EFFECTIVENESS MONITORING OF CTDOT CONSERVATION AREAS: POLLINATOR HABITAT SURVEY

Prepared by

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16. Abstract

A pollinator habitat survey project was conducted in 2023 and 2024 to determine the effectiveness of CTDOT reduced mowing and late season mowing practices in designated conservation areas. The project evaluated the presence of milkweed resources for monarch butterflies and of nectar resources for pollinators in general. The Candidate Conservation Agreement with Assurances (CCAA) guidelines and habitat thresholds were utilized to evaluate the conservation areas. Over 65% of conservation areas in 2023 and 57% in 2024 met the CCAA milkweed threshold. Common milkweed (*Asclepias syriaca* L.) and swamp milkweed (*A. incarnata* L.) were the only milkweed species recorded. The pollinator habitat survey determined that 63% of sample plots met the CCAA nectar plant cover threshold in from May to August 2023. In 2024, 65% of sample plots met the CCAA nectar plant 10% cover threshold.

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APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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Chapter 1

Introduction and Background

1.1 Project Background and Motivation

The Connecticut Department of Transportation (CTDOT) is promoting and protecting pollinator habitat within the CTDOT right-of-way in designated conservation areas. Since 2018, CTDOT has implemented best management practices such as reduced mowing and late season mowing in these conservation areas; however, there is no data on the effectiveness of these practices in creating the intended pollinator habitat. A pollinator habitat survey project was initiated in 2023 and here we report on the project results. Pollinator habitat conservation is critical for sustaining local insect pollinators including several species of bees, wasps, flies, moths and butterflies. Just in Connecticut, there are over 300 different species of bees. Included in the pollinator group are butterflies, and many butterfly species are facing population declines (Kral et al. 2018). Between 2000 and 2020, butterfly abundance has declined by 22% across 554 species in all regions of the United States (Edwards et al. 2025).

1.2 Monarch Butterfly Conservation Needs

One of the most admired butterflies is the monarch butterfly. The monarch butterfly *Danaus plexippus* holds the record for the longest regularly repeated migration. This seemingly delicate butterfly is able to travel between 1,200 and 2,980 miles to journey between three countries – Mexico, United States and Canada. Every fall, monarch butterflies found to the east of the Rocky Mountains in North America travel south to reach some of the tallest mountain peaks in Mexico. In these mountains, monarchs find overwintering shelter in dense 'oyamel' fir forests. There the butterflies form huge aggregations on oyamel firs and cypresses found also in the region. To make it through a journey of 2,980 miles, butterflies build up large quantities of body fat. Those that leave Canada and the US with poor body fat reserves are less likely to reach Mexico. During their trip, they stop to take nectar for their sustenance and to make sure that their body fat reserves are enough for their overwintering stay. The oyamel forests do not provide sufficient food for the millions of butterflies that assemble there (Waldbauer 2000), and these body fat reserves are key for survival.

In the spring, the overwintering monarchs begin their journey north to start colonizing their summer breeding grounds. Several generations result from their breeding during the summer. The monarch caterpillars require milkweeds as a food plant and they are able to utilize a substantial number of *Asclepias* species (Kaul and Wilsey 2019). Monarch females lay eggs on milkweed species (mainly *Asclepias* spp.) and studies have shown a preference for the common milkweed *Asclepias syriaca* and the swamp milkweed *A. incarnata* (Kaul and Wilsey 2019). Despite its prominence and public appeal, monarch butterflies are facing severe population declines due to threats from climate change disruptions, overwintering habitat loss, milkweed

host plant loss and pesticide exposure (Thogmartin et al. 2017). The population of monarch butterflies in the eastern U.S. has declined by 80 percent over the last two decades (Thogmartin et al. 2017). Similarly, the western U.S. monarch population has declined by 99 percent since the 1980s. Recent estimates of overwintering monarch populations are also concerning. Current data indicate that the butterfly population covered only 2.8 ha of the overwintering area in 2021-22, representing an over 50% decline from the 24-year average of 5.7 ha (Monarch Watch 2019, Xerces Society 2022). Surveys in 1996 and 1997 estimated that over 18 hectares were occupied at that time (Xerces Society 2022).

In December 2020, the US Fish & Wildlife Service determined that listing the monarch under the Endangered Species Act was warranted but precluded by higher priority listing actions. However, on July 21, 2022, the International Union for the Conservation of Nature placed the migratory monarch butterfly on its Red List of threatened species and classified it as endangered (IUCN 2022). Subsequently, in 2024 the U.S. Fish and Wildlife Service proposed to grant it protected status as a threatened species under the Endangered Species Act (USFWS, 2024). CTDOT has an opportunity to contribute to pollinator protection by conserving habitat that provides nectar plants and, for the monarch butterfly, by conserving habitat with milkweeds host plants.

Efforts to address habitat loss are underway to aid in the recovery of monarch populations (Johnston et al. 2019). The Rights-of-Way Habitat Working Group at the University of Illinois-Chicago led a national collaborative effort to develop a voluntary conservation agreement to provide habitat for the monarch butterfly. The working group, together with organizations from across the energy and transportation sectors, worked together to develop a Candidate Conservation Agreement with Assurances (CCAA) that encourages landowners and land managers to adopt measures to create net conservation benefits for the monarch butterfly. The conservation measures promoted under the CCAA, like changing the timing of vegetation management practices or targeted vegetation management, can contribute significantly to monarch butterfly conservation by enhancing the presence of milkweed host plants for monarch caterpillars and of nectar plants for the butterflies.

1.3 Project Objectives

The goal of this project was to determine how effective the vegetation best management practices are for promoting and protecting pollinators including the monarch butterfly. Data collected assessed the current situation and provided guidance for necessary changes or actions to enhance and increase available monarch habitat for breeding (presence of milkweed species) and foraging (presence of nectar plants). The project objectives were to answer the following questions:

1. Do the conservation areas provide milkweed and nectar resources across the growing season?

2. Do the conservation areas meet thresholds outlined in the Candidate Conservation Agreement with Assurances (CCAA) for the monarch butterfly?

The impact of this project is significant for monarch butterfly conservation efforts and for pollinator conservation in general. Conservation practices, like reduced mowing, implemented by CTDOT are important for improving the availability and abundance of nectar and milkweed plants. In contrast, conventional summer mowing has been shown to induce sharp short-term declines in butterfly numbers (Weber et al. 2008) by impacting insect survival and availability of food/nectar plants. Weber et al. (2008) noted that the monarch butterfly was one species that failed to rebound after conventional summer mowing. Therefore, it is critical to assess the impact of the conservation practices within the CTDOT right-of-way areas to document the outcome of current vegetation management activities and to identify areas for improvement if any. Information collected from this research project will allow CTDOT to enhance existing conservation areas to support the monarch butterfly and other pollinators in the state.

Chapter 2
Research Approach

2.1 Survey Methods and Data Collection

The project team collected data for two full plant growing seasons in 2023 and 2024. Study sites were located at CTDOT Conservation Areas designated throughout the state. Conservation areas were surveyed in the Eastern Connecticut (Southern New England Coastal Hills and Plains), Western Connecticut (Hudson Highlands), Connecticut Valley (Lower Connecticut River Valley) and Coastal Lowlands (Southern New England Coastal Lowlands) ecoregions (Fig. 2.1). Conservation areas were randomly selected from the CT DOT master list but with the condition to obtain an equal number of areas per ecoregion. The project team followed effectiveness monitoring sampling protocols laid out in out in the CCAA agreement (CCAA 2020). Sample plots were established for each visit to each selected conservation area. According to the CCAA guidelines, sample plots consisted of 1,500 sq. ft. areas defined by a 150 ft. long x 10 ft. wide transect. A new sample plot was randomly selected for each visit to a conservation area and visits were scheduled from May to August of each year.

All selected conservation areas were visited during an approximate two-week time frame in each month to minimize variation between areas due to plant phenology changes. Surveys emphasized documenting the presence of milkweed resources for monarch butterfly breeding. Data collection met CCAA requirements to monitor monarch butterfly habitat quality along with other information to characterize conservation areas such as vegetation cover type and invasive plant presence. Sample plots were categorized as to whether they met CCAA threshold of having at least 6 milkweed stems in the sample plot. Pollinator habitat was evaluated by percent land cover of nectar plants and by determining if sample plots within the conservation area met the CCAA threshold of having at least 10% nectar plant land cover within the sample plot.

During the sample plot inspection, milkweed stems were randomly sampled to determine the number of monarch butterfly eggs, larvae and pupae per stem. Ten stems were inspected per sample plot and all milkweed stems were inspected if sample plots had equal or less than 10 stems. Adult monarch butterflies were counted if they were observed in the sample plot – either on plants or flying within the plot boundary. Survey work was carried out during days with suitable weather for insect activity and weather conditions (wind speed, temperature, cloud cover) were recorded for each area visit. In addition to nectar plant cover, insect pollinator groups were scored for their presence in the sample plots. A score of ‘present’ was given when at least one individual of a pollinator group was observed.

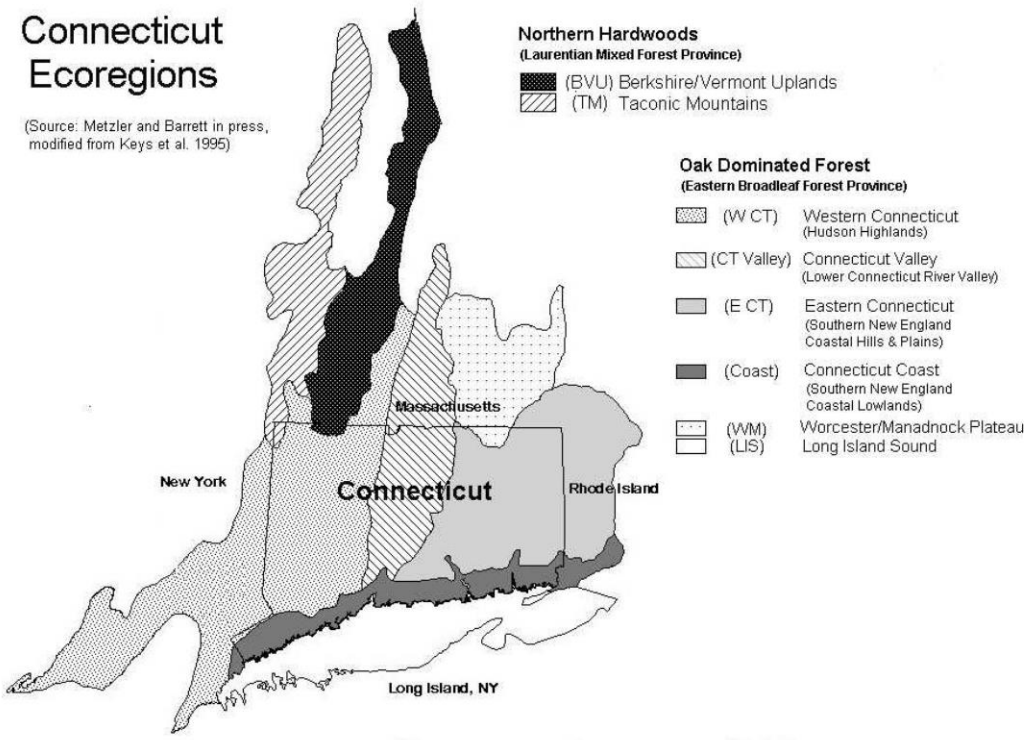

Fig. 2.1. Connecticut ecoregions map. Adapted from Connecticut's Wildlife Comprehensive Conservation Strategy (CT DEP 2005).

2.2 Field Survey Methods for 2023 Season

During 2023, thirty conservation areas were randomly selected from the dominant ecoregions as indicated above (Table 2.1). Habitat surveys were conducted from May to August 2023. In total, 97 sample plots were surveyed and they were selected at random using GIS random point generation within the conservation area boundary. Out of the original sites selected, CA-167 in Danbury was dropped because of steep terrain and access from highway created a safety issue. A reduced number of planned visits resulted for some conservation areas due to unexpected situations such as mowing and homeless tents in CA-43 in Wethersfield, construction equipment and site disturbance in CA-180 Norwich and extensive poison ivy cover in CA-93 in Branford.

In July and August, milkweed stems were randomly sampled to determine the number of monarch butterfly eggs, larvae and pupae within sample plots. Ten stems were inspected per sample plot and all milkweed stems were inspected in sample plots when stem counts were equal or less than 10.

Table 2.1. CT DOT conservation areas selected for 2023 habitat surveys.

