

National Monarch Habitat Suitability Modeling for Corporate Decision making

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Objectives

Develop a GIS-based approach to help electric power companies better understand the location and extent of monarch habitat within their landholdings in the contiguous United States.

1. Develop model to identify areas of monarch habitat that overlap with company landholdings

 Monarch Habitat Model

2. Analyze model results and company-specific factors to develop strategy.

 Company Monarch Management Strategy

Scientific Advisory Committee (SAC)



Wayne
Thogmartin
Research Ecologist
Upper Midwest Environmental
Sciences Center, USGS



Laura
Lukens
National Monitoring Coordinator
Monarch Joint Venture



Jay
Diffendorfer
Research Ecologist
Geosciences and Environmental
Change Science Center, USGS



Kasey
Allen
Principal GIS Specialist
ICF



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Expert Input

Numerous experts provided input at various stages, as described in the final methods report:

- Dr. Eric Lonsdorf, Emory College
- Stephanie McKnight, Xerces Society
- Stephanie Frische, Botanist, Xerces Society
- Dr. David Zaya, Plant Ecologist, University of Illinois
- Dr. Ray Moranz, Grazing Lands Ecologist, Xerces Society
- Dr. Tyler Flockhart , University of Maryland, Center of Environmental Sciences
- Dr. Chip Taylor, University of Kansas
- Dr. Kelly Nail, USFWS
- Phil Delphey, USFWS
- Ryan Drum, USFWS
- Sean Sweeney, USFWS

These experts did not necessarily “approve” the final methods.

Model Validation – Power Company Land Managers

Land managers at eight electric power companies across the United States reviewed various iterations of the modeling results against their landholdings.

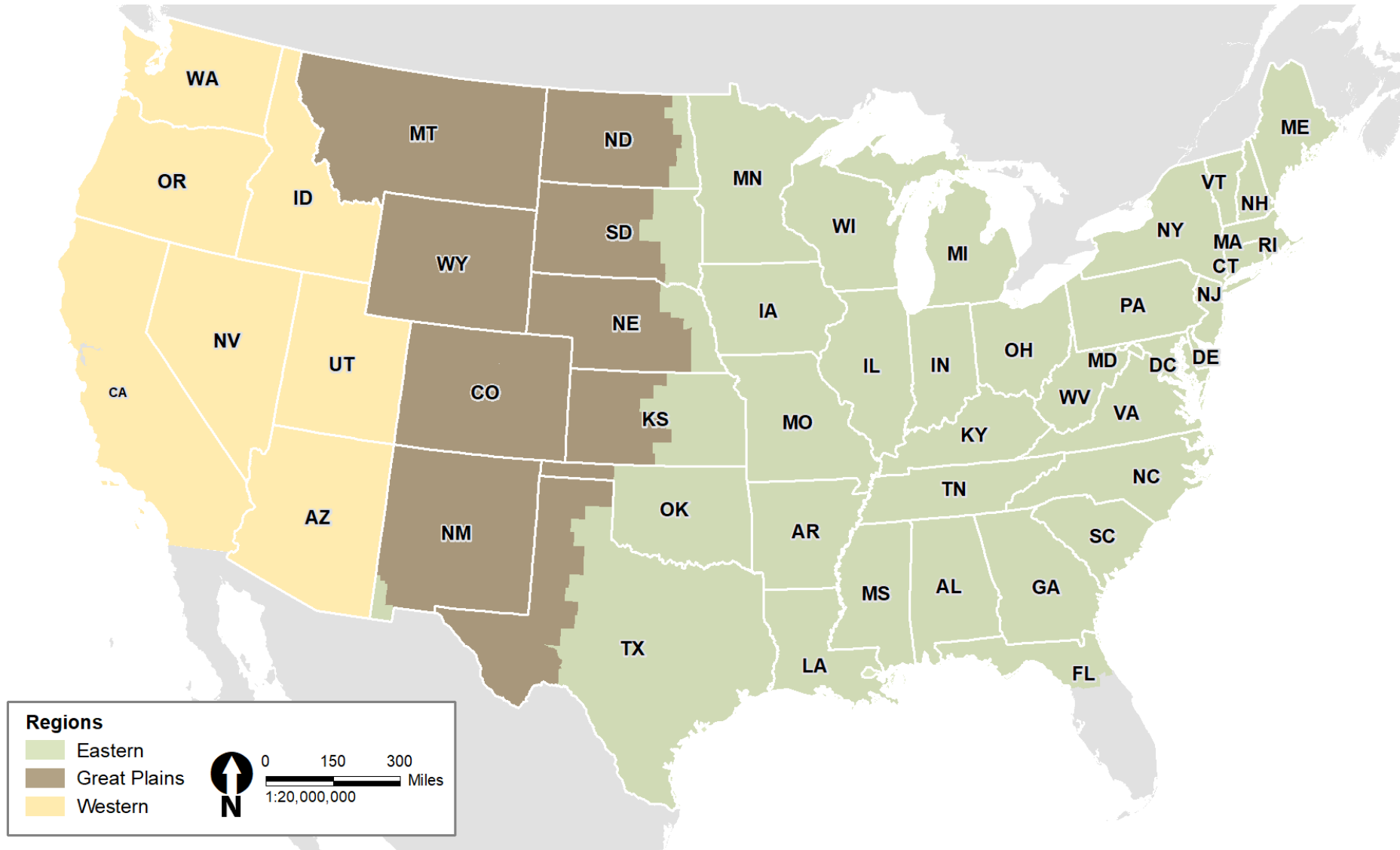
- Model results were considered as initial validation for the methods.
- In several cases, the validation step resulted in revisiting modeling assumptions, updating the methods, and re-validating with land managers.
- Several companies conducted site-based verification of the modeling results and reported good consistency.

