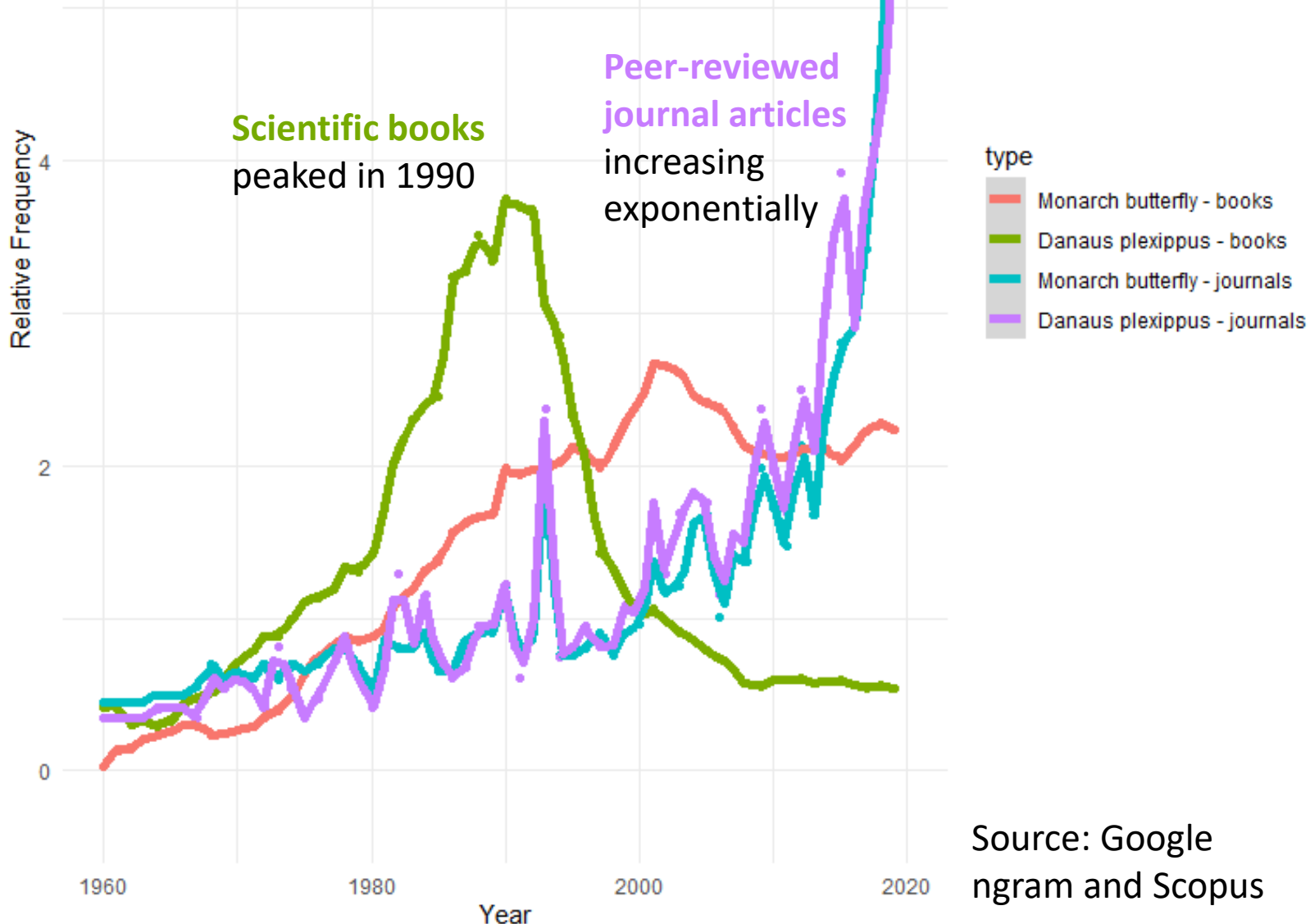




# State of Monarch Science

Wayne Thogmartin  
U.S. Geological Survey

# Scientific interest in monarch butterflies is exploding



Source: Google ngram and Scopus





# Incomplete and Rushed Overview of Monarch Science

Wayne Thogmartin  
U.S. Geological Survey



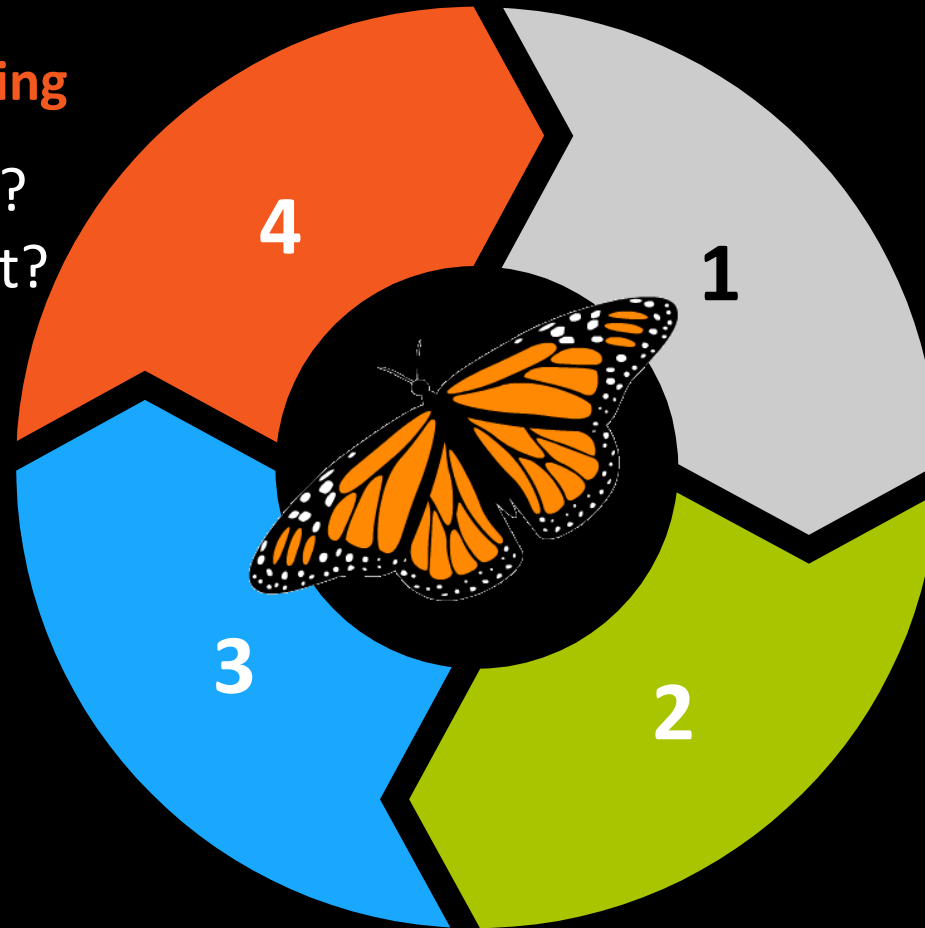
# Strategic Habitat Conservation

## Outcome-based Monitoring

Are monarchs doing better?  
What do we need to do next?

