DoD Natural Resources Program

Enabling the Mission, Defending the Resources

Conservation and Management of Western Monarchs on DoD Lands

August 12, 2020

Please mute your phones.

Audio Dial-In: 800-300-3070

Participant Code: 642-508-534

www.denix.osd.mil/nr/

Twitter: @DoDNatRes

Conservation and Management of Western Monarchs on DoD Lands

Cheryl Schultz[1], Stephanie McKnight[2], Cameron C. Thomas[1], Emma Pelton[2], Sarina Jepsen[2], David James[1], and Elizabeth Crone[3]

[1]Washington State University, [2]Xerces Society for Invertebrate Conservation, [3]Tufts University

This research project was funded by the Department of Defense Legacy Resource Management Program and US Fish and Wildlife Service

xerces.org

The Xerces Society

The Xerces Society is a science based nonprofit organization that engages in education, outreach, applied research, policy, and restoration to protect invertebrates and their habitats

Conservation programs:

- Pollinators
- Endangered Species
- Aquatic Conservation
- Pesticides

Photo: ©The Florida Museum

xerces.org

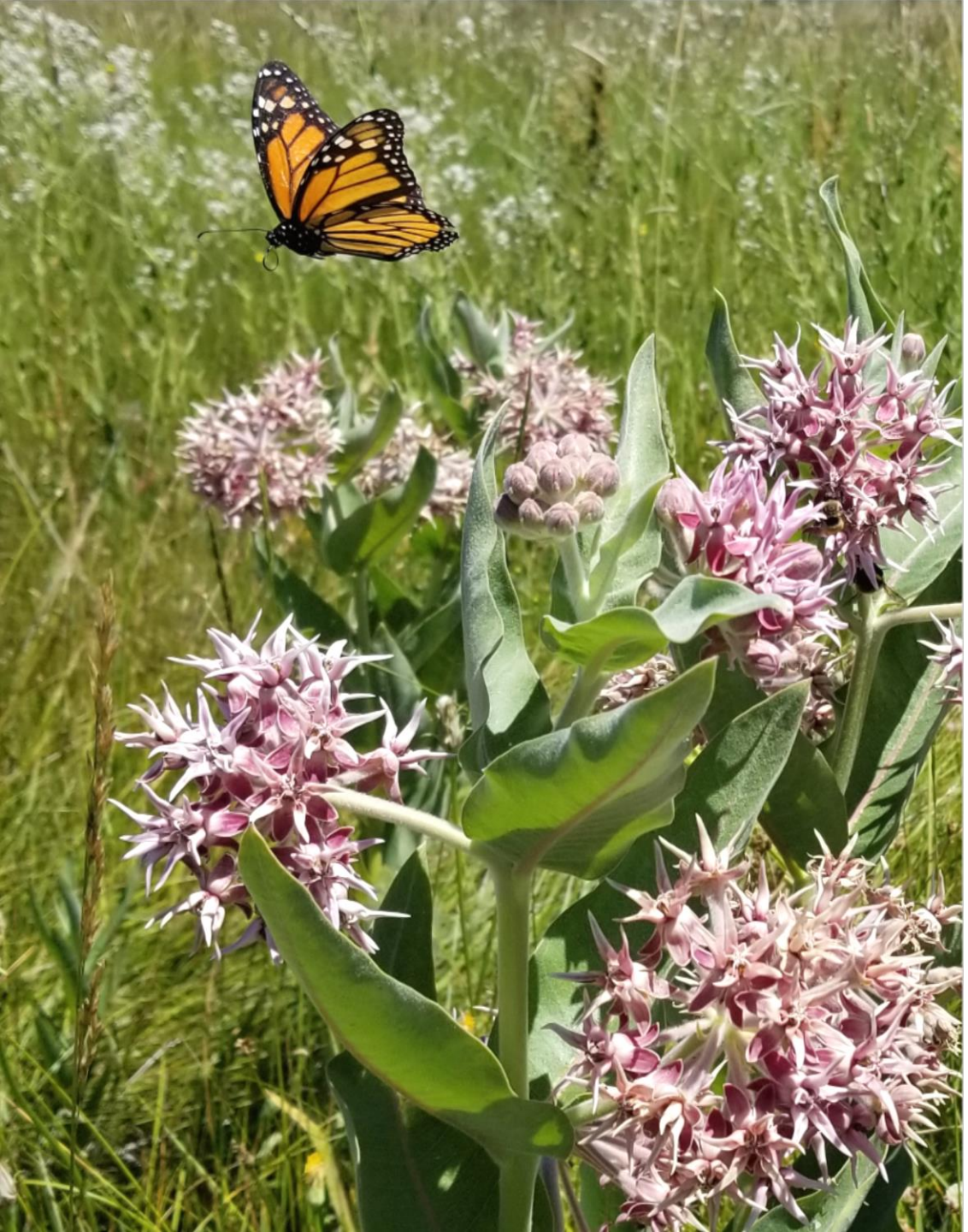


Photo: Stephanie McKnight, Xerces Society

Presentation Overview

I. Brief Overview of Western Monarch Life History

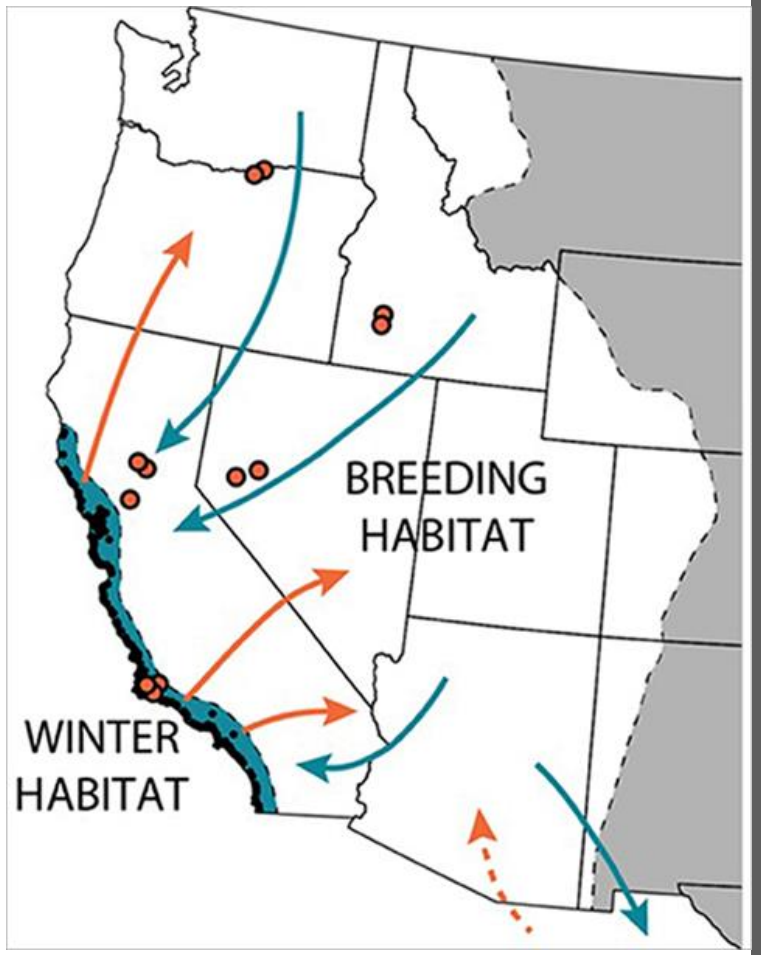
II. Western Monarch Population Status and Call to Action

III. Research Overview: Conservation and Management of Western Monarchs on DoD Lands: Implications of Breeding Phenology

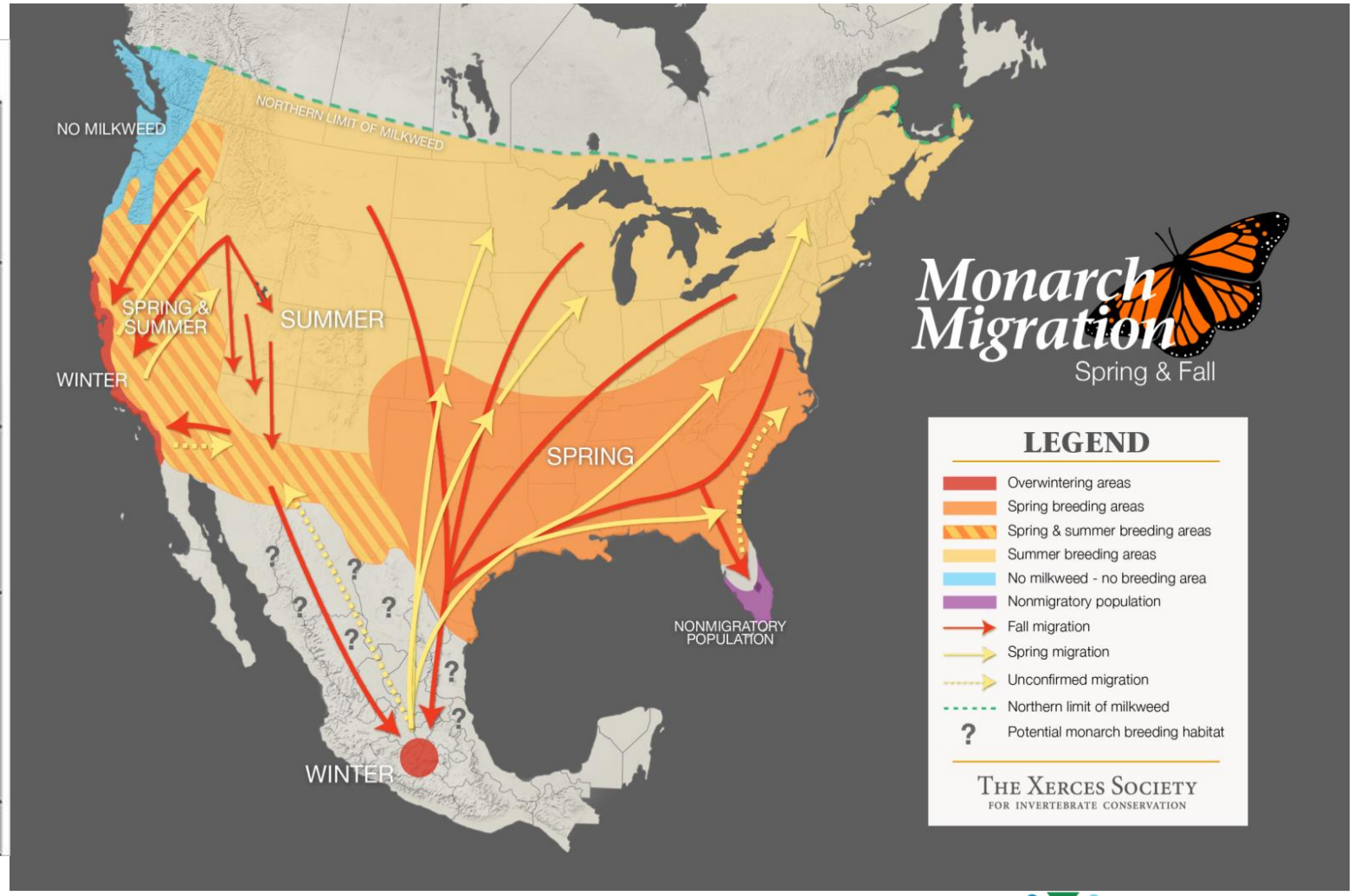
IV. Research implications for managing DoD Lands for Monarchs

xerces.org

What's a "western" monarch?



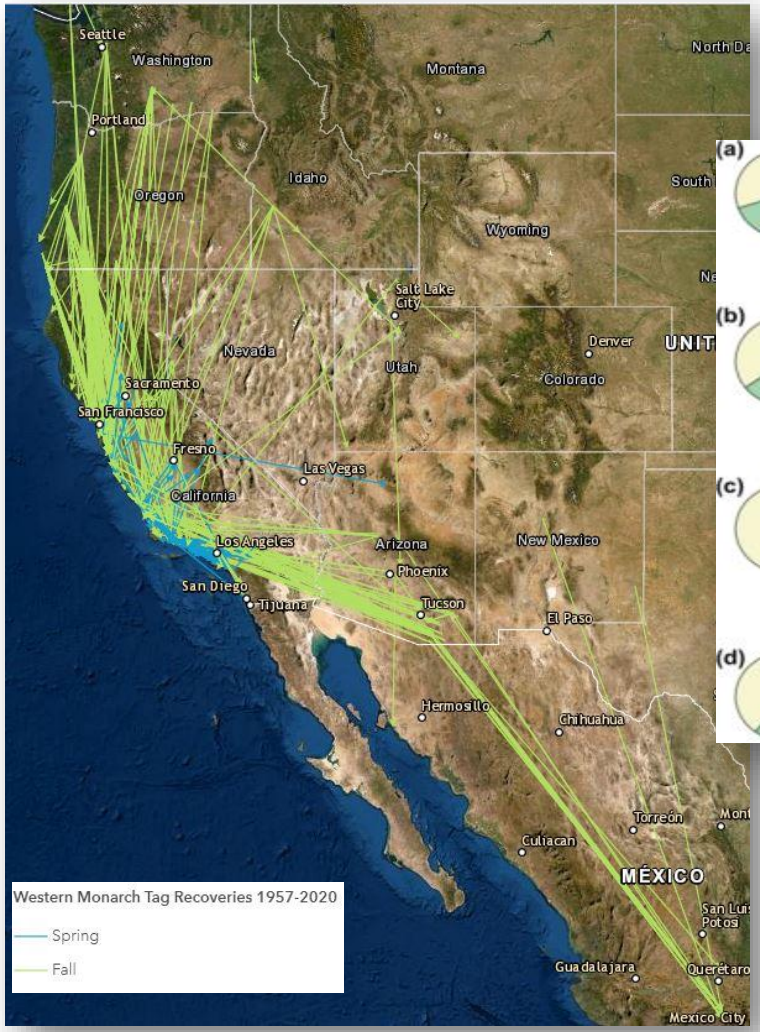
Graphic from Pelton et al. 2019



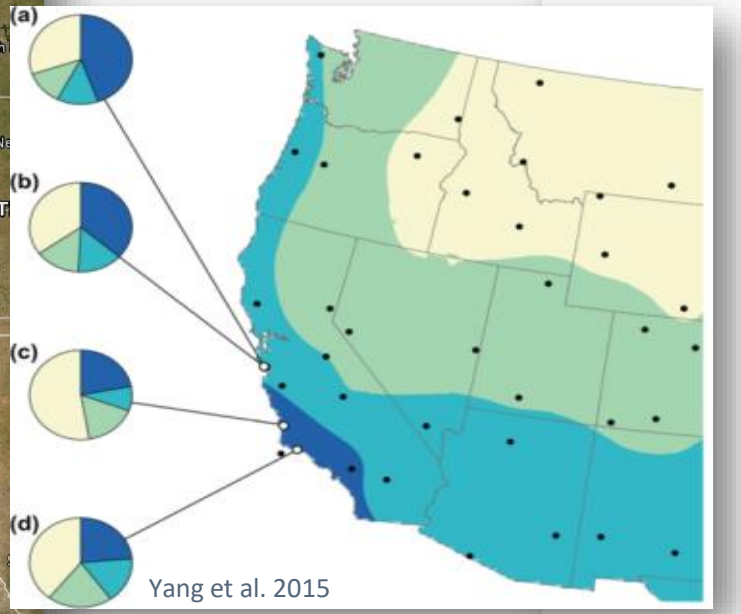
xerces.org

What's a "western" monarch?

