Pollinator Communities in Roadside Habitats: Identifying Patterns, Protecting Monarchs, and Informing Management

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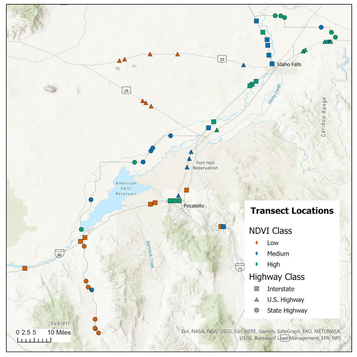
Abstract: Pollinating insects provide vital ecosystem services and are facing global declines and habitat loss. Roadsides are increasingly regarded as important potential areas for enhancing pollinator habitat. Understanding which roadsides best support pollinators—and why—is essential to helping locate and prioritize pollinator conservation efforts across roadside networks. To support this effort, we assessed butterfly, bee, and flowering plant species richness and abundance on a set of 63 stratified randomized roadside transects in southeastern Idaho. Our research evaluated pollinator diversity as a function of highway class (interstate, U.S., and state highways), remotely sensed NDVI values (a measure of vegetation greenness), and floral resources. We found that smaller highways and lower (less green) maximum NDVI values were associated with significantly more bee species and total bees. Roadsides bordering sagebrush habitats typically had low NDVI values and higher bee and butterfly species richness, potentially contributing to this observed pattern. Butterfly richness increased in association with higher floral abundance in roadsides. Additionally, we identified and mapped 1,363 roadside patches of milkweed (*Asclepias speciosa*), larval host plant for the imperiled monarch butterfly (*Danaus plexippus*), in a survey of 910 miles of southern Idaho highways. Based on these results and a literature review, we offer recommendations for management strategies to promote the health of pollinator populations in Idaho's rights-of-way and provide data to help prioritize areas for pollinator-friendly management practices and habitat restoration plantings within Idaho's highway system.

Overview



An equal number of sites were surveyed in each of three NDVI categories (colors) and three highway classes (shapes).

We surveyed **butterflies, bees,** and **flowering plants** at 63 randomized roadside transects in southeastern Idaho, stratified across three highway classes (interstate, U.S., and state highways) and three categories of NDVI, a remotely sensed measure of greenness, as **shown at left**. Higher NDVI categories represented greener, more densely vegetated sites.

Surveys were conducted in June and July 2021 and 2022, with each site surveyed twice per year. Butterflies and flowering plants were identified in field surveys, and bees were sampled at a subset of sites using pan traps.

Separately, in a rapid assessment, **milkweed and monarchs** were surveyed in rights-of-way (ROWs) along both sides of 1,465 km (910 miles) of highways across southern Idaho.

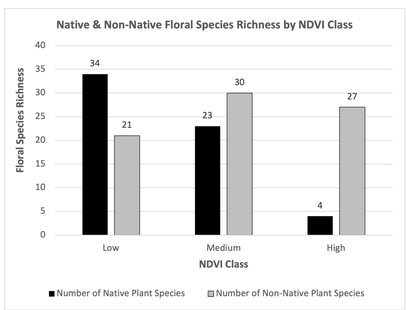
Flowering Plants

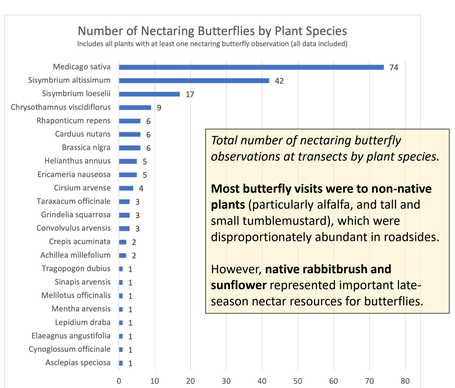
Idaho roadsides host a variety of native plants that provide food for pollinators, including (clockwise from left) penstemon, the range-restricted painted milkvetch, sunflower, yarrow, and tansy-aster.

