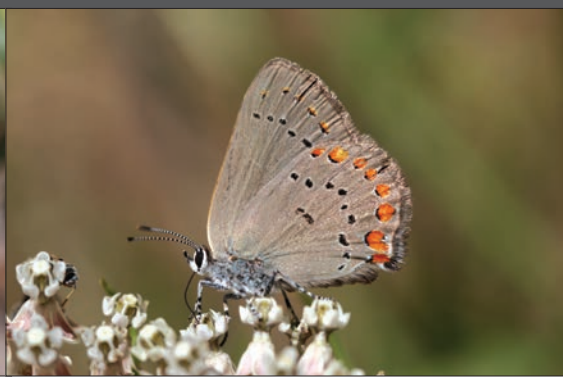
POLLINATORS AND CLIMATE CHANGE

Climate-Smart Natural Habitat





LEFT: Natural areas provide important host plants for native pollinators. MIDDLE: Climate change will have a variety of effects on pollinators, including bumble bees. RIGHT: Considering of the needs of specialist pollinators, like the coral hairstreak (*Satyrium titus*), in restoration can help make these species more climate resilient.

Pollinators are essential, providing a valuable service that affects the structure and function of terrestrial ecosystems. More than 85% of all flowering plants are pollinated by animals, primarily insects. Bees are the most effective insect pollinators, and there are more than 1,600 species of native bees in California. Unfortunately, many pollinators are at risk. The primary drivers of pollinator population decline include habitat loss, pesticide use, and climate change.

In California, climate change is expected to lead to higher temperatures and longer, more frequent heat waves. Drought frequency and intensity is forecasted to increase, as is the occurrence of extreme weather events. Precipitation is not expected to vary greatly, however more winter precipitation will fall as rain instead of snow, reducing snow pack.

Effects of Climate Change on Pollinators

The abiotic changes associated with climate change can have a variety of effects on pollinators, including:

- **Species range shifts.** Species may shift distributions to track more favorable climate. In general, species are expected to shift poleward and to higher elevations. Not all species will shift their ranges, and in some cases ranges may merely shrink. Range shifts may lead to the formation of new ecological communities.
- **Phenological mismatches.** Phenology, or the timing of biological events (such as the timing of budburst or the emergence of a pollinator species), is often influenced by temperature. Phenological mismatches are possible when pollinators and their host plants respond differently to climate change.
- **Physiological responses.** Many processes, such as metabolism, activity, and digestion, are temperature dependent in insects. As such, insect performance, including survival, growth rates, and fecundity, can all vary in response to warming. These effects on pollinators may be positive or negative.
- **Altered species interactions.** Climate change can alter species interactions, including pollinators' interactions with predators, pathogens, or competitors. Changes to species interactions can alter pollinator community composition.
- **Changes to the diversity, quantity, and quality of floral resources.** Plants will also respond to climate change. Alterations in plant diversity and abundance are likely to affect pollinators, especially specialists that rely on a narrow set of plants for food. Changes to the quality of floral resources, which can occur with events such as drought or even as a response to increased CO_2 levels, will affect pollinator carrying capacity.
- **Combined effects**. Climate change may combine with the effects of other stressors, such as habitat loss, pesticides, and pathogens, to exacerbate the effects of each stressor.

These effects are not mutually exclusive, as pollinators are likely to experience multiple effects simultaneously. While some species may fare better under climate change, many species will be negatively affected.

XERCES SOCIETY
for Invertebrate Conservation

Strategies to Increase Climate Resilience

Given the many ways that climate change is likely to affect pollinators and plant-pollinator interactions, we propose multiple strategies to increase climate resilience for pollinators in natural areas.

Increase habitat

Protecting habitat and increasing available habitat are the most crucial steps to increasing climate resilience for pollinators and other organisms. Larger habitat patches can support larger populations, which are generally less prone to extinction than smaller populations. Restoring and enhancing habitat whenever possible will ensure that more pollinators, as well as the plants and ecosystems that rely on them, can persist.

An added benefit to protecting and restoring natural habitats is that intact ecosystems act as carbon sinks, providing natural climate solutions that can help achieve international goals to limit climate change. Grasslands and well-managed rangelands can contribute significantly to carbon sequestration.

Use a variety of native plants

Providing a diversity of native plants that bloom from early spring through late fall will ensure that resources are available to pollinators, and it may buffer against potential effects of shifting phenology. Native plant species are more likely to be adapted to drought, which will become more common in California.

Consider specialists

Climate change is more likely to negatively affect specialist pollinators than generalists because they have narrower resource requirements. As host plants respond to climate change, changes in their abundance will have corresponding effects on specialist pollinator populations. The inclusion of host plants for specialist pollinators in restoration work may alleviate some of these potential effects. Contact centralvalleypollinators@xerces.org for a list of specialist bees and butterflies along with their host plants for California.

Increase habitat connectivity

Installing and enhancing habitat corridors to improve habitat connectivity will improve climate resilience in a number of ways. Habitat corridors enable range shifts by providing habitat for species to migrate through. Increased connectivity also allows populations to be larger and increases gene flow, and therefore genetic variability, among populations.

Increase genetic variation

An additional aspect to consider is evolutionary resilience. Species that can adapt to changing climate are more likely to persist, and populations with high genetic variation are most likely to be able to adapt. Because larger populations tend to have higher genetic diversity, increasing habitat availability and connectivity also serves to increase populations' genetic diversity. When selecting plant materials for restoration work, including a small portion from southern or low-altitude ecotypes may serve to increase genetic variation so that plant populations are better able to adapt to changing climate.

Reduce additional stressors

Multiple stressors may combine with climate change to have stronger than expected effects on pollinators. Pesticides, disease, and overgrazing are examples of important stressors for native pollinators. To help you reduce these stressors, Xerces has created guidance for reducing pesticide risk to pollinators and for placement of honey bees in natural areas (see Additional Resources).

Xerces is working to improve climate resilience for pollinators in California. If you are interested in partnering with us or if you would like to learn more, please contact us at centralvalleypollinators@xerces.org.

Additional Resources

Xerces Society, *An Overview of the Potential Impacts of Honey Bees to Native Bees, Plant Communities, and Ecosystems in Wild Landscapes: Recommendations for Land Managers*: https://xerces.org/pollinator-conservation/natural-lands

Xerces Society, *Guidance to Protect Habitat from Pesticide Contamination*: https://xerces.org/publications/fact-sheets/guidance-to-protect-habitat-from-pesticide-contamination

Acknowledgments

Thank you to the Wildlife Conservation Society Climate Adaptation Fund for their generous support of our work. Additional support provided by Annie's, California Community Foundation, Cascadian Farm, Ceres Trust, Cheerios, CS Fund, The Dudley Foundation, General Mills, Häagen-Dazs, Justin's, The Starbucks Foundation, Nature Valley, Turner Foundation, White Pine Fund, and Whole Systems Foundation.

Authors: Angela Laws, Sarina Jepsen, Aimée Code, and Scott Black. Photographs: Page 1, (L) Stephanie McKnight, (M) Kevi Mace-Hill, (R) Xerces Society / Stephanie McKnight. Our thanks go to the individuals who have allowed us to use their photos. Copyright of photos remains with the individuals or the Xerces Society. Layout and Editing: Krystal Eldridge of the Xerces Society.