# Native plant and pollinator survey on an organic herb farm in Washington state

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## Research

## Abstract

*Background*: Trout Lake Farm (TLF) is a certified organic herb farm in North America. Located in Trout Lake, WA, it supplies plant material to a leading nutritional supplement company. TLF's main crops include Coneflower (*Echinacea angustifolia* DC*., Echinacea purpurea* (L.) Moench*),* Catnip (*Nepeta cataria* L.), and Common Dandelion (*Taraxacum officinale* F.H.Wigg). TLF is beginning to adopt the principles of regenerative agriculture, including the documentation and support of biodiversity on the farm's property. The goal of this study was to provide a baseline understanding of pollinator habitat on farm property, as well as the proportion of native species found along the farm borders and field edges.

*Methods*: The methods included random sampling of uncultivated areas on farm property for native and non-native plant species and cover, as well as sampling both cultivated and uncultivated areas on property for Lepidopteran (butterfly and moth) and Hymenopteran (bee and wasp) pollinators.

*Results*: Results showed an estimated 8.3 percent of the farm's property can be considered beneficial habitat for pollinators and other key wildlife. Pollinators were observed to be more abundant within the crop fields than in the uncultivated areas. The most abundant pollinator observed was the non-native honeybee (*Apis mellifera*), followed by native *Bombus* species and the Western Tiger Swallowtail (*Papilio rutulus*).

*Conclusions*: TLF has a uniquely supportive relationship with native flora and fauna compared to traditional staple crop agricultural systems. Opportunities exist for increasing native habitat and improving sustainability practices. This initial evaluation of the farm's biodiversity is the first step of supporting native species in an agricultural setting.

*Keywords*: Regenerative agriculture, Uncultivated land, Working lands, Pollinator habitat, Organic farming, Native species

## Background

Trout Lake Farm (TLF) is situated in the Pacific Northwest of North America, in Klickitat County in the East Cascades ecoregion of Washington state (Figure 1). Crops grown at TLF include Coneflower (*Echinacea angustifolia* DC.*, Echinacea purpurea* (L.) Moench), Catnip (*Nepeta cataria* L.), Valerian (*Valeriana officinalis* L.), Blue Scullcap (*Scutellaria lateriflora* L.), and Common Dandelion (*Taraxacum officinale* F.H.Wigg). This study took place from May through August 2023.


Figure 1. The ecoregions of Washington. TLF is located in the East Cascades ecoregion, the location is marked by a star.

Trout Lake Farm is located at the southern facing base of Mount Adams, a sacred place known as *Pátu* in Yakama Nation tradition and revered as the source of all life (Fisher 2012). The Yakama Nation is actively involved in natural resource management and restoration in the region, and under the 1855 Treaty retains fishing rights in the White Salmon River, which runs along the border of the farm (Lipson 2022, Weimer 2024). In addition to salmon and game, camas bulb (*Camassia quamash* (Pursh) Greene) and wild huckleberry (*Vaccinium* spp.) are among the traditional indigenous species harvested in Klickitat County (Arnett & Crawford 2007, Fisher 2012).

The East Cascades ecoregion has the highest percent of native taxa (about 53%), and second highest number of taxa of conservation concern in the state (Fertig & Kleinknecht 2020). This biodiversity is being threatened by development of natural lands for agriculture, urbanization, wildfires, and the increasing presence of nonnative species (Yang *et al*. 2018). Efforts need to be taken to preserve the state's native flora as the ecoregion changes in the presence of human-induced impacts.

This study was designed to enable a better understanding of floral biodiversity and native pollinator habitat within a Pacific Northwest working landscape. According to Garibaldi *et al*. 2021, at least 20 percent of a farm's property should be natural habitat for an environmentally functional system. An environmentally functional working landscape retains many of the benefits of natural areas while also producing crops, with minimal tradeoffs to agricultural productivity (Pywell *et al*. 2015). Some of these benefits include improving soil microbiome and nutrient availability, providing corridors for gene flow, reducing the rate of and increasing resistance to climate change, and oftentimes improving crop yield (Garibaldi *et al*. 2021).