Ecoregion	Conservation Area ID	Town/City	Highway	Designation Year	Area (sq ft)
Eastern CT Upland	CA - 103	Griswold	I-395	2019	33128
Eastern CT Upland	CA - 36	Lebanon	Rte 2	2020	66052
Eastern CT Upland	CA - 23	Mansfield	Rte 6	2019	131671
Eastern CT Upland	CA - 17	Tolland	I-84	2019	59141
Eastern CT Upland	CA - 180	Norwich	I-395	2022	37122
Eastern CT Upland	CA - 39	Plainfield	I-395	2020	31741
Eastern CT Upland	CA - 175	Putnam	I-395	2022	44188
Eastern CT Upland	CA - 41	Colchester	Rte 2	2020	74850
Western CT	CA - 81	Brookfield	Rte 7	2019	28155
Western CT	CA - 79	Danbury	I-84	2019	68153
Western CT	CA - 123	Danbury	I-84	2019	29540
Western CT	CA - 167	Danbury	Rte 7	2021	96131
Western CT	CA - 82	Newtown	I-84	2019	58975
Western CT	CA - 84	Newtown	I-84	2017	21655
Western CT	CA - 169	Southbury	I-84	2021	32970
CT Valley	CA - 70	Glastonbury	Rte 3	2019	22939
CT Valley	CA - 15	New Britain	Rte 9	2019	64432
CT Valley	CA - 77	Rocky Hill	I-91	2020	69275
CT Valley	CA - 50	Southington	I-84	2019	50626
CT Valley	CA - 58	Middletown	Rte 9	2020	37109
CT Valley	CA - 43	Wethersfield	Rte 99	2019	71126
CT Valley	CA - 145	Windsor	I-91	2021	43860
Coastal Lowlands	CA - 93	Branford	I-95	2019	79218
Coastal Lowlands	CA - 158	Clinton	I-95	2021	49942
Coastal Lowlands	CA - 163	Guilford	I-95	2021	85528
Coastal Lowlands	CA - 92	Madison	I-95	2019	40620
Coastal Lowlands	CA - 113	Old Saybrook	Rte 9	2017	30968
Coastal Lowlands	CA - 177	Stonington	I-95	2022	33270
Coastal Lowlands	CA - 109	Trumbull	Rte 8	2019	80495
Coastal Lowlands	CA - 157	Westbrook	I-95	2021	57029

2.3 Field Survey Methods for 2024 Season

During 2024, 22 conservation areas were randomly selected from the dominant ecoregions in Connecticut as described earlier (Table 2.2). A group of 8 conservation areas were repeated from the 2023 survey to collect more data for a second year on the monarch butterfly (Table 2.3).

These areas were selected because they had evidence of monarch activity such as presence of eggs, larvae or adults. In these conservation areas, twenty milkweed stems were randomly sampled per sample plot.

Habitat surveys were conducted from May to August 2024. As before, the project team followed the effectiveness monitoring sampling protocols laid out in out in the CCAA agreement (CCAA 2020). New sample plots were established for every visit to each selected conservation area. In total, 86 sample plots were surveyed and they were selected at random using GIS random point generation within the conservation area boundary.

Table 2.2. CT DOT conservation areas selected for 2024 habitat surveys.

Ecoregion	Conservation Area ID	Town/City	Highway	Designation Year	Area (sq. ft.)
Coastal Lowlands	CA - 213	Branford	I-95	2024	94,271
Coastal Lowlands	CA - 195	Bridgeport	Rte 8	2023	48,605
Coastal Lowlands	CA - 190	Milford	I-95	2023	35,754
Coastal Lowlands	CA - 96	New Haven	I-91	2019	121,519
Coastal Lowlands	CA - 156	Old Saybrook	I-95	2021	32,596
Coastal Lowlands	CA - 178	Stonington	I-95	2022	56,615
Coastal Lowlands	CA - 179	Waterford	I-95	2022	54,584
CT Valley	CA - 134	Cromwell	Rte 9	2020	84,619
CT Valley	CA - 194	East Hartford	I-90	2023	102,656
CT Valley	CA - 97	Hamden	Rte 40	2019	75,944
CT Valley	CA - 146	Hartford	I-91	2021	74,275
CT Valley	CA - 172	Manchester	I-84	2022	107,883
CT Valley	CA - 141	Windsor Locks	Rte 20	2021	64,908
Eastern CT Upland	CA - 40	Colchester	Rte 2	2020	58,200
Eastern CT Upland	CA - 150	Lisbon	I-395	2021	67,851
Eastern CT Upland	CA - 26	Mansfield	Rte 6	2019	49,058
Eastern CT Upland	CA - 57	Middletown	Rte 9	2020	40,261
Eastern CT Upland	CA - 161	Norwich	I-395	2021	31,281
Eastern CT Upland	CA - 29	Windham	Rte 66	2019	57,834
Western CT	CA - 124	Danbury	I-84	2019	13,468
Western CT	CA - 80	Danbury	Rte 7	2019	66,499
Western CT	CA - 168	Danbury	I-84	2021	65,686

Table 2.3. CT DOT conservation areas surveyed in 2023 and 2024 for data collection on monarch butterfly presence.

Ecoregion	Conservation Area ID	Town/City	Highway	Designation Year	Area (sq. ft.)
Coastal Lowlands	CA - 92	Madison	I-95	2019	40,620
CT Valley	CA - 50	Southington	I-84	2019	50,626
CT Valley	CA - 145	Windsor	I-91	2021	43,860
Eastern CT Upland	CA - 17	Tolland	I-84	2019	59,141
Western CT	CA - 79	Danbury	I-84	2019	68,153
Western CT	CA - 123	Danbury	I-84	2019	29,540
Western CT	CA - 82	Newtown	I-84	2019	30,571
Western CT	CA - 169	Southbury	I-84	2021	32,970

Chapter 3

Findings and Applications

3.1 Monarch butterfly habitat

2023 Survey Results:

Common milkweed (*Asclepias syriaca* L.) and swamp milkweed (*A. incarnata* L.) were observed in multiple survey plots at several conservation areas (Table 3.1). Butterfly milkweed (*A. tuberosa* L.) was observed only once in conservation area CA-113 (Old Saybrook, Coastal Lowlands ecoregion). There was a substantial number of sample plots within conservation areas that met the CCAA threshold of having at least 6 or more milkweed stems within the sample plot. In May, 33% of the sites had sample plots with at least 6 milkweed stems. Similarly, 41% of sites in June and 50% of sites in July had sample plots with at least 6 milkweed stems. Out of 97 sample plots surveyed from May to August, 44 of them (45%) had met the CCAA threshold. Likewise, out of 29 conservation areas visited, 19 areas had at least one sample plot that met the CCAA threshold. The distribution of total sample plots that met the CCAA threshold was variable between ecoregions with the Western and CT Valley ecoregions having the most sample plots meeting the 6 milkweed stems threshold (Fig. 3.1).

The number of stems per milkweed species were recorded and common milkweed had a median value of 19 stems per sample plot while swamp milkweed had a median value of 16 in sample plots where they were observed. Common milkweed had a larger range of values with an outlying maximum of 302 stems in a sample plot while swamp milkweed had one of 242 stems in a sample plot (Fig. 3.2). Common milkweed stem counts were also categorized by year when the conservation area was designated and by ecoregion. There was an uneven number of conservation areas per designation year in the survey selection, with most areas designated in 2019. Maximum outlier values of common milkweed stem counts were observed from these areas. The median values were 22,17,18 and 8 stems for 2019, 2020, 2021 and 2022, respectively (Fig. 3.3). Stem counts grouped by ecoregion had median values of 18, 26, 17 and 20 for Coastal Lowlands, CT Valley, Eastern and Western ecoregions, respectively (Fig.3.4). Additional data on number of sample plots relative to the CCAA milkweed stem threshold are included in Appendix A.

Table 3.1. Milkweed species recorded in CT DOT conservation areas in 2023.

Ecoregion	Conservation Area	Milkweed Species
Coastal Lowlands	CA-92	*Asclepias syriaca*
Coastal Lowlands	CA-93	*Asclepias syriaca*
Coastal Lowlands	CA-113	*Asclepias tuberosa*
Coastal Lowlands	CA-163	*Asclepias syriaca*
CT Valley	CA-15	*Asclepias syriaca*
CT Valley	CA-50	*Asclepias syriaca, A. incarnata*
CT Valley	CA-70	*Asclepias syriaca*
CT Valley	CA-77	*Asclepias syriaca, A. incarnata*
CT Valley	CA-145	*Asclepias syriaca*
Eastern CT Upland	CA-17	*Asclepias syriaca*
Eastern CT Upland	CA-23	*Asclepias syriaca*
Eastern CT Upland	CA-39	*Asclepias syriaca*
Eastern CT Upland	CA-58	*Asclepias syriaca*
Eastern CT Upland	CA-103	*Asclepias syriaca*
Eastern CT Upland	CA-175	*Asclepias syriaca, A. incarnata*
Western CT	CA-79	*Asclepias syriaca*
Western CT	CA-81	*Asclepias syriaca*
Western CT	CA-82	*Asclepias syriaca, A. incarnata*
Western CT	CA-123	*Asclepias syriaca*
Western CT	CA-169	*Asclepias syriaca, A. incarnata*

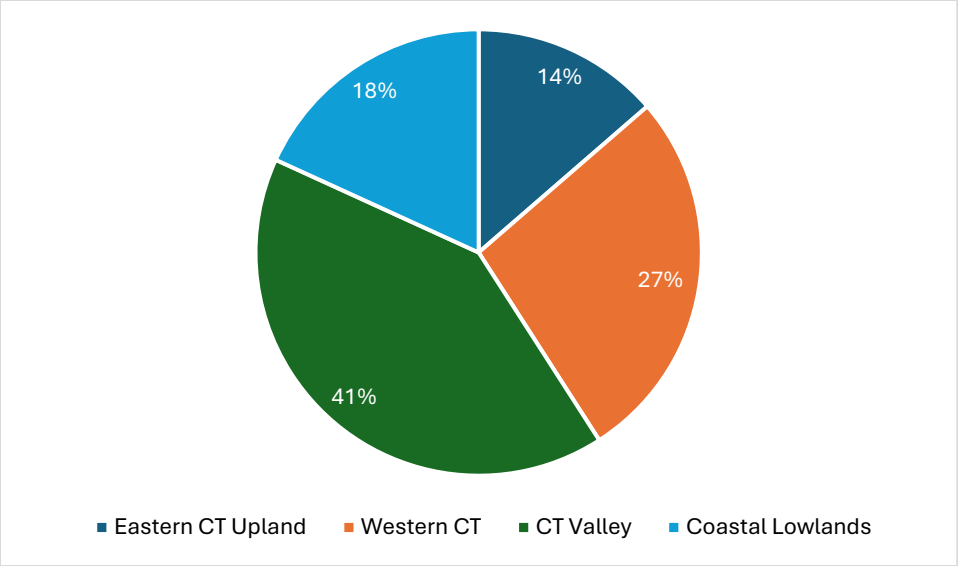

Figure 3.1. Distribution across ecoregions of 44 sample plots in conservation areas that had 6 or more milkweed stems per plot.

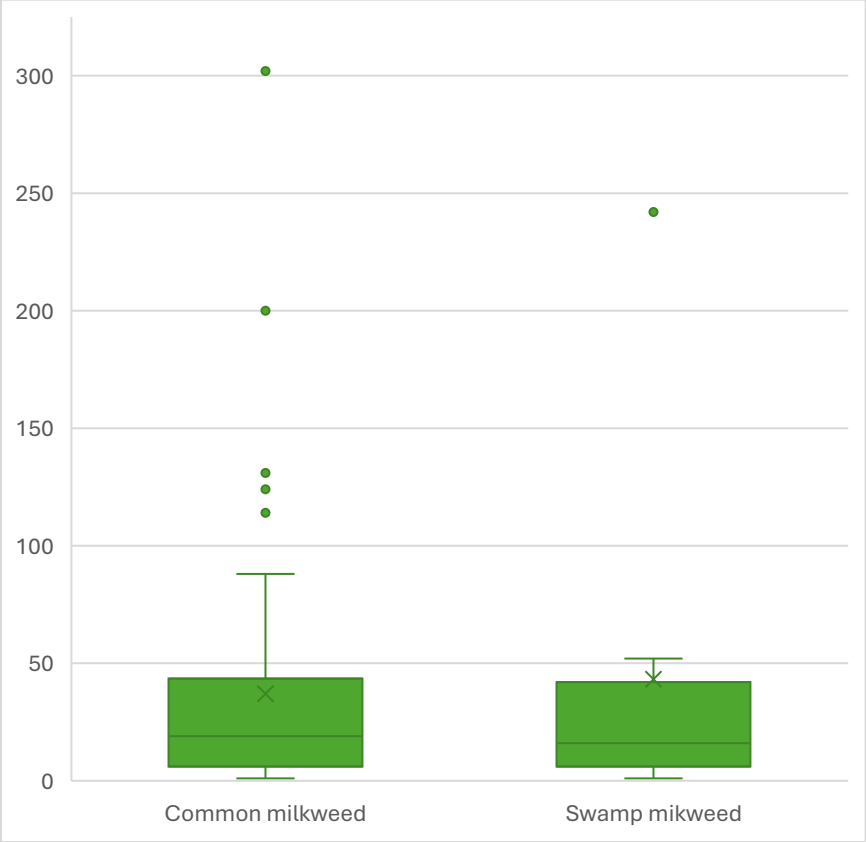

Figure 3.2. Distribution of common milkweed (*Asclepias syriaca* L.) and swamp milkweed (*A. incarnata* L.) stems counts recorded per sample plot across all surveyed conservation areas.