## Conservation Delivery

Are we conserving and  
restoring habitat?



## Biological Planning

What population size  
is needed to reduce  
the risk of extinction?

## Conservation Design

What is the most effective  
strategy for increasing the  
population size?



# Strategic Habitat Conservation

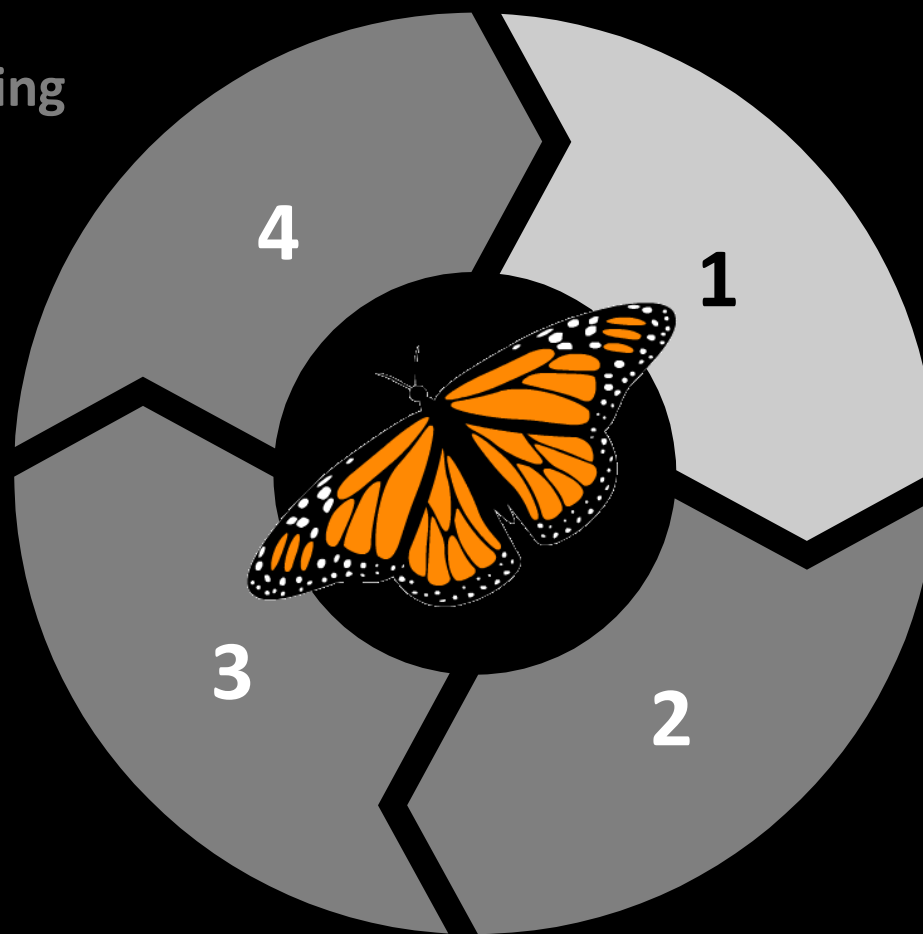
Outcome-based Monitoring

Biological Planning

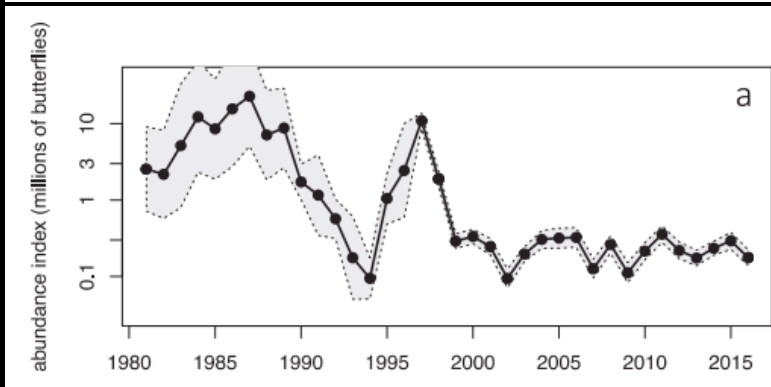
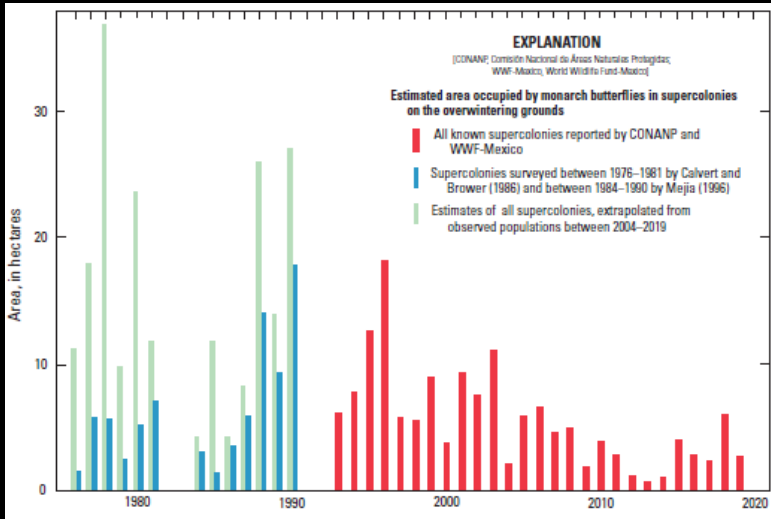
Goal Setting:  
How **many** monarchs  
do we want?