Transects of low and medium NDVI were typically drier and often associated with sagebrush steppe environments. These transects contained far more native flowering plants on average than high NDVI transects, which were typically dominated by non-native species. Most **high NDVI transects** had no native flowering plants, highlighting these sites as **target areas for invasive species management.**

Total number of native (black) and non-native (gray) flowering plant species by NDVI class, summing all transect surveys.

We found many **more native plant species at lower NDVI transects.**





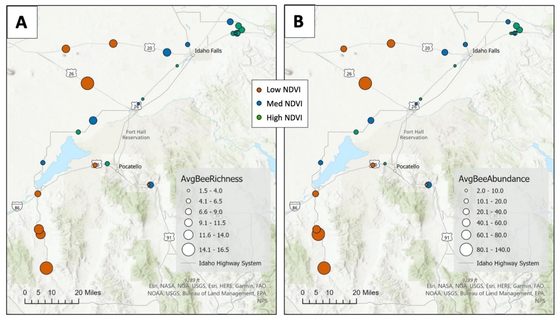
Total number of nectaring butterfly observations at transects by plant species.

Most butterfly visits were to non-native plants (particularly alfalfa, and tall and small tumblemustard), which were disproportionately abundant in roadsides.

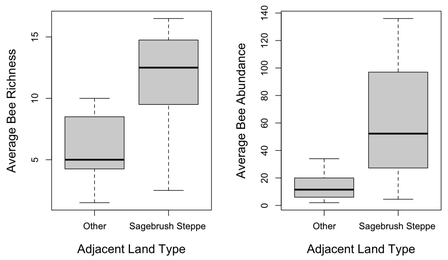
However, **native rabbitbrush and sunflower** represented important late-season nectar resources for butterflies.

Scan to read this **(RP 291)** and other Idaho Transportation Dept. Research Reports:

Bees



(A) Average bee species richness and (B) abundance of transects across our study area. **Low NDVI** (orange) transects along **State and U.S. highways** exhibited relatively **high bee richness and abundance**, as shown.

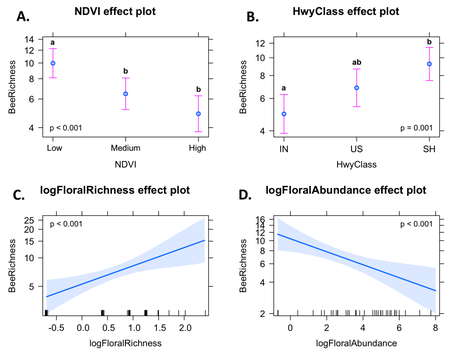


Left: The distribution of values for average bee richness (left) and average bee abundance (right) for transects bordering sagebrush steppe versus other land cover types.

Transects in ROWs adjacent to **sagebrush steppe averaged higher numbers of bees and bee species** than transects in ROWs adjacent to other land cover types, including pasture, agricultural lands, and developed areas.

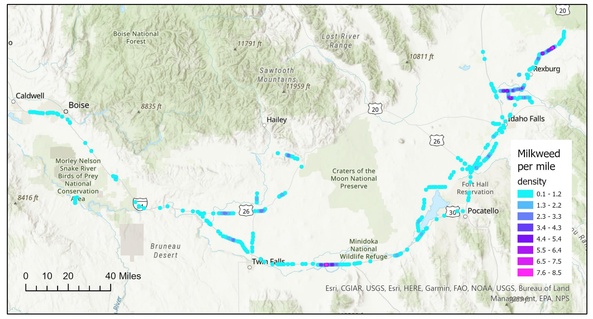
Right: P-values, calculated from an ANOVA on the model, indicate that **bee richness was significantly higher at lower NDVI sites and along smaller highways**, as well as at sites with **higher floral species richness** and lower floral abundance (the latter likely an artefact of pan-trap sampling).

Letters indicate significant differences between NDVI and highway classes ($p < 0.05$) based on Tukey's tests. Similar results were found for bee abundance.



