring	F	dGD	MSI	Location	Notes
942	968	1.0000	1	0.0000	0.0015	--		
935	938	1.0000	1	0.0000	0.0030	--		
962	1173	1.0000	1	0.0000	0.0045	--		
1173	935	1.0000	1	0.0000	0.0059	--		
938	942	1.0000	1	0.0000	0.0073	--		
968	962	1.0000	1	0.0000	0.0087	--		
500	269	1.0000	1	0.0000	0.0093	--		
269	1178	1.0000	1	0.0000	0.0099	--		
1186	1185	1.0000	1	0.0000	0.0101	--		
1178	500	1.0000	1	0.0130	0.0000	--		

\# Pairs = 10; # Offspring attempted = 10
\# Offspring expected = 10.00

Export | Remove | Remove All

Assumptions:
Do Not Include Founders; Parentage Assumptions = ProbParents; Unknown Weight = 0.00; Fixed Kinship Weight = 1.00

Change

Dynamic Population Variables
GD = 0.7008; GV = 0.5443; MK = 0.2992; % Known = 56.9%; N = 386.0

Which plants and how many?

Assigns best pairings based on Mean Kinship

Parent 1 **Parent 2**

PMx :: BrighamiaKinships :: Genetics

Overview | Founders | Individuals | Kinship Matrix | Pairwise Info | Pairing | Culling | Management Sets | Graphs | Settings | Selection

Males — Specify Pairs | Read Pair File | Repro Goals

UniqueID	MKdynamic	MKdynRank	KVdynamic	PedigreeKnown	AgeYears	Lc
110	0.2461	54	0.4100	1.0000	19	US
500	???	263	???	1.0000	19	US
51 U	0.7836	262	0.5656	0.0000	---	US
81	0.2915	61	0.5002	1.0000	19	US
82	0.2915	61	0.5002	1.0000	19	US
83	0.2915	61	0.5002	1.0000	19	US
86	0.2915	61	0.5002	1.0000	19	US
87	0.2915	61	0.5002	1.0000	19	US
88	0.2915	61	0.5002	1.0000	19	US
89	0.2915	61	0.5002	1.0000	19	US
90	0.2915	61	0.5002	1.0000	19	US
91	0.2915	61	0.5002	1.0000	19	US
92	0.2915	61	0.5002	1.0000	19	US
93	0.2915	61	0.5002	1.0000	19	US
94	0.3140	75	0.4932	1.0000	19	US
95	0.3365	84	0.4862	1.0000	19	US
96	0.2915	61	0.5002	1.0000	19	US
97	0.3140	75	0.4932	1.0000	19	US
269	0.0056	7	0.0042	1.0000	19	US
270	0.0456	23	0.0273	1.0000	19	US
935	0.0033	1	0.0034	1.0000	19	US

Export — Filtered (showing 376) — Filter

Females

UniqueID	MKdynamic	MKdynRank	KVdynamic	PedigreeKnown	AgeYears	Lc
110	0.2461	54	0.4100	1.0000	19	US
500	???	263	???	1.0000	19	US
51 U	0.7836	262	0.5656	0.0000	---	US
81	0.2915	61	0.5002	1.0000	19	US
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83	0.2915	61	0.5002	1.0000	19	US
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87	0.2915	61	0.5002	1.0000	19	US
88	0.2915	61	0.5002	1.0000	19	US
89	0.2915	61	0.5002	1.0000	19	US
90	0.2915	61	0.5002	1.0000	19	US
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96	0.2915	61	0.5002	1.0000	19	US
97	0.3140	75	0.4932	1.0000	19	US
269	0.0056	7	0.0042	1.0000	19	US
270	0.0456	23	0.0273	1.0000	19	US
935	0.0033	1	0.0034	1.0000	19	US

Export — Filtered (showing 376) — Filter

Results — Do not show Paired — Show F adjusted

Resulting Offspring F	0.9000	
	New Value	Change
Gene Diversi	0.6949	-0.0059
Gene Value	0.5437	-0.0005
FGE	1.6388	-0.0323
Analytic Kno	0.5698	0.0011

Success: 1 — # Offspring: 1 — Accept — Auto

Selected Pairs

Sire	Dam	Success	Offspring	F	dGD	MSI	Location	Notes
942	968	1.0000	1	0.0000	0.0015	--		
935	938	1.0000	1	0.0000	0.0030	--		
962	1173	1.0000	1	0.0000	0.0045	--		
1173	935	1.0000	1	0.0000	0.0059	--		
938	942	1.0000	1	0.0000	0.0073	--		
968	962	1.0000	1	0.0000	0.0087	--		
500	269	1.0000	1	0.0000	0.0093	--		
269	1178	1.0000	1	0.0000	0.0099	--		
1186	1185	1.0000	1	0.0000	0.0101	--		
1178	500	1.0000	1	0.0130	0.0000	--		