Tagging

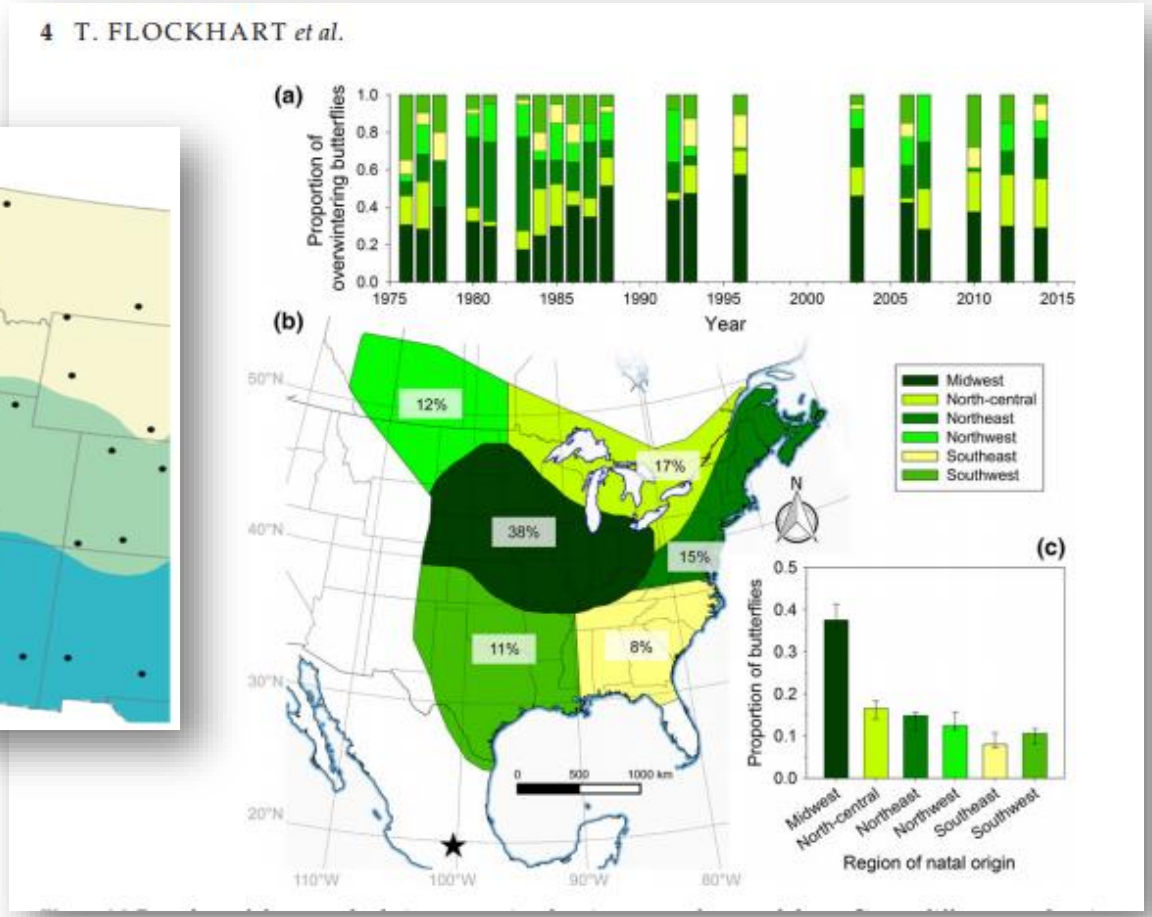


Isotopic signatures



Yang et al. 2015

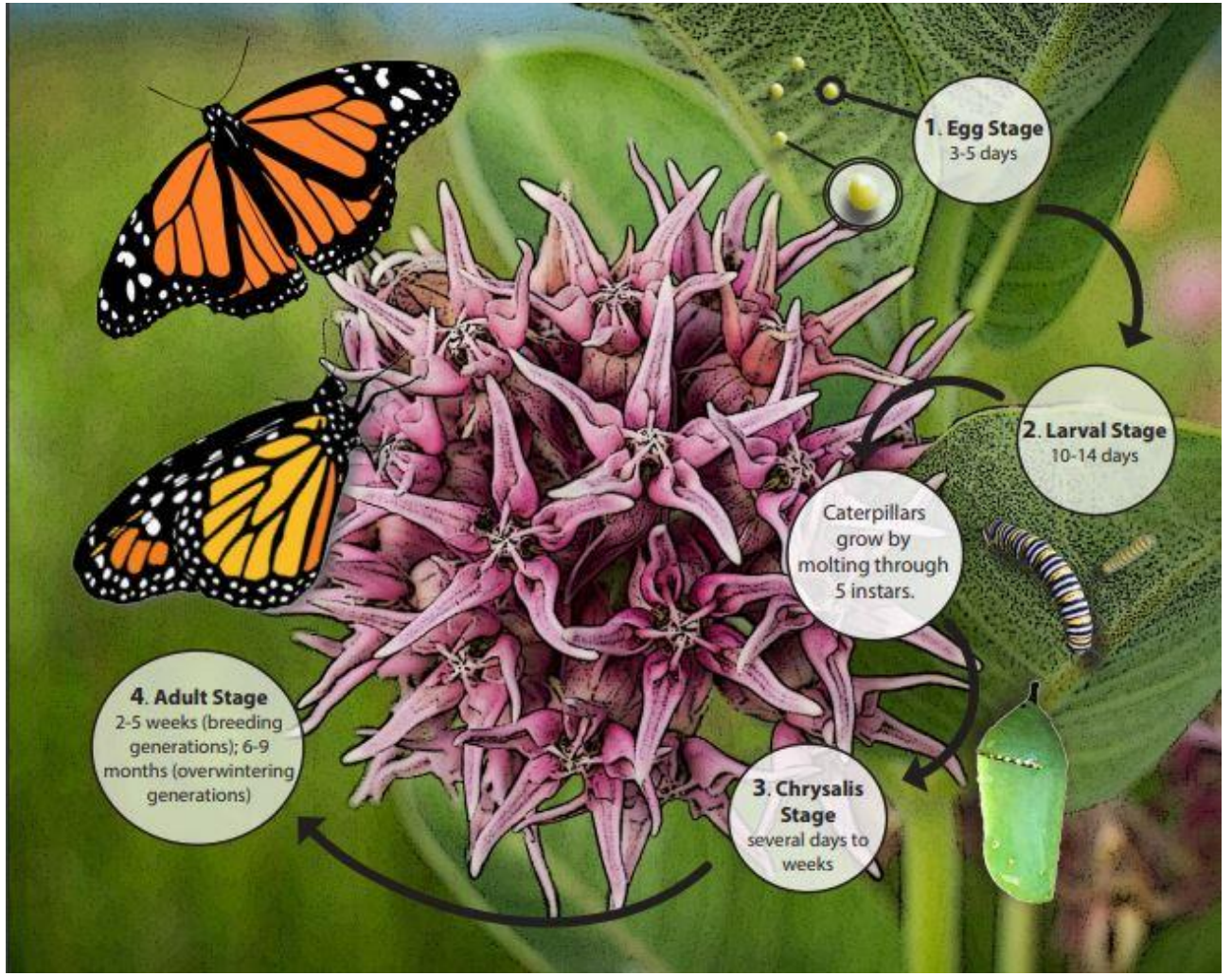
+ Genetics + Adaptations



xerces.org

Graphics sources: Left: Xerces western monarch tag recovery database; Right: inset: Yang et al. 2015, larger map: Flockhart et al. 2017

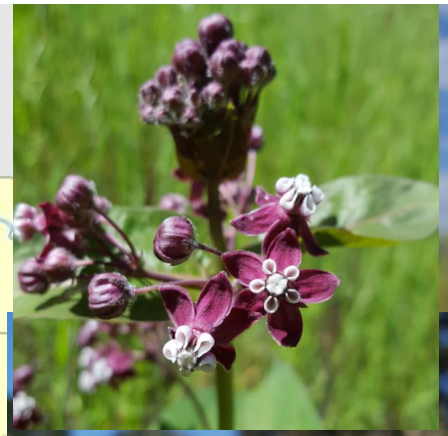
Monarch Life Cycle



xerces.org

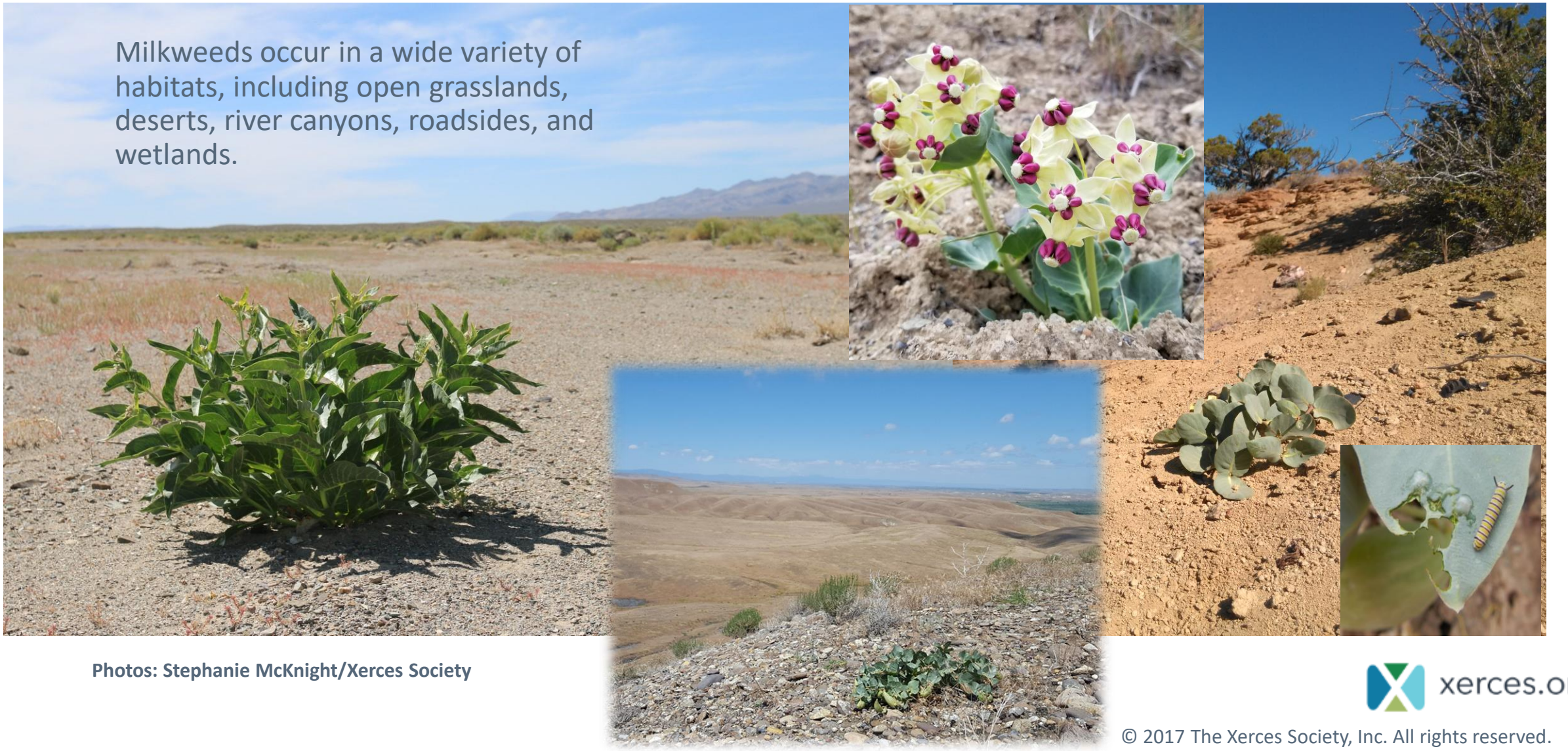
Western Milkweed Species

- There are approximately 72 milkweed species native to the U.S. and Canada (excluding ssp.)
- ~44 of these species are found in the western U.S.
- Showy milkweed (*A. speciosa*) is the most broadly distributed species in the West.
- Monarchs have been documented using ~20 of these species as larval hosts.
- Several non-native milkweed species occur in California, including tropical milkweed (*A. curassavica*)



xerces.org

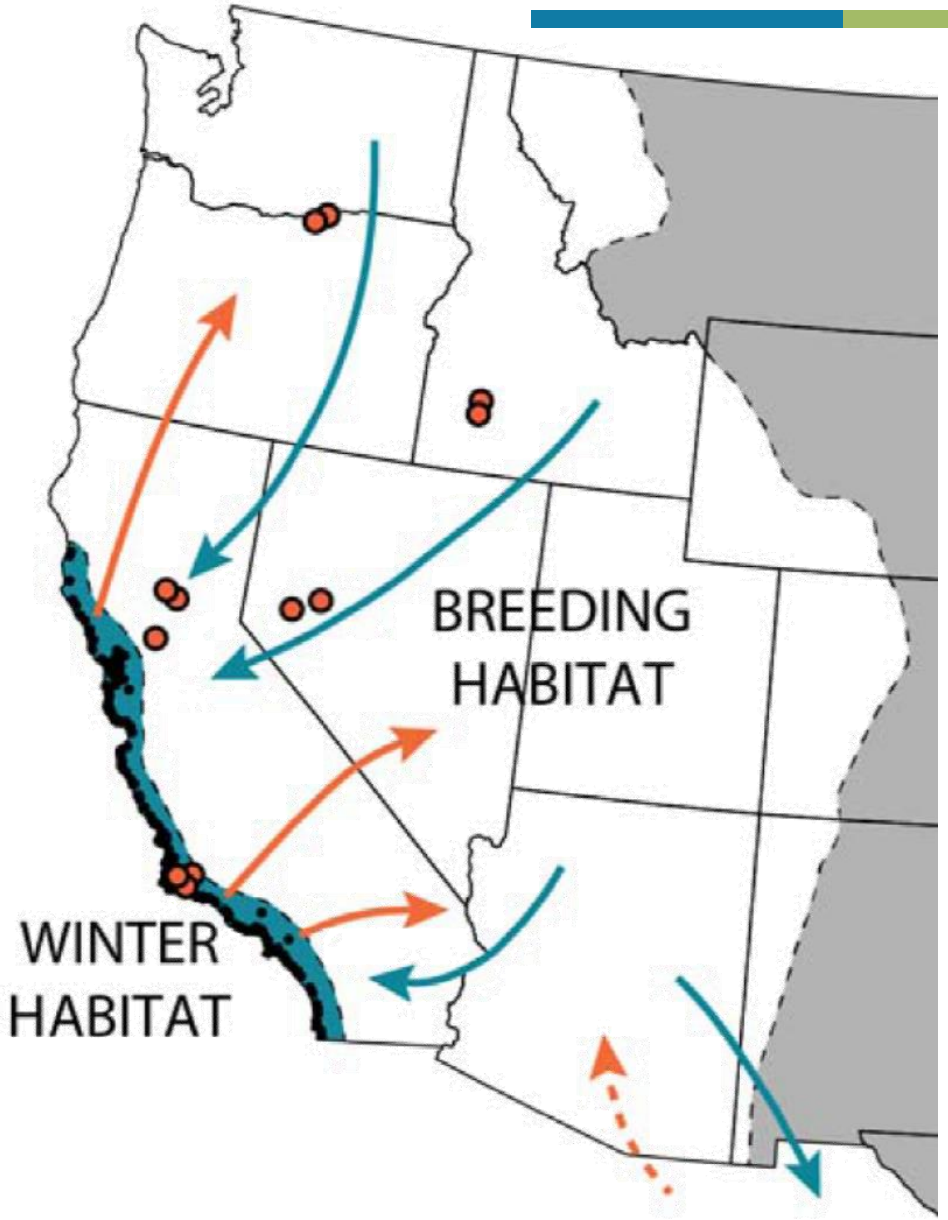
Milkweeds in the Landscape



Photos: Stephanie McKnight/Xerces Society

xerces.org

Western Monarch Migration and Breeding Timing



Map by Elizabeth Crone and Cheryl Schultz

Seasonal monarch movements in the West

- Monarchs typically overwinter from mid-Oct to mid-February
- Monarchs reach interior West in early summer
- Phenology in the West has been poorly understood.
  - Spring Dispersal - overwintering generation oviposits on milkweed in California to start first breeding generation: February-April
  - Summer Breeding and Range Expansion: May-September
  - Fall Migration: September-October
  - Overwintering: November-February

xerces.org

Western Monarch Overwintering Biology

Adult monarchs overwinter in clusters in protected microhabitats provided by groves of trees from ~October-February

Trees include native pines, cypress, and non-native eucalyptus trees, however research has found that monarchs prefer native trees.

- Monarchs are known to cluster **at over 400 locations** along the California coast from Mendocino to Baja, Mexico as well as small, inland sites in Inyo county, the Las Vegas area, and parts of Arizona
- Only ~30 sites routinely host more than 1,000 monarchs

Overwintering sites provide suitable micro-climate conditions such as

- protection from wind and freezing temperatures
- Variable light conditions (dappled sunlight)
- available nectar sources; water
- adequate humidity

Photo: Candace Fallon, the Xerces Society, Map by the Xerces Society

xerces.org

Western Monarchs: Population Status and Call to Action

Photo: Stephanie McKnight/Xerces Society

xerces.org

Photo: Xerces Society / Candace Fallon

Western Monarchs in Crisis

Western monarchs have declined by over 99% since the 1980s.

There were an estimated **4.5 million** monarchs overwintering in California in the 1980s.

This season's Thanksgiving count totaled ~29,000 monarchs, less than 1% of the population's size in the 1980s and nearly identical to last year's total of an all-time low.