Effects of four variables on bee species richness from a Generalized Linear Mixed Model with Poisson distribution; floral richness and abundance log-transformed.

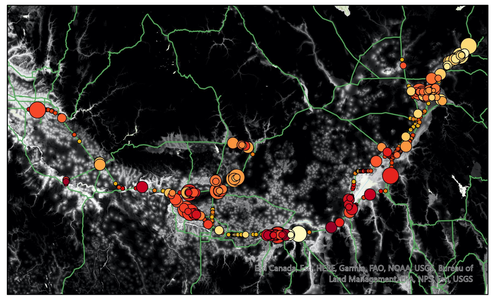
Milkweeds & Monarchs



Above: Our survey of 1,465 km (910 miles) of highways across southern Idaho in July 2021 located **1,363 patches of showy milkweed (*Asclepias speciosa*) in roadside rights-of-way**, ranging from 2 to 7,075 stems in size. Points are colored by the density of patches (number of patches per mile).

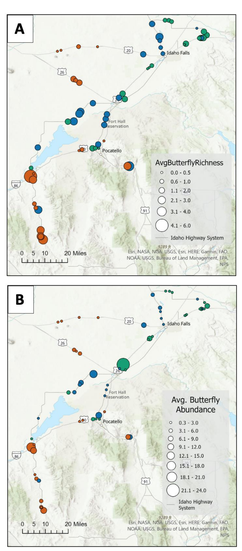
Below: Showy milkweed (*Asclepias speciosa),* at left, is abundant in Idaho roadsides and a critical host plant for larval monarch butterflies *(Danaus plexippus,* at right) and several native beetle species.

Roadside milkweed was primarily found **within 1.5 km of perennial water** sources, most often **bordering irrigated agricultural land**. We documented monarchs breeding on roadside milkweed but found them to be relatively scarce (11 observations over 2 years; more common in 2022).

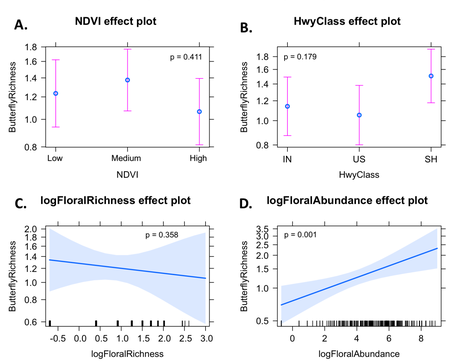


Above: Existing statewide milkweed models were a **poor predictor** of **roadside-specific** milkweed locations (mean suitability value of roadside patches = **0.53**). Circle size indicates size of milkweed patch; circle color indicates suitability value of patch location from low (white) to high (dark red); suitability derived from statewide showy milkweed suitability model (Svancara, Abatzoglou, Waterbury 2019).

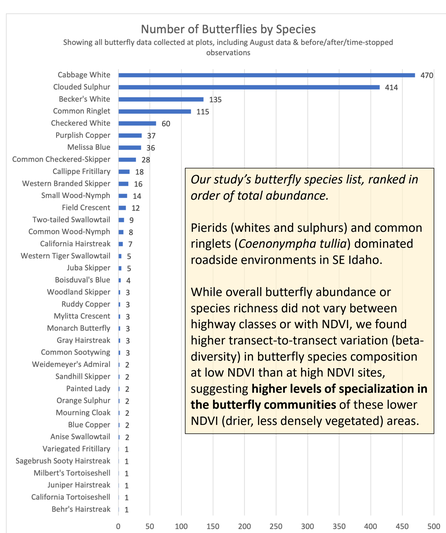
Butterflies



Left*: (A) Average butterfly species richness and (B) abundance of transects across our study area.* Overall, **butterfly richness and abundance showed little consistent variation between highway or NDVI classes**, although hotspots existed, as shown.



Effects of four variables on butterfly species richness from a Generalized Linear Mixed Model with Poisson distribution; floral richness and abundance log-transformed. p-values, calculated from an ANOVA on the model, indicate that **butterfly richness was significantly higher** with **higher floral abundance** but **did not differ with NDVI, highway class, or floral richness**. Butterfly *abundance* did not vary significantly with any of these variables.



