Incorporating Key Restoration Decisions into Habitat Suitability Models to Forecast SWFL Outcomes

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Lisa Markovchick

Photo: halcyonenv.com/swfl

Photo: Lisa Markovchick

SWFL fecundity in decline, linked to defoliation & nest temperatures

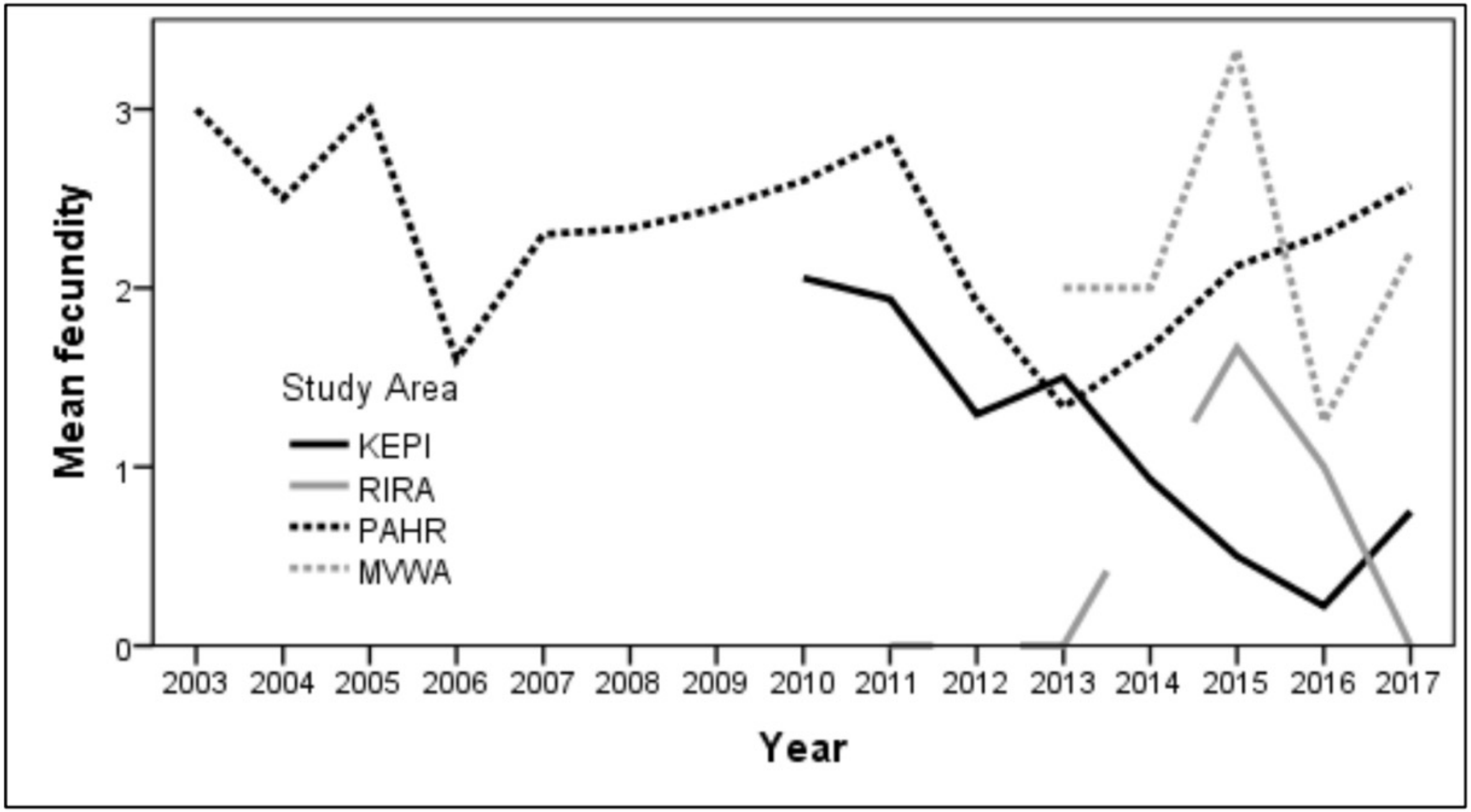
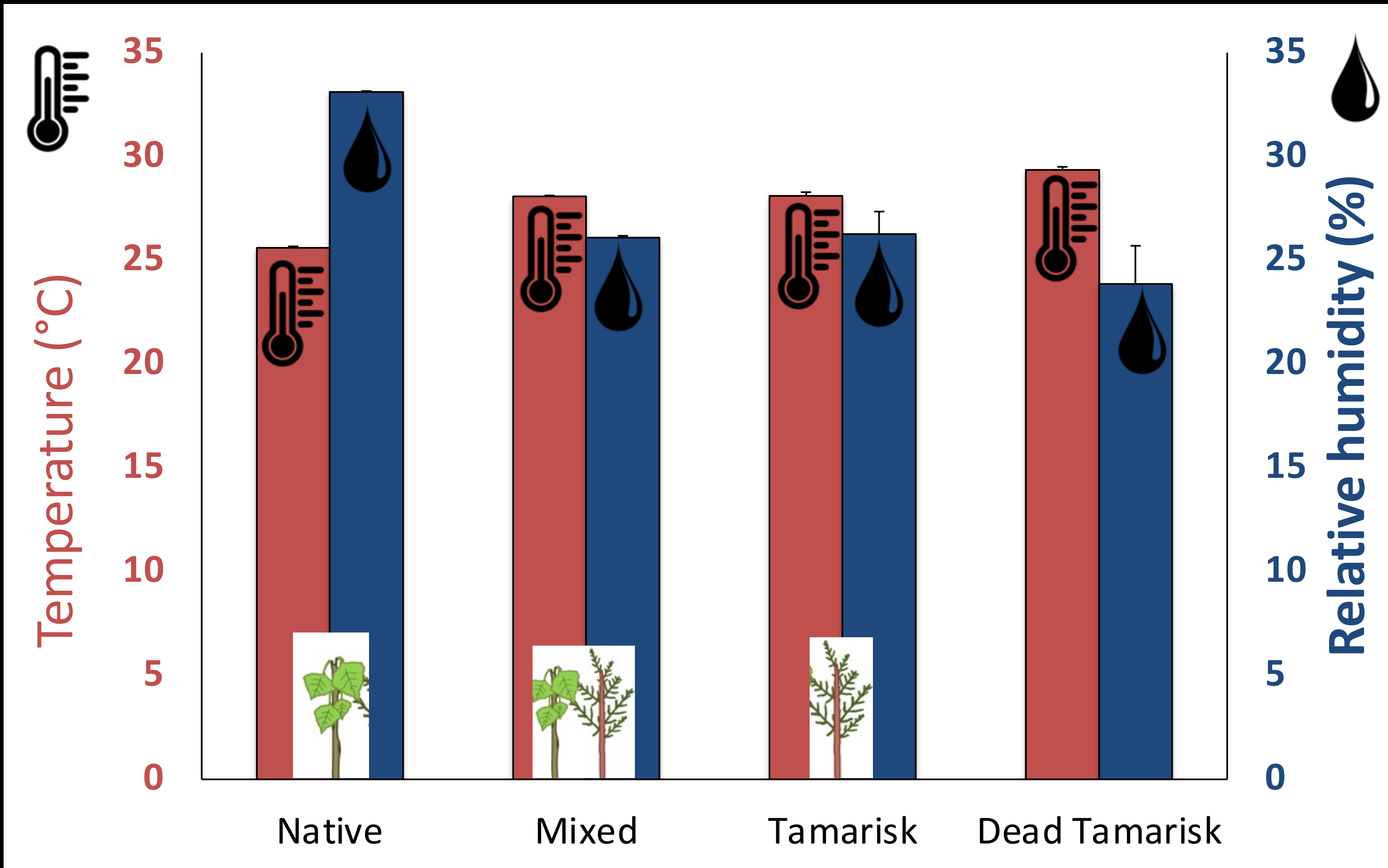


Figure 4-5.—Mean annual fecundity (young produced per female southwestern willow flycatcher) at Key Pittman (KEPI), River Ranch (RIRA), Pahranagat (PAHR), and Meadow Valley Wash (MVWA), 2003–17.