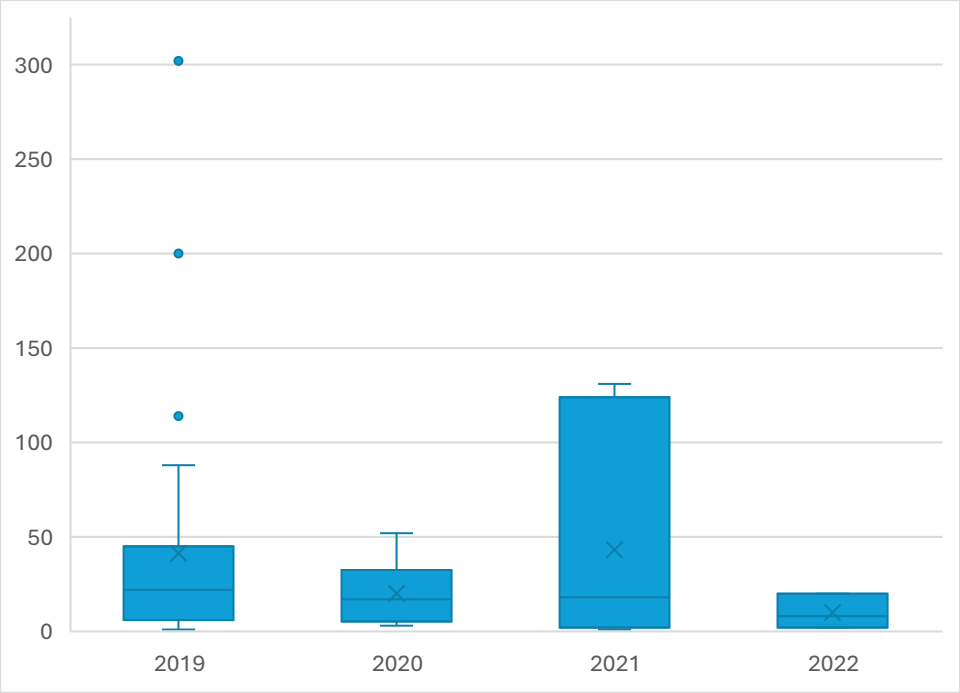

Figure 3.3. Distribution of common milkweed (*Asclepias syriaca* L.) stem counts recorded per sample plot across all surveyed conservation areas by year of conservation area designation.

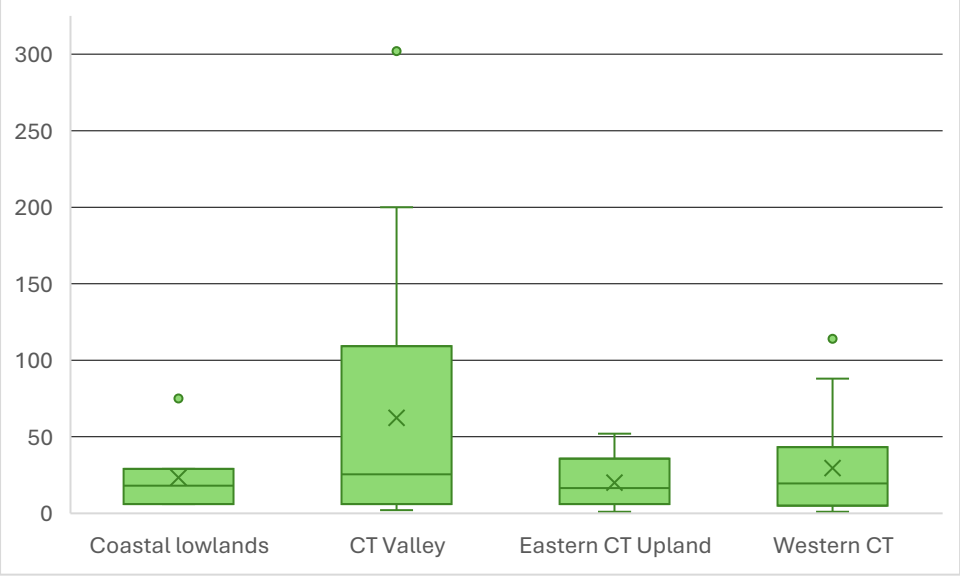

Figure 3.4. Distribution of common milkweed (*Asclepias syriaca* L.) stem counts recorded per sample plot across all surveyed conservation areas by ecoregion.

2024 Survey Results:

As in 2023, common milkweed (*A. syriaca* L.) and swamp milkweed (*A. incarnata* L.) were observed in multiple conservation areas (Table 3.2). Butterfly milkweed (*A. tuberosa* L.) was observed only in conservation areas CA-168 (Danbury, Western CT ecoregion) and CA-29 (Windham, Eastern CT Upland). There was a substantial number of sample plots within conservation areas that met the CCAA threshold of having at least 6 or more milkweed stems within the sample plot. In May, 25% of the sites had sample plots with at least 6 milkweed stems. This number increased in June to 59% and in July 60% of sites had sample plots meeting the threshold. Overall, out of 86 sample plots surveyed from May to August, 42 of them (49%) had met the CCAA threshold. Likewise, out of 30 conservation areas visited, 17 areas had at least one sample plot that met the CCAA threshold. The distribution of total sample plots that met the CCAA threshold was variable between ecoregions with the Western and CT Valley ecoregions having 40% of the sample plots meeting the 6 milkweed stems threshold followed by the CT Valley region at 29% (Fig. 3.5).

The number of stems per milkweed species were recorded and common milkweed had a median value of 85 stems per sample plot while swamp milkweed had a median value of 161.5 in sample plots where they were observed. Common milkweed had a range of values of 2 to an outlier maximum value of 912 stems in a sample plot while swamp milkweed ranged from 6 to 1231 stems in a sample plot (Fig. 3.6). It is important to note though, that common milkweed was recorded in forty-three sample plots while swamp milkweed was only noted in six sample plots. While this milkweed had higher counts it was present in fewer plots compared to common milkweed. Five of these six sample plots were in the Western CT region (CA-82 and CA-169) and one in the CT Valley region (CA-50).

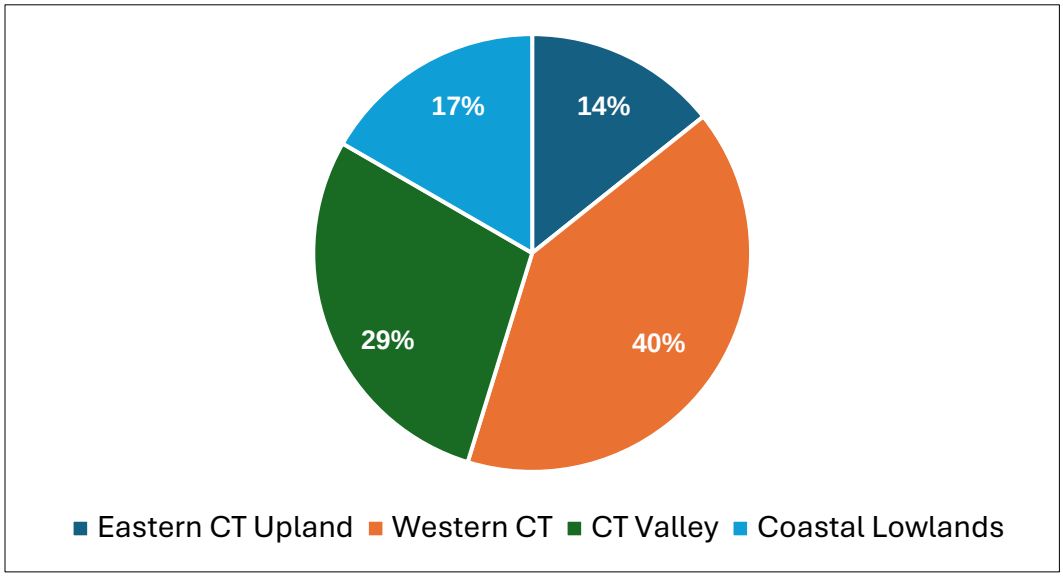

Figure 3.5. Distribution across ecoregions of 42 sample plots in conservation areas that had 6 or more milkweed stems per plot.

Table 3.2. Milkweed species recorded in CT DOT conservation areas in 2024.

Ecoregion	Conservation Area	Milkweed Species
Coastal Lowlands	CA-92*	*Asclepias syriaca*
Coastal Lowlands	CA-96	*Asclepias syriaca*
Coastal Lowlands	CA-213	*Asclepias syriaca*
CT Valley	CA-50*	*Asclepias syriaca, A. incarnata*
CT Valley	CA-141	*Asclepias syriaca*
CT Valley	CA-145*	*Asclepias syriaca*
CT Valley	CA-146	*Asclepias syriaca*
CT Valley	CA-172	*Asclepias syriaca*
CT Valley	CA-194	*Asclepias syriaca*
Eastern CT Upland	CA-17*	*Asclepias syriaca*
Eastern CT Upland	CA-29	*Asclepias tuberosa*
Eastern CT Upland	CA-57	*Asclepias syriaca*
Eastern CT Upland	CA-161	*Asclepias syriaca*
Western CT	CA-79*	*Asclepias syriaca*
Western CT	CA-80	*Asclepias syriaca*
Western CT	CA-82*	*Asclepias syriaca, A. incarnata*
Western CT	CA-123*	*Asclepias syriaca*
Western CT	CA-124	*Asclepias syriaca*
Western CT	CA-168	*Asclepias tuberosa*
Western CT	CA-169*	*Asclepias syriaca, A. incarnata*

** Conservation areas surveyed in 2023 and 2024.*

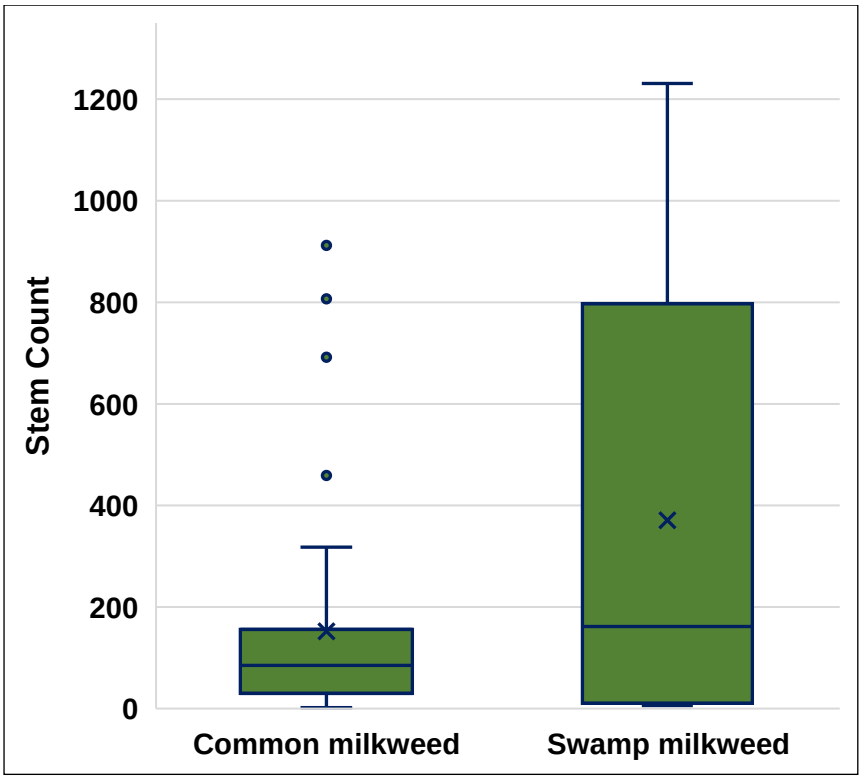

Figure 3.6. Distribution of common milkweed (*Asclepias syriaca* L.) and swamp milkweed (*A. incarnata* L.) stems counts recorded per sample plot across all surveyed conservation areas.