Conservation Delivery

Conservation Design



# Population Goals: Aspiration or Desperation?



**High risk of  
extirpation**

**62% probability  
dropping another  
90% in East**

**and ~50-75%  
probability in West**

SCIENTIFIC REPORTS

OPEN Quasi-extinction risk and population targets for the Eastern, migratory population of monarch butterflies (*Danaus plexippus*)

Received: 22 July 2015  
Accepted: 23 February 2016  
Published: 21 March 2016

Brice X. Semmens<sup>1</sup>, Darius J. Semmens<sup>2</sup>, Wayne E. Thogmartin<sup>3</sup>, Ruscena Wiederholt<sup>4</sup>, Laura López-Hoffman<sup>4</sup>, Jay E. Diffendorfer<sup>2</sup>, John M. Pleasants<sup>5</sup>, Karen S. Oberhauser<sup>6</sup> & Orley R. Taylor<sup>7</sup>

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: [www.elsevier.com/locate/biocon](http://www.elsevier.com/locate/biocon)

ELSEVIER

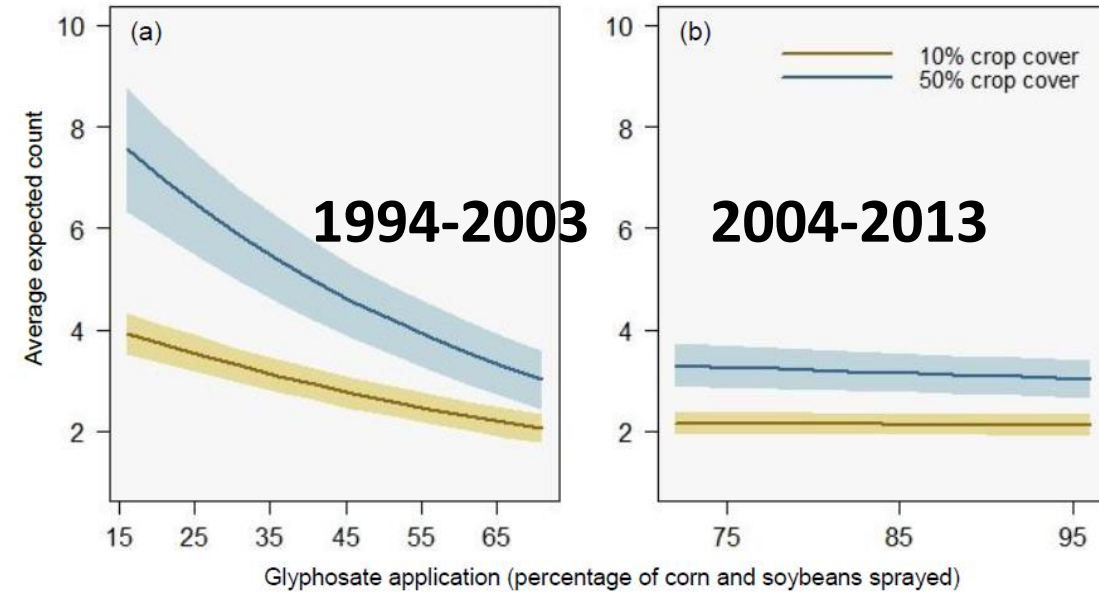
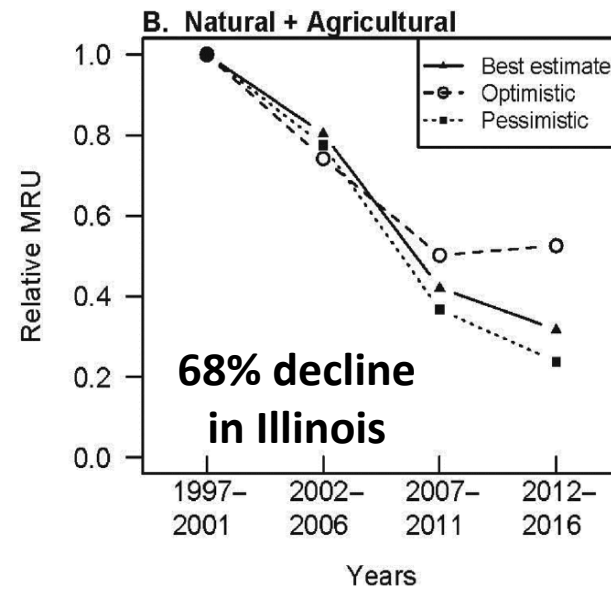
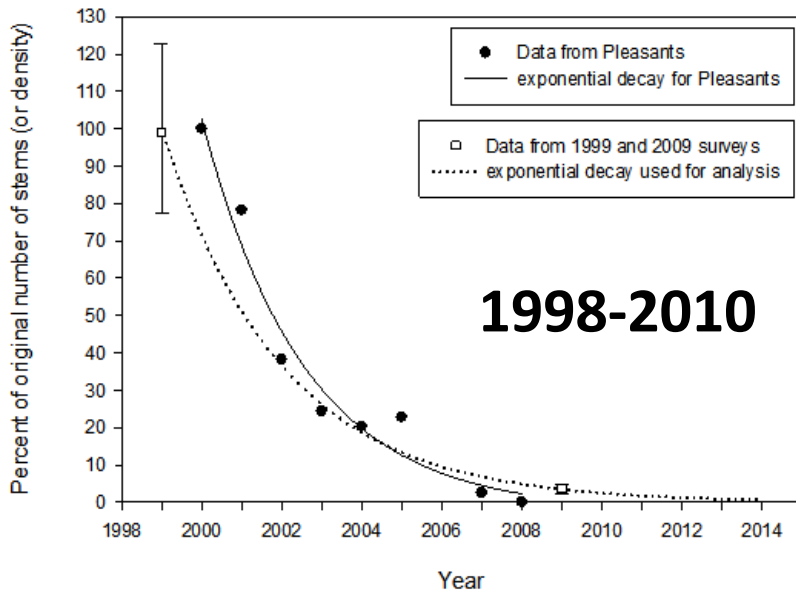
Short communication

Citizen science monitoring demonstrates dramatic declines of monarch butterflies in western North America

Cheryl B. Schultz<sup>a,\*</sup>, Leone M. Brown<sup>b</sup>, Emma Pelton<sup>c</sup>, Elizabeth E. Crone<sup>d</sup>