Southwestern Willow Flycatcher Surveys, Demography, and Ecology Along the Lower Colorado River and Tributaries, 2013–2017 Summary Report, May 2019

Mixed, tamarisk & dead tam sites warmer & drier – restoring native veg even more important



Temperature: $F=273.9$, $p<0.00001$

Relative Humidity: $F=590.2$, $p<0.00001$

Data by Sean Mahoney

Mycorrhizal effects on plants

Tons of data in Ag,
growing body of data in ecology

- Boost survival/growth
- Pest control
- Water/drought survival
- Toxicity protection
- continued…

Not negligible impacts:
~25-50%+

Invasive vegetation reduces mycorrhizas

- Spotted knapweed
  (Mummey & Rillig 2006)
- Garlic mustard
  (Stinson et al. 2006)
- Canada goldenrod
  (Zhang et al. 2010)
- Italian thistle
  (Vogelsang & Bever 2009)

Spotted Knapweed
Centaurea maculosa

Garlic Mustard
Alliaria petiolata

Italian thistle
Carduus pycnocephalus

Tamarisk-specific field data: Pulliam-Babbitt / SEGA common garden

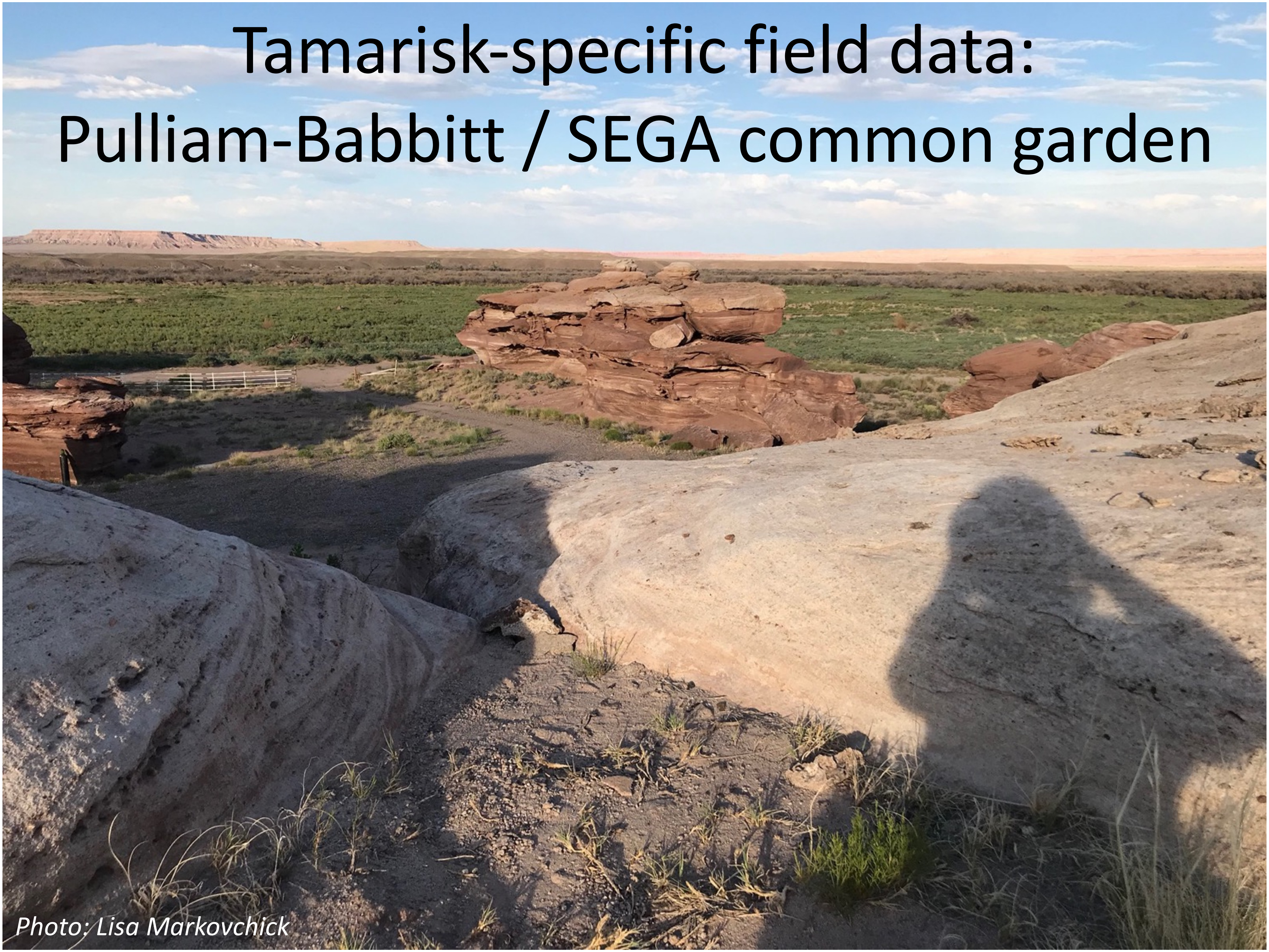


Photo: Lisa Markovchick

Tam legacy reduces cottonwood survival

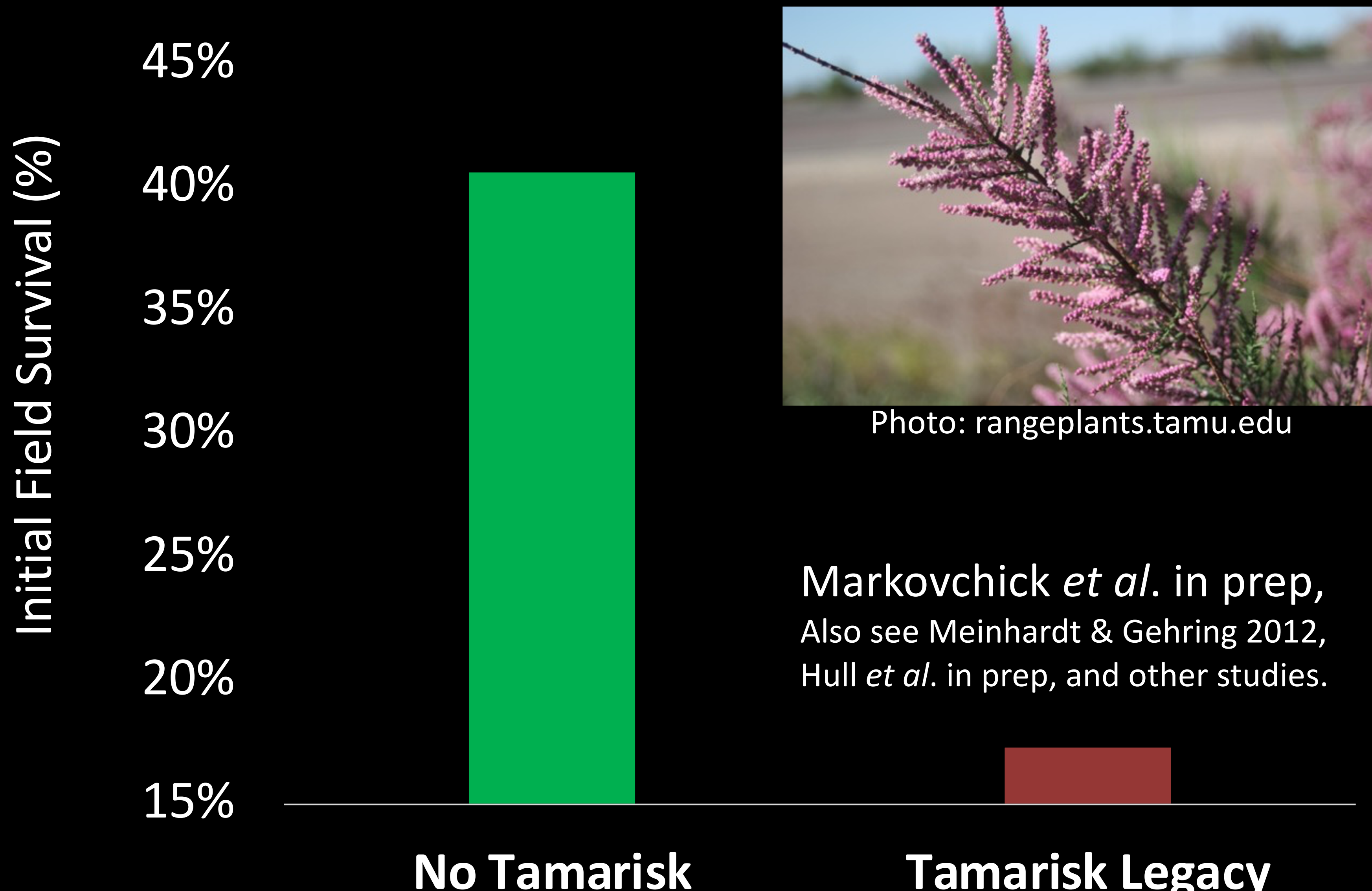
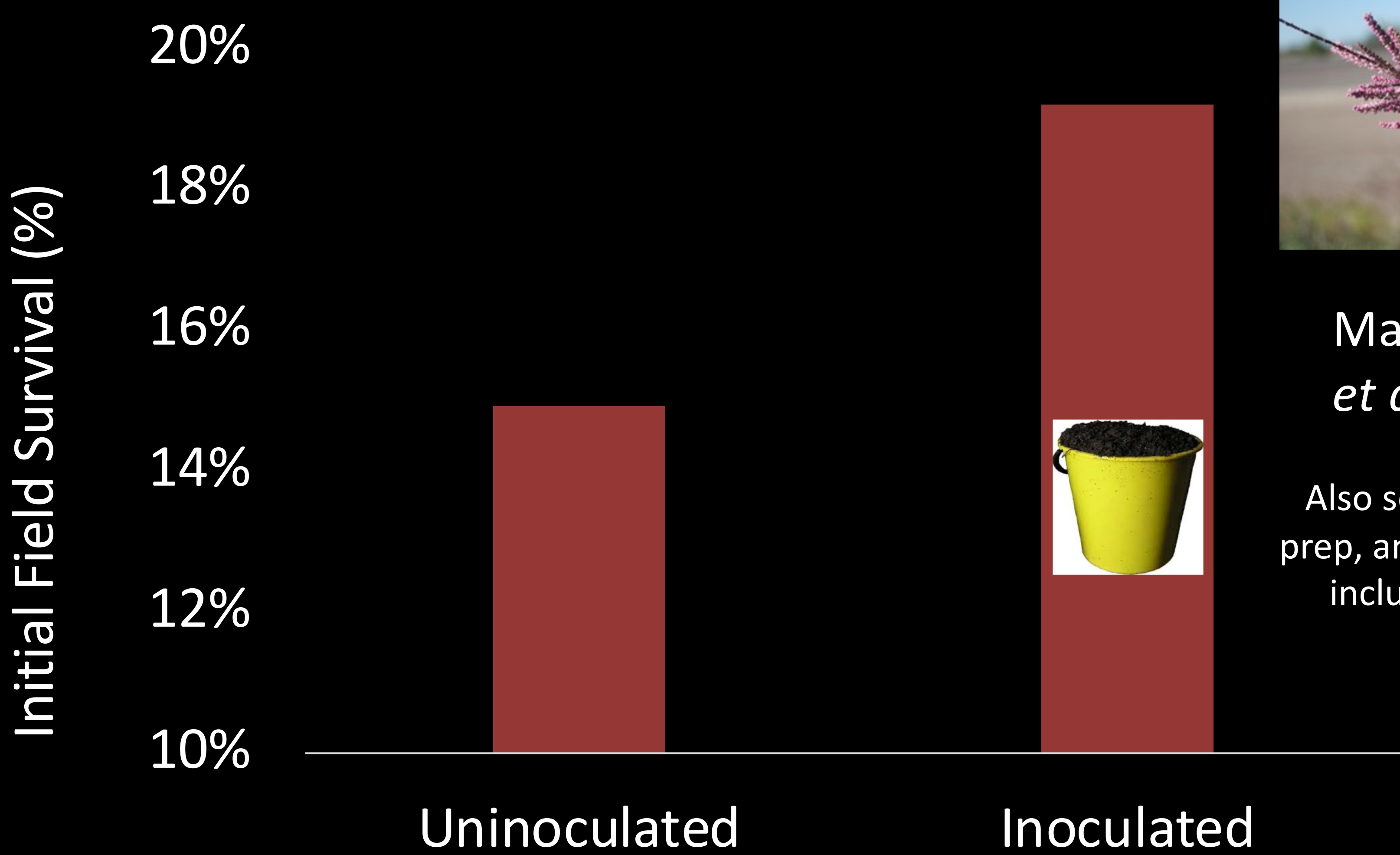


Photo: rangeplants.tamu.edu

Markovchick *et al*. in prep,
Also see Meinhardt & Gehring 2012,
Hull *et al*. in prep, and other studies.

Bars represent total survival proportions in study, thus no error bars are provided.