Common milkweed stem counts were also categorized by year when the conservation area was designated and by ecoregion. There was an uneven number of conservation areas per designation year in the survey selection and the number of sample plots per designation year reflect this. Fifty three percent of the sample plots included in the results come from areas designated in 2019 and 23% come from 2021 as the designation year. Common milkweed stem counts observed for 2019 designation year had a maximum outlier value of 912 with a median stem count of 100 (Fig. 3.7) and 2021 designation year had a median count of 67 milkweed stems. Stem counts grouped by ecoregion had median values of 38, 83, 107 and 66.5 for Coastal Lowlands, CT Valley, Eastern and Western ecoregions, respectively (Fig.3.8). Additional data on number of sample plots relative to the CCAA milkweed stem threshold are included in Appendix B.

3.2 Monarch butterfly presence in conservation areas

In 2023, monarch butterflies were not observed in large numbers throughout the survey period. Within the sample plots, one monarch was noted flying within the sample plot (July 24, CA-58, Middletown, CT Valley) and another one was ovipositing on common milkweed (July 24, CA-50, Southington, CT Valley). The CA-50 sample plot at this time was observed to have 200 common milkweed stems. One butterfly was observed within a sample plot on spotted Joe-Pye weed that was blooming at that time (Aug. 18, CA-103, Griswold, Eastern CT Upland).

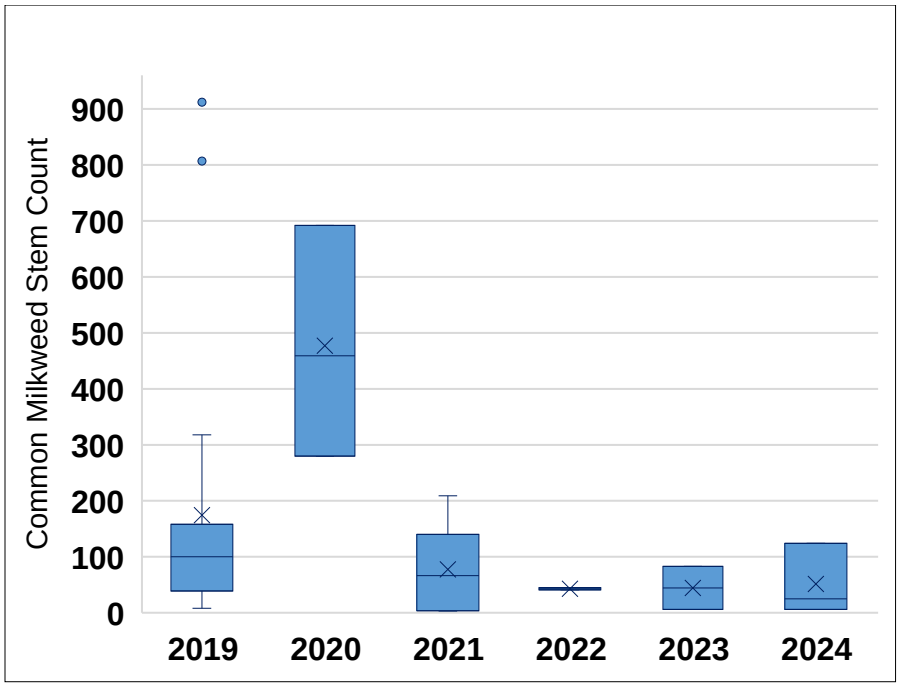

Figure 3.7. Distribution of common milkweed (*Asclepias syriaca* L.) stem counts recorded per sample plot across all surveyed conservation areas by year of conservation area designation.

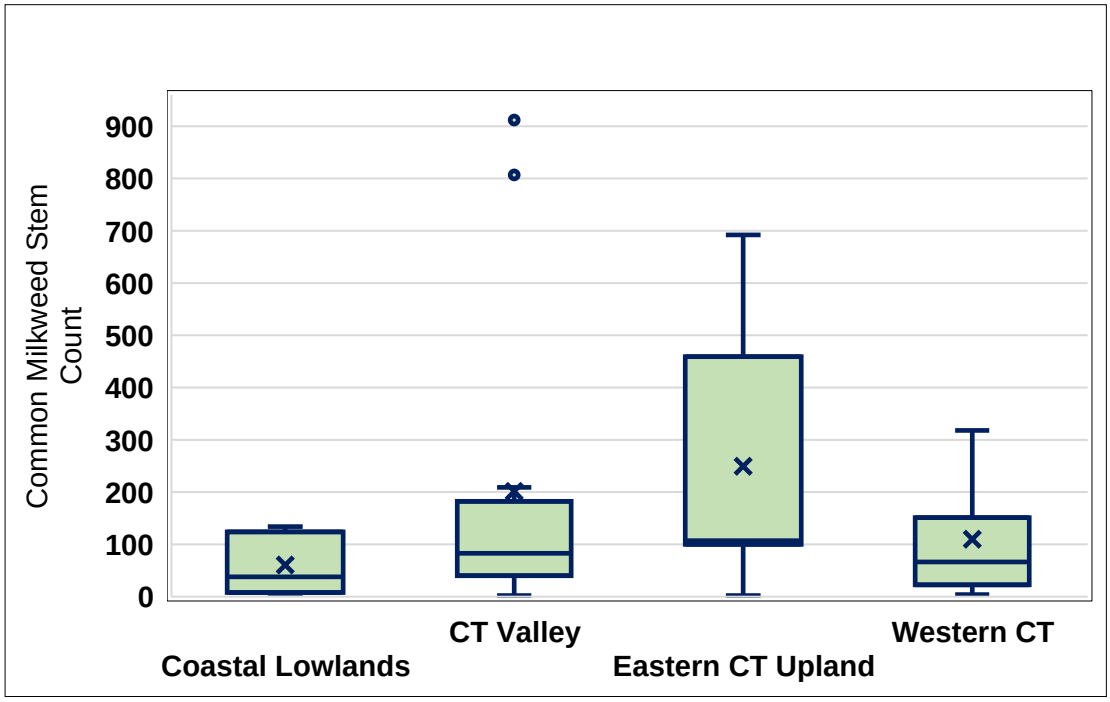

Figure 3.8. Distribution of common milkweed (*Asclepias syriaca* L.) stem counts recorded per sample plot across all surveyed conservation areas by ecoregion.

Altogether, there were few observations of adult monarchs during the survey. Eggs and monarch caterpillars were observed in only seven sample plots (Table 3.3). The annual census of monarch butterflies overwintering in central Mexico revealed that 2023-2024 was the second worst year ever recorded with a decrease of 59%. From the previous year, the overwintering area dropped by more than half, from 5.5 acres to 2.2 acres (WWF 2024).

In 2024 there were more observations of monarch adults, eggs and larvae compared to 2023. Fifty five percent of sample plots surveyed had evidence of monarch butterfly activity. A total of 24 monarch butterflies were recorded within the sample plots in conservation areas which was an improvement from the 3 butterflies observed in 2023. More eggs were counted on stems compared to larvae and no pupae were observed in all the sample plots (Fig. 3.9). Monarch pupae are difficult to find in natural areas due to their color camouflage and their sheltered locations (Oberhauser 2004).

Eight conservation areas examined in 2023 were surveyed again in 2024 to collect more data on the monarch butterfly. These results and results from areas visited only in 2024 are presented in Table 3.4. Of the 8 areas that were visited twice during the project, only 5 of them had evidence of monarch presence as eggs or larvae in 2024. Other conservation areas and survey dates not included in Table 5 did not have monarch eggs or larvae present on sampled stems.

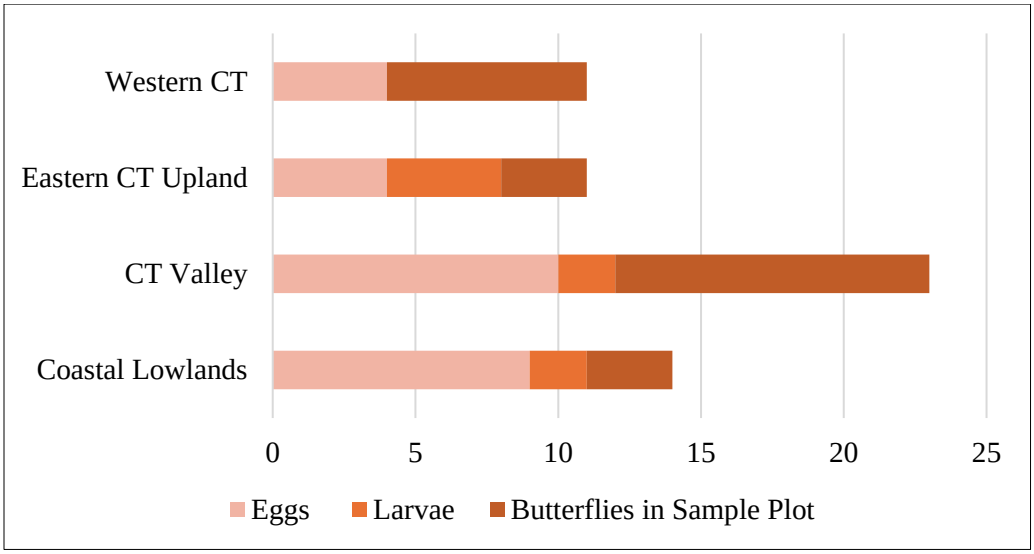

Figure 3.9. Total number of monarch butterfly life cycle stages recorded in 2024 in sample plot across all surveyed conservation areas by ecoregion.

The range of observed egg counts per stem in 2023 and 2024 are higher than those reported by citizen science studies done in Northeastern non-ag settings in 2000 and 2002 that show a range from 0 to 0.07 eggs/stem. It is important to note that the egg counts per stem in the Northeast region were generally lower compared to those reported from the Midwest citizen science projects and having a range of 0 to 0.25 eggs/stem (Prysby and Oberhauser 2004). Pleasants and Oberhauser (2013) report densities between 0.1 and 0.3 eggs/stem for the 1999-2010 period from

non-ag settings in the Midwest. A monarch butterfly female has the potential to lay 300 to 400 eggs in natural areas and captive butterflies lay an average of 700 eggs. Monarch butterflies experience high mortality rates of over 90% in the egg and larval stages (Oberhauser 2004). Adverse weather conditions, arthropod predators, insect parasitoids and insect pathogens can all take a toll. Monarch butterflies also face challenges in terms of surviving through their reproductive period and finding the required milkweed host plants.

Table 3.3. Monarch butterfly eggs and larval averages per milkweed stem in CT DOT conservation areas surveyed in 2023.

Ecoregion	Conservation Area ID	Date	Milkweed Species	Average Eggs/Stem	Average Larvae/Stem
Coastal Lowlands	CA-92	8/22/2023	Common milkweed	0.5	0
CT Valley	CA-145	8/21/2023	Common milkweed	0.1	0
Eastern CT Upland	CA-17	8/18/2023	Common milkweed	0.4	0
Western CT	CA-169	7/24/2023	Common milkweed	0	0.1
Western CT	CA-79	7/25/2023	Common milkweed	0.1	0
Western CT	CA-82	8/24/2023	Common milkweed	0.1	0
Western CT	CA-123	8/24/2023	Common milkweed	0	0.1

Table 3.4. Monarch butterfly eggs and larval averages per milkweed stem in CT DOT conservation areas surveyed in 2024.

Ecoregion	Conservation Area ID	Date	Milkweed Species	Average Eggs/Stem	Average Larvae/Stem
Coastal Lowlands	CA-213	6/5/2024	Common milkweed	0	0.05
Coastal Lowlands	CA-213	6/28/2024	Common milkweed	0.3	0
Coastal Lowlands	CA-213	7/26/2024	Common milkweed	0.17	0
Coastal Lowlands	CA-92*	6/28/2024	Common milkweed	0.1	0.05
Coastal Lowlands	CA-92*	7/26/2024	Common milkweed	0.15	0
CT Valley	CA-145*	7/1/2024	Common milkweed	0.2	0
CT Valley	CA-146	7/1/2024	Common milkweed	0.5	0
CT Valley	CA-50*	6/24/2024	Common milkweed	0.05	0
CT Valley	CA-50*	6/24/2024	Swamp milkweed	0	0.05
CT Valley	CA-50*	7/23/2024	Swamp milkweed	0	0.05
Eastern CT Upland	CA-17*	7/8/2024	Common milkweed	0.1	0
Eastern CT Upland	CA-17*	8/5/2024	Common milkweed	0	0.2
Eastern CT Upland	CA-57	7/8/2024	Common milkweed	0.2	0
Western CT	CA-123*	7/29/2024	Common milkweed	0.05	0
Western CT	CA-124	7/29/2024	Common milkweed	0.3	0

* Conservation areas surveyed in 2023 and 2024.