# 70% decline in milkweed over Midwest

## Milkweed eradicated from corn and soy



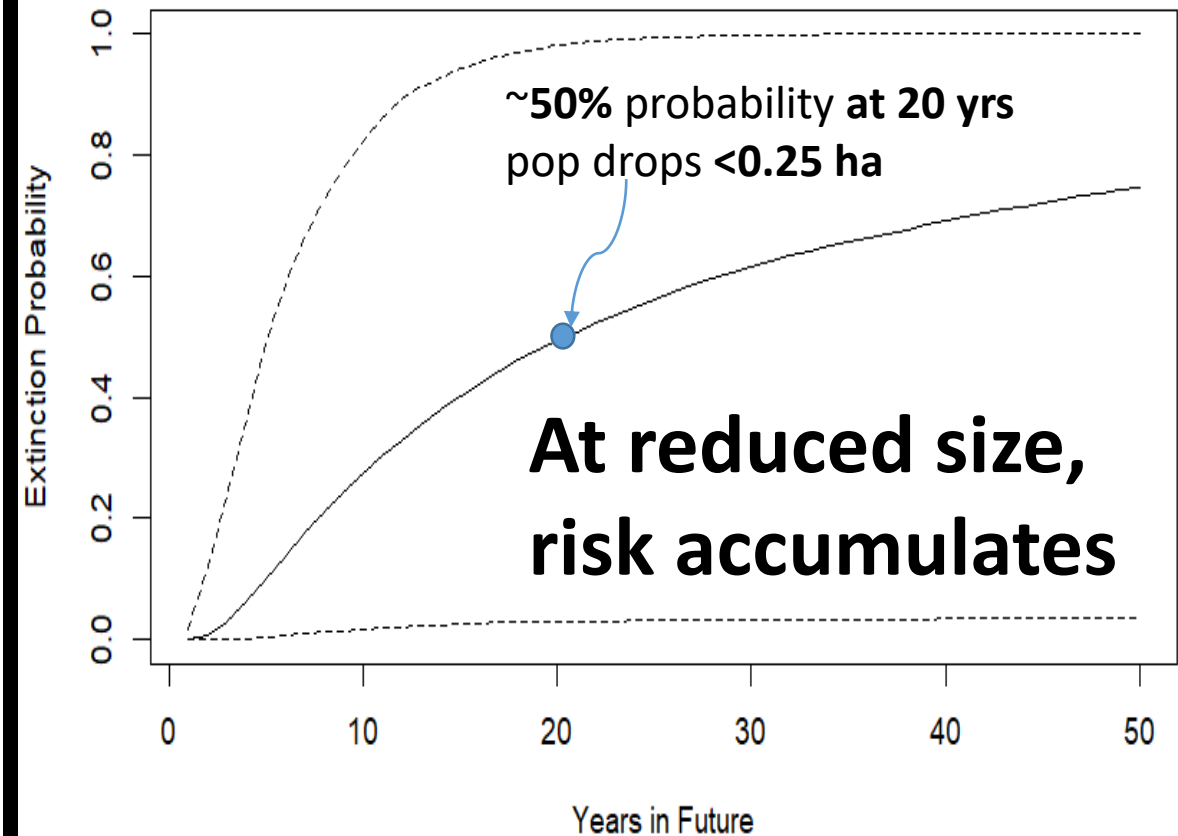
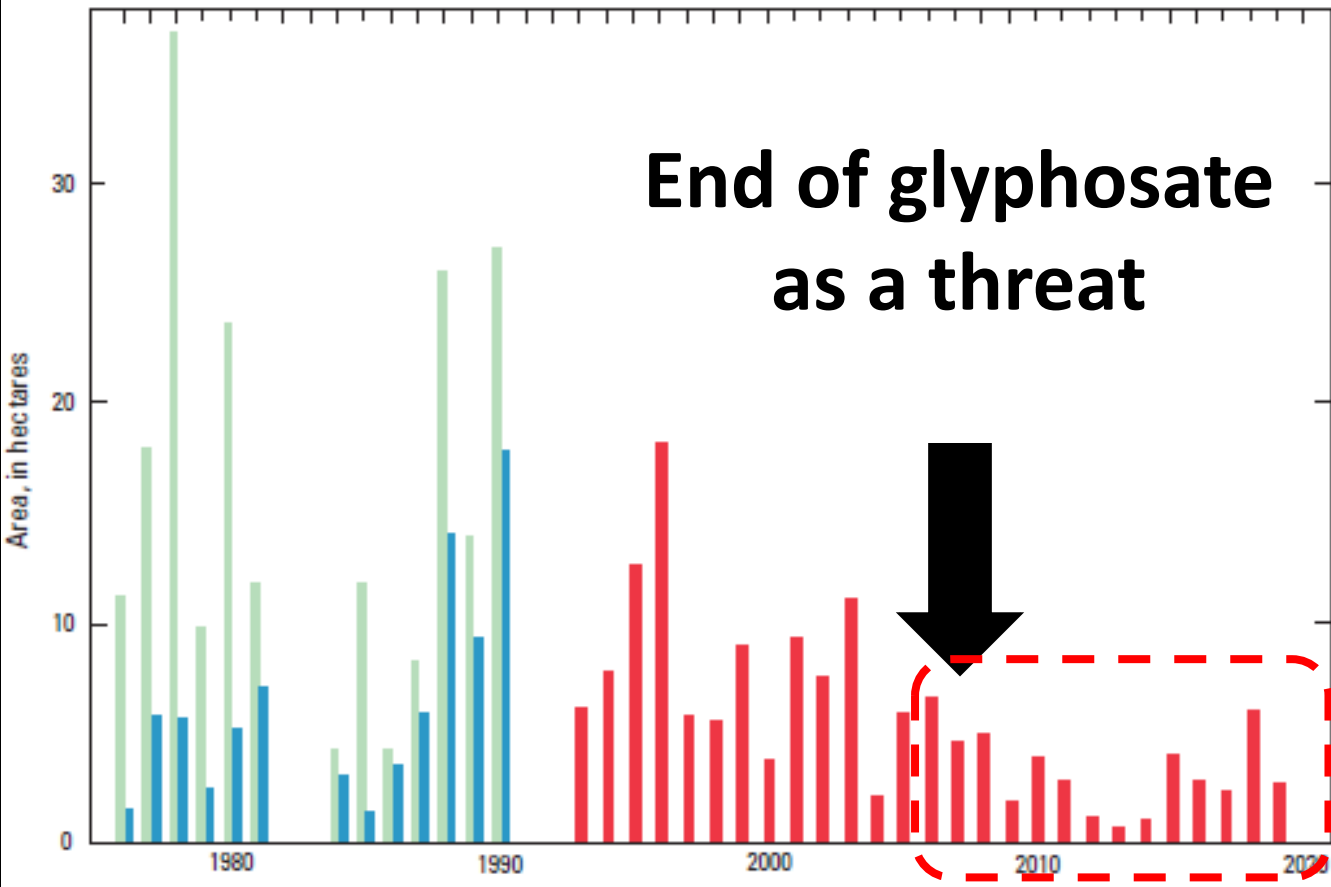
Pleasants and Oberhauser 2013  
Pleasants 2017