Pairs = 10; # Offspring attempted = 10
Offspring expected = 10.00

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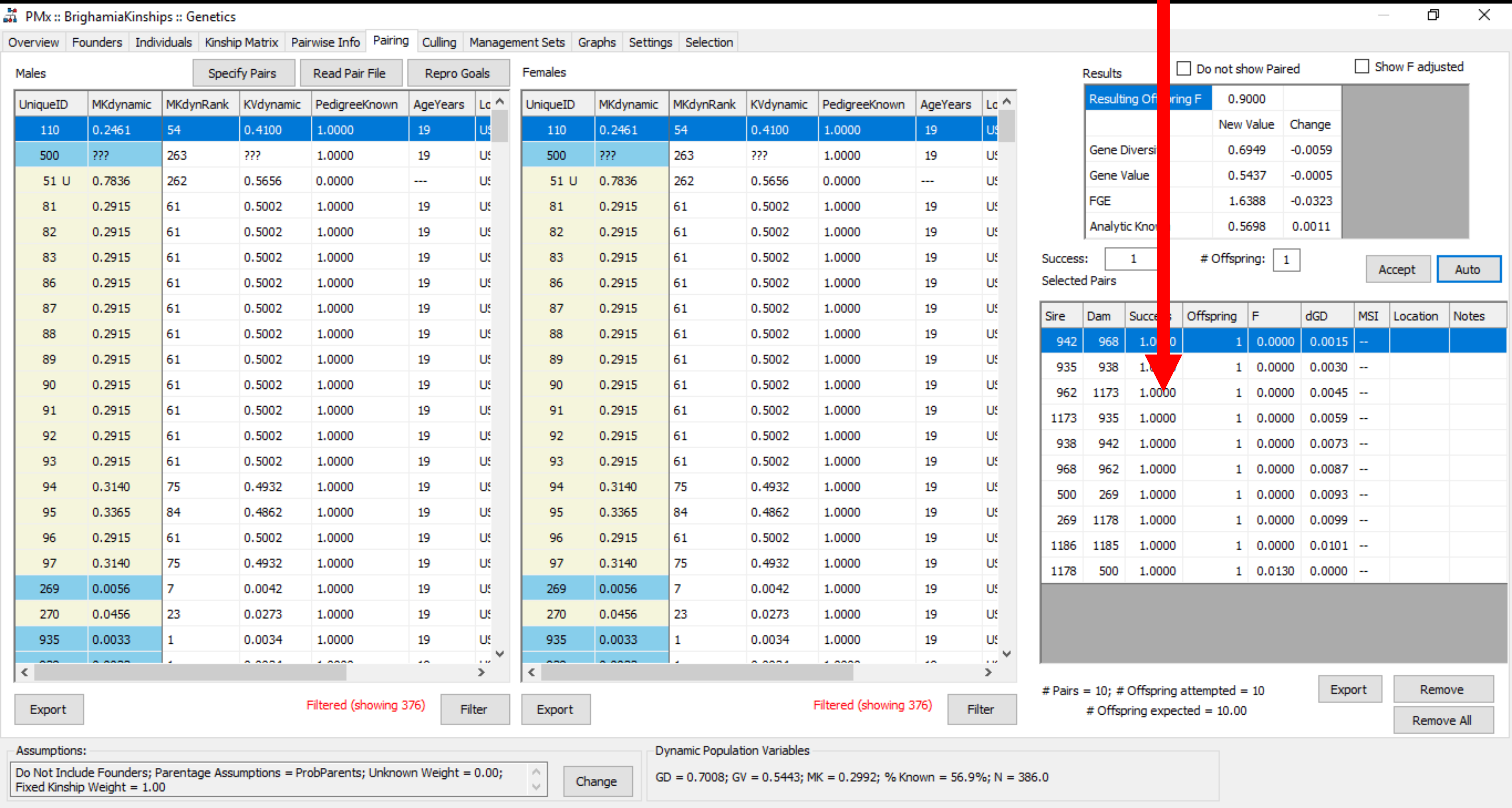
Parent 1 **Parent 2**