Inocculation can help counteract reduced survival

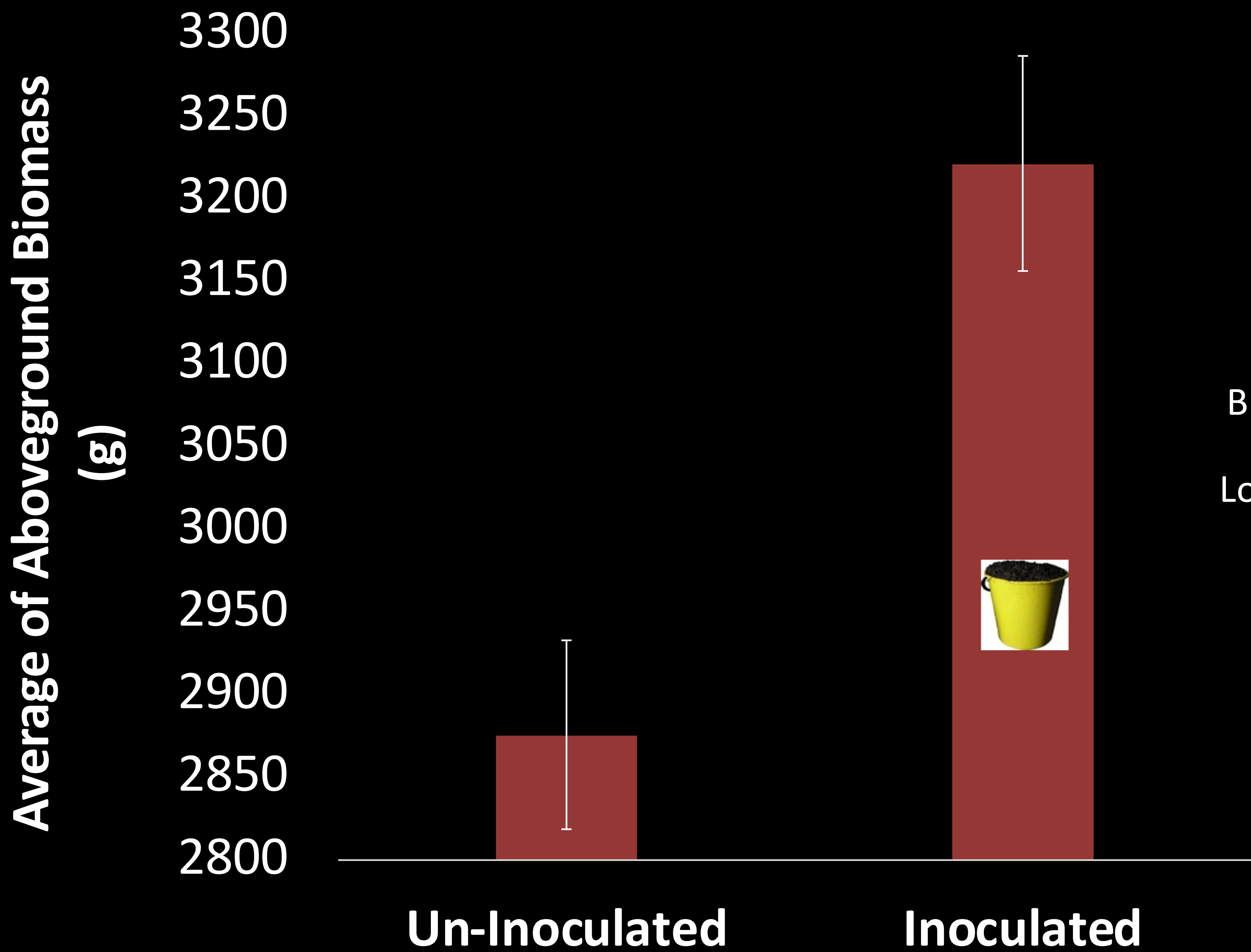


Markovchick *et al*. in prep

Also see Hull *et al*. in prep, and other studies, including willows.

Bars represent total survival proportions in study, thus no error bars are provided.

And increase above-ground biomass



Error bars = 2 SE.

Biomass equations from Lojewski *et al.* 2009

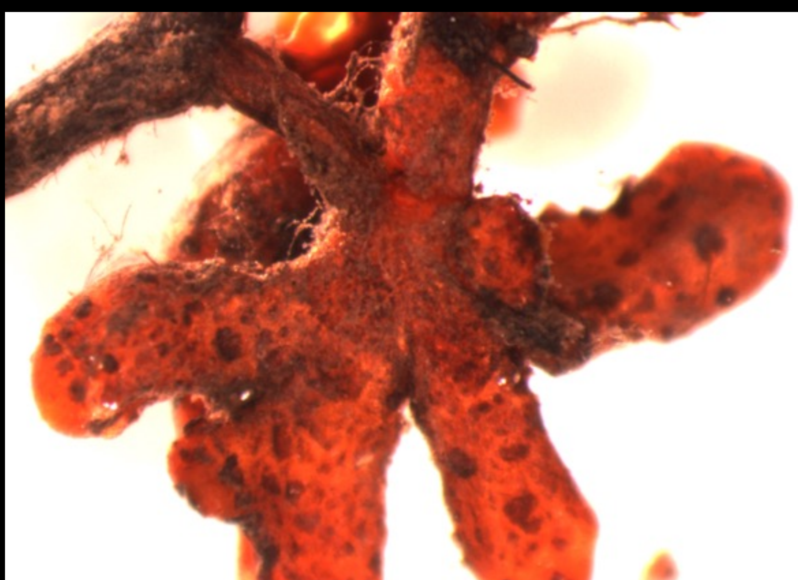
Markovchick *et al*. in prep

Similar results in Hull *et al*. in prep, and other studies.

Research questions

1) Shouldn't mycorrhizas boost SWFL habitat suitability?

2) Can fine-scale SWFL habitat models discriminate between specific restoration decisions at a site?



Hypotheses

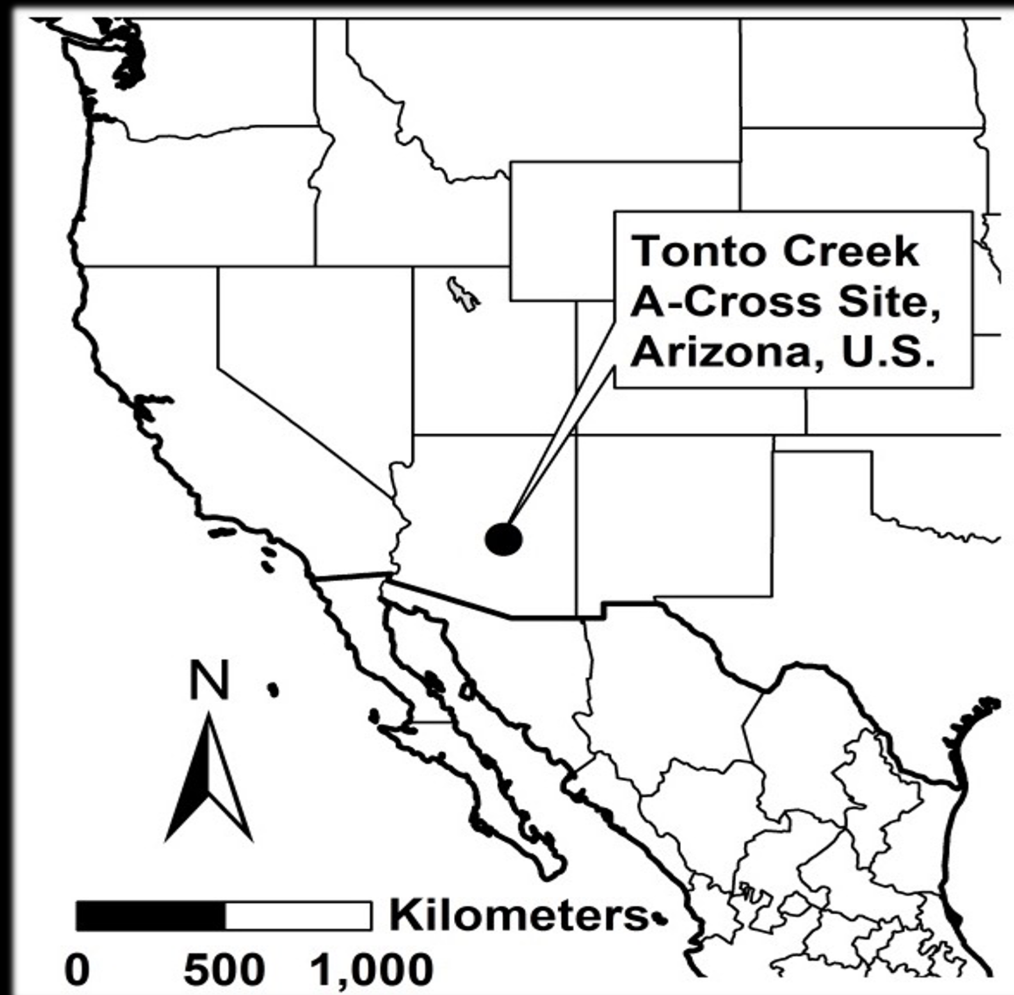
1) Appropriate mycorrhizal inoculations can improve SWFL habitat suitability in tamarisk restoration.