Key Decisions Made

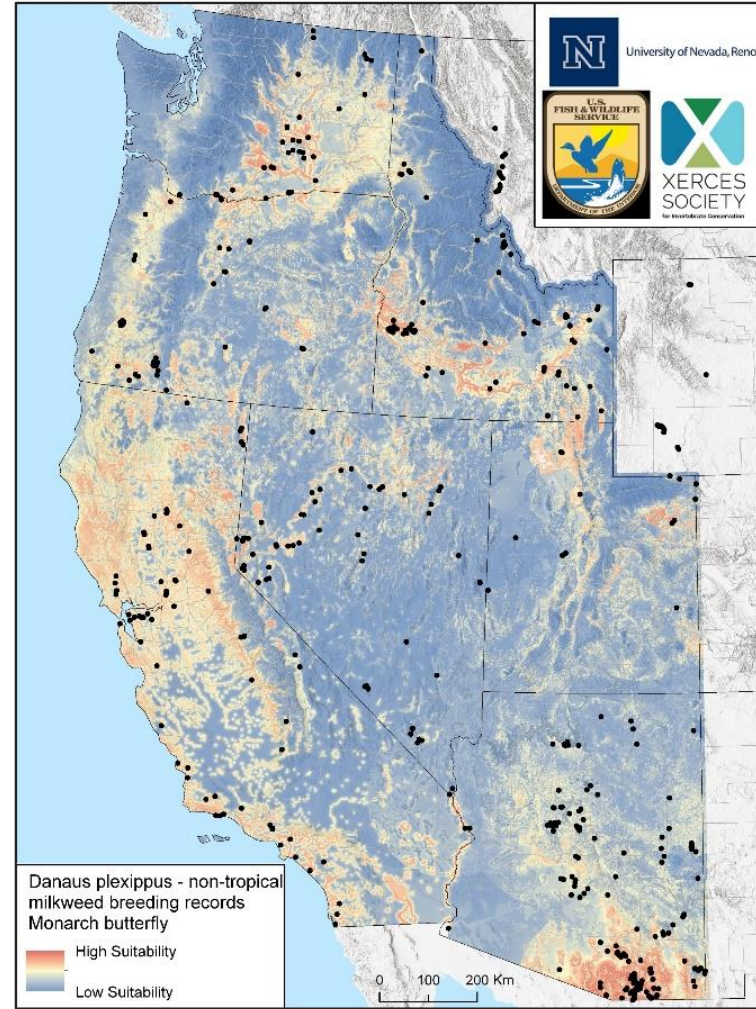
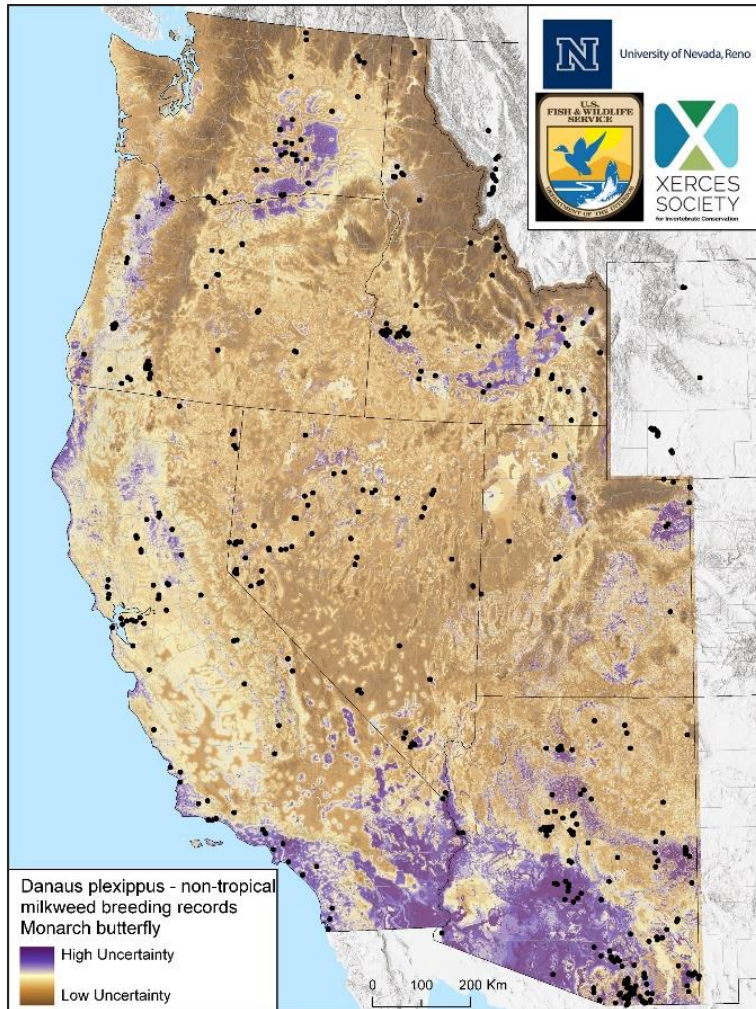
1. Wouldn't use Thogmartin et al. methodology as it focused on midwestern land cover and should not be assumed to apply to areas outside the Midwest
2. Western and eastern monarch populations are distinct - should identify best available existing methods from each region
3. Should not only focus on milkweed habitat (breeding) but also consider floral resources (migratory).
4. Focus on current habitat suitability