Sustains genetic diversity into next generation

One last example

Cacheito Palm:
Pseudophoenix ekmanii

Cacheito

Pseudophoenix ekmanii Burret

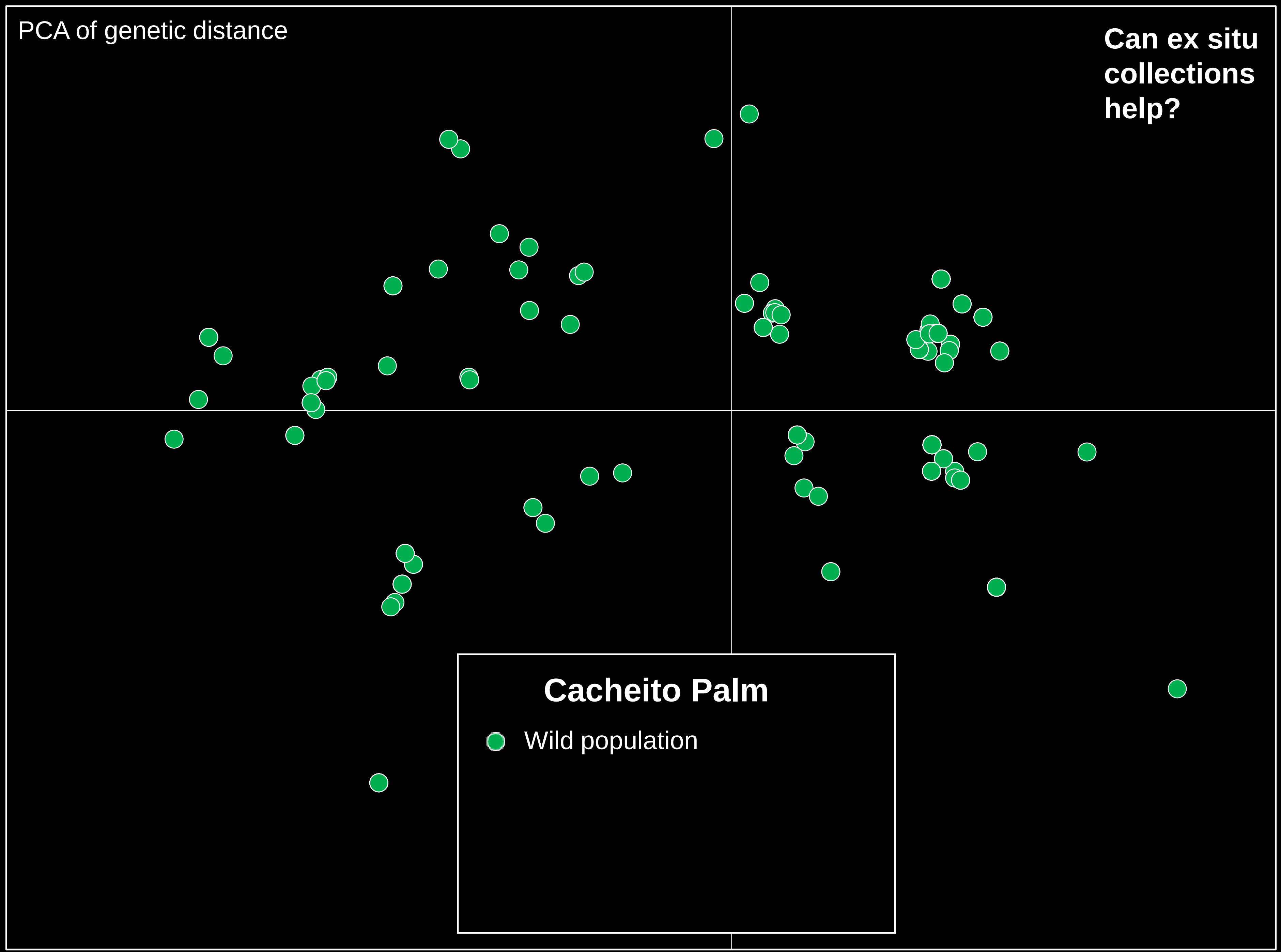
Estado de conservación: EN A1abcd; B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)