Opportunities to increase natural area coverage and habitat resources for native species on working lands can often be overlooked when assessing ways to improve biodiversity on a global scale (Kremen & Merenlender 2018). Although natural lands surrounding agricultural areas may be degraded from their original state, they are often still able to provide important ecosystem services (Hobbs *et al*. 2014) and therefore shouldn't be discounted when evaluating beneficial habitat of a particular area.

## Materials and Methods

**Native Plant Surveys**

Uncultivated areas of TLF property were identified and demarcated using ArcGIS and Klickitat County property maps. Sampling within uncultivated areas was done using 0.37 square meter quadrat frames, randomly placed. A total of 46 quadrats were sampled (Figure 2); all plants within the sampling frame were identified, and samples of each unique species were collected (in triplicate when possible) for herbarium deposit. Absolute percent canopy cover of each species within the quadrat was estimated and recorded, including overstory woody, understory shrubs and herbaceous plants. Percent cover of mosses, lichens, and fungi were not included in this survey. The collected specimens were pressed and dried in a Harvest Saver commercial tray drier at 110 degrees F for 48 hours or until moisture content was reduced to less than 10%. Dichotomous keys in the *Flora of the Pacific Northwest* (Hitchcock & Cronquist 2018) were used to identify unknown samples. Specimens were sent to the Burke Museum Herbarium (Seattle, WA) and the Michigan State University Herbarium (East Lansing, MI) for deposit; one complete set of specimens was also kept on TLF property in an in-house farm herbarium. Microsoft Excel was used to calculate the percent cover and observation frequency of native and nonnative species surveyed.

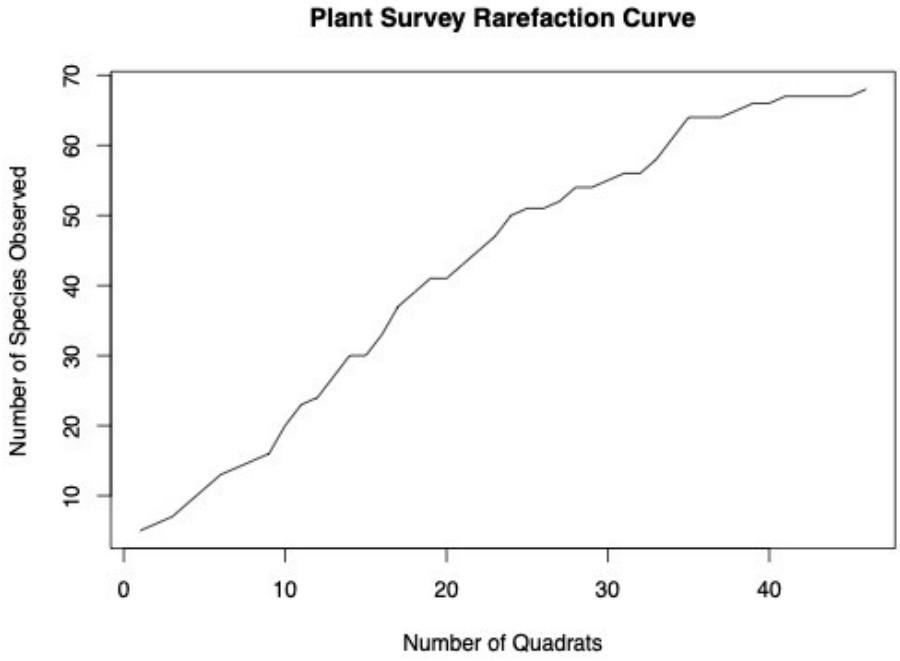


Figure 2. The cure is approaching asymptote, indicating effort adequately captured biodiversity.