Zaya et al. 2017

Saunders et al. 2017

Pleasants 2017 : 71% decline in milkweed in Midwest

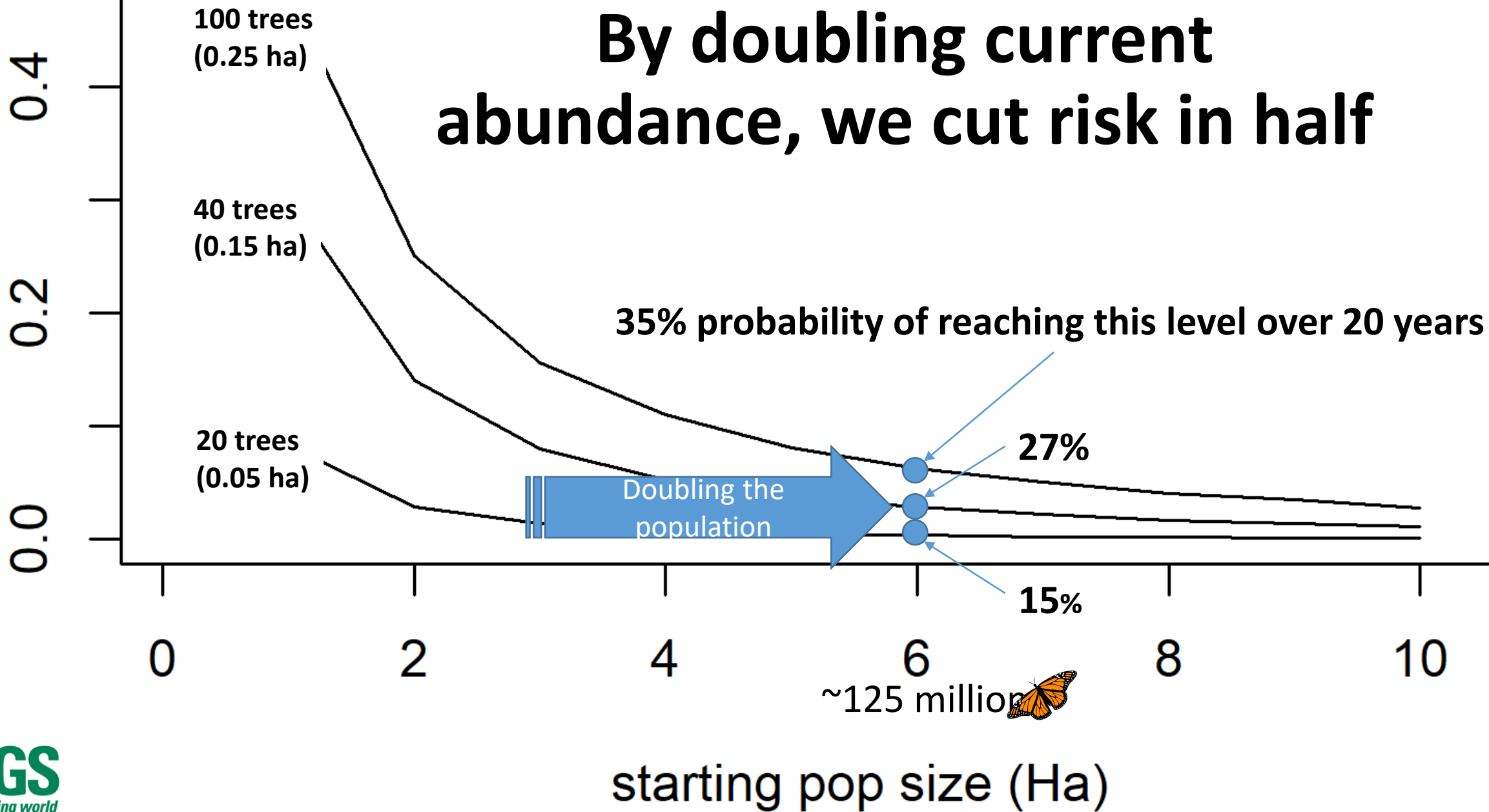
# At reduced population size, still at risk