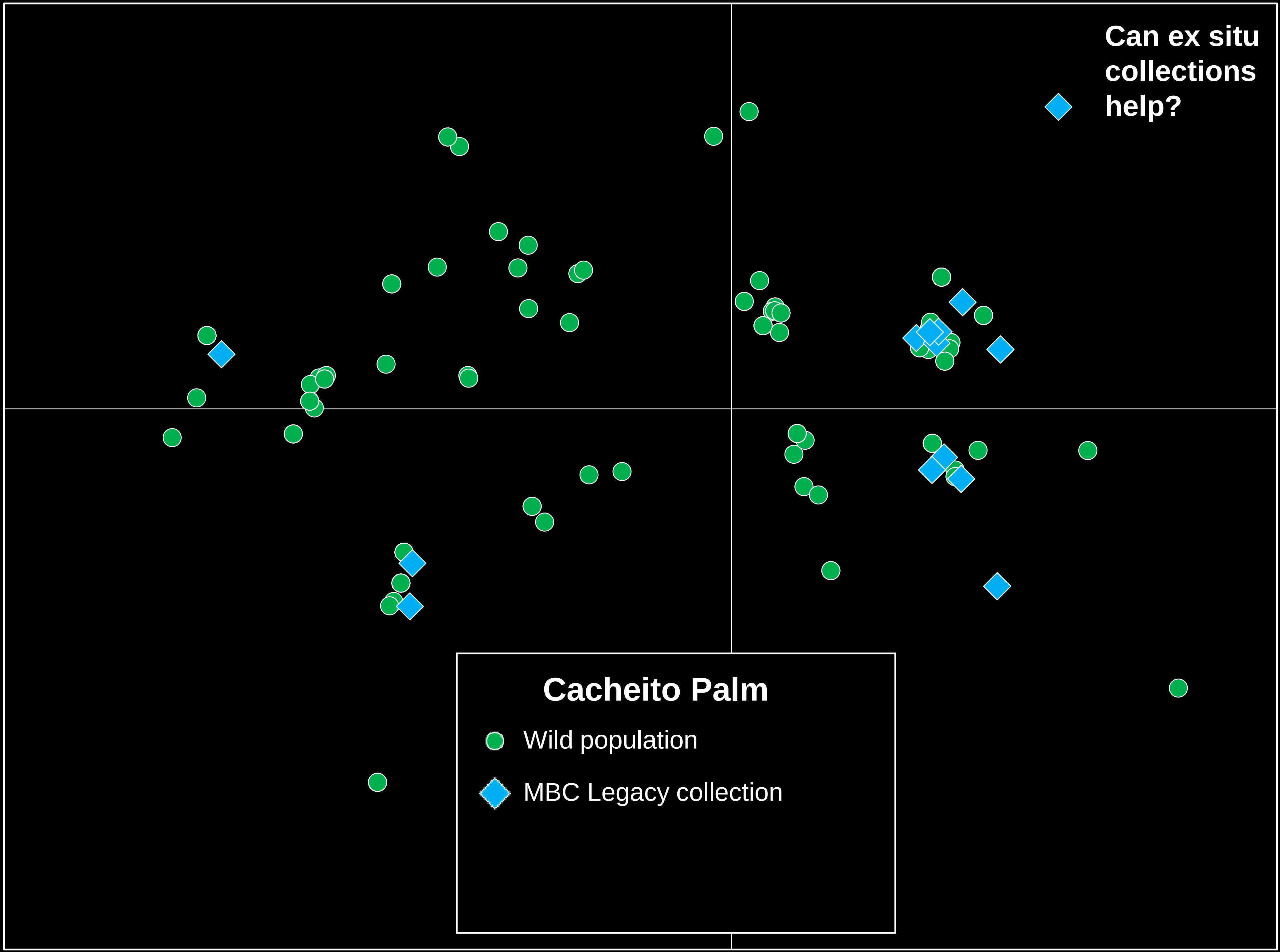
Estatus biogeográfico: Endémica

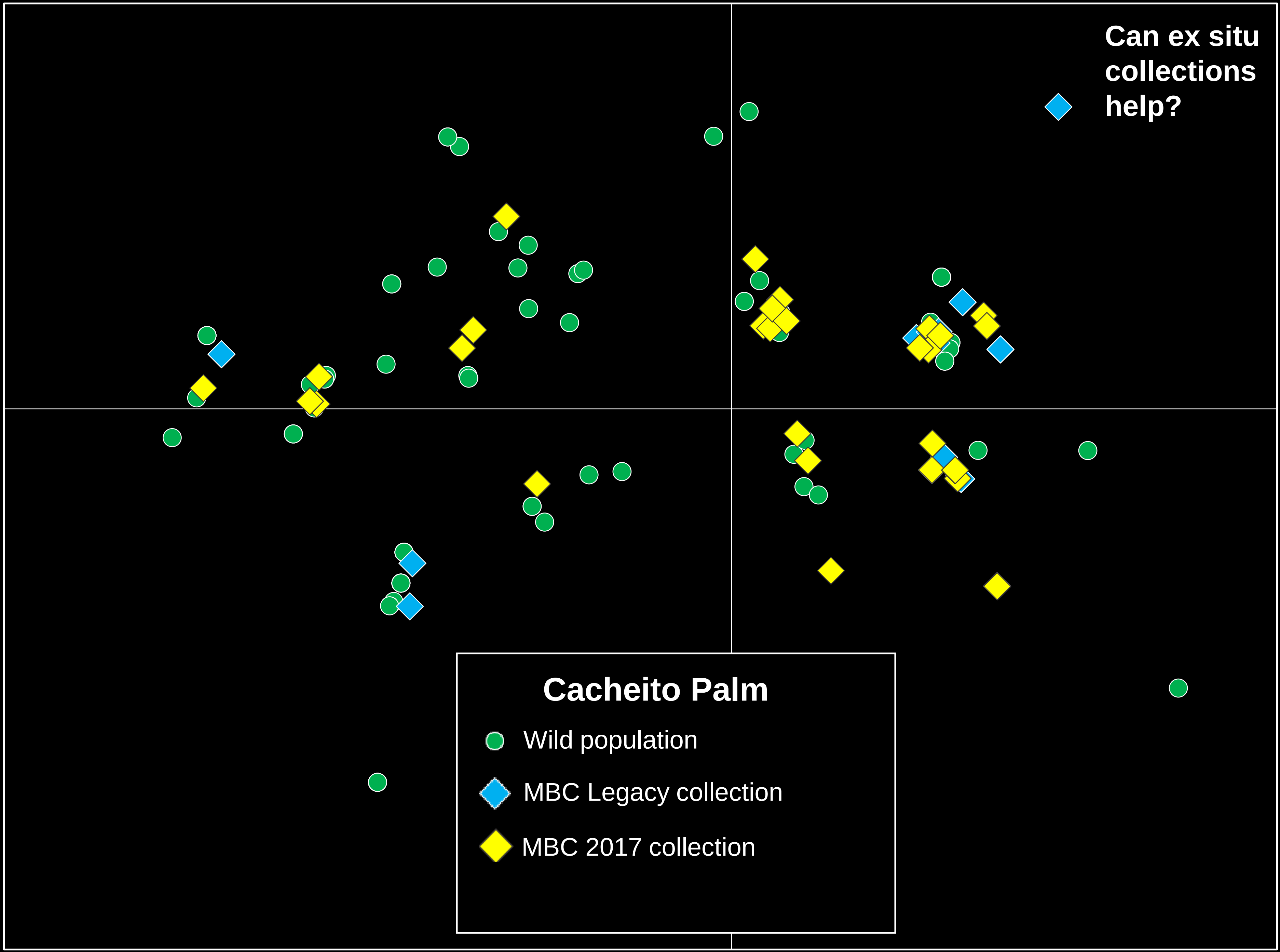
Tipo biológico: Estípite

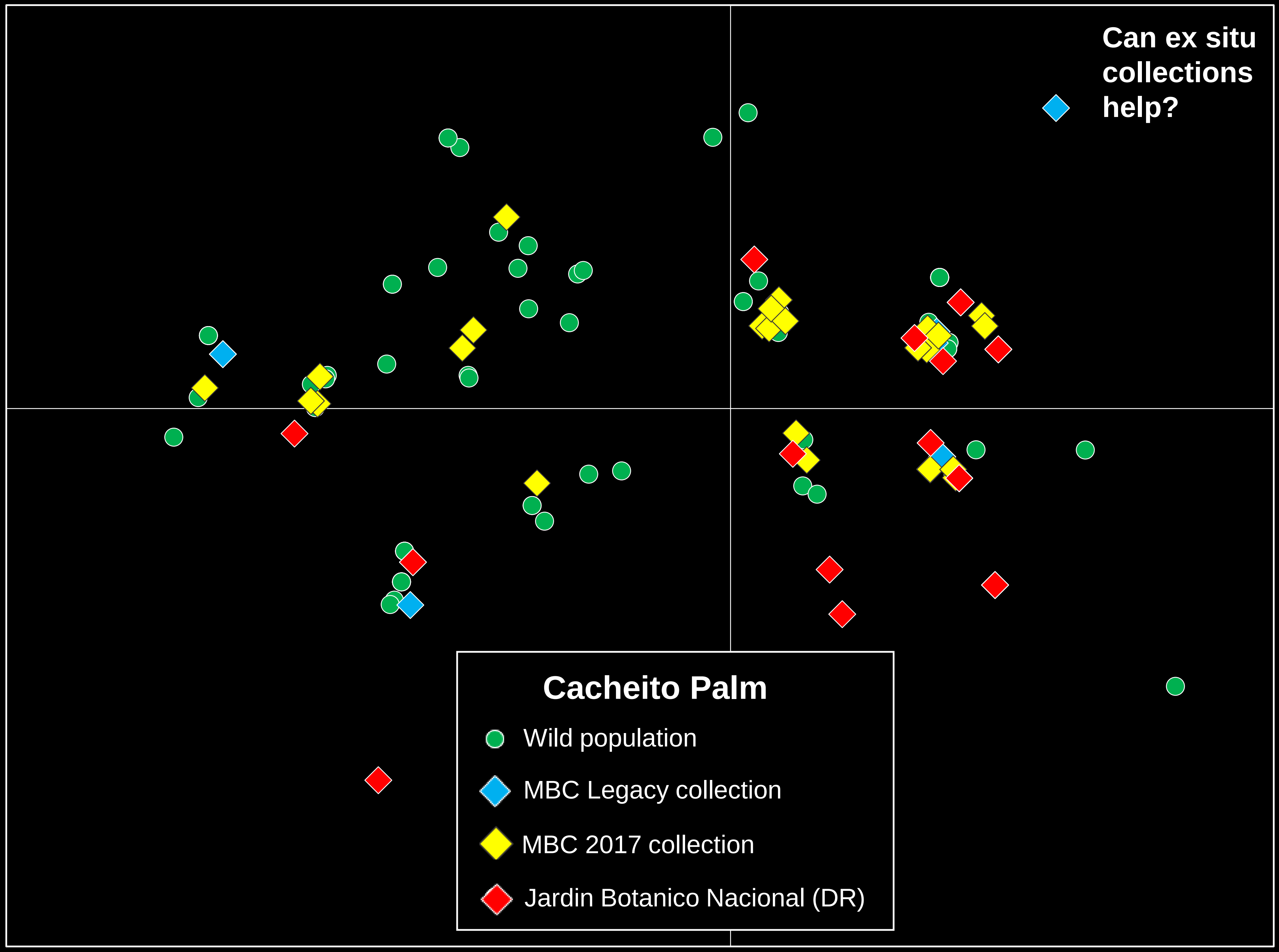

Threatened
by poaching

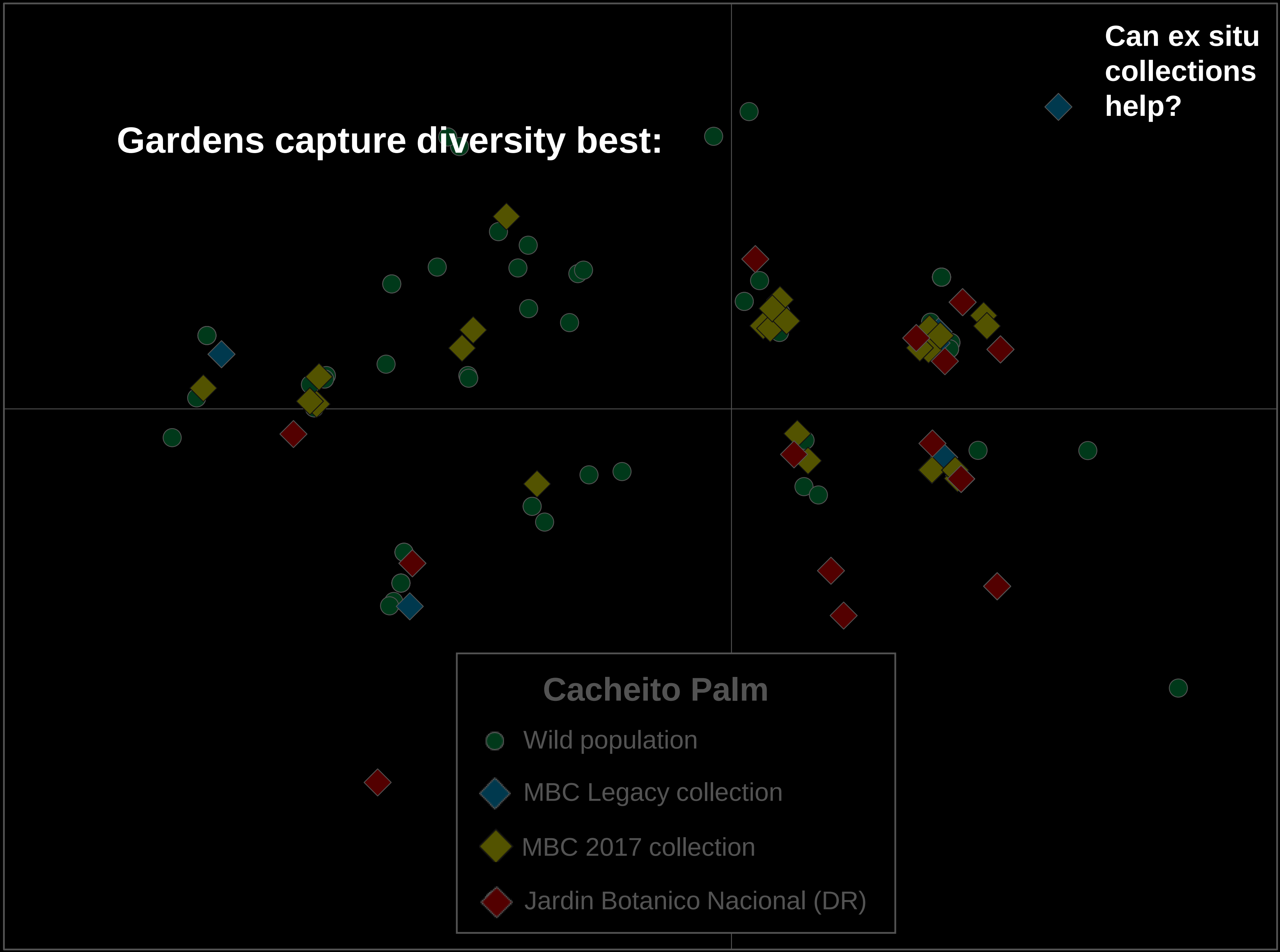
Can ex situ collections help?


PCA of genetic distance
Can ex situ collections help?
Cacheito Palm
Wild population


Can ex situ collections help?
Cacheito Palm
Wild population
MBC Legacy collection


Can ex situ collections help?
Cacheito Palm
Wild population
MBC Legacy collection
MBC 2017 collection


Can ex situ collections help?
Cacheito Palm
Wild population
MBC Legacy collection
MBC 2017 collection
Jardin Botanico Nacional (DR)