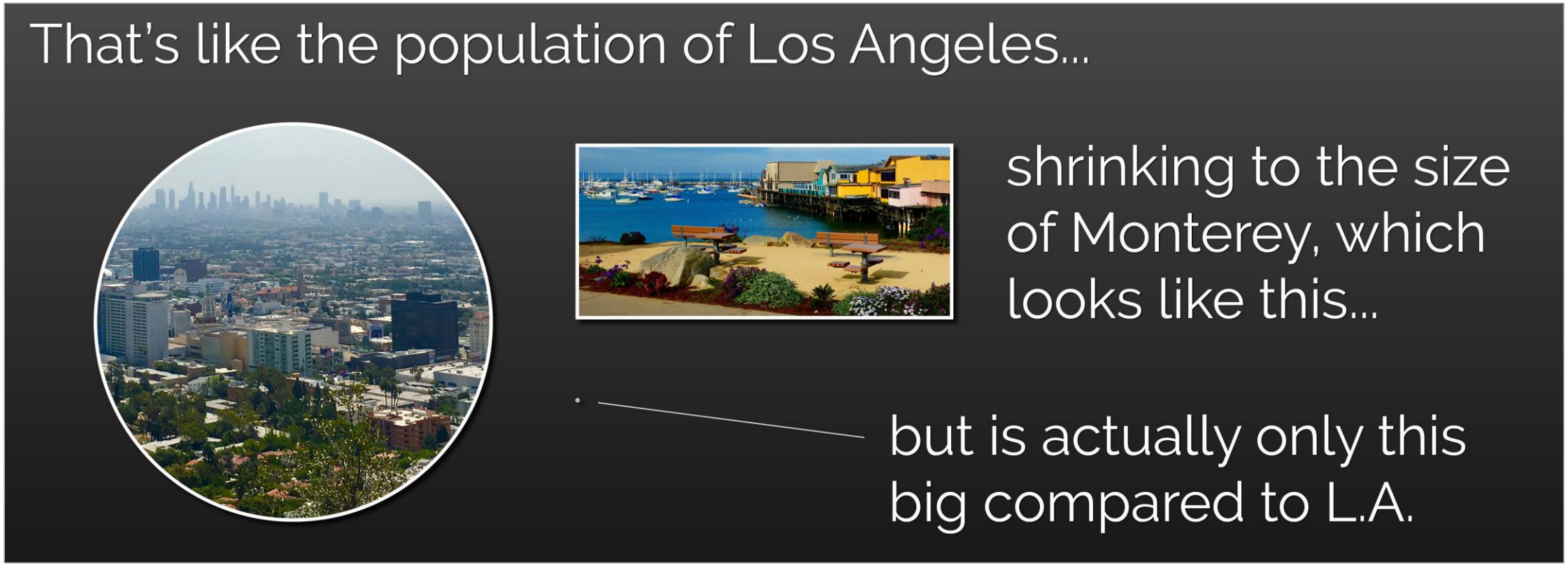
The projected threshold for quasi-extinction of western monarchs is 30,000 individuals (Schultz et al. 2017).

xerces.org

Western Monarchs in Crisis

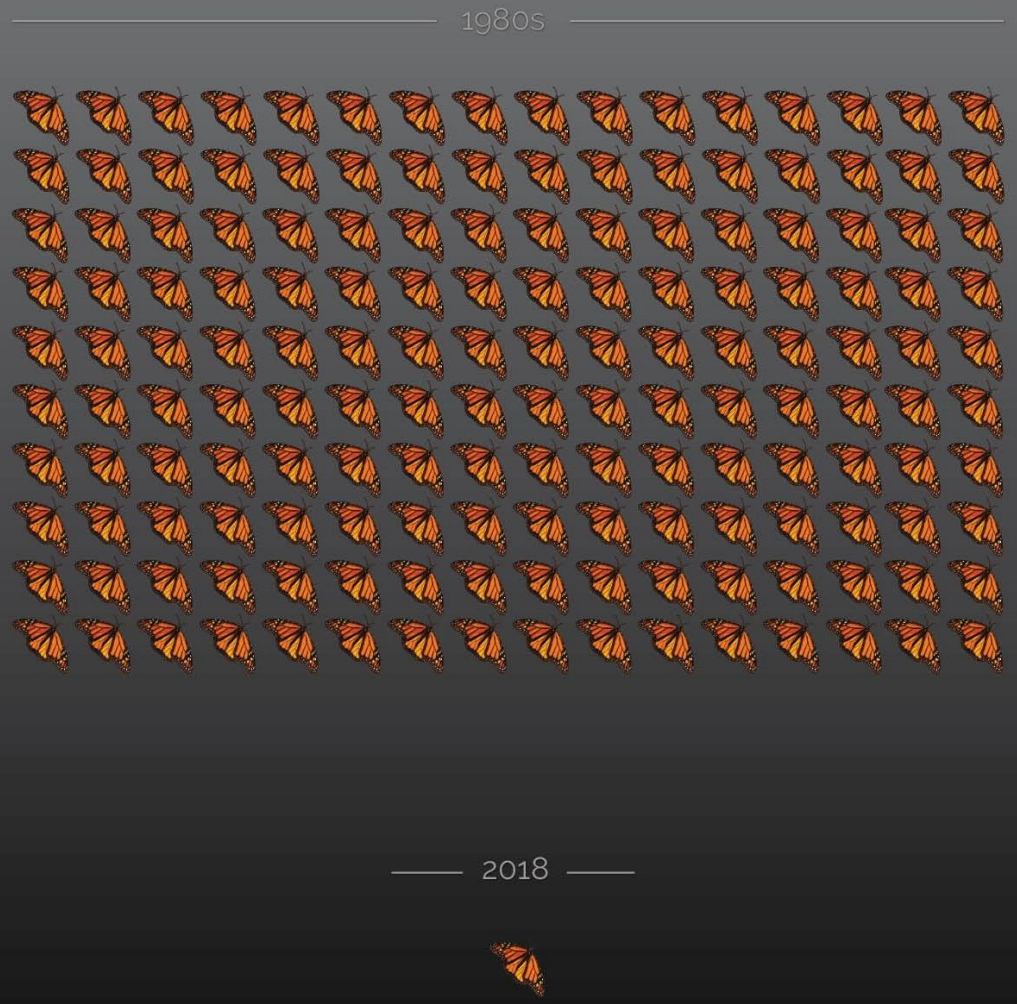
There were an estimated **4.5 million** monarchs overwintering in California in the 1980s.

In 2019, a mere **29,418** monarchs were counted.



Photos: Los Angeles, Sarah Castillo; Monterey, Harold Litwiler; both from Flickr Creative Commons 2.0

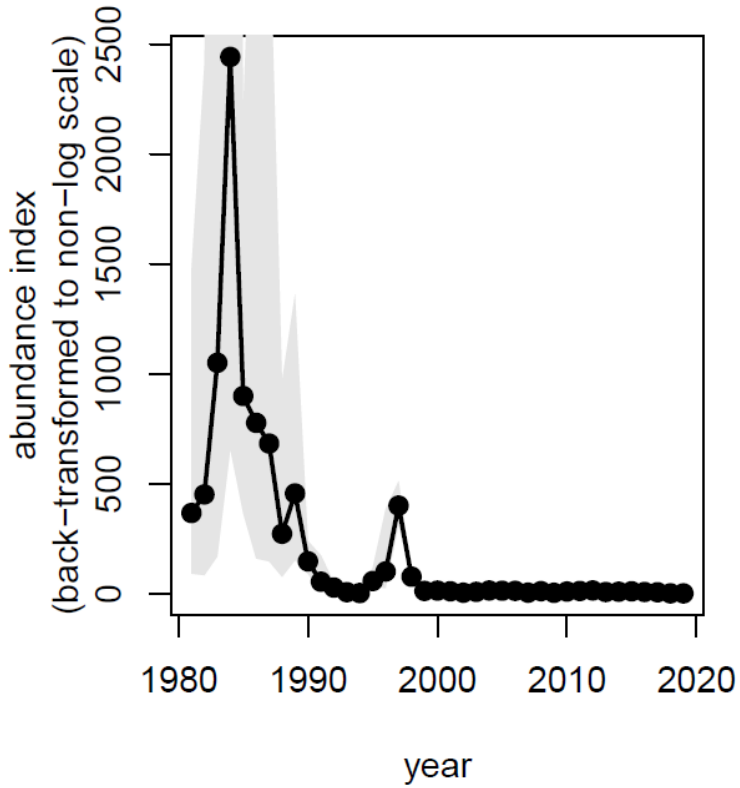
xerces.org



Western Monarchs in Crisis

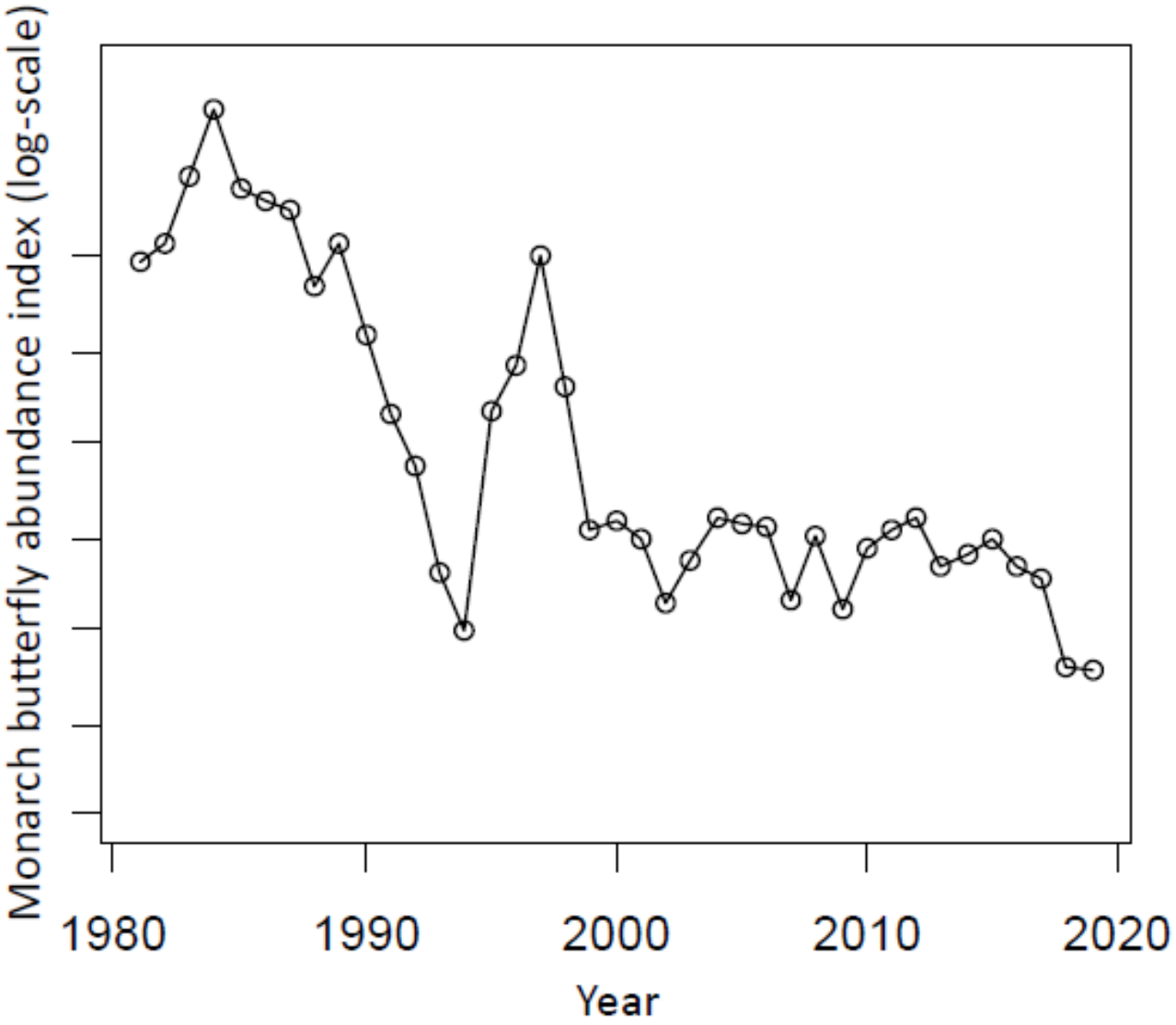
As of winter 2019-2020, only 0.6% of the historic population remains.

For every ~160 monarchs there were in the 1980s, there is now only one



xerces.org

Monarchs Overwintering in California



Western Monarch Thanksgiving Count

- **>99%** decline compared to the 1980s

  (Pelton et al. 2019)

- **>99% probability of quasi-extinction** (20,000+) in next 50 years

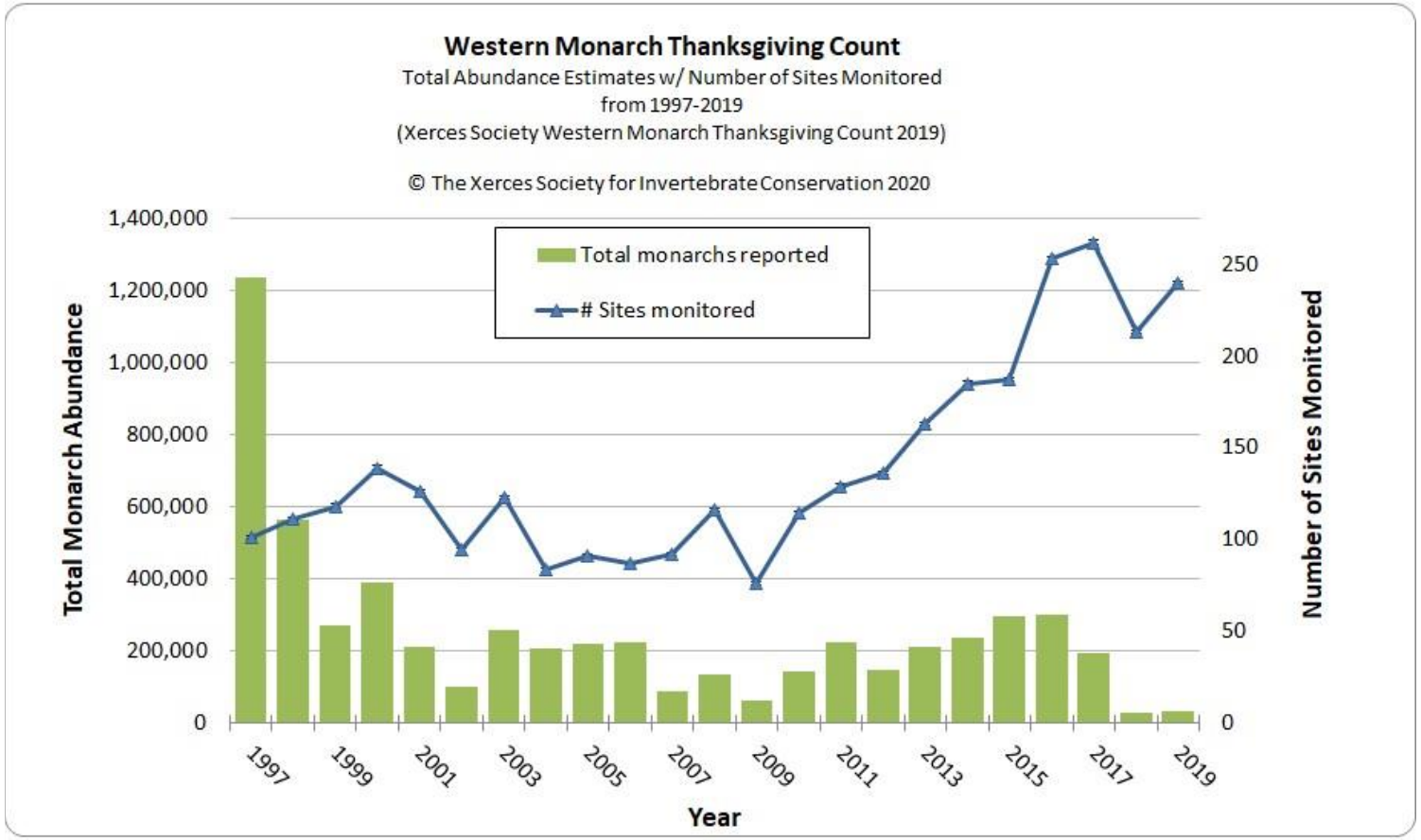
  (Voorhies et al. 2019)

xerces.org

Graph fr

Xerces Western Monarch Thanksgiving Count

- Data has been used in 10 peer reviewed publications.
  - Available at: www.westernmonarchcount.org/publications
- Data is used to inform conservation and management of Western Monarch overwintering sites.
  - More information available at: www.westernmonarchcount.org/overwintering-site-management-and-protection/



www.westernmonarchcount.org

xerces.org

Photo: Monarchs larva on woollypod milkweed (*A. eriocarpa*) Southern California -Stephanie McKnight/Xerces

How do we assess the status of the Western Monarch Population?

- Overwintering Counts:
  - Western Monarch Thanksgiving Count and New Year's Count
- Breeding Season:
  - Research:
    - Art Shapiro's long-term butterfly monitoring transects in California (35+ years)
    - Louie Yang at UC-Davis in CA (Yang & Cenzer 2019, Yang et al. 2020)
    - Dept. of Defense western monarch phenology study by Tufts, WSU, & Xerces (2017, 2018, 2019)
    - Habitat suitability models (Dilts et al. 2018)
    - Site-specific surveys (e.g., by David James at WSU in WA, Southwest Monarch Study in Arizona)
  - Community science projects:
    - Journey North, Western Monarch Milkweed Mapper, Integrated Monarch Monitoring Program (MJV), Monarch Larva Monitoring Project

xerces.org

Photo: Monarch larva on narrowleaf milkweed (*A. fascicularis*) Fallon Naval Air Station, Nevada -Stephanie McKnight/Xerces Society

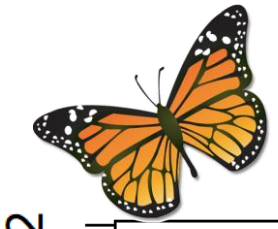
Why Are Monarchs in Trouble?

- Loss and degradation of breeding & migrating habitat
  - **Early season milkweed may be limiting**
- **Loss and degradation of overwintering habitat in California**
- **Pesticides (insecticides, herbicides, etc.)**
- Climate change
- Disease, parasites, and predation

(Crone et al. 2019, Cezner and Yang 2019, Pelton et al. 2019, Espeset et al. 2016, etc.)

xerces.org

Causes of monarch population declines (2018)



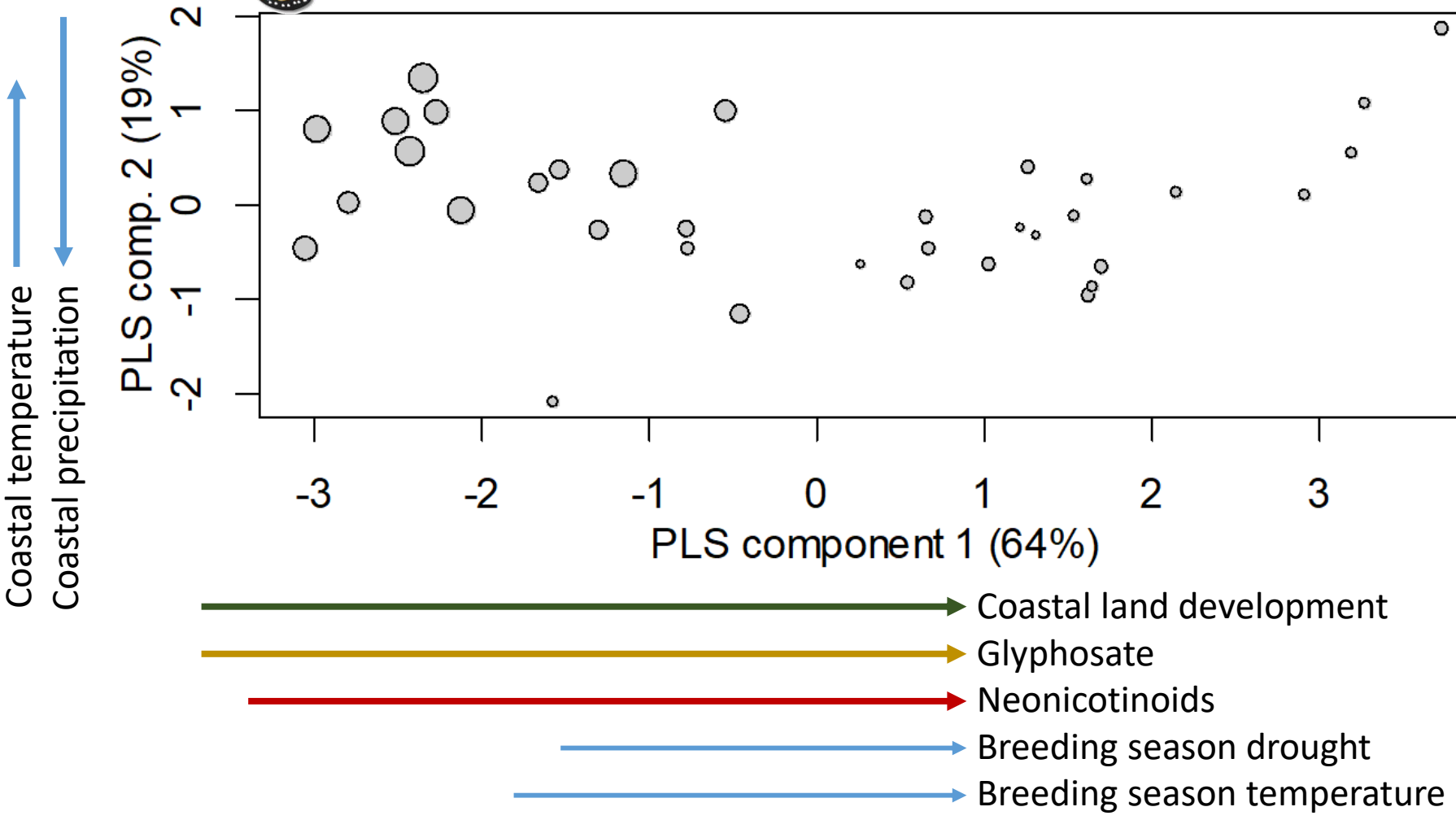


Photo: Stephanie McKnight/Xerces Society, Graph: Crone et al. 2019 *Ecological Applications*

Western Monarch Call to Action

This Western Monarch Call to Action, led by the Xerces Society for Invertebrate Conservation & with the input of the western monarch science community, aims to provide a set of rapid-response conservation actions that can help the western monarch population bounce back from its extremely low 2018 and 2019 overwintering size.