2) Appropriate mycorrhizal inoculations can decrease the time to achieve suitable SWFL habitat.

3) Fine-scale models can discriminate between SWFL outcomes based on key restoration decisions -> to evaluate the importance of specific decisions compared to their cost, ahead of action in the field.

Original fine-scale GIS SWFL Habitat Suitability Index (HSI) model

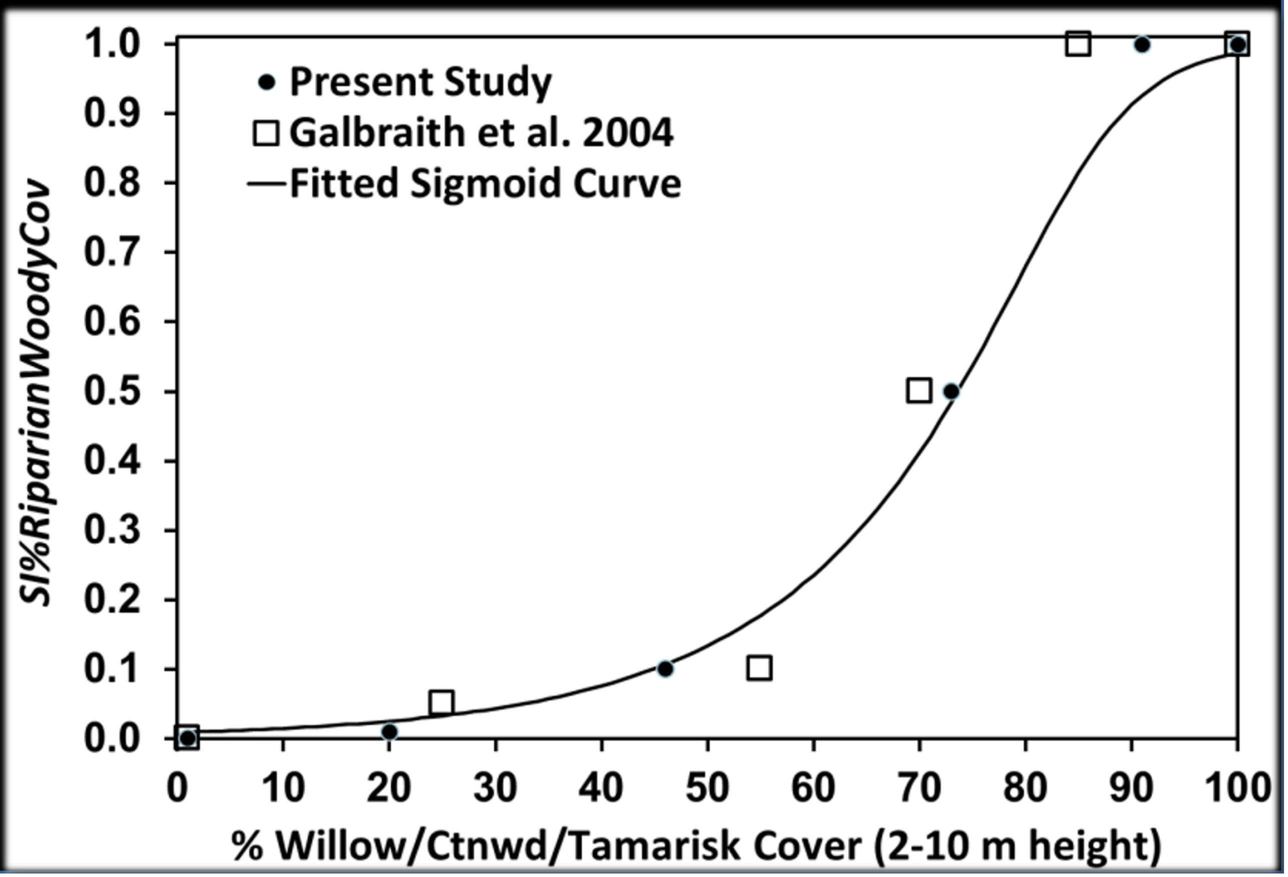
- 1 m resolution
- Tracy *et al*. 2016



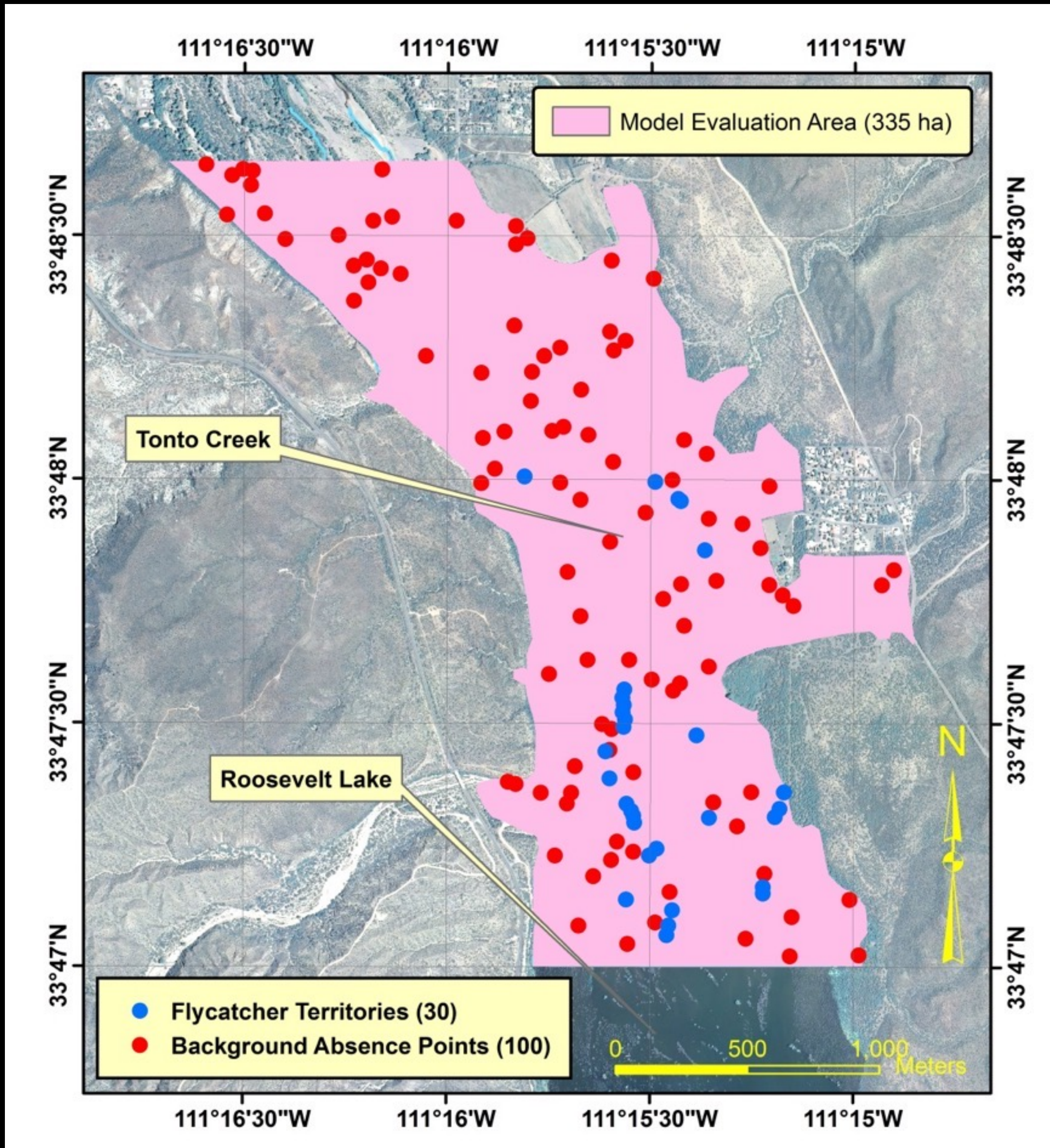
Original HSI model-building steps