extinction probability

# By doubling current abundance, we cut risk in half

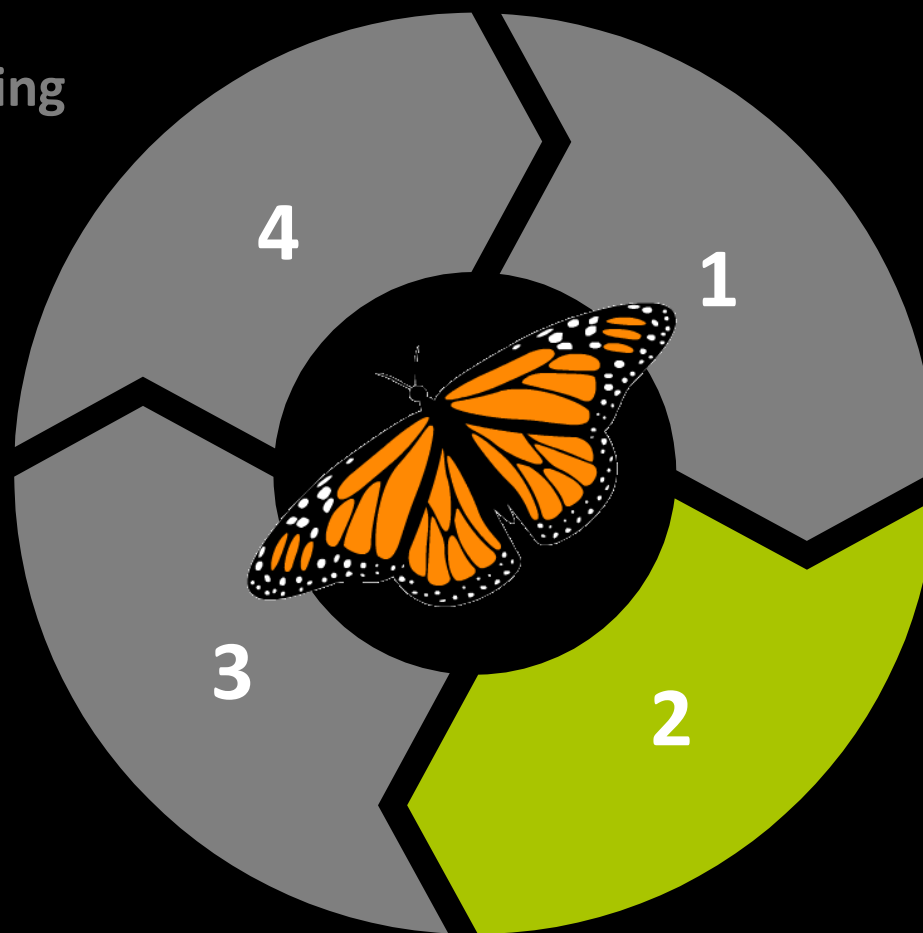




# Strategic Habitat Conservation

Outcome-based Monitoring

Biological Planning

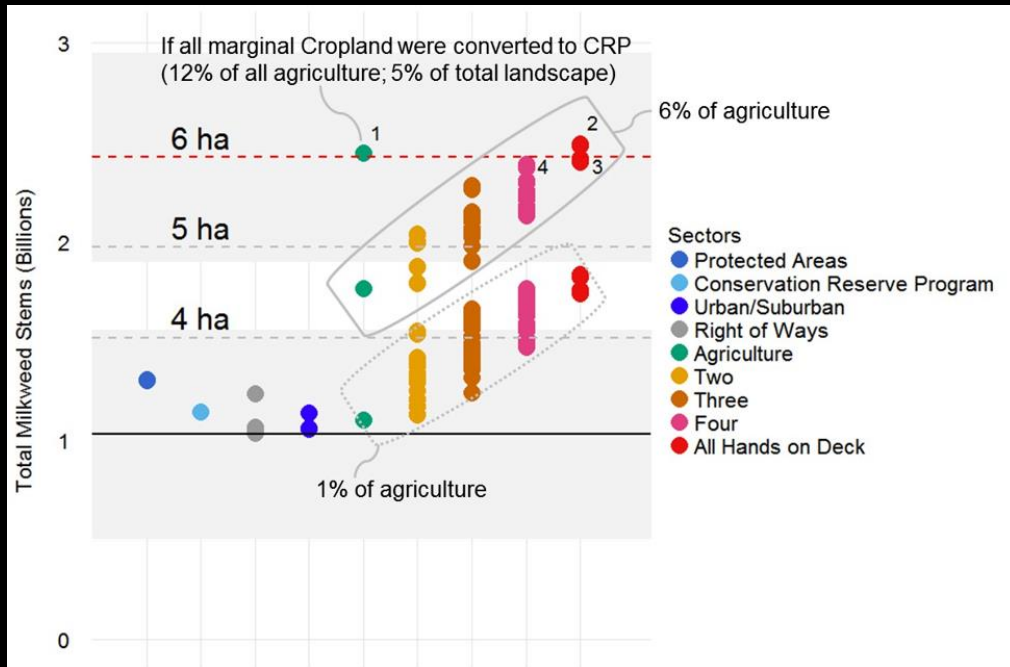


Conservation Delivery

**Conservation Design**

Spatially explicit models  
Habitat Objectives  
Priority Areas

# How can we achieve >1.3 billion more stems?



Environ. Res. Lett. 12 (2017) 074005

<https://doi.org/10.1088/1748-9326/aa7637>

## Environmental Research Letters

### LETTER

## Restoring monarch butterfly habitat in the Midwestern US: 'all hands on deck'

Wayne E Thogmartin<sup>1,21</sup>, Laura López-Hoffman<sup>2</sup>, Jason Rohweder<sup>1</sup>, Jay Diffendorfer<sup>3</sup>, Ryan Drum<sup>4</sup>, Darius Semmens<sup>5</sup>, Scott Black<sup>6</sup>, Iris Caldwell<sup>7</sup>, Donita Cotter<sup>8</sup>, Pauline Drobney<sup>9</sup>, Laura L Jackson<sup>10</sup>, Michael Gale<sup>9</sup>, Doug Helmers<sup>11</sup>, Steve Hilburger<sup>12</sup>, Elizabeth Howard<sup>13</sup>, Karen Oberhauser<sup>14</sup>, John Pleasants<sup>15</sup>, Brice Semmens<sup>16</sup>, Orley Taylor<sup>17</sup>, Patrick Ward<sup>18</sup>, Jake F Weltzin<sup>19</sup> and Ruscena Wiederholt<sup>20</sup>

## All Hands on Deck

Of >200 scenarios evaluated, only 4 identified a path to success, 3 of which required participation from all sectors of society to recover milkweed