Photo: Xerces Society / Stephanie McKnight

xerces.org

Western Monarch Call to Action

Savewesternmonarchs.org

1.) Protect and manage California overwintering sites.

2.) Restore breeding and migratory habitat in California.

3.) Protect monarchs and their habitat from pesticides.

4.) Protect, manage, and restore summer breeding and fall migration monarch habitat outside of California.

5.) Answer key research questions about how to best aid western monarch recovery.

xerces.org

Conservation and Management of Western Monarchs on DoD Lands: Implications of Breeding Phenology

Cheryl Schultz[1], Stephanie McKnight[2], Cameron C. Thomas[1], Elizabeth Crone[3], Emma Pelton[2], Sarina Jepsen[2], and David James[1],

[1]Washington State University, [2]Xerces Society for Invertebrate Conservation, [3]Tufts University

Objective of the Project:

The primary purpose is to determine seasonal timing of monarch butterflies in locations across the West, and to use this information to increase the efficiency and effectiveness of managing habitat for monarchs on DoD lands.

Summary of Approach:

The project involves systematic surveys and demographic models to determine seasonal timing of monarch breeding across the West.

Benefit:

Demographic data will enable DoD managers to balance habitat protection with training activities and other land uses. This work will contribute to key aspects of DoD land management plans, such as Integrated Natural Resources Management Plans (INRMPs) at each installation, by focusing efforts on the temporal windows with greatest importance to breeding monarchs throughout their range.

xerces.org

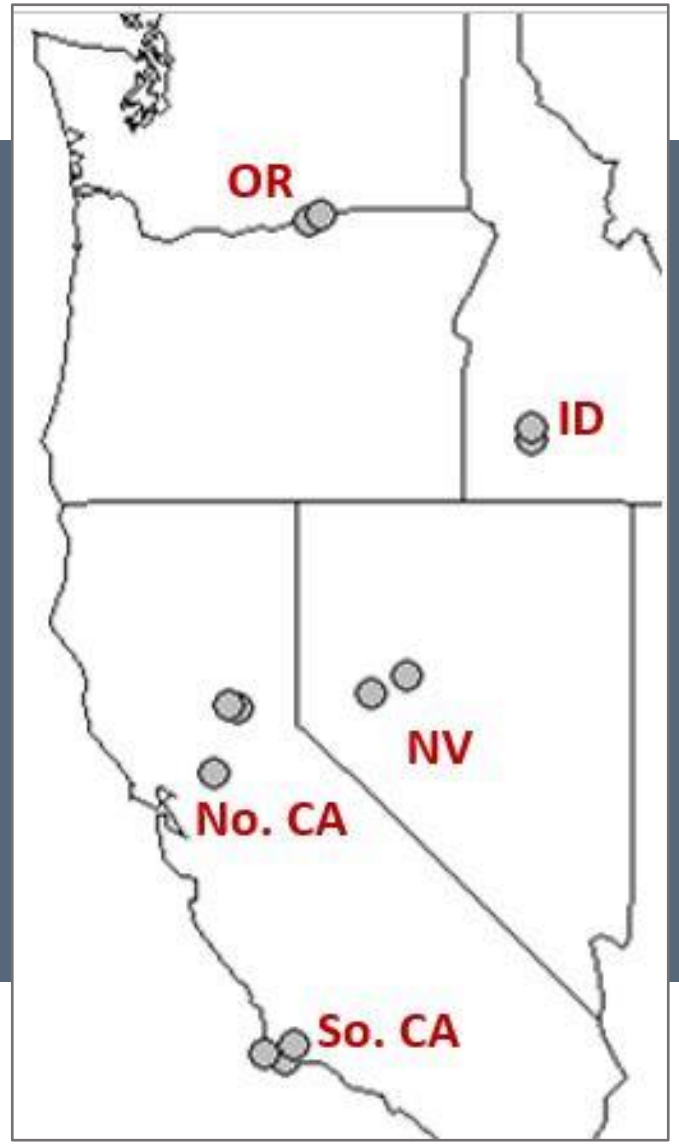
Research Approach and Field Sites

Monthly systematic surveys with statistical models to determine seasonal timing of monarch breeding across the West.

- Study sites in 5 Western states: Vandenberg AFB and Beale AFB in California, NWSTF Boardman in Oregon, JBLM Yakima Training Center in Washington, NAS Fallon in Nevada, and Mountain Home AFB in Idaho. In addition, we worked with US Army Corps of Engineers, Stone Lakes National Wildlife Refuge, and California State Parks in northern California, and Sedgwick Reserve - University of California Santa Barbara Natural Reserve System in Southern California. Thank you to all of the agency and university partners for participating in this research, and allowing access to field sites!

xerces.org

Research Approach and Field Sites



Breeding season monitoring

Site selection

- 5 regions
- 2-3 sites / region
- Transects/monitoring in “best” (not random) locations

Surveys

- Every 4 weeks
- Count milkweed stems, by species
- Count monarch eggs & larvae by stage class
- Surveys in 2017 & 2018 & 2019
- In 2019, Beale Air Force Base in California was added as a research site

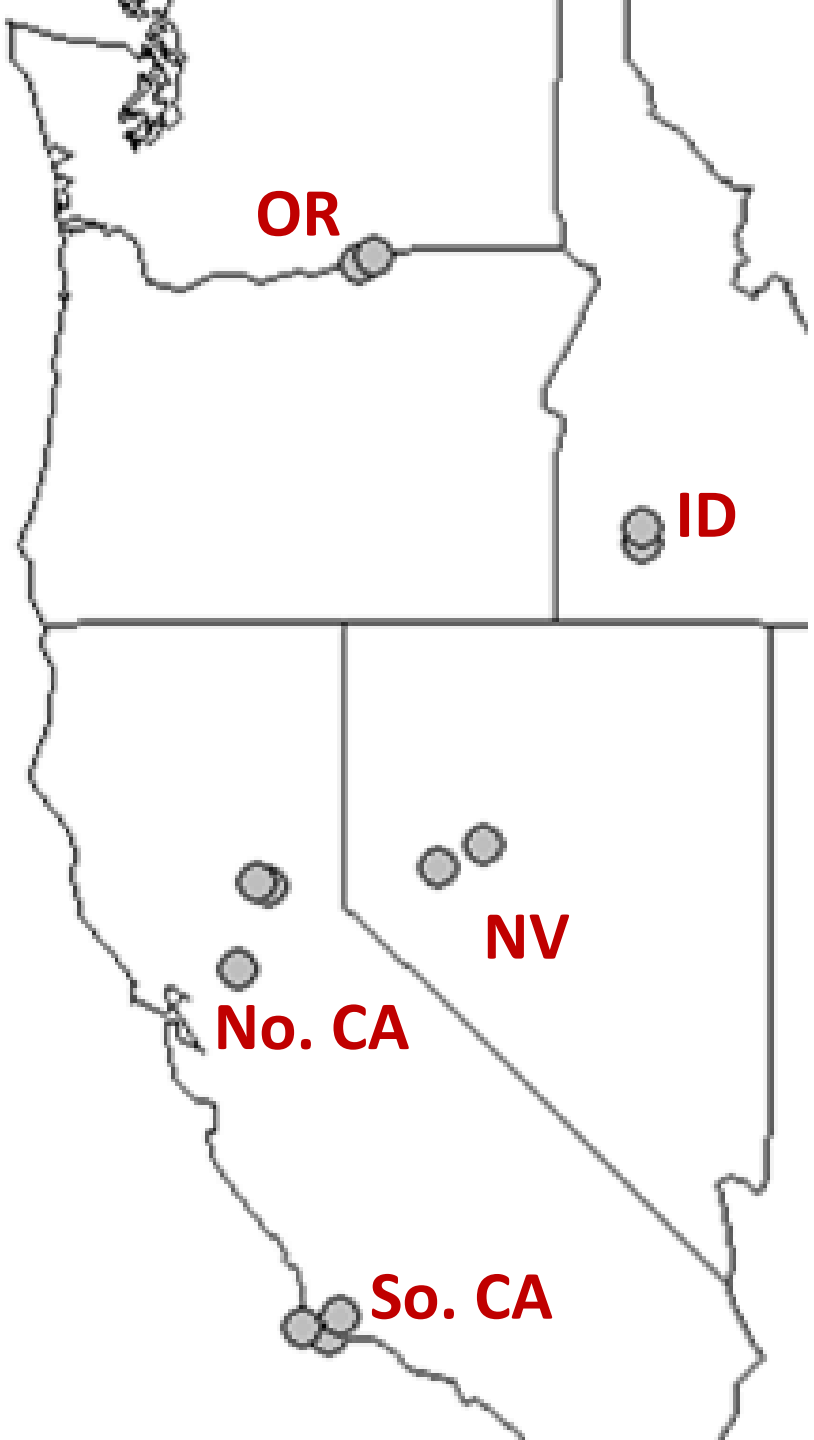
xerces.org

Breeding season monitoring

- 5 regions
- 2-3 sites / region
- Transects in “best” (not random) locations

Surveys

- Every ~4 weeks
- Count milkweed stems, by species
- Count monarch eggs & larvae by stage class
- Surveys in 2017, 2018 & 2019 *(no surveys in 2020)*



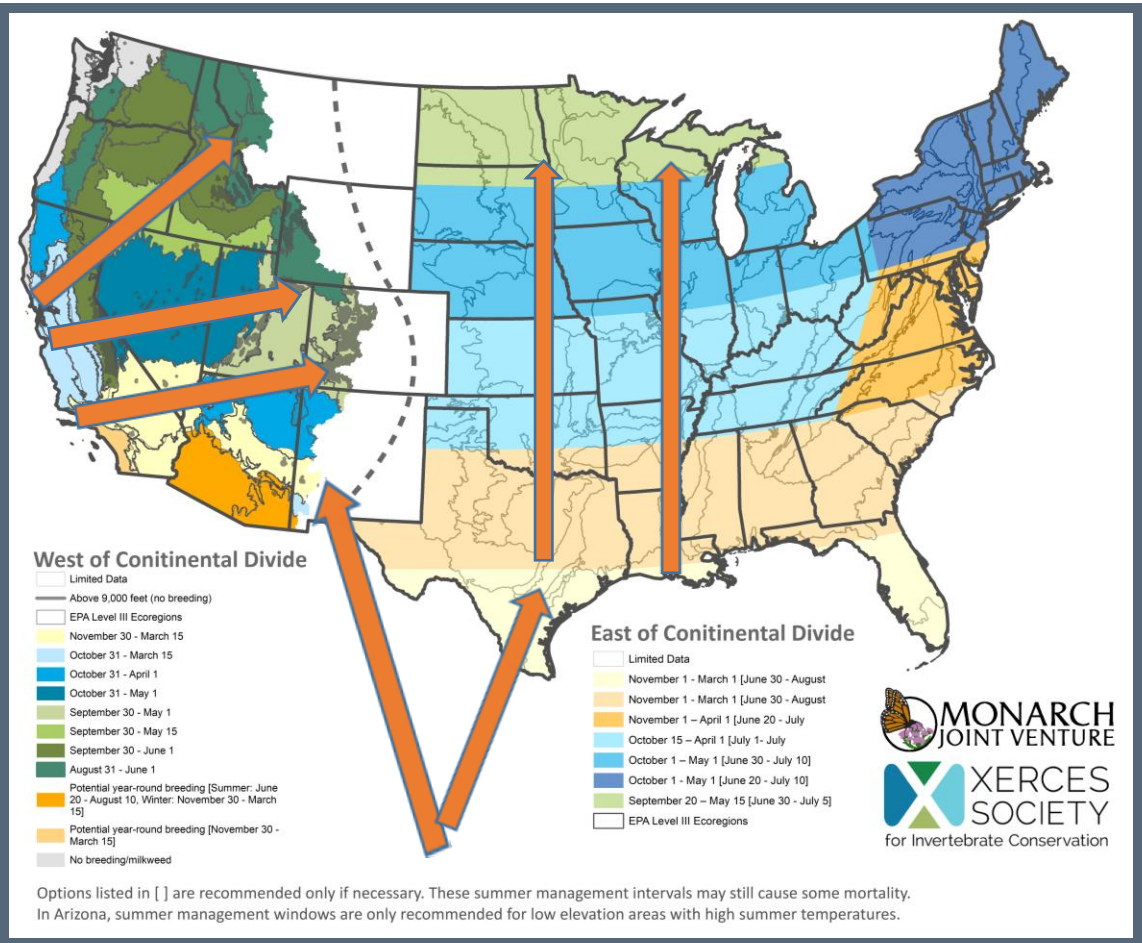
All sites, 2017-2019:
Monarch immatures in relation to shade

- Record cover over transects:
  - 0 = no shade
  - 3 = full shade
- Monthly counts of eggs & larvae

Focal site (Beale AFB), 2019:
Effects of shade on temperature

- iButtons, late June through October

Expanding vs. shifing population



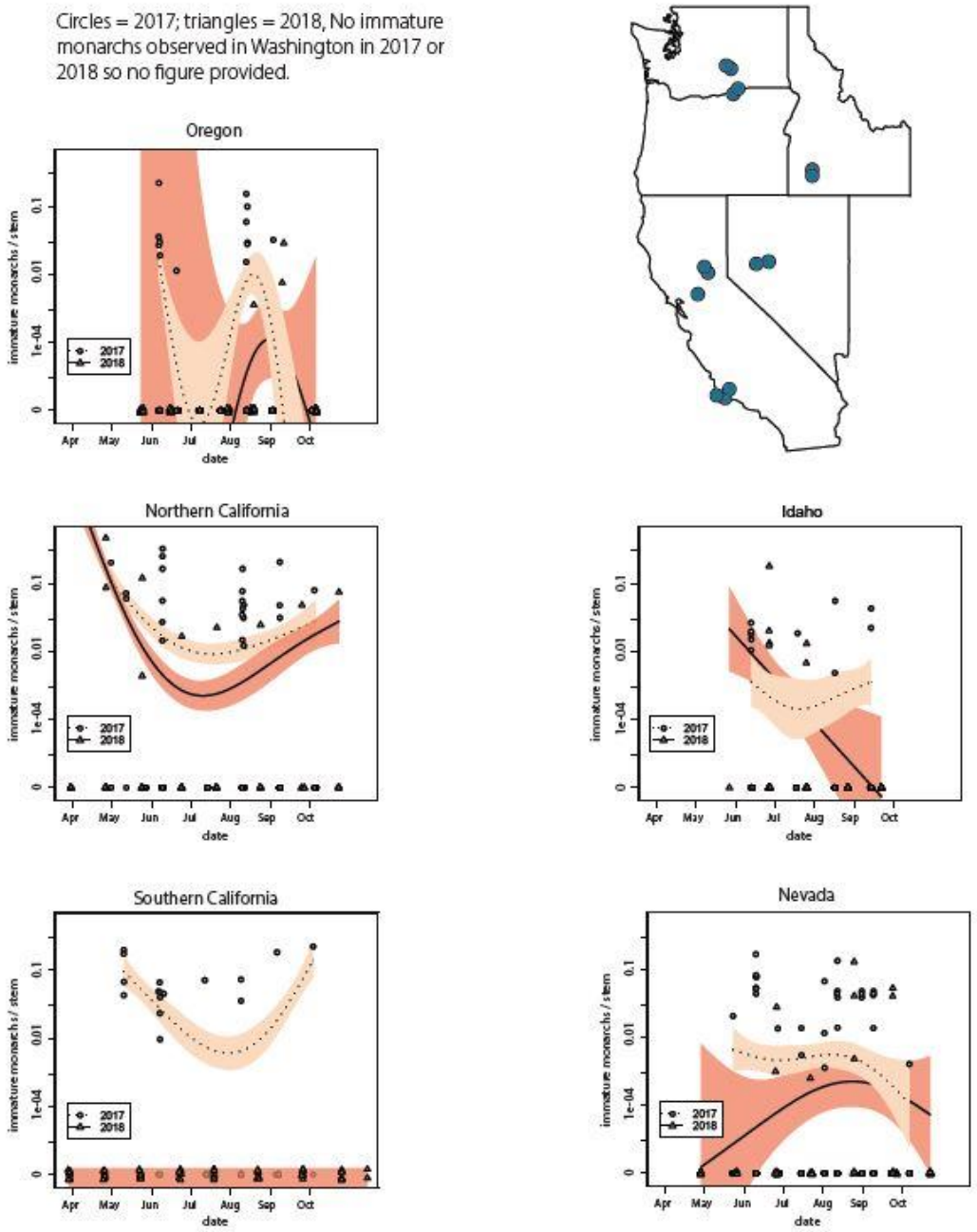
Western monarchs differ from eastern monarchs in at least two ways:

1. Western monarchs breed throughout the summer in central parts of their breeding range (California and Nevada), in contrast to eastern monarchs which migrate north through successive summer generations. Our monitoring data are consistent with an expanding population that spreads across the range rather than one that shifts throughout the breeding season.
2. Densities of immature monarchs (eggs and larvae per milkweed stem) in the west are much lower than reported numbers for the east (<0.1 eggs/stem in the West vs. 0.2 – 0.4 eggs/stem in the East); this implies that stem densities of milkweed per se are not the critical limiting factor in the same way that they are for eastern monarch (Nail et al. 2015, Thogmartin et al. 2017).

xerces.org

FIGURE 5: IMMATURE MONARCHS/MILKWEED STEM WITHIN EACH REGION.