- Pull info on habitat suitability from field studies
- Identify factors
- Estimate their relative contributions
- Curve: each variable value & its impact on habitat suitability

(Tracy *et al*. 2016)



Test model predictions verses SWFL field data



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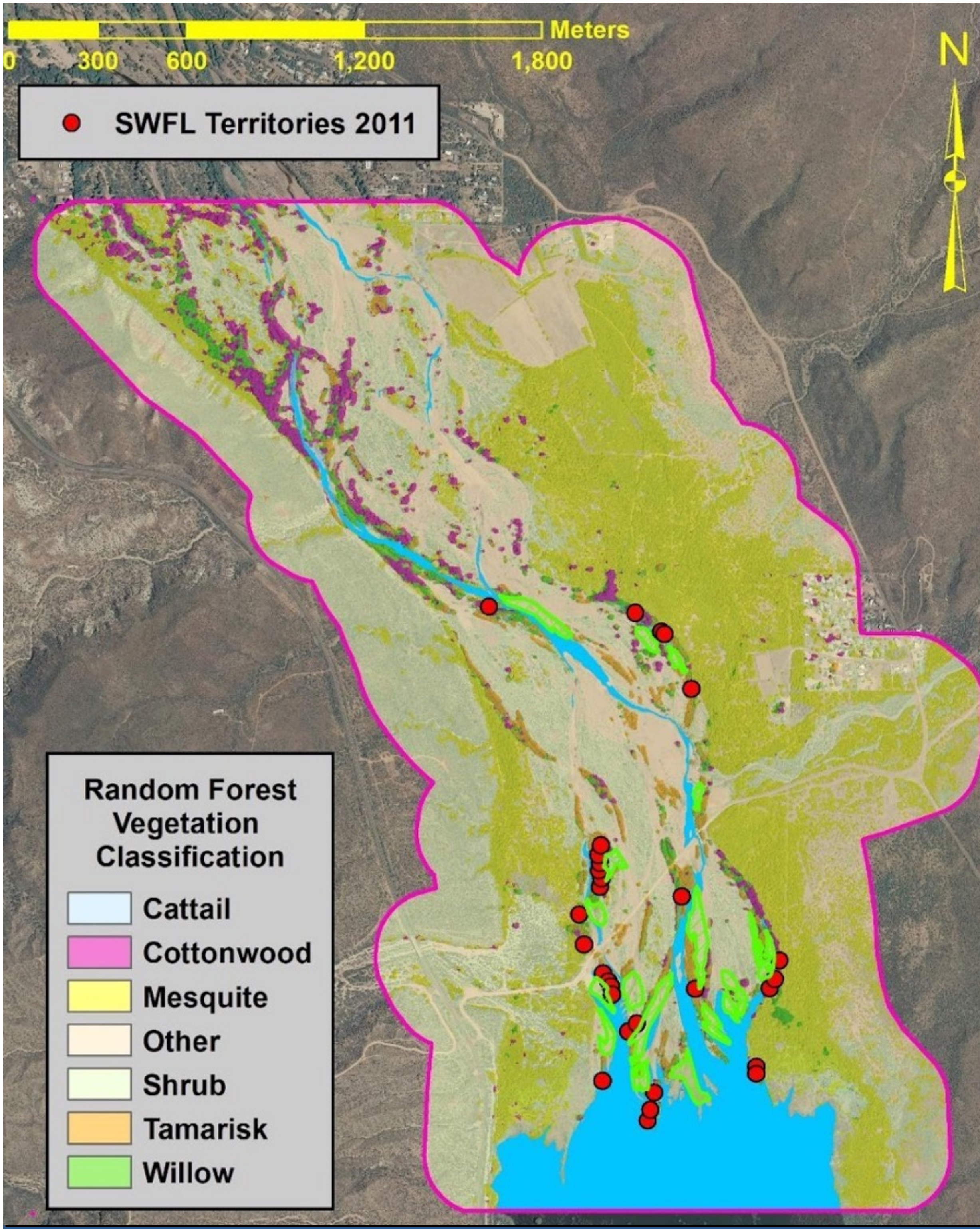
Added to Original Fine-Scale GIS Model

*Current results demo minor work over 2 months.
More to come!

We hope you'll ask for what is needed to support restoration projects!