# Strategic Habitat Conservation

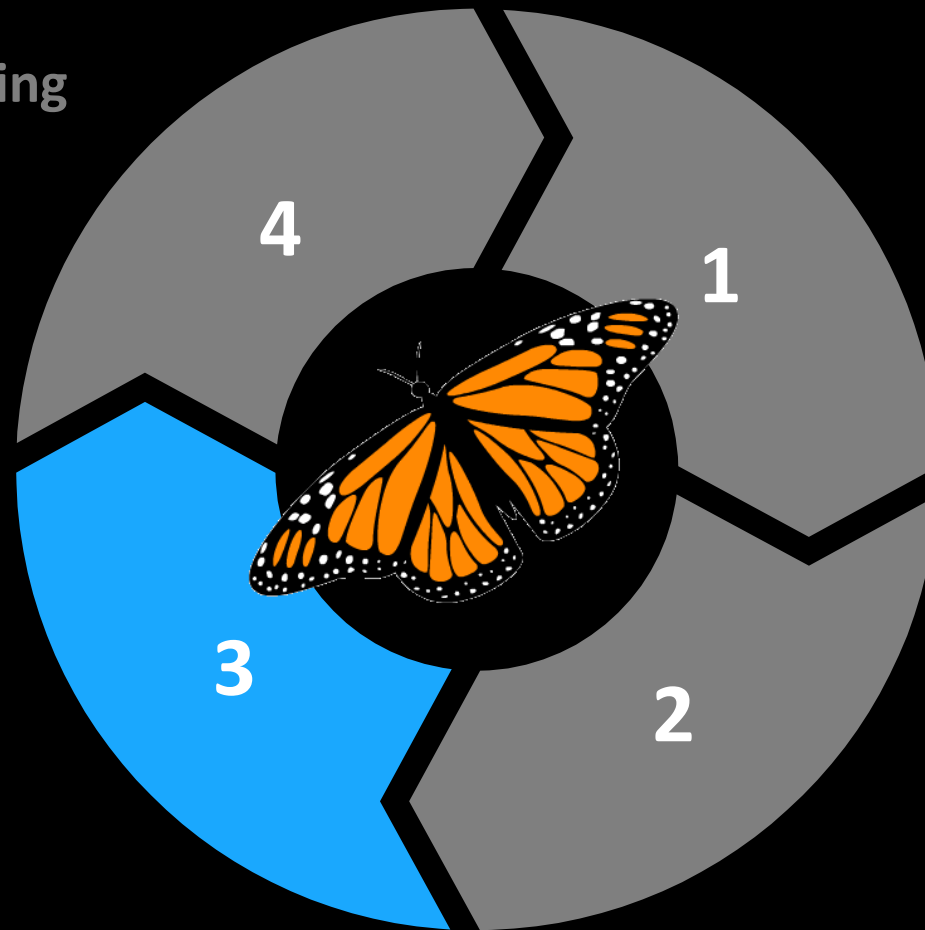
● Outcome-based Monitoring

● Biological Planning

● Conservation Delivery

● Conservation Design

Wholesale land transformation  
in the East



# Land Transformation

MAFWA Mid-America Monarch Conservation Strategy

Rights-of-way as Habitat Working Group & FWS Candidate Conservation Agreement with Assurances (CCAA)

Journal of Applied Ecology



RESEARCH ARTICLE | [Open Access](#) |

Influence of habitat quality and resource density on breeding-season female monarch butterfly *Danaus plexippus* movement and space use in north-central USA agroecosystem landscapes

Kelsey E. Fisher Steven P. Bradbury

Assessing a farmland set-aside conservation program for an endangered butterfly: USDA State Acres for Wildlife Enhancement (SAFE) for the Karner blue butterfly

Paula Kleintjes Neff , Christina Locke & Eric Lee-Mäder

[Journal of Insect Conservation](#) **21**, 929–941 (2017) | [Cite this article](#)

Front. Ecol. Evol., 21 June 2019  
Sec. Conservation and Restoration Ecology  
Volume 7 - 2019 | <https://doi.org/10.3389/fevo.2019.00220>

This article is part of the Research Topic  
North American Monarch Butterfly Ecology and Conservation  
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Does Nature Need Cities? Pollinators Reveal a Role for Cities in Wildlife Conservation

Abigail Derby Lewis<sup>1\*</sup>, Mark J. Bouman<sup>1</sup>, Alexis M. Winter<sup>1</sup>, Erika A. Hasle<sup>1</sup>,

Front. Ecol. Evol., 21 June 2019  
Sec. Conservation and Restoration Ecology  
Volume 7 - 2019 | <https://doi.org/10.3389/fevo.2019.00220>

This article is part of the Research Topic  
North American Monarch Butterfly Ecology and Conservation  
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Estimating Milkweed Abundance in Metropolitan Areas Under Existing and User-Defined Scenarios

Mark K. Johnston<sup>1</sup>, Erika M. Hasle<sup>1</sup>, Karen R. Klinger<sup>1</sup>, Marc P. Lambusch<sup>1</sup>,

ZOOBIOLOGY

RESEARCH ARTICLE | [Open Access](#) |

Conservation psychology strategies for collaborative planning and impact evaluation

Lily Maynard , Paige Howorth, Jaret Daniels, Katie-Lyn Bunney, Rebecca Snyder, David Jenike, Trent Barnhart, Edward Spevak, Patrick Fitzgerald, Zak Gezon

Conservation Letters

A Journal of the Society for Conservation Biology

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National Valuation of Monarch Butterflies Indicates an Untapped Potential for Incentive-Based Conservation

Jay E. Diffendorfer , John B. Loomis, Leslie Ries, Karen Oberhauser, Laura Lopez-Hoffman, Darius Semmens, Brice Semmens, Bruce Butterfield, Ken Bagstad, Josh Goldstein, Ruscena Wiederholt, Brady Mattsson, Wayne E. Thogmartin ... [See fewer authors](#) ^