Circles = 2017; triangles = 2018, No immature monarchs observed in Washington in 2017 or 2018 so no figure provided.



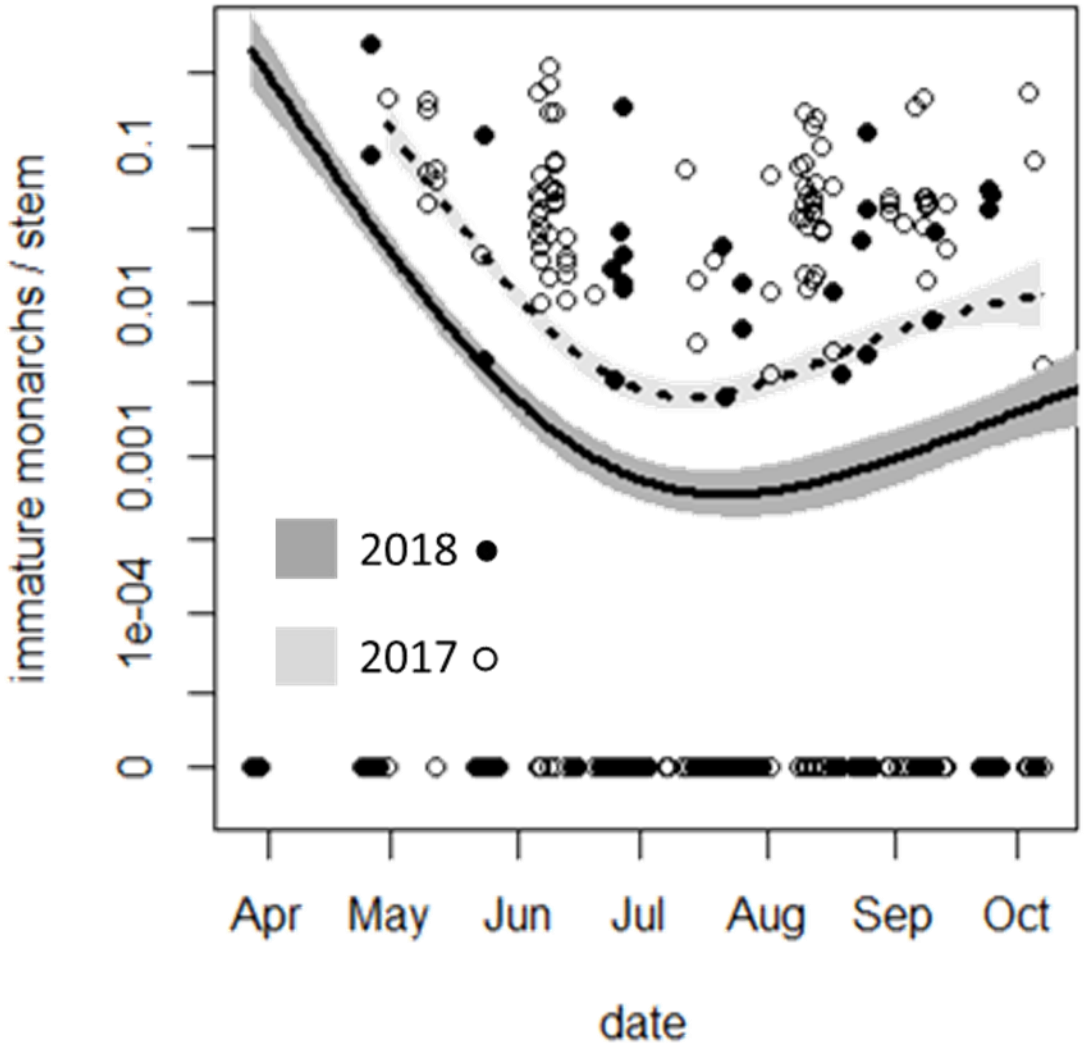
What we learned in years 1 & 2

- 2017-2018 monarch breeding was continuous throughout the summer in California and Nevada, and in Oregon there were distinct generations.
- Monarchs did not breed in Washington in 2018 or 2019 and was limited in 2017
- 10 fold decline in immature monarchs/stem between 2017 & 2018, similar numbers in 2019 as 2018!

Figure courtesy of Elizabeth Crone and Cheryl Schultz

xerces.org

2018 population drop happened before breeding…



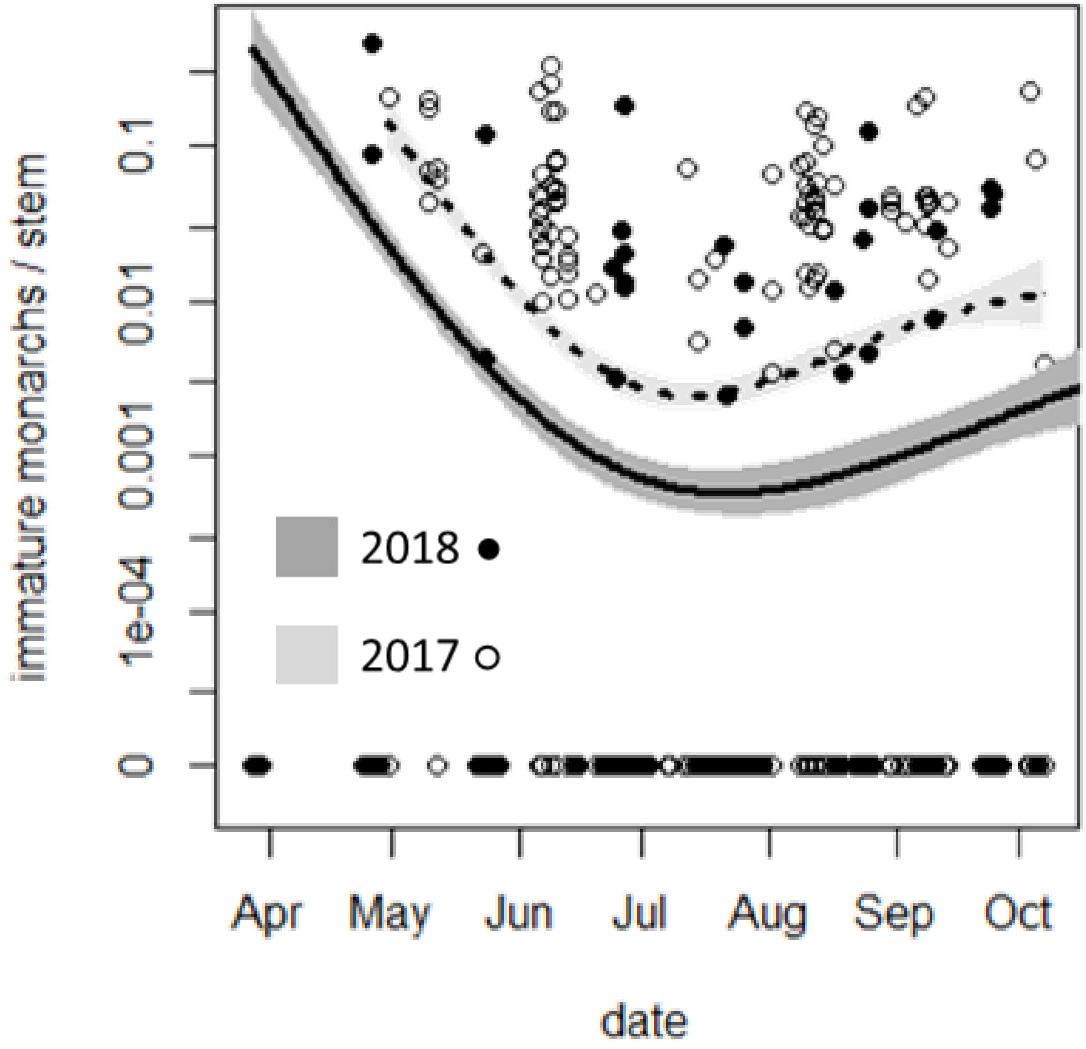
2017 vs. 2018: t = -2.53, P = 0.030

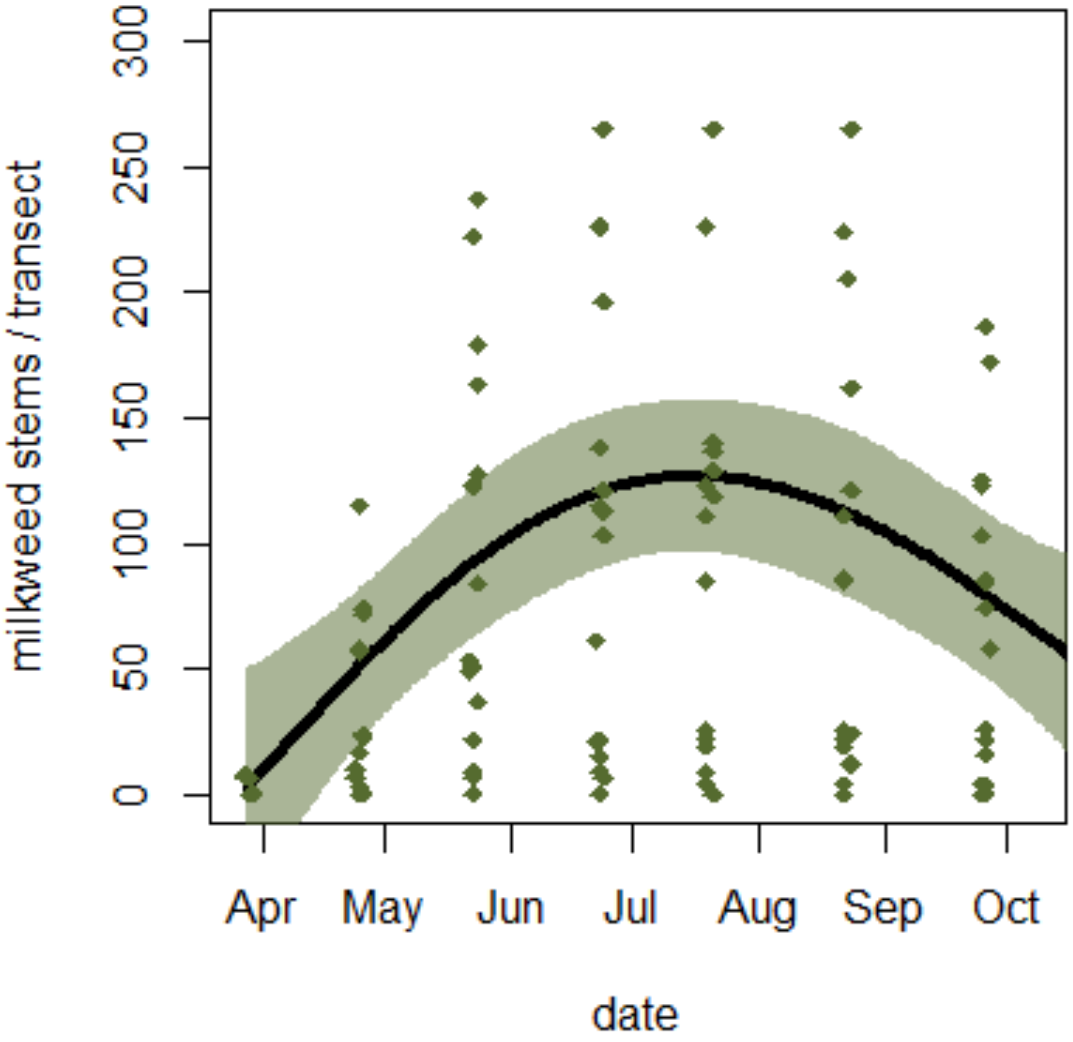
We did not set up this research program to understand factors responsible for a population crash, but because we were monitoring the year prior to the crash and in the year of the crash—we can draw valuable and timely insight into western monarch biology and what might (or might not) have caused the crash.

xerces.org

Higher immature densities in Spring than Summer

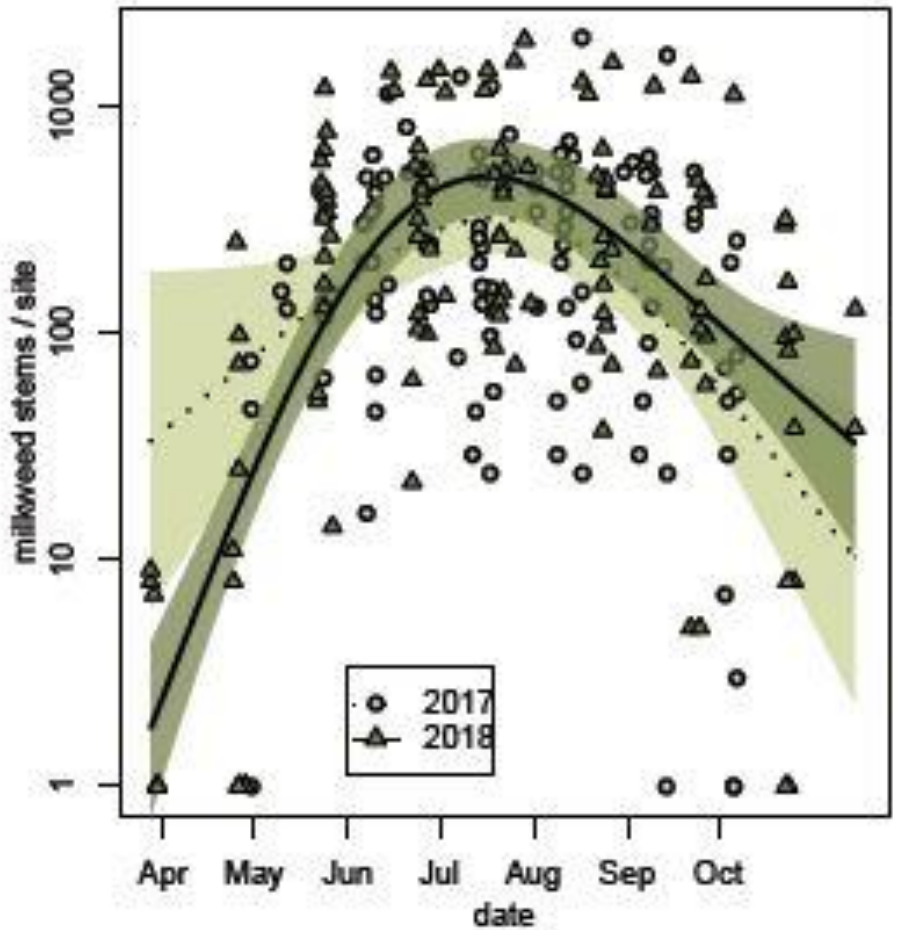
→ milkweed limitation in spring…?

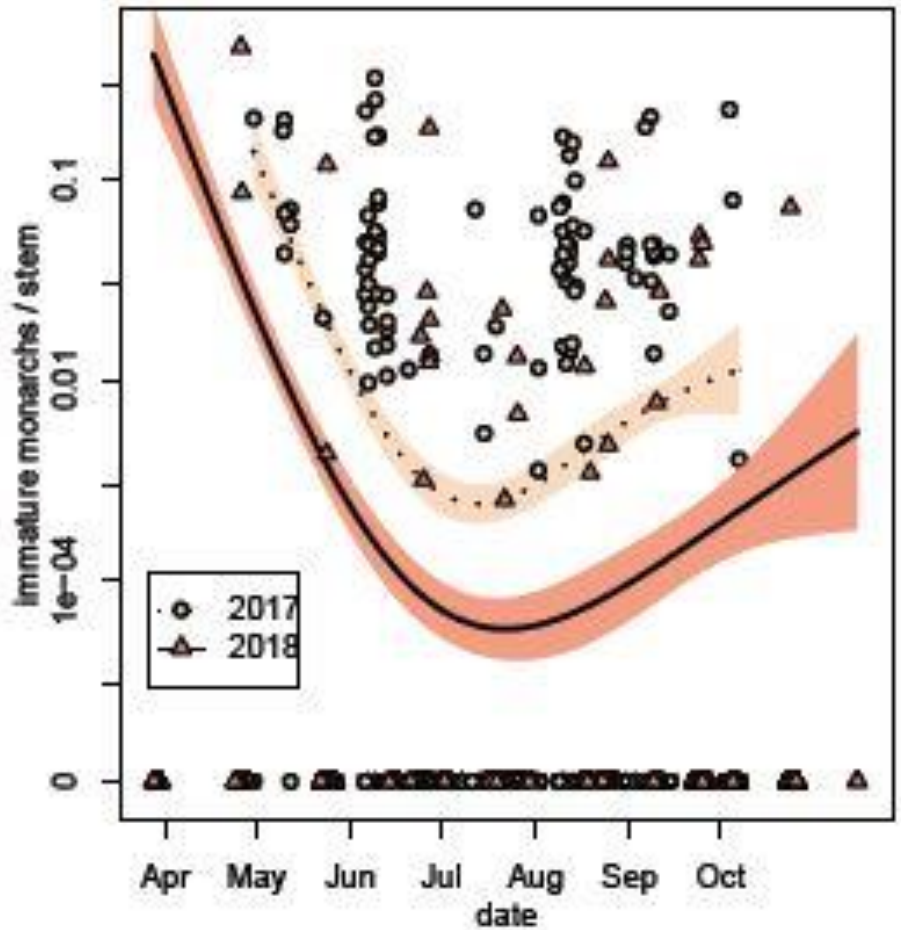




Slide courtesy of Elizabeth Crone and Cheryl Schultz

FIGURE 12: MILKWEED AND MONARCH PHENOLOGY. FIGURES SHOW SEASONAL CHANGES IN MILKWEED STEM DENSITY (LEFT PANEL) AND IMMATURE MONARCH DENSITY (RIGHT PANEL) IN BOTH 2017 AND 2018, ACROSS ALL STUDY SITES.



