

# Western Monarch Overwintering Science Priority Themes

Western monarch overwintering numbers have declined by more than 90% since the 1980s. Although the geographic footprint of the overwintering sites used by western monarchs is small compared to their migratory range, the conservation of these sites is essential for ensuring that the migration continues. Protecting and restoring monarchs' overwintering habitat is identified as a crucial part of the species' recovery, but significant knowledge gaps remain and have hindered effective conservation action to protect this stage of the migratory cycle.

From October until March, western monarchs overwinter in forested groves along the Pacific coast from Mendocino County to Baja California. Over 400 overwintering sites have been documented. These groves occur in many landscape types and can vary greatly from site to site. Over 60 overwintering sites have been lost to development over the last several decades and further sites are lost or degraded each year. Disease and drought have stressed the trees in many remaining overwintering sites and managers must balance competing needs, including fuels reduction to mitigate wildfire risk. Active management of the groves is critical to recovery of the western monarch, but much remains unknown about monarch overwintering biology and best management practices for these sites.

It is vital that we use applied research and an adaptive management approach to ensure these sites are protected and managed for the long term.

As part of a partnership with the U.S. Forest Service International Programs and the U.S. Department of Defense Legacy Resource Management Program, the Xerces Society brought together forty key researchers, land managers, state and federal agency representatives, and conservationists for an in-person meeting for collaborative strategic planning of shared priorities of western monarch overwintering science. The meeting took place on May 16th and 17th, 2023, in San Luis Obispo, California. The meeting objectives included identifying and prioritizing key knowledge gaps that are currently limiting the conservation of the overwintering population as well as identifying strategies and actions to close those gaps and improve conservation outcomes. The following list of priority themes and key questions arose from discussions stemming from the meeting.

## 1. Overwintering site coordinated study to understand monarch occupancy, within-grove movement, and grove selection

Begin comprehensive intensive monitoring of cluster locations, cluster size, and microclimate conditions at a subset of overwintering sites using standardized methods (“super study”) in order to better understand monarch occupancy, movement, and mortality, and what makes a grove habitable for overwintering. Use Lidar, weather sensors, and photography to directly test long-held hypotheses of why monarchs occupy some locations over



Cluster of monarchs overwintering in a Monterey pine tree.  
(Photo: Xerces Society / Candace Fallon.)

others. Analyze known cluster locations for possible grove- and landscape-scale associations.

Key questions to be addressed:

- ⇒ What attributes of overwintering sites are most important to monarchs? How are monarchs choosing overwintering sites based on those attributes?
- ⇒ What aspects of overwintering site grove structure affect monarch cluster size, cluster location, and survivorship?
- ⇒ How does overwintering site grove structure affect wind attenuation?
- ⇒ What do we need to learn about overwintering site grove structure in order to manage groves better?
- ⇒ How does disturbance such as wind, storms, smoke, vibration, or noise affect clustering?

## **2. Adaptive management of overwintering sites**

Experiment with restoration techniques in order to determine what techniques are more successful and which are not. This may include restoring overwintering sites that monarchs are not currently occupying, experimenting with tree species historically native to overwintering sites, and testing artificial wind-blocking structures.

Key questions to be addressed:

- ⇒ What management techniques and approaches are most effective to increase monarch use of and survival in overwintering site groves throughout the overwintering season?
- ⇒ What native tree species can be incorporated into overwintering site groves to reduce monarchs' reliance on non-native eucalyptus?
- ⇒ How do we restore habitat quality for monarchs in overwintering site groves whose trees are stressed due to drought?
- ⇒ How do we best manage to reduce catastrophic wildfire risk while preserving monarch overwintering habitat value?
- ⇒ Can we create "new" habitat that will be utilized by monarchs?

## **3. Overwintering site stakeholder outreach and technical assistance capacity-building**

Proactively reach out to land managers and rights-of-way users to make them aware of the habitat value of their sites, create incentives and provide funding for the protection and restoration of overwintering sites, and provide funding for technical expertise to advise on site management plans. Habitat assessments, site management plans, and implementation of management actions are needed for as many sites as possible. Addressing the growing demand for information and expertise will also require expanding the pool of people who can provide assistance to land managers, consultants, communities, and regulatory entities.

Key questions to be addressed:

- ⇒ How do we best make land managers, rights-of-way holders, and communities aware of known overwintering site locations?
- ⇒ How do we most effectively engage regulatory entities and consultants who plan, review, and approve projects that impact monarch overwintering habitat?
- ⇒ How do we best expand knowledge and capacity among land managers and other professionals who provide technical assistance about overwintering monarchs?
- ⇒ How do we best connect with private landowners and incentivize active management of overwintering sites?

## **4. Monarch movement between and away from overwintering sites**

Obtain a detailed understanding of how and when monarchs move between and away from overwintering sites

to inform habitat management. To accomplish this, use radio telemetry, potentially in combination with traditional sticker tagging. Conduct one study to evaluate how radio tags affect monarch movement. Conduct a second study utilizing radio-tagged monarchs at a complex of overwintering sites, such as Vandenberg Space Force Base.