Milkweed Suitability

Three Milkweed Regions

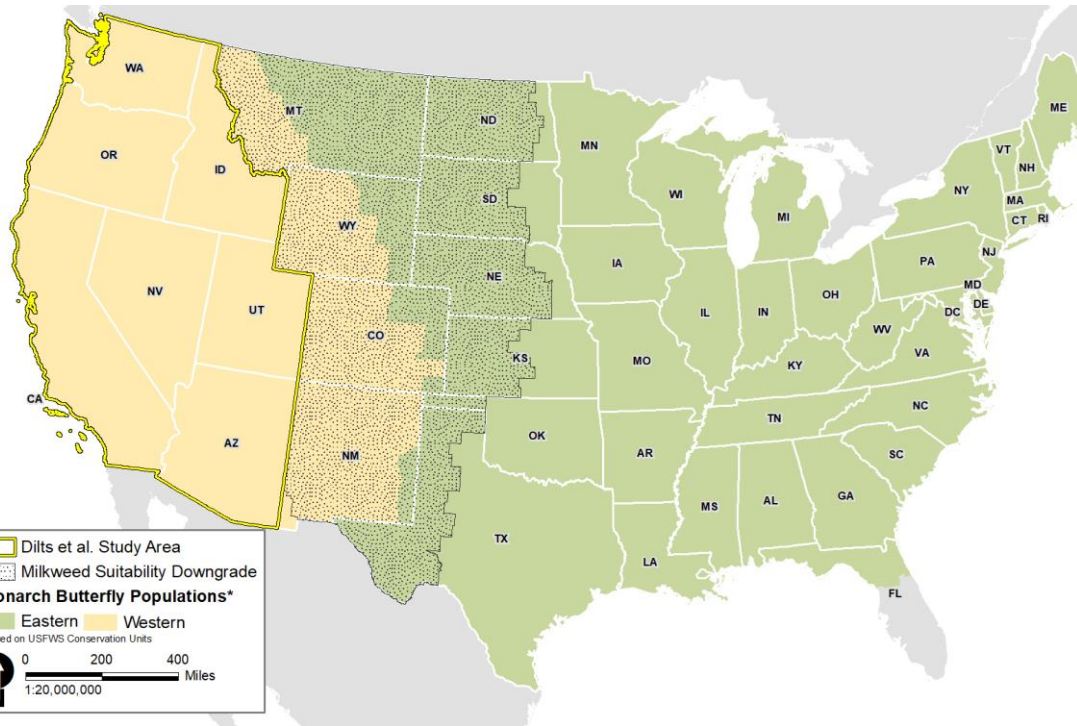


Milkweed: Western Region



Source: Xerces Society

Milkweed Suitability Eastern and Great Plains Downgrade



Land Cover Class	Eastern Region Milkweed Suitability	Great Plains Region Milkweed Suitability
Barren Land	Low	Low
Cultivated Crops	Low	Low
Deciduous Forest	Low	Low
Developed, High Intensity	Low	Low
Developed, Low Intensity	Medium	Medium
Developed, Medium Intensity	Low	Low
Developed, Open Space	High	High
Emergent Herbaceous Wetlands	Medium	Medium
Evergreen Forest	Low	Low
Hay/Pasture	Medium	Low
Herbaceous	High	Medium
Mixed Forest	Low	Low
Open Water	Low	Low
Shrub/Scrub	Medium	Medium
Unclassified	Low	Low
Woody Wetlands	Low	Low

Estimating Milkweed- Eastern was challenging

This survey is related to CURRENT milkweed abundance (not potential for restoration).

Current Milkweed Abundance are defined as:

- *High = >10 stems/acre*
- *Medium = 1-10 stems/acre*
- *Low = <1 stem/acre*

Confidence Level is your qualitative assessment based on current state of knowledge and observation.

- *High = Extremely Confident*
- *Medium = Mostly Confident*
- *Low = Somewhat Confident*

Land Cover Types	SAC Consensus	Expert 1	Expert 2	Expert 3	Expert 4	
		North Core	North Core	North Exterior	South Core	South Exterior
		Current Milkweed Abundance	Current Milkweed Abundance	Current Milkweed Abundance	Current Milkweed Abundance	Current Milkweed Abundance
Barren Land	Low	Low	Low	Low	Low	Medium
Cultivated Crops	Low	Low	Medium	Low	Low	Low
Deciduous Forest	Low	Low	Medium	Low	Low	Medium
Developed, High Intensity	Low	Medium	Low	Low	Low	Low
Developed, Low Intensity	Medium	Low	Medium	Low	Medium	Medium
Developed, Medium Intensity	Low	Medium	Medium	Low	Low	Medium
Developed, Open Space	High	Medium	Medium	Low	Low	Medium
Emergent Herbaceous Wetlands	Medium	Medium	High	Low	Low	Medium
Evergreen Forest	Low	Low	Low	Low	Medium	Medium
Hay/Pasture	Medium	Medium	High	Medium	Medium	Low
Herbaceous	High	High	High	High	High	High
Mixed Forest	Low	Low	Low	Low	Medium	Medium
Open Water	Low	Low	Low	Low	Low	Low
Shrub/Scrub	Medium	Medium	Medium	Medium	Medium	Medium
Woody Wetlands	Low	Low	Medium	Low	Low	Medium