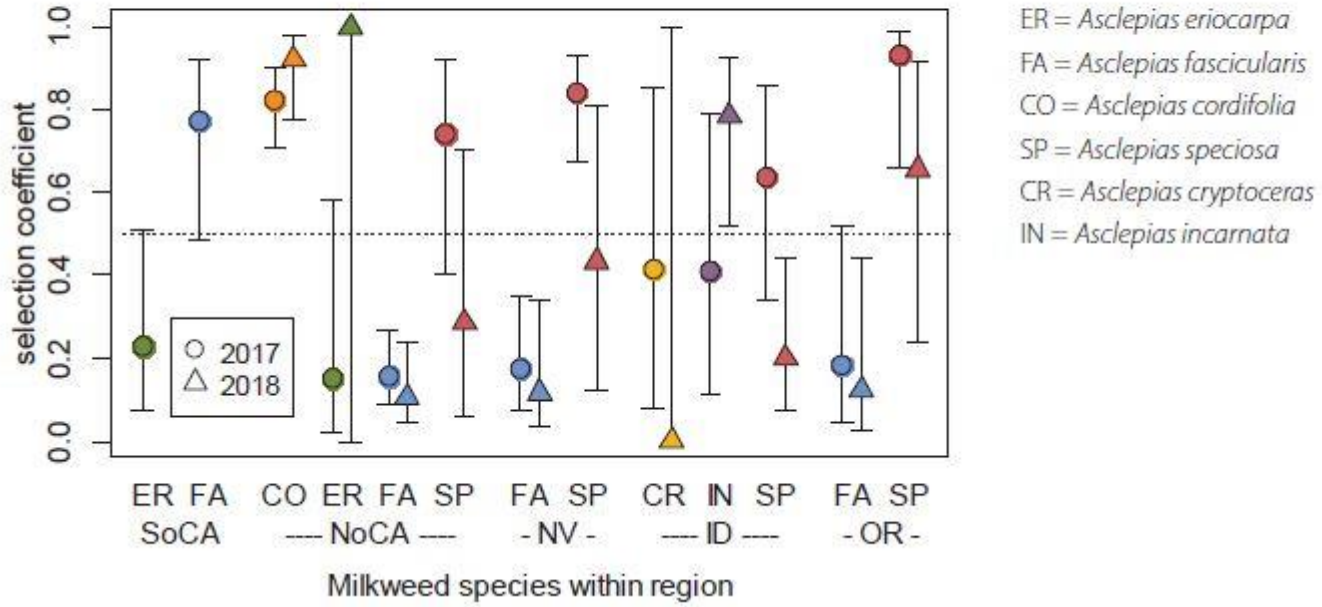


Milkweeds may be limiting in spring, not limiting during the rest of the breeding season. Overall, we found an increase in milkweed from 2017 to 2018, while monarchs declined.

Slide courtesy of Elizabeth Crone and Cheryl Schultz

Milkweed Preference by Region

FIGURE 9: SELECTION COEFFICIENT FOR MILKWEED SPECIES WITHIN EACH REGION AND YEAR COMBINATION.



Our analyses indicate that monarchs select some milkweed species more than others, but that these effects are strongest in some regions and vary by year.

Monarchs showed preferential use of *A. fascicularis* in Southern California, *A. cordifolia* in Northern California and *A. speciosa* in Oregon.

In some regions monarchs show preference in one year but no preference in another (e.g., *A. speciosa* in No CA and Nevada and *A. incarnata* in Idaho).

Figure courtesy of Elizabeth Crone and Cheryl Schultz

xerces.org

Additional Findings: Habitat Associations

Preliminary data from 2017 & 18 suggested that some habitat associations such as shade may be important for monarch breeding particularly in areas

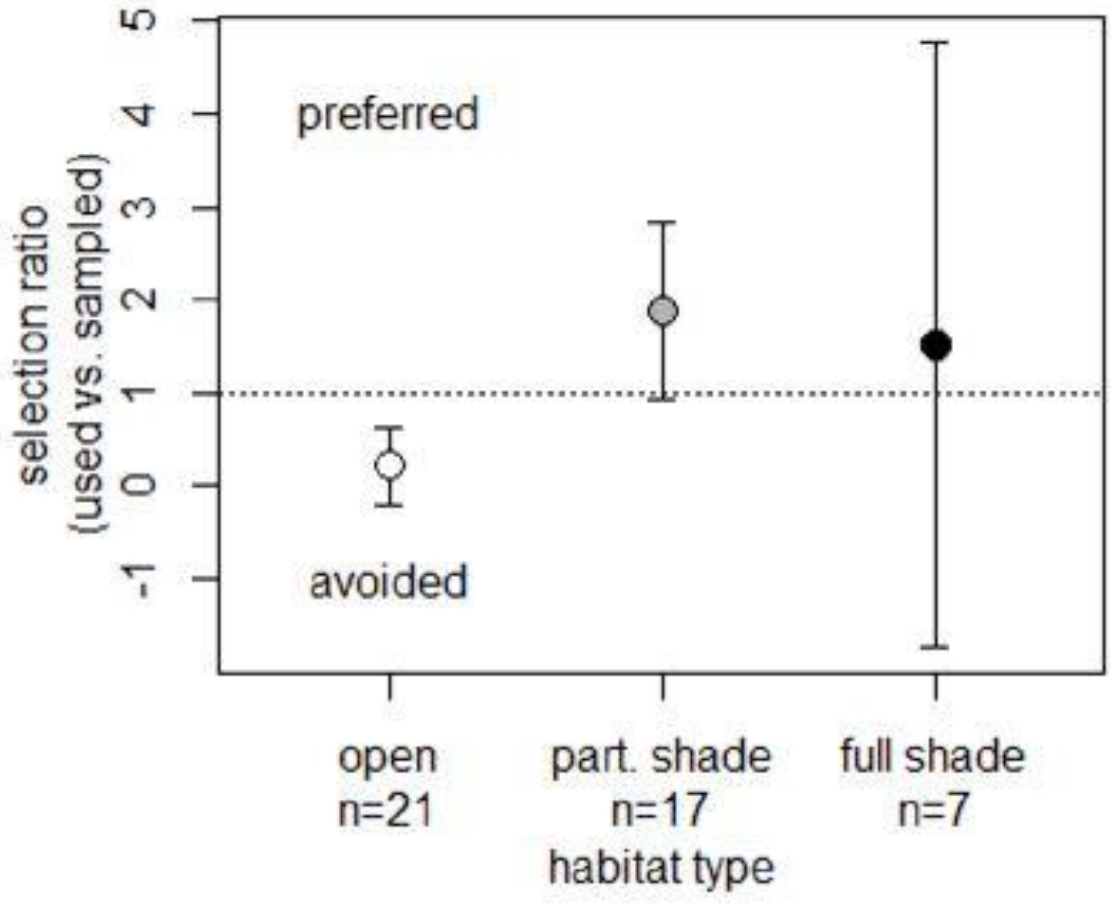
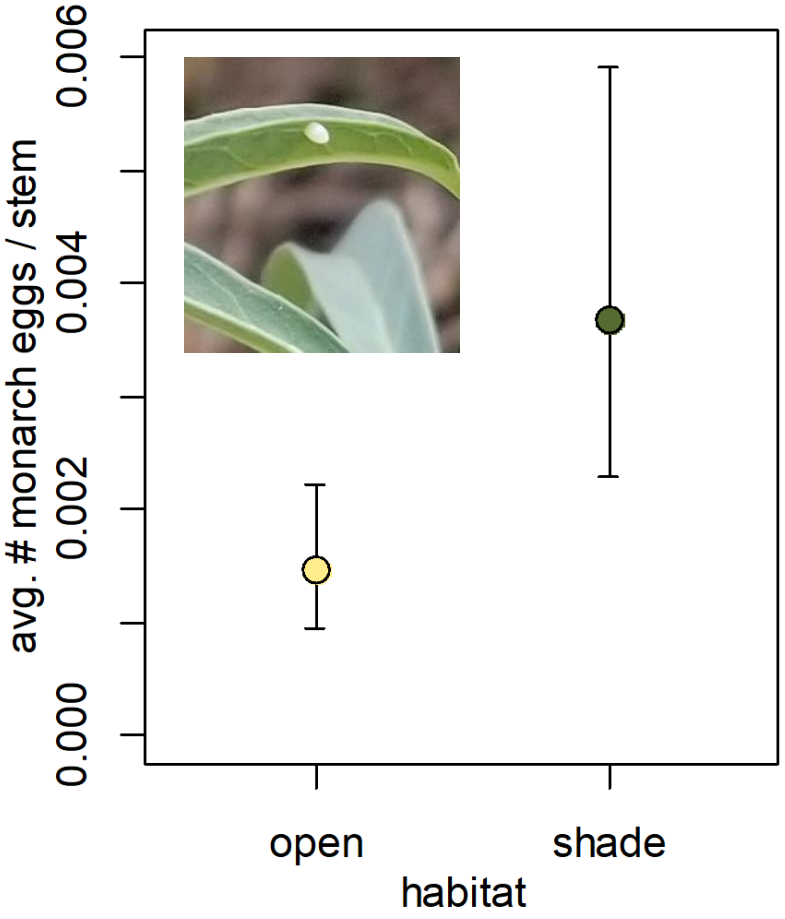
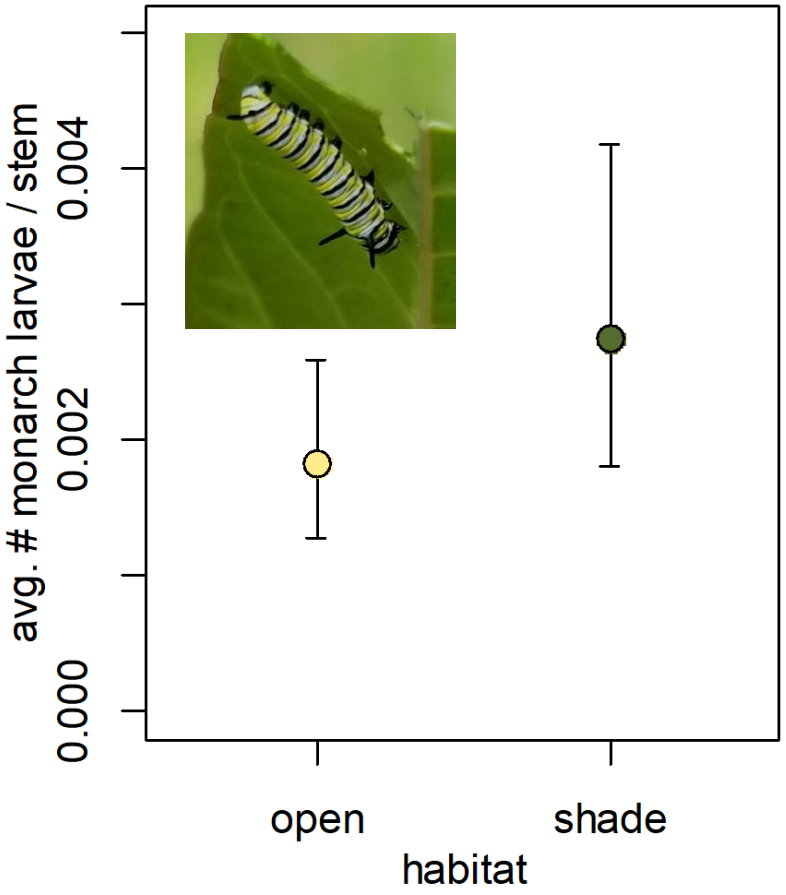


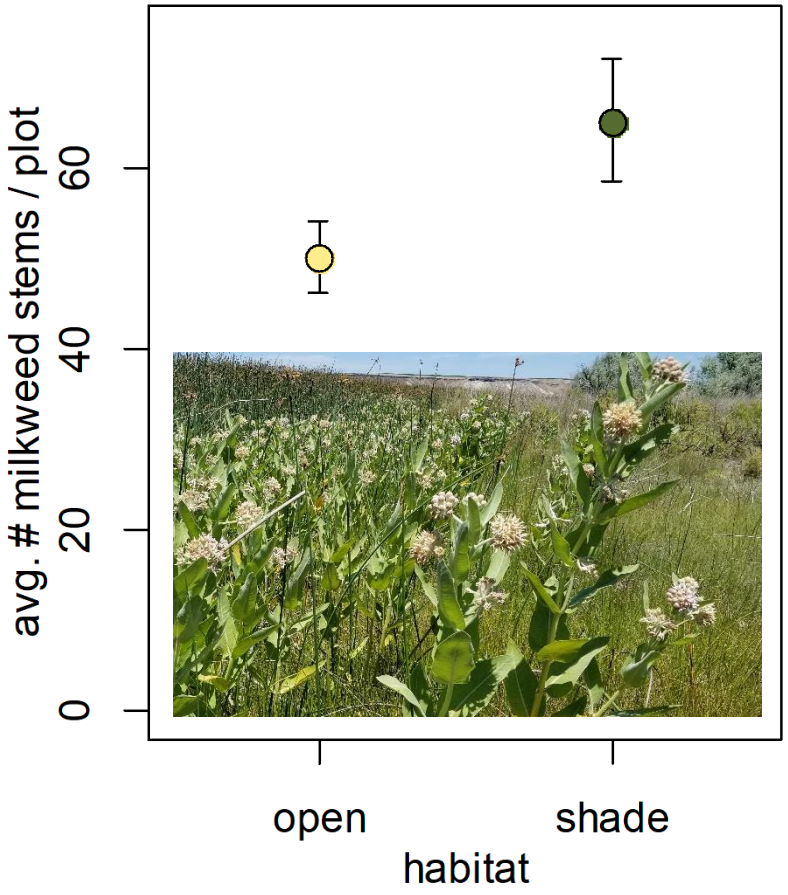
Figure courtesy of Elizabeth Crone and Cheryl Schultz

xerces.org

More immature monarchs in the shade:
(but they use both open and shaded sites)