Key questions to be addressed:

- ⇒ Why and how often do monarchs move within overwintering site groves or between overwintering site groves?
- ⇒ Does monarch movement or mortality account for significant declines in monarch numbers between the Thanksgiving and New Year counts?
- ⇒ What cues do monarchs use to begin dispersal in late winter?
- ⇒ How important are “transitory” or “autumnal” overwintering sites?
- ⇒ How can movement studies inform habitat management and the prioritization of overwintering sites? Which kind of movement-study design and technology(ies) best answer these questions?
- ⇒ Do radio tags significantly impact movement and/or survival? Can they be used to answer questions about intersite movement, dispersal, and/or help locate additional overwintering sites?



Studies of monarch movements within and between groves will inform site management. (Photo: Xerces Society / Carly Voight.)

## 5. Western Monarch Count

Expand the Western Monarch Count to improve accessibility for a wider range of volunteers and partners, as well as improve data collection tools and services to data users.

Key questions to be addressed:

- ⇒ What additional data should be collected and is that data best collected by volunteers or professional biologists?
- ⇒ How do we best assess groves post-restoration, following storm damage, and/or after fuels reductions work in order to understand how monarchs respond to changed conditions?
- ⇒ How can the program be adapted to engage a wider range of volunteers and partners (e.g., Spanish and other language accessibility; technology and equipment accessibility)?
- ⇒ In addition to the existing Thanksgiving Count and New Year Count, what long-term monitoring is needed to better understand western monarch population status and trends, as well as inform habitat management?

## 6. Climate change impacts on overwintering monarchs

Study how climate change may be affecting monarch physiology and behavior leading to changes in the timing of fall arrival, spring dispersal, reproductive status, and mortality rates.

Key questions to be addressed:

- ⇒ Is monarch overwintering survival determined by temperature effects on metabolism and fat storage? If so, how will warmer winter temperatures affect this relationship?

- ⇒ How do storms and other extreme weather events impact monarch clusters and dispersal?
- ⇒ How will overwintering behavior, reproductive behavior, and spring dispersal be affected by warmer fall and winter temperatures?

## 7. Encourage planting of winter-blooming nectar sources

Launch a public messaging campaign and provide funding for pesticide-free winter-blooming nectar plants along the California coast.

Key questions to be addressed:

- ⇒ Is nectar limiting overwintering survival and/or fecundity?
- ⇒ How far do monarchs travel from overwintering sites to get nectar?
- ⇒ What nectar species are preferred by overwintering monarchs? What nectar species are most likely to succeed in restoration efforts?

## Participants of the 2023 Western Monarch Overwintering Science Meeting



Photo taken while visiting Pismo Beach State Park overwintering site by Kyle Nessen (Althouse and Meade, Inc.).

Standing [l-r]: Bill Henry (Groundswell Coastal Ecology), Jeff Frey (California State Parks), Stephanie Little (California State Parks), LynneDee Althouse (Althouse and Meade, Inc.), Heather White (California State Parks), Jim Chu (U.S. Forest Service International Programs), Matt Horning (U.S. Forest Service), Scott Black (Xerces Society), Wayne Thogmartin (U.S. Geological Survey), Sarah Moor (U.S. Department of Defense), Esme & Lee Brown (James Madison University), Elizabeth Crone (University of California-Davis), Angela Laws (Xerces Society), Ryan Drum (U.S. Fish and Wildlife Service), Isis Howard (Xerces Society), Stu Weiss (Creekside Science), Nancy Wahl-Scheurich (California Association of Resource Conservation Districts), Emma Pelton (Xerces Society), Ashley Fisher (Xerces Society), Peter Ibsen (U.S. Geological Survey), Sarina Jepsen (Xerces Society), Sarah Gomes (Monarch Joint Venture), Cheryl Schultz (Washington State University), Emily Erickson (University of California-Davis).

Crouching [l-r]: Kristin Howland (Central Coast State Parks Association), Blake Barbaree (Point Blue Conservation Science), Stephanie Hertz (Texas A&M / U.S. Department of Defense), Charis van der Heide (Althouse and Meade, Inc.), Jessica Griffiths (CEMML / U.S. Department of Defense), Kyle Nessen (Althouse and Meade, Inc.), Jay Diffendorfer (U.S. Geological Survey), Hillary Sardiñas (California Department of Fish and Wildlife), VR Seagal (Washington State University).

Participating but not pictured: Melissa Burns (U.S. Fish and Wildlife Service), Katie Drexhage (California State Parks), Jodi Isaacs (California State Parks), Dylan MacArthur-Waltz (University of California-Davis), Mia Monroe (National Park Service / Xerces volunteer), Regena Orr (California State Parks), Francis Villablanca (Cal Poly).