Key: Low Confidence Medium Confidence High Confidence

Table 4. Expert Milkweed Suitability Estimates and Corresponding Confidence Level

Floral Resources Suitability

Floral Resource Suitability Simplification

Floral Resource Suitability

InVEST Relative Abundance of Floral Resources, with modifications, and 2020 Cropland Data Layer

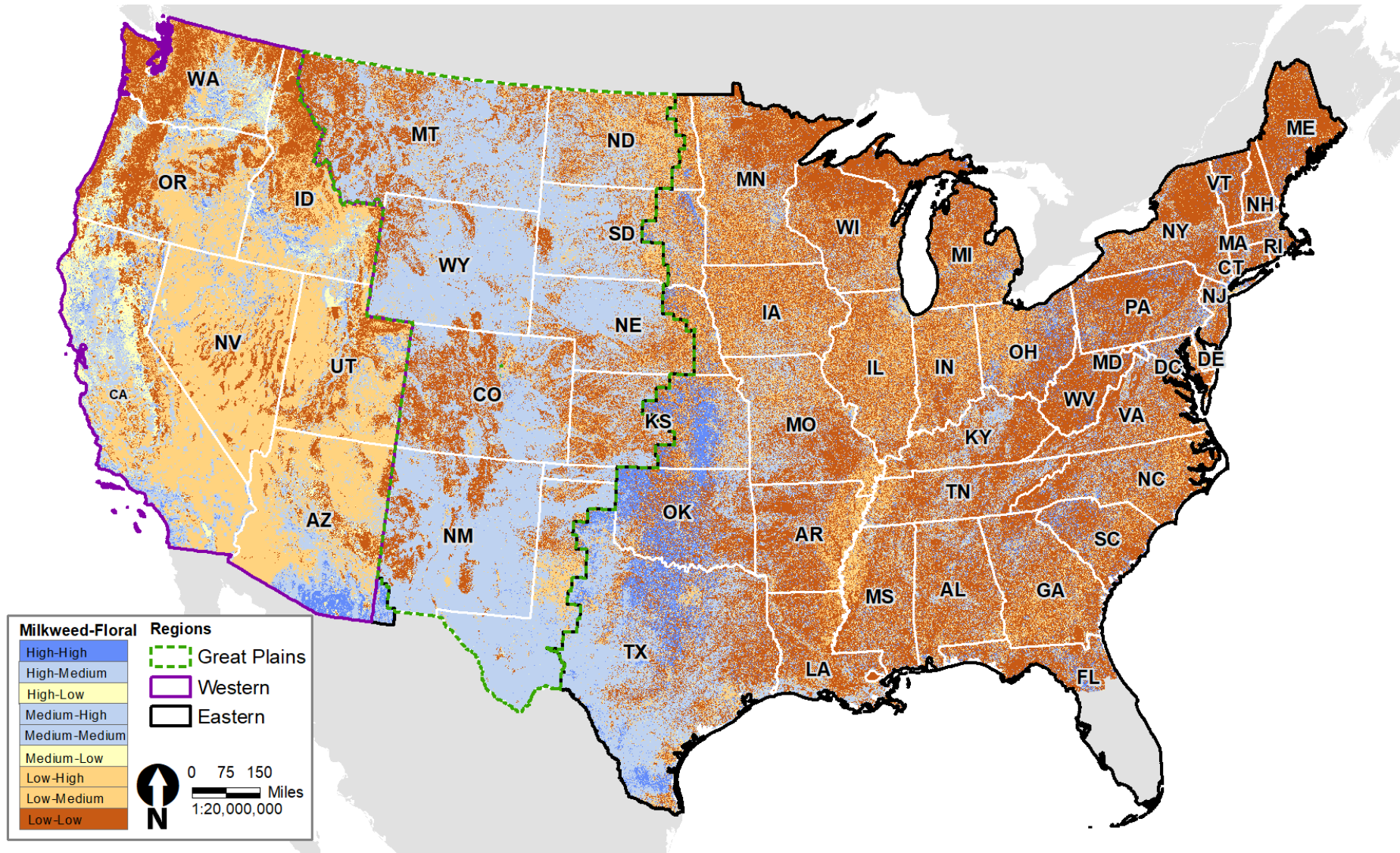
Cropland Data Layer Class	Bee Suitability	Monarch Suitability
Deciduous Forest	High	Low
Evergreen Forest	Medium	Low
Mixed Forest	Medium	Low
Woody Wetlands	High	Low