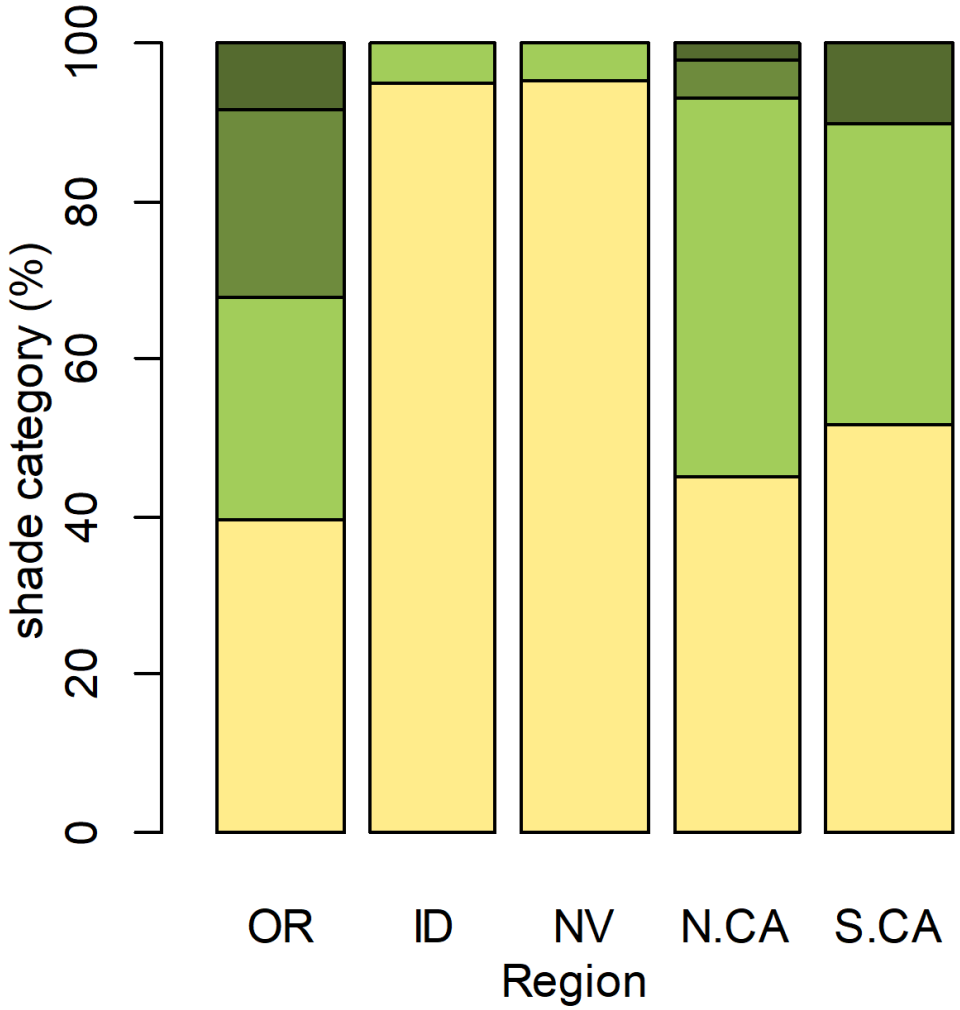


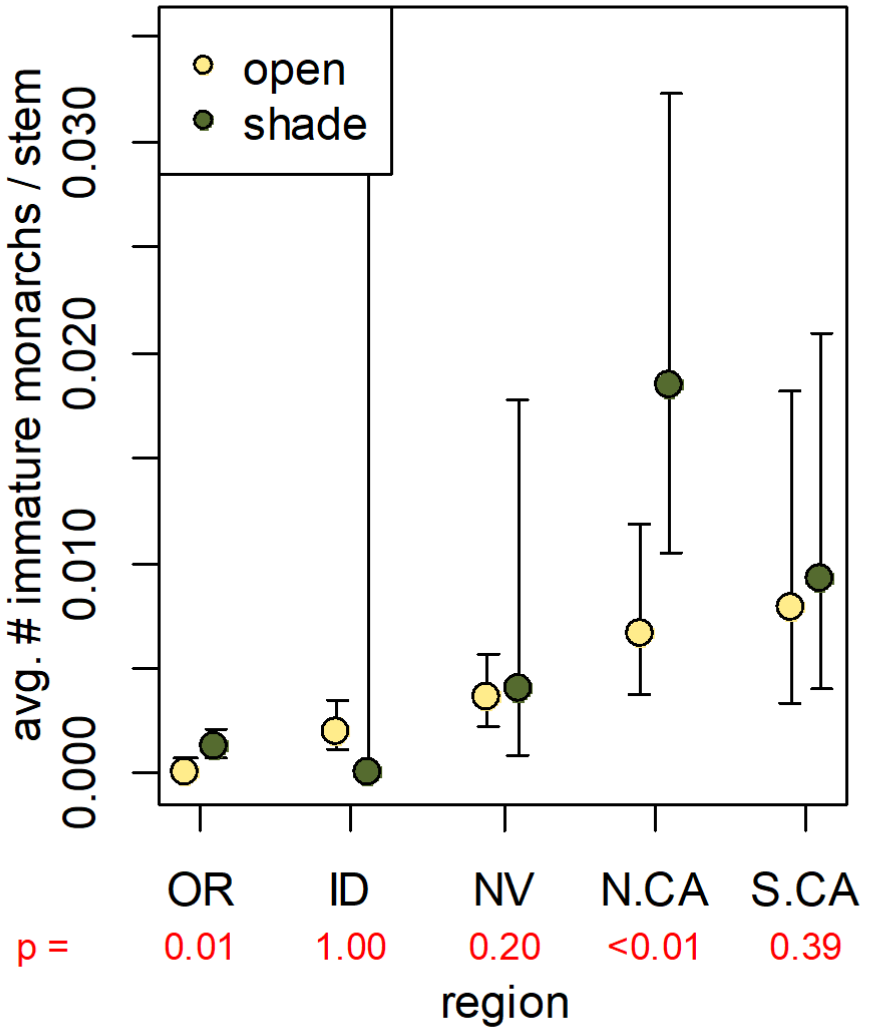


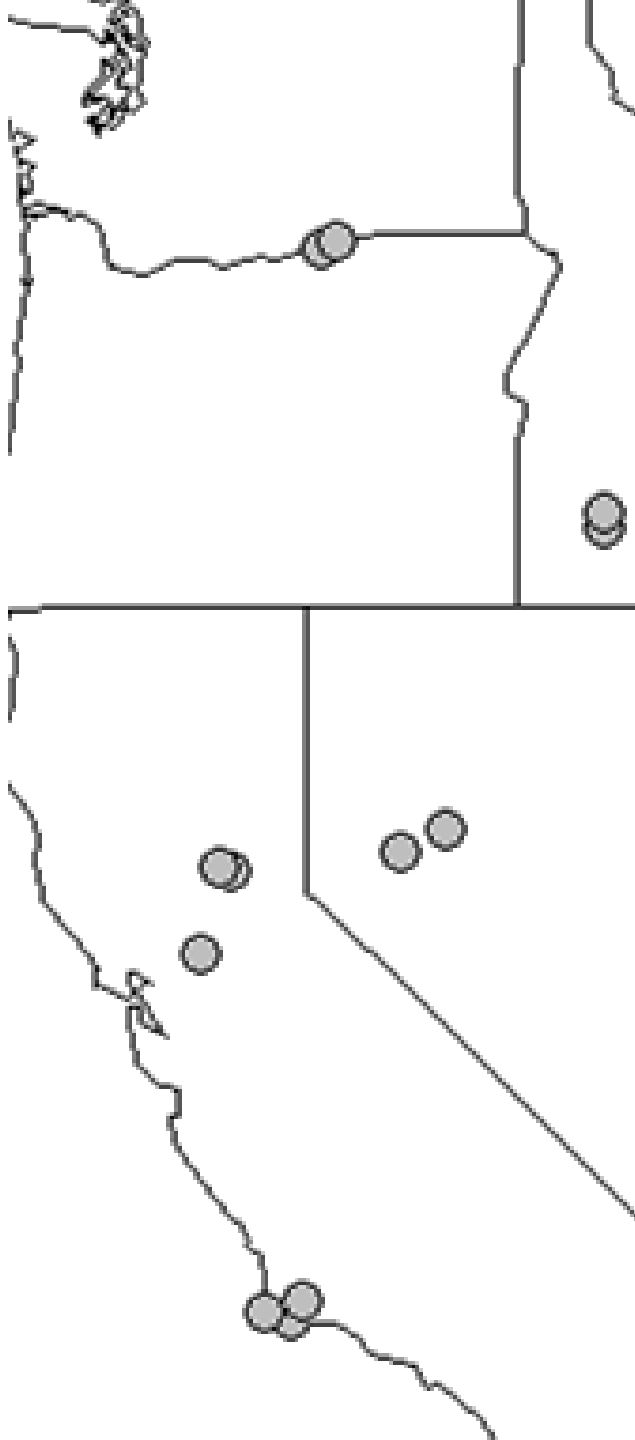


Slide courtesy of Elizabeth Crone and Cheryl Schultz, Photos: Stephanie McKnight/Xerces Society

Importance of shade differs by region:

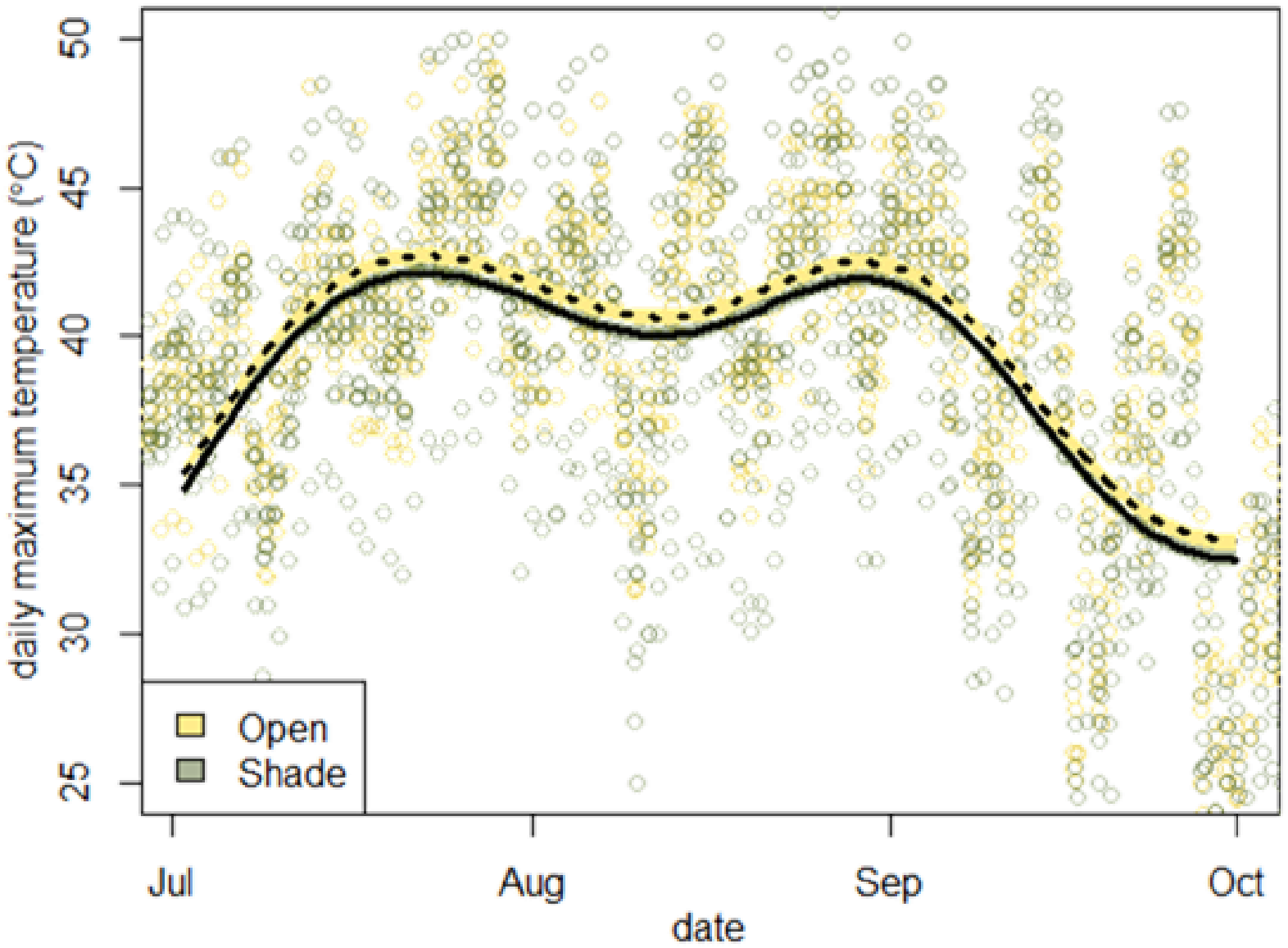






Slide courtesy of Elizabeth Crone and Cheryl Schultz

Temperature difference: 0.59°C cooler in shade



Slide courtesy of Elizabeth Crone and Cheryl Schultz, Photo: Stephanie McKnight/Xerces Society

Conclusions of shade/sun research:

1. Monarch butterflies lay eggs in both shade and sun (when both are available)
2. In hot places, monarchs may prefer shade for egg laying
3. Broadly, effects of changing temperature (so far) can be mitigated with habitat heterogeneity

    Unlikely to be a major player in observed declines to date

Research Implications for Management

1.) Western Monarch Management Windows: Timing Management in Monarch Breeding Habitat

2.) Habitat Heterogeneity: monarchs have a preference for shaded milkweed in places that have both sun and shade in the hottest times of the summer. Diversity of milkweed availability (temporally, # of species) - monarchs show preference for some milkweed species = aim for at least two species.

3.) Early spring is a crucial time for the Western Monarch population = early spring milkweed + nectar plants

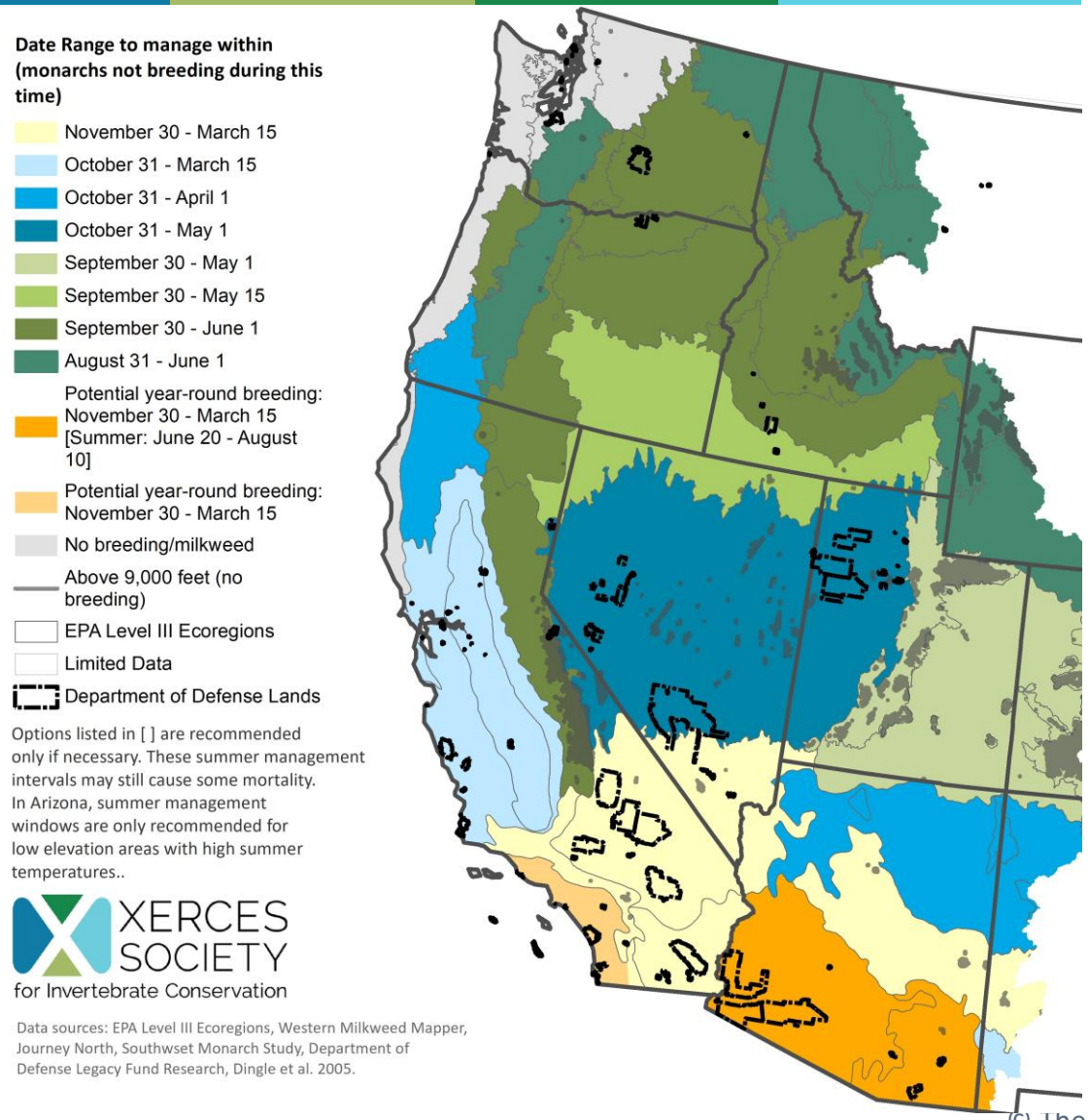
4.) Climate: warm springs are generally good for monarchs; high rain in spring may not be good for monarchs; monarchs are able to moderate microclimate by being in shade in heat of summer.

xerces.org

Timing Management in Monarch Breeding Habitat

Manage habitat in a way that minimizes harm to monarchs during the breeding season.

Fact sheet developed for DoD land managers – this map is included in the fact sheet.



xerces.org

Habitat heterogeneity

Protect existing milkweed and plant milkweed in both sun and shade.

Increase native milkweed & nectar plant availability.

Protect existing habitat!!!

Plant native milkweed and nectar species, especially early spring species (February–April) .

Plant and manage for more than one milkweed species.

A monarch larva on showy milkweed (*A. speciosa*). Providing sufficient milkweed (the monarch's larval host plant) and other nectar plants is a key component to aiding western monarchs' recovery. (Photo: Xerces Society / Stephanie McKnight)

xerces.org

Milkweed Emergence and Flowering in California

			Flowering Phenology = x (green box indicates possible plant emergence timing, grey indicates occasional winter growth on the SoCal coast)											
Species	**Common Name**	**When do monarchs generally use these plants as a host?**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Asclepias californica	California milkweed	Early spring - summer			x	x	x	x	x					
Asclepias cordifolia	heartleaf milkweed	Early spring - summer			x	x	x	x	x					
Asclepias eriocarpa	woollypod milkweed	Early spring - summer					x	x	x	x	x	x		
Asclepias erosa	desert milkweed	Early spring - summer				x	x	x	x	x	x	x		
Asclepias vestita	wooly milkweed	Early spring - summer				x	x	x	x					
Asclepias fascicularis	narrowleaf milkweed	Late spring - Fall					x	x	x	x	x	x		
Asclepias speciosa	showy milkweed	Late spring - Fall					x	x	x	x	x			

xerces.org

Regional Monarch Nectar Plant Guides

Nectar guides include information on species which are

- Native & attractive to monarchs (documented visitation)
- Commercially available
- Hardy and appropriate for large-scale restoration
- In bloom during the time period when monarchs are in a particular region

Bloom		Common Name	Scientific Name	Flower Color	Max. Height (Feet)	Water Needs (Low, Med., or High)	Notes
		Forbs					All species perennials, unless otherwise noted. Monarchs can be found year-round in California.
Spring to Summer	1	Nettleleaf giant hyssop	*Agastache urticifolia*	Purple/red	2	L	Establishes better from transplant than seed. Tolerates clay soil and wet or dry conditions.
	2	Yarrow	*Achillea millefolium*	White	3	L	Tolerates clay soil and wet or dry conditions. Attractive to many insects.
Spring to Fall	3	Coastal sand verbena	*Abronia latifolia*	Yellow	1	L	Tolerates salt spray and prefers sandy soils. Can bloom year-round.
	4	Gumplant	*Grindelia camporum*	Yellow	4	L–H	Tolerates clay soil and wet or dry conditions.
	5	Milkweed	*Asclepias* spp.	Pink/white/purple	2–4	L/M	Monarch caterpillar host plant. *Likely entire genus is attractive to monarchs.*
	6	Oregon gumweed	*Grindelia stricta*	Yellow	5	H	Wetland / riparian.
	7	Western vervain	*Verbena lasiostachys*	Purple	3	L	Good butterfly plant. Tolerates seasonal flooding, sand and clay. Can be used for erosion control.