**Pollinator Surveys**

To evaluate the farm's proficiency at supporting native pollinators, a series of random pollinator surveys were carried out within the uncultivated areas on farm property, as well as in some selected crop fields. The crops surveyed for pollinators included Coneflowers (*Echinacea purpurea* and *E. angustifolia*), and Blueberries (*Vaccinium* spp.). The natural areas surveyed consisted of the largest uncultivated areas on farm property. Within both area types, 76-meter transects were established and then surveyed for 25 minutes. All bees within 1 meter of either side of the transect and butterflies within 1.5 meters on either side of the transect were identified and recorded. Both bees and butterflies were identified to genus and species when possible. Samples of the pollinators were collected and pinned, when possible, to be kept in a collection on farm property. Analyses based on the most commonly observed pollinators were carried out.

**Native Plant Reintroduction**

To increase biodiversity and pollinator habitat on the farm's property, an uncultivated location was identified for native species outplantings. The selected area is an overflow retention basin situated next to the farm's root washer and experiences periodic inundation during peak fall harvest. Geographic Information Systems (GIS) images from ArcGIS and Google Maps, as well as consultations with experienced farm personnel for their personal recollection, were used to determine historical water patterns (Figure 3).

The farm's retention basin functions as an ephemeral pond, with water persisting throughout the winter and spring months, and drying out in the summer. To support seasonal wetland ecosystem services, including water quality improvement, sediment retention, pollinator attraction and nectar resources, as well as wildlife habitat, locally adapted riparian species were selected for outplanting around the basin perimeter, beyond the high-water mark. Four native species, *Penstemon serrulatus* (Cascade Penstemon), *Lonicera ciliosa* (Orange Honeysuckle), *Philadelphus lewisii* (Mock Orange), and *Carex obnupta* (Slough Sedge) were sourced from Humble Roots Farm and Nursery in Mosier, Oregon, and Northwest Meadowscapes Conservation Seed Co. in Port Townsend, WA. *Penstemon serrulatus, L. ciliosa, and P. lewisii* were selected to provide native pollen and nectar resources throughout the entire growing season for insect pollinators on the farm. *Lonicera cilisoa* was also selected to create fruit resources for birds and small mammals. *Carex obnupta* was selected for soil stabilization. Outplanting occurred in the fall of 2023 (Figure 4). Plugs of 100 *P. serrulatus*, 10 *L. ciliosa*, and 100 *P. lewisii*, and about 3000 *C. obnupta* seeds were directly seeded. The site was surveyed for surviving species in July 2024, nine months after planting. In the future, additional species may be sourced to fill in gaps.


Figure 3. Historical water patterns in the selected uncultivated area for native species reintroduction.


Figure 4. Images of the root washer area post outplanting. (A) The area selected for native plant reintroduction 8 months after planting. (B) A successful *Philadelphus lewisii* (Mock Orange) plug. (C) A successful *Lonicera ciliosa* (Orange Honeysuckle) plug. (D) A successful *Penstemon serrulatus* (Cascade Penstemon) plug.

## Results

### Native Plant Surveys

Geographical Information System maps were used to delineate cultivated and uncultivated land, as well as area covered by natural vegetation (Table 1). Random sampling within the 17 acres of natural vegetation revealed over 82% coverage by

native Washington Columbia River gorge species (Table 2), and therefore approximately 8.3% of the total working landscape can be considered functioning native habitat. This baseline of 8.3% native habitat within a working landscape can be used to assess land use change over time as TLF continues to implement regenerative farming practices that increase biodiversity of indigenous species, such as reintroducing native species to natural areas and planting permanent native plant pollinator strips along field borders.

Table 1. Property land use breakdown

| **Land Use** | **Acres** |
|---|---|
| Total Owned Property | 206 |
| Cultivated Land | 137 |
| Uncultivated Land | 69 |
| Natural Areas | 17 |
| Estimated Native Species Cover | 13 |
| Estimated Introduced Species Cover | 1 |