Selected restoration patches near water

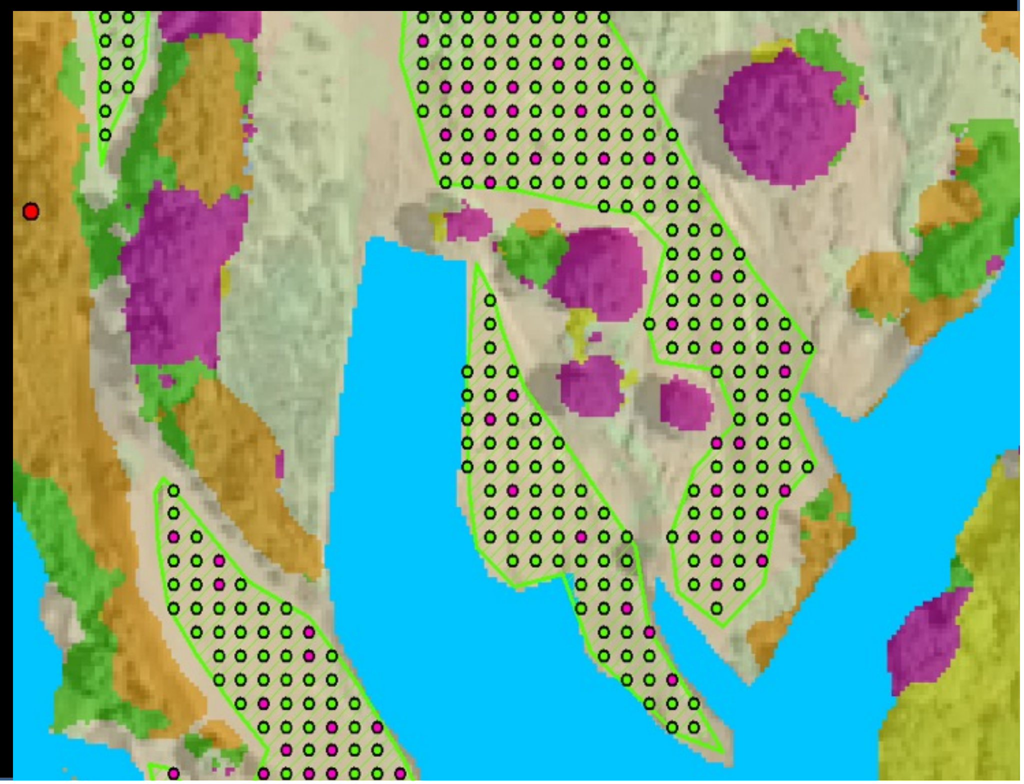
1) Plant installation & SWFL preferences.
2) 2011 water lines used for demo.
3) Future scenarios: sites identified for restoration & hydrological predictions.

Identified plant palette, planting type & plant spacing

Riparian restoration plantings of 2' deep pots at 3-meter spacings for Tonto Creek A-Cross site, AZ.

Species	Number Plantings	Percent Total
Goodding's Willow	8,952	98.9%
Fremont Cottonwood	100	1.1%
Total	9,052	100%

- 3 m apart
- 2' potted plantings



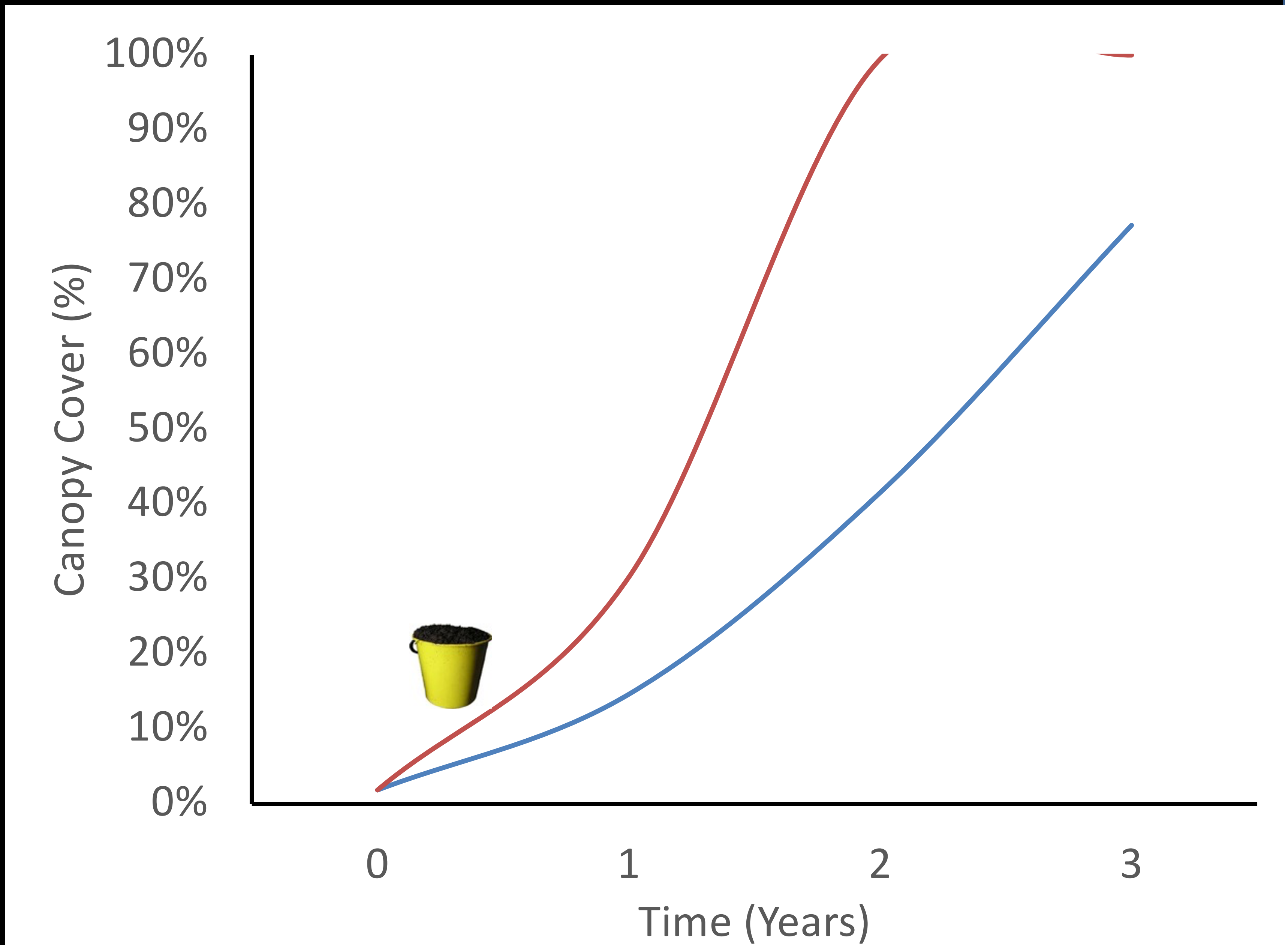
Added survival & growth by species & planting type

Reference	Location	Plant Spp.	Planting Type	Spacing	Duration	Survival
Laub et al. 2019	San Rafael River, Utah, U.S.A.	Fremont cottonwood	2-m-tall trees in 3.8 L pots	no info	1.25 years	35%
Amanda Clements, 2008 - 2010, Presentation	Western CO, Gunnison River	Cottonwood	poles	no info	1 growing season	0%
Amanda Clements, 2008 - 2010, Presentation	Western CO, Gunnison River	Cottonwood	poles	no info	1 growing season	12% yr 1, 0-6% yr 2
McMaster and Chaudhry 2017	Grand Canyon National Park, Colorado River	Salix gooddingii (Gooding's willow)	poles	no info	10 months	40%

Added responses to appropriate mycorrhizal inoculation for each plant species

Reference	Effect	Percent Change	Direction	Time Interval	Context
Meinhardt & Gehring 2012	Cottonwood biomass	33%	+		Greenhouse + Field, biomass results from Greenhouse
Beauchamp et al. 2005	Tamarisk biomass	75%	-	1 growing season (7 mo)	Greenhouse