Images: www.xerces.org

xerces.org

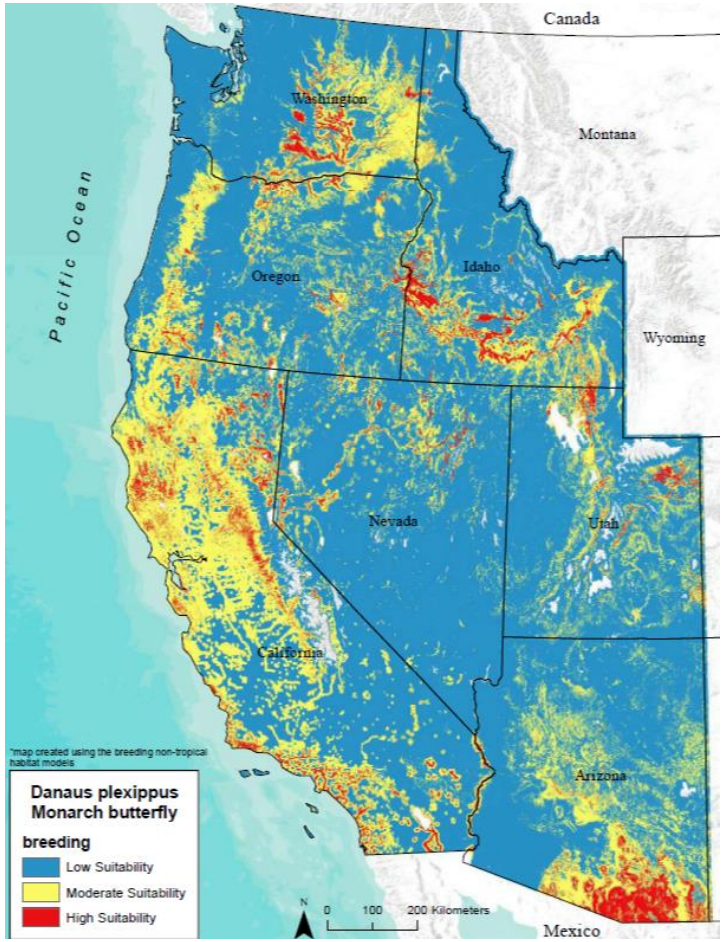
Best Management Practices

Protect, manage, and restore summer breeding and fall migration monarch habitat

Identify existing habitat and protect it from destruction.

Especially in the most important areas where it has been lost.

Learn more in Managing for Monarchs in the West



Dilts et al. 2019

xerces.org

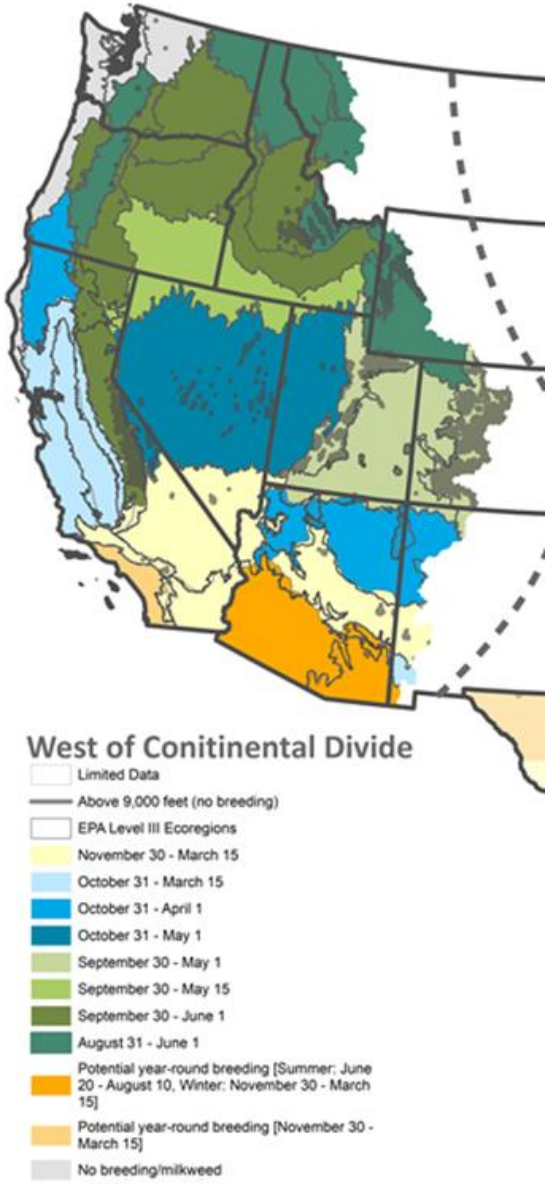
Manage habitat in a way to minimize harm. Example: Mowing

There are millions of acres of roadside habitat that are mowed in the West.

Mowing can kill pollinators – including monarch larvae - and remove nectar resources.

Excessive mowing reduces wildflower abundance and diversity over time.

Photo: Stephanie McKnight/Xerces Society



xerces.org

Sources: Thomas 1984; Wynhoff 1998; Di Giulio et al. 2001; Humbert et al. 2010; Hatfield et al. 2012; Kayser 2014

Adopt Monarch Friendly Roadside Management

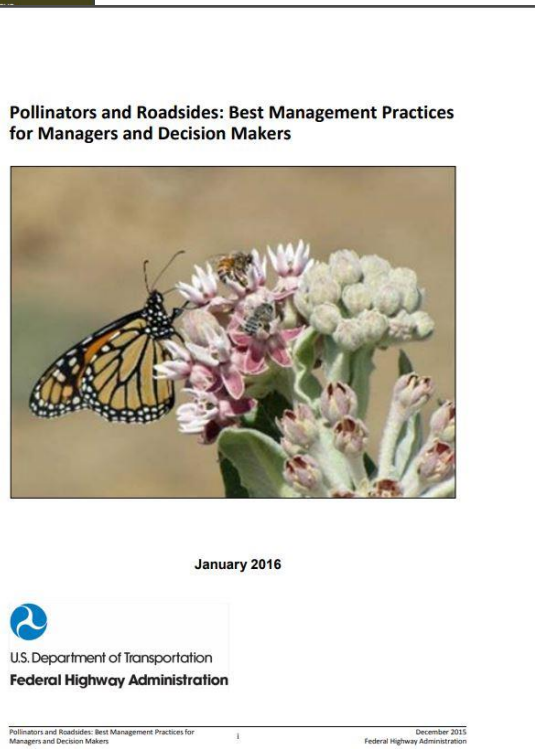
Milkweed in the West is common on roadsides. Resources for managing roadside habitat for monarchs:

-Monarch Butterflies, Weeds, and Herbicides

-Milkweed Guides for Roadsides

-Roadside BMPs

-Climate-Smart Right-of-Way Habitat



xerces.org

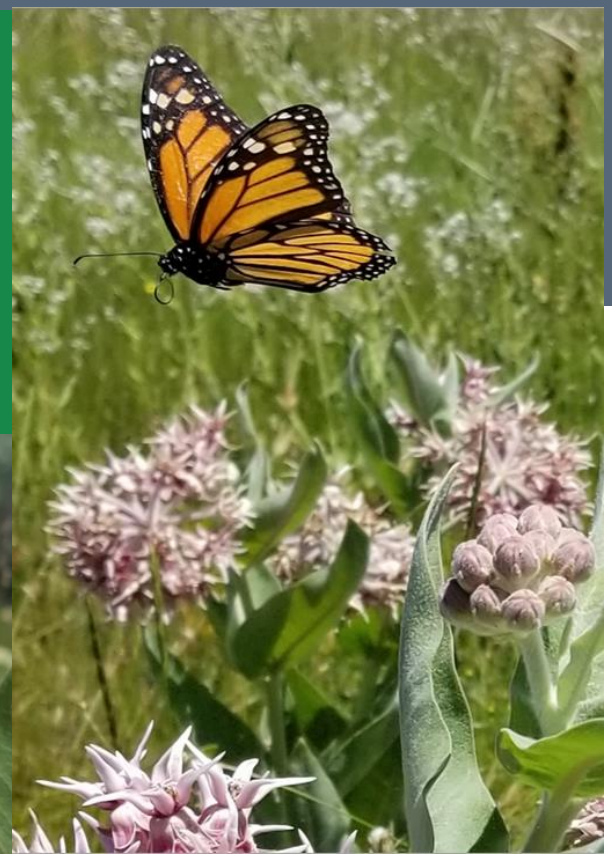
Key Management Implications

Managing Western Monarch Breeding Habitat

Incorporate Best Management Practices for Monarchs into INRMPs, including management timing for monarchs

Increase the availability of nectar and native milkweed. Plant a diversity of milkweed species, plant in sun and shade. Plant a diversity of monarch nectar plants.

Identify and protect existing milkweed from disturbance (mowing, fire, road maintenance, pesticide application, etc.) during the active monarch breeding season. Protect habitat in shade and sun.



xerces.org

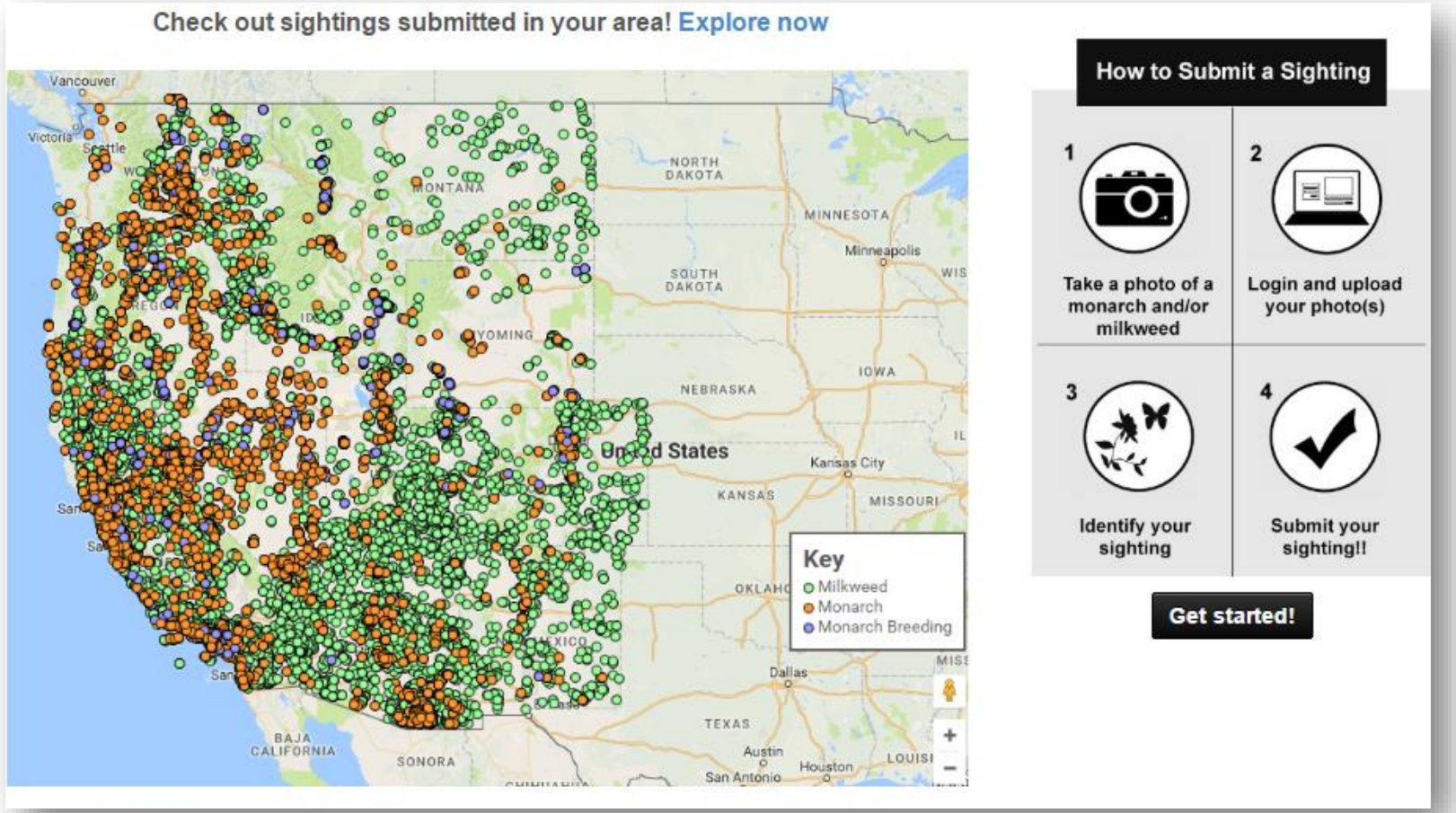
Research Products available at: https://www.denix.osd.mil/legacy/nr-legacy-project-deliverables

- Best Management Practices: Monarch Conservation on Department of Defense Lands in the West (Updated version will be published later this year)
- Fact Sheet: Western Monarch Management Windows: Timing Management in Monarch Breeding Habitat
- Annual Project Reports (2017 & 2018 season final report complete, 2019 final report in progress)
- Expected in the future: Publications from results of this research, Date: TBD

Photo: Stephanie McKnight/Xerces Society

xerces.org

Western Monarch Milkweed Mapper



WESTERN MONARCH MILKWEED MAPPER

Submissions

Milkweed Sightings: **38552**
Monarch Sightings: **16977**
Monarch Breeding Sightings: **2959**
Total Sightings: **55529**

Learn more & participate at www.monarchmilkweedmapper.org

Additional Community Science Projects

Community Science Monitoring Programs for Monarchs

Integrated Monarch Monitoring Program

This monitoring program is a tri-national initiative led by the Monarch Conservation Science Partnership to monitor monarch populations and habitat throughout their breeding range.

Journey North

Report observations of migrating monarchs to real-time migration maps.

Monarch Larva Monitoring Project

How many generations do western monarchs have annually? What is the survival rate of eggs/larvae?

Project Monarch Health

How common is OE in the West? Other parasites?

MONARCH JOINT VENTURE

Journey North

Monarch Larva Monitoring Project

PROJECT MONARCH HEALTH

xerces.org

Identifying Western Monarch Migration Pathways

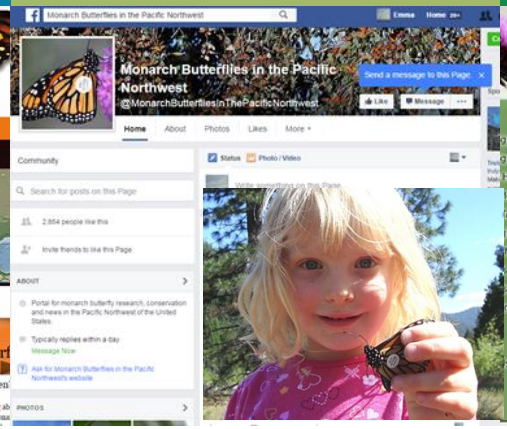
Western Tagging Programs

California

Monarch Alert at Cal-Poly

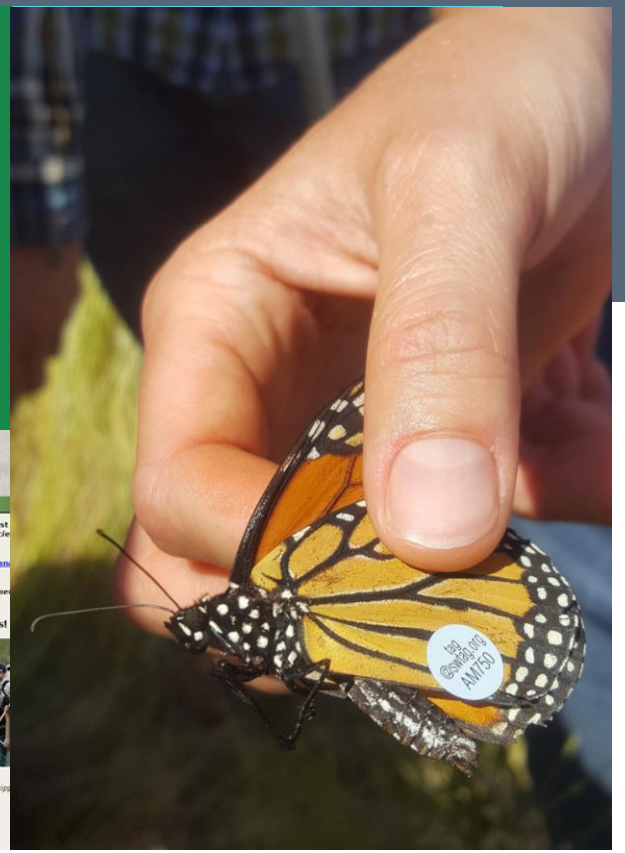
Northwest

Pacific Northwest Monarch Butterflies



Southwest

Southwest Monarch Study



xerces.org

Thank you for supporting this research!

This work is funded by the Department of Defense Legacy Resource Management Program, US Fish and Wildlife Service, and Xerces donors and members.

Field Work Support: Vandenberg AFB and Beale AFB in California, NWSTF Boardman in Oregon, JBLM Yakima Training Center in Washington, NAS Fallon in Nevada, and Mountain Home AFB in Idaho. In addition, we worked with US Army Corps of Engineers, Stone Lakes National Wildlife Refuge, and California State Parks in northern California, and Sedgwick Reserve - University of California Santa Barbara Natural Reserve System in Southern California.

xerces.org

Stephanie McKnight
stephanie.mcknight@xerces.org