Table 2. List of species observed

| **Plant Family** | **Scientific Name** | **Common Name** | **Native or Introduced** |
|---|---|---|---|
| Apocynaceae | *Apocynum androsaemifolium* L. | Spreading Dogbane | Native |
| Asteraceae | *Achillea millefolium* L. | Yarrow | Native |
| Asteraceae | *Antennaria howellii* Greene | Howell's Pussytoes | Native |
| Asteraceae | *Lactuca serriola* L. | Prickly Lettuce | Introduced |
| Asteraceae | *Madia citriodora* Greene | Lemon Scented Tarweed | Native |
| Berberidaceae | *Berberis nervosa* Pursh | Dull Oregon-Grape | Native |
| Betulaceae | *Alnus rubra* Bong. | Red Alder | Native |
| Betulaceae | *Corylus cornuta* Marshall | Beaked Hazelnut | Native |
| Boraginaceae | *Amsinckia* spp. Lehm. | Fiddleneck | Native |
| Boraginaceae | *Symphytum asperum* Lepech. | Rough Comfrey | Introduced |
| Brassicaceae | *Lepidium virginicum* L. | Tall Pepper-Grass | Native |
| Brassicaceae | *Sisymbrium altissimum* L. | Tall Tumble-Mustard | Introduced |
| Campanulaceae | *Campanula rotundifolia* L. | Common Harebell | Native |
| Caprifoliaceae | *Symphoricarpos albus* (L.) S.F.Blake | Common Snowberry | Native |
| Caryophyllaceae | *Silene vulgaris* (Moench) Garcke | Bladder Campion | Introduced |
| Convolvulaceae | *Calystegia sepium* (L.) R.Br. | Hedge Bindweed | Introduced |
| Dennstaedtiaceae | *Pteridium aquilinum* (L.) Kuhn | Bracken Fern | Native |

| | | | |
|---|---|---|---|
| Equisetaceae | *Equisetum arvense* L. | Common Horsetail | Native |
| Ericaceae | *Pterospora andromedea* Nutt. | Pinedrops | Native |
| Fabaceae | *Acmispon americanus* (Nutt.) Rydb. | Spanish-Clover | Native |
| Fabaceae | *Lathyrus sphaericus* Retz. | Grass Peavine | Introduced |
| Fabaceae | *Lupinus arbustus* Douglas | Longspur Lupine | Native |
| Fabaceae | *Lupinus argenteus* Pursh | Silvery Lupine | Native |
| Hydrangeaceae | *Philadelphus lewisii* Pursh | Mock-Orange | Native |
| Lamiaceae | *Origanum vulgare* L. | Oregano | Introduced |
| Liliaceae | *Calochortus subalpinus* Piper | Subalpine Mariposa Lily | Native |
| Onagraceae | *Clarkia rhomboidea* Douglas | Common Clarkia | Native |
| Poaceae | *Elymus glaucus* Buckley | Blue Wildrye | Native |
| Pinaceae | *Pinus ponderosa* Douglas ex. C.Lawson | Ponderosa Pine | Native |
| Pinaceae | *Pseudotsuga menziesii* (Mirb.) Franco | Douglas Fir | Native |
| Plantaginaceae | *Penstemon subserratus* Pennell | Fine-Tooth Penstemon | Native |
| Polygonaceae | *Polygonum douglasii* Greene | Douglas's Knotweed | Native |
| Polygonaceae | *Rumex acetosella* L. | Sheep Sorrel | Introduced |
| Polygonaceae | *Rumex stenophyllus* Ledeb. | Narrow-Leaved Dock | Introduced |
| Ranunculaceae | *Aquilegia formosa* Fisch. ex DC. | Red Columbine | Native |
| Rosaceae | *Amelanchier alnifolia* Sarg. | Saskatoon Serviceberry | Native |
| Rosaceae | *Crataegus douglasii* (Lindl.) Lodd. ex Loudon | Black Hawthorn | Native |
| Rosaceae | *Fragaria virginiana* Mill. | Wild Strawberry | Native |
| Rosaceae | *Rubus leucodermis* (Douglas ex Hook.) Douglas ex Torr. & A.Gray | Black Raspberry | Native |
| Rosaceae | *Rubus parviflorus* Nutt. | Thimbleberry | Native |
| Rosaceae | *Rubus ursinus* Torr. & A.Gray | Salmonberry | Native |
| Rosaceae | *Spiraea douglasii* Hook. | Hardhack | Native |
| Rubiaceae | *Kelloggia galioides* Torr. | Milk Kelloggia | Native |
| Salicaceae | *Populus trichocarpa* Torr. & A.Gray ex Hook. | Black Cottonwood | Native |
| Urticaceae | *Urtica dioica* L. | Stinging Nettle | Native |