3.3 Pollinator Habitat: 2023 Survey

Pollinator habitat was evaluated by percent land cover of nectar plants and by determining if sample plots within the conservation area met the CCAA threshold of greater than 10% cover of the sample plot composed by nectar plants. Sixty three percent of sample plots (61 plots) met this threshold out of 97 sample plots surveyed from May to August 2023. Most of the 61 plots that had more than 10% nectar plant land cover were found in the Western ecoregion followed by the CT Valley and Eastern CT ecoregions (Fig. 3.10). Nectar plants found in at least two different sample plots were categorized by ecoregion and are presented in Figs. 3.11 - 3.14. Some important nectar plants recorded in 2023 include birdsfoot trefoil, round headed bush clover, vetch, *Symphyotrichum* spp., goldenrods, common yarrow, Black-eyed Susan, spotted Joe-Pye weed and New England aster.

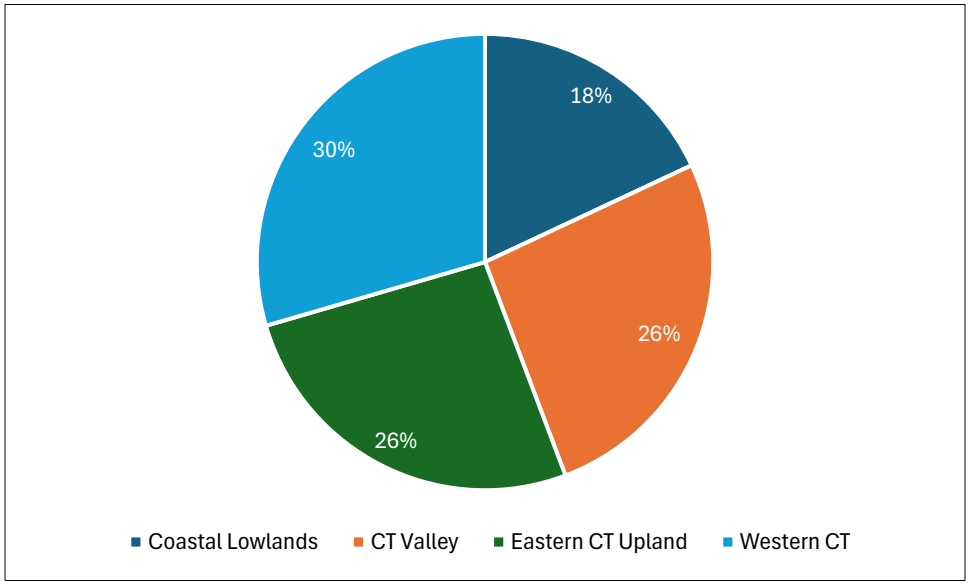

Figure 3.10. Distribution across ecoregions of 61 sample plots that had 10% or more of nectar plant total cover present in plots.

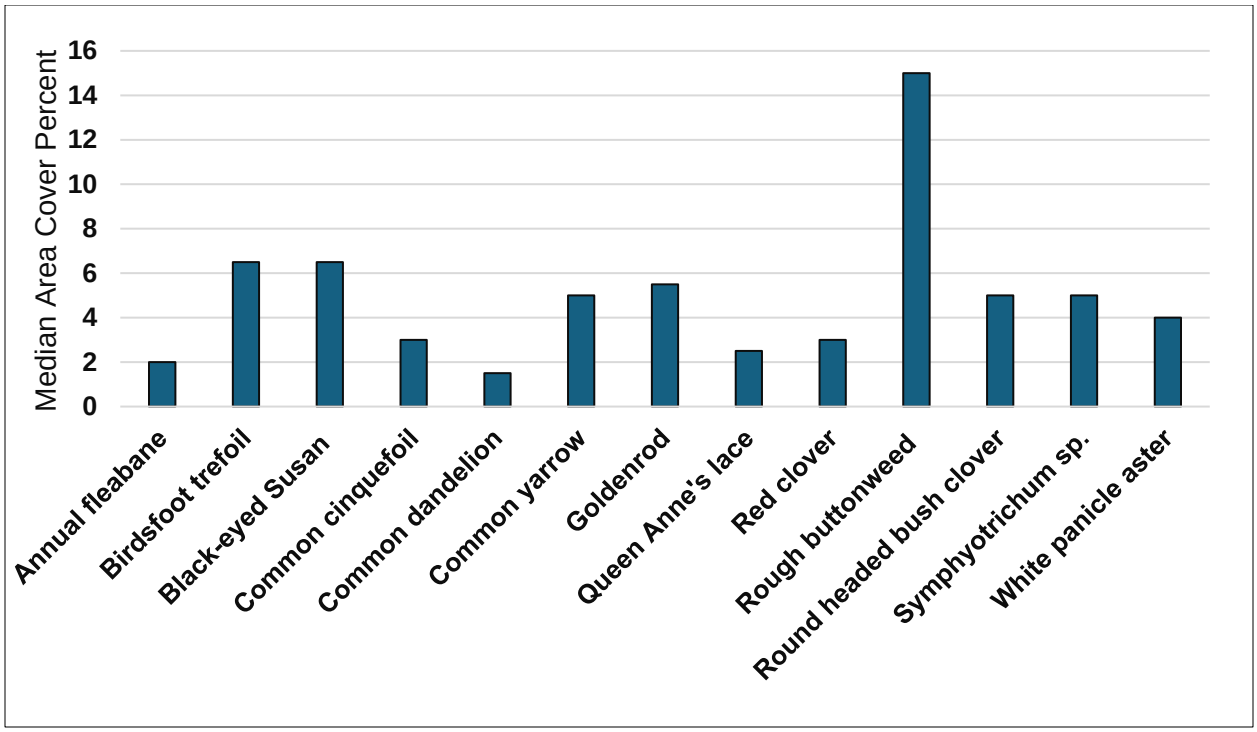

Fig. 3.11. Median percent cover observed for each plant species across all sample plots visited from May to August 2023 in Coastal Lowlands ecoregion conservation areas.

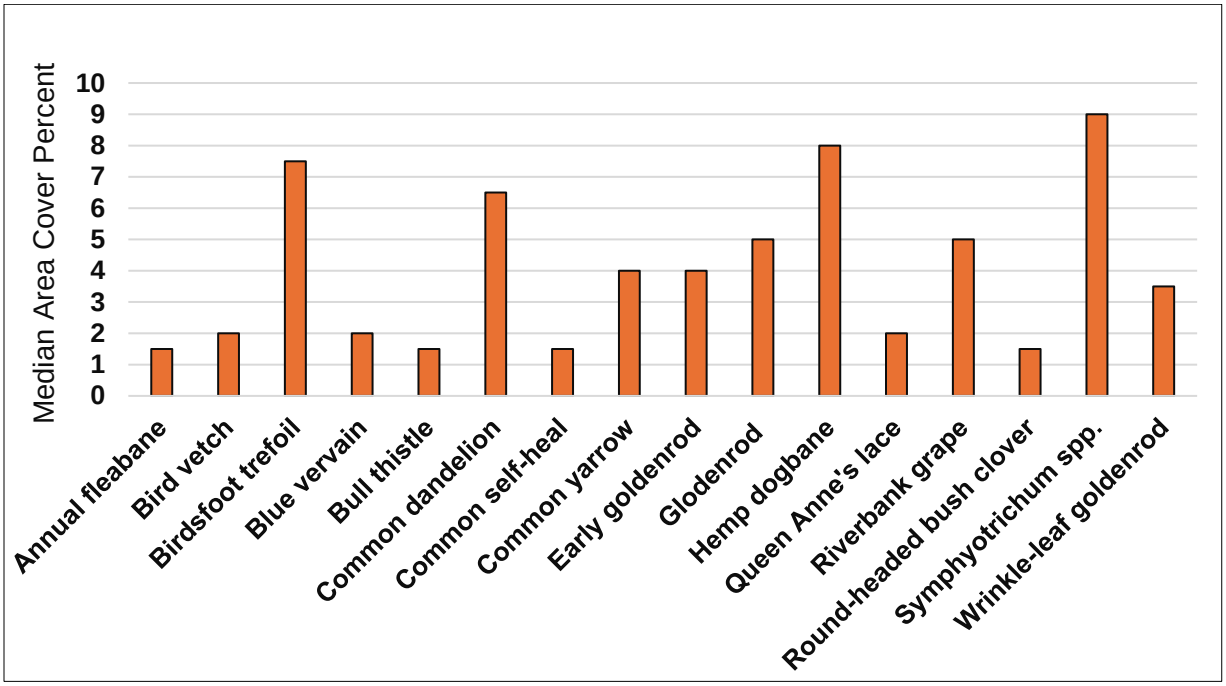

Fig. 3.12. Median percent cover observed for each plant species across all sample plots visited from May to August 2023 in CT Valley ecoregion conservation areas.

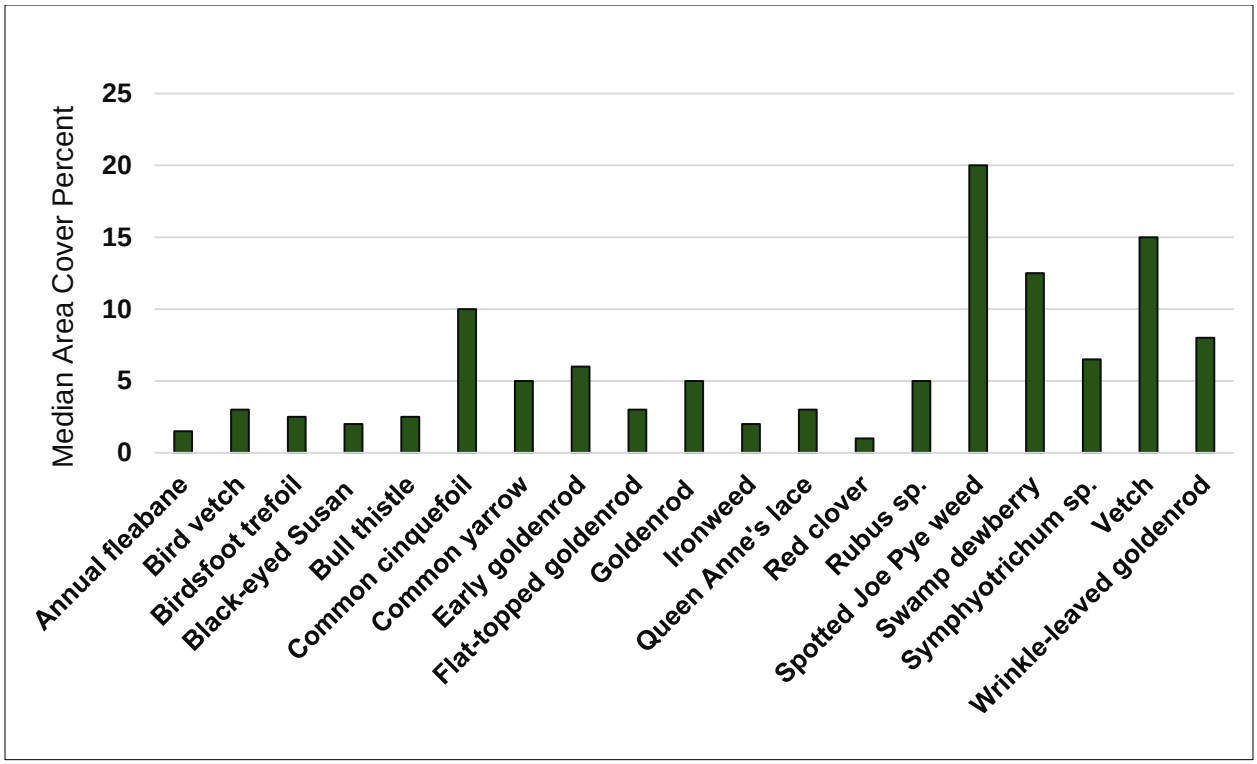

Fig. 3.13. Median percent cover observed for each plant species across all sample plots visited from May to August 2023 in Eastern CT Upland ecoregion conservation areas.