Can ex situ collections help?
Gardens capture diversity best:
Cacheito Palm
Wild population
MBC Legacy collection
MBC 2017 collection
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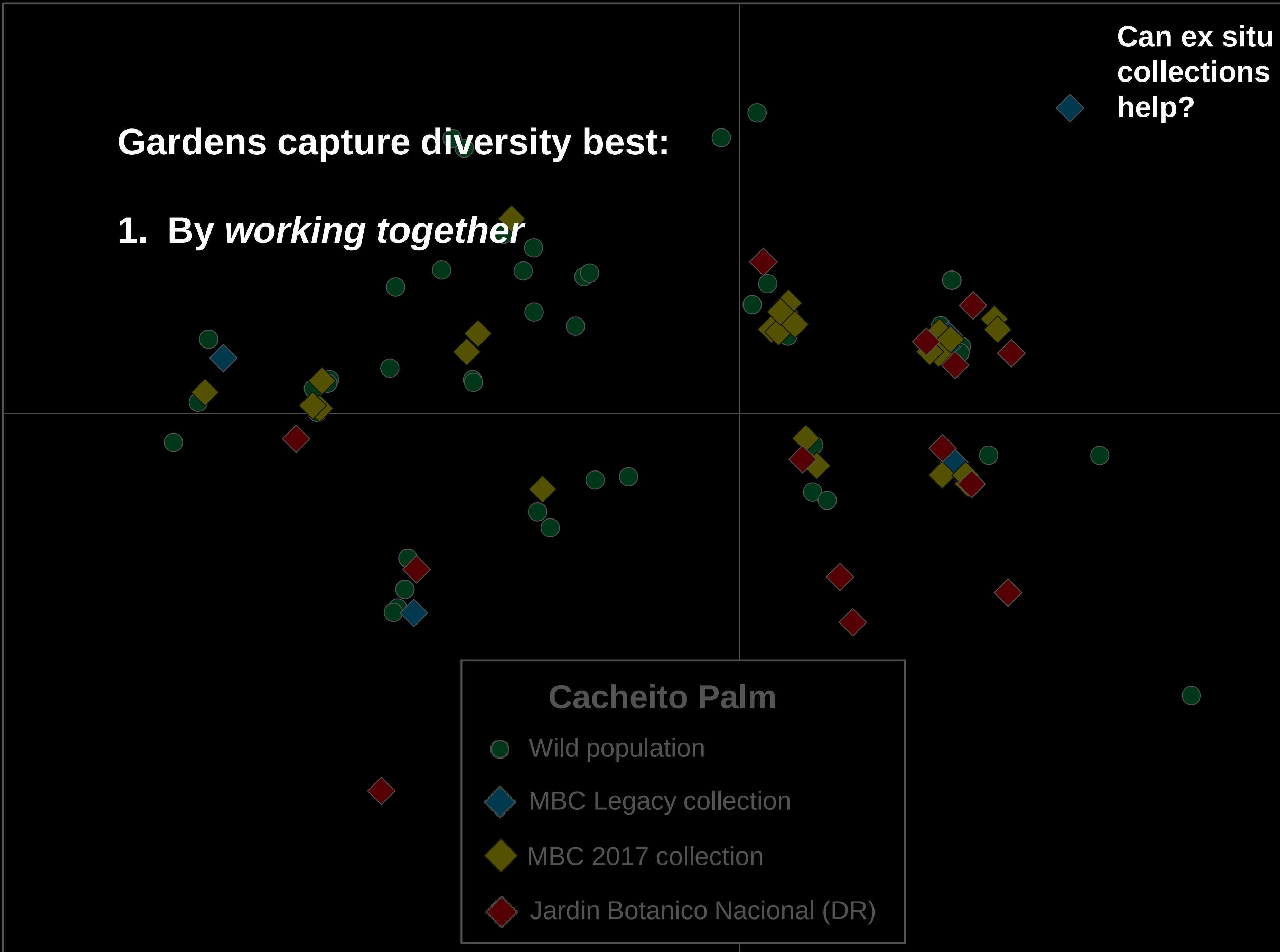
Can ex situ collections help?

Gardens capture diversity best:

1. By *working together*

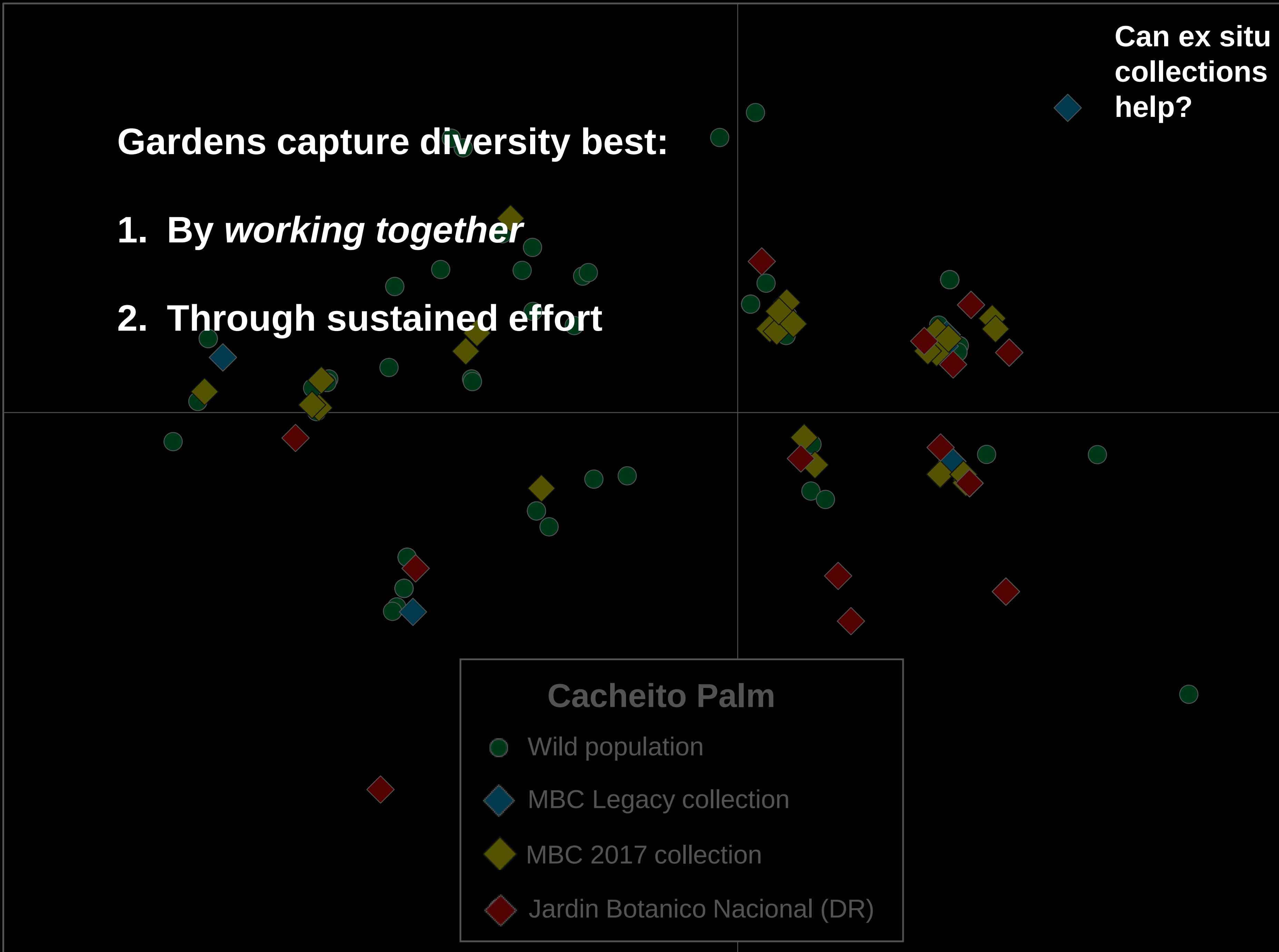


Can ex situ collections help?

Gardens capture diversity best:

1. By *working together*

2. Through sustained effort




i. improving garden conservation.
ii. What do we need?
iii. Where are we now?
iv. A path forward.


i. improving garden conservation.
ii. What do we need?
iii. Where are we now?
Coordinating diversity.
iv. A path forward.

i. improving garden conservation.

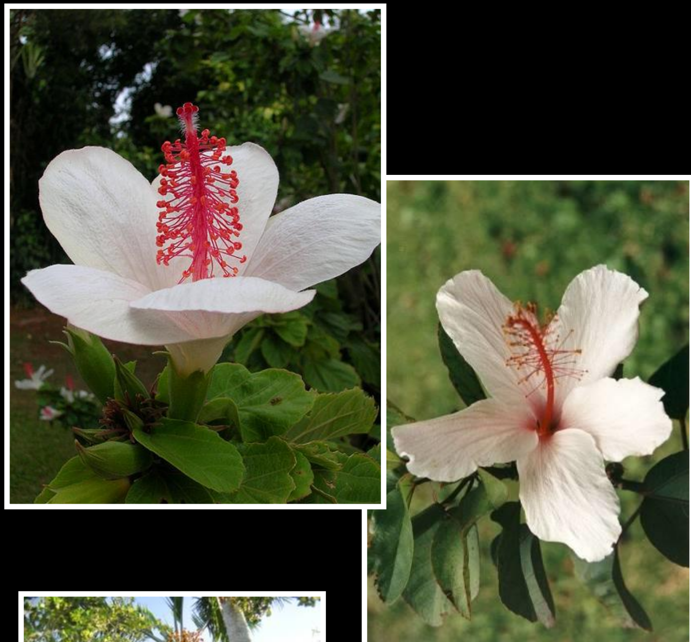
ii. What do we need?

iii. Where are we now?

iv. A path forward.


[Many hours of analysis]
DELL
SAMSUNG

Find patterns and principles




Find patterns and principles
Refine the protocols


Find patterns and principles
Refine the protocols
Reach our community

Find patterns and principles

Refine the protocols

Reach our community

Find patterns and principles

Refine the protocols

Reach our community

Coordinate Diversity!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National Science Foundation DEB 1050340, DBI-1461007
Mohamed bin Zayed Species Conservation Fund
Association of Zoological Horticulture
International Palm Society
SOS-Save Our Species
Eppley Foundation
Dr. Lin Lougheed
INSTITUTE of Museum and Library SERVICES
NSF
Thank you