**Native Pollinator Surveys**

Pollinator surveys were conducted to establish preliminary pollinator visitation patterns. The most frequently observed hymenopteran pollinator was *Apis mellifera* (Honeybee), and the most frequently observed lepidopteran pollinator was *Papilio rutulus* (Western Tiger Swallowtail). 18 different species of pollinators were observed during surveys, including 5 different species of native bumble bees. Along with the honeybee, native pollinators were found to be more abundant within the crop fields surveyed than within the uncultivated areas, demonstrating the importance of the crop fields as floral resources for many native pollinators. More surveys need to be carried out to determine a statistically valid quantitative difference between pollinators in the crop fields and pollinators in the uncultivated areas on the farm property.

**Native Plant Reintroduction**

The area selected for native plant reintroduction borders the farm's retention basin (an ephemeral pond) and is approximately 325 square meters. Native species survival counts indicate approximately 30% of the four species of native plants established successfully at this site.

## Discussion

**Native Plant Surveys**

The most common plant family represented in the surveys of native plants was Rosaceae (Table 2), with seven different species observed. Fabaceae and Asteraceae were the next most widely represented families, with four species observed from each. Rosaceae species are important to the ecosystem as they are characterized by showy flowers with nectar resources, as well as fleshy fruits (Hitchcock & Cronquist 2018) that can support native macrofauna. Fabaceae and Asteraceae species also provide showy flowers that attract diverse pollinators. Asteraceae have been shown to provide larger amounts of nectar sugar and pollen than other families (Hicks *et al.* 2018). The bilateral symmetry and long tubular corollas of Fabaceae species such as *Lupinus* can provide unique flower shapes for native pollinators attracted to diverse flowers. Increasing the diversity of flower shape and color attracts a more diverse pollinator community (Wang *et al.* 2024).

The two species with highest percent cover are coniferous trees (Figure 5), suggesting that native habitat on TLF property is structurally complex, with multiple canopy layers, providing cover and forage, not only for beneficial insects, but for native macrofauna as well. Documented examples of wildlife nesting and foraging in these areas include the protected bald eagle (*Haliaeetus leucocephalus*), shown in Figure 6, black bears (*Ursus americanus*), and cougars (*Puma concolor*).