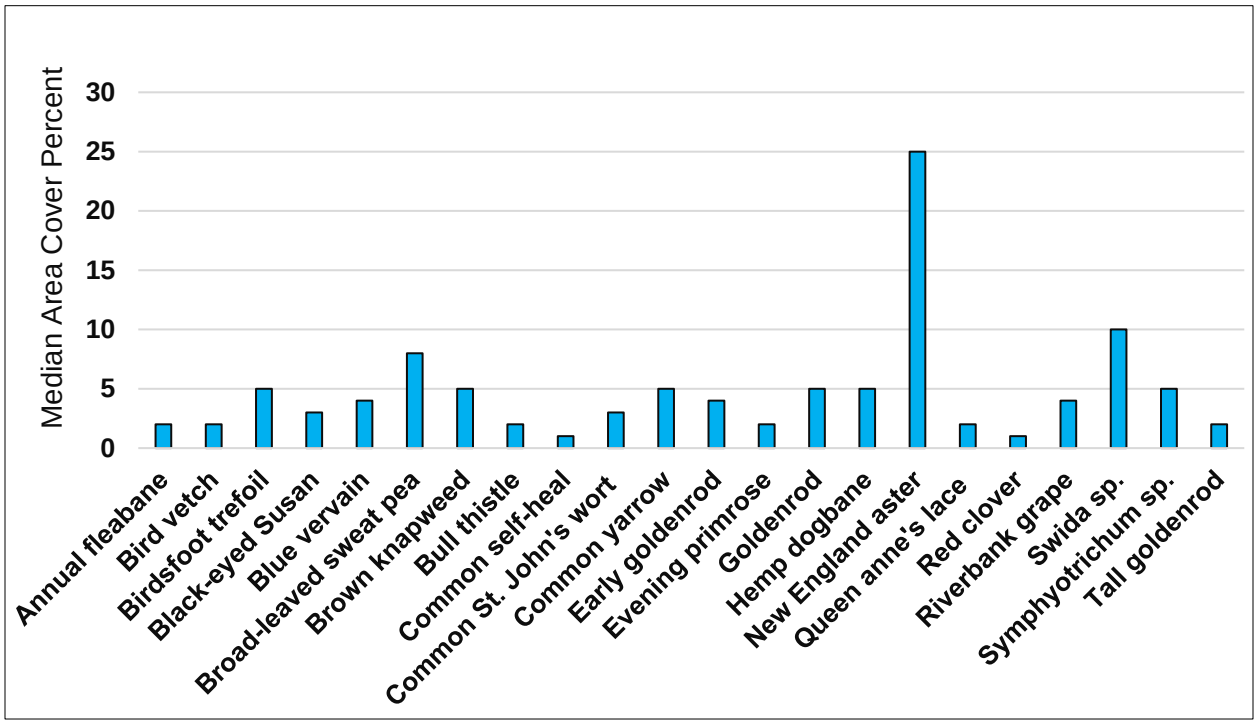

Fig. 3.14. Median percent cover observed for each plant species across all sample plots visited from May to August 2023 in Western CT ecoregion conservation areas.

Insect pollinators were scored as to whether or not they were observed on nectar plants within the sample plots. This was a categorical present/absent scoring and individual insects were not counted. Across all sample plots with pollinator observations, the most common groups were bumble bees followed by other native bees and butterflies (Fig. 3.15). These results only indicate the pollinator groups observed on plants on the instant of survey visits and are not meant to indicate population levels or overall status of pollinator communities. Pollinator insects moved rapidly between plants and can be disturbed by the survey activity. Plants where pollinators were frequently observed included common milkweed, birdsfoot trefoil, broad-leaved sweet pea and New England aster.

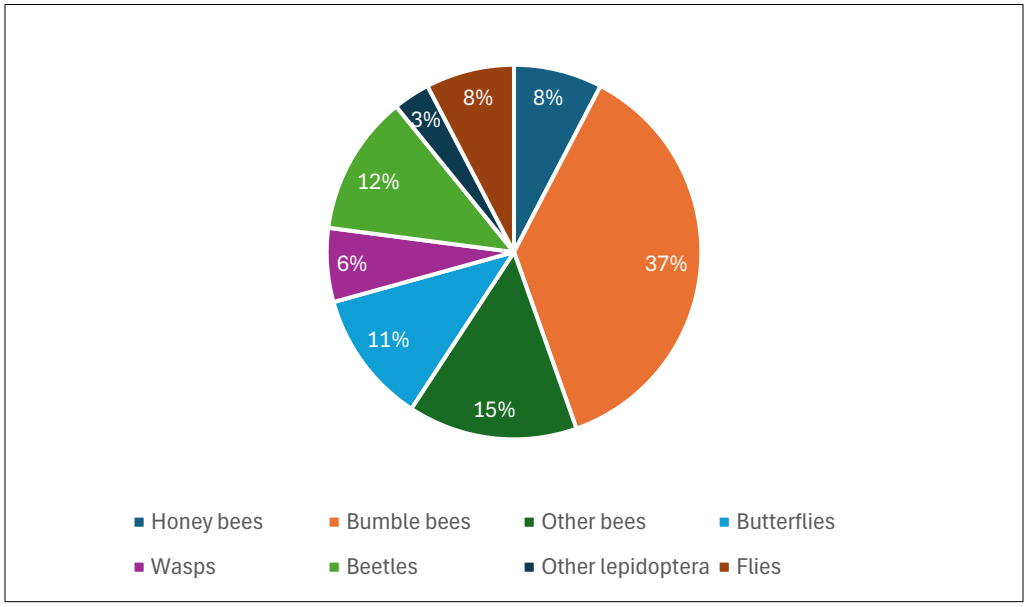

Fig. 3.15. Distribution of presence scores according to insect pollinator groups observed in sample plots for all conservation areas visited from May to August 2023.

3.4 Pollinator Habitat: 2024 Survey

In 2024, the pollinator habitat survey indicated that 65% of sample plots (56 plots) met the CCAA nectar plant 10% cover threshold out of 86 sample plots surveyed from May to August 2024. Most of the 56 plots that had more than 10% nectar plant land cover were found in the Eastern CT Uplands and CT Valley ecoregions (Fig. 3.16). Nectar plants present in at least two different sample plots are presented in Figs. 3.17 - 3.20. Some of the nectar plants with higher median percent cover included birdsfoot trefoil, alfalfa, annual fleabane, hop trefoil or hop clover, horseweed, vetch and swamp dewberry.

Insect pollinators were scored as to whether they were observed within the sample plots. This was a categorical present/absent scoring and individual insects were not counted. Across all sample plots with pollinator observations, the most common group was lepidoptera (Fig. 3.21).

These results only indicate the pollinator groups observed on plants on the instant of survey visits and are not meant to indicate population levels or overall status of pollinator communities. Plants where pollinators were frequently observed included birdsfoot trefoil, red clover, Queen Anne's lace, common yarrow, sweet clover, vetch and annual fleabane.

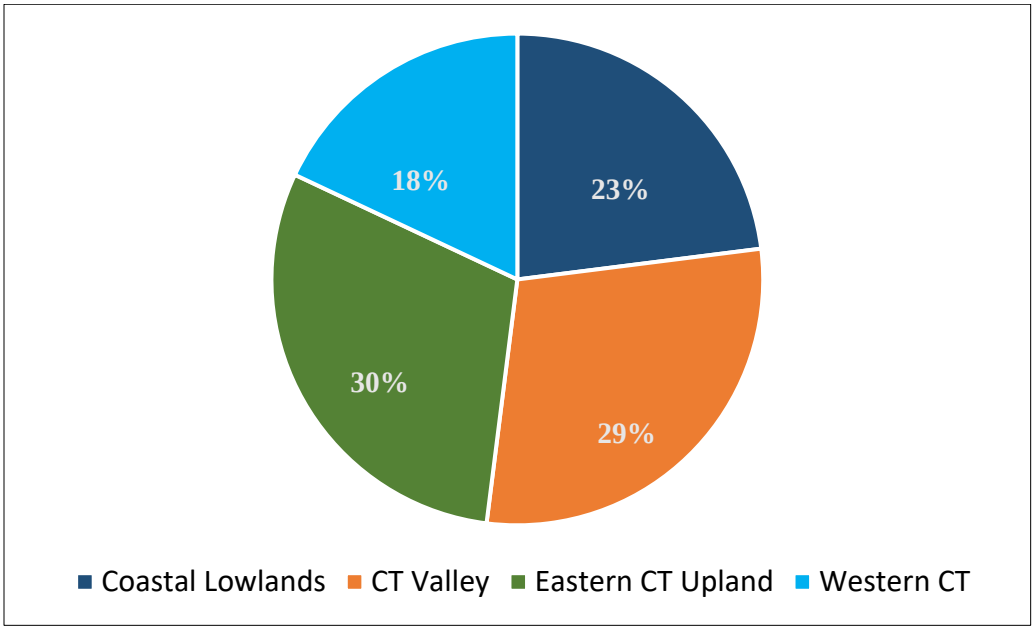

Figure 3.16. Distribution across ecoregions of 56 sample plots in conservation areas that had 10% or more cover of nectar plants present in plots.

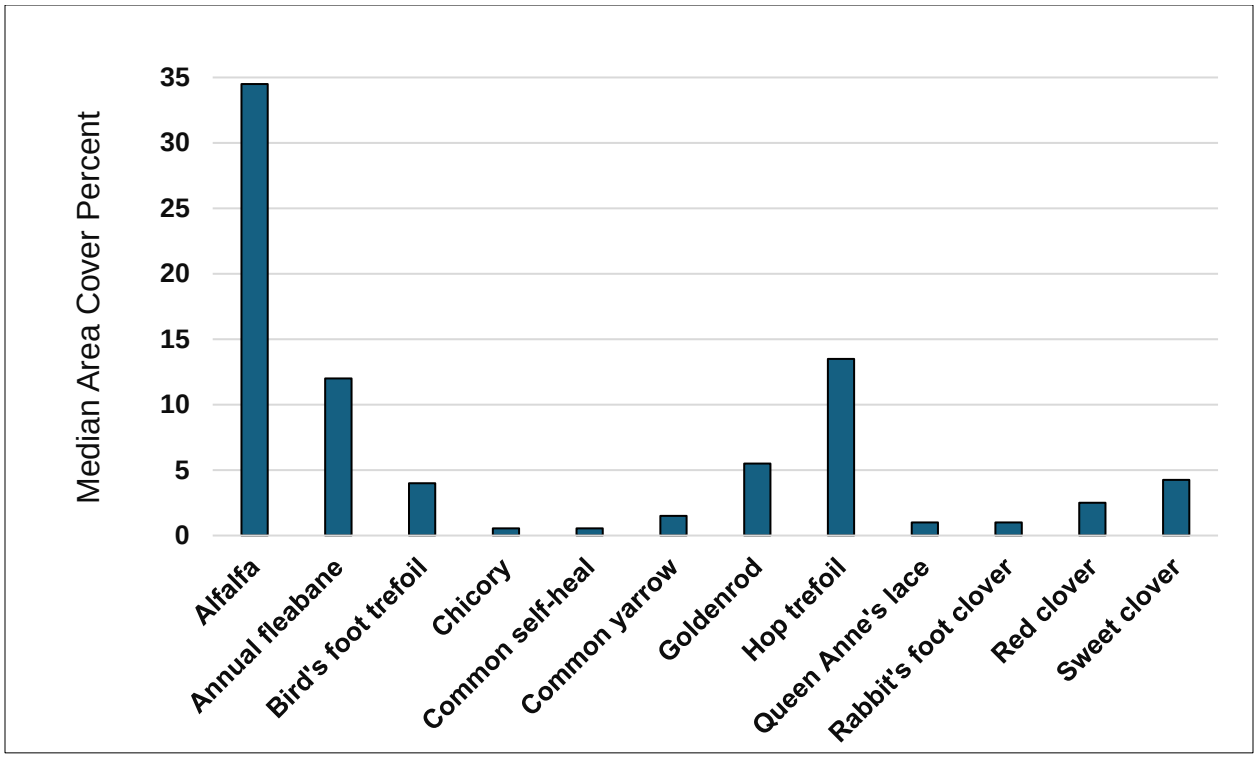

Fig. 3.17. Median percent cover observed for each plant species across all sample plots visited from May to August 2024 in Coastal Lowlands ecoregion conservation areas.