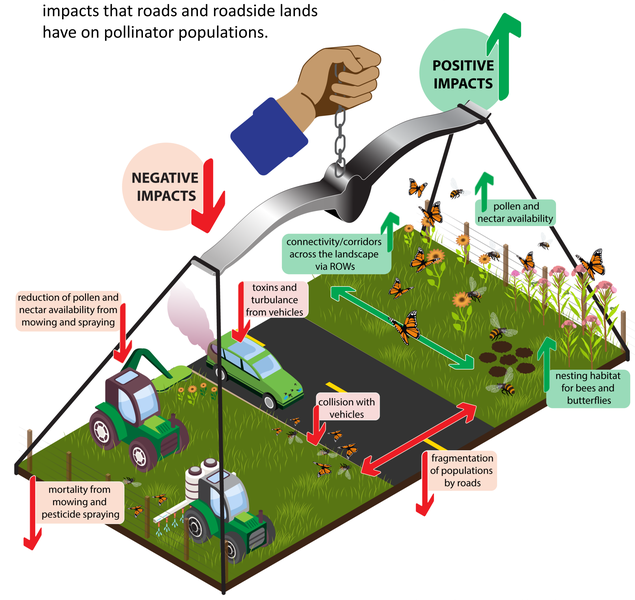
Our study's butterfly species list, ranked in order of total abundance.

Pierids (whites and sulphurs) and common ringlets (*Coenonympha tullia*) dominated roadside environments in SE Idaho.

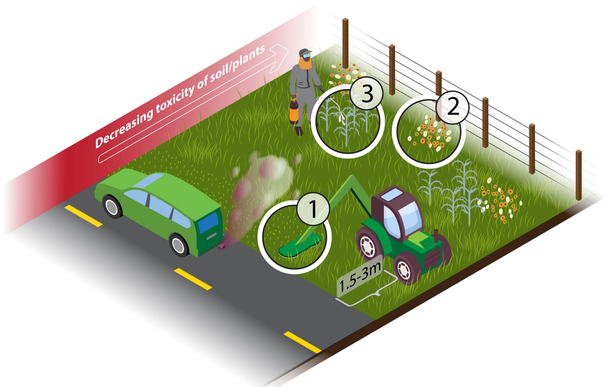
While overall butterfly abundance or species richness did not vary between highway classes or with NDVI, we found higher transect-to-transect variation (beta-diversity) in butterfly species composition at low NDVI than at high NDVI sites, suggesting **higher levels of specialization in the butterfly communities** of these lower NDVI (drier, less densely vegetated) areas.

Recommendations: Managing Roadside Lands for Pollinators

Right-of-way (ROW) **management practices** by Departments of Transportation can **shift the balance** of positive (*green arrows*) and negative (*red arrows*) impacts that roads and roadside lands have on pollinator populations.



ROWs provide **benefits as well as hazards** to pollinators, and the balance of these factors is often unknown and dependent on several factors, including management activities.



Above: Three best practices for ROW management to support pollinators

1) For roads with considerable traffic, maintain a **close-cropped mow zone of 1.5 to 3 m** bordering the pavement (narrower on lower traffic roads), reducing pollinator exposure to roadway **toxins.**
2) Plant **diverse, native wildflowers** in areas **farthest from the road**, away from the zone of toxicity. These areas should **not typically be mown** in the growing season.
3) Noxious **weeds** should be **spot-treated with herbicides** rather than blanket-treating ROWs. Treatment should **not occur** while weeds are in flower.

Key Conclusions:

- **Bee** communities were more abundant and diverse along smaller highways, in lower NDVI (less green) areas, and with more species of flowers
- **Butterfly** communities were more diverse with more abundant flowers
- **Non-native plants** dominated high NDVI areas
- **Milkweed** and **monarch** habitat in ROWs correlated with water access, proximity to irrigated agriculture