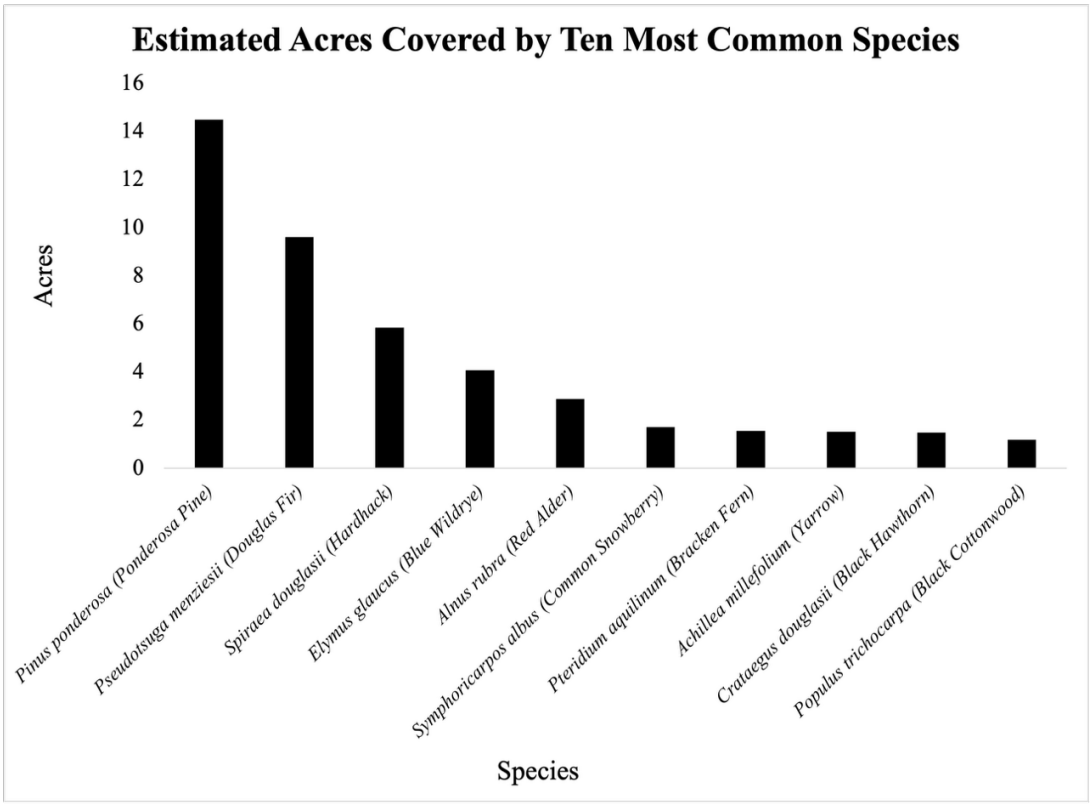


Figure 5. The estimated acres of cover of the species observed during the native plant surveys. Only the 10 most prominent species are displayed in this figure, all of which are native to Washington.

Figure 6. The protected bald eagle (*Haliaeetus leucocephalus*) nesting in a tree on TLF property.

***Pollinator surveys***

The most frequently observed pollinators include the honeybee (*Apis mellifera*), bumble bees (*Bombus* spp.), and the Western Tiger Swallowtail (*Papilio rutulus*). A high presence of *A. mellifera* is to be expected as there are several managed hives in the area. Introducing more native plant habitat would support and potentially increase populations of native Apidae (bumble bees), as well as native Halictidae (sweat bees), Megachilidae (leafcutter bees), and Andrenidae (mining bees) species. Native bees are not only beneficial to the natural ecosystem, but they are often more efficient and effective crop pollinators than honeybees (Greenleaf & Kremen 2006), so it is essential to support their presence within our working landscapes.

***Native Plant Reintroduction***

The low survival rate of the outplanted species around the pond area is likely due to below-average precipitation during the end of 2023 and beginning of 2024, and to the lack of irrigation to the site. The species were strategically planted in the fall to take advantage of natural precipitation in winter and early spring, but the lower-than-average precipitation (Figure 7) led to lower success than anticipated. Many of the surviving plants had been planted in areas that were partially shaded and had moderate ground cover from other plants, providing relief from the extreme heat and sun exposure. Irrigation would increase costs for future plantings but would improve the probability of successful establishment of the plants. Additional drought tolerant native species, such as those native to the dry Columbia Basin of Western Washington, are being investigated for a second round of plug plantings in the designated area in the future.

***Additional Research***

Future studies focused on documenting a wider range of biota, including macrofauna, insect predators and parasitoids in addition to native pollinators, would provide a greater understanding of the ecological cooperation between cultivated land and native habitat within the working landscape of Trout Lake Farm, and would, in turn, provide important information for other working landscapes. Quantitative assessments of pollinators, both native and introduced, in crop fields would be key to understanding how crop diversity and floral phenology impact the quality and seasonality of nectar resources available for native fauna. Additionally, it would be important to understand how native habitat fragmentation within a working landscape, and distance between cultivated and native areas impacts local pollinator community migration patterns and population health. Many of these questions will require a great amount of time and effort to investigate, but some higher-level evaluations, such as primary production, animal species abundance, and ecosystem resilience, can be made using new technologies such as Terrestrial Light Detection and Ranging (LiDAR) (Atkins *et al*. 2018) and multi-resolution optical imagery (Corbane *et al*. 2015) for better understanding of ecosystem function on working lands. We recognize that many aspects of the interactions between the native flora and fauna and the cultivated lands of TLF are still unexplored.