Final Methodology

	Western Region	Eastern Region	Great Plains Region
Milkweed Suitability	<i>Danaus plexippus</i> —non-tropical milkweed breeding (Dilts et al. 2019)	Species expert opinion and 2019 National Land Cover Database	Species expert opinion and 2019 National Land Cover Database
Floral Resource Suitability	<i>InVEST Relative Abundance of Floral Resources, with modifications, and 2020 Cropland Data Layer</i>	<i>InVEST Relative Abundance of Floral Resources, with modifications, and 2020 Cropland Data Layer</i>	<i>InVEST Relative Abundance of Floral Resources, with modifications, and 2020 Cropland Data Layer</i>

Floral and milkweed resource maps are 30-meter and 270-meter resolution, respectively

Monarch Habitat Suitability



Other Data Considered

- **Pesticides**

- Limited data available
- Application of pesticides shifts over time
- Monarch habitat can exist in areas near pesticide use

- **Core Habitat Patches**

- Small habitat patches can contain a higher abundance of monarch compared to larger patches

Constraints

- **Resolution:** East and west maps are 30-meter resolution.
 - State/regional high resolution land cover data can help
- **Misclassification:** Land cover data are imperfect
- **Uncertainty:** Varying levels regarding the milkweed estimates in the eastern monarch population
 - Could be updated as more data become available (e.g., Integrated Monarch Monitoring Program)
- **Verification:** Habitat suitability map does not replace the need for field surveys to accurately determine the location of suitable habitat

Limitations

Application of the modeling results at a national scale for guiding national monarch conservation priorities would be entirely inappropriate. The purpose of this effort was to develop outputs to guide company decisions, which involved using the model at sub-regional and sometimes parcel scales.

- USFWS is continuing to determine the most appropriate approach for defining habitat. USFWS's definition of habitat may ultimately be different than the methods applied in our model.
- Floral and milkweed resource maps are 30-meter and 270-meter resolution, respectively. Using these resolution data was necessary to develop a method that could be applied to many regions throughout the United States. In the future state or local land cover data could be used to create higher resolution maps.
- The CDL and National Land Cover Database (NLCD) are imperfect, each with various misclassification rates for land cover. This misclassification can lead to incorrect habitat suitability classifications.
- There are varying levels of certainty regarding the milkweed estimates in the range of the eastern monarch population. This method could be updated as more milkweed occurrence and density data become available (e.g., the Integrated Monarch Monitoring Program).
- This habitat suitability map does not replace the need for field surveys to accurately determine the location of suitable habitat. However, it is a reasonable approach for efficiently analyzing large areas of land to identify monarch conservation and restoration opportunities, particularly when overlaid with organization-specific landholding information.
- As companies develop a monarch management plan, GIS data cannot be used alone; other factors and/or expert analysis and interpretation of the GIS modeling outputs must be considered.
- The monarch habitat maps applied at a company-specific level can help identify areas most likely to support monarch habitat, but site-based verification would be required for confirming the presence and quality of suitable habitat.
- There are regional differences in how monarchs use milkweed and nectar resources. Our model equally weights nectar and milkweed and does not account for regional differences in how monarch depend on these resources from north to south or east to west. Accordingly, there are embedded scientific limits to interpreting the national maps from the model, as monarch depend on these resources at varying degrees and at different times of year throughout the country.
- An estimate for milkweed *quality* was not done, only abundance. We used the abundance estimates as a proxy for overall milkweed suitability.