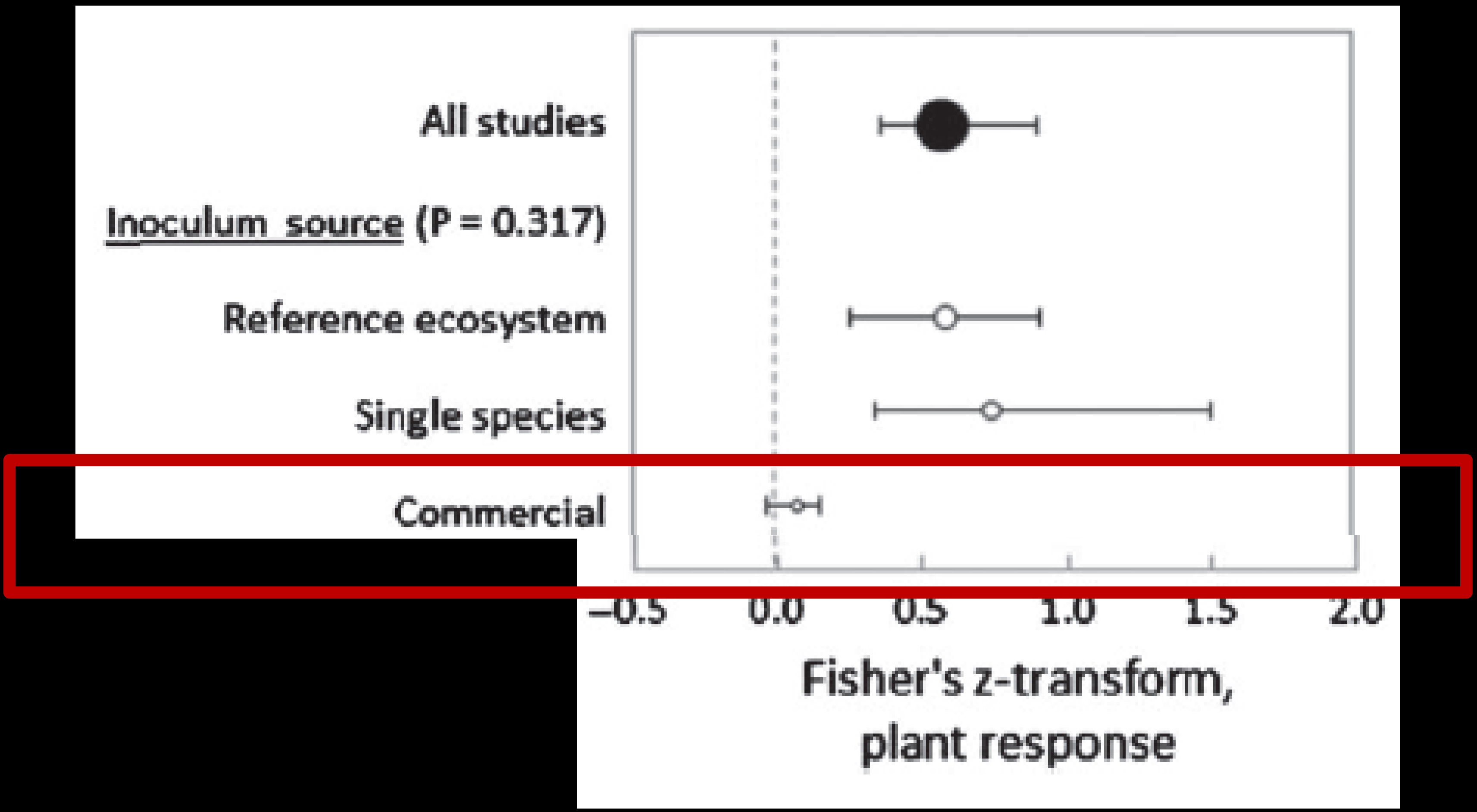
Inoculation increases canopy cover, and faster



Discussion

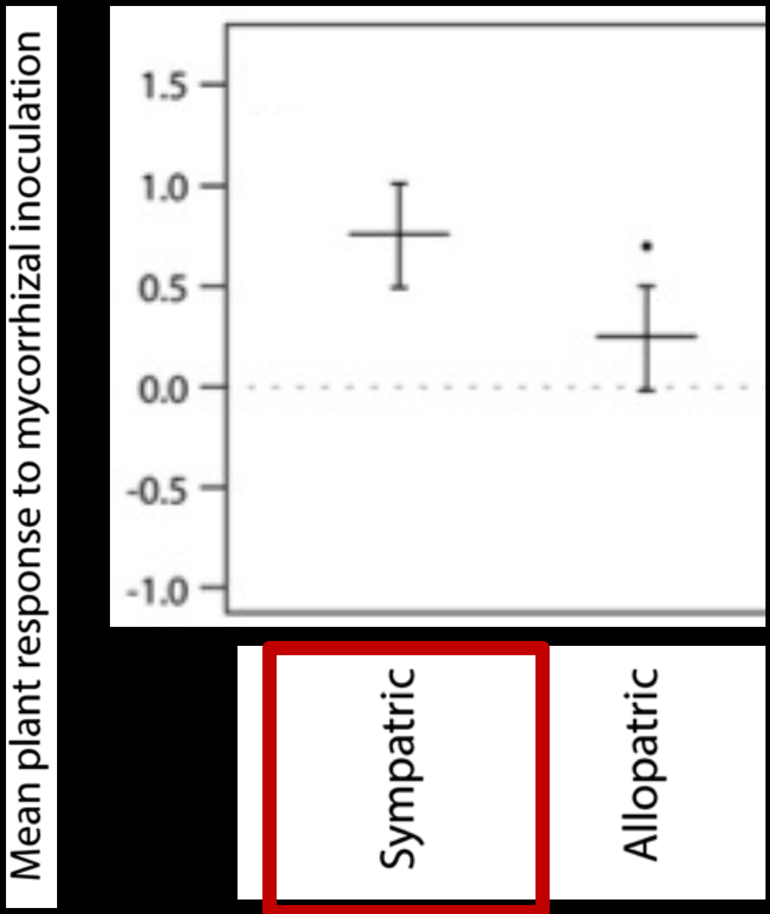
1) What is ”appropriate” mycorrhizal inoculation?

Please do not use commercial inoculum
Neutral to negative effects occur with a poor match between plants, soil, and mycorrhizas



Maltz & Treseder, 2015

“These results … emphasize the importance of routinely considering the origin of plant, soil, and fungal components.”



Rua et al. 2016

Discussion

1) What other factors might affect inoculation outcomes?

   - Water availability
   - Timing of inoculation
   - Other management actions that impact mycorrhizas (e.g. pesticides, fuel management…)

[redacted]

THURSDAY, FEBRUARY 6, 2020

OPTION 3

WORKSHOP | USING MYCORRHIZAL FUNGI IN RESTORATION PROJECTS OF THE SOUTHWESTERN U.S.
WITH NORTHERN ARIZONA UNIVERSITY

8:00 AM ~ 12:00 PM
$20, TRANSPORTATION PROVIDED
MEET IN THE WEST BALLROOM AT 8 AM

[redacted]

Discussion

2) What decisions are practitioners facing at specific sites that should be included in model scenarios?

Nest Steps

1) Refine model specifics
   (e.g. each planting type modeled for comparisons).

2) Add sites under consideration for restoration.

3) Incorporate manager scenarios, to address key decisions.

4) Use model to weight SWFL outcomes vs. cost.

Thank you!

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SWFL photo, 1st slide: S&D Maslowski, nps.gov