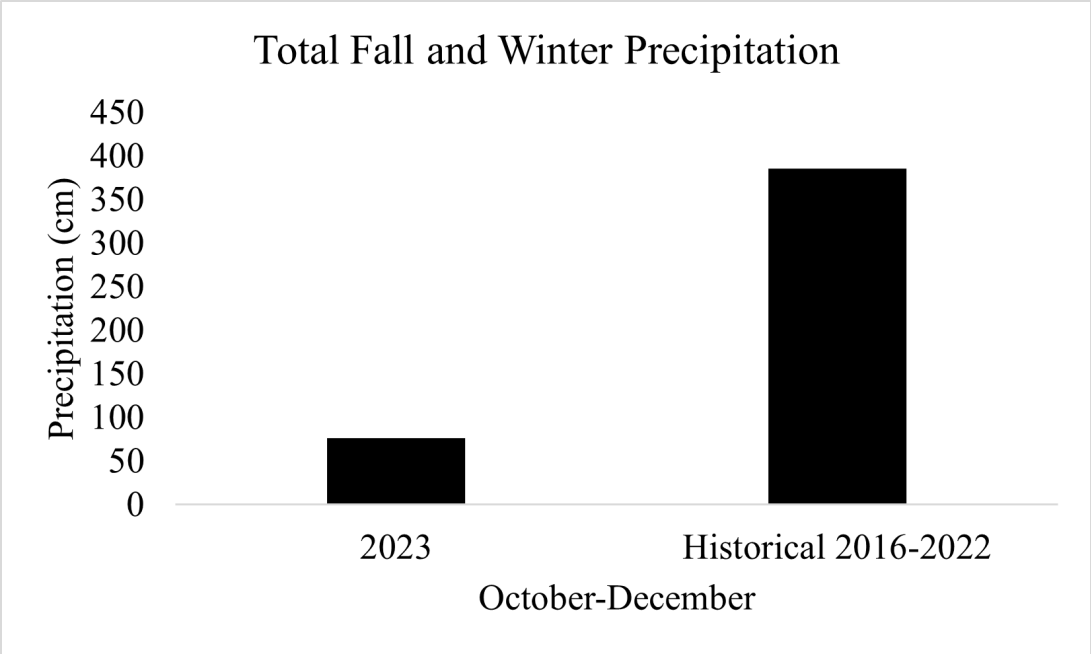


Figure 7. Precipitation during the fall and winter (October to February) post outplanting was significantly lower than the previous seven-year average precipitation, which could be a cause for the low survival rate of planted plugs.

## Conclusion

This project established baseline assessments of native species habitat within uncultivated areas of an organic farm in the East Cascades ecoregion of Washington state. The overarching goal was to document and characterize native species habitat - and, in particular, the presence of pollinators within a working landscape, and to support efforts to increase on-site ecosystem services through native species reintroductions. Specific ecosystem services targeted during this study were the pollination services provided by native pollinators and soil stabilization provided by native plants. More data is necessary to determine more nuanced pollinator patterns between crop fields and uncultivated areas. Continued surveys are recommended to better understand effects of regenerative agriculture management practices on landscape, biodiversity, and farm productivity changes over time.

## Declarations

**List of abbreviations:** TLF: Trout Lake Farm; GIS: Geographic Information Systems

**Ethics approval and consent to participate:** Not applicable

**Consent for publication:** Not applicable

**Availability of data and materials:** Vouchers of collected plants from this study have been deposited to Burke Museum Herbarium and Michigan State University Herbarium. Insect specimens and one set of vouchers are kept on site at Trout Lake Farm, LLC. in Trout Lake, WA. Plant survey data generated in this study has been deposited at Open Science Framework under the database identifier DOI 10.17605/OSF.IO/KBYUD and is publicly available as of the date of publication. All data generated by this study will be shared by the lead contact upon request.

**Competing interests:** Not applicable

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**Author contributions:** Conceptualization, A.M., S.R., & D.K.; Methodology, A.M. & S.R.; Investigation, A.M.; Writing - Original Draft, A.M.; Writing - Reviewing and Editing, S.R. & D.K.; Funding Acquisition, S.R.; Resources, S.R. & D.K.; Supervision, S.R. & D.K.

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