# Strategic Habitat Conservation

## Outcome-based Monitoring

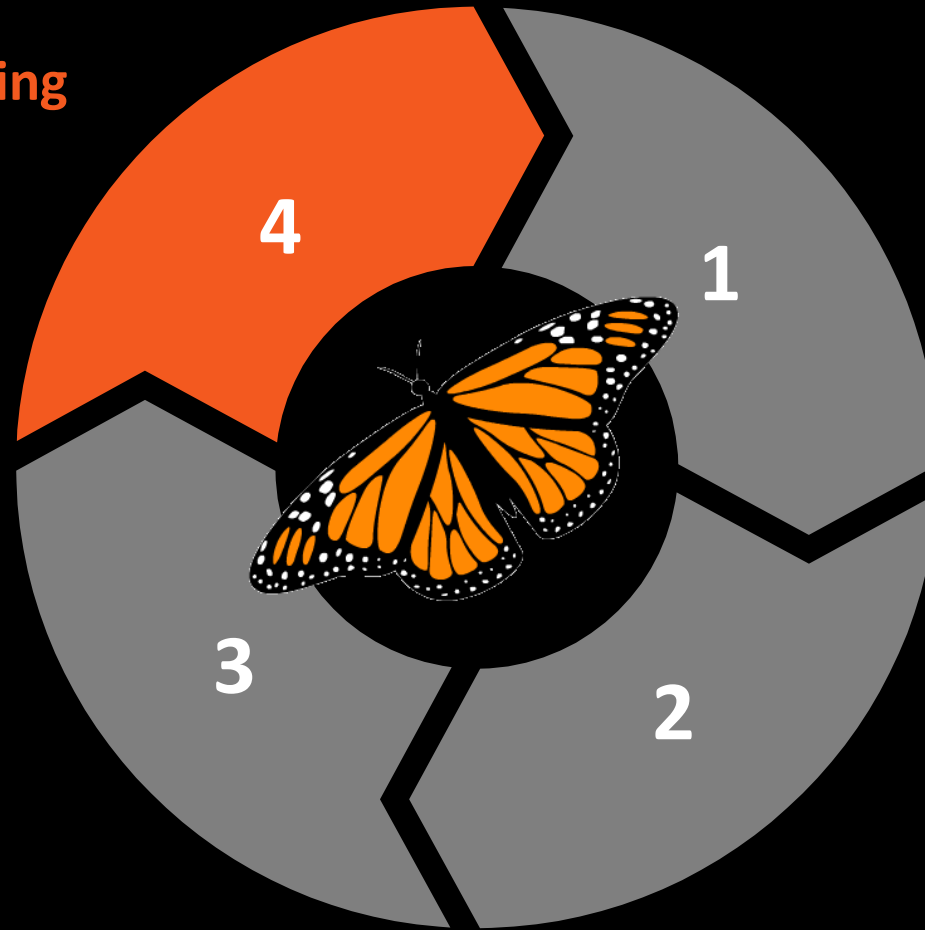
Were our assumptions correct?

Did our actions achieve intended results?

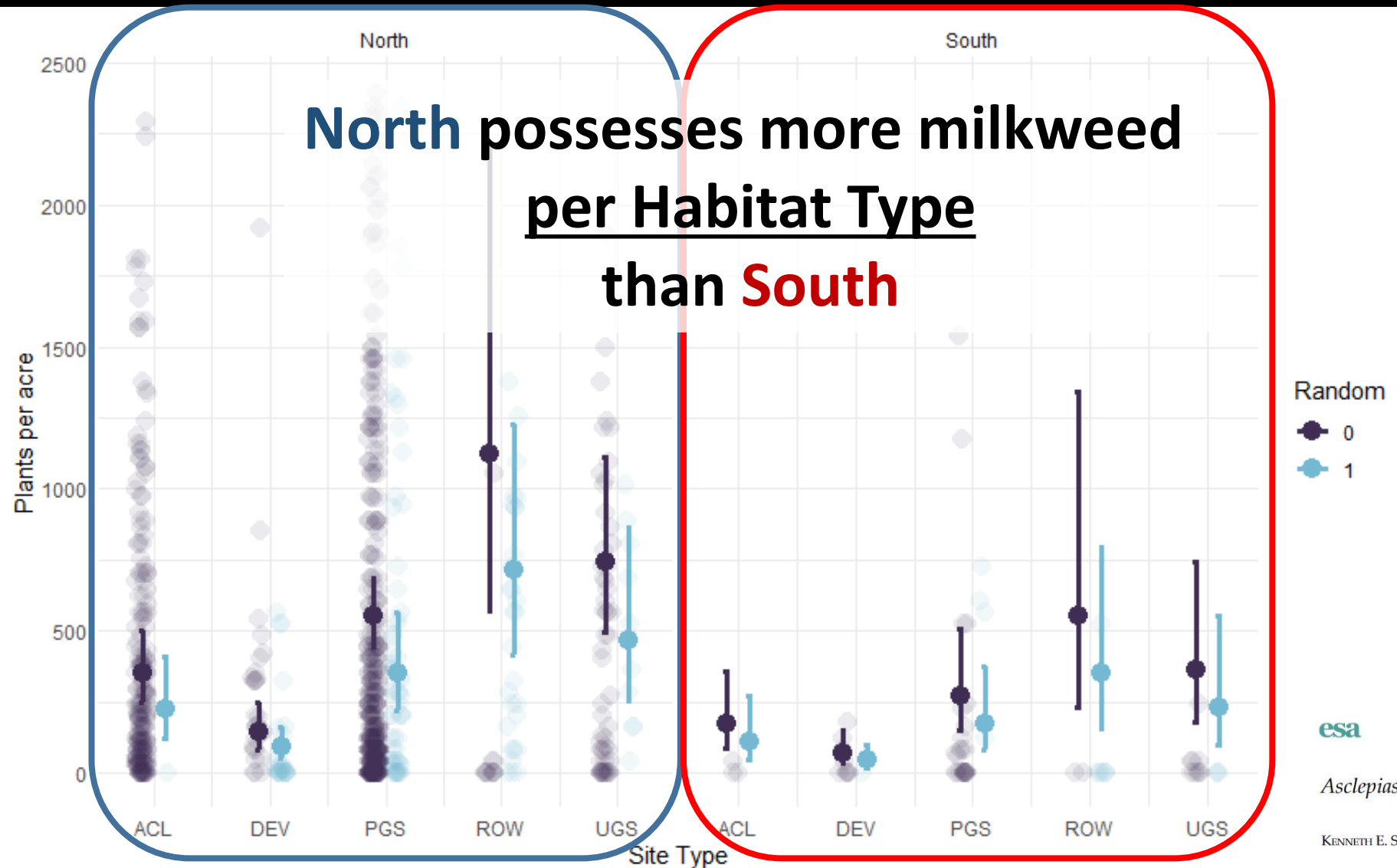
Conservation Delivery

Biological Planning

Conservation Design



# Burgeoning research testing our assumptions



~1 billion stems in Midwest

(goal: +1.3-1.8 billion more)

In Texas rangelands, ~800M plants (~2.4B stems)

esa

ECOSPHERE

*Asclepias* dynamics on US rangelands: implications for conservation of monarch butterflies and other insects

KENNETH E. SPAETH JR,<sup>1,†</sup> PHILIP J. BARBOUR,<sup>1</sup> RAY MORANZ,<sup>2</sup> STEPHEN J. DINSMORE,<sup>3</sup> AND C. JASON WILLIAMS<sup>1,4</sup>



[wthogmartin@usgs.gov](mailto:wthogmartin@usgs.gov)

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