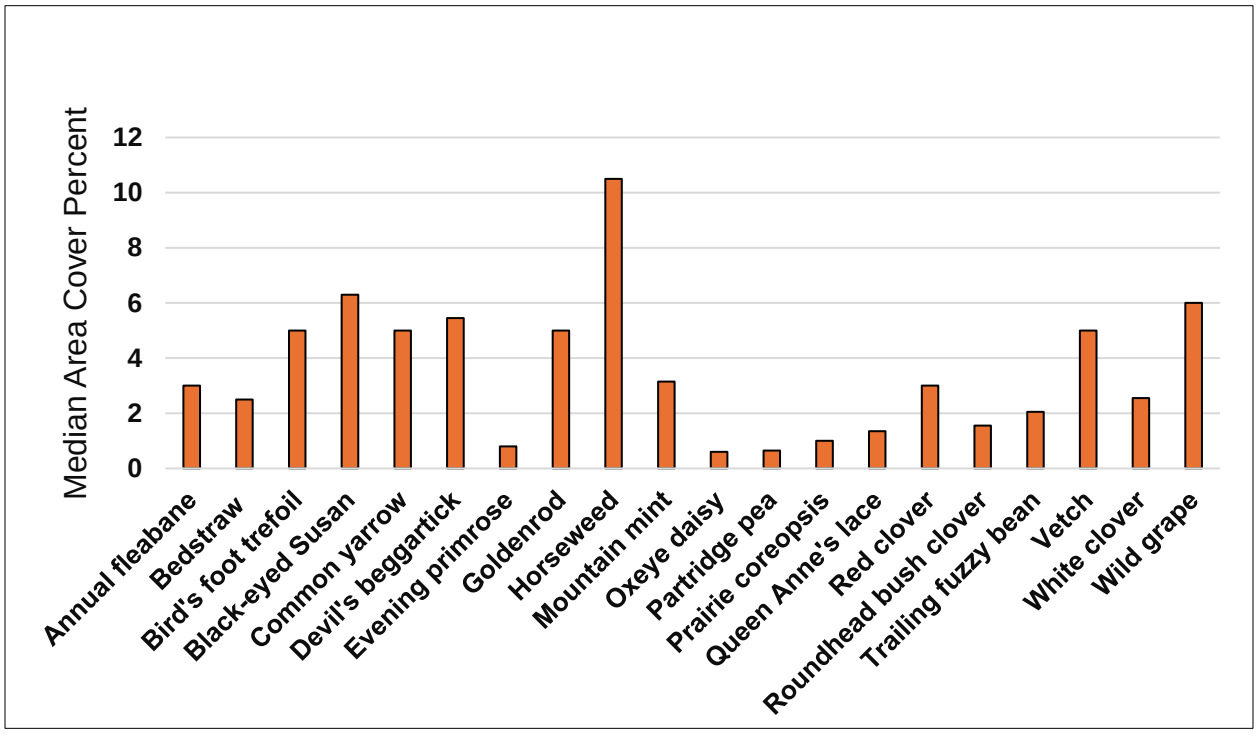

Fig. 3.18. Median percent cover observed for each plant species across all sample plots visited from May to August 2024 in CT Valley ecoregion conservation areas.

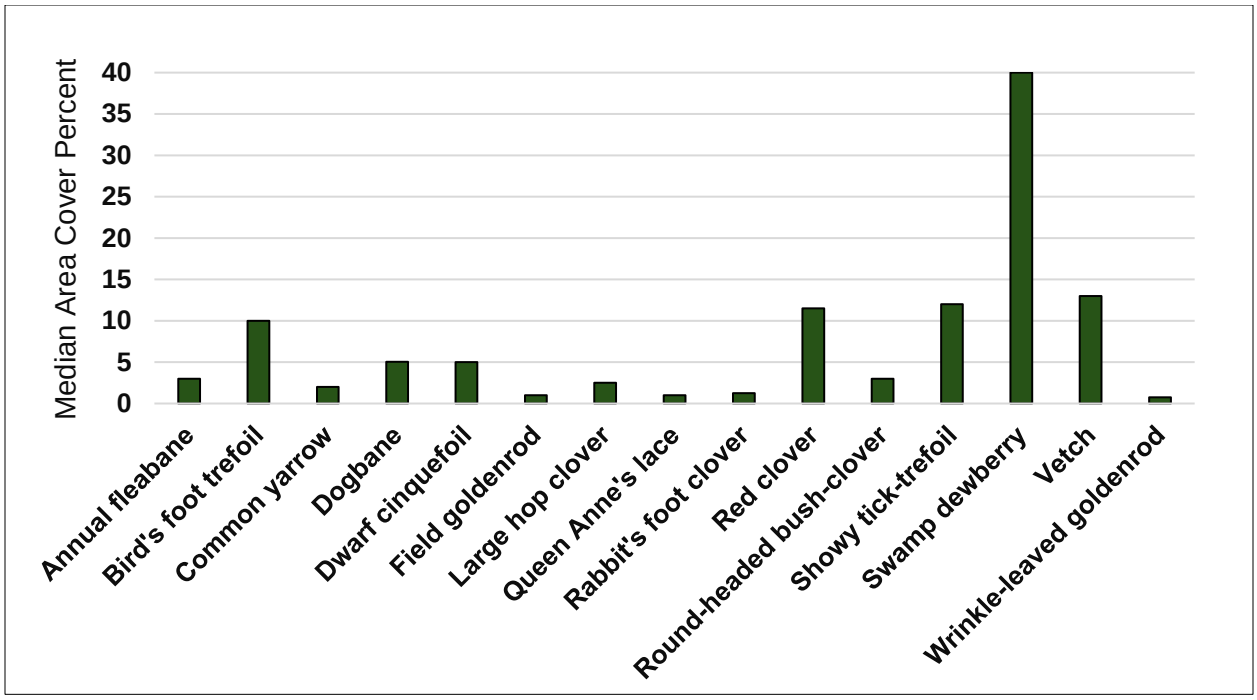

Fig. 3.19. Median percent cover observed for each plant species across all sample plots visited from May to August 2024 in Eastern CT Upland ecoregion conservation areas.

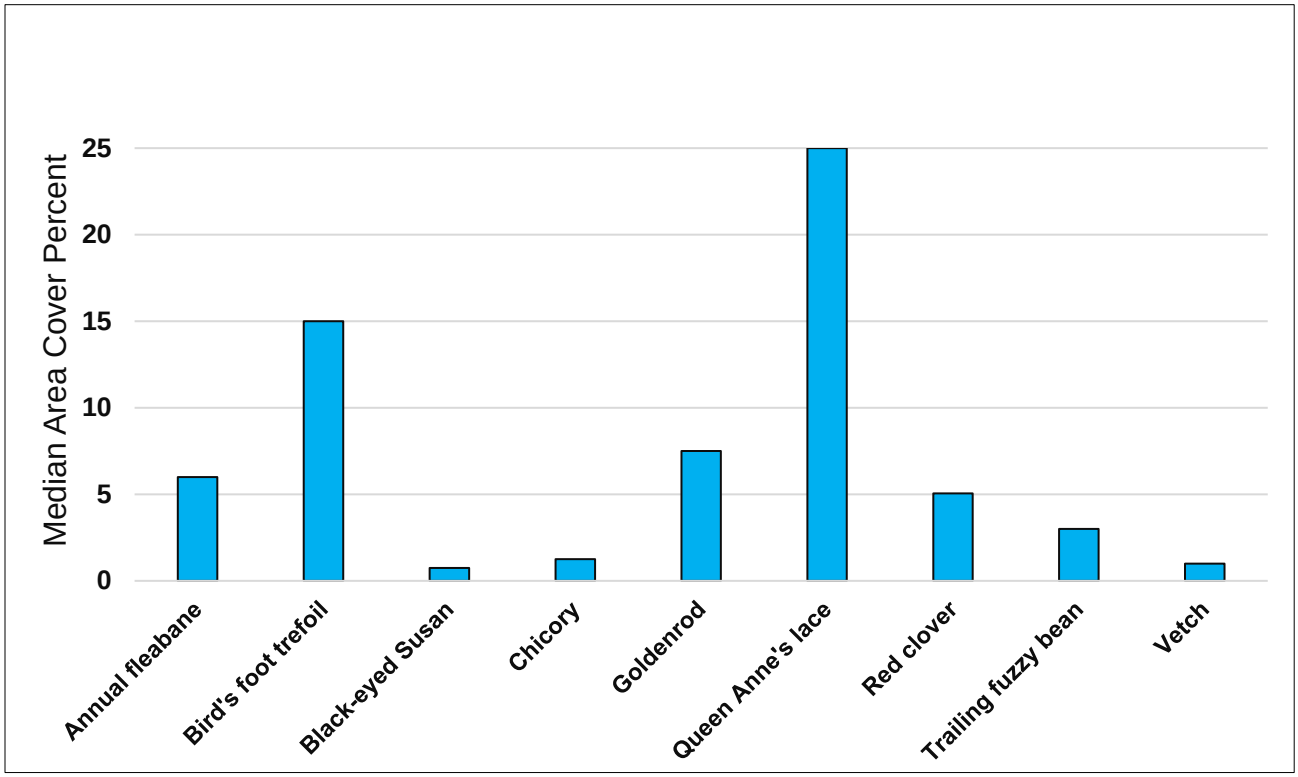

Fig. 3.20. Median percent cover observed for each plant species across all sample plots visited from May to August 2024 in Western CT ecoregion conservation areas.

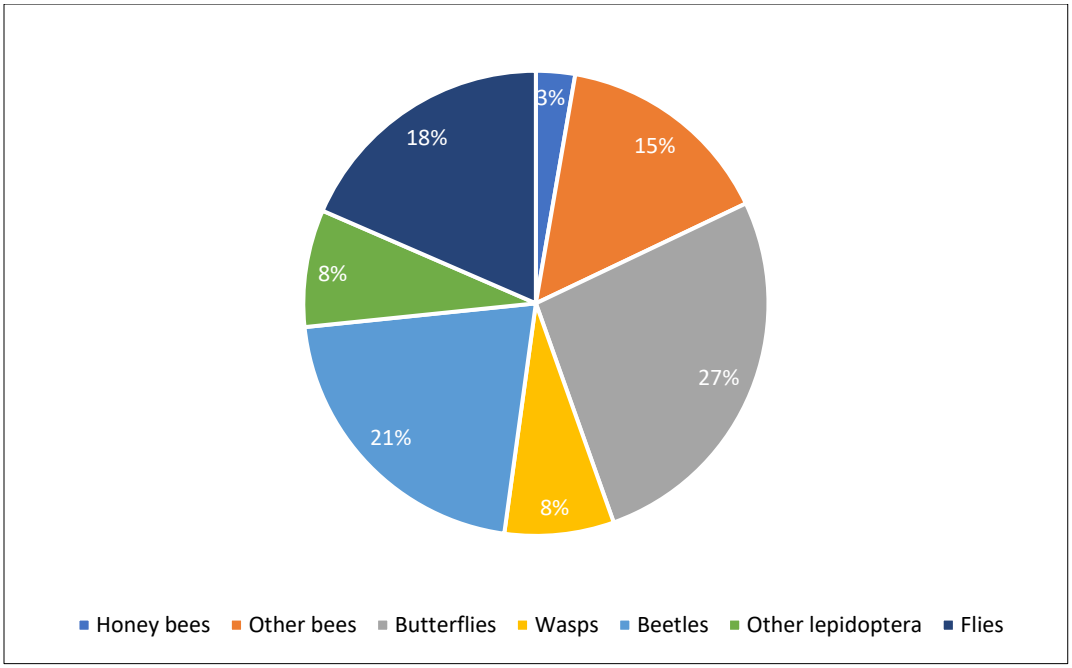

Fig. 3.21. Distribution of presence scores according to insect pollinator groups observed in sample plots for all conservation areas visited from May to August 2024.

3.5 Invasive plant presence in conservation areas

2023 Survey

Invasive plants were recorded as part of the habitat survey data collection. Percent land cover for each invasive plant species was estimated in the sample plots. Invasive plants were determined according to the CT Invasive Plant List (2024). Spotted knapweed was the dominant invasive species in three out of four ecoregions followed by multiflora rose, autumn olive and mugwort. The ranking, based on percent land cover of sample plot, of invasive plants differed between ecoregions (Table 3.5). None of the invasive plants had more than 50% land cover in the sample plots.

2024 Survey

In 2024, invasive plants were recorded, and a ranking based on land cover was developed as described above. Spotted knapweed, mugwort and multiflora rose were among the most common in the two top ranks across the ecoregions (Table 3.6). None of the invasive plants had more than 50% land cover in the sample plots.

Table 3.5. Rank of invasive plants recorded in 2023 in sample plots within conservation areas. Rank is based on percent land cover of each plant present in sample plots.

Ecoregion	Invasive or NOX weed	Rank
Coastal Lowlands		
	Spotted knapweed	1
	Cypress spurge	2
	Mugwort	3
	Multiflora rose	3
	Autumn olive	4
	Red sorrel	5
	Callery pear	6
	Oriental bittersweet	7
	Tree of heaven	7
CT Valley		
	Spotted knapweed	1
	Callery pear	2
	Canada thistle	2
	Multiflora rose	3
	Purple loosestrife	4
	Glossy buckthorn	5
	Honeysuckle sp.	6
	Oriental bittersweet	6
Eastern CT Upland		
	Spotted knapweed	1
	Multiflora rose	2
	Autumn olive	3
	Red sorrel	4
	Purple loosestrife	5
	Morrow's honeysuckle	6
	Cypress spurge	7
Western CT		
	Purple loosestrife	1
	Multiflora rose	2
	Autumn olive	3
	Mugwort	4
	Spotted knapweed	4
	Oriental bittersweet	5
	Meadow campion	5

Table 3.6. Rank of invasive plants recorded in 2024 in sample plots within conservation areas. Rank is based on percent land cover of each plant present in sample plots.

Ecoregion	Invasive or NOX weed	Rank
Coastal Lowlands		
	Spotted knapweed	1
	Mugwort	2
	Purple loosestrife	3
	Meadow campion	4
	Autumn olive	5
	Callery pear	5
	Multiflora rose	5
CT Valley		
	Mugwort	1
	Spotted knapweed	2
	Callery pear	3
	Oriental bittersweet	4
	Autumn olive	5
	Multiflora rose	5
	Purple loosestrife	5
	Cypress spurge	6
Eastern CT Upland		
	Spotted knapweed	1
	Multiflora rose	2
	Oriental bittersweet	3
	Callery pear	4
	Sheep's sorrel	4
	Mugwort	5
Western CT		
	Mugwort	1
	Spotted knapweed	2
	Purple loosestrife	3
	Callery pear	4
	Oriental bittersweet	4
	Sheep's sorrel	4
	Tree of heaven	5

CHAPTER 4
Conclusions, Recommendations and Suggested Research

4.1 Conclusions

Since 2018, CTDOT has implemented best management practices such as reduced mowing and late season mowing (mowing after October 15) in designated conservation areas. The pollinator habitat survey project was initiated in 2023 to address the effectiveness of these management practices. Data collected through the project was also meant to assist in CTDOT efforts of participation in the CCAA. The CCAA may help mitigate future endangered species requirements that may restrict the CTDOT's construction and maintenance activities in the future in exchange for directed conservation efforts on enrolled acres. The data collected addressed the following questions:

1. Do the conservation areas provide milkweed and nectar resources across the growing season?
2. Do the conservation areas meet thresholds outlined in the Candidate Conservation Agreement with Assurances (CCAA) for the monarch butterfly?

In regard to the first question, habitat survey results showed that milkweeds and other nectar plants were available throughout the season for most of the conservation areas. Milkweed stems were present in the third week of May and only continued to increase in number throughout the season in conservation areas where they were present. The diversity of nectar plants observed also supported the availability of nectar sources through the season. For example, birdsfoot trefoil was blooming in the third week of May and continue through August. Similarly, common yarrow was blooming in May and June while early goldenrod was blooming in July and August. Sixty three percent of sample plots evaluated met the CCAA threshold for nectar plant cover in 2023 and 65% of sample plots met the threshold in 2024. Reduced mowing regimes, like annual mowing in late fall, improve native plant communities that sustain many ecosystem services. Entsminger et al. (2017) reported that reduced mowing increased native grasses and wildflower species along roadsides. Mowing in late fall allows plants to reach maturity and produce seed. Reduced mowing also results in less fuel costs and pollution.

Some areas have low diversity of flowering plants but are still effective for some pollinators. One example is the CA-26 conservation area where azure bluet (*Houstonia caerulea* L.) is found in a sizable proportion of the conservation area. While this wildflower is very small, its value is great as a host plant for the spotted thyri moth (*Thyris maculata*) and as nectar source for long-tongued flies and small bees (Wyatt and Hellwig 1979).

On the second question, over 65% in 2023 and 57% in 2024 of conservation areas met the CCAA milkweed threshold. As expected, the areas where monarchs were observed (eggs, larvae or adults) had most or all of their sample plots meeting the milkweed habitat effectiveness threshold. There are differences in how abundant milkweeds are in each conservation area that has them but with protection, one would expect the number of stems to increase over time. Some conservation areas have high numbers of milkweed stems as shown in Figs. 3.2 and 3.6. Overall, over half of the conservation areas are effective in meeting the habitat requirements specified by

the CCAA and that will facilitate CTDOT participation in that program. Further work is required to determine how to improve other areas that did not meet the thresholds during the survey period.

4.2 Recommendations and Suggested Research

While many conservation areas have healthy populations of swamp and common milkweed, there are other areas that have only mowed grass as the main ground cover. A review of their vegetation management and their soil quality (i.e., salinity, compaction, soil type, other pollutants) should be a first step in evaluating how to improve these areas. The areas that did not meet the CCAA thresholds are listed in Appendices A and B. Further research into the management and monitoring of these areas will help ascertain whether they continue to be included as a conservation area. Perhaps, these areas are early in their trajectory of ecological succession and further monitoring will be beneficial. However, some areas may have environmental constraints that must be identified before attempting remediation. In addition to physical limitations, conservation areas are also facing biological threats in the form of invasive plants. Invasive plants like spotted knapweed, mugwort, multiflora rose, autumn olive and noxious weeds like poison ivy are present in conservation areas. Invasive plant and noxious weed management needs to be a priority, especially for those areas where milkweeds are beginning to thrive. This report identified the most common invasive plants present in conservation areas and the next step will be to define management plans for them. The survey data files that accompany this report note the invasive plant species found in each conservation area.

An important topic to address is the presence of monarchs (eggs, larvae) in conservation areas. The egg densities observed fall well within or even at higher numbers in comparison to previous studies. One concern though, is that there are areas where few monarchs were found despite large milkweed stem counts. Several explanations can account for this. As mentioned earlier, monarch butterflies experience high mortality rates of over 90% in the egg and larval stages (Oberhauser 2004). Yearly natural variation due to predation, weather extremes and pollution can be at play. Researchers have reported drastic differences in egg numbers from one year to the next, changing from a total of 36 to 437, for eggs counted over a whole season (Knigth et al. 2019). Another possible explanation is a mismatch in terms of monarchs searching for egg-laying sites and availability of preferred egg-laying sites for the females.

Previous studies have documented a preference for taller plants in small low-density milkweed areas. However, monarch butterflies also prefer to lay eggs on younger shoots (Knigth et al. 2019). Therefore, it has been suggested that mowing milkweeds once before the peak egg-laying period could increase the number of eggs per stem by providing younger regrown milkweeds. While this approach has potential benefits, the authors proposing it also caution about the need to time it carefully. The mowing period needs to be timed according to the local milkweed species phenology. Moreover, they also stress the need to not mow some milkweed patches as to leave egg-laying substrate while the mowed milkweeds regenerate (Fischer et al. 2015, Knight et al. 2019). If CTDOT is to consider this approach, it is strongly recommended that further study be done to evaluate potential gains and to set the proper local timing for mowing in relation to local

milkweed and monarch phenology. Most importantly, conservation area managers will need to strictly use the correct timing and to leave patches of mature milkweed without mowing. If the milkweeds are mowed too late in the summer, they will not have time to provide oviposition substrate or to flower again and set seed pods (Fischer et al. 2015).

Lastly, it is recommended that all conservation areas be visibly identified as such. Most areas visited during this survey did not have a sign and it is imperative that all areas be clearly marked. Within safety limits, signs need to be larger than what they are now, or a second sign could be added to the existing ones. Signs need to more visibly state that these are CTDOT Conservation Areas rather than just say Conservation Area with a small logo. The signs will help educate the public about the efforts and alert staff about the areas and their reduced mowing maintenance. This will also help with preventing unintended mowing or preventing third-party contractors from using the conservation areas to park heavy equipment or for staging construction materials.

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Appendix A

Number of sample plots meeting the CCAA milkweed stem threshold and total number of sample plots per conservation area in the 2023 survey

Ecoregion	Conservation Area ID	Town/City	Designation Year	Number of sample plots at CCAA threshold	Total number of sample plots
Coastal Lowlands	CA - 113	Old Saybrook	2017	1	4
Coastal Lowlands	CA - 93	Branford	2019	1	1
Coastal Lowlands	CA - 92	Madison	2019	3	4
Coastal Lowlands	CA - 109	Trumbull	2019	1	3
Coastal Lowlands	CA - 158	Clinton	2021	0	3
Coastal Lowlands	CA - 163	Guilford	2021	2	3
Coastal Lowlands	CA - 157	Westbrook	2021	0	3
Coastal Lowlands	CA - 177	Stonington	2022	0	3
CT Valley	CA - 70	Glastonbury	2019	2	3
CT Valley	CA - 15	New Britain	2019	4	4
CT Valley	CA - 50	Southington	2019	4	4
CT Valley	CA - 43	Wethersfield	2019	0	2
CT Valley	CA - 77	Rocky Hill	2020	3	4
CT Valley	CA - 58	Middletown	2020	3	3
CT Valley	CA - 145	Windsor	2021	2	4
Eastern CT Upland	CA - 103	Griswold	2019	0	4
Eastern CT Upland	CA - 23	Mansfield	2019	0	4
Eastern CT Upland	CA - 17	Tolland	2019	3	4
Eastern CT Upland	CA - 36	Lebanon	2020	0	4
Eastern CT Upland	CA - 39	Plainfield	2020	1	3
Eastern CT Upland	CA - 41	Colchester	2020	0	3
Eastern CT Upland	CA - 180	Norwich	2022	0	2
Eastern CT Upland	CA - 175	Putnam	2022	2	4
Western CT	CA - 84	Newtown	2017	0	1
Western CT	CA - 81	Brookfield	2019	2	4
Western CT	CA - 79	Danbury	2019	2	4
Western CT	CA - 123	Danbury	2019	3	4
Western CT	CA - 82	Newtown	2019	4	4
Western CT	CA - 167	Danbury	2021	n.a	n.a.
Western CT	CA - 169	Southbury	2021	1	4

Appendix B

Number of sample plots meeting the CCAA milkweed stem threshold and total number of sample plots per conservation area in the 2024 survey

Ecoregion	Conservation Area ID	Town/City	Designation Year	Number of sample plots at CCAA threshold	Total number of sample plots
Coastal Lowlands	CA - 213	Branford	2024	3	3
Coastal Lowlands	CA - 195	Bridgeport	2023	0	3
Coastal Lowlands	CA - 190	Milford	2023	0	3
Coastal Lowlands	CA - 92	Madison	2019	3	3
Coastal Lowlands	CA - 96	New Haven	2019	1	1
Coastal Lowlands	CA - 156	Old Saybrook	2021	0	3
Coastal Lowlands	CA - 178	Stonington	2022	0	1
Coastal Lowlands	CA - 179	Waterford	2022	0	3
CT Valley	CA - 134	Cromwell	2020	0	3
CT Valley	CA - 194	East Hartford	2023	2	3
CT Valley	CA - 97	Hamden	2019	0	3
CT Valley	CA - 146	Hartford	2021	2	3
CT Valley	CA - 50	Southington	2019	3	3
CT Valley	CA - 172	Manchester	2022	2	3
CT Valley	CA - 141	Windsor Locks	2021	0	3
CT Valley	CA - 145	Windsor	2021	3	3
Eastern CT Upland	CA - 40	Colchester	2020	0	3
Eastern CT Upland	CA - 150	Lisbon	2021	0	3
Eastern CT Upland	CA - 26	Mansfield	2019	0	3
Eastern CT Upland	CA - 17	Tolland	2019	3	3
Eastern CT Upland	CA - 57	Middletown	2020	3	3
Eastern CT Upland	CA - 161	Norwich	2021	0	3
Eastern CT Upland	CA - 29	Windham	2019	0	3
Western CT	CA - 124	Danbury	2019	3	3
Western CT	CA - 80	Danbury	2019	2	3
Western CT	CA - 79	Danbury	2019	3	3
Western CT	CA - 123	Danbury	2019	2	3
Western CT	CA - 168	Danbury	2021	1	3
Western CT	CA - 82	Newtown	2019	3	3
Western CT	CA - 169	Southbury	2021	3	3